Sabina
GOLD & SILVER CORP.

# The BACK RIVER PROJECT

## Terrestrial Environment

## Volume 5

Prepared by:

Rescan™
an ERM company

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# Back River Project Fact Sheet

December 2013

## Location

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

## Reserves

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

## Site Preparation and Construction Phase

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

## Operational Phase

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

## Production

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

## Processing

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

## Transport

- Gold doré bars shipped out by aircraft

## Access Roads

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

## Re-supply

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

## Environment

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

## Employment

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

## Social and Economic Benefits

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

## Closure and Post-closure Phase

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

# BACK RIVER PROJECT

# DRAFT ENVIRONMENTAL IMPACT STATEMENT
# Supporting Volume 5:
# Terrestrial Environment

**December 2013**
Project #0194096-0040

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**Prepared for:**

Sabina Gold & Silver Corp.

**Prepared by:**

Rescan Environmental Services Ltd., an ERM company
Vancouver, British Columbia

# Executive Summary

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# Executive Summary

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

The scoping of potential Valued Ecosystem Components (VECs) involved Sabina-led public consultations, the use of Traditional Knowledge (TK), regulator consultations and regulatory considerations such as conservation status of species or groups, and recommendations presented in the NIRB EIS guidelines (NIRB 2013). The *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project Report* (KIA 2012) was consulted extensively for TK information. Based on these sources, the following terrestrial components were selected as VECs: vegetation and special landscape features, caribou, grizzly bear, muskox, wolverine and furbearers, migratory birds, and raptors. Geology, permafrost, and landforms and soils were considered Subjects of Note and all required information noted in the EIS guidelines is included in this volume.

Potential effects on terrestrial and wildlife VECs were evaluated spatially within a Local Study Area (LSA) and a larger Regional Study Area (RSA). The terrestrial LSA covered 1,344 $km^2$ and included the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively, the MLA PDA, the winter roads connecting the Goose, George, and MLA PDAs, and a buffer (1 to 1.5 km) surrounding the outer boundary of the PDAs and roads. The terrestrial RSA encompasses the LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three PDAs and covers approximately 12,620 $km^2$. All potential Project effects were assessed during the Site Preparation, Construction, Operations, Reclamation and Closure, and Post-closure Project phases, with a focus on a "worst-case" scenario approach whereby the phase or phases with the largest effect on the VEC are discussed. Specific legislation was considered during the assessment, including the *Species at Risk Act* (SARA), the *Migratory Birds Convention Act*, and the *Nunavut Wildlife Act*.

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

Geology

The Goose and George PDAs are located over the northeastern corner of the Slave and Churchill Geologic Provinces. The Marine Laydown Area (MLA) is underlain by Lower to Middle Proterozoic sedimentary rocks of the Kilohigok Basin, part of the Bear Geologic Province. Glacial material deposited after the Quaternary Wisconsin Glaciation covers much of the Archean Geological Provinces.

Glacial deposits are predominantly comprised of moraine type deposits (glacial till), which mostly consist of sand and variable amounts of silt. The Goose and George Properties consist of a package of variably folded and faulted sedimentary rocks. Greywacke and subordinate mudstone surround and variably interbed with silicate banded iron formation and oxide banded iron formation. The sedimentary package is cross-cut by mafic dikes, lesser volumes of felsic dikes, and volumetrically insignificant quartz veins. Gold mineralization is most often associated with sulphide minerals, particularly arsenopyrite, and visible gold is found almost exclusively in zones with abundant arsenopyrite. Other sulphide minerals (pyrite and pyrrhotite) are typically enriched in a halo in the banded iron formation and greywacke around the arsenopyrite-rich ore zones. The mafic dikes have very low sulphide contents and are devoid of gold mineralization.

Permafrost

The Project is located within the continuous permafrost region of western Nunavut. A seasonally thawed active layer is present immediately beneath ground surface, with a mean maximum depth of approximately 2 m. Subsurface temperatures are perennially below 0 $^{0}$C at depths up to approximately 500 m below ground surface, except beneath some surface waterbodies. Open taliks are present beneath surface waterbodies with depths exceeding 1.3 m. Through taliks that connect to the deep groundwater are inferred to be present beneath waterbodies with widths greater than 200 m and 350 m at the Goose and George Property Area PDAs, respectively. Cryopegs are inferred to be present at the base of the permafrost and adjacent to deep talik, as the groundwater beneath the permafrost has been shown to be hyper-saline. The basal cryopeg at the Goose Property Area is estimated to be 100 m thick.

Landforms and Soils

The Project is located in an area dominated by gently undulating or rolling landscapes with numerous kettle lakes connected by streams. Terrain elevation ranges between 300 and 700 metres above sea level (masl) and slope gradients rarely exceed 7%. Uplands are typically covered by morainal materials (44% of the total PDA) deposited on Precambrian, sedimentary, metamorphic or intrusive rocks. Glaciofluvial (9.5%), organic (6.5%), marine (5.1%), and lacustrine (3%) deposits are less common. Exposed bedrock occurs over 5.2% of the PDA. The thickness of mineral soils overlaying bedrock (overburden) is the highest in plains and very gently sloping areas (avg. 10.6 m) and decreases in rolling and undulating landscapes (avg. 4.8 m).

A number of distinct landform types, including eskers, morainal rocky ridges, and boulder fields exist throughout the terrestrial RSA. Cold climate is also associated with several soil phenomena. Thermokarst typically occurs in wetlands as a system of very irregular hummocks and hollows, which form as a result of frost heaving and ice accumulation on the bottom of organic horizons. Frostboils are typically circular (1 to 3 m in diameter) upwellings of mud that are created by frost heaving. The Project is located within continuous permafrost. The presence of permafrost and annual cycles of freezing and thawing results in poor development of soils. About two-thirds of the inspected soils have been classified as Static Cryosols and one-third as Turbic Cryosols.

Baseline soil samples were collected at 51 sites within the LSA and 20 sites outside of the LSA but within the RSA in 2012. Most soils have a low proportion of coarse fragments (below 30%) and low surficial stoniness (below 15%). Most soils are moderately coarse (loam, sandy loam, fine sandy loam). Mineral soils in the terrestrial RSA are predominantly acidic (median pH is 5.9, range from 4.7 to 6.8). While in general soil metal concentrations in the LSA do not exceed CCME guidelines, arsenic levels can be naturally-elevated (greater than CCME soil guidelines for industrial use) within the George PDA.

Vegetation and Special Landscape Features

Terrestrial ecosystem mapping (TEM) and rare plant surveys were conducted in 2012 within the 134,370 ha vegetation and terrestrial wildlife LSA. Vegetated ecosystems, constituting 73% of the LSA, are dominated by mesic tundra, dry-sparse tundra, and moist shrub-dominated tundra. The mesic tundra association, comprising nearly one-third of the LSA, is characterized by extensive areas dominated by dwarf woody shrub species, with a highly variable component of herbs, graminoids, mosses, and lichens. Sparsely-vegetated ecosystems, constituting nearly 9% of the total LSA, typically occur on thin morainal veneers or exposed bedrock, windswept esker crests, blocky tundra, marine beaches and other barren sites that limit vegetation establishment. Non-vegetated ecosystems, constituting approximately 18% of the LSA, are dominated by freshwater lakes and ponds. Special landscape features, identified for their importance as wildlife habitat or potential to support rare plant species, include esker complexes, cliffs, bedrock outcrop and lichen-dominated ecosystems, riparian ecosystems, wetland ecosystems, and marine beaches and old beach heads. A total of 890 plant species identifications were made during the TEM and rare plant field surveys within the LSA and RSA. The largest species group in the identified flora is that of the vascular plants, followed by the macrolichens. Ninety rare plant species were identified and were mainly found close to the shoreline of Bathurst Inlet throughout the LSA and RSA. No invasive plant species were found in the LSA during the 2012 field surveys.

Potential Project effects on the VEC vegetation and special landscape features included the direct loss or degradation of vegetation or special landscape features. These potential effects were characterized by using the indicators diversity, productivity, and resiliency. The mitigation and management measures designed to eliminate or minimize potential Project effects on vegetation and special landscape features include: minimizing the Project footprint, using winter roads, and reducing fugitive dust where possible.

Following the application of mitigation and management measures, two residual effects were identified: vegetation loss, and special landscape feature loss. These residual effects are a result of the assumption that the entire PDAs would be lost. In reality, the area of vegetation/special landscape feature loss will be much less as it will be confined to the final footprint of the Project. The magnitude of the anticipated residual effects is expected to be low, the duration long term, the frequency is once but continuous/permanent, and the residual effects would be confined to within the Project footprint (PDA). The residual effects were assumed to be irreversible; however there may be some recovery after closure. Contingent on the implementation of mitigation measures outlined in the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17) and the Site Water Monitoring and Management Plan (Volume 10, Chapter 7), the significance of residual effects for vegetation and special landscape features is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. The reasonably foreseeable Hackett River Project and Bathurst Inlet Port and Road (BIPR) project would each have spatial and/or temporal overlap with the terrestrial RSA. In addition to the Project residual effect of vegetation loss within the PDAs, an estimated 370 hectares of cumulative nibbling loss within the terrestrial RSA could result from development of infrastructure and roads associated with the proposed Hackett River Project and BIPR Project. The magnitude of the anticipated cumulative effect is expected to be low (less than 1% of the RSA), the duration long term, the frequency is once but continuous/permanent, and the cumulative effect would be confined to within the project footprints of each project. The significance of the residual cumulative effect (vegetation loss) for the VEC vegetation and special landscape features is predicted to be **Not Significant**. The Project residual effects and cumulative effects were confined to the PDA and the project footprints of

potential future projects within the RSA. These areas reside entirely within Nunavut, so there was no potential for transboundary effects.

Caribou

There are three barren-ground caribou herds whose ranges overlap with the terrestrial RSA. Satellite collaring data indicate that the Bathurst herd is found in the western portion of the terrestrial RSA primarily during post-calving period, and the Beverly herd (formerly the Ahiak herd) is found in the terrestrial RSA, primarily during the late-summer and early-fall. Results of aerial surveys conducted between 2001 and 2010 and the use of remote motion-triggered cameras in the RSA and adjacent and west of the RSA confirm results of satellite collar data. The winter distribution of Dolphin and Union caribou likely overlaps the marine RSA to a small extent during the winter. The Dolphin and Union herd is SARA-listed as a species of special concern while the Bathurst herd and the Beverly herd have not been assessed by COSEWIC.

Recent evidence suggests that over-winter survival may be related to forage conditions on the post-calving and summer ranges. High leaf biomass, early start date and late end date of green leaf biomass, and high quality of leaf biomass in these ranges are generally believed to be beneficial to caribou growth and pregnancy rates during the summer-fall period and calf:cow ratio in the next year. Habitat suitability modeling in the terrestrial RSA indicate that there is a fair amount of high-quality habitat for caribou during the calving (52%), post-calving and summer (86%), and fall (59%) periods although it should be noted that the Bathurst and Beverly caribou are not present in the RSA during all seasons. Results of resource selection function modeling on the Bathurst herd post-calving and summer ranges indicate that the regions around Contwoyto and Nose lakes (which are located over 100 km and 60 km away from the RSA, respectively) and around large rivers were areas that were heavily used by caribou. Across the post-calving range, Bathurst caribou tended to select for highly productive areas and avoided barren and sparsely vegetated cover types, as well as prostrate dwarf shrub and tussock graminoid areas. During summer, areas with low-lying vegetation such as barren and sparsely vegetated areas were selected for while wetter areas, such as wetlands and moist non-tussock graminoid tundra cover types, were avoided.

Potential Project-related effects on the VEC caribou included Project activities that could alter the following indicators: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimization of Project footprint, noise abatement measures, speed control measures, the use of winter roads, waste management and chemical handling measures to avoid attracting wildlife to waste and avoid exposure to contaminants, and the implementation of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Following the application of mitigation and management measures, three residual effects were identified: habitat loss, disturbance due to noise, and reduction in reproductive productivity. The magnitude of all three of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the Project footprint which would be long term. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss, the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for caribou is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted (habitat loss, disturbance, reduction in reproductive productivity). The geographical boundary used for the potential cumulative effects assessment was based on the post-calving and summer seasonal ranges of the Bathurst herd and the summer and winter ranges of the Beverly herd, and included areas within Nunavut and the Northwest Territories. As outlined in the EIS guidelines (NIRB 2013a), the Minister of Aboriginal Affairs and Northern Development Canada highlighted the importance of the Bathurst herd caribou in the region and identified the need to conduct a cumulative effects assessment for this herd (letter dated December 17, 2012). There were 10 possible projects (including 4 potential future projects) that could act cumulatively with Project residual effects within the Bathurst herd cumulative assessment area, and 5 possible projects (including 3 potential future projects) that could act cumulatively with Project residual effects within the Beverly herd cumulative assessment area.

In order to support the potential cumulative effects assessment for caribou, a broad-scale Resource Selection Function model was developed for the Bathurst caribou herd on their post-calving and summer ranges. Results of this model were used to determine where caribou are typically found in their ranges, and what types of habitat they use while on these ranges. The model was also used to derive habitat quality ratings for vegetation to determine the extent of cumulative habitat loss and disturbance to Bathurst caribou on their foraging ranges and the remaining predicted condition of these foraging areas, which have been linked to overwinter calf survival. The magnitude of all three of the residual cumulative effects on both caribou herds is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprint, sporadic in nature, confined to local areas for habitat loss and noise disturbance, and potentially the cumulative study area for reduction in reproductive productivity. The residual cumulative effects are also anticipated to be reversible with the possible exception of habitat loss within specific areas of the project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of residual cumulative effects for caribou is predicted to be **Not Significant**.

The cumulative effects assessment spatial boundary included a portion of the Northwest Territories for both the Bathurst herd and the Beverly herd. As such, the potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant.**

Grizzly Bears

Barren-ground populations of grizzly bears are federally listed as species of “Special Concern” (SARA; COSEWIC 2012) and are listed as Sensitive in Nunavut (CESCC 2010). Mark-recapture DNA baseline studies conducted in 2012 identified a total of 61 grizzly bears in the RSA and an additional 62 bears were detected in an identically-sized study area directly west of the RSA. Twelve bears overlapped both the RSA and the area to the west. The average distance travelled by these bears between May and August was 25.7 km for female bears (max 65 km), 42.5 km for male bears (max 138 km) and 32.6 km for bears travelling in family units (max 84.8 km). In spring, detections of grizzly bears mainly occurred in the eastern portion of the RSA and along major river systems. During the summer and fall, bear detections were evenly distributed throughout the RSA. Four grizzly bear dens have been recorded in the terrestrial wildlife RSA between 2007 and 2012 – two located along the Western River corridor in sandy glacial fluvial habitat and two located in moderately sloped, heath tundra habitat within approximately 20 km of the George Property Area. Habitat suitability modeling in the RSA indicates that there is between 57% and 76% high-quality habitat within the RSA during spring, summer and fall seasons, but less than 2% of high-quality denning habitat.

Potential Project-related effects on the VEC grizzly bear included Project activities that could alter the following indicators: habitat loss, disturbance due to noise (e.g., displacement from areas of habitat),

disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Winter roads were excluded from the assessment as grizzly bears are hibernating when these roads are constructed and used. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimization of Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste management and chemical handling measures to avoid attracting wildlife to waste and avoid exposure to contaminants, and the implementation of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Following the application of mitigation and management measures, four residual effects were identified: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity. The magnitude of all four of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss which will be long term within specific areas of the Project footprint, sporadic in nature, and confined to within the Project footprint for habitat loss and attraction, and the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for grizzly bear is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because four residual Project effects were predicted. The geographical boundary used for the potential cumulative effects assessment was based on a buffer around Project infrastructure using the diameter of the largest area within which a grizzly bear can range and still interact with the Back River Project. There are eleven potential projects (including four potential future projects) that could act cumulatively with Project residual effects within the cumulative assessment area. The magnitude of all four residual Project effects on grizzly bears in the cumulative effects boundary is low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprints, sporadic in nature, and confined to the local areas for habitat loss and noise disturbance, and potentially the cumulative study area for reduction in reproductive productivity. The residual effects are anticipated to be reversible with the possible exception of habitat loss within specific areas of the project footprints. Contingent on the implementation of mitigation measures outlined in the wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of cumulative effects for grizzly bear is predicted to be **Not Significant**.

The cumulative effects assessment spatial boundary included a portion of the Northwest Territories for grizzly bears and is anticipated to be the largest area that any one grizzly bear may be able to interact with the Project. As such, the potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant**.

Muskox

Muskox are large herbivores that occur at moderate to low densities across the Canadian Arctic and are valued by the Inuit as a source of food, hides, horns, and wool, as well as for the commercial export of meat. Aerial baseline surveys conducted between 2001 and 2010 indicate that muskox occur at low densities in the RSA. Muskox have been routinely observed on the low, shelving hills, to the west of Bathurst Inlet and two other herds may occur near the Project, one to the southeast of the George Property Area and another near the Goose Property Area. Habitat suitability modeling in the RSA indicates that roughly one-third of the RSA is high-quality habitat for muskox during both the foraging (summer and fall) and winter (winter and early spring) seasons.

Potential Project-related effects on the VEC muskox included Project activities that could alter the following indicators: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimization of Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste management and chemical handling measures to avoid attracting wildlife to waste and avoid exposure to contaminants, and the implementation of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Following the application of mitigation and management measures, three residual effects were identified: habitat loss, disturbance due to noise, and reduction in reproductive productivity. The magnitude of all three of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the Project footprint which would be long term. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss, the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for muskox is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted for muskox because three residual Project effects were predicted. The geographical boundary used for the potential cumulative effects assessment was based on a diameter around the Project using the longest straight line distance travelled by a radio-collared muskox in the west Kitikmeot region. There were 12 possible projects (including five potential future projects) that could act cumulatively with Project residual effects within the muskox cumulative effects assessment area. The magnitude of all three of the residual effects on muskox is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprints, sporadic in nature, and confined to local areas for habitat loss and noise disturbance, and potentially the cumulative study area for reduction in reproductive productivity. The residual effects are anticipated to be reversible with the exception of habitat loss within specific areas of the project footprints. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of cumulative effects for muskox is predicted to be **Not Significant**.

The cumulative effects assessment spatial boundary included a portion of the Northwest Territories for muskox and is anticipated to include the largest straight line distance that a muskox may be able to interact with the Project. As such, the potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant**.

Wolverine and Furbearers

Wolverines and grey wolves were selected as the representative furbearer species for the DEIS. Wolverines and wolves in Nunavut are both ranked as “Secure” (CESCC 2010), but wolverines are federally listed as a species of “Special Concern” (COSEWIC, 2003). Mark-recapture DNA baseline studies conducted for wolverine in 2012 identified a total 12 wolverine within a 1,692 $km^2$ area between the Goose and George Properties. Minimum recorded area estimates for individual wolverines ranged from 89 $km^2$ and 264 $km^2$, with an average area of 162 $km^2$. Male wolverines had slightly larger areas of use than females (166 $km^2$ versus 157 $km^2$). Habitat suitability modeling for wolverine indicates that there is approximately 44.7% high-quality habitat within the wildlife RSA. For grey wolf,

aerial denning surveys conducted between 2007 and 2013 identified eight active wolf dens located within the wildlife RSA, of which five had successfully produced pups. Habitat suitability modelling for grey wolf indicates that there is approximately 1% high-quality denning habitat within the RSA.

Potential Project-related effects on the VEC wolverine and furbearers included Project activities that could alter the following indicators: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimization of Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste management and chemical handling measures to avoid attracting wildlife to waste and avoid exposure to contaminants, and the implementation of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Following the application of mitigation and management measures, four residual effects were identified for wolverine: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity, and two residual effects were identified for wolves: habitat loss and disturbance. The magnitude of all of the residual effects for both wolverine and wolves is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the Project footprint which would be long term. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss and attraction, the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the possible exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for wolverine and furbearers is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. The geographical boundary used for the potential cumulative effects assessment was based on the movement distances defined for wolverine and wolves that interact with the Project. For wolverine this area was identical to the RSA, but also included a buffer around the TCWR connector. For wolves, this area represents the summer ranges of the Bathurst and Beverly caribou herds as wolves follow caribou for prey when they occur within range of the Project. There were three possible projects (including two potential future projects) that could act cumulatively with Project residual effects within the wolverine cumulative effects assessment area, and fifteen possible projects (including six potential future projects) that could act cumulatively with Project residual effects within the wolf cumulative effects assessment area. The magnitude of all residual effects on wolverine and furbearers is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprints, sporadic in nature, and confined to local areas for habitat loss, disturbance, and attraction, and potentially the cumulative study area for reduction in reproductive productivity. The residual effects are anticipated to be reversible with the exception of habitat loss within specific areas of the project footprints. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of cumulative effects for wolverine and furbearers is predicted to be **Not Significant**.

Wolverine that may interact with the Project are not anticipated to travel into the Northwest Territories, thus transboundary effects for wolverine are not anticipated. The cumulative effects assessment spatial boundary for wolves included a portion of the Northwest Territories. As such, the

potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant**.

Migratory Birds

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994) and the *Nunavut Wildlife Act* (2003), which prohibit destruction of bird nests when these are being used by birds, and prohibits disturbance to flocks of migratory birds. No species of migratory bird occurring in the RSA is listed as a species of conservation concern under the federal *Species at Risk Act* (SARA 2002). However, three waterbird and ten upland bird species occurring in the RSA are listed as 'Sensitive' under the CESCC designations for Nunavut (CESCC 2010). Aerial surveys for waterbirds conducted between 2007 and 2013 indicate that Canada geese accounted for 80% to 90% of all detections of waterbird species. Several large wetlands, particularly in the southeast portion of the RSA are used by geese as a migration corridor, and as moulting areas. Additionally, a key staging site was identified at a small shallow lake just outside the George Property PDA where large flocks of geese and ducks were consistently observed during both spring and fall staging surveys. Ground-based surveys for upland birds indicated that counts of upland birds (species and individuals) were highest in survey plots along the shoreline of Bathurst Inlet, relative to elsewhere in the RSA. A density estimate of 133 ± 9.8 upland bird pairs per $km^2$ was recorded in moist to wet lowland habitat, and 94 ± 6.8 upland bird pairs was recorded in dry upland habitat.

Potential Project-related effects on the VEC migratory birds included Project activities that could alter the following indicators: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimizing the Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste and chemical handling measures to avoid attracting wildlife to wastes and contaminants, and the implementation of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Following the application of mitigation and management measures, two residual effects were identified for migratory birds: habitat loss, and disturbance. The magnitude of both of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) for disturbance and long term for habitat loss within specific areas of the Project footprint. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss, and to the LSA for disturbance. The residual effects are anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for migratory birds is predicted to be **Not Significant**.

A potential cumulative effects assessment was not conducted for migratory birds as the zone of influence of Project-related effects on migratory birds in expected to be limited to within the Project PDAs. No additional projects fall inside of the Project PDAs, thus no cumulative effects on migratory birds are anticipated to occur. Similarly, no transboundary effects are expected, as the Project PDAs fall entirely within Nunavut.

Raptors

Five of the eight raptors species occurring in the wildlife RSA are species of conservation concern. The cliff-nesting peregrine falcon and the ground-nesting short-eared owl are listed as species of Special

Concern on Schedule 1 of the federal *Species at Risk Act* (Government of Canada 2013). Three additional cliff-nesting species - the golden eagle, gyrfalcon, and rough-legged hawk - are listed as "Sensitive" in Nunavut by the Canadian Endangered Species Conservation Council SARA (CESCC 2010). Ground-based surveys for upland birds confirmed that ground-nesting raptors occur relatively rarely within the wildlife RSA. Thus, baseline studies for raptors were focused on mapping the location of cliff-nesting raptor nests, and measuring the productivity of breeding pairs. Aerial surveys of cliffs were conducted between 2002 and 2013 over approximately 80% of the wildlife RSA. A total of 147 raptor nest sites were mapped; nests of the peregrine falcon were the most abundant of all raptor species. Two nest sites occur within the PDAs, and an additional seven raptor nest sites occur within a 12 km radius of the PDAs.

Potential Project-related effects on the VEC raptors included Project activities that could alter the following indicators: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimizing the Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste management and chemical handling measures to avoid attracting wildlife, and the implementation of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

Following the application of mitigation and management measures, five residual effects were identified: habitat loss, disturbance, direct mortality and injury, attraction, and reduction in reproductive productivity. The magnitude of all five of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss which would be long term within specific areas of the Project footprint. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss and attraction, and the LSA for disturbance, direct mortality and injury, and reduction in reproductive productivity. The residual effects are also anticipated to be reversible or reversible with effort for attraction, with the possible exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for raptors is predicted to be **Not Significant**.

A potential cumulative effects assessment was not conducted for raptors as the zone of influence of Project-related residual effects on raptors in expected to be limited to within a 12 km radius from the Project infrastructure which corresponds to the maximum expected home range of breeding raptors. No additional projects fall within 12 km of the Project PDAs, thus no cumulative effects of the Project on raptors are anticipated to occur. Similarly, no transboundary effects are expected, as the Project PDAs fall entirely within Nunavut.

# ᓄᓇᖏᑦ ᐊᕐᑎᑎᐊᓄᑦ ᓇᐃᓚᒋᑦᑐᐊᔪ ᐅᓂᒃᑲᖅ

ᓴᵒᓂᖏᓚᓪᒋᑦ ᑯᖏᓂᓂ ᓴᓇᕆᐅᔪᒥ (ᓴᓇᕆᐅᔪᖅ) ᐅᓴᕋᵒᓂᐊᖏᒪᑦ ᖃᓂᒃᓱᑎᒃ ᓴᕆᕋᓴᒃᓴᓂᒃ ᔪᓪᓕᖅᑲᖅᑐᑦᑐᒃ ᓄᓇᕋᑯᑎᑎᕋᐅᔪᓂ ᓴᐱᓇᒃᑯᑦ ᓴᓚᑐᖅᑎᐊᓂᓪ ᑎᒥᕋᑯᑎᐊᓄᑦ (ᓴᐱᓇ) ᑕᒪᔪᒪᓂ ᖃᐅᑎᒥᐅᓂ ᓄᓇᖃᖅᑎᑦ ᐅᐊᓕᓂᖅᓱᒪᓂ. ᓴᓇᕆᐅᑎᓴᑦ ᐱᖏᓱᖏᒪᑦ ᓄᓇᑦᑕᓕᕆᖏᒪᑦ ᓄᓇᒥ: ᔪᓴᒥ ᓴᓇᕆᐅᔪᖅᑐᖅ, ᔨᐊᓕᒥ ᓴᓇᕆᐅᔪᖅᑐᖅ, ᐊᓚᒪᓪ ᓂᓴᒥ ᑐᓪᒃᑕᕋᕆᐅ ᓂᐅᕋᐃᖏᖏᓴᑦ (MLA) ᑕᵒᓇᓪᓕ ᐅᐊᓕᓂᖅᓱᒪᖏᓴᓐᓂᑐᖅ ᖃᑦᖏᓴᐅᑎᐅᑦ ᑲᖏᖅᓂᖏᓴᓂ. ᓴᐱᓇᒃᑯᑦ ᐸᕋᓇᓂᒪᔨᑦ ᐊᕐᑎᑎᓴᓄᑦ ᐃᐱᐅᖏᓂᕋᖅᑎᓂᐊᕋᖅᑐᓂᒃ ᐅᓂᒃᑲᓕᐅᖅᓂᒪᓕᕋᖅᑐᑦ ᑕᒪᑐᓴᖏᑦ (EIS) ᓇᓗᓇᐃᔨᐃᓪᓗᑎᒃ ᖃᓄᖅᑲ ᑕᒪᐅᖏᓴᐅᓂᐊᕋᓂᕐᒥᓂᒃᑐᒃ ᐊᒪᓚᓪ ᐊᖅᑯᓲᖅᑕᐅᓂᐊᕋᖅᑐᑦ ᐊᕐᑎᑎᕐᓂ ᐊᑦᑕᕋᓂᖅᓱᒪᖏᓕᖅᑐᑦ ᐊᒪᓚᓪ ᖃᓄᖅᑲᑎᑎᑦ ᑕᐃᓕᖅᑕᒥᐅᑦ ᐃᓕᓴᕐᓂᐅᑎᓪᓗᑎᒃ ᐃᓕᓴᕐᓂᐅᑎᓪᓗᑎᒃᑐᑦ ᐃᓕᓴᕐᓂᐅᑎᓪᓗᑎᒃᑐᑦ ᐊᒪᓚᓪ

ᓇᓕᐅᑦᑕᑭᑎᑦᓯᑎᑦ "ᐱᐅᖏᓂᓂᕐᒧᐊᓐᓇᖅᑐᑦ" ᐃᓱᒪᑎᓯᑎᑦ ᑕᒪᐅᑯᐊ ᓇᓕᐅᑦᑕᑭᑎᑦᓯᑎᑦ ᐃᐅᐱᖏᓇᑦᓂᕐᒧᐊᓂᖅᑐᑦ VEC-ᓂ ᐅᑦᖁᐅᓱᐊᖅᑐᑦ. ᐊᒻᒪᓗ ᐊᑐᓂ ᒪᓕᒐᓕᐅᑕᐅᑦᑯᐅᐅᓕᐅᖅᑐᑦ ᑕᒪᑐᒪᓂ ᖁᖃᓴᓇᖅᑕᐅᑎᑦᓯᑎᑦ, ᐃᓕᐅᓗᑎᐅ ᒪᑯᐊ ᐃᓱᐊᓕᑎᒃᓴᐅᕐᔪᑦ ᑭᒪᔪᐃᑦ ᐊᑎᑦᓇᖏᓂᖅᑐᑦ ᒪᓕᒐᖏᓪᓗᓯᑦ (SARA), ᐊᐅᓚᖅᑯᑦ ᑕᒪᐅᖏᓪᓗᖁᑎᖅᑐᑦᓯᑎᒥᑦᒪᓕᒐᖏᓪᓗᓯᑦᐊᒻᒪᓗ ᓄᓇᕗᒻᒥ ᑭᒪᔪᐃᑦᓯᑎᑦᓯᑎᒥᑦᒪᓕᒐᖏᓪᓗᓯᑦ.

ᐅᑯᐊ ᑕᖅᖄ ᓇᐃᓚᒋᑎᐊᑦᓯᑎᑦ ᐅᓂᒃᑲᒋᐅᕈᑕᐅᓱᒪᓕᕐᓂᑦ ᐊᖄᑎᖏᓪᓗᓄᑦ, ᓱᕐᔪᑦᒋᓴᖅᓯᒪ ᓴᓇᙵᐅᓂᐊᖅᑐᑦ ᖃᑎᒌᓇᓴᐅᕐᓂᒪ ᐃᓱᐊᓇᑦᓂᖅᑎᓂᐊᑦᓂᖅᖏᑎᓄᓂᓄᑦ ᓄᓇᒪᑦ ᓄᓇᒥᑕᓴᓄᑦᓗ VECs, ᐊᐅᓱᓗᐊᖅᑕᐃᒋᑦᑯᑦᓯᑎᑦ ᐊᑦᖃᐅᓱᖅᑕᐅᕐᓂᒪ ᐃᓱᐊᓇᑦᓂᖅᑎᖅᑐᑦ, ᐊᒻᒪᓗ ᐱᕐᓇᓵᖏᓕᑕ ᑲᑎᑦᓯᓗᓄᑦ ᓴᓇᙵᐅᓂᐊᖅᑐᑦ ᐃᓱᐊᓇᑦᓂᖅᑎᓂᐊᑦᓂᖅᑐᑦ ᓇᐅᑦᓯᑎᑦᑕᐅᓕᐅᕐᓂᒪ ᓄᓇᒪᑦ ᐱᐅᓇᓱᐊᖅᑐᑦ ᓇᐃᓚᒋᑎᐊᑦᓯᑎᑦ ᑕᒪᐃ ᓄᓇᒥ VEC-ᓂ.

<u>ᐅᓴᖏᓐᓂ</u>

ᔪᓂᒥ ᔨᐊᓕᒥᓗ ᐅᓴᖏᓐᓂᓪᓄᑦ ᐱᖃᑎᒋᑦᑯᐅᕐᓂᑦ PDAs ᐅᑯᐊᖏᔪᓂᑦ ᓄᓇᖏᓂᓂ ᑲᓇᖏᓇᖏᑕ ᐅᓵᖅᑯᖏᓐᓇᖏᓂᓂ ᐃᓱᐊᓂ ᓱᓕᓴᖃᓪᓄᑦ ᓱᓱᐊᓕᖃᓪᓄᓗᓂᓗ Slave ᐊᒻᒪᓗ Churchill Geologic Provinces ᐅᓴᖏᓐᓂᐅᑎᑎᒋᐅᓕ:ᓴᓂ ᓄᓇᓂ. ᓱᖏᒥ ᑐᓕᕆᔨᖏᓂ ᓂᐅᕋᐃᓐᖏᐅᑦᑕᕆᓂᐊᓂᓂ ᑐᓕᕆᔨᕋᓕᐅᕋᐅᔨᒪᔨᒥ (MLA) ᐃᓗᐊᐃᓚᒪᑕ ᐊᕐᑎᓵᓂᖅᓴᐅᓕᓗᑎᒃ ᕿᑎᖏᓐᓂᐃᓕᓴᑎᒃ ᐅᓴᖏᓂ ᐱᖃᑎᒋᑦᑯᐅᕐᓂᒪ ᑭᓇᐅᔪᓂᒃ ᐅᓴᖏᓂ ᑕᒪᐃᐅᑦ ᐊᐅᓚᖅᑕᐅᕐᓂᒪ, ᐃᓕᓐᓂ ᐱᐅᒥ Bear ᑕᐃᓴᐅᔨᒥ ᐅᓴᖏᓐᓂᐅᑎᑎᒋᐊᕐᓇᖏᓂᓂᒃ. ᓱᕐᒥᐊᓵᓕᐅᖅᑐᒥᓚᑦ ᑕᒪᐃᓐᓇ ᓄᓇᖏᓐᓂ ᑲᑕᒪᓕᐅᓂᖏᓐᓂ ᑭᓱᐊᓂ ᓱᑕᒪᕐᒥ ᕆᐃᓴᖅᓴᓐᒥ Quaternary Wisconsin Archean Geological Provinces ᑕᐃᓴᐅᔨᒥ ᓱᕐᒥᕐᔨᐊᖅᑎᓕᓂᑦ ᐃᓱᓕᐅᓴᒪᑦ ᑕᒪᑐᒪᓕᒐᓴᖅ ᖃᐅᖅᑲᖅᓯᒪᓂᖅ ᐊᐱᐊᓐ ᐅᓴᖏᓐᓂᖅᑎᖅᓯᐊᓂ. ᓱᕐᒥᐊᓗᓐᓄᑦ ᑲᑕᓐᓂᕐᓂᐅᔨᐊᓂᕐᑐᑦ ᒪᔪᐊ ᐅᓴᖏᓱᓴᐃᑦ ᑐᐊᐸᐃᑦ ᓱᓴᐅᑎᐃᑦ (ᓱᕐᒥᐊᓗᑦ ᑐᐊᐸᖅ), ᐃᓗᓕᖅᑎᖅᑕᐅᓕᒪᓕᑦ ᓱᓴᐅᑎᐃᑦ ᐊᐱᐊᓐ ᐃᓱᐊᓇᑦᓂᖅᑎᖅᑐᑦ ᐅᓴᖏᓂ. ᑕᐃᓴᐅᔨᒥ ᓱᐊᖏᓴᐃᑦ ᐅᓴᖏᓐᓂ ᐊᒻᒪᓗ ᐃᓐᓇᐃᓐᖏᓕᑕᓂᖅ ᐃᓕᓴᕐᓂᖅ ᐊᐱᐊᓐ ᐊᐱᐅᓐᖏᓕᑕᓂᖅ ᑲᑕᓐᓂᕐᓂᐅᔨᒪᔨᒥ ᐃᓗᓕᖅᑎᖅᑕᐅᓕᒪᓕᑦ ᐅᓴᖏᓂ ᒪᐃᑲᖅ ᐊᐅᓚᖅᑕᐅᓕᒪᓕᑦ ᐅᓴᖏᓂ. ᑕᐃᓴᐅᔨᒥ ᓱᐊᖏᓴᐃᑦ ᐅᓴᖏᓐᓂ ᐊᒻᒪᓗ ᐃᓐᓇᐃᓐᖏᓕᑕᓂᖅ ᓴᖅᑭᑐᖅ ᐊᐱᐊᓐ ᐊᐱᐅᓐᖏᓕᑕᓂᖅ ᐅᓴᖏᓂ ᒪᐃᑲᖅ ᐊᐱᐅᓐᖏᓕᑕᓂᖅ ᐅᓴᖏᓂ. ᐃᓗᓕᖅᑎᖅᑕᐅᓕᒪᓕᑦ ᐊᐱᐅᓐᖏᓕᑕᓂᖅ ᑲᑎᒪᔨᖏᑦ

ᓄᓇᐃᑦ ᐃᓕᐊᐃᓕᓐᓄ

ᐱᓇᕆᐱᐅᑦ ᒪᓂᕆᖅᑐᒥ ᓇᓕᖅᑕᖅ ᐱᖓᕆᖅᐅᖏᓪᓕᑦ ᐅᐊᒍᑕᐃᓴᑐᓂᖅ ᑲᑎᒪᖅᓯᐅᓕᕐᓂᖅ ᓄᓇᖅᓯᓂ ᐅᓱᕆᐃᑦ ᐊᒥᓱᓂᖅ ᑎᑕᐅᑭᑎᖓᐊᓂᖅ ᑕᓯᕆᐅᖅᓯᓂᖅ ᐊᑯᐟᓂᖅᓯᓂ ᑯᓚᖅᓴᓂᖅ. ᓄᓇᖅᑐᑕ >ᖅᑐᓂᖅᑎᑦ ᐃᓗᒪᕆᐅ 300-ᒥᑦ 700-ᒍᑦ >ᖅᑐᓂᕆᐅᐅᖅᑐᑦ ᓱᓴᖅᓯᓂᑦ ᑕᑯᓪᓗᑎᑦ (ᒪᓱᓕᒥ) ᐊᓪᒪᓗ ᓴᓂᕆᖅᓯᓂ ᓱᑐᐟᓪᓕᐊᓂᕆᐅᖅᑐᓂᖅᓱᓂ 7-ᐳᓴ ᐅᖅᓯᑕᓄᕐᐃᑦᓱᓂ. >ᖅᑐᓂᖅᓴᓂᓗ ᓄᓇᓂ ᕿᑲᕐᕿᑲᖅᑕᒪᒃᑕ ᑐᐊᐸᓂᖅ ᒪᕐᕆᓂᓗ (44-ᐳᓴᖅᑎᑦ ᑲᑎᒪᓗᑎᑦ ᐱᖁᑎᑎᕐᓴᐅᕐᔪᓂ) ᑲᑕᖅᓂᕆᔨᖁᕐᒪᒃᑕ ᐅᓴᕆᕆᖅᑲᖅᑐᑦ ᐳᓚᑭᐳᓪᓚᐊᒥᒃ, ᑲᑕᖅᓂᕆᔨᖁᓂᓗ ᐅᓴᕆᖅᑎᑦ ᐅᐊᑭᑎᓱᒪᓴᖅᓯᓂᖅ ᐃᓗᓕᕆᑲᐅᖅᓯᓂ ᓱᕆᐊᓗᓐᓄᒪᑦ ᑯᐊᐅᓚᕐᓂᓂᖅ (9.5-ᐳᓴᖅᓱᓂ), ᐱᑭᖅᑐᑭᐃᓕᓕᓂ (6.5-ᐳᓴᖅᓱᓂ), ᓱᓴᖅᓱᓂ (5.1-ᐳᓴ) ᐊᒪᒪᓗ ᓭᐃᓱᑐᐃᓂᕆᓂᖅᑕᒪᐅᕐᓇᖅ (3-ᐳᓴ) ᓴᙵᕆᑲᖅᓴᑲᑲᐅᐊᖅᑐᓂᖅᓴᖅᑦ. ᑕᑯᓴᐅᐸᓂᓕ ᐅᓴᕆᖅᑲᖅᑐᑦ 5.2-ᐳᓴᖅᓱᓂ ᐱᖁᑎᑎᕐᓂᖅᓴᖅᐅᐸᓂ. ᐃᓱᐸᓂᖅᑎᑦ ᓴᙵᕆᑲᖅᑲᖅᑐᑦ ᓄᓇᐃᑦ ᖃᐅᔨᖅᓱᒪᒥᒃᑕ ᐅᓴᕆᐃᑦ ᑕᐃᓴᐅᐸᓂ (ᖃᐅᓕᓂᖅᑎᑦ) ᐊᖅᑎᓂᖅᓯᓂᕐᔪᓂ ᑕᒪᓂ ᖃᐃᑎᖅᓂᖅᓴᓂ ᓄᓇᓂ ᑲᑕᖅᓂᕆᐅᐅᖅᑐᖅᑐᓂ (ᐃᓗᒪᖃᖅ 10.6-ᒋᑐᒥᖅ) ᐊᒪᒪᓗ ᒥᑭᓕᓕᓪᓚᐊᓪᓚᑐᓂ ᖃᐃᑎᖅᓂᕆᓴᓕᓕᓪᓚᐊᓪᓚᑐᓂ ᐅᐊᒍᑕᐃᓴᑐᓂᖅᓴᓂᒃᑕᓂᖅ ᓄᓇᖅᓯᓂ (ᐃᓗᒪᖃᖅ 4.8-ᒋᑐᒧᑦ ᑎᑭᓪᓗᒍ.

ᐊᒥᓱᑦ ᓄᓇᖅᓯᓂ ᑕᑯᓴᐅᓕᕐᓇᒪᒃᑕ ᐊᐅᔨᖏᑦᑑᑐᑦ ᒪᓕᐊᑐ, ᑐᐊᕐᓗᓪᓕᐃᑦ ᐊᖏᐅᖅᑕᐅᔨᕆᐘᑦ ᓱᕆᒥᐊᓪᓚᒧᒪᑦ, ᓱᓴᖅᒥᐅᑕᐅᖅᑐᑦ ᐅᖅᓱᖅᑐᐅᖅᓯᓂᖅᑐᑦ ᑕᒪᑐᒪᓂ ᓄᓇᖅᓯᓂ RSA-ᓕᒫᒥ. ᓂᓪᓕᓇᕐᓂᖅᓯᓄᑦ ᓱᓕ ᓄᓇᖅᓯᓄᑦ ᐊᐅᐅᖅᖏᕐᓕᐊᓂᖅ ᐃᒪᐃᑐᑐᓂᖅ ᐱᑕᖅᑕᓂᖅ ᐱᑕᖅᑐᑦᑑᖅᑐᑦ ᑐᐊᕐᓗᓐᓄᑦ ᐱᑕᖅᑐᑦᑑᖅᑐᑦᓗ, ᖃᐅᔨᖅᑕᑦᑎᓂᖅ ᑕᐃᒪᓇᓗ ᐋᕿᑭᓱᓕᕆᓕᓕᐅᔨᓂᓂ ᖃᐅᓂᖅᓯᐅᓂᖅ ᐊᑎᓂᓯᐅᓂᖅ ᖃᐅᔨᖅᑕᑦᑎᓂᕐᓂᑦ ᒪᓕᓗᓂᑦ ᐱᑕᖅᑐᖅᑐᑦ, ᖃᐅᔨᖅᑕᑦᑎᓂᖅᑐᑦᓗ ᓴᓇᓂᓗ ᐃᓕᓴᐅᑎᖅᑐᑦ ᐊᐅᑭᓯᓂᖅᑐᖅᑐᑦᓗ ᐊᑎᓂᓯᐅᓂᖅᑐᖅᑐᑦ ᐊᑎᓂᓯᐅᓂᖅᑐᖅᑐᑦᓗ ᐃᓕᓴᐅᑎᖅᑐᑦ ᐃᓕᓴᐅᑎᖅᑐᑦᓗ ᑐᐊᕐᓗᓐᓄᑦ ᐃᓕᓴᐅᑎᖅᑐᑦ ᓄᓇᖅᓯᓂ ᐃᓱᕆᖅᑐᐅᖅᓯᓂᖅ. ᓱᓕᒥᓪᓕᐊᓕᓂᖅ ᐋᕿᑭᓱᓕᕆᓕᓕᐅᔨᓂᓂ ᖃᐅᓂᖅᓯᐅᓂᖅᑐᑦ ᐊᖅᑎᓂᖅᓯᓂᕐᔪᓂ ᓴᓇᓂᓗ (1-ᒥᑦ 3-ᒍᑦ ᓱᓪᓚᖅᓯᖅᑐᖅᑐᑦ) ᐃᓪᓕᖅᑐᓪᓗ ᓴᓂᕆᑎᓂᓂ ᓱᓕᒥᓂᔨᐃᑦ. ᓴᓇᕆᐊᓂᒪᓂᖅ ᑕᑭᓱᓕᕆᓕᓕᐅᔨᓂᓂ ᑕᐃᒪᓐᓇᓂᓂ ᓱᓕᒥᐊᓪᓚᒥ ᐊᓂᖅᑐᓂᖅᓴᖅᑐᓂᖅ ᐊᐅᖅᓱᒪᓂᖅᓴᖅᑐᓪᓚᐊᓪᓚᑐᓂ ᓴᓇᐃᓚᓂᖅᓴᖅᑐᓪᓚᐊᓪᓚᑐᓂ ᐊᐅᖅᓱᒪᓂᖅᓴᖅᑐᓪᓚᐊᓪᓚᑐᓂᓗ ᑕᐃᒪᐃᓐᓇᓂᖅ ᐃᓪᓕᖅᑐᓪᓗ ᓴᓂᕆᑎᓂᓂ ᓱᓕᒥᓂᔨᐃᑦ. ᓴᓇᓕᐊᓂᒪᓂᖅ ᑕᑭᓱᓕᕆᓕᓕᐅᔨᓂᓂ ᑕᐃᒪᓐᓇᓂᓂ ᓱᓕᒥᐊᓪᓚᒥ ᐊᖅᑎᓂᖅᓯᓂᕐᔪᓂ ᓴᓇᓂᓗ (1-ᒥᑦ 3-ᒍᑦ ᓱᓪᓚᖅᓯᖅᑐᖅᑐᑦ)

ᖃᐃᖅᓯᒍᑦ, ᐅᓴᕋᓯᔾᔨᐃᑦ ᓄᓇᒥ ᑕᑯᖏᐅᔾᔪᑎ ᐊᒻᒪᓗ ᑐᖅᑐᐃᑦ ᓂᕈᐳᖅᓂᒃ ᖃᐅᔨᖅᐸᖅᑐᑦ ᐅᓄᕐᓂᖅᖏᐅᓕᐅᔪᑦᑐᑦ ᓄᓇᖓᓂ ᑯᐃᐅᔾᔨᓂᓕ ᑕᓯᓪᓗ ᓯᓚᖅᓂᕐᓂᑦ, ᒪᖅᖏᐃᑦ, ᐊᒻᒪᓗ ᐃᑭ�untᒪᓂ ᓯᓚᖅᓂᓕ ᓄᑖᑦ ᐱᑐᖅᑎᓗᓪᓗ. ᑲᑎᓯᑎᑦ 890-ᖅᑎᐅᓂᑐᑎᒃ ᐊᔪᕈᖅᑎᑦᑐᒃ ᓄᓇᕐᓂᒃ ᓇᓗᐃᐃᖅᓯᓕᐅᖅᑐᑦ ᑕᒪᑐᒪᓂ TEM-ᑯᑦ ᖃᓇᔾᔪᑦ ᐊᐅᓕᐅᔾᔨᓕᐅᖅᑐᑦᑕᐅᖅᑐᑦᑕᐅᑦᑐᑎᒃ ᑕᑯᐅᑎᓕᐅᑦᑐᒃ ᐱᒋᐊᖅᑐᑦ LSA-ᓂ ᐊᒻᒪᓗ RSA-ᓂᓗ. ᐅᓄᕐᓂᖅᓱᖓᓕᓕᐅᖅᑐᑦ ᑕᖅᑲᓕᑦ ᐅᕐᖅᐅᔪᓚᑦ, ᑭᖓᓂᖓᔪᑦ ᒥᑭᐅᑎᑦᑐᖅᑐᑦ ᐱᑐᖅᑐᑦ ᓂᕈᐳᖅᑐᑦ ᑐᓂᖅᑐᑦ. 90-ᖅᑎᐅᓂᑐᑎᒃ ᐊᔪᕐᓇᖅᑎᑦᑐᒃ ᑕᒧᓂ ᐱᕈᖅᑐᑦᑕᐅᖅᑐᑦ ᐱᓗᐊᖏᖅᑐᒥ ᓂᕈᐳᖅᑎᑦᑐᒃ ᑕᒧᓂ LSA-ᒥ ᐊᒻᒪᓗ RSA-ᒥᓗ. ᐃᓕᓴᖅᑎᓂᑦ ᓄᓇᓂᑦ ᑎᑭᑎᑕᐅᔾᔨᐃᓂᓂᒃ ᐱᕈᖅᑐᑦᑕᐅᓇᖅᑐᑦᓯᓚᖅᑐᑦ ᑕᒧᓂ LSA-ᒥ 2012-ᒥ ᖃᐅᔨᔪᓇᐊᖅᑐᑦᓂᓕᒫᑦᓗᑎᑦ.

ᐃᓕᐱᓇᓂᖃᖅᑎᓇᖅᑐᑦ ᐱᓕᕆᑎᒃᐅᔾᔨᓂ ᓄᓇᓂ VEC-ᓂ ᐱᕈᖅᑐᑦᖃᐅᖅᑐᑦ ᐊᒻᒪᓗ ᐊᔪᐅᖅᓯᑐᓂᒃ ᑲᓱᓇᓇᐊᖅᑐᑦ ᓄᓇᖅᑐᑦ ᒪᑐᐃᓐᓇᖅᑐᑦ ᒪᑐᐃᓐᓇᖅᑐᑦ ᓄᓇᖅᑐᑦ ᒪᓕᐊ ᑕᒪᑐᒪᓂᓴᐅᑎᑎ ᐊᓯᐅᓴᐅᓕᑦᓴᓂᓂ ᓯᑕᓓᑕᐅᓂᑦᑎᓂᓂ ᐱᕈᖅᑐᑦᑕᐅᓇᖅᑐᑦ ᐊᔪᐅᖅᓯᑐᓂᒃ ᐱᕈᖅᑐᑦᑕᐅᓇᖅᑐᑦ ᐊᔪᐅᖅᓯᑐᓂᒃ ᓄᓇᖅᑐᑦ. ᑕᒃᑯᓄᖓ ᐃᓕᐱᓇᓂᖃᖅᑎᓇᖅᑐᑦ ᐅᖃᐅᓯᖅᑐᑦ ᐊᔪᐅᖅᓯᑐᓂᒃ ᐱᕈᖅᑐᑦᑕᐅᓇᖅᑐᑦ ᐊᔪᐅᖅᓯᑐᓂᒃ ᓄᓇᖅᑐᑦ ᐊᐅᓚᑦᑎᓂᒃ ᐊᐅᓚᑦᑎᓂᒃ ᐱᕈᖅᑐᑦᑕᐅᓇᖅᑐᑦ ᐊᐅᓚᑦᑎᓂᒃ ᐊᐅᓚᑦᑎᓂᒃ ᓄ

ᑐᒃᑐᓄᑦ

ᑕᒪᓂ ᐱᖅᓯᓕᓕᖅᓯᖓᓚᒥᑕ ᓇᐸᑐᖓᓕᕐᓂᑐᒥᐅᑕᐃᑦ ᑐᒃᑐᐃᑦ ᑲᑎᖅᓚᐃᕐᓂᒃᑯᑦᓂᖅᑕᖅᓂᕐᓂᑦ ᑕᒪᐃᑕ ᐊᑐᓂ ᑲᑎᖅᓚᓕᐅᖅᑯᓗᒃᑲᓗᑎᑎᒃ ᐅᐊᑭᓕᓴᓗᑎᑎᒃ ᓄᓇᖅᓱᓂ ᕿᑎᕐᕈᐅᓂ. ᖃᐅᔨᓴᖅᑎᑕᐅᓯᒪᔪᓄᑦ ᐅᓇᑐᓂᖅᑕᐅᓕᕐᓂᖅᑐᑦ ᓴᖅᑭᑐᓂᖅᑕᕐᓂᖅᑕᖅᓂᕐᓂᑦ ᕿᑎᕐᕈᐅᓂ ᑐᑭᓯᓚᐅᑦ ᑕᒪᐃᑕ ᐃᓕᓴᕐᓂᖅᑕᐅᓂᖅᑐᑦ, ᐊᒻᒪᓗ ᐱᖓᓕᐅᑦ ᑐᒃᑐᐃᑦ (ᐊᕿᐃᐊᐅᖅᓯᓂᕐᓂᖅᑕᐅᓕᖅᓴᖅᑦ) ᓄᓇᒥᐅᑕᐅᖅᓯᓴᑦ ᕿᑎᕐᕈᐅᓂ, ᐊᐅᔪᖅ ᓄᓯᓕᖅᑎᑦᓗᒍ, ᐅᑭᐊᖅᑯᓂᕐᓂᖅᑕᐅᓕᖅᓴᖅᑎᑦᓗᒍᓗ. ᐃᓕᖅᑕᐅᖅᑯᓂᕈᐅᖅᓯᒪᓚᐅᑦ ᖃᑎᖅᑕᐅᓂᖅᑐᖅ 2001-ᒥ ᐊᒻᒪᓗ 2010-ᒥ ᐊᒻᒪᓗ ᐊᑐᖅᓯᑎᑦ ᓄᓇᒧᖅᑕᐅᓯᒪᔪᓂᖅ ᐊᖏᓕᐅᑭᑎᓂᖅ ᕿᑎᕐᕈᐅᓂ ᖃᓄᐅᔪᓐᓇᓂᓗ ᐊᒻᒪᓗ ᐅᐊᑕᓂᖅᑐᓐᓇᖅᓯᓂ ᐅᓇᓚᐅᖅᓯᓂᕐᓂᖅᑕᐅᓕᖅᓴᖅᑎᑦᓗᒍᓂ. ᐅᑭᐅᖅᑯᑦ ᑕᓪᓕᐊᓂᖅᑐᑦ ᐱᔪᖅᓯᖅᑕᐅᔪᓂ ᑐᑭᓯᓚᐅᑦ ᐊᒻᒪᓗ ᐅᖓᑖᓂ ᐅᑭᐅᖅᑯᑦ ᐊᑐᖅᓯᑎᑦ ᐅᓇᓚᐅᖅᓯᓂᕐᓂᖅᑕᐅᓕᖅᓴᖅᑎᑦᓗᒍᓂ. ᑕᓪᓕᐊᓂᖅᑐᑦ ᐊᒻᒪᓗ ᐃᓕᖅᑕᐅᖅᑯᑦ ᐊᑐᖅᓯᑎᑦ ᐊᒻᒪᓗ ᐅᖓᑖᓂ

ᐊᒻᒪᓗ ᖃᐅᔨᖅᑕᐅᖃᖅᑕᕐᓂᕐᒧᑐᒃ ᐅᒪᔾᐃᖅ LSA-Γ ᓂᐸᖅᔪᐊᖅᑕᐅᓕᖃᖅᑕᕋᖅᑕᕐᓗᒍ ᓴᓇᖅᑯᑎᖅᑎᓂᒃ, ᑕᐃᒪᓐᓇᔨᖅ ᓄᖅᓇᐅᖅᓂᓂᖅᓴᐅᓕᖃᖅᑕᕐᓗᒍ ᓂᐸᖅᔪᓇᓄᑦ. ᐃᒃᐱᖅᓴᓂᖃᖅᑎᓂᐊᖅᑎᒋᔭᐅᑦ ᖃᓄᐅᑕᐅᔪᓄᑦ ᐱᖅᓯᒪᔨᖅᑐᑦ ᐃᓕᔾᔨᐃᑦ ᓴᓇᐃᖅᑐᖃᖅᑎᓄᑦ ᐅᑎᖅᓂᐊᖅᑐᒃ ᓴᓇᓐᓂᒃᑯᑦ ᑕᓪᓕᐊᓂ ᓇᓗᓇᐃᔾᔨᖅᑭᒃᑐᑦ ᐊᑐᖅᑐᒃ ᓴᓇᓐᓂᒃᑯᑦ ᐊᑐᖅᑐᒃ ᐅᓪᓗᖅᑭᒃᑐᑦ ᓇᓗᓇᐃᔾᔨᖅᑭᒃᑐᑦ ᐊᑐᖅᑐᒃ ᐅᓪᓗᖅᑭᒃᑐᑦ ᐃᓕᓴᐃᖅᑐᑦ (ᐃᓱᒪᓕᖅ 10, ᐃᓕᓐᓄ 20-Γ), ᐃᒃᐱᓐᓇᖅᓂᓚᓂᖅᑕᕐᓄᑦ ᑐᑐᓄᑦ ᑕᐃᒪᓐᓇᖅᑐᑦ **ᐊᒃᑭᓗᐊᖏᓐᓄᓂᖅᑕᐅᓗᓂᓐ.**

ᑲᑎᒪᓗᑎᒋᒃ ᓴᓇᓐᓂᒃᑯᑦ ᐅᓇᖅᑭᒃᑐᑦ ᐃᒃᐱᓐᓇᖅᓂᓚᓂᖅᑕᐅᓗᖅᑐᑦ ᐅᑐᑎᖅᑕᐅᑭᓚᖅᑐᑦ ᓇᓗᓇᖏᑦᓯᒪᒃᑯᑦ ᓂᐸᖅᔪᓂᖅᑐᓂᐅᓕᖅᑎᓂᒃᑐᑦ ᑕᐃᒪᓐᓇ ᑲᑎᒪᓗᑎᒋᒃ ᐱᑕᖃᑎᒌᖅᑐᑦ ᐃᓕᓴᐃᖅᑐᑦ ᐃᓕᓴᐃᖅᑐᑦ. ᐃᓕᓴᐃᖅᑐᖃᖅᑎᓂᐊᖅᑎᒋᔭᐅᑦ ᐃᒃᐱᓐᓇᖅᓂᓚᓂᖅᑕᐅᓗᖅᑐᑦ ᐃᒃᐱᓐᓇᖅᓂᓚᓂᖅᑕᐅᓗᖅᑐᑦ ᐃᓕᓴᐃᖅᑐᑦ ᐃᓕᓴᐃᖅᑐᑦ ᐃᓕᓴᐃ

<u>ᐊᒃᓴᐃᑦ</u>

ᓇᓵᖅᑐᖃᖅᓴᓕᓴᐅᑕᐃᑦ ᐊᒃᓴᐃᑦ ᒪᓕᒪᑎᑐᖃᖅᖢᓂᓕᑦ ᑎᑎᕋᐅᓴᐅᓴᒪᖅᒪᒃ "ᐃᓕᓴᒃᑯᖅᑎᓪᓗᑎᒃ ᐃᓴᒪᓗᑎᓴᐅᖅᑎᖅᒪᒃ" (SARA; COSEWIC 2012) ᐊᓕᒪᓗ ᑎᑎᕋᖅᑕᐅᓴᖅᑎᓪᓗᓕᒃ ᓂᖅᑲᖅᓯᓂᕋᖅᑕᐅᑦᓗᑎᒃ ᓇᓇᕐᒥ (CESCC 2010). ᓇᓗᓇᐃᒃᑯᑕᖅᓴᖅᑕᐅᓕᐅᕋᒪᑕ ᐋᖅᓴᕐᐳᐃᐅᕋᑲᑕᐅᖅᓴᖅᑎᒃ DNA-ᖅᑎᓂᒃ ᑐᖅᖢᒪᐃᖅᑎᑦ ᖃᐅᐅᓴᖅᑕᐅᓕᐅᕋᒥᔪᑦ 2012-ᒥ ᓇᓗᓇᐃᖅᓴᓕᕋᒪᑕ ᑲᑎᓴᑦ 61-ᓂᒃ ᐊᒃᓴᓂᒃ ᑕᒪᓂ ᖃᑎᖅᒥᐅᓂ RSA ᐊᓕᓗᓗ 62-ᓂᒃ ᑕᐃᒪᓕᐃᐃᓇᖅ ᐊᒃᑎᑎᕈᔪᑦ ᓇᓇᕐᒥ ᖃᐅᐅᓴᖅᑕᐅᓕᐅᕋᒪᑕ ᐅᐊᑕᓂᖅᓯᓄᓕᓂ ᖃᑎᖅᒥᐅᓂ RSA. 12 ᐊᒃᓴᐃᑦ ᑕᒪᐃᐃᓇᑦᑕᕈᓕᐅᖅᑐᑦ ᖃᑎᖅᒥᐅᓂ ᐊᓕᓗᓗ ᐅᐊᑕᓂᖅᓯᓄᓕᑎᐅᓂ. ᐃᖅᑕᖅᓂᖅᑲᑲᑕᖅᓴᑎᒃ ᑕᒪᐅᖅᓯᒪ ᒪᐃᒥ ᐊᓕᓗᓗ ᐊᑭᓴᒍ 25.7-ᑭᑕᒥᑐ ᐊᖅᓀᐃᐊᓂᓂᑦ ᐊᒃᓴᓂᑦ (ᐃᓕᒪᖅᑲᒃ 65-ᑭᓪᓕᒥᑐ ᐊᑐᓂ), 425 ᑭᑕᒥᑐ ᐊᖓᑎᖅᔪᐊᑦ (ᐃᓕᒪᖅᑲᒃ 138-ᑭᑕᒥᑐ) ᐊᓕᓗᓗ 32.6 ᐊᒃᓴᐃᑦ ᐃᖅᑕᕋᖅᑲᑕᕈᓕᐅᖅᑐᑦ ᑲᑎᑕᐅᑎᑦᑎᓂᒃ (ᐃᓕᒪᖅᑲᒃ 84.8 ᑭᓪᓕᒥᑐᓂ). ᐅᐱᖅᓴᑲᓂᓪᓕ, ᐅᖅᑯᖅᓴᑲᓂᑕᑲᑕᓕᐅᕋᒪᔪᑦ ᑕᒪᑐᐃᑐᑦ ᐊᒃᓴᓂᑦ ᖃᑎᖅᒥᐅᓂ RSA ᐊᓕᓗᓗ ᑲᑎᓂᕐᖅᓴᖅᑕᐅᓪᓗᑎᒃ ᓴᐅᔪᐊᓂᒃ ᑕᒪᓂ. ᐊᐅᐱᖅᓴᓂ ᐊᒃᓴᓂᑦ ᐅᑭᐃᓴᖅᑐᑦ ᐊᓕᓗᓗ ᐅᑭᐃᓴᖅᑲᒃᑲᓂᑦ ᐊᑐᓂᑦ ᐊᓕᓗᓗ ᐅᑭᐃᓴᖅᑲᒃᑲᓂᑦ ᐊᒃᓴᓂᑦ ᐃᖅᑕᕋᖅᑲᑕᕈᓕᐅᖅᑐᑦ ᖃᑎᖅᒥᐅᓂ RSA ᐅᐱᖅᓴᑲᓂᑦ ᐊᐅᐱᖅᓴᓪᓗ ᐊᓕᓗᓗ ᐅᑭᐃᓴᖅᑲᒃᑲᓂᑦ, ᑭᑕᒥᑐᓂᑦ ᐊᓕᓗᓗ ᐅᑭᐃᓴᖅᑲᒃᑲᓂᑦ ᐊᒃᓴ

ᐃᑲᐦᓇᓂᕆᑦᑎᓂᐊᖅᑐᑦ ᑐᓴᒪᓂᑎᖅᑐᑦ ᐊᑯᐊᖅᑎᓂᐊᖅᓯᒪᒃᑕ ᐋᓇᓚᐅᓪᓛᑦ ᐃᒡᓗᖅᐸᐊᖅᑭᑦ ᐃᓱᒪᑭᓪᓗᑦ ᐊᑭᓯᐃᔪᐊᖅᑭᑦ ᐊᑐᕆᓂᖅᑕᖅᑕᖅᑭᑦ ᖃᐅᔨᒧᑦ ᐊᒻᒪᓗ ᓇᐸᒪᓂᖅᑎᓂᖅᑕᖅᑭᑦ ᑕᒧᓂ ᓴᓂᓕᒪᓂᖅᑕᖅᑭᑦ ᐋᓇᓚᐅᓛᑦ ᑕᑯᓂᑦ. ᐃᓱᒪᑎᐅᖅᓯᒪᒃᑕ 11-ᓂᒃ ᑕᒪᓂ ᐋᓇᓚᐅᐅᑭᓇᓱᑭᓪᓗᑎᒃ (ᐃᓕᐅᑎᓪᓗᑦ ᑲᒃᑯᐊ ᓱᑕᒪᑦ ᐋᓇᓚᐅᐸᒪᐸᑦ ᓱᕐᓂᓚᓂᐊᖅᑕᑦᑎᓐᓂ) ᑲᑎᓪᓗᑦ ᐅᓇᖅᑐᓂᒃ ᐋᓇᓚᖃᑕᖅᖢᑕ ᐃᑲᐦᓇᓂᕆᑦᑎᖅᑐᓇᓂᑦ ᐅᓇᖅᓱᓲᓪᓕᐹᑕᐅᐸᓇᓪᓕᒪᑕ ᑕᒪᓂ ᐅᓇᖅᓱᑕᖅᖢᑕ ᐱᓕᕆᓚᐅᐸᐊᖅᑭᑦ ᐅᓴᕃᓂᓂᑕᖅᑐᓂᓂᓂᒃᓂ ᐊᑭᓯᐃᔪᐊᖅᑭᑦ ᐅᓇᓱᑕᑕᖅᑐᓂᓂᓂᒃᓂ ᐃᑲᐦᓇᓂᕆᑦᑎᖅᑐᓇᓂᑦ ᐊᑯᐊᖅᑎᓂᐊᖅᑭᑦ ᐃᓕᓴᐅᓂᒃᑐᓂᑦᑎᓐᓂᖅᑐᓂᒃ, ᐊᑯᓂᐅᓂᓂᑦᓂ ᐊᑯᓂᓗᒍᓂᐊᖅᑭᑦ (ᐊᓇᓚᐅᐸᑦ ᐃᓅᓂᓂᑦ ᒪᓕᓗᑎᑦ) ᐊᓂᐊᒍᑦ ᓄᓇᖅᑐᓂᒃ ᐊᑐᖅᓯᐊᓂᖅᑎᑦ ᐊᓂᐅᓴᐸᖅᑲᖅᑎᑦᑐᖅ ᐋᓇᓚᐊᐸᑦ ᐃᓂᖅᑐᓂᒃ, ᐃᓐᓇᐅᑦᓂᖅᑐᑦ ᐋᓇᓚᐅᐸᑦ ᐃᓂᖅᑐᓂᒃ ᐊᑐᖅᓯᐊᓂᖅᑎᑦ ᐊᓂᐅᓴᐸᖅᑲᖅᑎᑦ ᐅᓪᓛᖅᑲᐃᓐᓇᖅᑐᑦ ᐃᓂᖅᑐᓂᒃ ᐃᑲᐦᓇᓂᕆᑦᑎᖅᑐᓇᓂᑦ ᐅᓇᖅᓱᑕᖅᖢᑕ ᐃᓕᓴᐅᓂᒃᑐᓂᑦᑎᓐᓂᖅᑐᓂᒃ ᐊᑯᐊᖅᑎᓂᐊᖅᑭᑦ ᐃᓂᖅᑐᓂᒃ

ᑭᖓᓂᖅᓱᑦ ᐊᒃᓱᓕᐊᕐᐃᐅᒃᓯᐊᑎᑦ ᐊᑐᐊᖅᓱᕐᕕᖅᑎᓕᓕᒃᑐᑦ ᐊᐅᓚᕎᑎᔨᑎᓕᓪ, ᐱᖓᓱᓂᓂᒃ ᐊᒥᐊᒃᓯᑎᕐᕕᐅᔪᓐᓇᖅᑐᓂᒃ ᓇᓕᓇᐃᕐᐃᓚᐅᕐᖅᑐᑦ: ᓇᓯᓚᖅᑲᖅᑕᖅᑕᖓᓂᓂᒃ ᐊᓱᐅᕐᑐᐃᓐᓇᓚᐊᖅᑎᓪᓗᒡᓗ, ᕿᓘᐊᓴᑕᐅᑐᐃᓕᓇᓚᐊᖅᑎᓪᓗᒡᓗ ᓂᕆᔨᕐᓴᕐᓄᑦ, ᐊᓚᓪᓗ ᓄᓴᐅᕐᖓᓂᒃᓴᓴᐅᑕᑐᐃᓐᓇᓚᐊᖅᑎᓪᓗᒡᓗ. ᖃᓄᐃᑎᒋ ᐊᒃᑐᐊᓂᖅᑲᓂᕐᖓᑦ ᐅᒃᑐᖅᑕᐅᓕᓪᓗᑎᒃ ᐱᖓᓱᓂᓄᑦ ᑕᒃᑯᓄᖅᓯᓂᒃ ᕿᓘᐊᓴᖅᑕᐅᓂᖅᑕᐅᓯᖅᑐᖓᓚᐅᑎᓪᓗᒡᓗ, ᐊᑯᓂᐅᔪᓐᓇᐃᓐᓇᕐᓚᓪᓗᒡᓗ ᑕᐃᓂ ᓴᓇᓪᓗ (ᑲᔪᓯᔪᑎᒃ ᐃᓅᓂᖓᓂ ᓴᓇᖏᓐᓄᑦ) ᐊᓯᖏᑐᓂᒃ ᓇᔨᖏᑦᑑᓂ ᐃᓇᖅᑐᑦᑕᐅᓂᐊᖅᑎᓪᓗᒡᓗ ᑕᐃᓂ ᓴᓇᓄᐃᓕᓂᒃ ᑕᒪᓐᓇᖅᑐᑦ ᐃᓇᖅᑐᑦᑕᐅᓂᐊᖅᑎᓪᓗᒡᓗ, LSA ᓂᕆᔨᕐᓴᓂᒃ ᕿᓘᐊᓴᖅᑕᐅᔪᓐᓇᖅᑐᑦ, ᐊᓚᓪᓗ RSA-ᒥ ᐊᒃᓱᓕᐊᕐᐃᐅᒃᓯᐊᑎᑦ ᓄᓴᓇᐃᔅᓯᑕᖅᑕᖓᓂ ᐱᑕᖅᑲᖅᕿᑕ. ᑭᖓᓂᖅᓱᑦ ᐃᒪᐃᓐᓇᔪᓂᖅᑲᓐᓇᖅᑕᖓᓂ ᐱᖅᑯᔪᖓᑕᖅᑲᖅᑕᖓᓂᒃ ᐅᑎᕐᓇᓕᑦ ᐅᓇᖅᑐᓂ ᐃᓇᖅᑐᑦᑕᐅᓂᐊᖅᑎᓪᓗᒡᓗ ᐊᑐᐊᖅᑎᓪᓗᒡᓗ ᐃᓇᖅᑐᑦᑕᐅᓂᐊᖅᑎᓪᓗᒡᓗ ᐃᓕᓴᕐᓇᓚᐅᓂ ᕿᓘᐊᓴᖅᑕᐅᓂᐊᖅᑎᓪᓗᒡᓗ ᐃᓕᓴᕐᓇᓚᐅᓂ ᑕᒪᓐᓇᖅᑐᑦ ᐃᓇᖅᑐᑦᑕᐅᓂᐊᖅᑎᓪᓗᒡᓗ ᐃᓕᓴᕐᓇᓚᐅᓂ ᓴᓇᓄᐃᓕᓂᒃ

ᓱᐊᖃᓇᓂᓪᓕ ᐊᒪᑭᓇᓂ, ᖃᖏᕐᒪᑕᓱᒃᑯ ᑎᓱᖃᖅᓴᕐᑎᖃᕐᑕᖃᖅᖢᖓᑦ ᓇᓴᖃᖅᑕᐅᓕᐅᕐᖏᒪᑕ 2007-ᒥ ᐊᓚᒐ 2013-ᒥ. ᓇᓗᓇᐃᖃᓱᓕᐅᑦᑐᑦ 8-ᓂᒃ ᓇᐸᖃᖅᐅᖃᑎᒌᕐᑕᖃᖅᑐᓂᒃ ᑎᓱᕐᓂᒃ ᑕᒪᓂ ᐊᒪᑭᓇᓂ ᖃᐅᔨᓴᖃᖅᑕᐅᐃᐅᓱᒪᔪᒥ RSA-ᒥ, ᑕᑦᓚᒪᑦ ᐊᒪᑭᐊᓕᕐᖃᐅᕐᖃᑦᑐᑦ, ᓇᐸᒪᓂᖃᑎᒌᖃᖅᖢᖓᑦᓕᓂ ᐅᐸᑐᔨᐅᑎᑦᓯᓗᑦᑎᑦ ᓄᓇᒃᑯᒥᑎᑕᐅᖓᑦ ᓱᐊᖃᓇᐃᑦ ᐊᒪᑭᐃᑦ ᓇᓗᓇᐃᔭᐃᓕᐅᕐᖃᑦᑐᑦ 1->ᓴᖏᓐ ᐱᐅᓂᖃᓵᖓᓐᓂᑦ ᓄᓇᐅᑦ ᐊᒪᑭᓇᓂ ᓇᐸᒪᓂᔭᐅᕐᐊᖃᖅᓴᖃᓂ ᑕᒪᓂ RSA-ᒥ.

ᐃᐹᒪᓇᖅᑎᑦᓴᓇᓄᓇᕐᖃᖅᖢᖓᓕᓂᓪᓕ ᓴᓇᓀᐅᑦᓵ VEC-ᒥ ᖃᖅᖁᓘᓇᓂ ᒥᖃᑯᖃᖅᑐᓇᓕᓂᓗ ᓂᕐᐸᑎᓇᓂ ᐃᒪᒃᐅᑎᓂᑦᑐᑦ ᓴᓇᓀᐅᑦᓵ ᐊᓯᔪᖃᖅᑕᐅᐸᓄᓇᕐᖃᖅᑐᑦ ᐅᑯᓇᖅᑐᓄ: ᐊᓯᐅᔪᓄᓇᕐᒪᑕ ᐊᖃᕆᔨᖃᖅᑕᐅᓗᑎᒃ, ᐸᖁᓴᔨᖃᖅᑕᐅᓗᑎᓗ ᓇᓗᓇᖅᑐᓂ ᐊᑯᓂ ᓴᓇᓀᖃᖅᐸᑕ ᓂᕐᐸᕈᔪᓇᓂ, ᐸᖁᓴᔨᖃᖅᑕᐅᐸᓄᓇᕐᒪᑕ ᐃᓕᓴᕐᓂᖃᖅᑕᐅᓕᕐᖃᑦᑐᑦ, ᑐᑭᒪᔨᖃᖅᑕᐅᓗᑎᒃ ᑐᖁᑎᖃᖅᑐᑦ ᐅᑯᓇᖅᑐᓄᓪᓚᕆᑦ, ᑐᙵᒪᔨᖃᖅᑕᐅᓗᑎᒃ ᐅᑭᐅᖃᖅᑐᑦ ᐊᒪᑭᐃᑦ ᓴᓇᓀᖃᖅᑕᐅᓗᑎᒃ ᐊᖏᔪᒪᓂᖅᑐᑦ ᐊᒪᑭᐃᑦ ᓴᓇᓀᖃᖅᑕᐅᓗᑎᒃ ᐊᐅᓚᑦᑎᓂᒃ ᐊᒪᑭᐃᑦ ᓴᓇᓀᖃᖅᑕᐅᓗᑎ

ᑕᒪᐅᓗᐊ ᓴᓇᕐᐳᓪᓕ ᑭᖓᓂᖅᓱᑦ ᐃᐅᐱᓇᓂᖅᑲᑎᒋᔭᖅᑕᖅᑐᑦ ᑲᔪᓯᔭᖅᓯᒪᑕ ᐊᓯᐅᓄᑦ ᓇᐋᑎᖅᑐᑦᑕᖅᑎᓪᓗᒍ, ᐊᒥᐊᐅᓯᐳᐅᔭᖅᓯᒋᓐᓂᒃ ᑲᑎᓂᓐᓂᑦ ᐃᐅᐱᖅᓯᒪᔭᖅᓯᒥᒃᑕ ᐊᒥᐊᓯᓂᖅ ᓴᓇᕐᑲᑎᓂᖅᑐᑦ ᐃᐅᐱᖅᓯᓂᖅᑲᑎᓪᓗᒍ ᐊᒥᐊᓯᓂᖅ ᓴᓇᕐᑲᑎᓂᖅᑐᑦ ᐃᐅᐱᖅᓯᓂᖅᑲᑎᓪᓗᒍ ᐊᓯᖏᓐᓂᒃ ᐊᐅᓚᓐᓂᖅᑐᑦ ᐊᓯᖏᓐᓂᒃ ᐃᓕᓴᕐᓂᖅᑐᑦ ᐊᓯᖏᓐᓂᒃ ᐊᓯᖏᓐᓂᒃ ᐃᓕᓴᕐᓂᖅᑐᑦ

ᓴᓇᖅᑯᑦ ᐊᐅᓪᓚᐅᕐᔪᑎᒃᐅᕙᓪᓗᑎᒃ ᒪᓕᑦᑎᒃᐅᕙᓪᓗᑎᓗ ᐊᑐᖅᑕᐅᕐᔪᐊᑎᖅᑭᓐᓂᐅᖅ ᐱᑕᖅᑳᐊᖅᑕᐃᓕᓚᓗᑎᒃ ᐊᒃᑕᕐᓗᑯᓂᐅᖅ ᐅᒃᑐᒥᓂᐅᖅ ᐅᐊᓕᖅᖢᓂ ᐅᐊᐅᓚᐅᖅᑎᑦᑎᓕᕐᓂᑎᒃ ᐅᐊᓪᓚᐅᕐᓯᐊᑎᖅᑐᑦᑎᓗᑎᒃ ᑐᓴᐅᓐᓇᖅᑐᑦᑎᓕᕐᓂᑎᒃ ᐅᓪᓚᐅᕐᓯᐊᑎᖅᑎᑦᑎᓗᑎᒃ ᑐᓴᐅᓐᓇᖅᑐᑦᑎᓕᕐᓂᑎᒃ ᓴᓇᖅᑯᑎᓂᑦ ᓴᓯᐅᐊᕐᑕᐃᓕᓚᓗᑎᒃ ᓇᔨᓴᐃᑦᑕᐃᓕᓚᓗᑎᒃ ᐅᓪᓚᐅᕐᓯᐊᑎᖅᑭᓐᓂᐅᖅ ᐊᐅᓚᓐᓂᐊᖅᑐᑦ (ᐃᓵᓴᖅ 10, ᐃᓚᖓ 20-ᒥ).

ᐅᑯᐊ ᑕᖅᖢ ᐊᐅᓚᓂᕆᑕᐅᓂᐊᖅᑐᑦ ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᑦ ᓴᓇᖅᑯᑎᓂᑦ ᓴᓇᕐᓂᖅ, ᒪᑭᑕᐃᓕᖅᓯᓂᖅ ᐊᒥᐊᒃᑯᑐᐃᓇᐊᖅᑐᖅᓚᒃ ᐃᒃᐱᓐᓇᕐᓂᖅᑐᖅᑐᓂᖅ ᑕᒪᐅᖅᓯᑕᖅᑐᖅᑐᓂᖅ ᑎᖅᒥᐊᓂᑦ ᓇᓗᓇᐃᕐᓂᖅ; ᐊᓴᐊᔪᓂᐊᖅᑐᓂᖅ ᓇᔨᓴᖅᑐᑦᑎᖅᒥᓂᖅ ᑕᒋᓂ, <ᓴᕕᓴᖅᑕᐅᓂᐊᖅᑐᓂᓗ. ᖃᓄᐃᑎ ᐃᒃᐱᙵᓇᖅᑐᖅᖃᖅᑐᖅᑕᒪᓕᖅᓴᓐᓂ ᐊᒥᐊᒃᑯᑦ ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᓂᐅᓂᖅᑕᐅᖅᑎᒥᑦ, ᐊᑯᓂᐅᖅᑎᑦᑐᒥ ᑕᒋᐅᓐᓂᖅᑎᓂᐅᓂ (ᐃᓄᓴᖅᓴᓂ ᓴᓇᕕᐅᓴᑦ) <ᓴᕕᓴᖅᑕᐅᓂᖅᑕᐅᓂᓐᓇᖅᑐᖅᓴᑦ ᐃᓕᓂᓕᐅᓴᖅᓴᓐᓂᓗᑐᓗ ᐱᓂᐊᖅᓴᑎᒃ, ᑕᐃᒪᐃᓐᓂᖅᓴᓐᓂᑦ ᐱᖅᑯᓴᑐᖅᑎᓕᑦ ᐅᑎᕐᓐᓇᖅᑐᓂᖅᑐᖅᑐᑦ ᐊᐅᑦᑕᓇᖅᓴᓕᓕᖅᐊᑕ ᓴᓇᔪᑦ ᑕᒋᖅᓴᑦ ᓴᓇᕕᐅᓴᕕᑦ **LSA** ᓴᓇᕕᐅᓴᕕᑦ. ᐊᒥᐊᒃᑯᓗᑎᒃ ᐃᒃᐱᓐᓇᖅᑐᖅᑐᓐᓇᖅᑐᑦ ᑕᒪᐃᓐᓂ ᐱᖅᑯᓴᑐᖅᑎᓕᕐᓂᖅ ᐅᑎᖅᑐᓂᖅᑕᐅᖅᑐᑦ ᐊᓴᐅᓂ ᑭᓴᐊᓂ ᐊᐅᓚᑎᑦᑕᑦ ᓴᓇᕕᐅᓴᕕᑦ. ᐊᑐᐊᒪᖅᑎᖅᑎᑎᒃ ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᓂᐅᓂᖅᑕᐅᖅᑐᑦ ᐅᓪᓗᖅᓴᖅᑕᐅᖅᑐᑦ ᐊᐅᓚᓐᓂᐊᖅᑐᓂᓗ ᓴᓇᕕᐅᓴᕕᑦ. ᐊᑐᐊᒪᖅᑎᖅᑎᑎᒃ ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᓂᐅᓂᖅᑕᐅᖅᑐᑦ ᐅᓪᓗᖅᓴᖅᑕᐅᖅᑐᑦ ᐊᐅᓚᓐᓂᐊᖅᑐᓂᓗ ᓴᓇᕕᐅᓴᕕᑦ (ᐃᓵᓴᖅ 10, ᐃᒪᖓ 20-ᒥ), ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᓂᐅᓂᖅᑐᖅᑐᑦ ᐊᐅᑦᑕᓇᖅᓴᓕᓕᖅᐊᑕ ᐃᓅᓐᓇᖅᑐᖅᑐᓂᖅᑕᐅᖅᑐᑦ ᑕᒪᐅᖅᓯᑕᖅᑐᖅᑐᓂᖅ ᑎᖅᒥᐊᓂᑦ ᐅᓚᐅᖅᑕᐅᖅᑐᑦ ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᓂᐅᓂᖅᑕᐅᖅᑐᑦ **ᐊᒃᓴᓗᐊᕐᐃᓐᓇᑯᓂᐅᓂᖅᑕᐅᖅᑎᓕᑎᒃ.**

ᑲᑎᖅᓴᓗᓂᓪᓕ ᐃᒃᐱᓐᓇᖅᑐᖅᑐᓐᓇᖅᑐᑦ ᐅᒃᑐᕆᐅᖅᑕᐅᓚᐅᖅᑎᒪᒡᓕ ᑕᒪᐅᖅᓗ ᑎᐱᖅᑎᕐᑕᕐᑐᓂᖅ ᑎᖅᒥᐊᓂᑦ ᑕᒋᓂ ᓇᔨᓴᒪᖅᓗᓂ ᐃᒃᐱᓐᓇᖅᑐᖅᑐᓐᓇᖅᑐᑦ ᑎᖅᒥᐊᓂᑦ ᓇᓚᐅᖅᑕᐅᓕᖅᑎᒪᒡᓕ ᑕᕐᕕᖅᓯᑎᑐᓂᖅ ᐱᖅᑯᓴᑐᖅᑎᓕᕐᓂᖅ **PDAs**. ᓴᓚᐅᖅᐳᓂᖅ ᐊᓴᖅᑎᓂᓂᖅ ᐃᒃᐱᓐᓇᖅᑐᖅᑐᓐᓇᖅᑐᑦ ᓴᓚᑦᓂᖅ ᐱᖅᑯᓴᑐᖅᑎᓕᕐᓂᖅ **PDAs**-ᒥ, ᑕᐃᒪᐃᓐᓂᖅᓱᓂᓂᖅ ᑕᕐᕕᖅ ᑲᑎᓕᓚᓂ ᐃᒃᐱᓐᓇᖅᑐᖅᑐᓐᓇᖅᑐᖅᑐᒪᒡᓕ ᐊᐅᖅᓱᖅᓂ ᑎᖅᒥᐊᓂᑦ ᓇᓚᐅᖅᑕᐅᓕᖅᑎᒪᒡᓕ ᑕᕐᕕᖅ ᑲᑎᓕᓚᓂ ᐃᒃᐱᓐᓇᖅᑐᖅᑐᓐᓇᖅᑐᖅᑐᒪᒡᓕ ᐊᐅᖅᓱᖅᓂ ᑎᖅᒥᐊᓂᑦ ᓇᓚᐅᖅᑕᐅᓕᖅᑎᒪᒡᓕ ᑕᕐᕕᖅᓯᑎᑐᓂᖅ **PDAs**-ᒥ, ᑕᐃᒪᐃᓐᓂᖅᓱᓂᓂᖅ ᓇᓚᐅᖅᑕᐅᓕᖅᑎᒪᒡᓕ ᓴᓇᕕᐅᓴᕕᑦ **PDAs**. ᓇᔨᓴᖅᑎᖅᓯᓂᖅ ᑕᒪᐅᖅᓯᑕᖅᑐᖅᑐᓐᓇᖅᑐᑦ ᐊᐅᖅᓱᖅᓂ ᓴᓇᕕᐅᓴᕕᑦ ᑎᖅᒥᐊᓂᑦ ᓇᓚᐅᖅᑕᐅᓕᖅᑎᒪᒡᓕ ᑕᕐᕕᖅᓯᑎᑐᓂᖅ

ᐃᒃᐱᖓᓇᓗᐊᕐᐃᒃᑯᑎᓂᒃ ᐊᖏᕐᕼᓯᐃᔨᓇᖅᑎᓪᓚᖅ ᐃᓕᐅᕐᕼᒃᐃᓗᓂᑎᒃ ᐊᐅᓪᓚᑎᔨᑎᓕᐅᕐᓂᖅᓗᓂᓗ ᐊᒃᓱᓗᐊᖓᓕᕐᐃᒃᑯᑎᓂᒃ ᐱᑕᖅᑭᓂᓕᐊᖅᑕᐅᓂᖅᓗᐊᖅᑕ ᐅᐃᖏᖓᓇᖅᓂᕆᑭᓇᖅᑐᖓᓂ ᐊᖓᔪᖅ ᐊᒃᓱᓗᐊᖓᔪᓂᕐᓂᖅᓗᐊᖅᑕ ᐃᒃᐱᖓᓇᖅᓂᕆᐸᑭᓇᖅᑐᖓᓂ ᐊᖓᔪᖅ ᐊᕐᕿᑕᓗᐊᖅᑐᑦ ᓴᖅᑭᑎᓪᓗᓂ, ᓂ <ᕿᑐᓗᐊᖅᑕᐃᓕᓕᔨᑎᓂᒃ ᐊᐅᕐᒃᓱᐃᓗᓂᒃ, ᓯᒃᑲᓕᓴᕐᓗᓂᓗ ᐃᓚᖅᑎᓂᒃ ᐅᑭᐅᖅᑕᐅᓗᓂ, ᐊᖓᔪᖅ ᐱᓕᕆᓂ, ᐊᐅᑦᓗᑯᓂᓗ ᐊᐅᓕᕐᓂᖅᓗᐊᖅᑕᐅᓗᓂᒃ ᐊᓚᓗ ᑐᓂᑯᓇᖅᑐᖓᓂᒃ ᐅᓚᔨᓂᒃ, ᐊᓚᓗ ᐊᐅᓕᕐᓂᖅᓗᐊᖅᑕᐅᓗᓂᒃ ᐅᓚᔨᓂᒃ. ᖃᐅᔨᒪᓂᖅᐸᒃᖢᑎᓪᓗᒍ ᐃᓕᓴᐅᕐᓂᖅᓗᐊᖅᑐᓂᒃ ᐊᒥᓱᓂᖅᐸᒃᖢᑎᓪᓗᒍ ᐊᓂᔪᓂᖅᓗᐊᖅᑐᓂᒃ ᐊᓚᓗ ᖃᐅᔨᓴᖅᑭᑦᑐᓂ ᐊᓂᔪᓂᖅᓗᐊᖅᑐᓂᒃ ᐊᓚᓗ

# Executive Summary – Inuinnaqtun

Not included in this version

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Rescan™
an ERM company

# BACK RIVER PROJECT
# DRAFT ENVIRONMENTAL IMPACT STATEMENT
# Supporting Volume 5:
# Terrestrial Environment

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# Acronyms and Abbreviations

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# Acronyms and Abbreviations

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

| | |
|---|---|
| **AAFC** | Agriculture and Agri-Food Canada |
| **AANDC** | Aboriginal Affairs and Northern Development Canada |
| **BIF** | Banded Iron Formation |
| **BIPR** | Bathurst Inlet Port and Road |
| **CCME** | Canadian Council of Ministers of the Environment |
| **CESCC** | Canadian Endangered Species Conservation Council |
| **COSEWIC** | Committee on the Status of Endangered Wildlife in Canada |
| **CWS** | Canadian Wildlife Service |
| **DDT** | Dichlorodiphenyltrichloroethane |
| **DEIS** | Draft Environmental Impact Statement |
| **EIS** | Environmental Impact Statement |
| **FID** | Flight Initiation Distance |
| **GN DOE** | Government of Nunavut Department of Environment |
| **KIA** | Kitikmeot Inuit Association |
| **LSA** | Local Study Area |
| **m** | Metre(s) |
| **masl** | Metres above mean sea level |
| **mbsl** | Metres below mean sea level |
| **mbg** | Metres below grade |
| **mg/L** | Milligrams per litre |
| **MLA** | Marine Laydown Area |
| **mm** | Millimetre |
| **mol/kg** | Molality (moles per kilogram) |
| **NAD 83** | North American Datum 1983 |
| **TEM** | Terrestrial Ecosystem Mapping |
| **NIRB** | Nunavut Impact Review Board |
| **NRCan** | Natural Resources Canada |
| **NWA** | Nunavut *Wildlife Act* (2003) |

| | |
|---|---|
| **NWT** | Northwest Territories |
| **NTU** | Nephelometric turbidity units |
| **NU** | Nunavut |
| **PDA** | Proposed Development Area |
| **pH** | The pH is a measure of the hydrogen ion (H+) content of the soil. Term commonly used to describe soil reaction. |
| **psi** | Pounds per square inch |
| **ppb** | Parts per billions |
| **PRISM** | Program for Regional and International Shorebird Monitoring |
| **Project, the** | The Back River Project |
| **RSA** | Regional Study Area |
| **RST** | RST Instruments Ltd. |
| **R-XRD** | Rietveld X-ray Diffraction |
| **SARA** | *Species at Risk Act* (2002) |
| **TDS** | Total dissolved solids |
| **TIA** | Tailings Impoundment Area |
| **TK** | Traditional Knowledge |
| **µS** | Micro Siemens |
| **US EPA** | United States Environment Protection Agency |
| **US OAQ** | United States Office of Air Quality |
| **UTM** | Universal Transverse Mercator coordinate system |
| **VEC** | Valuable Environmental Component |
| **VSEC** | Valued Socio-economic Component |
| **VTS** | Volcanic-Turbidite Series rocks |
| **VWP** | Vibrating wire piezometer |
| **WCED** | World Commission of Environment and Development |
| **WEMP** | Wildlife Effects Monitoring Program |
| **WHO** | World Health Organization |
| **WKSS** | West Kitikmeot / Slave Study |
| **WMMP** | Wildlife Mitigation and Monitoring Program |
| **WWF** | World Wildlife Fund |

# 1. Geology

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# 1. Geology

## 1.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 1.1.1 Regional Setting

#### *1.1.1.1 Bedrock Geology*

The Back River Project (the Project) is located at the intersection of three geological provinces in the West Kitikmeot Region of Nunavut (Figure 1.1-1). The majority of the Project area (the Goose Property and most of the George Property) extends over the northeastern corner of the Slave Geologic Province dominated by Precambrian clastic metasediments of the Yellowknife Supergroup. East of the Project area is the Churchill Geologic Province, which is characterized by Precambrian intrusive granitoid rocks and metamorphic gneiss. The Marine Laydown Area (MLA) and northern most portion of the George Property are underlain by sedimentary rocks the Bear Geologic Province.

The most widespread and abundant supracrustal units in the Slave Province consist of volcanic-turbidite series rocks (VTS), which are dominated by large areas of turbidites that are flanked by narrow volcanic belts and include distinct volcanic complexes (Figures 1.1-1 and 1.1-2). Two "types" of volcanic rocks in the Project area have been identified (Cater 2011):

- Hackett River-type volcanic rocks which are comprised of felsic to intermediate composition and calc-alkaline affinity; and
- Yellowknife-type volcanic rocks which are comprised of intermediate to mafic composition and displaying tholeiitic differentiation trends.

Within the Hackett River Geological Area, the Yellowknife Supergroup has been divided into the Hackett River, Beechey Lake, and Back Groups. The intimate interbedding of the Hackett River and Back Group volcanic rocks with the Beechey Lake Group sedimentary rocks has led to an evolutionary model consisting of volcanism punctuated by erosion and periods of fluvial fan deposition.

Iron formations are locally abundant in VTS rocks of the Slave Province with turbidite-hosted banded iron formations (BIFs) hosting most of the stratiform and stratabound gold prospects in the northeastern Slave Province (Cater 2011).

The Bear Geological Province is part of the Canadian Shield and represents material that was added to the Archean Slave Geologic Province during the Proterozoic. The MLA is underlain by sedimentary rocks of the Kilohigok Basin. The sedimentary rocks are comprised of congomerates, sandstones, siltstones, breccias, and minor quantities of carbonates (Hoffmann and Hall 1993). The region is interpreted to represent a basin adjacent to the continental margin and contains material of similar age and depositional environment as the Thelon Basin.

#### *1.1.1.2 Quaternary Geology*

The last major advance of the North American Laurentide ice sheet over the Kitikmeot Region of Nunavut occurred during the Wisconsin Glaciation. The maximum extent of the continental glacier occurred approximately 21,000 years ago and began withdrawing from the Kitikmeot Region approximately 10,000 years ago (NRCAN 2013). Typical glacial material deposited in the Kitikmeot Region includes ground moraines, terminal moraines, drumlins, eskers, and kames.

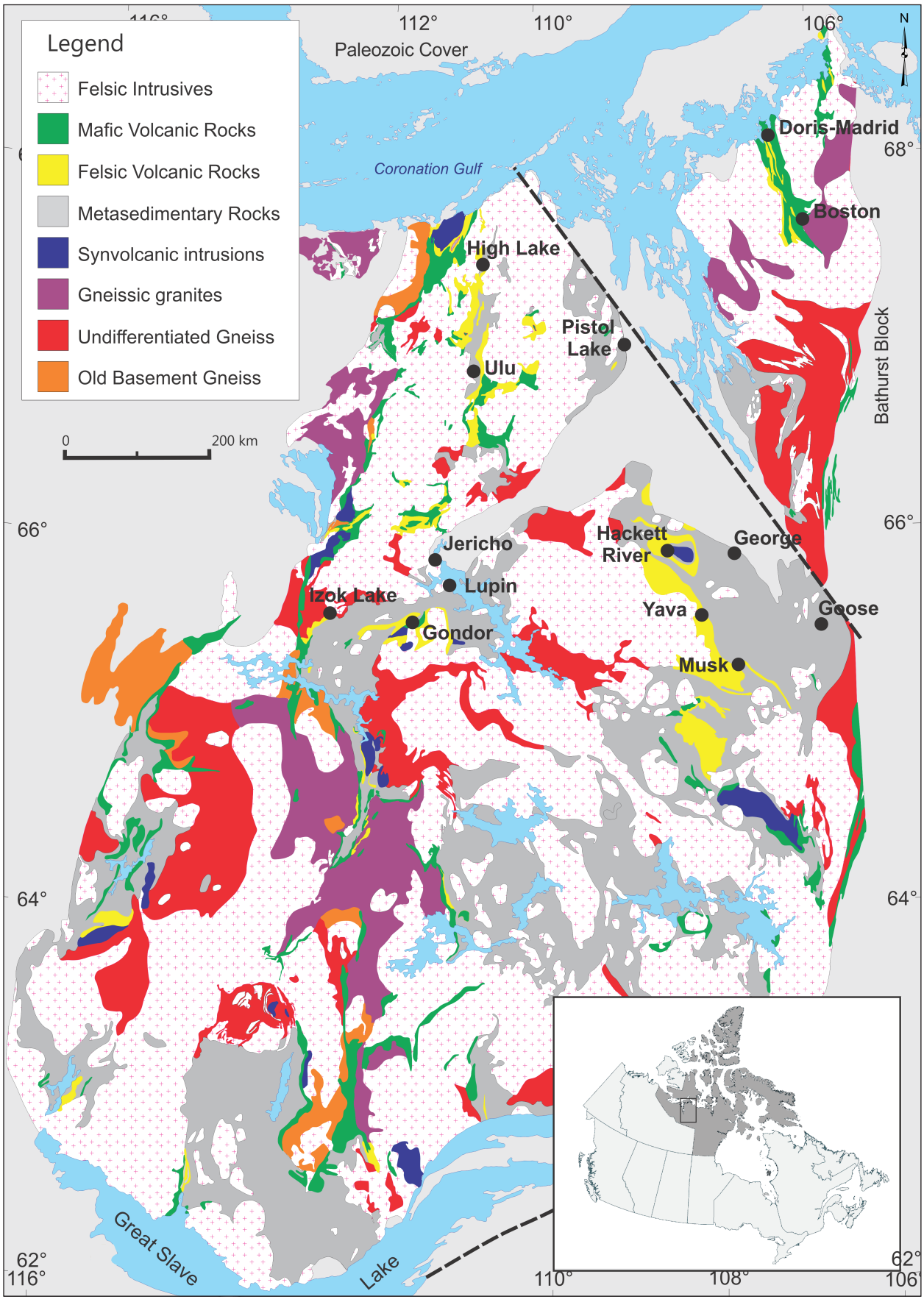


Figure 1.1-1

# Regional Geology Bedrock Map

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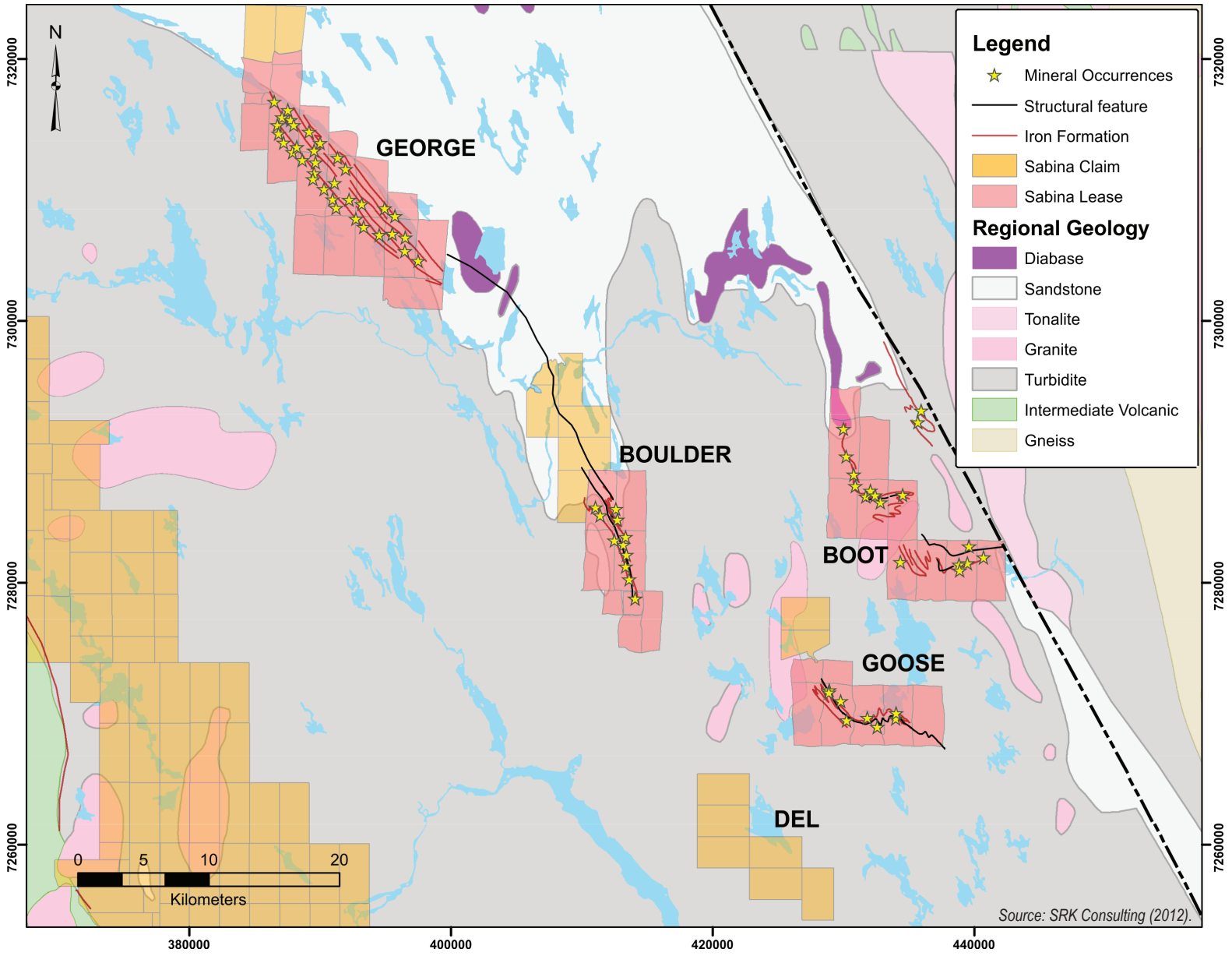


Figure 1.1-2

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# Back River Property Geology

Figure 1.1-2

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## 1.1.2 Local Setting

### *1.1.2.1 Lithological Units*

The Project, located in the northeastern corner of the Hackett River Geological Area, is comprised of rocks belonging to the Beechey Lake Group turbidites, which host oxide and silicate BIFs. The iron formations in the Beechey Lake Group exhibit similarities in stratigraphic setting and mineralogy to the Sequence C iron formations of the Back River Volcanic Complex (Cater 2011).

Table 1.1-1 summarizes generalized impressions of the different lithological units based on all available drill logs, experience of Rescan personnel at the Goose and George Properties, and discussions with Sabina geology personnel.

**Table 1.1-1. Geological Units and Lithocodes for the Back River Project**

| Unit | Subunit | Major R-XRD Mineral Phases[†] | Description |
|---|---|---|---|
| (1) Greywacke | | Quartz, clinochore, and muscovite | |
| | (1a) Thickly bedded greywacke | | • Frequently interbedded with minor mudstone units;<br>• Fine to medium grained, usually chlorite altered;<br>• Trace amounts of sulphide minerals, mostly pyrite and pyrrhotite; and<br>• Occasional carbonate veins. |
| | (1b) Siliceous greywacke | | • Rare. |
| | (1c) Thinly bedded greywacke | | • Interbedded at millimetre to centimetre scale with mudstone units to a much greater degree than 1a;<br>• Chlorite and amphibole alteration was noted;<br>• Trace amounts of sulphide minerals, mostly pyrite and pyrrhotite; and<br>• Occasional carbonate veins. |
| (2) Banded Iron Formation | | quartz, muscovite, and clinochlore | |
| | (2c) Oxide BIF | | • "Zebra core" with alternating bands of magnetite, amphibole and chert, the unit had a characteristic feel when running a magnet over the core that results from the alternating bands of magnetite;<br>• Chlorite and grunerite alteration is common;<br>• Sulphide minerals can make up to 2% of the core and consist of pyrite, pyrrhotite, and arsenopyrite and more than 10% magnetite;<br>• Carbonate veinlets were reported; and<br>• Rare graphitic patches occur, typically associated with slickenlines. |
| | (2ca) Sulphide-bearing oxide BIF | | • As 2c but with more than 2% sulphide minerals; and<br>• Visible gold was very rarely reported, common in high grade gold zones. |

*(continued)*

**Table 1.1-1. Geological units and Lithocodes for the Back River Project (continued)**

| Unit | Subunit | Major R-XRD Mineral Phases | Description |
|---|---|---|---|
| (2) Banded Iron Formation (cont'd) | (2d) Silicate BIF | | • Alternating bands of iron silicates and chert;<br>• There was less than 10% magnetite;<br>• Chlorite and grunerite alteration is common;<br>• Sulphide minerals can make up to 2% of the core and consist of pyrite, pyrrhotite, and arsenopyrite; and<br>• Carbonate veinlets were reported. |
| | (2da) Sulphide-bearing silicate BIF | | • As 2d but with more than 2% sulphide minerals; and<br>• Visible gold was very rarely reported. |
| | (2dc) Magnetite-bearing silicate BIF | | • As 2d but with 2-10% magnetite. |
| | (2dca) Sulphide-bearing magnetite silicate BIF | | • Rare unit as 2dc but with more than 2% sulphides. |
| (3) Mudstone | | quartz, clinochlore, muscovite, and actinolite | |
| | (3a) Phyllitic mudstone | | • Typically sheared or foliated and very fine grained; and<br>• Rare sulphides and carbonate were reported. |
| | (3b) Chloritic mudstone | | • Rarely reported, notable feature was the pervasive chlorite alteration resulting in a distinctly dark green, fine grained unit. |
| | (3c) Argillitic mudstone | | • Typically more massive than 3a. |
| (4) Dikes and volcanic rocks | | quartz, plagioclase, and muscovite | |
| | (4a) Felsic dikes | | • Quartz and feldspar dominated mineralogy;<br>• Arsenopyrite was the commonly reported sulphide phase; and<br>• Carbonate minerals rarely reported. |
| | (4b) Intermediate dikes | | • feldspar dominated with biotite, amphibole, chlorite, sericite, and minor carbonate. |
| | (4c) Mafic dikes | | • Very rare; and<br>• Probably normally reported as 8. |
| | (4v) Volcanic/ volcaniclastic rocks | | • Very rare; and<br>• Distinguished from 4a, 4b, and 4c through blue quartz eyes. |
| (5) Veins | | quartz | |
| | (5a) Sulphide-bearing quartz veins | | • Arsenopyrite with pyrrhotite and pyrite is the main reported sulphide mineral; and<br>• Carbonates were reported in chlorite rich areas. |
| | (5b) Carbonate-bearing quartz veins | | • Minor. |
| (7) Proterozoic sedimentary rocks | | | • Goulburn Group sedimentary rocks were occasionally encountered at the George and Boulder Properties; and<br>• Not reported at Goose Property. |

*(continued)*

**Table 1.1-1. Geological units and Lithocodes for the Back River Project (completed)**

| Unit | Subunit | Major R-XRD Mineral Phases | Description |
|---|---|---|---|
| (8) Gabbro | | kaolinite, actinolite, clinochlore, and quartz | • Units varied from sub-metre to greater than 10 m in thickness, thicker units frequently had chilled margins;<br>• Chlorite alteration was not specifically noted, but many units have a green colour;<br>• Disseminated magnetite and carbonate veinlets were identified frequently; and<br>• Sulphide minerals of pyrrhotite and chalcopyrite were rare. |
| (9) Overburden | | quartz, plagioclase, and muscovite | • Infrequently recovered;<br>• Overburden typically consisted of granitic boulders or greywacke; and<br>• Organics and sandy till were reported in the 2011 overburden drill holes. |

*† (Rescan 2013; Appendix 11-2A; Back River Project: 2007 to 2012 Metal Leaching/Acid Rock Drainage Baseline Report)*

### *1.1.2.2 Structural Geology*

During the Archean Eon, three periods of deformation occurred in the north east portion of the Slave Geologic Province (Cater 2011):

- D1 - large scale folding and down-warping of volcanic margins;
- D2 - foliation development caused by uplift when peak regional thermal metamorphism was occurring; and
- D3 - sub-vertical foliation formation. Metamorphic grades ranged from greenschist to upper amphibolite facies.

### *1.1.2.3 Quaternary Geology*

The quaternary geology at the Project is predominantly comprised of moraine type deposits (glacial till), which mostly consist of sand and variable amounts of silt. There is a large glacial moraine in the south-eastern portion of the Project area, which is approximately 200 km long and extends in the north-east direction. Other glacial materials in the area include coarse-grained glaciofluvial and fine-grained glaciolacustrine deposits. Glaciofluvial deposits in the area include eskers that are approximately 100 m wide and several kilometres in length. Drumlins and kettle lakes are also a common feature within the Project area (Rescan 2012). The glacial overburden deposits are commonly found in valleys and are on average 10 m thick, although some glacial deposits are up to 42 m thick (Cater 2011).

### *1.1.2.4 Goose Property Geology*

The Goose Property is underlain by folded turbiditic meta-sediments of the Beechey Lake Group, including silicate and oxide BIFs (Figure 1.1-2). This sequence is cut by felsic dikes and gabbroic dikes. From oldest to youngest, the sequence is composed of central greywacke, lower iron formation, middle mudstone, upper iron formation, and upper sediments. Gold mineralization tends to be hosted in the central greywacke and the lower iron formation units. A narrow (3 to 5 m) felsic dike is located along the axial plane of the major antiform at the Goose Main Deposit. Multiple thin (0.5 to 5 m) felsic dikes trend nearly parallel to the synform/antiform structures at Llama and Umwelt deposits. All units are cross cut by gabbro dikes. A summary of each lithological unit is presented in Table 1.1-1.

Numerous structural studies have been conducted on the Goose Property. The structural history can be summarized in two major phases (Cater 2011):

- D1 - regional northwest trending asymmetrical tight to isoclinal folds; and
- D2 - superimposed on the previous deformation events and is represented by megascopic structures that consist of open to locally tight cross-folds that trend north to northwest.

The emplacement of the quartz veins was promoted by the deformation of the BIF units, which were later fractured and acted as conduits for gold rich fluids.

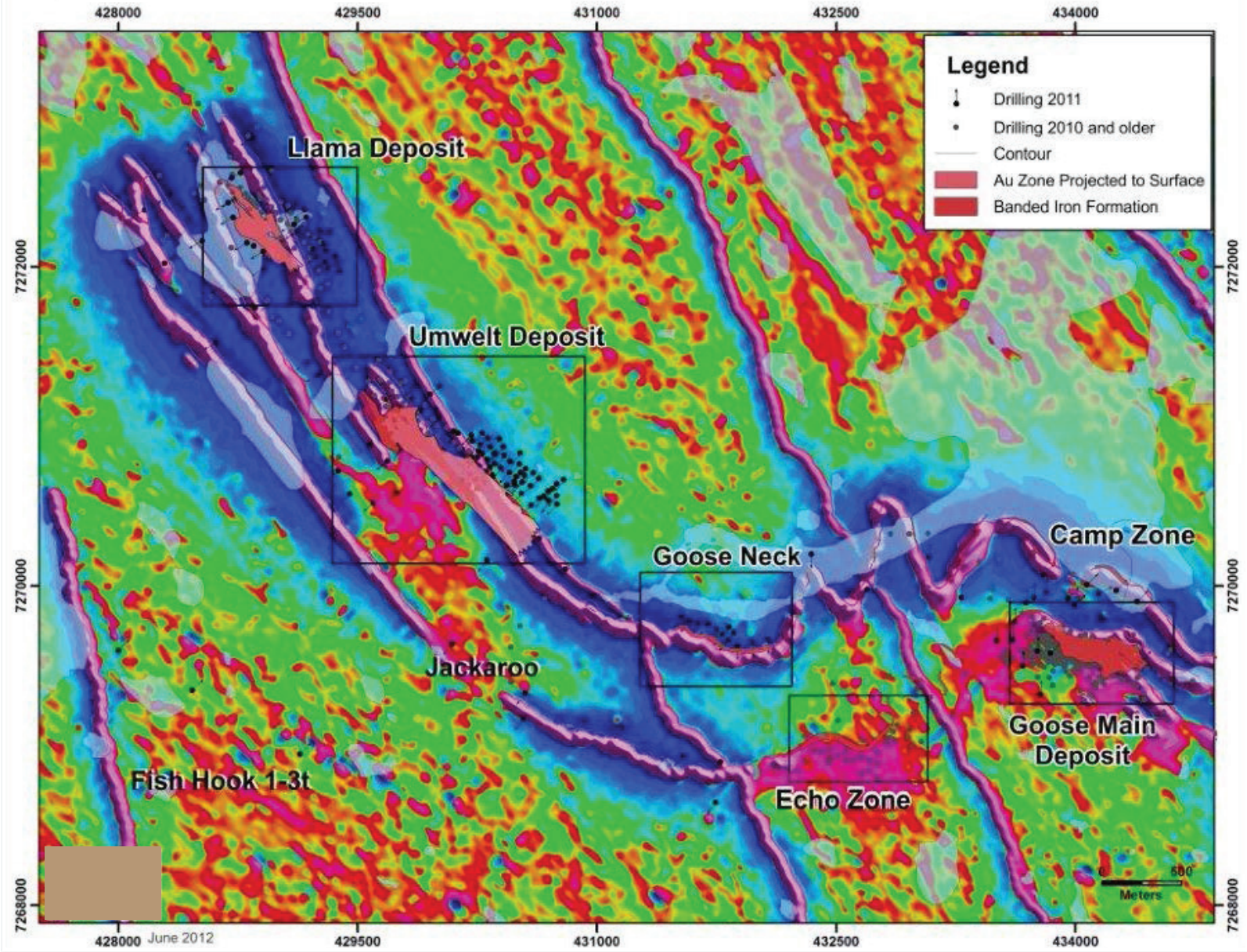
The metamorphic grade of the Goose Property is upper greenschist to lower amphibolite facies. The metamorphic grade increases to garnet-amphibolite facies to the west of the Llama Deposit (proximal to the quartz-muscovite intrusion and adjacent to the granodiorite intrusion to the southeast of the property) (Cater 2011). Figure 1.1-3 presents the results of airborne magnetic surveys for the Goose Property with an emphasis on the BIF units and the gold-rich zones projected to surface. Figure 1.1-4 is a stylized geologic cross-section based on a typical west-east Llama Deposit cross-section.

Mineralization Characteristics of the Llama, Umwelt, and Main Deposits

Most of the known or observed gold mineralization identified at the Goose Property is structurally controlled with associated quartz veining, zones of shearing, and silicified BIFs. Gold mineralization predominantly occurs within silicified and variably sulphidized BIFs and, to a lesser extent, mixed iron formation and meta sedimentary units located in the underlying central greywacke. The main observed sulphide minerals include pyrite, arsenopyrite, and pyrrhotite. Accessory chlorite, carbonate, hornblende, and grunerite may be associated with sulphide gold mineralization. Visible gold is locally present, especially when sulphides are greater than 10% and when coarse-grained arsenopyrite is present (Cater 2011).

The Goose Property deposit mineralogy is dominated by quartz ($SiO_2$), plagioclase feldspar ($NaAlSi_3O_8$ - $CaAl_2Si_2O_8$), muscovite ($KAl_2(AlSi_3O_{10})(OH)_2$), and clinochlore ($(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$). Calcite ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), and siderite ($FeCO_3$) carbonate minerals were detected in abundances lower than 3%. Pyrite ($FeS_2$), pyrrhotite ($Fe_{1-x}S$), arsenopyrite (FeAsS), sphalerite ((Zn,Fe)S), and marcasite ($FeS_2$) sulphide minerals were noted. No sulphate minerals were detected in any of the samples. The R-XRD results for deposit samples collected for the geochemistry baseline program can be found in Rescan 2013 (Appendix V11-2A: The Back River Project: 2007 to 2012 Metal Leaching/Acid Rock Drainage Baseline Study).

The gold mineralization at the Goose Main Deposit is structurally controlled and is predominantly stratabound. The deposit is located within the Goose Antiform structure, which is part of a zone of normal faults (north to northeast trending and southeast dipping). The normal faults are widely spaced within a 500 m wide zone and have up to 30 m of left-lateral displacement and a down dropping of individual fault blocks of up to 75 m. The gold mineralization is controlled by a series of northwest oriented structures that are axial planar to the Goose Antiform and sub-parallel to the strike of the felsic dikes. These structures are interpreted to cut all sedimentary units within the antiform. Approximately 60% of the gold mineralization occurs within the lower iron formation (sulphidized oxide BIF), and the remaining 40% occurs in the core of the underlying central greywacke. Visible gold is common and is associated with pyrrhotite and/or pyrite in the presence of arsenopyrite. The key gold mineralizing event appears to be late D2 deformation where existing partially or wholly discordant quartz veins act as fluid pathways. Areas of brittle deformation exhibit higher grades of gold mineralization (Cater 2011).




*Source: SRK (2012).*

Figure 1.1-3

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# Airborne Magnetic Survey Results for the Goose Property

Figure 1.1-3

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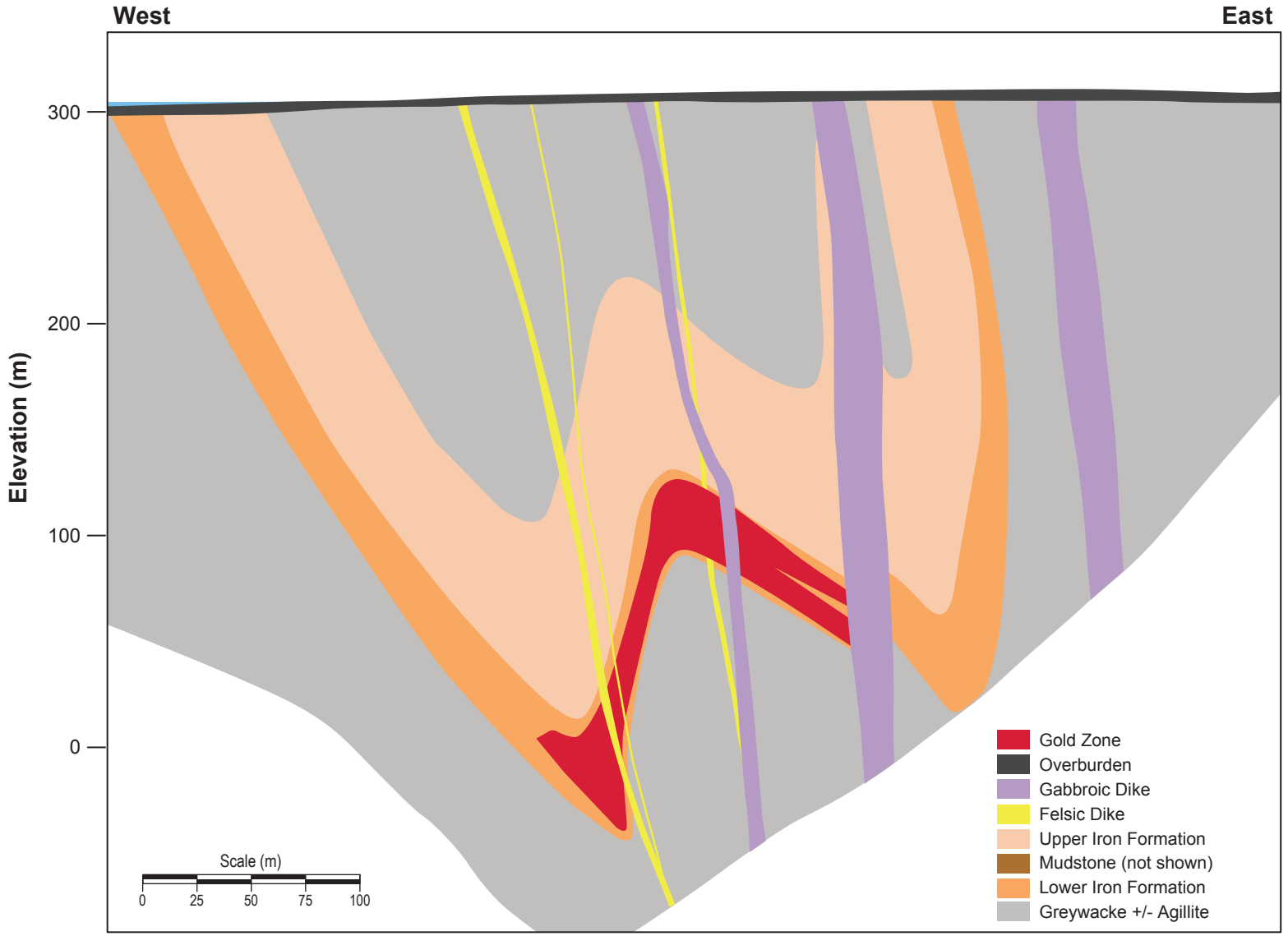


Figure 1.1-4

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## Goose Property Stylized Geologic Cross-section

Figure 1.1-4

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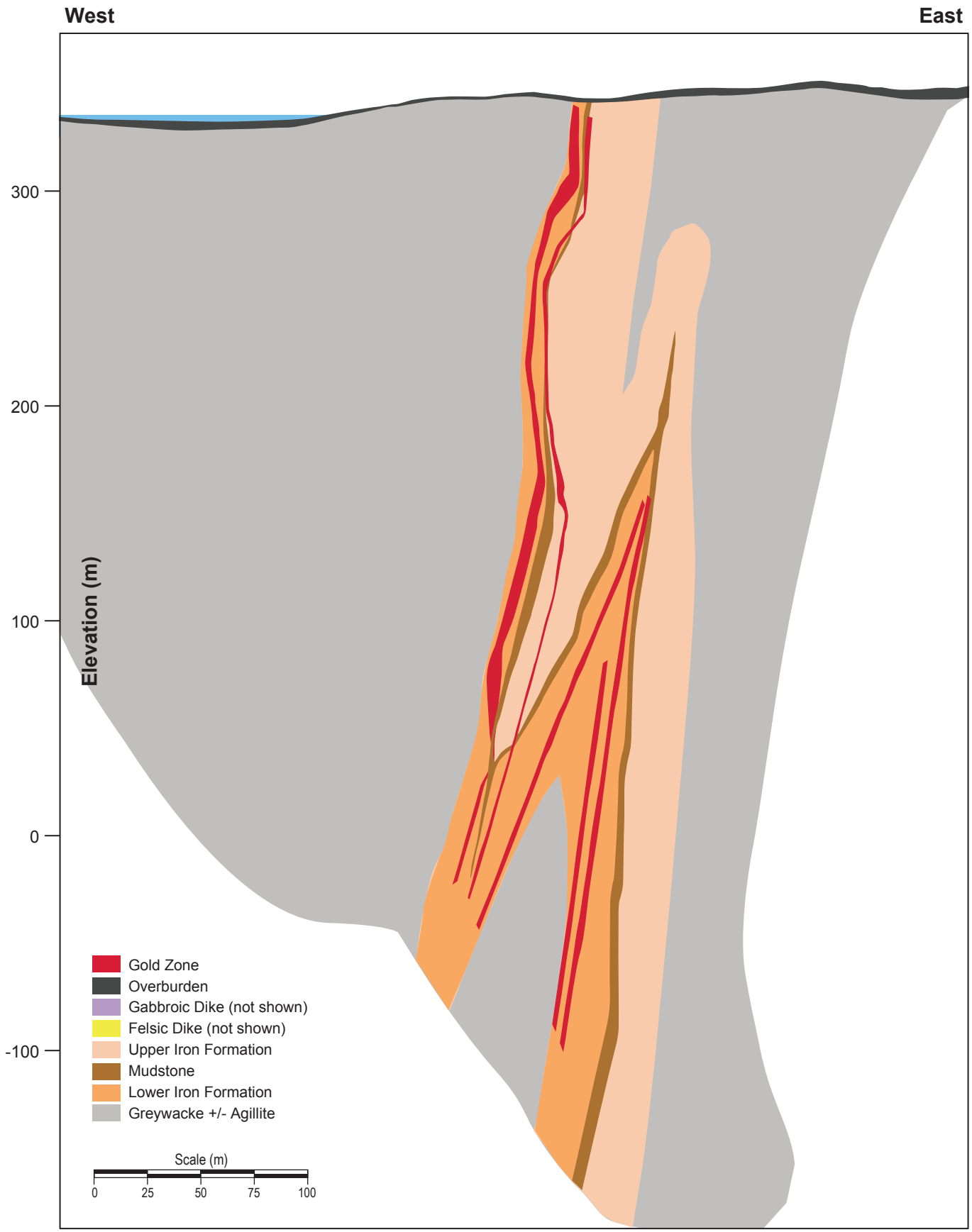
The Llama Deposit is hosted by a turbidite sedimentary sequence of locally sulphidized silicate and oxide BIF. This turbidite sequence is interbedded with greywacke, siltstone, and mudstone which contain varying amounts of minor gold mineralization. The host stratigraphy is a BIF and clastic sediment sequence that occurs within a northwest to southeast trending plunging fold. Late stage felsic and gabbroic dikes have intruded the plunging fold. The main host for the Llama Gold Zone is interpreted to be a major deformation corridor that transects a portion of the fold and is semi-concordant to the western limb (Cater 2011). Figure 1.1-4 is a stylized geologic cross-section for the Goose Property based on a typical west-east Llama Deposit cross-section. The complexity of the structural history of the Llama Deposit has been confirmed by recent drilling. It has yet to be confirmed if the gold mineralization is related to the pre-existing structural conduits in which the gabbro and porphyritic felsic dikes intruded the clastic and chemical sediments (Cater 2011). Gold mineralization in the Llama Deposit is recognized to be hosted in both chemical and clastic sedimentary lithologies as well as quartz veins within quartz ± feldspar porphyry dikes. The majority of the gold mineralization is hosted by the lower iron formation, an oxide BIF, consisting of chert + grunerite + magnetite.

The Umwelt Deposit is underlain by similar geology to that of the Main and Llama deposits with felsic and gabbroic dikes cross cutting sulphidized oxide and silicate BIFs. Airborne and ground magnetic survey results suggest that the BIFs are strongly folded. The gold mineralization occurs within quartz ± carbonate veins and sulphidized BIF lithologies most often associated with arsenopyrite ± pyrite ± pyrrhotite. Pyrite and pyrrhotite are the most common sulphides in the Umwelt Deposit with pyrrhotite becoming significantly more prominent as the gold mineralized zone becomes deeper to the south. Arsenopyrite is the most common sulphide associated with gold and occurs as euhedral individual crystals (fine to coarse grained), vein halos, and masses of crystals occasionally located preferentially along bedding planes or trailing along fractures. Magnetite appears to be replaced by pyrrhotite. The pyrrhotite is present in beds with or without magnetite and is associated with veins and fractures. Gold mineralized zones are characterized by sulphide and silica alteration accompanied by shearing and veining (Cater 2011).

#### *1.1.2.5 George Property Geology*

The George Property is located 50 km northwest of the Goose Property. The dominant underlying lithology at the George Property consists of the Beechey Lake Group greywacke, mudstone, and BIFs. The Beechey Lake Group deposits are cross-cut by felsic to intermediate sills, dikes, and small intrusions of the Regan Suite. The largest Regan Suite intrusion is a quartz-feldspar porphyry intrusion that outcrops immediately northwest of the George Property. Proterozoic-aged (Aphebian) sediments of the Goulburn Group unconformably overlie Archean-aged rocks of the Yellowknife Supergroup and are exposed on the north and east margins of the property with scattered remnants of basal unconformity material exposed elsewhere. The rocks listed above have been intruded by northwest trending gabbroic dikes. The structural and geologic grain on the property is northwest to southeast. The Archean-aged rocks have been affected by at least two early fold deformation episodes with a third fold event deforming the overlying Goulburn Group sediments (Cater 2011). Figure 1.1-5 contains a stylized west-east geologic cross section of the George Property based on the Locale 2 deposit.

The relationship of the gold genesis to the spatial correlation between certain gold deposits and ductile shearing has not been fully determined. Other faulting includes late, north to northeast, steep-dipping, conjugate brittle faults that offset stratigraphy in an oblique fashion (Cater 2011).

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# George Property Stylized Geologic Cross-section

Figure 1.1-5

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The rocks at the George Property have undergone lower to middle greenschist facies metamorphism. Iron formations on the property are dominated volumetrically by oxide BIF (magnetite ± chert ± grunerite) with subordinate silicate BIF (chert ± grunerite ± chlorite). There is evidence of the oxide BIF grading into the silicate BIF, which is a function of magnetite depletion. The BIFs occur in three distinct fold belts named from west to east, the George Belt, the Fold Nose Belt, and the Lookout Hill Belt. The common stratigraphy within these three belts suggests that they may represent one continuous sequence of BIF that has been separated, and repeated by faulting and folding, although the relationship between the three has not been clearly established. The three belts contain gold, but the largest and most important deposits located to date occur within the George Belt (including the Locale 1, Locale 2, and the GH deposits) (Cater 2011).

Mineralization Characteristics of the George Property

Gold mineralization at the George Property (Locale 1, Locale 2, and LCP North deposits) is located near the stratigraphic base of the oxide BIFs. Lower amounts of gold mineralization are also hosted within silicate BIFs. Gold-bearing zones are associated with sulphide (pyrite, pyrrhotite, and arsenopyrite) concentrations in the BIF and with veins (quartz, carbonate, hornblende), either in fractured areas within the vein, or in vein zones altered with chlorite. Occurrences of visible gold have commonly been observed within arsenopyrite grains or beside euhedral arsenopyrite grains. Gold bearing zones are associated with sulphide concentrations in the iron formation and are commonly accompanied by increae quartz weining and alteration of surrounding rock (Cater 2011). R-XRD results will be available for the FEIS.

### 1.1.3 Summary

The Project is located near the intersection of the Slave, Churchill, and Bear Geologic Provinces. Glacial material deposited after the Quaternary Wisconsin Glaciation covers much of the Archean geological provinces.

The Goose and George Properties consist of a package of variably folded and faulted sedimentary rocks. Greywacke and subordinate mudstone surround and variably interbed with silicate banded iron formation (BIF) and oxide BIF. The sedimentary package is cross-cut by mafic dikes, lesser volumes of felsic dikes and volumetrically insignificant quartz veins. The rocks in the area have undergone prograde metamorphism up to lower amphibolite facies, resulting in abundant replacement of mafic minerals by chlorite and grunerite.

Gold mineralization is most often associated with sulphide minerals, particularly arsenopyrite, and visible gold is found almost exclusively in zones with abundant arsenopyrite. Other sulphide minerals (pyrite and pyrrhotite) are typically enriched in a halo in the BIF and greywacke around the arsenopyrite-rich ore zones. The mafic dikes have very low sulphide contents and are devoid of gold mineralization.

## 1.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

### 1.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available regional level Traditional Knowledge (TK) from the Naonaiyaotit Traditional Knowledge Project (KIA 2012) was reviewed for geology existing environment and baseline information. The TK collected is focused on landforms, particularly eskers, cliffs, and soapstone, including the following comments:

> *"Black soapstone called 'okohikhaat' was used to carve the large kudlik (stone oil lamps), and for making cooking pots. Inuit looked for this stone around riverbanks or the ocean shore. Stone for making oil lamps and pots was found at a variety of places."*

> *"Ulu blades, arrowheads and knife blades were made from copper or silver. Copper used to be abundant along the Coppermine River but now all readily available metal has been collected. The major source of copper for Kiligiktokmiut was at Kanuyak (which means "copper"). Copper was also obtained from Egloyoalik (Cockburn Islands)."*
>
> *"Additional sources of carving stone were mapped at Buchan Bay, two areas at Kilanaktokvik (near Omingmaktok), and the northeast corner of Ekalulia Island."*

The areas referenced above are located hundreds of kilometres from the Project footprint.

### 1.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The KIA (2012) report presents clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the VEC/VSEC list. There were few comments relating to geology. Geology has been included as a Subject of Note, rather than a VEC or VSEC.

### 1.2.3 Incorporation of TK for Spatial and Temporal Boundaries

The Project footprint did not overlap with any known occurrences of soapstone, copper, or silver (Coppermine River, Buchan Bay, Kilanaktovik, and Ekalulia Island; KIA 2012). No soapstone was noted in drill logs, during quarry sampling or in the technical assessment report (Cater 2011).

### 1.2.4 Incorporation of TK for Mitigation and Adaptive Management

If soapstone or other valued geological units were present near Project footprint areas, these areas would be avoided by Project design. However, the areas referenced in KIA 2012 are hundreds of kilometers away from the Project footprint.

## 1.3 VALUED COMPONENTS

### 1.3.1 Potential Valued Components and Scoping

Surficial and bedrock geology were included in the scoping and refining process with all other potential VEC/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations geology is classified as a Subject of Note.

### 1.3.2 Valued Components Included in Assessment

Geology is considered a Subject of Note for the DEIS. All information requested in the NIRB-issued EIS guidelines relating to geology is included in this DEIS.

## 1.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

Additional information on the geology of the Project is provided in the technical assessment report (Cater 2011) prepared as part of a preliminary economic assessment.

# 2. Permafrost

# 2. Permafrost

## 2.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 2.1.1 Regional Setting

Permafrost extents have been characterized at a number of sites in the Canadian Arctic, including existing and prospective mine sites on mainland Nunavut (identified in Figure 2.1-1). Documentation in Environmental Impact Statement submissions to the Nunavut Impact Review Board (NIRB) has provided a publicly available database of permafrost extents at sites in similar settings as the proposed Back River Project (the Project), including the following:

- Meadowbank Gold Project (Cumberland Resources Ltd. 2005);
- Kiggavik Project (Areva Resources Canada Inc. 2011);
- High Lake Project (Wolfden Resources Inc. 2006);
- Doris North Project (SRK Consulting Inc. 2005); and
- Meliadine Gold Project (Golder Associates Ltd. 2012).

An academic research program has documented permafrost at the Lupin Mine/Exploration Site (Ruskeeniemi et al. 2002; Stotler et al. 2009). A data-sharing agreement exists with the nearby Hackett River Exploration Project under the ownership of Glencore Canada Corporation. A summary of permafrost characterization parameters available at sites located within mainland Nunavut is provided in Table 2.1-1.

All components of the Project are situated within the zone of continuous permafrost (Figure 2.1-1), as delineated in a database compiled by the Geological Survey of Canada (Government of Canada, Natural Resources Canada, and Earth Sciences Sector 2002). The Lupin, Meadowbank, Kiggavik, High Lake, Doris North, and Meliadine Sites are also situated within continuous permafrost.

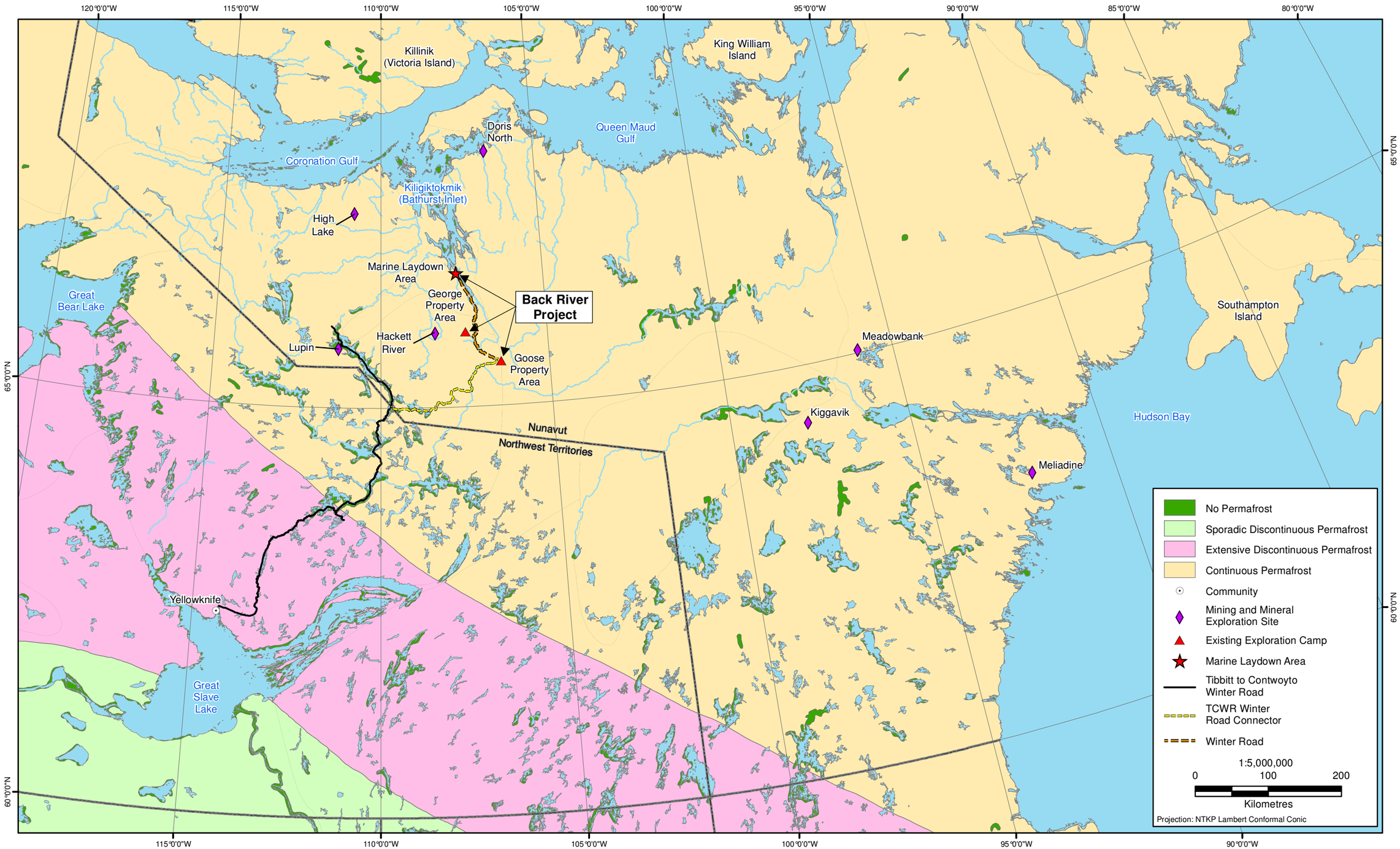
Basal permafrost depth has been estimated to be as shallow as 210 metres below grade (mbg) at the Kiggavik site (proximal to the transition to discontinuous permafrost) and as deep as 560 m at the Doris North site. Through taliks have been estimated to exist beneath lakes with radii as low as 145 m at Kiggavik and as large as 470 m at High Lake.

Permafrost at Lupin extends to depths of 400 to 600 metres below grade (mbg) in the region and 541 mbg in the mine shaft. Through talik has been identified beneath Lake Contwoyto (the lake is approximately 3 km wide by 90 km long) and is bounded vertically 30 to 60 m offshore. Talik and active layer characterization was based on interpretation of geophysical (seismic and ground penetrating radar) surveys.

**Table 2.1-1. Permafrost Characteristics Identified for Mining Projects within Mainland Nunavut**

| Project | Distance from Project [A] | Active Layer Thickness | Talik Characterization | Basal Permafrost Depth | References |
|---|---|---|---|---|---|
| Meadowbank | 510 km East | 1.3 m (overburden away from lakes), 4.0 m (adjacent to lakes), up to 6.5 m (beneath major streams) | Through taliks for lakes greater than 570 m in diameter, or long with width greater than 320 m. Talik below surface waterbodies with depth greater than 2.0 m. | 450 to 550 m, related to terrain (slopes, aspect, proximity to lakes) | Cumberland Resources Ltd. 2005 |
| Doris North | 290 km North | Not available (approximately 2.0 m 60 km south of site) | Through taliks predicted below Doris and Tail lakes (Tail Lake is 200 to 600 m wide by 2.5 km long, Doris Lake is much larger). | 550 to 560 mbg, as estimated by geothermal gradient. 400 m, as estimated by geothermal modelling | SRK Consulting Inc. 2005 |
| High Lake | 280 km Northeast | 5 m in exposed bedrock, 2 m in soils | Through talik below lakes greater than 470 m diameter, or long with width greater than 240 m. Talik below surface waterbodies with depth greater than 2 to 2.5 m. | 440 mbg | Wolfden Resources Inc. 2006 |
| Kiggivik | 430 km East | 1.0 to 5.0 m | Through talik below lakes with radius greater than 145 m, or elongated with width greater than 80 m. Talik below surface waterbodies with depth greater than 2 m. | 210 to 280 mbg | Areva Resources Canada Inc. 2011 |
| Meliadine | 800 km East | 1.0 to 3.0 m | Through taliks below lakes with radius greater than 290 to 330 m, below elongated lakes with width greater than 160 to 195 m. Taliks below surface waterbodies with depth greater than 1.0 to 2.3 m. | 360 to 495 m, as measured with thermistor strings. Depth to liquid water estimated at 375 m, based on sub-permafrost TDS measurements. | Golder Associates Ltd. 2012 |
| Lupin | 220 km East | 1.2 to 1.8 m | Through talik below Lake Contwoyto bounded vertically 30 to 60 m offshore. | 400 to 600 m regionally, 541 m locally in mine shaft. | Stotler et al. 2009; Ruskeeniemi et al. 2002 |
| Hackett River | 100 km East | 1.8 to 2.4 m | Lakes with widths greater than 200 m were predicted to overlie through taliks, however warmer and deeper lakes with smaller widths may also overlie through taliks. | 520 mbg as indicated by two deep thermistor strings- basal cryopeg from 440 to 520 mbg. | Rescan 2013b |

[A] *Estimated distances from the existing Goose exploration camp*




Sabina GOLD & SILVER CORP.

Rescan an ERM company

**Figure 2.1-1**

## Regional Permafrost Context

### 2.1.2 Local Setting

Site investigations as early as 2007 have provided subsurface temperature records. Existing data and analyses that have been used to characterize the permafrost environment are documented in the following sources:

- 2010 Goose Property Thermistor Data Summary Memorandum Report Prepared by Rescan Environmental Services Ltd. for Sabina Gold & Silver Corp. (Rescan 2010a, Appendix V5-2A);
- 2012 Goose Property Thermistor Data Summary Memorandum Report Prepared by Rescan Environmental Services Ltd. for Sabina Gold & Silver Corp. (Rescan 2012, Appendix V5-2B);
- Back River 2012 Geotechnical and Hydrogeological Drilling Program Factual Data Report Prepared by SRK Consulting Inc. for Sabina Gold & Silver Corp. (Appendix V6-2C); and
- 2013 Geomechanical and Hydrogeological Site Investigation Prepared by Knight Piésold Consultants Inc. for Sabina Gold & Silver Corp. (Appendix V6-2D).

Field and analytical methods employed to characterize the subsurface permafrost environment and thermal regime are described in Section 2.1.2.1, followed by the results and interpretations for the Goose Property Area (Section 2.1.2.2), George Property Area (Section 2.1.2.3), and Marine Laydown Area and winter road corridors (Section 2.1.2.4).

Permafrost has been defined by convention as the subsurface extents that remain perennially below 0ºC. Cryopegs may exist within the base of permafrost where fluids are present in the fractures and pores at temperatures less than 0ºC.

#### *2.1.2.1 Field and Analytical Methods*

Site Instrumentation

Borehole thermistor strings have been the principal tool used to measure subsurface temperatures, and to estimate permafrost extents. Vibrating wire piezometers (VWPs) and a Wesbtay system have also been used to characterize the permafrost. All installed instruments used to characterize the permafrost are identified in Figures 2.1-2 and 2.1-3 for the Goose and George Property Areas, respectively.

Thermistor strings have been installed in 18 boreholes, including 13 at the Goose Property Area and five at the George Property Area. Seasonal manual measurements dating back as early as 2007 exist for one 300 m long thermistor string at the Goose Property. Continuous daily temperature measurement logging began at two thermistor strings at the Goose Property in 2011. Three thermistor strings were installed at the Goose Property in 2012 and programmed for daily data logging. Eight thermistor strings were installed at the Goose property and five at the George Property in 2013, all programmed for daily data logging. The depths and elevations spanned by each thermistor string vary, with the shortest string penetrating 20 metres below grade (mbg) and the longest 652 mbg. All installed thermistor strings are identified in Figures 2.1-2 and 2.1-3. Construction details and available records for each individual thermistor string are identified in the primary documentation (Appendices V6-2C and V6-2D).

All thermistor strings were installed fixed to a PVC support pipe. Backfill materials varied, as did the manufacturers and models of thermistor strings and data loggers. Modern industrial-grade thermistors generally provide precision to the nearest 100th of a degree, and are calibrated for +/- 0.01ºC accuracy by the manufacturer. Installation methods, calibration results, and manufacturer/model information is

provided in the primary sources documenting the thermistor string installations (Appendices V6-2C and V6-2D).

Damage to individual thermistor nodes or wires during installation or freeze-back occurs occasionally. Thermistor nodes that were interpreted to be damaged were not included in analyses. Damage is considered to have occurred where physically unreasonable readings occurred. Physically unreasonable readings include considerable temperature variability below the depth of zero amplitude (depth below which no seasonal temperature variability is expected), and temperatures that lie considerably outside the expected trumpet-curve temperature vs. depth shape.

Subsurface temperatures were measured within the Westbay system casing using a thermistor installed in the sampling probe. A temperature profile was developed by taking temperature readings at a range of depths within the casing. Further information regarding methods used for data collection from the Westbay system is provided in Volume 6, Chapter 2 (Groundwater).

VWPs provide temperature readings. Certain VWPs were installed within the permafrost, as indicated by a building pressure profile resulting from freeze-back. VWPs installed in the permafrost have been used to bound cryopeg extents. Further information regarding installation and data collection methods employed for vibrating wire piezometers are presented in Volume 6, Chapter 2 (Groundwater).

Permafrost Characterization and Delineation

Thermal characteristics of the subsurface were determined by inspection of the temperature vs. depth and temperature time series obtained from the thermistor strings. The depth of the active layer (surficial layer that undergoes an annual freeze/thaw cycle) was determined by interpolating between the deepest thermistor node indicating summer thaw and the shallowest perennially frozen, at the time when the summer thaw attained its greatest depth of penetration (typically mid-September). The depth of zero amplitude was determined by interpolating between the deepest node demonstrating seasonal temperature variability (greater than 0.05ºC) and the shallowest demonstrating a static temperature year-round. The basal depth of the permafrost was determined by extrapolating along the geothermal gradient beneath the deepest node to a temperature of 0.0ºC, or by interpolating between nodes that straddle 0ºC at depth.

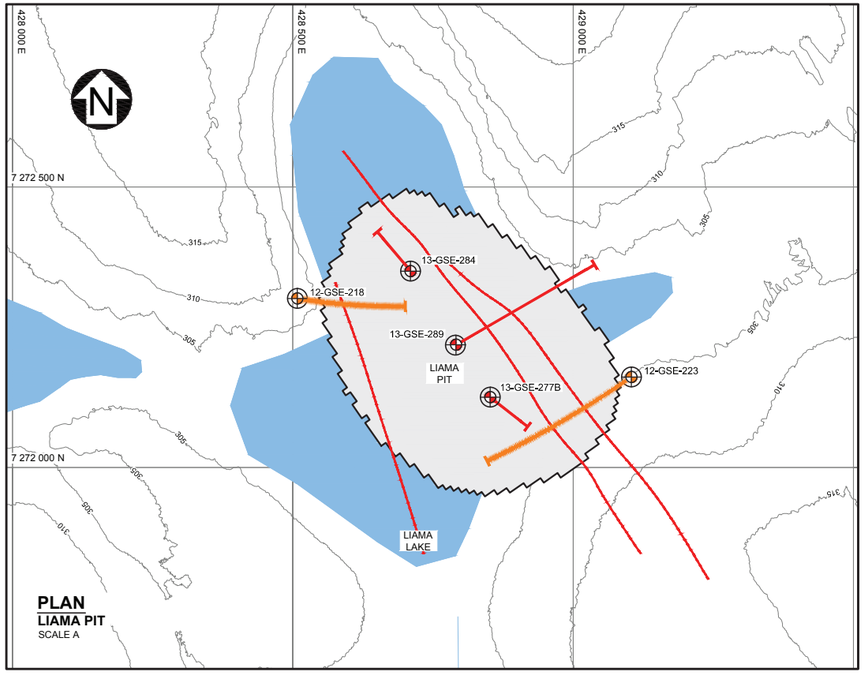
Cryopeg Extent Estimation

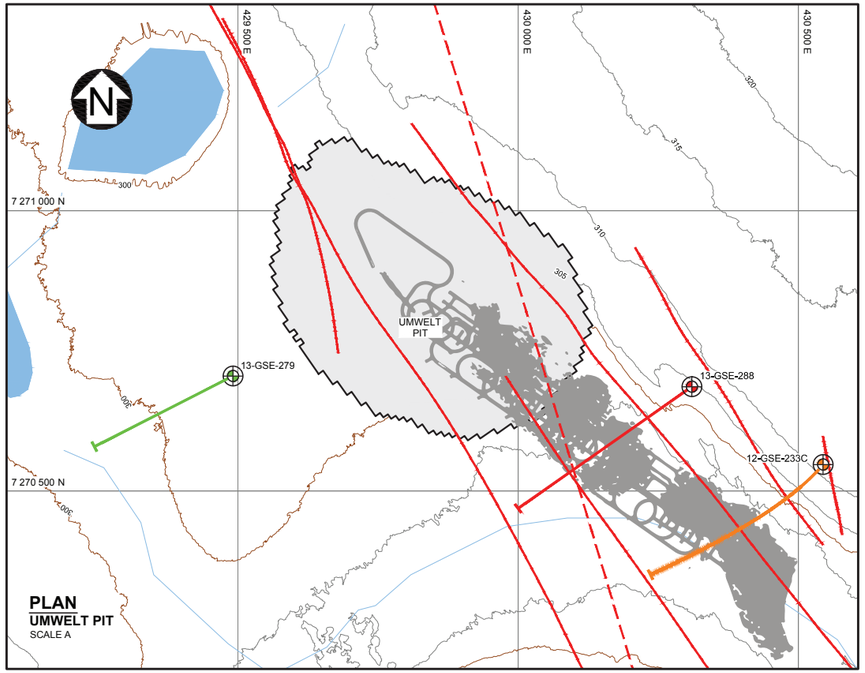
Cryopegs may exist in the permafrost where the salinity of the pore fluids depresses their freezing temperature. Cryopegs have been theorized to exist at the base of the permafrost and beneath lake talik where groundwater has been shown to be hyper-saline.

Groundwater samples were collected from a Westbay sub-permafrost groundwater monitoring system installed adjacent to the Umwelt Deposit, indicating hyper-saline groundwater (Refer to Volume 6, Chapter 2). The total dissolved solids (TDS) reported for the Westbay samples were used to generate a freezing temperature vs. depth profile. The freezing temperature of water may be estimated using equation 1 (adapted from Ebbing 1990).

$$T = K_f m i \qquad (1)$$

Where $T$ = Freezing temperature of water;
$K_f$ = Cryoscopic constant of the solvent ($K_f$ = 1.853 K*kg/mol for water);
$m$ = Molality of the sample solution; and
$i$ = Van't Hoft Factor (number of ion particles per individual molecule of solute).



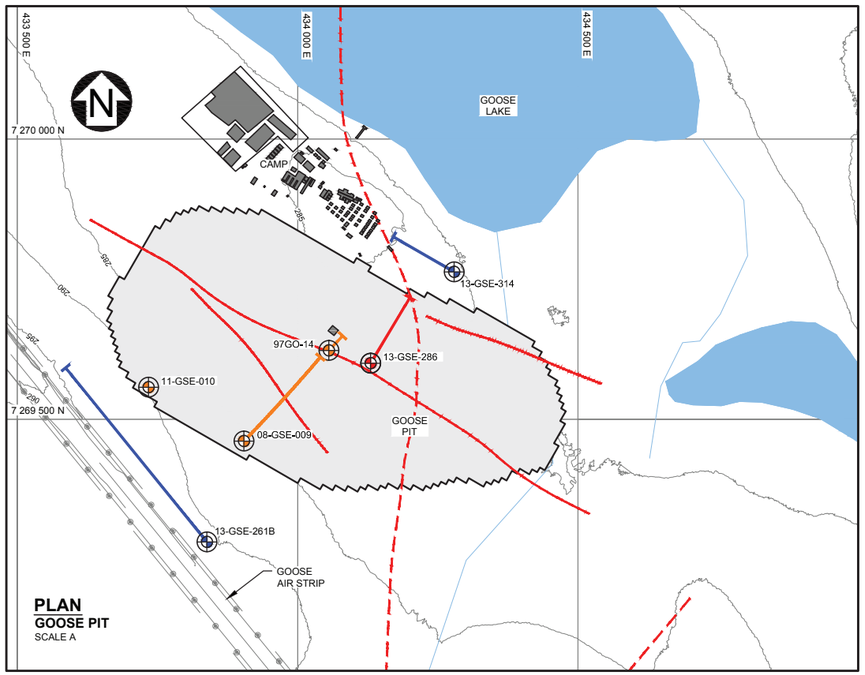



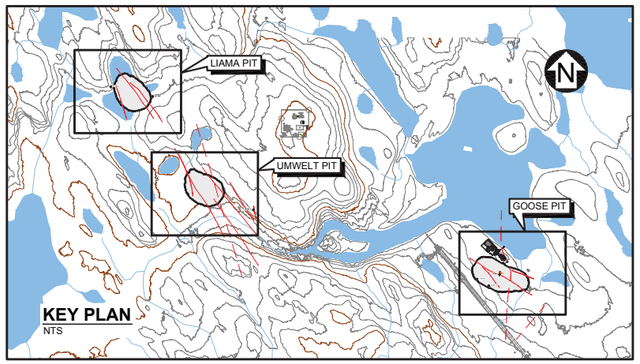

**LEGEND:**

- 2013 GEOMECHANICAL DRILLHOLE
- 2013 HYDROGEOLOGIAL DRILLHOLE OR EXPLORATION DRILLHOLE
- TWINNED WESTBAY ENVIRONMENTAL DRILLHOLE
- HISTORICAL GEOMECHANICAL OR EXPLORATION DRILLHOLE
- INSTRUMENTATION INSTALLED IN DRILLHOLE
- FAULT INTERSECTION WITH SURFACE
- BUILDING / STRUCTURE
- PROPOSED OPEN PIT OUTLINE
- PROPOSED UNDERGROUND MINE

**NOTES:**

1. COORDINATE GRID IS UTM (NAD83) ZONE 13.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, NOVEMBER 9, 2012.
3. CONTOUR INTERVAL IS 5 METRES.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. FAULTS AND BUILDINGS BASED ON INFORMATION PROVIDED BY SABINA, RECEIVED JANUARY 28, 2013 AND MARCH 15, 2013.
6. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.
7. PROPOSED OPEN PIT SHELLS PROVIDED BY AMC, DATED MAY 8, 2013.




**Installation Details and Data History**

| Borehole ID | Collar Location | | | Dip | Thermistor node elevation range (masl) | VWP elevations (masl) | Records | Reference |
|---|---|---|---|---|---|---|---|---|
| | Northing (m) | Easting (m) | Elevation (masl) | | | | | |
| ***Main Deposit Area*** | | | | | | | | |
| 97GO-14 | 7269623 | 434056 | 282 | 45 | 281 to 275 | - | Five manual measurements 2007-2010 | Rescan 2010 |
| 08-GSE-009 | 7269461 | 433904 | 286 | 57 | 286 to -14 | - | continuous 17/08/2011 to 27/02/2013 | Rescan 2012 |
| 11-SRK-GL-10 | 7269557 | 433734 | 294 | 90 | 294 to 274 | - | Nine manual readings May 2008 to Sep. 2010, Continuous 17/8/2011 to 27/2/2013 | Rescan 2012 |
| 13-GSE-261B | 7,269,381 | 433,838 | 289 | 54 | 270 to -163 | -162.6,-240.4 | continuous 30/03/2013 to 23/04/2013, 27/04/2013-14/06/2013 | KP 2013 |
| 13-GSE-286 | 7,269,612 | 434,066 | 283 | 47 | 268 to 136 | 135.8 | continuous 08/04/2013 to 25/06/2013 | KP 2013 |
| 13-GSE-314 | 7,269,764 | 434,278 | 280 | 51 | 263 to 123 | 122.7 | continuous 08/05/2013 to 25/06/2013 | KP 2013 |
| ***Umwelt Deposit Area*** | | | | | | | | |
| 12-GSE-233C | 7270547 | 430544 | 311 | 57 | 251 to -213 | -246 | continuous 27/08/2012 to 15/2/2013 | SRK 2012 |
| 13-GSE-279 | 7,270,260 | 430,189 | 297 | 68 | 283 to -197 | -138, -197.1 | continuous 15/04/2013 to 26/05/2013 | KP 2013 |
| 13-GSE-288 | 7,270,686 | 430,310 | 305 | 42 | 289 to -85 | -76.9 | continuous 09/05/2013 to 26/05/2013 | KP 2013 |
| ***Liama Deposit Area*** | | | | | | | | |
| 12-GSE-218 | 7272301 | 428508 | 307 | 50 | 280 to 89 | 77 | continuous 12/10/2012 to 15/2/2013 | SRK 2012 |
| 12-GSE-223 | 7272161 | 429104 | 306 | 42 | 224 to 16 | 12 | continuous 12/10/2012 to 15/2/2013 | SRK 2012 |
| 13-GSE-277B | 7,272,125 | 428,852 | 303 | 58 | 288 to 169 | 169.0 | continuous 02/04/2013 to 14/06/2013 | KP 2013 |
| 13-GSE-284 | 7,272,370 | 428,710 | 303 | 57 | 287 to 169 | 169.5 | continuous 12/04/2013 to 27/06/2013 | KP 2013 |
| 13-GSE-289 | 7,272,218 | 428,790 | 303 | 50 | 295 to -77 | 222.4, -76.9 | continuous 04/05/2013 to 27/06/2013 | KP 2013 |

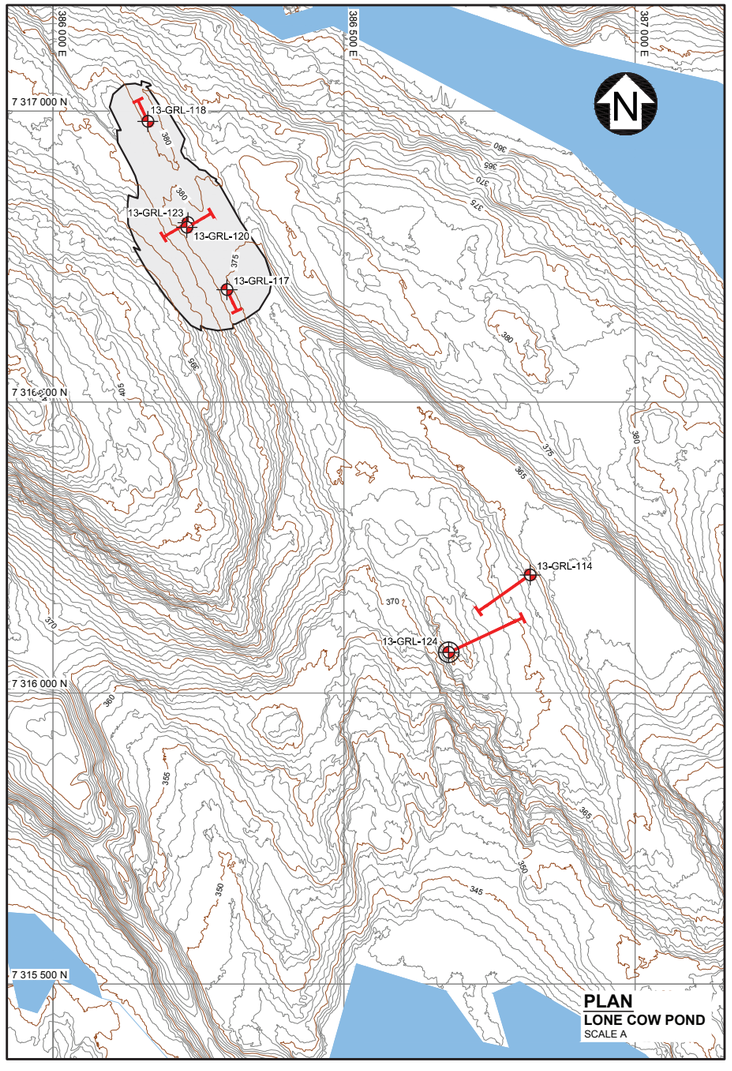
100 50 0 100 200 300 400 500 m
SCALE A

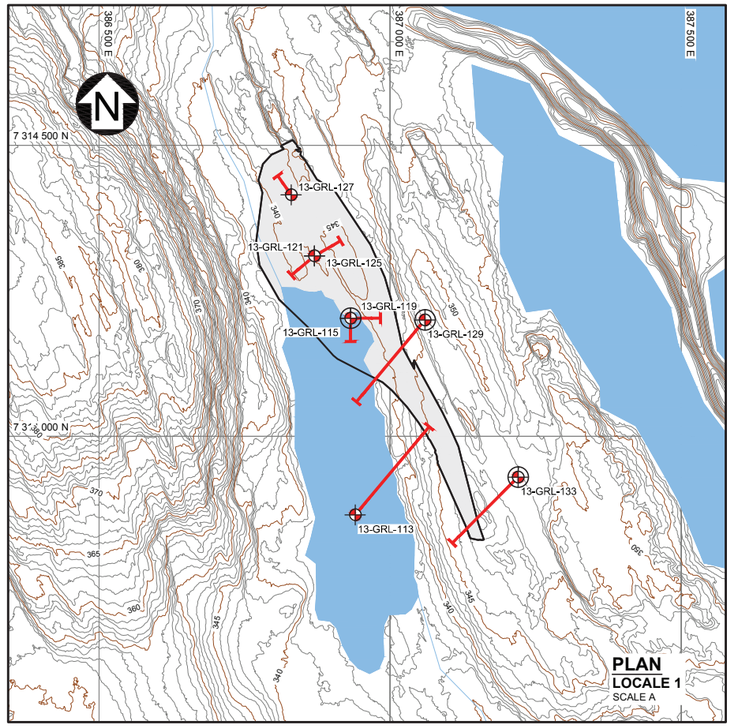
Sabina GOLD & SILVER CORP. Rescan Engineers & Scientists

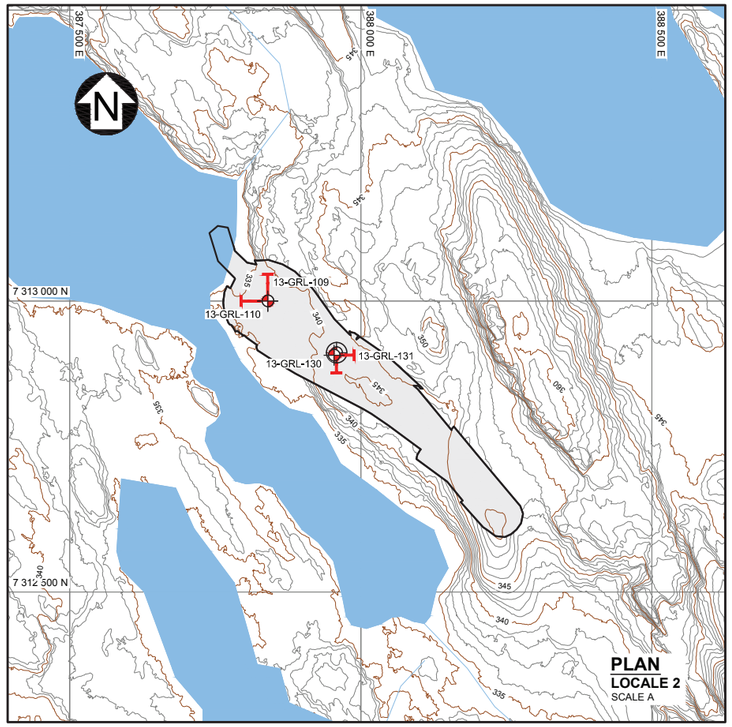
*Source: Knight Piésold Ltd (2013).*

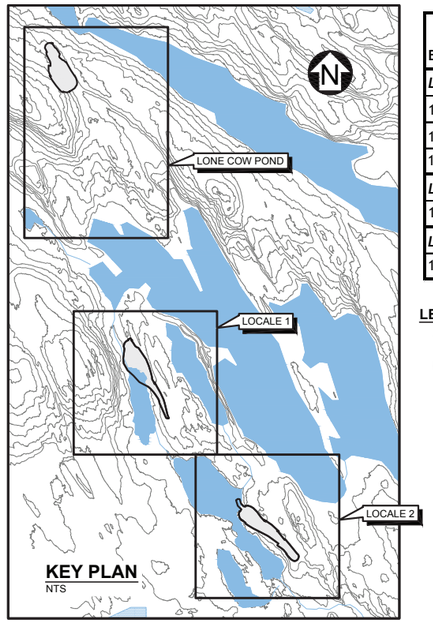
Figure 2.1-2

**Installed Instruments Used for Characterization of the Existing Permafrost Environment at the Goose Property Area**




**Installation Details and Data History**

| Borehole ID | Northing (m) | Easting (m) | Elevation (masl) | Dip | Thermistor node elevation range (masl) | VWP elevations (masl) | Records | Reference |
|---|---|---|---|---|---|---|---|---|
| *Locale 1 Deposit Area* | | | | | | | | |
| 13-GRL-115 | 7,314,200 | 386,932 | 337 | 52 | 334-287 | - | continuous 28/05/2013 to 21/07/2013 | KP 2013 |
| 13-GRL-129 | 7,314,199 | 387,059 | 348 | 52 | 335-191 | 191.0 | continuous 10/06/2013 to 21/07/2013 | KP 2013 |
| 13-GRL-133 | 7,313,928 | 387,218 | 347 | 50 | 334-194 | - | continuous 12/06/2013 to 21/07/2013 | KP 2013 |
| *Locale 2 Deposit Area* | | | | | | | | |
| 13-GRL-130 | 7,312,904 | 387,962 | 344 | 54 | 330-298 | 297.3 | continuous 06/06/2013 to 21/07/2013 | KP 2013 |
| *Lone Cow Pond Area* | | | | | | | | |
| 13-GRL-124 | 7,316,085 | 386,678 | 376 | 59 | 362-206 | - | continuous 01/06/2013 to 21/07/2013 | KP 2013 |

**LEGEND:**

- GEOMECHANICAL DRILLHOLE
- INSTRUMENTATION INSTALLED IN DRILLHOLE
- PROPOSED OPEN PIT OUTLINE

**NOTES:**

1. COORDINATE GRID IS UTM (NAD83) ZONE 13.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, DATED NOVEMBER 9, 2012.
3. CONTOUR INTERVAL IS 1 METRE.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.
6. PROPOSED UNDERGROUND MINE LAYOUT AND OPEN PIT SHELLS PROVIDED BY AMC, DATED MAY 8, 2013.

SCALE A 200 100 0 200 400 600 800 1000 m

Sabina GOLD & SILVER CORP. Rescan Engineers & Scientists

*Source: Knight Piésold Ltd (2013).*

Figure 2.1-3

**Installed Instruments Used for Characterization of the Existing Permafrost Environment at the George Property Area**

A TDS versus depth profile was generated by adopting a linear interpolation between measured concentrations of salts in the sub-permafrost groundwater at two different depths. A freezing temperature versus depth profile was then generated using equation 1. A Van't Hoft factor of 2.6 was used, as the groundwater is dominated by a mixture of sodium chloride (i of 2) and calcium chloride (i of 3). However varying the Van't Hoft factor between 2 and 3 had little effect on the resulting basal cryopeg thickness prediction.

Vertical extents of the basal cryopeg were determined by plotting the freezing temperature profile alongside the measured temperature profile. The intercept represents the depth above which the temperature is lower than the freezing temperature of the groundwater. The temperature versus depth profile measured at the Umwelt Westbay System was used.

A linear TDS versus depth profile may be regarded as highly conservative. Frape and Fritz (1987) and Kuchling, Chorley, and Zawadzki (2000) suggest a logarythmic relation; however, their sites are not in continuous permafrost environments and a logarythmic relationship does not fit the observations at the Umwelt Westbay system. Frozen VWPs were used to adjust the inferred basal cryopeg upper limit.

Talik Extent Estimation Using One-dimensional Steady-state Analytical Geothermal Models

Talik can generally be expected below lakes with depths greater than two thirds of the maximum thickness of ice forming annually on their surface (Mackay 1992). Ice thicknesses and bathymetry data (refer to Volume 6, Chapter 3) have been used to identify lakes which are theorized to overlie taliks.

Models documented by Mackay (1962), Smith (1976), and Burn (2002) have been used to generate temperature profiles below the deepest cross-sections of lakes with and without terraces. These models were developed for use at study sites in the Canadian Arctic and have been used for talik characterization at other proposed mine projects located in the continuous permafrost region of mainland Nunavut, including the Meliadine (Golder Associates Ltd. 2013), Kiggavik (Areva Resources Canada Inc. 2011), High Lake (Wolfden Resources Inc. 2006), Doris North (SRK Consulting Inc. 2005), and Meadowbank (Cumberland Resources Ltd. 2005) projects.

The vertical extents of talik beneath round lakes have been modelled by Mackay (1962). The temperature profile beneath the centre of a circular lake without terraces may be modelled using equation 2.

$$T_z = T_g + \frac{z}{I} + (T_p - T_g)\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right) \qquad \text{(2; adapted from Mackay 1962)}$$

Where $T_z$ = temperature at depth z (°C);
$T_p$ = average annual temperature at the bottom of the lake (°C);
$T_g$ = average annual ground temperature (°C);
$I$= inverse of the geothermal gradient (m/°C);
$z$ = depth below bottom of lake (m); and
$R$ = radius of the lake (m).

The temperature profile beneath the centre of a circular lake with terraces may be modelled using equation 3.

$$T_z = T_g + \frac{z}{I} + (T_p - T_g)\left(1 - \frac{z}{\sqrt{z^2+R_p^2}}\right) + (T_t - T_g)\left(\frac{z}{\sqrt{z^2+R_p^2}} - \frac{z}{\sqrt{z^2+R_{p+t}^2}}\right) \qquad \text{(3; adapted from Burn 2002)}$$

Where $T_z$ = temperature at depth z (ºC);
$T_p$ = average annual temperature at the bottom of the central pool (ºC);
$T_t$ = average annual temperature at depth along the terrace (ºC);
$T_g$ = average annual ground temperature (ºC);
$I$= inverse of the geothermal gradient (m/ºC);
$z$ = depth below bottom of lake (m);
$R_P$ = radius of the central pool (m); and
$R_{P+t}$ = radius of the lake, including terraces (m).

Smith (1976) provides an analytical method for thermal profiling beneath elongated lakes. The temperature profile beneath the centroid of a symmetrical elongated lake (without terraces) may be estimated using equation 4.

$$T_z = T_g + \frac{z}{I} + \frac{T_p - T_g}{\pi}\left(2\tan^{-1}\frac{w}{z}\right) \quad \text{(4; adapted from Mackay 1962)}$$

Where $T_z$ = Temperature at depth z (ºC);
$T_p$ = Average annual temperature at the bottom of the lake (ºC);
$T_g$ = Average annual ground temperature (ºC);
$I$= inverse of the geothermal gradient (m/ºC);
$z$ = depth below bottom of lake (m); and
$w$ = half width of an elongated lake/pool.

Burn (2002)provides an analytical method for thermal profiling beneath elongated lakes with terraces. The temperature profiles beneath the centroid of an elongated lake with terraces may be modelled using equation 5.

$$T_z = T_g + \frac{z}{I} + \frac{T_t - T_g}{\pi}\left(2\tan^{-1}\frac{H_{p+t}}{z}\right) + \frac{T_p - T_t}{\pi}\left(2\tan^{-1}\frac{H_p}{z}\right) \quad \text{(5; adapted from Burn 2002)}$$

Where $T_z$ = temperature at depth z (ºC);
$T_p$ = average annual temperature at the bottom of the central pool (ºC);
$T_t$ = average annual temperature at depth along the terrace (ºC);
$T_g$ = average annual ground temperature (ºC);
$I$ = inverse of the geothermal gradient (m/ºC);
$z$ = depth below bottom of lake (m);
$H_P$ = half width of the central pool (m); and
$H_{P+t}$ = half width of the lake, including terraces (m).

Water temperatures have been derived from measurements documented in freshwater aquatic ecology baseline reports (refer to Volume 6, Chapter 3). Lake-bottom temperatures were taken to be a weighted mean (Equation 6) of winter (April) and summer (August) measurements at the deepest points available. Measurements taken in April were treated as representative of the mean temperature during months with ice cover (October through May). August temperatures were treated as the mean water temperature during ice-free months. Maximum water temperatures are typically observed during August in the Canadian Arctic (e.g., Burn 2002). Therefore the computed annual average water temperature is likely somewhat high, resulting in conservative (high) estimates of present talik extents.

$$\bar{T} = 8T_{apr} + 4T_{Aug} \quad (6)$$

Terrace water temperatures were estimated from corresponding depths in temperature profiles obtained at survey locations, which are typically situated in deeper pools. Weighted averages were also used to determine annual average temperatures along terraces (equation 6). Where terraces freeze during the winter a temperature of 0ºC was used for the winter months.

The geothermal gradient and mean ground temperature were calculated from thermistor string records. Geothermal gradients of 70 and 83 m/ºC have been adopted for Goose and George Property Areas, respectively. The geothermal gradient adopted for the George Property was determined based on deep temperature measurements at the Hackett River exploration site, 40 km to the west (similarities between the George Property and Hackett River site are discussed in Section 2.1.2.3).

Lake dimensions were obtained from bathymetry data (refer to Volume 6, Chapter 3).

Burn (2002) provides validation for the equations of Mackay (1962) with field data from a site in the continuous permafrost region of the Canadian Arctic. Limitations of the sub-lake temperature models that have been used must none-the-less be recognized for interpretations. The equations (equations 2, 3, 4, and 5) are one-dimensional. Local variability in the geothermal gradient arising from geologic considerations is not accounted for. For example, different rock types may possess different heat conductivity properties. Ground temperature may vary across the site due to different overburden types and variability in ambient conditions, such as snow cover and sun exposure. Ideal lake geometries are assumed, however real lakes can only be approximated as elongated or round. Steady-state conditions are assumed. Paleo-climate variability is not considered, and the temperature at depths up to 600 mbg may be influenced by air temperatures as far into the past as 100,000 years (Lunardini 1995). A recent change in water or ground temperature or lake geometry would induce transience in the thermal regime.

A temperature envelope was developed for each sub-lake temperature profile to address uncertainty. A “cold case” sub-lake temperature profile was created by treating all lakes as round, using a geothermal gradient 10 m/ºC lower, and using water and ground temperatures 0.5ºC colder than the calculated annual mean values. A “warm case” profile was created treating the lake as elongated, using a geothermal gradient 10 m/ºC warmer, and using water and ground temperatures 0.5ºC warmer than the calculated annual mean values. The warm case results in a highly conservative estimate of present talik depth (favouring greater talik extents, and presenting a more extensive groundwater flow regime exposed to ground surface). The cold case provides a measure of confidence for through talik identification.

The thermal model results have been used to categorize the taliks beneath lakes as open taliks less than 50 m deep, open taliks 50 to 200 m deep, or through taliks. Where a through talik was predicted for all model cases (cold, base, and warm cases) the confidence in a through talik prediction was considered high. Where through talik was predicted for the base and warm cases, but not the cold case, the confidence in an identified through talik was considered moderate.

A number of lakes located within and near the potential development areas were not included in the modelling exercises. Interpreted talik extents have been estimated for a number of lakes not included in the modelling exercises by comparison with lakes of similar size and shape that were included in the modelling exercises.

Input parameters adopted for each sub-lake geothermal model are listed in Table 2.1-2.

**Table 2.1-2. Input Parameters for Sub-lake One-dimensional Analytical Geothermal Models**

| Lake | Water Temperatures (°C) [A] | | | | | Radius or Half-width (m) [B] | Approximately Elongated or Circular | Terraced (Yes/No) | Central Pool Radius or Half-width (m) | Terrace-bottom Temperature [C, E] | Analytical Model [F] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | April Mean | Aug. Mean | Weighted Mean [D] | Cold Case | Warm Case | | | | | | |
| ***Goose Property Area*** | | | | | | | | | | | |
| Big | 3.9 | 10.8 | 5.3 | 4.8 | 5.8 | 800 | Elongated | No | - | - | 4 |
| Chair | 2.1 | 10.9 | 4.1 | 3.6 | 4.6 | 200 | Elongated | No | - | - | 4 |
| Echo | 0 | 10.4 | 2.6 | 2.1 | 3.1 | 80 | Circular | No | - | - | 2 |
| Fox | 3.3 | 12.2 | 5.3 | 4.7 | 5.8 | 210 | Elongated | No | - | - | 4 |
| Gander Pond | 1.9 | 10.5 | 3.9 | 3.4 | 4.4 | 80 | Elongated | No | - | - | 4 |
| Giraffe North | 2.9 | 12.5 | 5.1 | 4.5 | 5.6 | 230 | Elongated | No | - | - | 4 |
| Giraffe South | 3.7 | 11.2 | 5.3 | 4.7 | 5.8 | 150 | Elongated | No | - | - | 4 |
| Goose (Central) | 2.4 | 13.4 | 5.0 | 4.4 | 5.5 | 460 | Elongated | No | - | - | 4 |
| Goose (Neck) | 2 | 14.15 | 4.9 | 4.3 | 5.4 | 135 | Elongated | No | - | - | 4 |
| Goose (Tail) | 3.6 | 11.8 | 5.4 | 4.8 | 5.9 | 105 | Elongated | No | - | - | 4 |
| Llama | 2.7 | 12.3 | 4.9 | 4.3 | 5.4 | 160 | Elongated | No | - | - | 4 |
| Mam | 4.1 | 9.6 | 5.1 | 4.6 | 5.6 | 110 | Circular | N/A | - | - | 2 |
| Moby | 1.8 | 11.5 | 4.1 | 3.5 | 4.6 | 320 | Circular | N/A | - | - | 2 |
| Pond 19 | 0 | 9.6 | 2.4 | 1.9 | 2.9 | 40 | Elongated | N/A | - | - | 4 |
| Propeller | 2.7 | 14.1 | 5.3 | 4.8 | 5.8 | 900 | Elongated | N/A | - | - | 4 |
| Rabbit | 0 | 10.5 | 2.6 | 2.1 | 3.1 | 150 | Elongated | Yes | 60 | 0.0 | 5 |
| Rascal | 1 | 10.5 | 3.3 | 2.8 | 3.8 | 130 | Elongated | N/A | - | - | 4 |
| Umwelt | 2.1 | 12.5 | 4.5 | 4.0 | 5.0 | 120 | Elongated | No | - | - | 4 |
| ***George Property Area*** | | | | | | | | | | | |
| Dragon | 4 | 11.5 | 5.5 | 5.0 | 6.0 | 185 | Elongated | N/A | - | - | 4 |
| Fold | 2.6 | 11.5 | 4.6 | 4.1 | 5.1 | 200 | Elongated | N/A | - | - | 4 |
| George | 3.5 | 10.9 | 5.1 | 4.5 | 5.6 | 310 | Elongated | Yes | 100 | 1.7 | 5 |

*(continued)*

**Table 2.1-2. Input Parameters for Sub-Lake One-Dimensional Analytical Geothermal Models (completed)**

| Lake | Water Temperatures (°C) [A] | | | | | Radius or Half-width (m) [B] | Approximately Elongated or Circular | Terraced (Yes/No) | Central Pool Radius or Half-width (m) | Terrace-bottom Temperature [C, E] | Analytical Model [F] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | April Mean | Aug. Mean | Weighted Mean [D] | Cold Case | Warm Case | | | | | | |
| ***George Property Area (cont'd)*** | | | | | | | | | | | |
| Komatic | 3.6 | 11.2 | 5.2 | 4.7 | 5.7 | 155 | Elongated | N/A | - | - | 4 |
| Lytle | 0 | 10.7 | 2.7 | 2.1 | 3.2 | 70 | Elongated | No | - | - | 4 |
| Occurrence | 0 | 11.6 | 2.9 | 2.4 | 3.4 | 175 | Circular | No | - | - | 2 |
| Lower Long | 2.5 | 11.4 | 4.5 | 4.0 | 5.0 | 200 | Elongated | N/A | - | - | 4 |
| Sleigh | 0 | 11.1 | 2.8 | 2.2 | 3.3 | 100 | Elongated | No | - | - | 4 |

*Notes*

*[A] Estimated from deepest measurement at profiling location*

*[B] Measurements based on Bathymetry surveys (Appendix V6-3E). Half-width measured along secondary axis for lakes with elongated shapes.*

*[C] Terrace-bottom temperature estimated from corresponding depth in temperature profile obtained at survey location.*

*[D] Weighted Mean determined by applying April temperature for eight months of ice cover, August temperature for two months (summer), half of August temperature for two months (ice-free spring and fall).*

*[E] Where average terrace depth is less than 2.0 m a temperature of 0.0°C is used.*

*[F] Equation numbers refer to those presented in the text, as adapted from McKay (1962) and Burn (2002).*

### *2.1.2.2 Goose Property Area*

Permafrost Extents

Thermistor strings installed at the Goose Property Area (Figure 2.1-2) indicate the presence of permafrost approximately 500 m thick (Table 2.1-3). The active layer has been measured to penetrate up to 1.65 mbg. Depth of zero amplitude is approximately 19 mbg. The basal permafrost depth ranges from 195 to 240 metres below sea level (mbsl), corresponding with 490 to 530 mbg.

**Table 2.1-3. Permafrost Properties Interpreted from Subsurface Temperature Data Acquired at the Goose Property Area**

| Installation | Active Layer Depth (mbg) | Basal Permafrost Depth | | Zero Amplitude Depth (mbg) |
|---|---|---|---|---|
| | | mbg | masl | |
| 08-GSE-009 Thermistor String | 1.25 | 500 | -215 | 19 |
| 11-SRK-GL-10 | 1.65 | na | | 19 |
| 13-GSE-319 Westbay Well | na | 490 | -195 | na |
| 13-GSE-261B | na | 530 | -240 | na |
| 13-GSE-279 | na | 495 | -200 | na |

*na = temperature measurements not available at depths necessary for corresponding interpretation*

Basal Cryopeg Extents

Hypersaline groundwater has been observed and characterized beneath the permafrost (results of the Westbay Program are described in Volume 6, Chapter 2), suggesting presence of a basal cryopeg. A linear interpolation of TDS between sampling zones 3 (620 mbg) and 5 (515 mbg) extrapolates to a basal cryopeg reaching as high as 300 mbg. VWPs have frozen back at depths up to 382 mbg. Thus, the thickness of the basal cryopeg has been estimated to be approximately 100 m (Figure 2.1-4). Fluids are inferred to exist in fracture spaces at depths exceeding approximately 400 mbg throughout the Goose Property Area.

Talik Extents

Sub-lake temperature profiles derived from steady-state one-dimensional analytical geothermal modelling are presented in Figures 2.1-5a to 2.1-5b. Taliks are interpreted to exist beneath numerous lakes and large ponds (water depth greater than 1.3 m) within and near the Goose Property Area (Figure 2.1-6). Open or through taliks exist beneath waterbodies with maximum depths greater than two-thirds of maximum ice thickness (1.3 m). Round ponds and lakes with widths up to 175 m (e.g., Echo Lake) are interpreted to overlie open talik up to 50 m deep. Elongated waterbodies with widths up to 150 m (e.g., Gander Pond), round with widths up to 120 m (e.g., Mam Lake), and those with extensive shallow terraces (e.g., Rabbit Lake) are interpreted to overlie open taliks ranging 50 to 100 m deep. Larger lakes tend to have elongated shapes, and have been predicted to overlie through taliks where widths exceed 200 m. A moderate level of confidence is attributed to this classification for lakes for which the cold case model did not indicate presence of through talik: Chair, Fox, Giraffe, Llama, Moby, and Umwelt lakes. A high level of confidence is attributed to lakes for which all cases (cold case, base case, warm case) indicated presence of through talik: Big, Goose, and Propeller lakes.

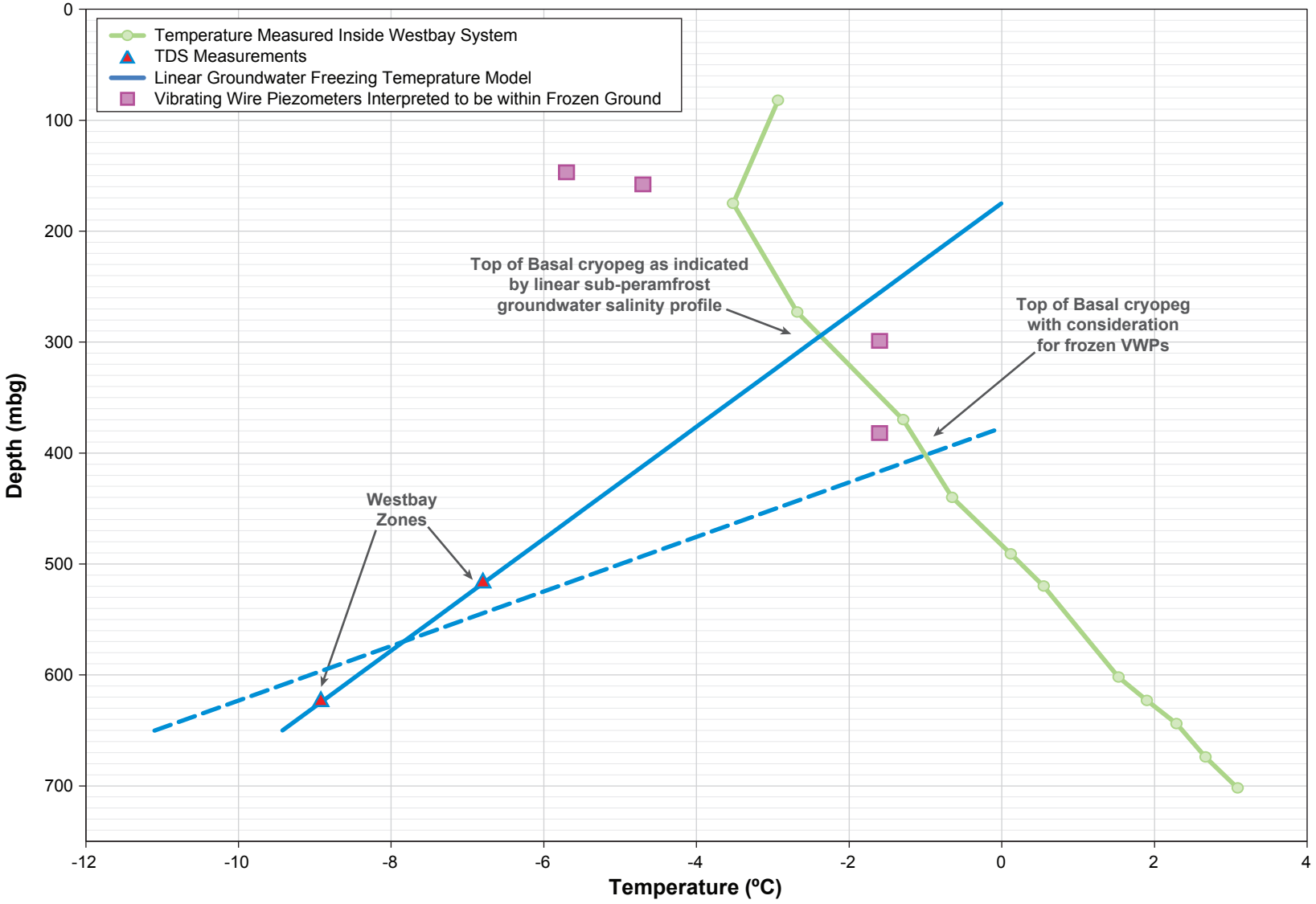



Figure 2.1-4

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# Basal Cryopeg Depth Interpretation

Figure 2.1-4

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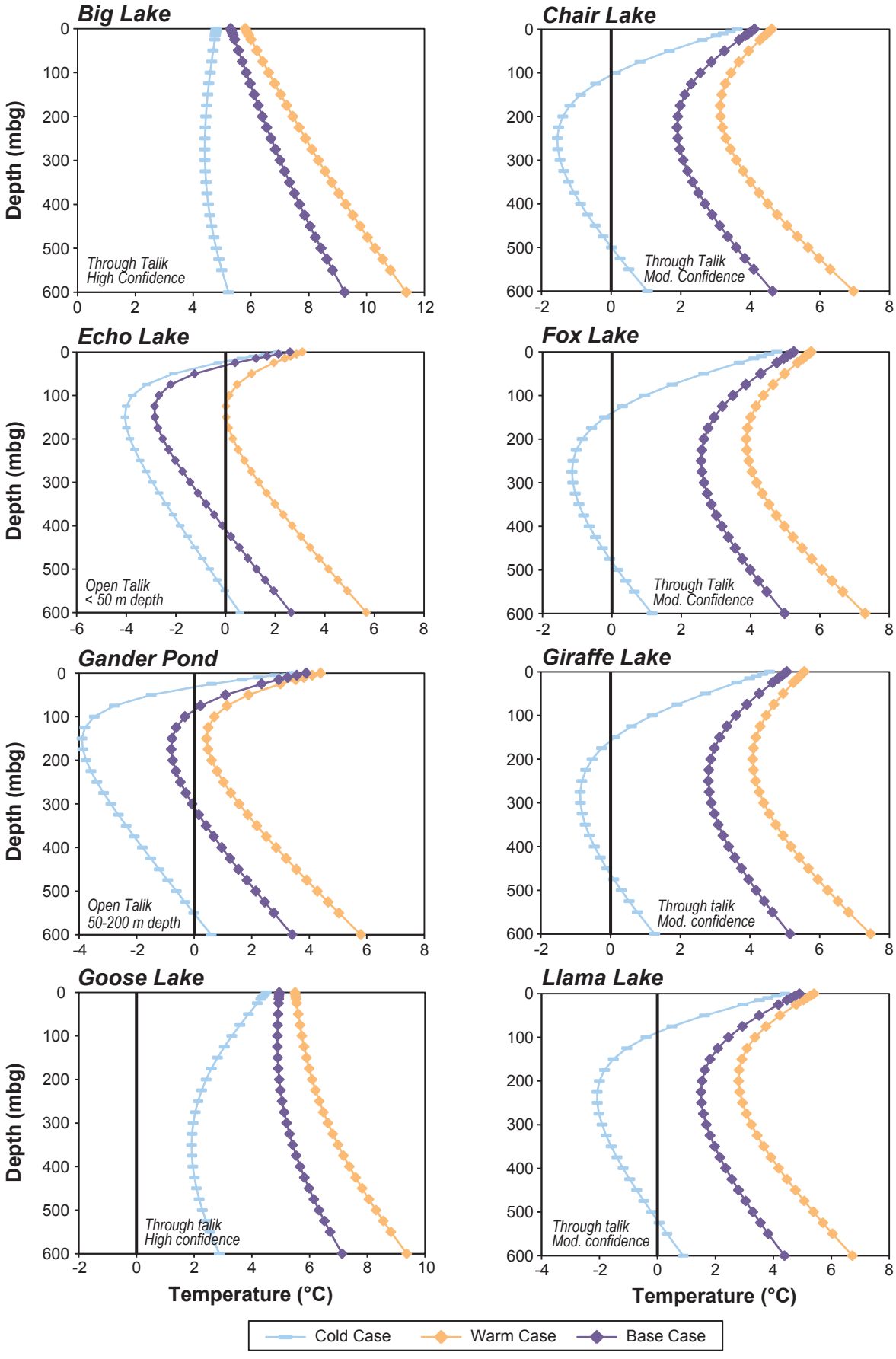


# Sub-lake Temperature Profiles Derived from Steady-state One-dimensional Analytical Geothermal Models for the Goose Property Area

Figure 2.1-5a

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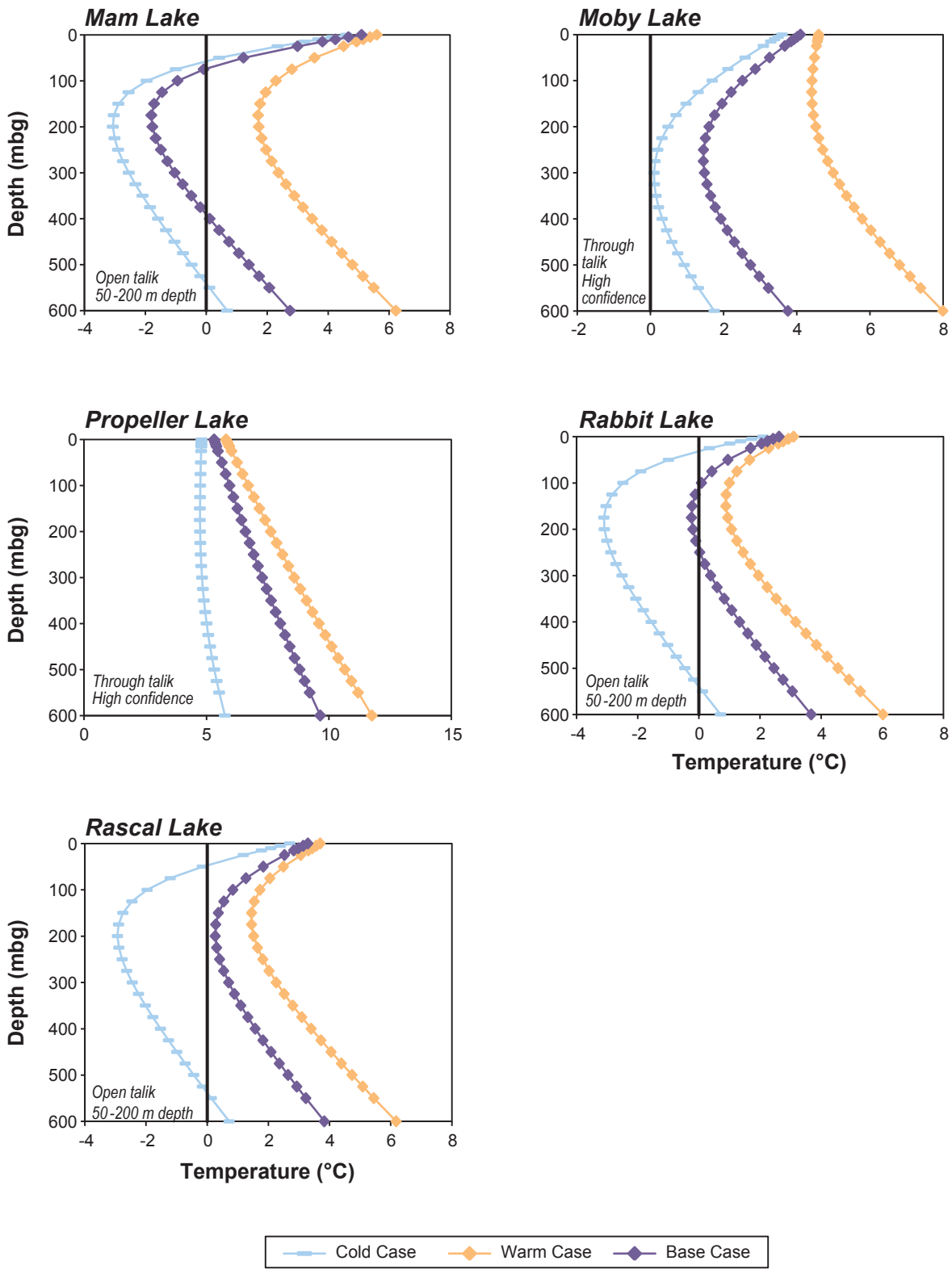


Sub-lake Temperature Profiles Derived from Steady-state One-dimensional Analytical Geothermal Models for the Goose Property Area

Figure 2.1-5b

Instrumentation has been installed in the talik beneath Llama Lake, within and near the Llama Deposit. Records exist for functional thermistor nodes and vibrating wire piezometers (refer to Appendices V6-2C and V6-2D) at depths up to 230 mbg beneath the lake, and indicate the presence of talik. The recorded data appear to validate the prediction of talik up to at least 230 mbg beneath Llama Lake, and appear to suggest that the actual subsurface temperatures are colder than those predicted by the base cases. The discrepancy between the measured and predicted temperatures may be a result of colder mean paleo temperatures. However, direct comparison is not possible because no temperature measurements exist beneath the deep pool of the Lake, where the model applies and mean annual water temperature is greatest. The deep pool of Llama Lake is located in its northern extremity, and reaches water depths up to 13.5 m. Thermistor strings are installed beneath extremities of the lake where the water depth does not exceed 6.5 m.

Hyper-saline groundwater has been observed in sub-lake talik at the Phase 2 Hope Bay Belt Project (Newmont 2011). As such, cryopegs are also thought to be present at the base of open taliks at the Goose Property Area. It is expected that in some cases cryopegs at the base of open taliks result in hydraulic connection between the open talik and the basal cryopeg beneath. For example, if the talik beneath Llama Lake is not in fact through, then a cryopeg is likely present beneath the talik connecting it with the sub-permafrost flow regime.

#### *2.1.2.3 George Property Area*

Permafrost Extent

Five thermistor strings were installed at the George Property Area in 2013, ranging in length from 60 to 320 m (identified in Figure 2.1-3). Permafrost is interpreted to be present along the lengths of all five thermistor strings, with temperature readings between -3 and -8°C. The thermistor node locations are not appropriate for interpretation of active layer or basal permafrost depths. Thermistor string records obtained at the George Property Area are documented in Appendix V6-2C.

Thermistor strings installed at the Hackett River Project have been used to characterize active layer and permafrost extents at the George Property Area. The George Property Area is approximately 40 km East of the Hackett River exploration site, and atmospheric temperature records over a 3-year period have shown mean annual temperatures within 1°C at the two sites. Therefore subsurface thermal conditions are expected to be similar. Thermistor String installation methods, location maps, and data for the Hackett River Project are documented in Rescan (2010b), Rescan (2013) and Appendix V5-2C.

The Permafrost is approximately 520 m thick at the Hackett River Site (Table 2.1-4). The active layer has been measured to penetrate up to 2.4 mbg. Depth of zero amplitude is approximately 20 mbg. The basal permafrost depth is approximately 110 m above sea level at the Hackett River Project, corresponding with approximately sea level at the George Property Area, due to a 100 m elevation difference.

Basal Cryopeg Extents

Hypersaline groundwater has been observed and characterized beneath the permafrost at the Goose Property Area, and this corresponds with regional observations (e.g., Newmont 2011; Golder Associates Ltd. 2013). Therefore the sub-permafrost groundwater quality observed at the Goose Property Area has been adopted for the George Property Area as well, and indicates presence of a basal cryopeg. Thickness of the basal cryopeg has been estimated to be approximately 100 m near the Umwelt Deopsit at the Goose Property Area, where the Westbay sub-permafrost groundwater monitoring system has been installed. Thus, fluids are expected to exist in fracture spaces at depths exceeding approximately 420 mbg throughout the George Property Area.

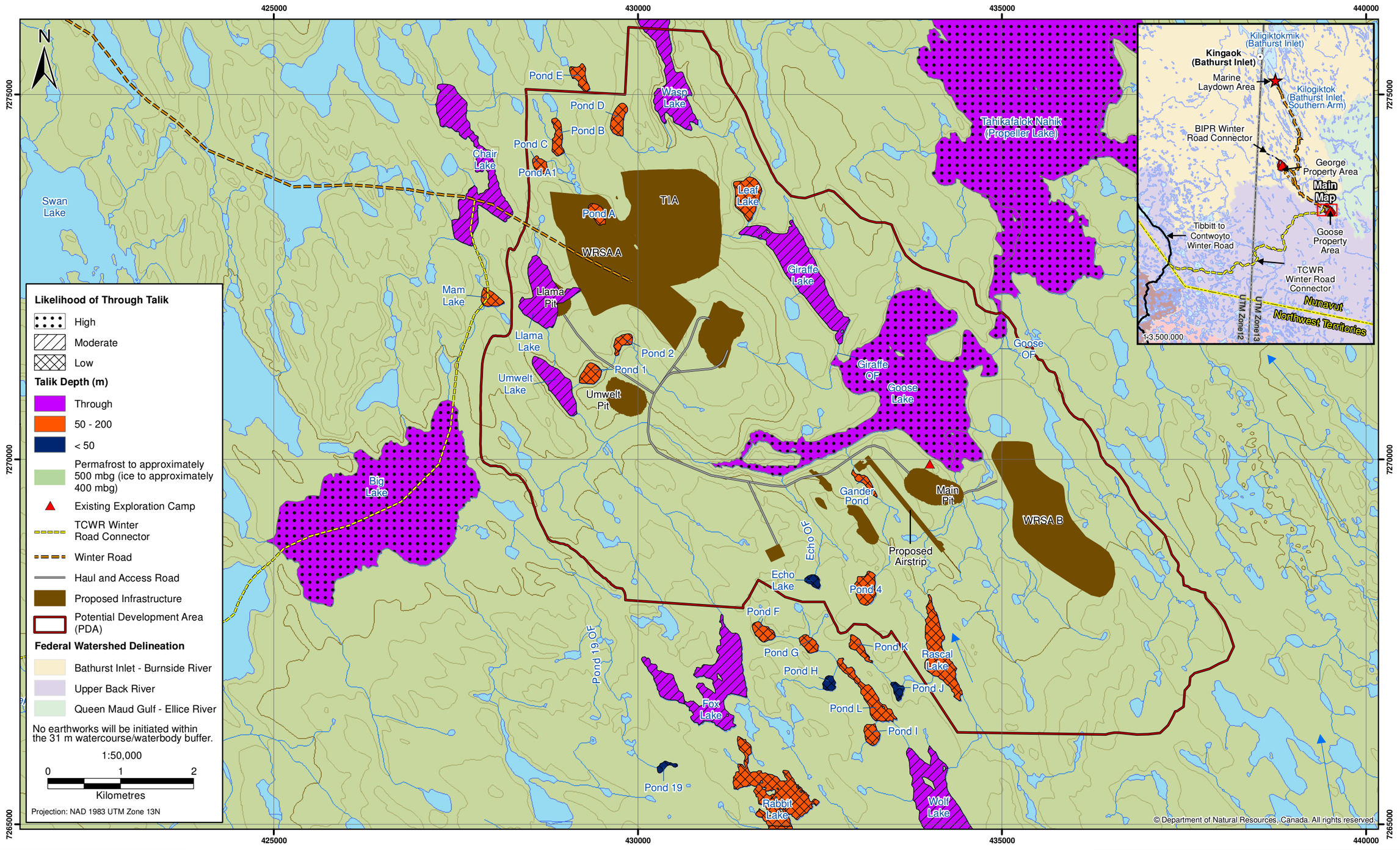


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**Figure 2.1-6**

## Talik Extents at the Goose Property Area

**Table 2.1-4. Permafrost Properties Interpreted from Subsurface Temperature Data Acquired near the George Property Area**

| Installation[A] | Active Layer Depth (mbg) | Basal Permafrost Depth | | Zero Amplitude Depth (mbg) |
|---|---|---|---|---|
| | | mbg | masl | |
| Therm-12-Q | 2.1 | na | na | na |
| Therm-12-G | 2.1 | na | na | na |
| Therm-12-F | 1.8 | na | na | na |
| Therm-12-E | 2.4 | na | na | na |
| Therm-12-H | 1.4 | na | na | na |
| Therm-12-I | 1.8 | na | na | na |
| Therm-12-B | 2.2 | na | na | 20 |
| Therm-12-R | 2 | na | na | 20 |
| 2006 Boot Lake | na | 520 | 110 | > 17.7; < 45.8 |
| 2006 Camp Lake | 1.5 | 520 | 110 | > 17.7; < 45.8 |

*[A] All installations located at the Hackett River Site, 40 km west of the George Property Area, as documented in Rescan (2010b) and Appendix V5-2C*
*na = data not appropriate for corresponding interpretation*

Talik Extents

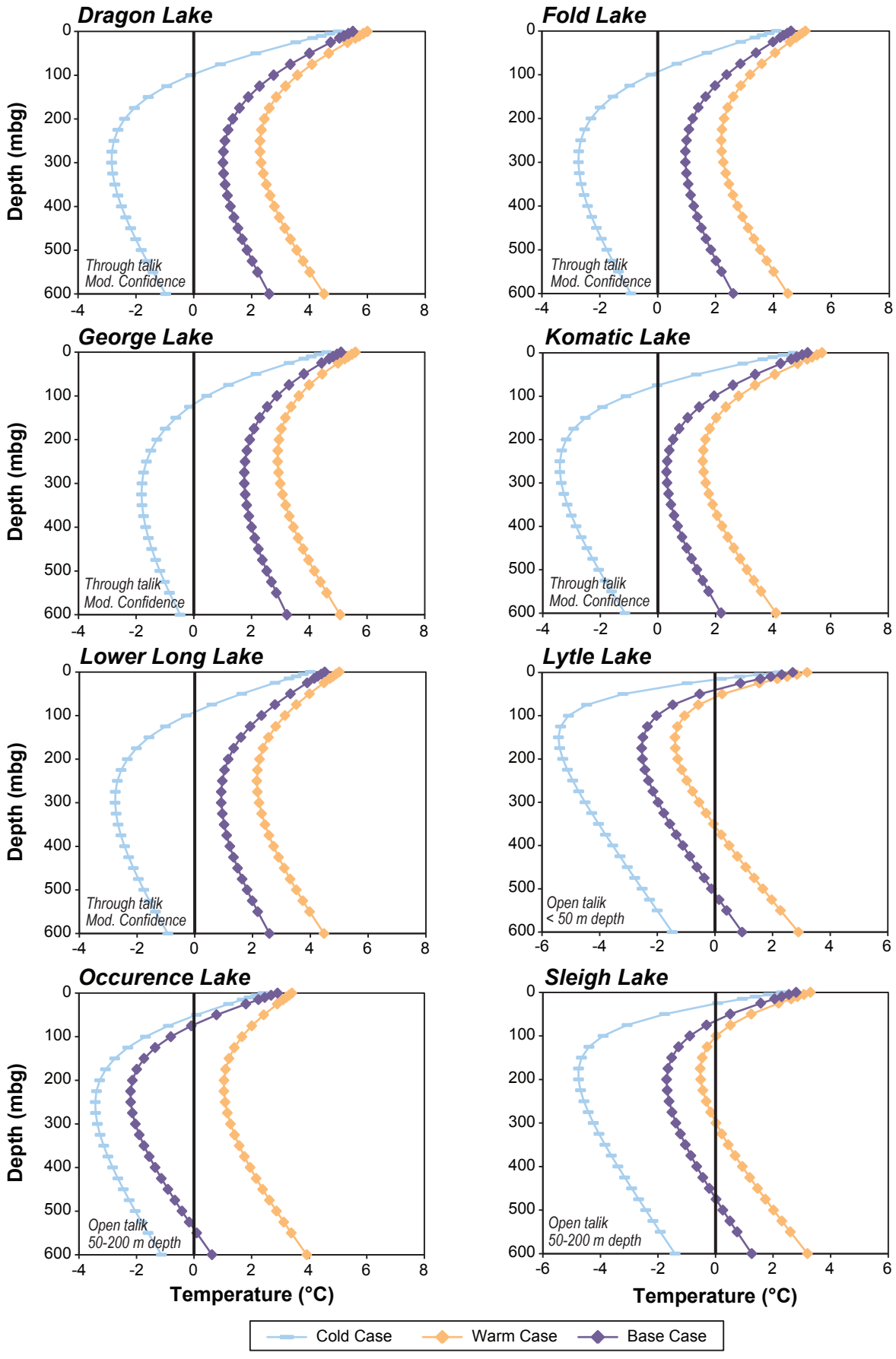
Sub-lake temperature profiles derived from steady-state one-dimensional analytical geothermal modelling are presented in Figure 2.1-7. Talik is interpreted to exist beneath numerous lakes and large ponds within and near the George Property Area (Figure 2.1-8). Open or through taliks exist beneath waterbodies with maximum depths greater than two-thirds of maximum ice thickness (1.3 m). Ponds and lakes with widths up to 150 m (e.g., Lytle Lake) are interpreted to overlie open talik up to 50 m deep. Waterbodies with widths up to 350 m (e.g., Occurrence Lake) are interpreted to overlie open taliks ranging 50 to 200 m deep. Larger lakes have been predicted to overlie through taliks where widths exceed 350 m. A moderate level of confidence is attributed to lakes for-which the cold case model did not indicate presence of through talik: Dragon, Fold, George, Komatic, and Lower Long lakes.

Instrumentation has been installed in the talik beneath Lytle Lake, within and near the Locale 1 deposit (Figure 2.1-3). A vibrating wire piezometer installed 157 mbg beneath the lake has been interpreted to be within permafrost. Thermistor nodes beneath the lake indicate presence of permafrost at depths exceeding 200 m. Talik has not been directly observed beneath Lytle Lake, but the available data suggest that it is less than 157 m deep. The calculated sub-lake temperature profile corresponds with the field observations.

Hyper-saline groundwater was observed in sub-lake talik at the Hope Bay Gold Project (Newmont 2011). As such, cryopegs are thought to be present at the base of open taliks at the George Property Area. It is expected that in some cases cryopegs at the base of open taliks result in hydraulic connection between the open talik and the basal cryopeg beneath.

### *2.1.2.4 Marine Laydown Area and Winter Road Corridors*

Similar permafrost conditions are expected to exist along the Winter Road corridors and at the Marine Laydown Area (MLA).

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# Sub-lake Temperature Profiles Derived from Steady-state One-dimensional Analytical Geothermal Models for the George Property Area

Figure 2.1-7

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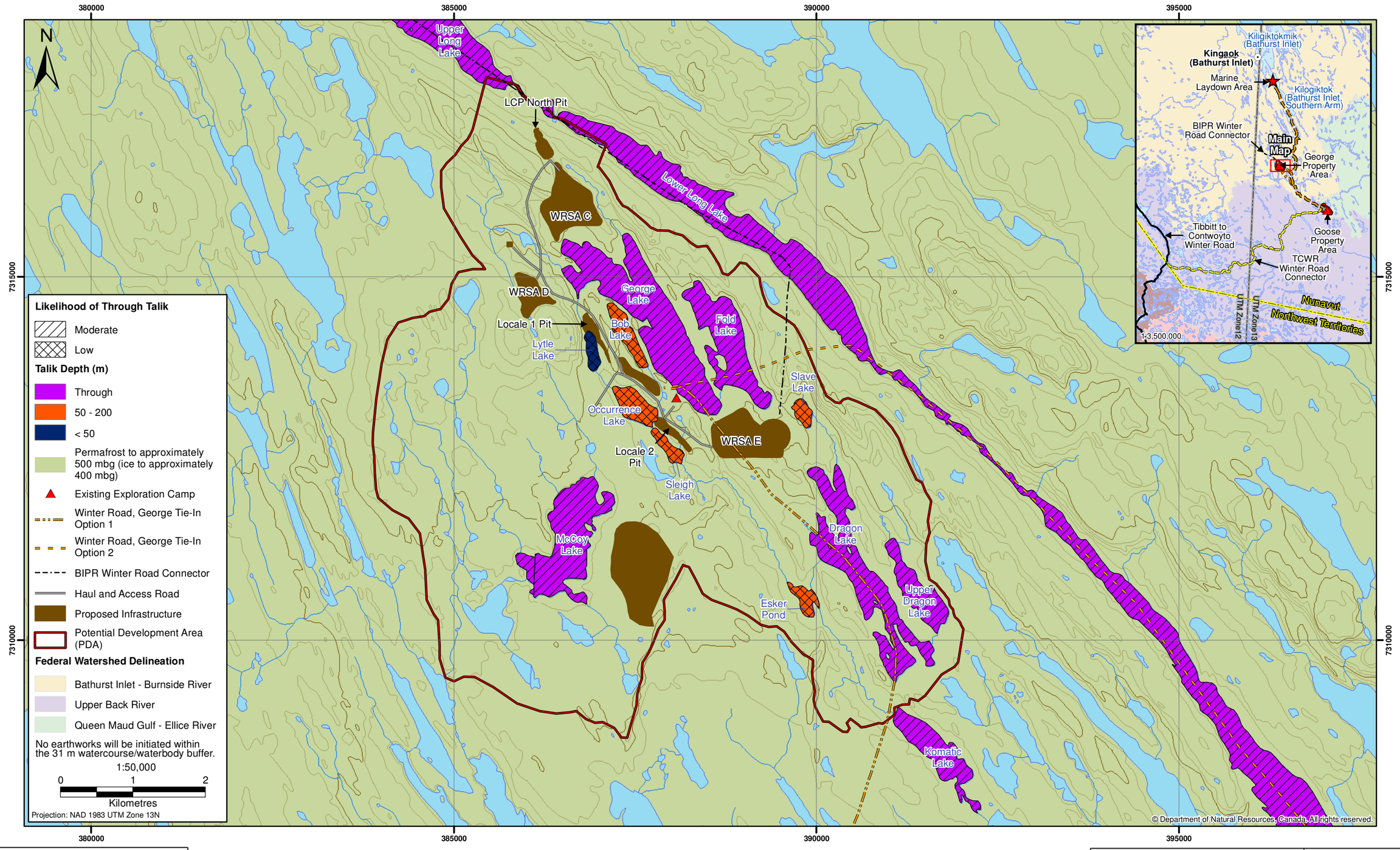


Figure 2.1-8

## Talik Extents at the George Property Area

The MLA is approximately 100 km north of the George Property Area. Meteorological data collected 15 km south of the MLA indicate similar temperatures to the George and Goose Properties, with greater rainfall. The active layer may extend deeper during the summer months due to increased rainfall, otherwise permafrost conditions would be similar to those observed at the Goose and George Property Areas. A similar permafrost thickness (around 500 m) is expected at the MLA and along the winter road alignments. Bathurst inlet and Bathurst Lake are expected to overlie through talik, although there are no known observations of ground temperatures beneath Bathurst Inlet.

The TCWR connector winter road corridor extends 150 km southwest of the Goose Property Area. Continuous permafrost underlies the complete road alignment where it crosses land. The permafrost thickness is expected to decrease towards the southwestern terminus, as it trends towards the transition into discontinuous permafrost.

#### *2.1.2.5 Impacts of Climate Change on Permafrost Conditions*

Mean annual temperatures in Canada's North have been predicted to increase by 2.0ºC by the year 2030, and by 5 to 6ºC by 2100 (Volume 4 Chapter 3: Climate and Meteorology). The warming trend is expected to thaw permafrost.

On the time scale of the Project it is expected that the active layer will thicken and ground temperatures in the top tens of metres will increase. A mean air temperature change is expected to begin to influence the temperature at depths exceeding 100 m in several hundred years, and up to 200 m in over one thousand years (Lunardini 1995).

Thaw season (summer) temperatures are most influential on active layer depth, and are predicted to rise by about half that of the mean annual temperature (Lemme et al. 2008). Increases in summer temperatures of 1ºC (2030) and 2.5ºC (2100) will result in slight active layer thickness increases. For example, an increase in mean summer temperature by 2.5ºC corresponds with an active layer thickness increase of 10 to 20 cm in the glacial tills commonly found in the Goose and George Property Areas, as determined using the Stefan equation (Gregory & Goudie 2011). Active layer thickness will continue to be highly variable and controlled by soil texture, with deeper penetration in coarser materials.

Thinning of winter lake ice cover will result in widening of taliks beneath shallower extents of waterbodies, and development of new open taliks beneath shallower ponds. Talik expansion will be limited to the top tens of metres on the time scale of the Project. On the time scale of hundreds to thousands of years, open taliks are expected to lengthen at depths greater than 100 m, and in some cases to develop through taliks beneath smaller lakes than present.

## 2.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

In 2012 the KIA completed a report which presented Traditional Knowledge (TK) for the region encompassing the proposed Project using the Naonaiyaotit Traditional Knowledge Project (NTKP; KIA 2012). The TK makes a brief reference to effects of climate change on permafrost:

> *Inuit had seen many changes in water quality over the past few decades…*
>
> *In general, these changes had lowered the quality of water. The changes were attributed to …, melting of permafrost because of global warming,…*

### 2.2.1 Incorporation of TK for Existing Environment and Baseline Information

The observation that permafrost degradation had occurred as a result of global warming may be attributed to a deepening of the active layer. It is likely that, as climate change progresses, the active layer will continue to penetrate deeper.

### 2.2.2 Incorporation of TK for Spatial and Temporal Boundaries

Permafrost is not referred to as a unique or valued feature of the environment in the TK report. Spatial boundaries established for assessment of effects of the Project on surface water quality (Volume 6, Chapter 4) and quantity (Volume 6 Chapter 1) are set along watershed divides, and thus incorporate potential effects of permafrost degradation on water quality and quantity.

### 2.2.3 Incorporation of TK for Mitigation and Adaptive Management

There are no references to mitigation or adaptive management measures associated with permafrost or its degradation in the traditional knowledge reports.

## 2.3 VALUED COMPONENTS

### 2.3.1 Potential Valued Components and Scoping

Permafrost was included in the scoping and refining process with all other potential VEC/VSECs (Volume 9, Chapter 1). Permafrost was classified as a Subject of Note, as determined from Sabina-led public consultation, the TK report (Bianci and Spicker 2012), consultation with regulatory agencies, and regulatory considerations.

### 2.3.2 Valued Components Included in Assessment

Permafrost is considered a Subject of Note for the DEIS. All information requested in the NIRB-issued EIS guidelines related to Permafrost is included in this DEIS.

## 2.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

### 2.4.1 Interaction of Permafrost with the Project

The Project is expected to interact with the permafrost environment where excavations, landfilling, and changes to ground thermal conditions will occur. Infrastructure that may interact include the open pits and underground mines, tailings impoundment area (TIA), waste rock storage areas (WRSAs), and landfills. Numerical geothermal modelling will be conducted as part of the future feasibility study. Changes to the permafrost environment in response to Project development are conceptually described here.

New talik may form beneath the TIA, due to the introduction of a large pond. The extents of this talik will be dependent on the temperature and size (width and depth) of the pond, and will grow and shrink as the pond size fluctuates over time. Artesian conditions are not anticipated to develop beneath the TIA, as through taliks have been shown to sustain downward hydraulic gradients in the Goose Property Area (discussed in Volume 6, Chapter 2, Groundwater) and the TIA is not situated in a low-lying area. The construction of an earth embankment around the TIA perimeter will result in permafrost aggradation into its core.

In general, pits and underground mines are not expected to thaw permafrost during the operational phase. The local subsurface temperatures are expected to persist within underground mines. Open pits will expose deeper bedrock to ambient air temperatures, likely resulting in development of an active layer with an annual freeze/thaw cycle. Flooding of pits at closure will result in development of talik beneath. Thawing

of the permafrost beneath pit lakes is expected to penetrate to depths exceeding 100 m on the time scale of hundreds of years (Lunardini 1995).

Existing open talik beneath Llama Lake is expected to close from above in response to lake dewatering, due to exposure to cold atmospheric air temperatures. A period of geothermal transience would occur following initiation of excavation and dewatering, with development and thickening of a frozen layer beneath the deepening excavation each winter. Flooding of the pit at closure is expected to bring about a return of talik beneath the excavation.

Dewatering of small portions of Lytle and Occurrence lakes will result in shrinking of the open talik (expansion of the permafrost from the lake beds above and the pre-existing permafrost below) beneath the lake footprints and gradual replacement with permafrost.

Permafrost aggradation (upward expansion) is expected to occur within and beneath earth-fill infrastructure, including the WRSAs, landfills, and the roadbeds of local site roads.

# 3. Landform and Soils

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# 3. Landforms and Soils

## 3.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 3.1.1 Regional Overview

The Back River Project (the Project) is located in the West Kitikmeot region of Nunavut, in the Takijuq Lake Upland Ecoregion of the Southern Arctic Ecozone (Figure 3.1-1). Temperature ranges are typical of Arctic Canada. Permafrost, which occurs throughout the Project area, contributes to the formation of landforms and topographical features characteristic of the Arctic tundra and affects development and structural integrity of soil. The region is dominated by gently undulating landscapes with numerous kettle lakes connected by streams. Several soil parent materials can be distinguished based on material texture, coarse fragment content and sequence of glacial or post-glacial deposition. Soils of the Cryosolic Order are widespread.

#### *3.1.1.1 Topography*

The topography of the region is generally characterized by low relief. The land is dominated by undulating or rolling landscapes, presented as a sequence of smooth, non-linear rises and hollows, and elongated rises and valleys that repeat in a wave-like pattern. Slopes are generally uniform and in the vicinity of the proposed Project infrastructure typically range between 0 and 5%. Slopes rarely exceed 7% and terrain elevation ranges between 300 and 700 masl (Natural Resources Canada 2013). Smoothness of the landforms reflects the influence of local hydrological patterns associated with the impermeable permafrost layer.

Uplands, which are dominant, are typically covered by veneers of morainal materials deposited on Precambrian, sedimentary, metamorphic, or intrusive rocks (Natural Resources Canada 2013). Consequently, much of the upland surface is composed of sparsely vegetated, rocky outcrops, with evidence of glacial scour along the exposed bedrock of the Bathurst fault (Zoltai S. C., Karasiuk D. J., and Scotter G. W. 1980). Wetlands occupy a relatively small portion of the area, covering only 5 to 10 % of the Takijuq Lake Upland Ecoregion (Natural Resources Canada 2013). Small- and medium-size kettle lakes formed from large blocks of melting ice left by the last retreating ice sheet (about 8,500 years ago) exist throughout region. Lakes are usually connected by a complex network of streams.

The thickness of overburden, defined as unconsolidated organic or mineral material overlaying bedrock (e.g., peat, till, sand, gravel, boulders, highly fractured bedrock), is highest in plains and very gently sloping areas (ranging from 1.0 to 37.0 m, average thickness 10.6 m). Rolling and undulating landforms are typically characterized by thinner overburden (ranging from 0.6 to 17.8 m, average thickness of 4.8 m).

A number of distinct landform types, including eskers, moraines, and boulder fields, exist throughout the region. Several large eskers occur in the region as elongated, sinuous ridges up to 100 m wide and several kilometres long. They were formed from sands, gravels, cobbles, and boulders deposited in the glacial melt water channels flowing below or within glaciers. Coarse fragment content within the top 1 m of deposit varies, in most instances, from 35 to 85%. Although not observed directly during the 2012 field program, the majority of eskers located in the Project region likely contain massive ice cores (S. R. Dallimore and Wolfe 1988; Gowan and Dallimore 1990; S. R. Dallimore and Davis 1992; Wolfe et al. 1997; Moorman and Michel 2003; Robinson et al. 2003; Macumber et al. 2011).

Besides being a unique geomorphological landscape feature, eskers provide several ecological functions. For example, the annual pattern of groundwater flow within the esker active soil layer governs soil moisture and nutrient regimes in lower sections of eskers and adjacent ecosystems. Also, because burrowing material is limited in the areas dominated by boulder fields and shallow morainal veneers over bedrock, the unconsolidated, coarse mineral material of eskers provides valuable denning sites for wildlife.

Moraines are rocky ridges composed of unconsolidated, unsorted mineral debris deposited at the glacier edge. A large, over 200-km long glacial moraine extends approximately 30km in the eastern direction from the Goose Property (Natural Resources Canada 2013).

Arctic boulder fields are often derived from weathered bedrock, from which finer fractions have been removed by various periglacial processes (e.g., solifluction, surface erosion; Sonesson 1985). Intense frost heaving also causes fracturing of bedrock and subsequent migration of large rock fragments to the surface. These phenomena created several boulder fields and belts in the Project region.

Repeated freezing and thawing of the soil creates unique features on the ground surface. Frostboils (also known as mud boils or mud circles) are typically circular (1 to 3 m in diameter) upwellings of mud that are created by frost heave and cryoturbation in permafrost areas. Common characteristics include an elevated centre, a formation of an organic layer on the outer edge, and resistance of the soil surface to vegetation colonization. Extensive areas of patterned ground covered by frostboils are commonly found in the region.

Thermokarst typically occurs in wetlands as a system of very irregular hummocks and hollows, which form in result of frost heaving and ice accumulation on the bottom of organic horizons. When they eventually thaw and collapse they form depressions, which further contribute to surface unevenness.

Massive ground ice of up to 10-m depth is a relict feature formed in late glacial or early postglacial times and has been reported in hummocky morainal deposits and eskers in the Contwoyto Lake and Lac de Gras areas (Wolfe 1998; Dredge, Kerr, and Wolfe 1999). Massive ice is likely present in parts of the Takijuq Lake Upland where late glacial conditions allowed rapid cover of residual forms of glacial ice and frozen melt water, especially along the west side of Bathurst Inlet (Ecological Framework for Canada 2012).

#### *3.1.1.2 Surficial Deposits*

Various surficial materials and geomorphic processes (i.e., isostatic rebound, periglacial processes, wind erosion, and mass wasting) have resulted in the present day surficial (parent) material types in the Project region. Surficial materials include bedrock; weathered bedrock; boulder field; as well as colluvial, fluvial, glaciofluvial, lacustrine, marine, morainal, and organic deposits. Hydrologic processes have played a major role in the redistribution of surficial deposits, and have contributed to considerable mixing of various deposits.

Morainal surficial materials are dominant the area. Morainal till generally consists of well compacted, non-stratified material composed of a mixture of sand, silt, and clay, with a heterogeneous mixture of sub-rounded to angular coarse fragments of different sizes.

Organic veneers (less than 1 m in depth) are also common, resulting from the accumulation of very slowly decomposing vegetation, typically in the wet lowlands and in areas of intense seepage. Glaciofluvial materials deposited as eskers or veneers over morainal materials can also be found.

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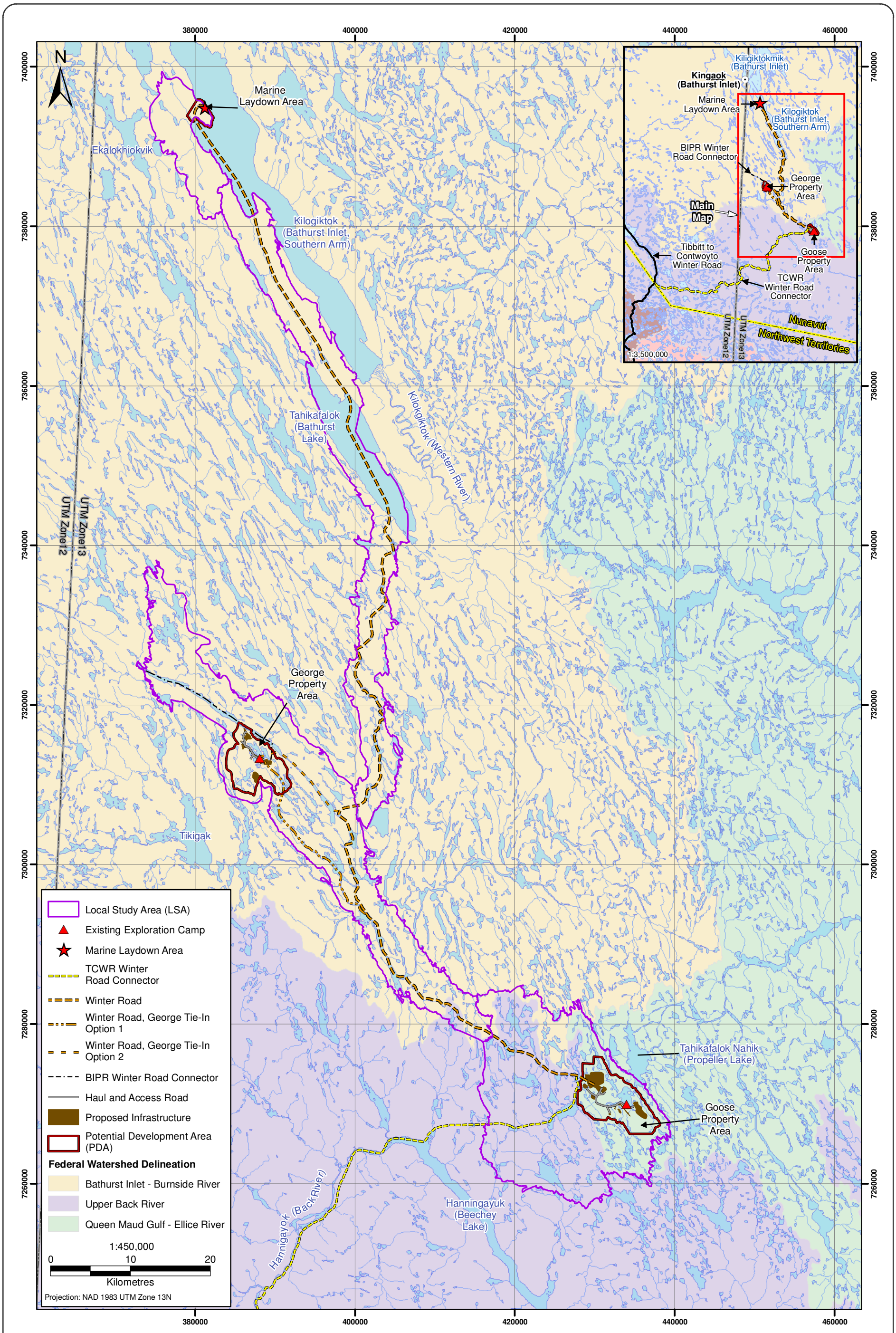


Figure 3.1-1

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# Back River Project: Landforms and Soils Local Study Area

Figure 3.1-1

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Eolian parent materials, wind-deposited materials that consist primarily of sand or silt-sized particles, may also be present at higher elevations. Glaciolacustrine and lacustrine deposits, containing significant proportions of silt and clay, may be found in some lowlands and deltas. These are often associated with sedge-dominated wetlands. Bedrock and weathered rock are common in uplands. Colluvial materials are the products of bedrock mass-wasting typically occurring on steep slopes, and are very rare in the region.

#### *3.1.1.3 Soils*

Soil development in the Project region is influenced by the interaction of factors associated with characteristics of surficial deposits (parent material), topography, local climate, biotic influences, hydrology and permafrost, and time.

The region is underlain by continuous permafrost with sporadic occurrences of massive ground ice (Natural Resources Canada 2013). Permafrost describes soil or bedrock that remains at or below freezing (0°C) for two or more years. The mean annual air temperature ranges from -11.6ºC to -5.8ºC at George and -11.5ºC to -6.6ºC at Goose (Rescan 2013b) and the continuous permafrost extends down past 500 m (Paananen and Ruskeeniemi 2003). Under these conditions, soil development generally occurs only close to the ground surface. The depth of active layer (the soil depth to which the permafrost melts each summer) is predominantly governed by the water/ice content of the surficial material and by the thickness of organic layer. The active layer can vary from 0.3 m with thick organic layer to over 3 m on well drained eskers or bedrock crests (more details can be found in Volume 5, Chapter 2).

Permafrost restricts the downward flow of water, causing precipitation and melt water to move horizontally, either as a surficial runoff or as shallow underground seepage within the active layer of the soil. Consequently, the soils within the seepage areas are often waterlogged throughout most of the growing season. Annual frost heaving of the soil upon freezing and its subsequent settlement upon thawing creates several phenomena, including cryoturbation (e.g., patterned ground and thermokarst) and solifluction (downslope movement of waterlogged soil). Organic Cryosols usually have particularly high ground ice content.

Permafrost has a strong influence on landform and soil dynamics. It affects local topography (e.g., its disintegration can cause thermokarst, thaw slumps, or active layer detachments), surficial hydrology (e.g., it affects flow patterns in soil active layer), wildlife habitat(e.g., it affects vegetation compositional patterns, and species diversity through changes in soil temperature, moisture, and nutrient availability), and can influence dynamics of greenhouse gas release from the soil (Jorgenson and Osterkamp 2005; Walter 2006; Shur and Jorgenson 2007; Turetsky et al. 2007; Schuur et al. 2009; Grosse et al. 2011).

The presence of shallow permafrost and cryoturbation affect both the pedogenic process and, thus, soil classification. Most soils in the region are classified as Cryosols, which are usually poorly developed. In general, the rates of soil development in the Project region are very slow, typically in the order of a few millimetres per century (SENES Consultants Limited 2013), while peat-derived organic materials accumulate considerably faster. This is due primarily to the very low rates of biological activity within the soil due to low temperatures.

Field results suggest that the mineral soils in the Project region are predominantly acidic, ranging from pH 4.5 to 6.8, with pH tending to increase with soil depth (Rescan 2013a, Appendix V5-3A).

### 3.1.2 Baseline Study Methods

Baseline characterization of local terrain and soils was conducted in 2012. Results of this work can be found in the Appendices V5-3A and V5-3B. Terrain mapping was completed as part of the baseline characterization and involved using PurVIEW and ArcMap software, which enables users to view stereo

pairs of digital air photos in three dimensions at variable scales. Terrain polygons were delineated based upon observable characteristics such as surficial material, surface expression, and geomorphological processes. In the absence of a system for Nunavut, terrain attributes were described using BC's Terrain System Classification (Howes and Kenk 1997). The terrain maps were prepared at a 1:20,000 scale. The final terrain attributes were later adjusted according to the data collected during field inspections of terrain polygons.

The Terrain and Soils Baseline Field Program involved the assessment of terrain and soils at 323 inspection sites (Figure 3.1-2). Soil inspection followed hand excavation of a soil pit to a depth of 100 cm, where possible. The soil and site characteristics were described in detail according to the methodology specified in the Field Manual for Describing Terrestrial Ecosystems (BC MELP and BC MOF 1998) as there is no similar system developed for Nunavut. Soils were classified according to *The Canadian System of Soil Classification (Agriculture and Agri-Food Canada 1998)*. Field data was used to update terrain and soils mapping, and to characterize local baseline conditions.

Soil samples were collected at 51 sites within the Local Study Area (LSA) and in 20 reference sites located at least 10 km outside of the LSA (Figure 3.1-2), but within the Regional Study Area (RSA). Where possible, the samples were collected at two depths: 0 to 5 cm and 50 to 60 cm (at several of the inspected sites, the mineral soils were shallow and only the upper soil layer[s] could be sampled). The 0 to 5 cm layer represents the organically enriched horizon and the surface layer where atmospherically deposited particles (e.g., dust) could potentially accumulate. The 50 to 60 cm depth samples target subsoil conditions, which reflect parent material chemistry influenced by pedogenesis. Chemical analysis of sampled soil enabled a comparison of baseline concentration of extractable metals with the *Canadian Soil Quality Guidelines for Protection of Environmental and Human Health* (CCME 2013).

In addition to chemical analysis, the spatial distribution of total metal concentration (a sum of extractable and non-extractable forms not comparable with the CCME guidelines) in surficial soils was assessed with a portable X-ray Fluorescence (XRF) analyzer. The data collected at 129 geo-referenced sampling points were later interpolated using Geostatistical Analyst (ArcGIS program) with the Inverse Distance Weighting technique to produce metal distribution maps.

### 3.1.3 Characterization of Local Baseline Conditions

The Back River Project consists of three main areas: The Goose Property Area, the George Property Area, and the Marine Laydown area (MLA) located on the southwest side of Bathurst Inlet (Figures 3.1-1 and 3.1-2). The three areas are remote from each other and will be connected by winter roads. Topography, surficial deposits, and soil types vary between these areas.

The following descriptions of topography, surficial deposits, and soils are based on the studies conducted within the entire extent of the LSA section surrounding each of the properties (Figure 3.1-1). The Project development, however, will take place only within the three Potential Development Areas (PDAs), which together cover 9.3% of the LSA (Goose PDA 4.4%, George PDA 4.5%, and MLA PDA 0.4%). The LSA sections and the PDAs are marked on the map in Figure 3.1-1.

#### *3.1.3.1 Goose Property Local Study Area*

Topography

The area is characterized as gentle to moderately sloped, undulating or rolling plains. Elevation ranges between 249 and 392 masl. While slopes range between 0 and 26%, only less than 1% of the Goose Property LSA has uneven relief and slopes in excess of 16%. Approximately 60% of the Goose LSA land is covered by plains and the rest is covered by gentle slopes. Open waterbodies cover a relatively small proportion of the LSA (15%) and, while the largest of the lakes covers more than 500 ha, the median area of a kettle lake extends only over 2.4 ha.

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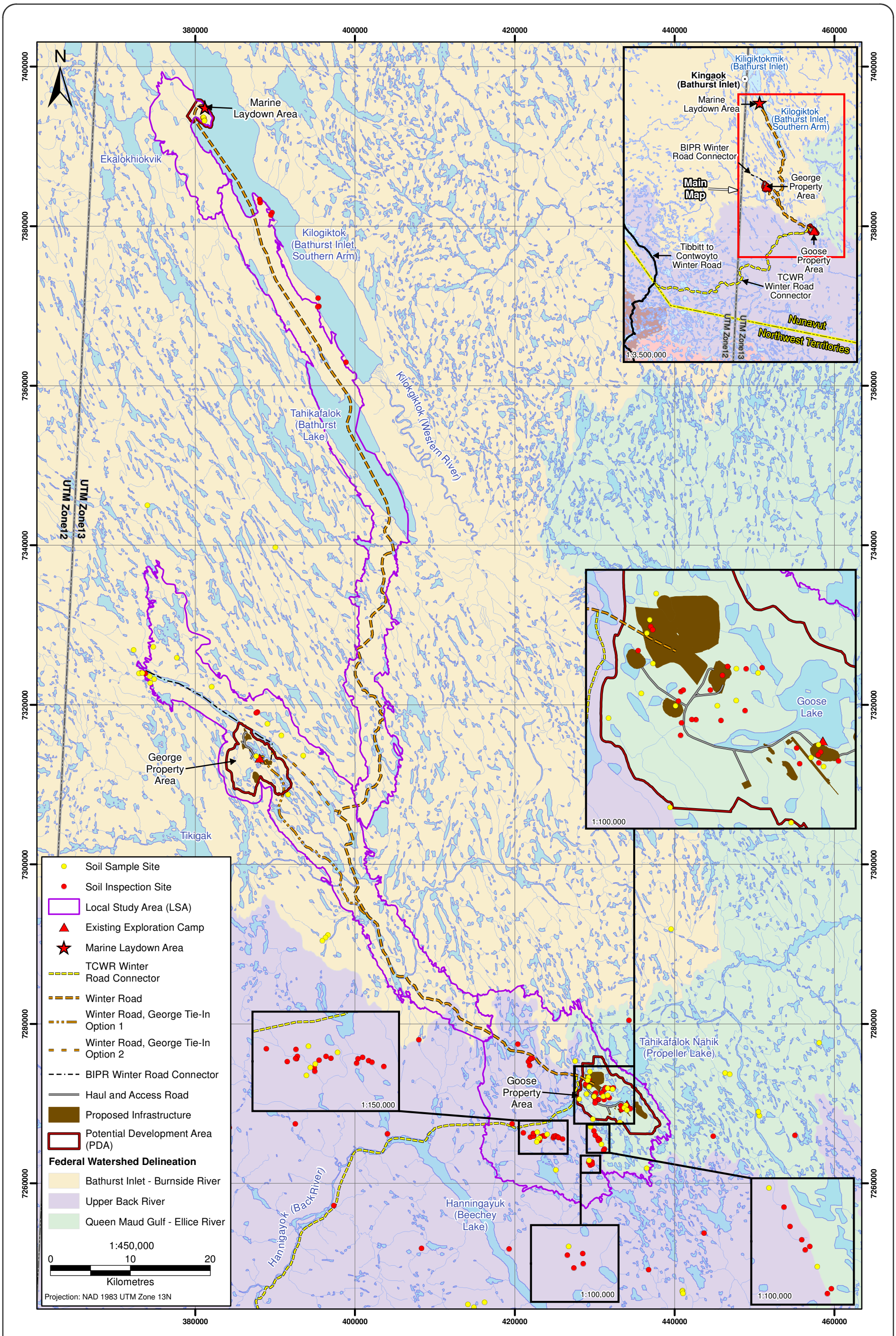


Figure 3.1-2

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# Soil Baseline Inspection Points and Sampling Locations

Figure 3.1-2

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Unique landforms in close proximity to proposed Project infrastructure include an esker located 2.2 km northwest of Goose Lake (Figure 3.1-3). Several boulder fields and belts, as well as extensive areas of patterned ground covered by frostboils, are commonly found in the Goose Property Area.

Surficial Deposits

Morainal deposits are found on over 50% of the Goose Property LSA (Table 3.1-1). This material is variable in characteristics, but dominated by moderately coarse and coarse textures (from silty loam to gravelly sand). The coarse fragment content ranges from 5% of gravels and cobbles, to greater than 75% of boulders and stones. Drainage is also variable (from well to poor) depending on site slope position, coarse fragment content, texture, and depth to restricting layer (such as permafrost).

**Table 3.1-1. Proportion of the Potential Development Areas Dominated by Different Surficial Materials**

| Dominant Surficial Materials | Potential Development Areas | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Goose Property | | George Property | | Marine Laydown Area | | All PDAs | |
| | ha | % | ha | % | ha | % | ha | % |
| Anthropogenic | - | - | 6.4 | - | - | - | 6.4 | 0.05 |
| Colluvium | 39.0 | 0.7 | 24.8 | 0.4 | 26.5 | 4.9 | 129.9 | 0.9 |
| Weathered Bedrock | 13.5 | 0.2 | 511.8 | 8.4 | - | - | 525.3 | 3.7 |
| Eolian | 129.8 | 2.2 | 48.3 | 0.8 | - | - | 178.1 | 1.2 |
| Fluvial | 33.2 | 0.6 | 31.9 | 0.5 | - | - | 99.1 | 0.7 |
| Glaciofluvial | 844.2 | 14.2 | 371.6 | 6.1 | - | - | 1359.5 | 9.5 |
| Lacustrine | 70.8 | 1.2 | 335.6 | 5.5 | - | - | 430.4 | 3.0 |
| Morainal | 3296.7 | 55.6 | 2516.3 | 41.5 | - | - | 6271.6 | 44.0 |
| Organic | 427.4 | 7.2 | 445.3 | 7.3 | - | - | 921.5 | 6.5 |
| Open water | 915.1 | 15.4 | 1705.6 | 28.1 | - | - | 3369.5 | 23.6 |
| Bedrock | 157.0 | 2.6 | 52.9 | 0.9 | - | - | 211.4 | 1.5 |
| River | - | - | 19.2 | 0.3 | - | - | 22.4 | 0.2 |
| Marine | - | - | - | - | 519.6 | 95.1 | 730.6 | 5.1 |
| **Total** | **5926.7** | 100.0 | **6069.6** | 100.0 | **546.1** | 100.0 | **14255.8** | 100.0 |

Organic material accumulation over mineral parent materials in depressions and seepage are common. Accumulations of poorly decomposed, poorly drained, and saturated peat are generally less than 50-cm deep and cover approximately 7% of the Goose Property LSA. Since Organic Cryosols often have high ground ice content, potential degradation of permafrost in these areas may be associated with changes in topography and hydrology.

Coarse-textured glaciofluvial deposits (including eskers) typically contain high proportion of coarse mineral fragments and cover 14% of the Goose Property LSA. These are present within the proposed Tailing Storage Area and adjacent to both waste rock storage areas.

Exposed bedrock can be found throughout the Goose Property LSA. Bedrock is also present close to the surface, covered with mineral or organic veneers. Associated sporadic colluvial materials are generally poorly sorted and contain a wide range of particle sizes, but are rare within the LSA.

In the Goose Property Area, over 70% of the soil parent materials are deposited as blankets (thicker than 1 m). The thickness of surficial materials is highest in lowlands covered with morainal, organic, and fluvial deposits (up to 37.0 m deep, Table 3.1-2). Colluvial and glaciofluvial deposits, as well as boulder fields, are typically underlain by thinner overburden (up to 17.8 m deep, Table 3.1-2).

**Table 3.1-2. Thickness of Overburden under Various Surficial Deposit Types**

| | George PDA Overburden Depth (m) | | | Goose PDA Overburden Depth (m) | | |
|---|---|---|---|---|---|---|
| **Surficial Material** | **Minimum** | **Average** | **Maximum** | **Minimum** | **Average** | **Maximum** |
| Colluvial | - | - | - | 2.5 | 5.8 | 9.0 |
| Eolian | 4.0 | 8.8 | 19.6 | - | - | - |
| Fluvial | - | - | - | 6.6 | 14.8 | 20.0 |
| Glaciofluvial | 0.6 | 3.3 | 9.1 | 4.6 | 7.0 | 12.6 |
| Lacustrine | 0.3 | 4.3 | 18.3 | - | - | - |
| Morainal | 0.6 | 5.0 | 22.0 | 1.0 | 12.2 | 37.0 |
| Organic | 1.5 | 5.4 | 12.2 | 2.6 | 8.9 | 22.0 |
| Shallow bedrock, boulder field | 3.1 | 3.8 | 6.7 | 3.0 | 4.7 | 6.0 |
| **All Surficial Materials** | **0.3** | **4.5** | **22.0** | **1.0** | **11.2** | **37.0** |

*Note: Overburden is defined as unconsolidated organic or mineral material (e.g., peat, till, sand, gravel, boulders, highly fractured bedrock) overlaying bedrock.*

Soils

Most soils have a low proportion of coarse fragments (below 30%) and low surficial stoniness (below 15%). Median pH of mineral soils is 5.9 (range from 4.7 to 6.8; Rescan 2013a). Soil metal concentrations in the Goose Property LSA do not exceed Canadian Council of Ministers of the Environment (CCME) guidelines (2013). About two-thirds of the inspected LSA has been classified as Static Cryosols, and one-third as Turbic Cryosols. Median active layer depth is 75 cm.

### *3.1.3.2 George Property Local Study Area*

Topography

Gentle topography characterizes the George Property LSA; ridges and hummocky terrain are found on less than 2% of the LSA and the median slope measured during field inspections is 3%. Elevation ranges between 273 and 461 masl. The area has a large number of small kettle lakes, with over 400 occupying 16% of the LSA, with a median size of 2.8 ha. Unique landforms such as esker complexes and wetlands are located in close proximity to proposed Project infrastructure within the George Property LSA (Figure 3.1-4).

Surficial Deposits

Similarly to the Goose Property, the George Property LSA is dominated by morainal blankets (60%) with variable textures and coarse fragment content. Their drainage, as well as moisture and nutrient regimes, often depends on site landscape position.

Coarse glaciofluvial materials (7.3% of the George Property LSA) have been deposited as eskers or veneers over morainal materials. They mainly consist of sands with a considerable component of rounded or sub-rounded coarse fragments, which often display evidence of stratification. Some eskers are located in close proximity to proposed Project infrastructure (Figure 3.1-4).

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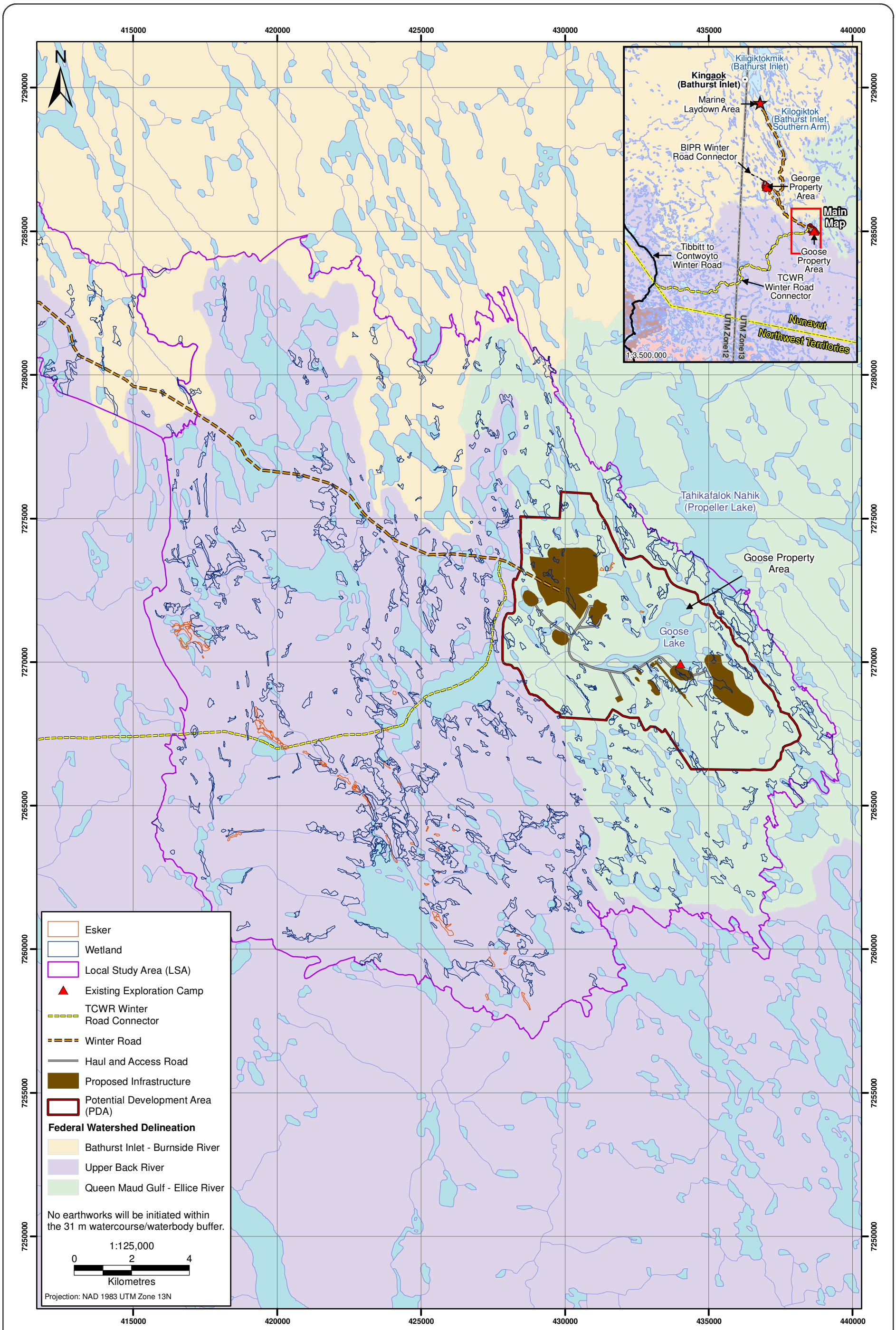


Figure 3.1-3

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## Back River Project: Goose Property Local Study Area

Figure 3.1-3

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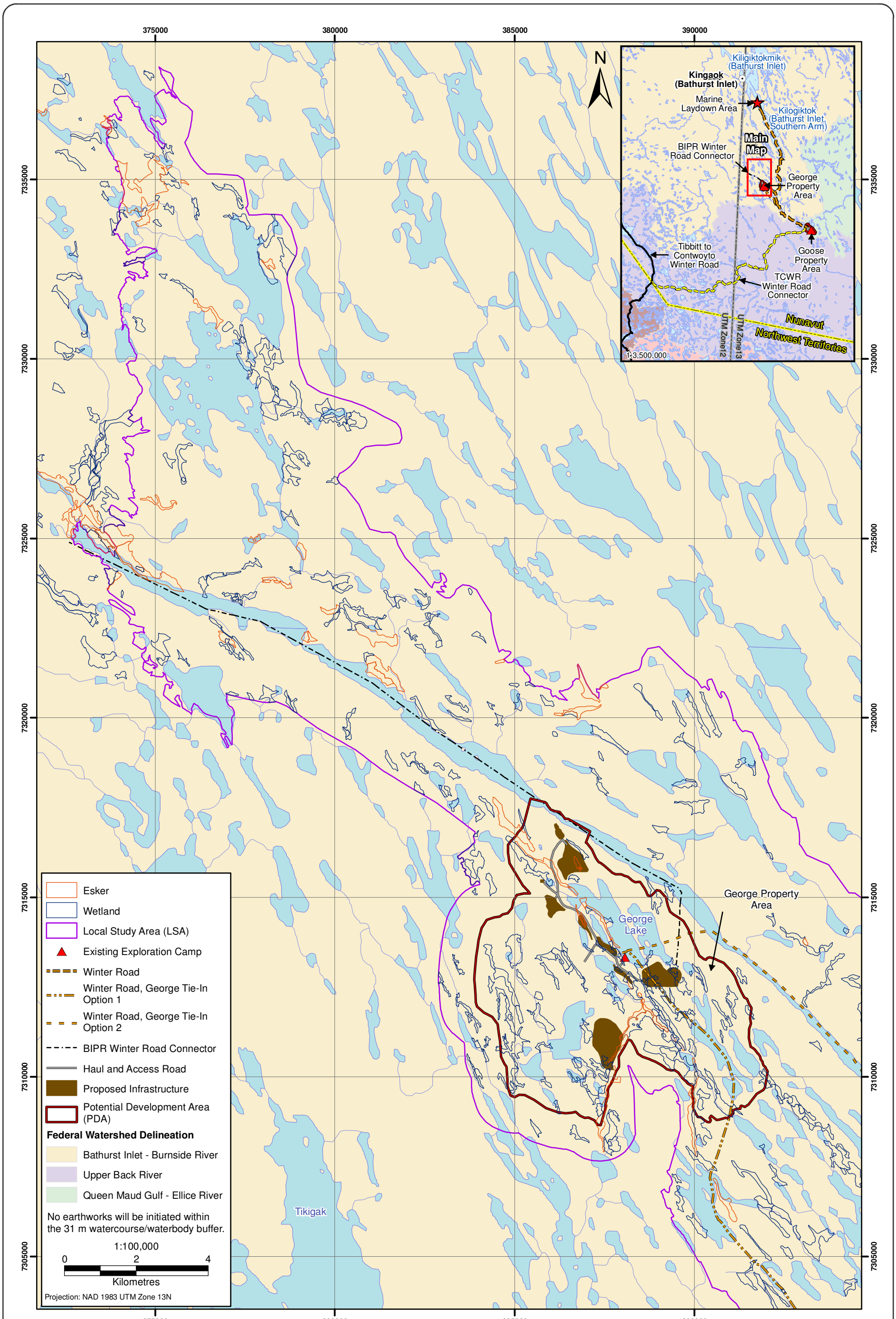


Figure 3.1-4

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# Back River Project: George Property Local Study Area

Figure 3.1-4

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Poorly decomposed and poorly drained organic veneers are found over bedrock, morainal, and lacustrine deposits in seepage areas and in depressions. While they cover only 6% of the George Property, they intersect with some of the proposed infrastructure. Since Organic Cryosols often have high ground ice content, potential degradation of permafrost in these areas may be associated with changes in local topography and hydrology.

The thickness of overburden is the highest in lowlands covered with eolian, lacustrine, morainal, and organic deposits (up to 22.0 m deep, Table 3.1-2). Glaciofluvial deposits and boulder fields typically found in higher elevations are underlain by thinner overburden (up to 9.1 m, Table 3.1-2).

Soils

Most soils that developed on morainal parent materials are relatively deep (thicker than 1 m). In about half of the George Property LSA, soils have low proportion of coarse fragments (below 30%) and low surficial stoniness (below 15%; Rescan 2013a, Appendix V5-3A). Median soil coarse fragment content is 17.5%. Over 70% of soils are moderately coarse (loam, sandy loam, fine sandy loam). Most soils are classified as Static Cryosols. Median active layer depth is 50.5 cm.

The median pH of mineral soils in the George Property LSA is 5.84 (range from 4.5 to 6.5; Rescan 2013a, Appendix V5-3A). Arsenic levels found in some samples collected within the George Property LSA but outside of the PDA (Figure 3.1-2) exceed the recommended CCME guideline industrial limit (CCME 2013).

### *3.1.3.3 Marine Laydown Area Local Study Area*

Topography

The deeply indented, rocky shoreline of Bathurst Inlet is surrounded by rugged ridges of massive granite rocks that reach about 610 masl (Ecological Framework for Canada 2012). Most of the proposed MLA, however, is near sea level with elevation ranging between 2 and 103 masl. Over half of the MLA LSA is covered by gentle slopes, about 30% by level plains, and the remaining 15% by steeper terrain (greater than 16% slope).

While only a small proportion of the MLA LSA contains glaciofluvial deposits (3%; Figure 3.1-5), two belts of prominent eskers are located on the uplands outside of the LSA, 5 km west of Bathurst Inlet (outside of the area shown on the map). These eskers are over 30 km long and reach 20 m in height.

Surficial Deposits

MLA is dominated by marine and morainal deposits (each covers about 30% of the MLA LSA). Marine deposits consist mainly of coarse sands with low proportion of coarse mineral fragments. Morainal deposits have variable textures and coarse fragment content.

In general, besides a large number of small lakes, bedrock outcrops are one of the most prominent characteristics of the regional topography. Nevertheless, bedrock rarely extends over an area large enough to dominate the entire terrain polygon. The MLA LSA has the highest proportion of polygons dominated by bedrock; 5% of the mapped polygon area is covered by exposed bedrock. Due to greater relief, the MLA LSA has also the highest proportion of colluvial deposits in the LSA (5.3%).

Soils

Many soils developed within the proposed MLA LSA are coarse textured, and are generally poorly suited for reclamation. The area is generally dominated by Static Cryosols with pockets of Orthic Regosols in

rapidly drained sites. The median pH of mineral soils near Bathurst Inlet is 5.8 (range from 5.1 to 7.0; Rescan 2013a, Appendix V5-3A). Soil metal concentrations in Bathurst Inlet areas did not exceed the CCME guidelines (CCME 2013).

#### *3.1.3.4 Winter Access Road Local Study Area*

Topography

The southern portion of the proposed road extends through plains and gentle slopes, while the northern section is characterized by stronger relief and steeper slopes. The elevation varies from about 310 masl in Goose Lake area to above 400 masl in George Lake area, to sea level near Bathurst Inlet over a distance of approximately 100 km.

The road will intersect several groups of eskers, boulder fields, areas of exposed bedrock, and several large wetland complexes (Figure 3.1-6).

Surficial Deposits

The proposed winter access road corridor is underlain by mainly morainal deposits (46%) and waterbodies (39%). Morainal deposits, characterized by variable textures and coarse fragment content, form blankets and veneers over undulating bedrock. Coarse glaciofluvial deposits, often in the form of eskers, comprise over 6% of the Winter Road LSA. Wetlands, as well as lacustrine, colluvial, fluvial, and eolian deposits, cover a minor component of the route (Figure 3.1-6).

Soils

Most soils along the route are of the morainal origin, characterized by variable textures (sandy loams to silty clays) and variable, but generally low coarse fragment content (most ranging between 5 and 35%). Due to high surface stoniness, shallow deposit thickness, and fine soil textures, the availability of soils suitable for reclamation is relatively low. Static and Turbic Cryosols are the most common soil great groups.

#### *3.1.3.5 Mineral Soil Chemistry in the Project LSA*

Analytical results indicate that most mineral soils in the LSA are slightly to very strongly acidic. These soils have low organic carbon content and are non-calcareous, which is typical of the upland tundra ecosystems in the region.

The mean pH of soils collected in the LSA is 4.9 at 0 to 5 cm depth and pH 5.5 at the depth of 50 to 60 cm. Soil pH variability within each soil depth is low. Inputs of organic acids derived from the decomposition of the detritus of low woody shrubs (i.e. crowberry) and the predominance of acidic bedrock contribute to the acidity of the soils in the LSA.

Metals reside in the soil in various forms, of which some are highly mobile and bio-available (e.g., Fe cations associated with soluble organic and inorganic soil complexes), while the other forms are much less mobile (e.g., Fe atoms associated with sesquioxides). The mobility and thus bio-availability of metals depends on soil mineral surface properties, organic matter content, and on the composition, pH and reduction-oxidation (redox) potential of soil solution (McLean and Bledsoe 1992). Typically only a portion of the total metal concentration is bioavailable and the CCME guidelines regulate the concentration of metals extractable from the soil by a particular, standard method (Rescan 2013a, Appendix V5-3A).

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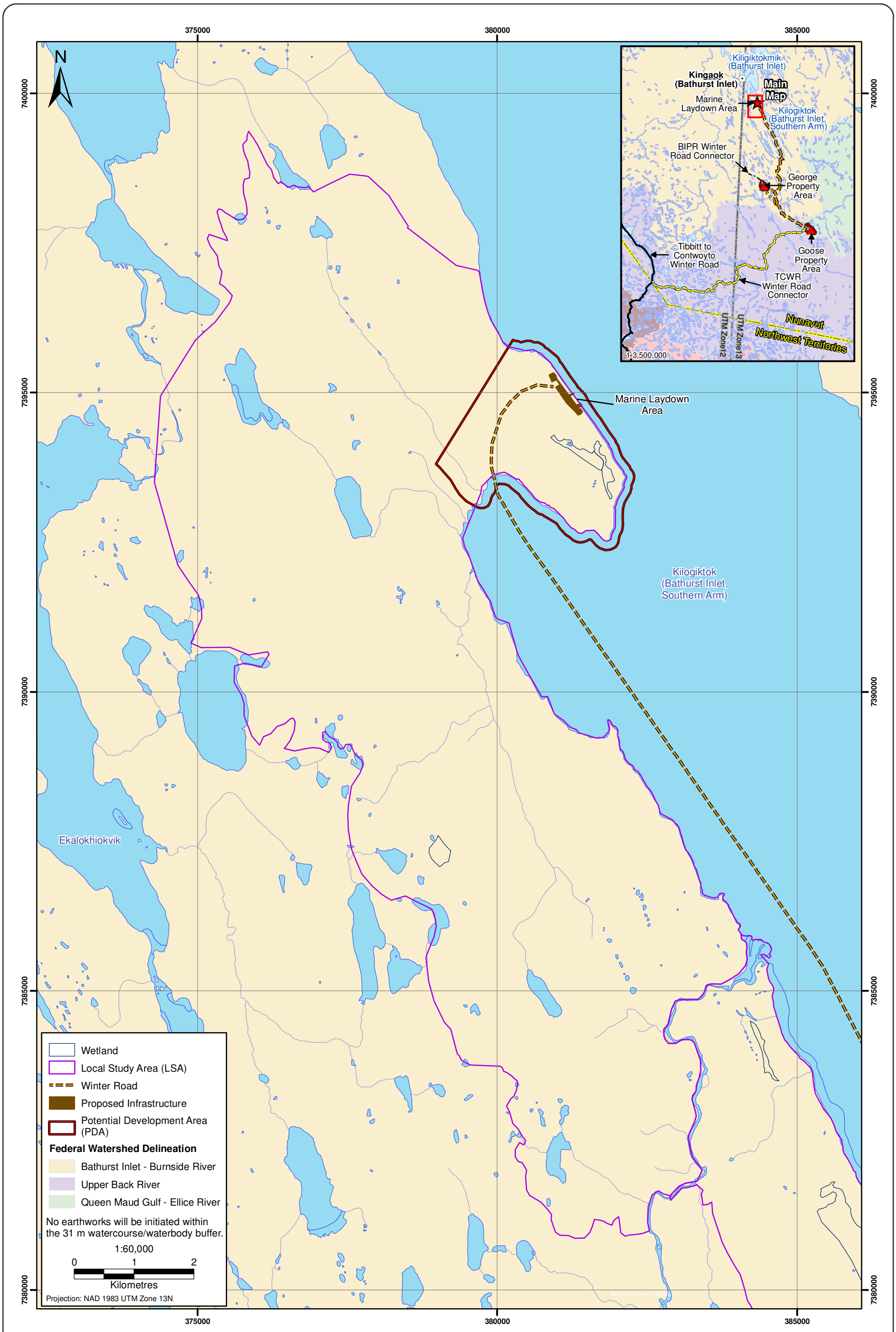


Figure 3.1-5

Sabina GOLD & SILVER CORP.

# Back River Project: Marine Laydown Area
# Local Study Area

Figure 3.1-5

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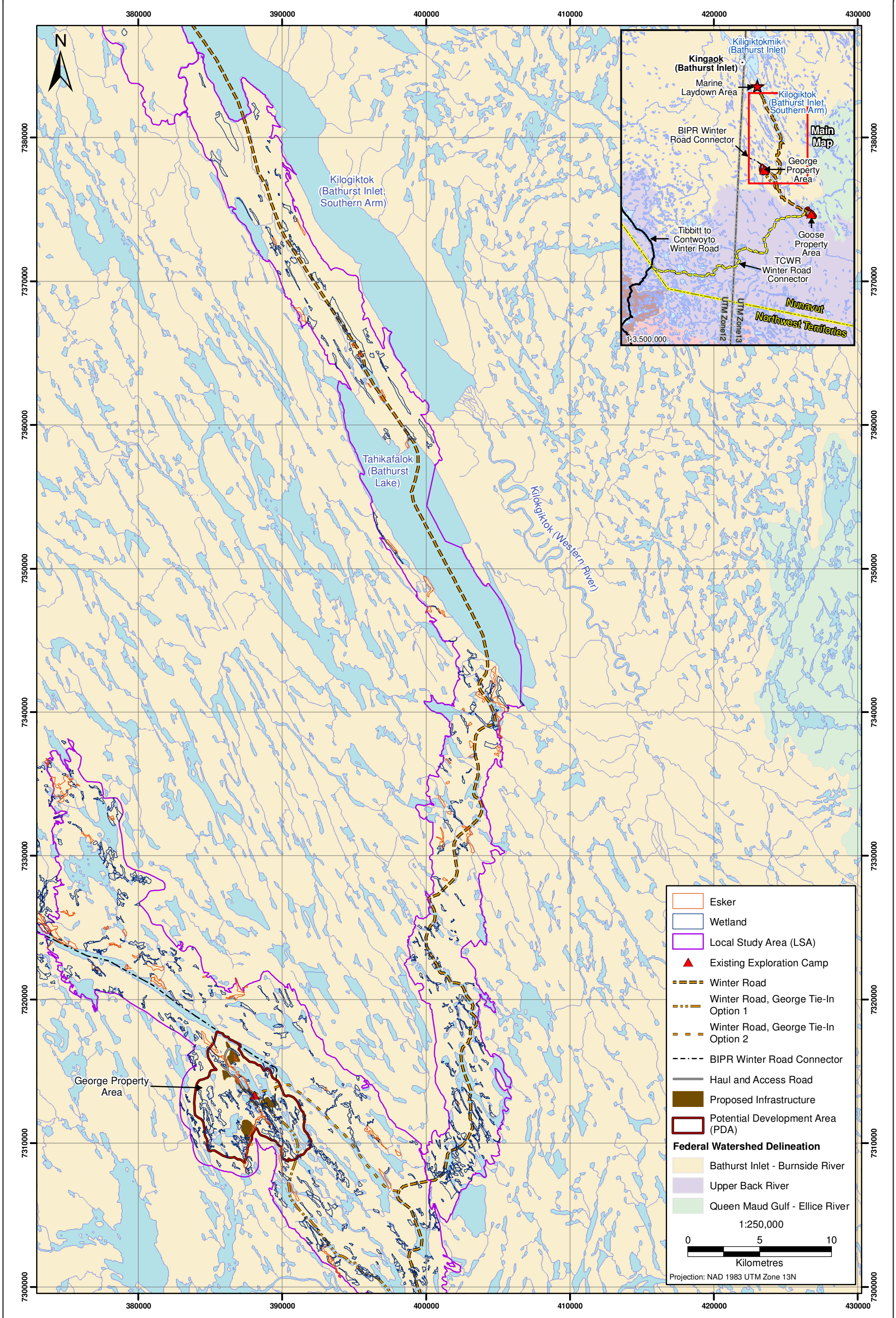


Figure 3.1-6

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# Back River Project: Winter Roads Local Study Area

Figure 3.1-6

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Metal concentrations in soil sampled within the LSA varied between sampling locations and depths. Naturally elevated concentrations of extractable arsenic, exceeding CCME industrial limits (2013), were found in mineral soil at several locations near George Lake (in 5 out of 11 sampled sites) and in some of the reference areas located outside the LSA (in 5 out of 13 sampled sites). Detailed results of soil chemical analyses are presented in the Terrain and Soil Baseline Report and in the Plant Tissue and Soil Metal Compilation of 2012 Samples (Rescan 2013a, 2013c). Elevated levels of extractable metals were also found in organic wetland soils (with organic carbon content > 17%). The highest metal levels (i.e, above 90 percentile of recorded As, Cr, Cu, Pb, Ti, U, and V) were found in wetlands located in the Goose LSA.

One of the techniques that allow the assessment of the *total* concentration of metal in the soil (as opposed to the *extractable* metal fraction) involves the use of XRF equipment. During the 2012 Field Program, a portable XRF analyzer was used to evaluate the total concentration of several metals in soils within the LSA. The spatial distribution of five metals: arsenic, iron, manganese, nickel, and zinc in the LSA is shown in Figures 3.1-7, 3.1-8, 3.1-9, 3.1-10, and 3.1-11. While the distribution of total metal concentration provides important information on mineralogy of local soils, the values shown on the map are not directly comparable to the CCME guidelines, which are based on extractable metal concentrations.

## 3.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Inuit who live in the Kitikmeot region have been using the area for fishing, hunting, wood, and plant collection. They migrate seasonally among hunting, trapping and fishing grounds and consider wetlands the most important habitat because of their extensive use by wildlife. Throughout the millennia they acquired a profound understanding of the local environment and its functioning.

The incorporation of Traditional Knowledge (TK) into regulatory frameworks reflects a widespread recognition that TK can significantly contribute to our understanding of the principles of conservation and sustainable resource use (Alcorn 1989; Schmink, Redford, and Padoch 1992; Gadgil, Berkes, and Folke 1993; Colding 1998; Johannes 1998; Berkes 1999). It also reflects a concern regarding the social and economic sustainability of communities whose livelihoods largely depend on the availability and quality of natural resources (Blaikie and Brookfield 1987; World Commission on Environment and Development 1987; Meadows, Meadows, and Randers 1992). Consequently, both TK and the Nunavut Impact Review Board (NIRB) guidelines constitute key guiding principles considered in this report.

### 3.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available TK from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (Kitikmeot Inuit Association 2012) was reviewed for *landforms and soils* existing environment and baseline information. The following information is included in the TK report:(Racine and Ahlstrand 1991)

1. Landforms such as eskers, cliffs, rocky ridges, wetlands, ocean shores and riverbanks are valuable because they provide a preferred habitat for wildlife such as caribou, grizzly bears, wolves, foxes, wolverines, and birds.

   *Section 4.1:"During summer, when it was hot and the insects started to emerge, the caribou would take advantage of the wind relief and easy walking provided by eskers. They hid in the shade provided by hills, cliffs and eskers. The ocean shoreline and islands provided caribou much needed relief from biting flies and heat."*

   *"Grizzly bears would walk the cliff ridges to hunt caribou that were seeking relief in the shade of the cliff."*

*"Wolves and foxes den at eskers used by caribou."*

*Section 4.5: "Wolverine stay under rocks, crevices and cliffs in "rough areas" to den, as it was used for security and hiding cover. Cliffs were used for scavenging and for caching food."*

*Section 4.11: "Cliffs were important nesting habitat for a variety of raptors, and other colonial nesting birds such as gulls and Cliff Swallows. Cliff nesters also included raves, geese and some ducks."*

*"Important wetlands for waterfowl are found around Perry Island, Ellice River, Perry River, and the coast of Bathurst Inlet from Omingmaktok south to Hiukkittak. There are also wetlands at the Kilingoyak Isthmus, and just above Parry Bay and part of Katimanak, which were used for nesting by Canada Geese, White-fronted Geese, and Brants. These ducks all nest together where it's wet and grassy."*

*"Snowy Owls nest on the ground near wetlands where they hunt mice."*

2. Because eskers, cliffs, rocky ridges, wetlands, ocean shores, and riverbanks provide a preferred habitat for wildlife, they were also prime hunting and trapping grounds for people.

   *Section 3.4: "Birds were an important source of food for ocean and coastal Inuit, because of the large concentrations of nesting waterfowl on the ocean coast."*

   *"Inuit trapped white fox in wetlands as well, where they were quite numerous."*

   *"They hunted ground squirrel in the late spring and throughout the summer, concentrating on riverbanks where higher densities were found."*

3. Cliffs are also important to Inuits as a source of water when they travel across the land.

   *Section 7: "Inuit obtained water and ice from: lake; rivers and creeks, as long as they were flowing; pools under cliffs; pools of water among deep rock crevasses…"*

4. Ocean shores and riverbanks are also important sources of carving stone.

   *Section 9: "Black soapstone called 'okohikhaat' was used to carve the large kudlik (stone oil lamps), and for making cooking pots. Inuit looked for this stone around riverbanks or the ocean shore."*

### 3.2.2 Incorporation of TK for Valued Environmental Component Selection

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

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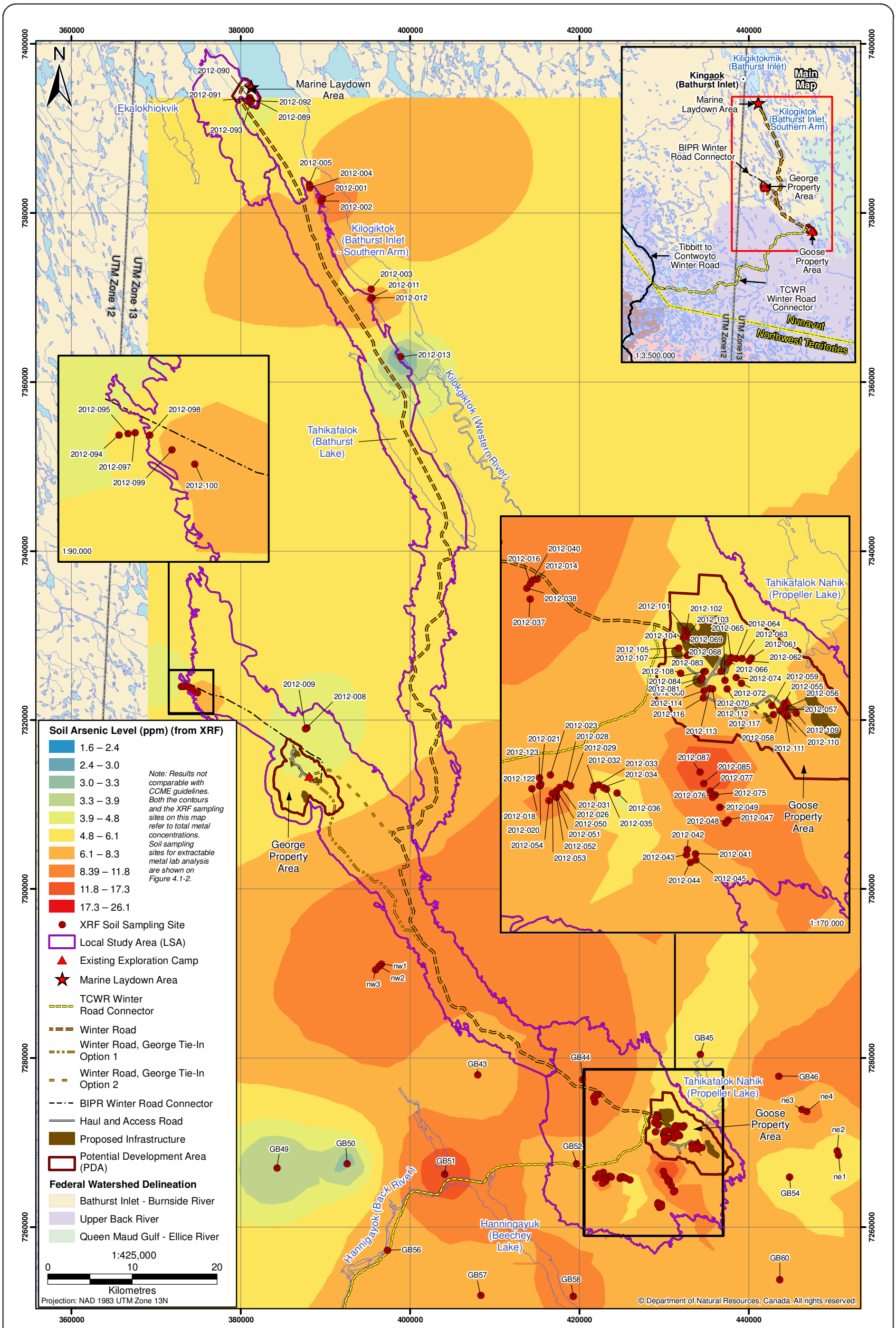


**Soil Arsenic Level (ppm) (from XRF)**

- 1.6 – 2.4
- 2.4 – 3.0
- 3.0 – 3.3
- 3.3 – 3.9
- 3.9 – 4.8
- 4.8 – 6.1
- 6.1 – 8.3
- 8.39 – 11.8
- 11.8 – 17.3
- 17.3 – 26.1
- XRF Soil Sampling Site
- Local Study Area (LSA)
- Existing Exploration Camp
- Marine Laydown Area
- TCWR Winter Road Connector
- Winter Road
- Winter Road, George Tie-In Option 1
- Winter Road, George Tie-In Option 2
- BIPR Winter Road Connector
- Haul and Access Road
- Proposed Infrastructure
- Potential Development Area (PDA)

**Federal Watershed Delineation**

- Bathurst Inlet - Burnside River
- Upper Back River
- Queen Maud Gulf - Ellice River

*Note: Results not comparable with CCME guidelines. Both the contours and the XRF sampling sites on this map refer to total metal concentrations. Soil sampling sites for extractable metal lab analysis are shown on Figure 4.1-2.*

1:425,000
0 10 20
Kilometres
Projection: NAD 1983 UTM Zone 13N

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Figure 3.1-7

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# Back River Project: Natural Distribution of Soil Arsenic in the Local Study Area

Figure 3.1-7

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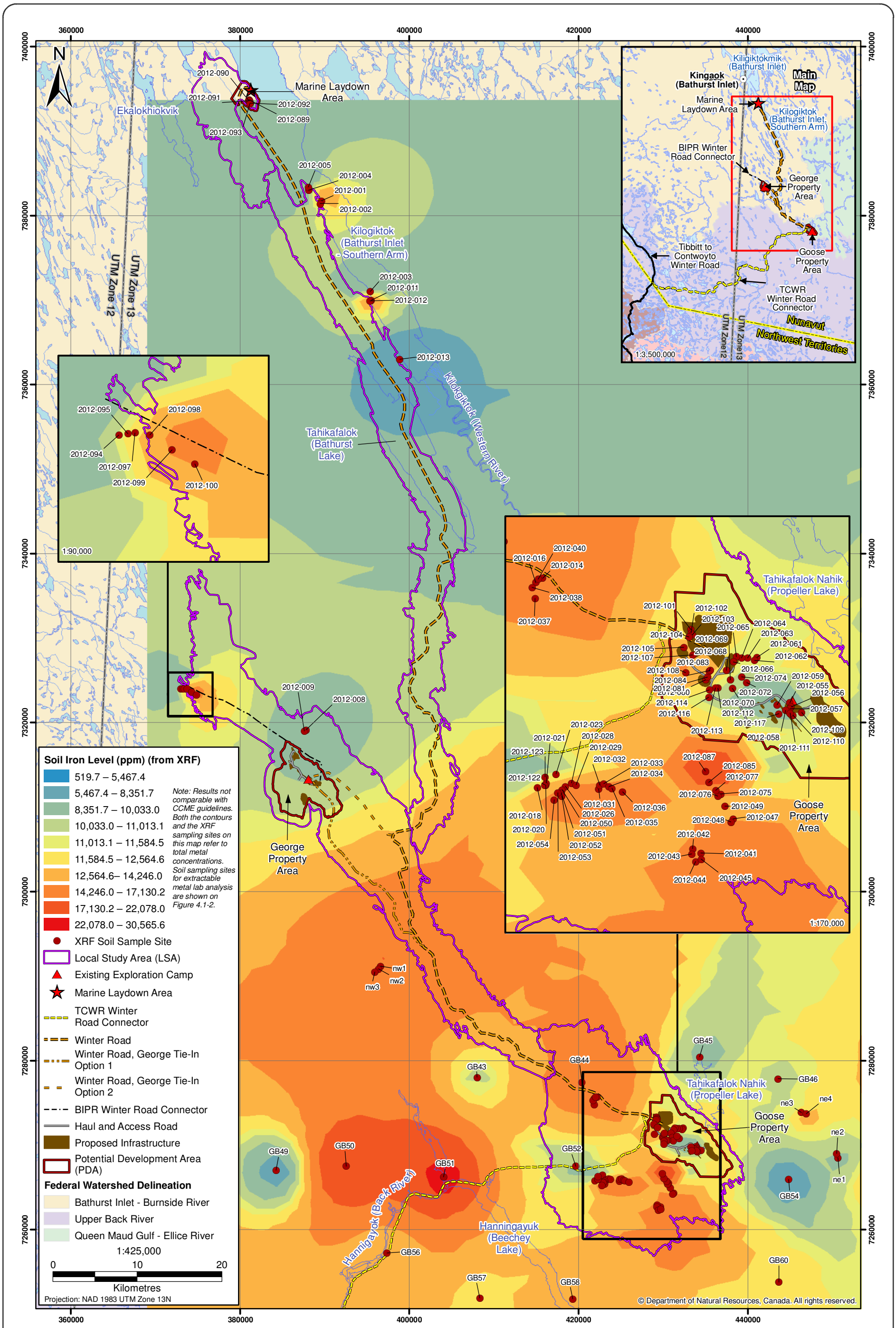


Figure 3.1-8

Sabina GOLD & SILVER CORP.

# Back River Project: Natural Distribution of Soil Iron in the Local Study Area

Figure 3.1-8

Rescan an ERM company

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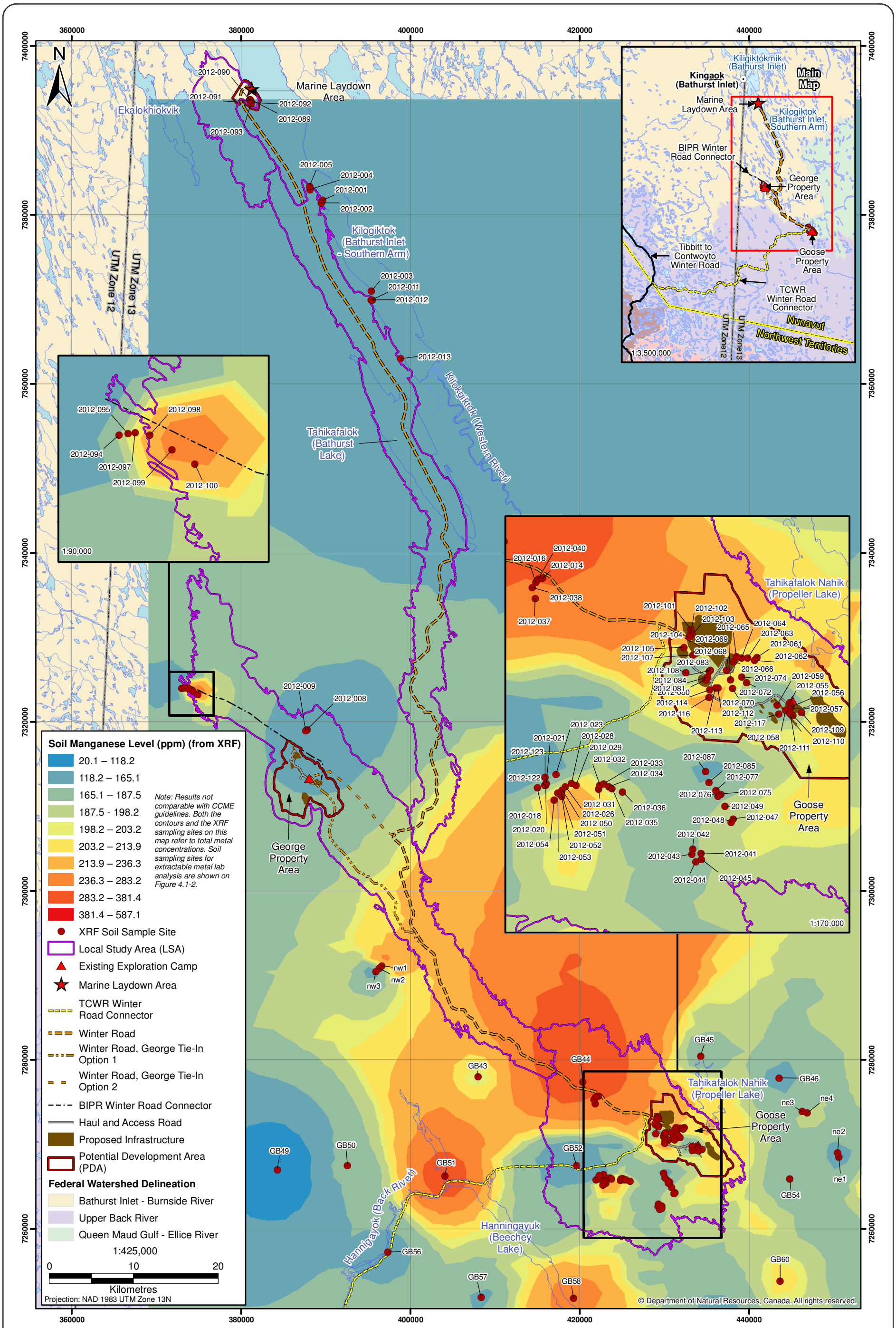


Figure 3.1-9

Sabina GOLD & SILVER CORP.

# Back River Project: Natural Distribution of Soil Maganese in the Local Study Area

Figure 3.1-9

Rescan an ERM company

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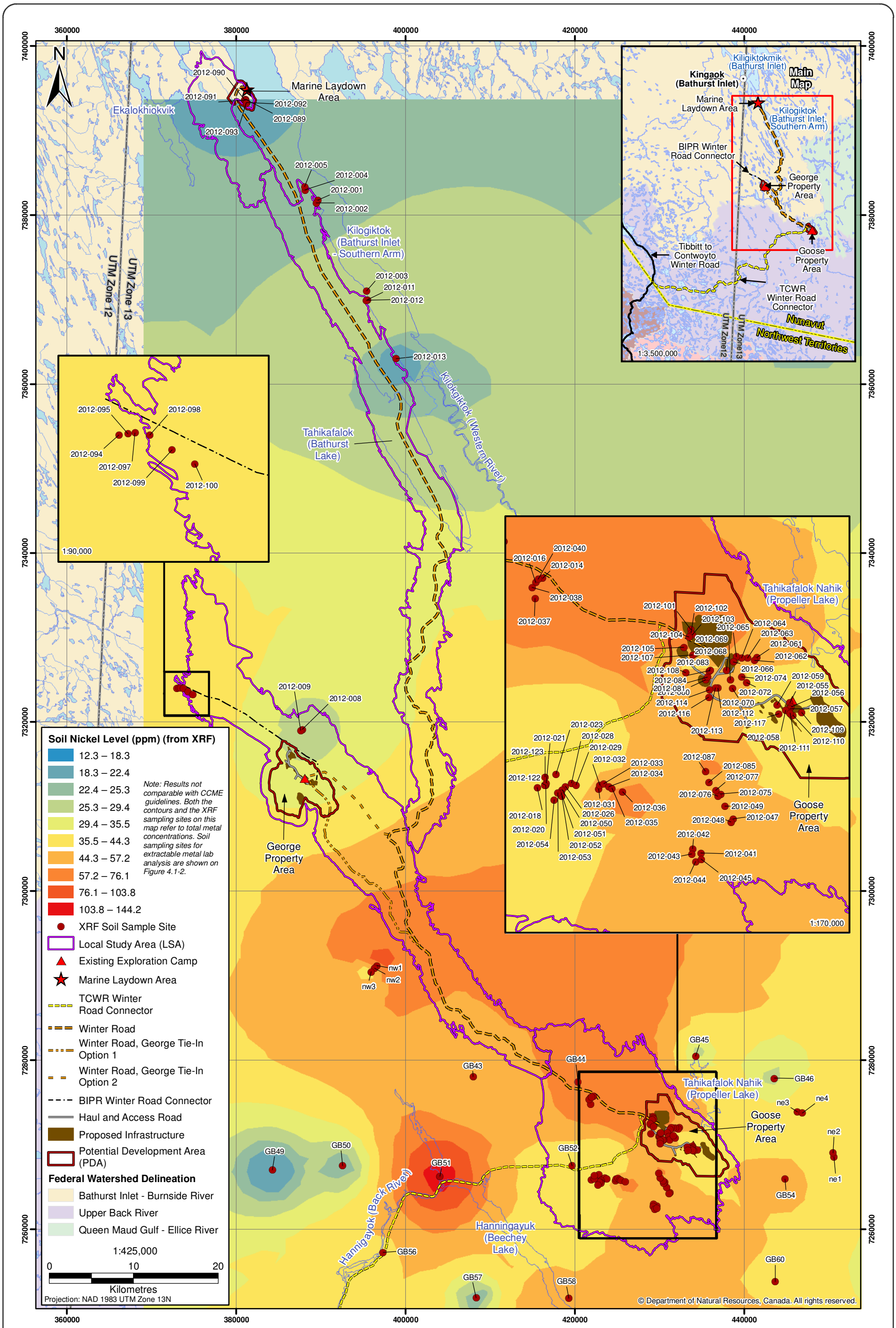


Figure 3.1-10

Sabina GOLD & SILVER CORP.

# Back River Project: Natural Distribution of Soil Nickel in the Local Study Area

Figure 3.1-10

Rescan an ERM company

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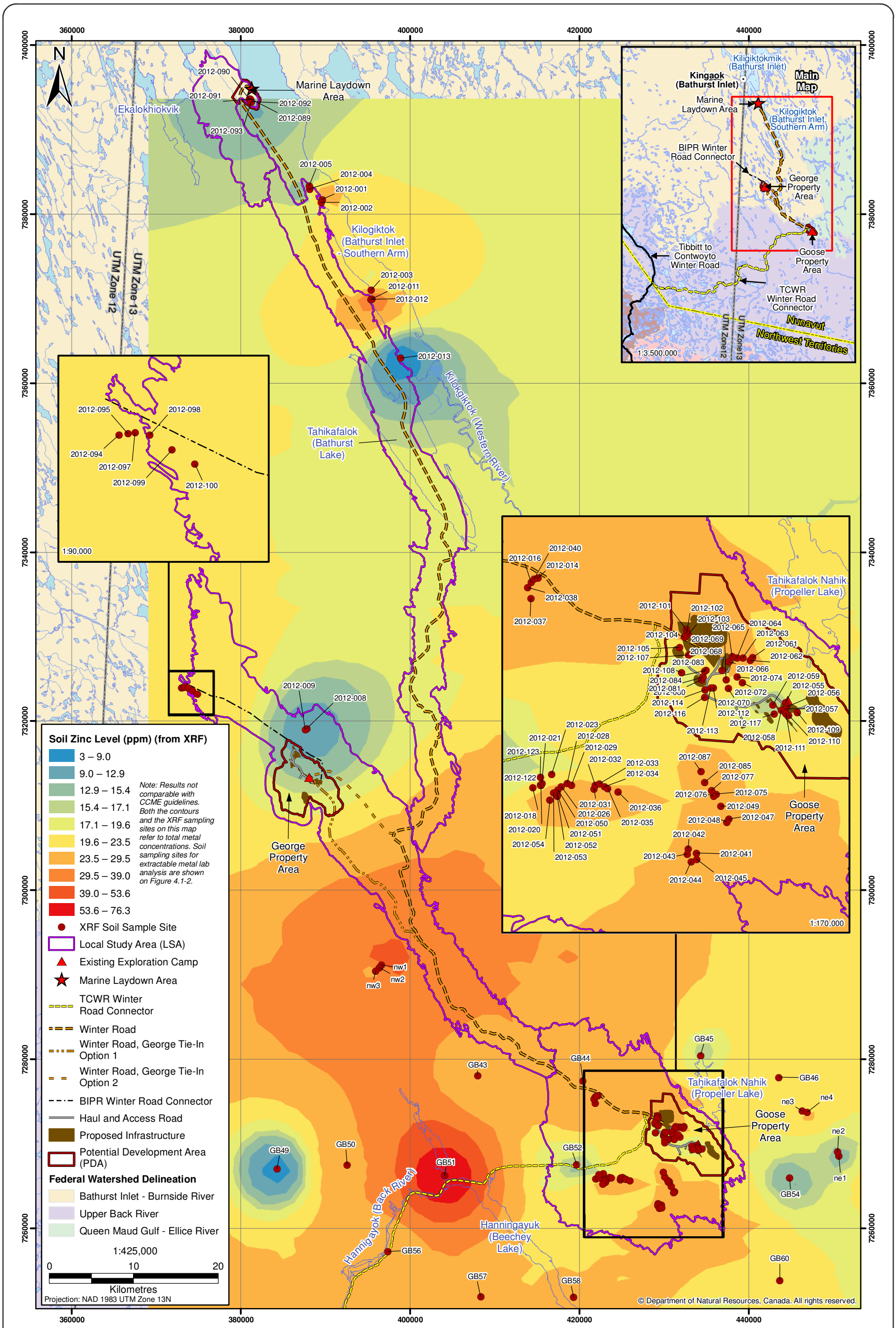


Figure 3.1-11

Sabina GOLD & SILVER CORP.

# Back River Project: Natural Distribution of Soil Zinc in the Local Study Area

Figure 3.1-11

Rescan an ERM company

## 3.3 VALUED COMPONENTS

### 3.3.1 Potential Valued Components and Scoping

Landforms and Soils were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, Landforms and Soils are classified as a Subject of Note.

### 3.3.2 Valued Components Included in Assessment

Landforms and Soils are considered a Subject of Note for the draft EIS. All information requested in the NIRB-issued EIS guidelines relating to Landforms and Soils is included in this draft EIS.

## 3.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

This section provides supplemental information as requested in the EIS guidelines (Nunavut Impact review Board (NIRB) 2013), Section 8.1.9.2).

#### *3.4.1.1 Potential for Soil Erosion Associated with the Project Components and Activities*

Soil disturbance associated with the Project that potentially may lead to erosion is expected only within the PDAs, as the development activity will be confined to these areas. Because it is assumed that the entire area of the PDAs is lost for the duration of the Project life (Project Description Volume 2, section 4.2), the effects of project activities on soil erosion are assessed only for the Project closure phase.

The Project closure phase will be associated with the increased potential for soil erosion. In newly decommissioned/reclaimed areas where soil surface is disturbed or devoid of vegetation, the most fertile surficial fractions of soil may be lost due to wind erosion. Wind erosion of exposed soils may also result in dust and sediment entering waterways.

Exposed mineral soils are also sensitive to water erosion. For example, the ice rich surficial materials, once excavated and stockpiled, will thaw, process which is associated with of the release of seepage and sediment. On disturbed slopes soil erosion can also occur during spring snow/ice melt and during rainfall events. Even on relatively flat terrain, exposed finer soils may be susceptible to splash erosion, which can result in a loss of soil structure and crusting of the surface, thereby impeding development of seeded protective vegetation.

Areas dominated by bedrock and glaciofluvial deposits are expected to exhibit relatively low erosion potential. Morainal deposits are expected to display variable but generally higher erosion potential; especially if soil disturbance takes place on slopes exceeding 5% or if the soil is stockpiled. When disturbed, deposits currently covered by organic horizons may display high erosion potential due to typically finer mineral soil textures and shallow active layer above the permafrost. Disturbance of the surficial protective organic layer could lead to permafrost degradation and land subsidence (Racine and Ahlstrand 1991). Appendix V5-3A provides detailed information on spatial distribution of surficial deposits and their characteristics.

Streams in the LSA are generally well protected against current levels of stream bank erosion. Fluvial deposits are generally coarse, contain high proportion of coarse mineral fragments, and are often covered by a tough organic layer reinforced by a network of intertwined root systems. Construction work in the riparian zones is expected to temporarily increase stream bank erosion potential, but mitigation measures for erosion control will be in place as outlined in the Fish Habitat mitigation measures (See Volume 6, Chapter 6).

The Site Water Monitoring and Management Plan (Volume 10, Chapter 7) and the Mine Closure and Reclamation Plan (Volume 10, Chapter 29) include management measures to avoid or minimize soil erosion.

#### *3.4.1.2 Potential Impacts to Soil Quality from Compaction*

Soil disturbance leading to soil compaction is expected only within the PDAs. Because it is assumed that the entire area of each PDA will be lost for the duration of the Project life, the effects of Project activities on soil compaction are assessed only for the Project closure and post-closure phases.

During the Project closure increased machinery traffic will lead to soil compaction. Within the growing season, when soils are not frozen, most tundra soils are highly sensitive to compaction associated with even light intensity of traffic over the soil surface (Rescan 2011). Compaction results in significant soil temperature changes, degradation of the organic horizon, and reduction of pore space between soil particles, which in turn limits water, nutrient, and air movement in the soi, leading to a decline in soil fertility and reduction in plant establishment and growth. In the Arctic, soil compaction can also leads to ground surface subsidence due to thawing of ice-rich permafrost (Racine and Ahlstrand 1991).

Areas dominated by bedrock and glaciofluvial deposits are expected to exhibit relatively low susceptibility to compaction, whereas wetlands and tundra located in lower topographic positions (e.g., lower slopes, slope toes, depressions, and valley floors) are most vulnerable.

The assessment of potential soil degradation resulting from aerial deposition of acid and metals is provided in the Atmospheric Environment chapter (Volume 4, Chapter 1), and the Human Health and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Potential of soil degradation resulting from spills is assessed in the Spill Contingency Plan (Volume 10).

#### *3.4.1.3 Implications to the Project Design Related to Terrain Conditions, in Particular Permafrost, Sensitive Landforms, High Ice-content Soils, Ice Lenses, Thaw-sensitive Slopes, and Talik Zones.*

One of the objectives of Project design is to minimize the area of impact on local landforms and soils, especially in areas where local terrain conditions indicate existence of sensitive surficial deposits, permafrost or high ice content soils. The total area (14,256 ha) of the four PDAs: Goose, George, Marine Laydown, and Winter Roads will be considered lost from the time of Project construction to its closure. While varying levels of soil degradation are expected within the four proposed Project Development Areas, the residual soil loss will affect only the areas delineated by the size of the maximum Project footprint (855 ha). This area will consist of three separate sections located in three PDAs: 670 ha in the Goose PDA, 172.5 ha in the George PDA, and 12.5 ha in the MLA PDA. These losses correspond with 11.3%, 2.8%, and 2.3% of the respective PDAs. It is expected that most of the soils located within the PDAs, but outside of the footprint areas (13,401 ha), will gradually regain their ecological potential after mine closure, but only over the long term.

Table 3.4-1 quantifies the implications of the Project design in relation to specific surficial material types and provides an overview of the spatial extent of the residual effects of the Project development on soils. It lists the estimated areas of land that will be directly affected at the time of mine closure. The following section 3.4.1.4 discusses sensitivity of particular deposits to surface disturbance. Permafrost chapter (Volume 5, Chapter 2) provides a review of potential interactions of Project with permafrost and talik zones.

**Table 3.4-1. Summary of the Residual Effects of the Project Development on Soil Quantity**

| Dominant Surficial Material | Goose PDA | | George PDA | | MLA | | Grand Total | |
|---|---|---|---|---|---|---|---|---|
| | ha | % | ha | % | ha | % | ha | % |
| Anthropogenic | - | - | 6.4 | 100.0 | - | - | 6.4 | 100.0 |
| Colluvial | 6.3 | 16.3 | 0.003 | 0.0 | - | - | 6.4 | 7.0 |
| Eolian | 4.4 | 3.4 | 1.0 | 2.0 | - | - | 5.4 | 3.0 |
| Fluvial | 4.0 | 12.1 | - | - | - | - | 4.0 | 6.2 |
| Glaciofluvial | 127.0 | 15.0 | 18.2 | 4.9 | - | - | 145.2 | 11.9 |
| Lacustrine | - | - | 22.2 | 6.6 | - | - | 22.2 | 5.5 |
| Morainal | 414.7 | 12.6 | 98.1 | 3.9 | - | - | 512.8 | 8.8 |
| Organic | 76.9 | 18.0 | 4.0 | 0.9 | - | - | 80.9 | 9.3 |
| Open water | 26.3 | 2.9 | 9.1 | 0.5 | - | - | 35.3 | 1.3 |
| Bedrock | 10.4 | 6.6 | 13.5 | 25.6 | - | - | 23.9 | 11.4 |
| Marine | - | - | - | - | 12.5 | 2.4 | 12.5 | 2.4 |
| Total | 670.0 | 11.3 | 172.5 | 2.8 | 12.5 | 2.4 | 855.0 | 6.8 |

*Note: The % columns list the lost proportion of the particular surficial material present within the PDA.*

#### *3.4.1.4 Potential Impacts on the Thermal Stability of Terrain in the Vicinity of Facilities and Infrastructure due to the Thawing of the Ice-rich Permafrost Soils and Other Sensitive Landforms.*

It is expected that most of the areas dominated by colluvium, weathered bedrock, eolian, bedrock, and marine deposits will display relatively low sensitivity to surface disturbance. In the areas where the Project infrastructure will be built upon fill or foundation material (e.g., crushed rock) degradation of permafrost or ice lenses is less likely.

Organic surficial deposits and riparian zones, where fluvial material is covered by organic veneers, are likely to exhibit high susceptibility to surface disturbance, which may result in permafrost or ice lens degradation. Similarly, morainal and lacustrine deposits located on slopes or in low topographical positions are expected to have high ice content and as such display high susceptibility to surface disturbance.

Evidence of massive ice cores located within glaciofluvial deposits (e.g., eskers) have been reported in a large number of studies conducted in Northwest Territories (S. R. Dallimore and Wolfe 1988; S. R. Dallimore and Davis 1992; Wolfe et al. 1997; Moorman and Michel 2003; Robinson et al. 2003; Macumber et al. 2011). as The evidence suggests that ice cores are a characteristic feature of eskers at the time of their origin (Banerjee and McDonalds 1975; Moorman and Michel 2003; Huddart and Stott 2010). A review of the above evidence suggests that majority of glaciofluvial deposits located the West Kitikmeot region of Nunavut may contain massive ice cores and that disturbance of mineral materials associated with them will likely affect ice core integrity.

# 4. Vegetation and Special Landscape Features

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# 4. Vegetation and Special Landscape Features

## 4.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

Baseline studies to characterize the baseline ecosystems and vegetation present within the regional and local area of the Back River Project (the Project) were carried out in 2012. The focus of these studies was on ecosystems, habitat and vegetation identified by Inuit, scientists, regulators, or the public as ecologically, socially or culturally important.

This information is provided in the 2012 Ecosystems and Vegetation Baseline Report (Rescan 2013a, Appendix V5-4A) and forms the basis for evaluating potential effects of the Project on ecosystems, vegetation and special landscape features.

A local study area (LSA) of 134,370 ha was established, using watershed boundaries and buffers around project infrastructure. Baseline studies included a combination of ecosystem classification and mapping, field verification, rare plant surveys (Appendix 1 of Rescan 2013a), invasive plant surveys, and plant tissue collection for baseline metals analysis.

Studies affirmed a great variety and diversity of ecosystems present within the Project area. Generally speaking they include lichen-dominated ecosystems occupying large areas of exposed bedrock of the Canadian Shield, mesic tundra ecosystems on glacial till, sedge wetlands in the lowlands, perpetually supplied by runoff fed by the summer melt of permafrost, and areas at Bathurst Inlet with warmer temperature soils, relatively rich soils and diverse flora. In order to facilitate classification, study, and assessment, the LSA was divided into four sub-areas, the delineation of which was based upon disturbance type, ecosystem heterogeneity, and spatial extent of infrastructure. The four sub-areas below are presented graphically in Figure 4.1-1.

- George Property Sub-area (36% of LSA);
- Goose Property Sub-area (32% of LSA);
- Winter Road Sub-area (26% of LSA); and
- Marine Laydown Sub-area (6% of LSA).

Appendix 3 of Rescan 2013a provides the detailed data and descriptions for identified ecosystems. A summary of the environmental characteristics, including the typical site characteristics; structural development; dominant vegetation species; typical soil, terrain and parent material characteristics; and, where applicable, other vegetation associations that occur as complexes, is provided. The distribution of these mapped ecosystems within the LSA is presented in Figures 4.1-2a through 4.1-2d. For discussion purposes, these ecosystems were categorized as Vegetated, Sparsely-vegetated and Non-vegetated (Table 4.1-1).

Vegetated ecosystems occur when adequate soil intersects with favourable climate. Soil is required for rooting, water storage and nutrient supply, while favourable climate (and microclimate) reduce exposure to extensive snowpack and desiccating winds. This allows for colonization of the site by plants, and the subsequent development of ecosystems. Upland areas with soil parent materials such as glacial till and glaciofluvial deposits, and with adequate drainage, allow for the development of tundra ecosystems, with associated flora dominated by dwarf woody shrubs. Slow decomposition rates result in accumulation of fibric and mesic peat, typically 20 to 50 cm in thickness. Within the LSA, vegetated ecosystems are largely dominated by mesic tundra, although dry-sparse tundra and moist to mesic shrubby tundra are

also present. The mesic tundra association, the most extensively mapped ecosystem in the LSA, represents the "typical" tundra situation and is characterized by extensive areas dominated by dwarf woody shrub species, with a highly variable component of herbs, graminoids, mosses, and lichens. Dry sparse tundra is associated with windswept hillcrests, steeper slopes and rockier substrate. Moist tundra forms in downslope positions, where seepage occurs from seasonal melting permafrost. These ecosystems are transitional to wetlands, as indicated by the presence of woody shrubs, sedges and cottongrasses.

Sparsely-vegetated ecosystems are often associated with areas of thin morainal veneers or exposed bedrock ecosystems, windswept esker crests, blocky tundra, marine beaches and other disturbed or barren sites that limit vegetation establishment and vigour. Of the sparsely-vegetated ecosystems, the bedrock-lichen veneer and exposed bedrock associations were the dominant units mapped.

Sensitive ecosystems, or special landscape features, were classified as such due to their value as wildlife habitat or higher likelihood to support rare plants or culturally valued plant species. They include esker complexes, shrubby riparian ecosystems, sedge and shrub-dominated wetlands, marsh ecosystems, shallow open water, bedrock cliffs, and bedrock-lichen veneers.

Within the Project area, wetlands are particularly extensive and forming on plains, often previously occupied by lakes. The parent materials are the depositional product of erosion from upland areas; as a result, the mineral fraction of soils is very well sorted with medium to fine textures. Soils are saturated to the surface during the growing season, as permafrost at 50 to 80 cm depth restricts drainage. The vegetation is dominated by graminoids, specifically sedges and cottongrasses.

Two regional classification systems (Figure 4.1-3) were used to map ecosystems in the regional study area (RSA). The West Kitikmeot / Slave Study (WKSS) classification by Matthews, Epp and Smith (2001) covers approximately 87% of the RSA, while the Geobase Land Cover data set (Government of Canada 2009) was use to infill areas that were lacking coverage. By using these two systems, regional classification was obtained for 99.6% of the RSA (Table 4.1-2). These two classification systems are reconciled in Table 4.1-2 into generalized ecosystem classes, similar to those mapped in Rescan 2013a. Assessment of the two datasets against the TEM field surveys suggests that, for the Project area, the WKSS data set more accurately represents the ecosystems on the ground. There are no existing or proposed parks, protected areas, special management areas and conservation areas within the RSA.

Approximately 60% of the total RSA is comprised of ecosystems that are generalized, within this assessment, into Bedrock – Sparse and Tundra – Heath classes. Within these classes, the Boulder Association and Heath Tundra, mapped within the WKSS dataset, comprise the largest area. Regional ecosystems generalized into Wetland and Tussock classes, comprise a collective 16% of the RSA and non-vegetated units, dominated by lakes, ponds, and Bathurst Inlet, at the northern tip, comprise 21% of the RSA.

Each of the plants identified during the Socio-economic and Land Use Baseline (Rescan 2013b, Appendix V8-3A) as having cultural importance were identified during the 2012 baseline field sampling. Cloudberry, a preferred local country food species, was commonly identified within wetland ecosystems. A total of 890 species identifications were made during the TEM and rare plant field surveys. The largest species group is that of the vascular plants, followed by the macro-lichens. Of the 90 rare species identified, 20 are newly discovered vascular plants within Nunavut. None of the invasive plant species identified as potentially occurring in the LSA were identified.

Soil, berry, sedge and lichen tissue samples were collected throughout the LSA, and from reference sites beyond the LSA, to determine baseline concentrations of metals. This includes 72 soil samples, 46 berry samples, 12 aquatic sedge samples and 49 lichen samples. The environmental media baseline data was used in the Country Foods assessment (Volume 8, Chapter 5).

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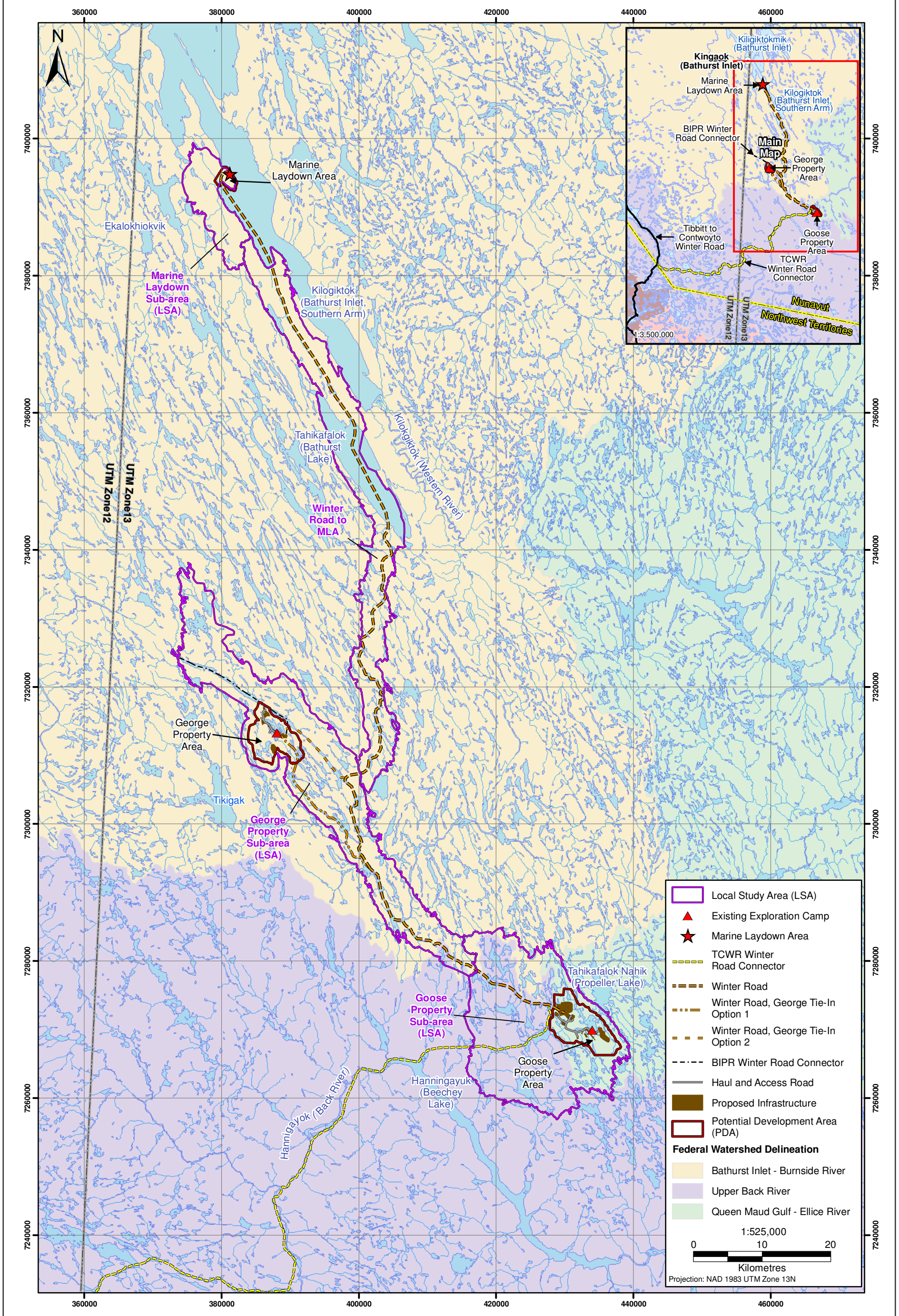


Figure 4.1-1

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## Sub-areas of the Local Study Area

Figure 4.1-1

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**Table 4.1-1. Summary of Mapped Ecosystems in the Local Study Area**

| | | | | | George Property Sub-area | | | Goose Property Sub-area | | | Marine Laydown Sub-area | | | Winter Road Sub-area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ecosystem Name** | **TEM Code** | **Ecosystem Class** | **Area (ha)** | **% Total LSA** | **Area (ha)** | **% George** | **% LSA** | **Area (ha)** | **% Goose** | **% LSA** | **Area (ha)** | **% MLA** | **% LSA** | **Area (ha)** | **% Winter Rd** | **% LSA** |
| **Non-vegetated Ecosystems** | | | | | | | | | | | | | | | | |
| Lake | LA | Freshwater | 17961.8 | 13.4% | 5310.5 | 11.1% | 4.0% | 3979.9 | 9.2% | 3.0% | 0 | 0% | 0% | 8671.4 | 24.7% | 6.5% |
| Pond | PD | Freshwater | 6173.7 | 4.6% | 2342.1 | 4.9% | 1.7% | 2635.3 | 6.1% | 2.0% | 211 | 2.5% | 0.2% | 985.3 | 2.8% | 0.7% |
| River | RI | Freshwater | 289.6 | 0.2% | 135.9 | 0.3% | 0.1% | 57.9 | 0.1% | 0.0% | 25.1 | 0.3% | 0.0% | 70.7 | 0.2% | 0.1% |
| Saltwater | MW | Marine | 4.1 | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% | 4.1 | 0% | 0% |
| Mine camp | DR | Disturbed/Barren | 10 | 0.0% | 3.2 | 0% | 0% | 6.8 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% |
| Road surface | DZ | Disturbed/Barren | 3.2 | 0.0% | 3.2 | 0.0% | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% |
| **Total** | | | **24442.4** | **18.2%** | **7794.9** | **16.4%** | **5.8%** | **6679.9** | **15.4%** | **5.0%** | **236.1** | **2.8%** | **0.2%** | **9731.5** | **27.7%** | **7.2%** |
| **Sparsely Vegetated Ecosystems** | | | | | | | | | | | | | | | | |
| Exposed soil | ES | Disturbed/Barren | 176.8 | 0.1% | 10.5 | 0.0% | 0.0% | 5 | 0% | 0% | 11.3 | 0.1% | 0.0% | 150 | 0.4% | 0.1% |
| Bedrock-lichen veneer | BL | Bedrock | 6704.4 | 5.0% | 3522.8 | 7.4% | 2.6% | 386 | 0.9% | 0.3% | 794.1 | 9.6% | 0.6% | 2001.5 | 5.7% | 1.5% |
| Bedrock outcrop | BR | Bedrock | 3381.8 | 2.5% | 1492.2 | 3.1% | 1.1% | 600.3 | 1.4% | 0.4% | 527.1 | 6.3% | 0.4% | 762.2 | 2.2% | 0.6% |
| Blockfield | TB | Bedrock | 154.1 | 0.1% | 85.9 | 0.2% | 0.1% | 5.5 | 0% | 0% | 0 | 0% | 0% | 62.7 | 0.2% | 0.0% |
| Cliff | BC | Bedrock | 8.1 | 0.0% | 5.9 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% | 2.1 | 0% | 0% |
| Talus | BT | Bedrock | 4.6 | 0.0% | 0 | 0% | 0% | 4.6 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% |
| Sparsely vegetated esker | EC | Esker | 577.6 | 0.4% | 383.1 | 0.8% | 0.3% | 57.9 | 0.1% | 0.0% | 0 | 0% | 0% | 136.6 | 0.4% | 0.1% |
| Shallow open water | WO | Wetland | 81.2 | 0.1% | 8.2 | 0% | 0% | 72.6 | 0.2% | 0.1% | 0 | 0% | 0% | 0.4 | 0% | 0% |
| Saline shallow open water | MO | Wetland (Marine) | 55.8 | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% | 3.6 | 0% | 0% | 52.2 | 0.1% | 0.0% |
| Marine beach | MB | Marine | 59.5 | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% | 42 | 0.5% | 0.0% | 17.4 | 0% | 0% |
| Old beach heads | MH | Marine | 476.3 | 0.4% | 0 | 0% | 0% | 0 | 0% | 0% | 62.6 | 0.8% | 0.0% | 413.7 | 1.2% | 0.3% |
| **Total** | | | **11680.2** | **8.7%** | **5508.6** | **11.6%** | **4.1%** | **1131.9** | **2.6%** | **0.8%** | **1440.7** | **17.3%** | **1.1%** | **3598.8** | **10.2%** | **2.7%** |
| **Vegetated Ecosystems** | | | | | | | | | | | | | | | | |
| Disturbed vegetation | DV | Disturbed/Barren | 0.7 | 0.0% | 0.7 | 0.0% | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% |
| Dwarf shrub esker | EH | Esker | 570.2 | 0.4% | 306.3 | 0.6% | 0.2% | 64 | 0.1% | 0.0% | 0 | 0% | 0% | 199.9 | 0.6% | 0.1% |
| Shrubby esker | EW | Esker | 189.3 | 0.1% | 118.7 | 0.2% | 0.1% | 15.1 | 0% | 0% | 0 | 0% | 0% | 55.5 | 0.2% | 0.0% |
| Mesic dwarf-shrub tundra | TL | Tundra | 40373.2 | 30.0% | 14731.4 | 30.9% | 11.0% | 18556.1 | 42.9% | 13.8% | 891.1 | 10.7% | 0.7% | 6194.6 | 17.6% | 4.6% |
| Dry-sparse tundra | TH | Tundra | 22876 | 17.0% | 9739.8 | 20.4% | 7.2% | 6373.8 | 14.7% | 4.7% | 1142 | 13.7% | 0.8% | 5620.4 | 16.0% | 4.2% |
| Shrubby tundra | TS | Tundra | 11144.4 | 8.3% | 4446.6 | 9.3% | 3.3% | 4877.3 | 11.3% | 3.6% | 17.8 | 0.2% | 0.0% | 1802.8 | 5.1% | 1.3% |
| Marine dwarf shrub tundra | MT | Tundra (Marine) | 5447.3 | 4.1% | 0 | 0% | 0% | 0 | 0% | 0% | 2719.6 | 32.7% | 2.0% | 2727.7 | 7.8% | 2.0% |
| Marine shrubby tundra | MS | Tundra (Marine) | 1831.1 | 1.4% | 0 | 0% | 0% | 0 | 0% | 0% | 391.1 | 4.7% | 0.3% | 1440 | 4.1% | 1.1% |
| Willow riparian | RW | Riparian | 1405.1 | 1.0% | 498 | 1.0% | 0.4% | 572.8 | 1.3% | 0.4% | 18.1 | 0.2% | 0.0% | 316.2 | 0.9% | 0.2% |
| Low bench floodplain | RL | Riparian | 36.5 | 0.0% | 13.8 | 0% | 0% | 7.8 | 0% | 0% | 0 | 0% | 0% | 14.9 | 0% | 0% |
| Mid bench floodplain | RM | Riparian | 3.8 | 0.0% | 0 | 0% | 0% | 3.2 | 0% | 0% | 0 | 0% | 0% | 0.7 | 0% | 0% |
| Marine riparian shrub | MR | Riparian (Marine) | 439.6 | 0.3% | 0 | 0% | 0% | 0 | 0% | 0% | 229.7 | 2.8% | 0.2% | 209.9 | 0.6% | 0.2% |
| Raised bog complex | WB | Wetland | 4147.3 | 3.1% | 1116.2 | 2.3% | 0.8% | 1776.3 | 4.1% | 1.3% | 64.9 | 0.8% | 0.0% | 1189.8 | 3.4% | 0.9% |
| Cottongrass-sedge fen | WC | Wetland | 3263.6 | 2.4% | 1415.2 | 3.0% | 1.1% | 1165.8 | 2.7% | 0.9% | 0 | 0% | 0% | 682.5 | 1.9% | 0.5% |
| Undifferentiated fen | WF | Wetland | 2525.1 | 1.9% | 1064.5 | 2.2% | 0.8% | 767.4 | 1.8% | 0.6% | 329.4 | 4.0% | 0.2% | 363.7 | 1.0% | 0.3% |
| Water sedge marsh | WA | Wetland | 2312.2 | 1.7% | 733.3 | 1.5% | 0.5% | 1053 | 2.4% | 0.8% | 16.2 | 0.2% | 0.0% | 509.7 | 1.5% | 0.4% |
| Willow-sedge fen | WS | Wetland | 366.8 | 0.3% | 142.5 | 0.3% | 0.1% | 186.2 | 0.4% | 0.1% | 0 | 0% | 0% | 38.1 | 0.1% | 0.0% |
| Tussock meadow | WT | Wetland | 64.5 | 0.0% | 4.8 | 0% | 0% | 59.7 | 0.1% | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% |
| Saline Fen | MF | Wetland (Marine) | 993.5 | 0.7% | 0 | 0% | 0% | 0 | 0% | 0% | 695.8 | 8.4% | 0.5% | 297.8 | 0.8% | 0.2% |
| Estuary marsh | ME | Wetland (Marine) | 4.2 | 0.0% | 0 | 0% | 0% | 0 | 0% | 0% | 0 | 0% | 0% | 4.2 | 0% | 0% |
| Saline Marsh | MM | Wetland (Marine) | 252.1 | 0.2% | 0 | 0% | 0% | 0 | 0% | 0% | 116.9 | 1.4% | 0.1% | 135.2 | 0.4% | 0.1% |
| **Total** | | | **98246.5** | **73.1%** | **34331.8** | **72.1%** | **25.6%** | **35478.5** | **82.0%** | **26.4%** | **6632.6** | **79.8%** | **4.9%** | **21803.6** | **62.1%** | **16.2%** |
| **Grand Total** | | | **134369.1** | **100.0%** | **47635.3** | | **35.4%** | **43290.3** | | **32.2%** | **8309.4** | | **6.2%** | **35133.9** | | **26.1%** |

PROJECT #0194096-0040 GIS # BAC-20-032a November 27 2013

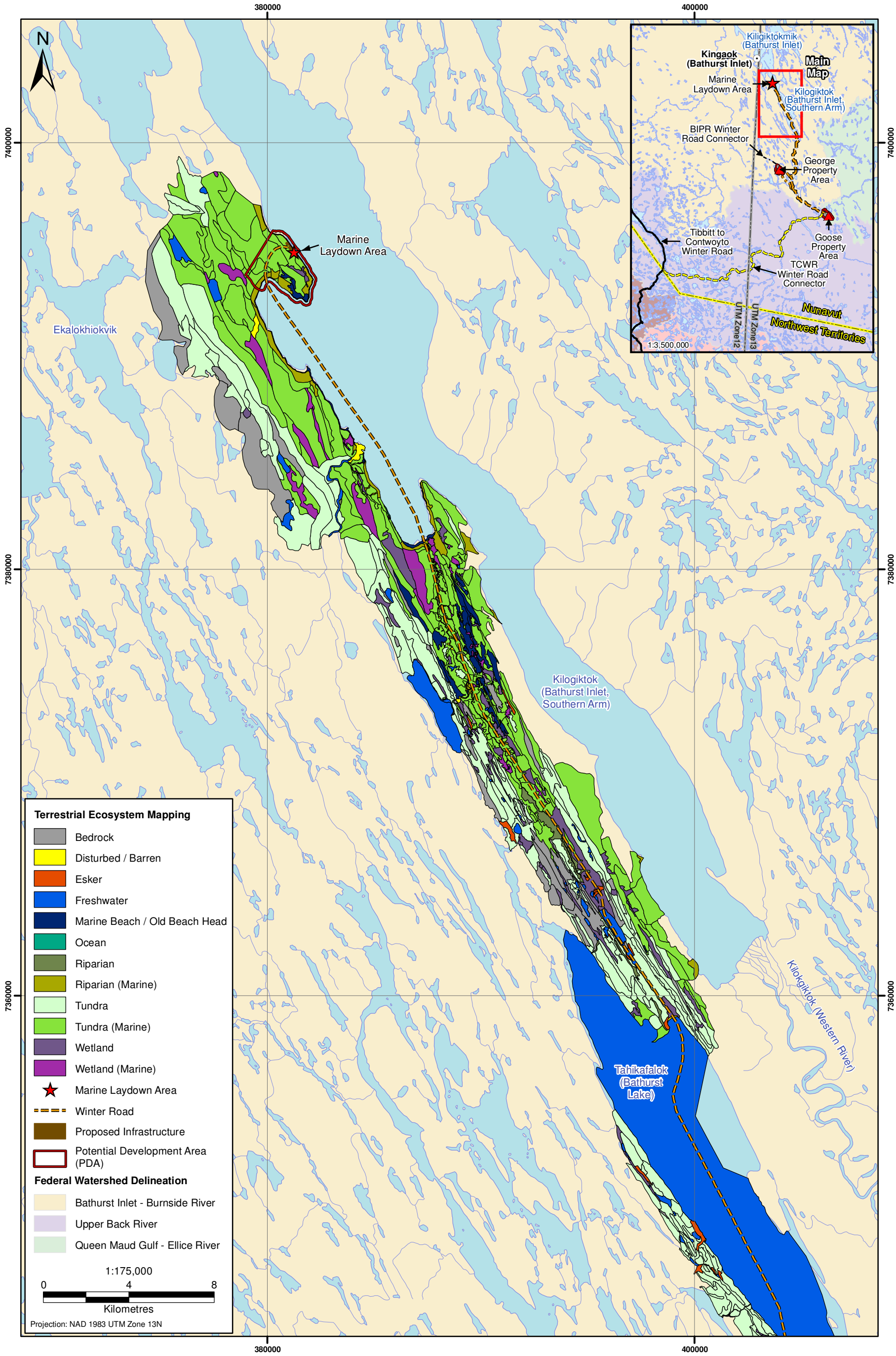



Figure 4.1-2a

Sabina GOLD & SILVER CORP.

# Terrestrial Ecosystem Mapping - Overview Map A

Figure 4.1-2a

Rescan an ERM company

PROJECT #0194096-0040 GIS # BAC-20-032b December 18 2013

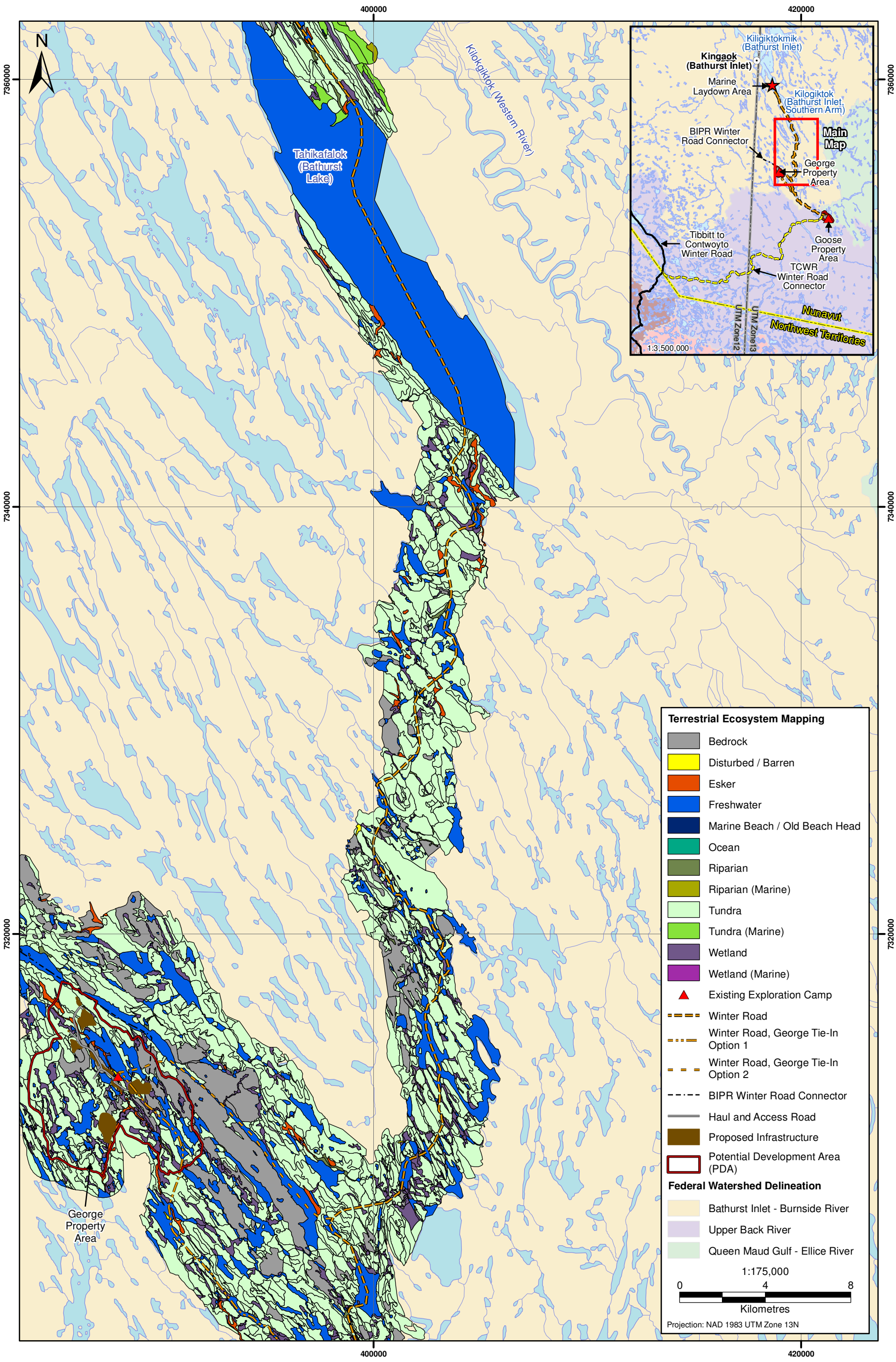



Figure 4.1-2b

Sabina GOLD & SILVER CORP.

# Terrestrial Ecosystem Mapping - Overview Map B

Figure 4.1-2b

Rescan an ERM company

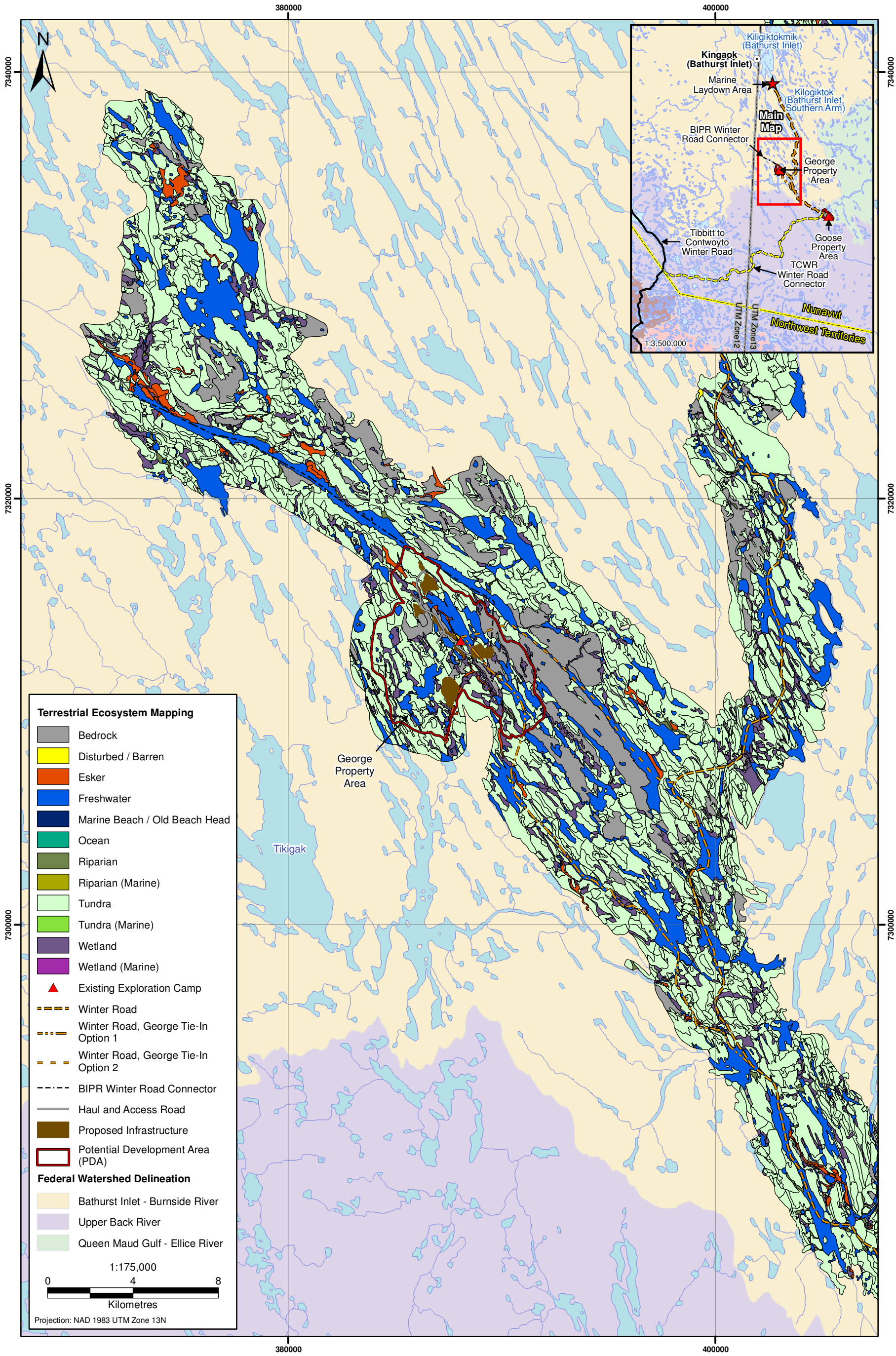



Figure 4.1-2c

Sabina GOLD & SILVER CORP.

# Terrestrial Ecosystem Mapping - Overview Map C

Figure 4.1-2c

Rescan an ERM company

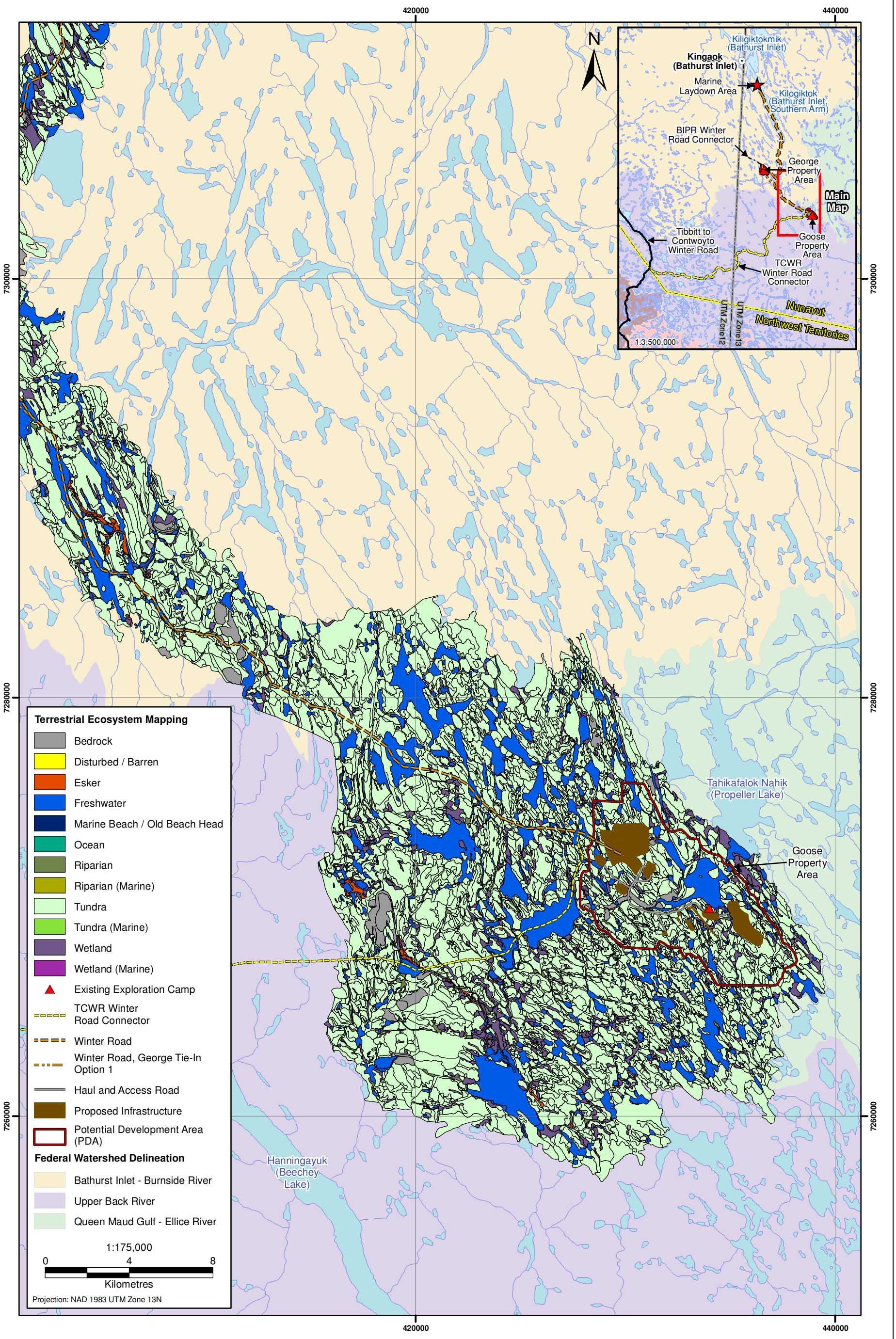



Figure 4.1-2d

Sabina GOLD & SILVER CORP.

# Terrestrial Ecosystem Mapping - Overview Map D

Figure 4.1-2d

Rescan an ERM company

*PROJECT #* 0194096-0040 *GIS #* BAC-20-030 *November 27 2013*

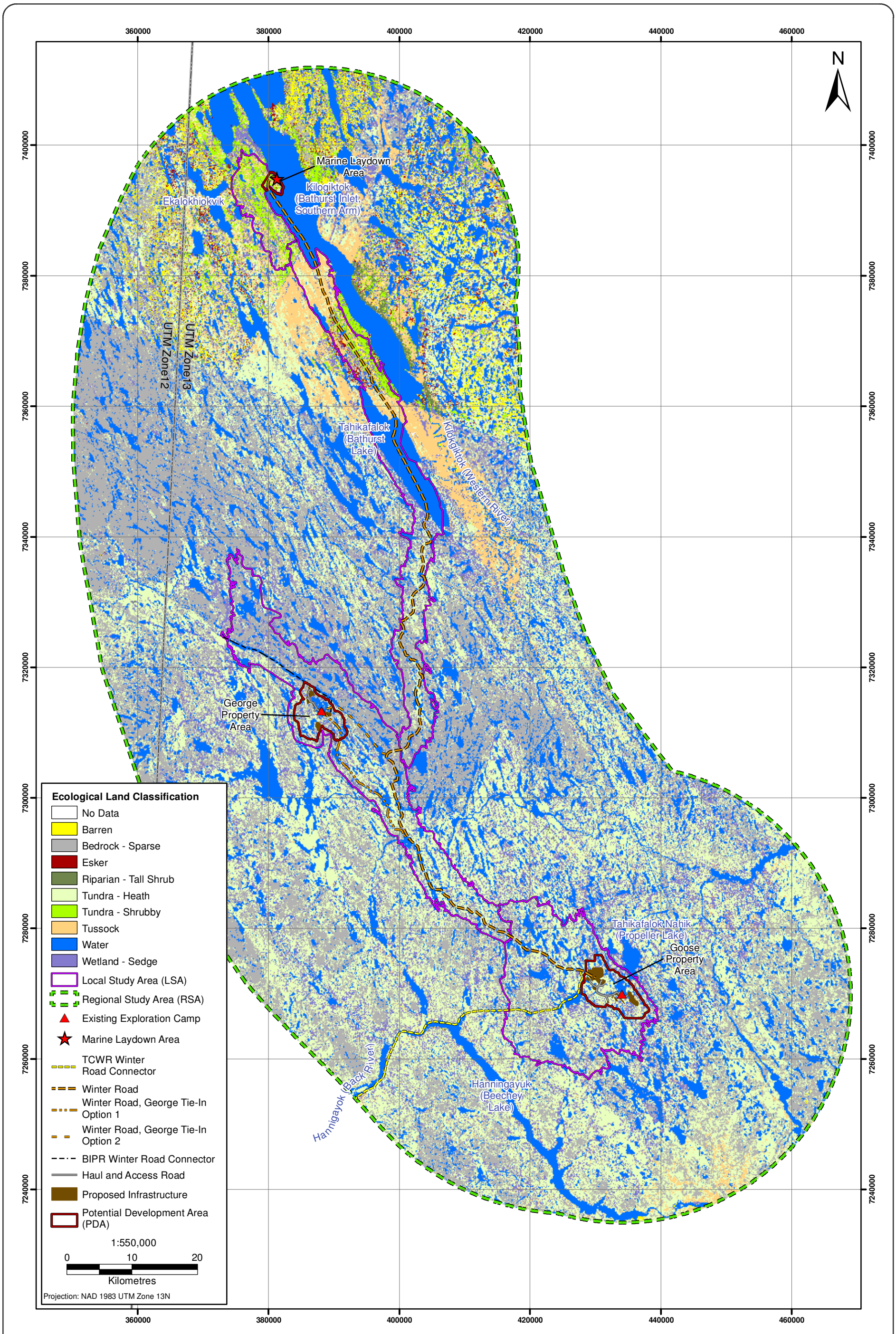



Figure 4.1-3

Sabina GOLD & SILVER CORP.

## Regional Ecological Classification within the Regional Study Area

Figure 4.1-3

Rescan an ERM company

**Table 4.1-2. Ecological Land Classification Summary within the RSA**

| Regional Ecological Land Classification Unit | Generalized Ecosystem Class | RSA (ha) | Total Area (ha) | RSA (%) |
|---|---|---|---|---|
| Unclassified | No Data | 4,797 | 4,852 | 0.4 |
| No data | | 55 | | |
| Deep Water | Water | 102,226 | 265,197 | 21.0 |
| Ice and Snow | | 33,356 | | |
| Water[1] | | 27,709 | | |
| Shallow Water | | 101,906 | | |
| Bedrock Association | Bedrock - Sparse | 14,877 | 337,670 | 26.8 |
| Sparsely vegetated bedrock[1] | | 57 | | |
| Sparsely vegetated till-colluvium[1] | | 80 | | |
| Boulder Association | | 216,650 | | |
| Heath/Bedrock | | 62,909 | | |
| Tussock graminoid tundra[1] | | 42,040 | | |
| Lichen Veneer | | 1,057 | | |
| Bare Ground | Barren | 4,912 | 24,383 | 1.9 |
| Bare soil with cryptogam crust-frost boils[1] | | 69 | | |
| Barren/non vegetated[1] | | 229 | | |
| Gravel Deposit | | 19,174 | | |
| Esker Complex | Esker | 5,457 | 5,457 | 0.4 |
| Tall Shrub | Riparian - Tall Shrub | 6,616 | 6,616 | 0.5 |
| Heath Tundra | Tundra - Heath | 228,591 | 418,525 | 33.2 |
| Moist to dry non-tussock graminoid/dwarf shrub tundra[1] | | 3,034 | | |
| Prostrate dwarf shrub[1] | | 4,912 | | |
| Shrub low[1] | | 47,062 | | |
| Heath/Boulder | | 118,881 | | |
| Birch Seep | Tundra - Shrubby | 54 | | |
| Low Shrub | | 15,992 | | |
| Tussock/Hummock | Tussock | 37,697 | 199,302 | 15.8 |
| Shrub tall[1] | | 23,888 | | |
| Wetland (Sedge Meadow) | Wetland - Sedge | 131,934 | | |
| Wet sedge[1] | | 3,605 | | |
| Wetland[1] | | 2,178 | | |
| **Total** | | **1,262,004.6** | **1,262,004.6** | **100.0** |

[1] *Source: Government of Canada et al. (2009)*

## 4.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The effects assessment relies on the information collected from Inuit-led TK information, public scoping, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available TK is incorporated into the evaluation of the potential effects of the Project on the

environment. The following reports were reviewed for TK specific information related to vegetation and special landscape features:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Omingmaktok as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

### 4.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize vegetation, soils and special landscape features, which form the foundation of the environment. In Section 4.3.1, berries are identified as an important food source for the Inuit. The 2012 baseline program included the collection and analysis of baseline metal concentrations within the berries of country food plants, including blueberries (*Vaccinium uliginosum*), bog cranberries (*Vaccinium vitis-idaea*), lichens (*Cladina stygia* and *Stereocaulon* spp.), wetland sedge (*Carex aquatilis*) tissue, and soil (in Rescan (2013a). As berries are ingested directly, and lichens, wetland sedge tissue and soil may be ingested by caribou, and subsequently by local Inuit, this information is used as baseline information for the Country Foods assessment (Volume 8, Chapter 5). While Inuit did indicate harvesting a variety of plants in areas within and beyond the LSA, the harvested plant species are not unique to these areas and are also collected from outside the LSA. The baseline program also included a rare plant assessment, which targeted unique features on the landscape, such as cliffs, beaches, and brackish water communities, that have highest likelihood of supporting rare plants or communities.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were mapped as unique ecosystems, wherever possible.

### 4.2.2 Incorporation of TK for VEC and VSEC Selection

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

### 4.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Terrestrial ecosystem mapping, together with supporting field surveys, was completed during the baseline program within a study area that will encompass the measurable effects on vegetation resulting from development of infrastructure and other activities and equipment associated with the Project. To enable an assessment between vegetation and terrestrial ecosystems at local and regional scales, the

results of the WKSS regional ecological classification (Matthews, Epp, and Smith April 2001) and GeoBase Land Cover data (Government of Canada et al. 2009) are summarized within the regional study area (RSA). Given that terrestrial ecosystems provide habitat and forage to wildlife, the Vegetation RSA is consistent with the RSA developed for the assessment of wildlife habitat, which was delineated based on the expected use of the region by wildlife valued components. The vegetation and terrestrial wildlife RSA boundary represents an approximate 30 kilometre buffer surrounding proposed Project infrastructure.

### 4.2.4 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities. Specific comments are summarized in Section 4.3.1.

As terrestrial vegetation provides habitat and forage for valued wildlife species, mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial vegetation and special landscape features, which support unique plant communities and provides unique wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction. The known locations of rare plants were considered during the design of all-weather roads. The mitigation measures to minimize effects from physical loss and degradation are provided within Section 4.5.3. Volume 4 addresses the mitigation measures to minimize effects due to fugitive dustfall and atmospheric emissions and Volume 8 addresses mitigation measures pertaining to human health.

## 4.3 VALUED COMPONENTS

Defined within the EIS guidelines (NIRB 2013a), Valued Ecosystem Components (VECs) include "*those aspects of the environment considered to be of vital importance to a particular region or community, including:*

- *resources that are either legally, politically, publically, or professionally recognized as important, such as parks, land selections, and historical sites;*
- *resources that have ecological importance; and*
- *resources that have social importance."*

The sections below summarize the identification of potential VECs and Project scoping and define the final VECs carried through the effects assessment process relating to vegetation.

### 4.3.1 Potential Valued Components and Scoping

Described within the EIS guidelines (NIRB 2013a), NIRB developed a list of potential biophysical and socio-economic components of potential relevance for project scoping. The list of potential VECs (Section 7.6.1 of NIRB 2013a), including *Terrestrial Ecology* and V*egetation*, was provided to the Proponent for consideration. Summarized in Appendix B of the EIS guidelines, NIRB consulted with the public and interested parties to determine the scope of its review of Sabina Gold & Silver Corp.'s proposed Back River Project. This included consultation with local communities and interested parties throughout the Kitikmeot Region, and in Yellowknife, during February 2013 to determine the final scope of the EIS. From this consultation, a Public Scoping Meetings Summary Report (NIRB 2013b) and a Final Scope List for the NIRB's Assessment of the Back River Project (Appendix B of the EIS guidelines [ NIRB 2013a]) were issued.

Section 3.0 of the Public Scoping Meetings Summary Report summarizes community feedback. Most comments included concerns regarding potential for loss, disturbance or contamination of vegetation consumed by important wildlife, such as caribou, a major supplier of subsistence to the Kitikmeot (KIA 2012). Specific vegetation-related concerns within the Public Scoping Meetings Summary Report include the:

- potential loss or disturbance of vegetation (i.e., from piling of overburden), and subsequent reduction in its availability to animals;
- potential effects on rare plants;
- potential effects of salt used in drilling on the ability of vegetation to regenerate;
- need for reclamation or re-vegetation after the mine closes;
- need to maintain vegetation and flowers to uphold aesthetic values; and
- potential impacts of fugitive dust on wildlife and vegetation, including the potential that caribou may not cross areas where dust and chemicals have settled and concerns that dust could affect vegetation near, and far away from (i.e., up 10-15 miles), the Project before settling (Kugluktuk Hunter Focus Group 2012).

Described further within the Socio-economic and Land Use Baseline (Rescan 2013b), harvesting of terrestrial plants was identified through a number of focus group meetings with hunters from the Kitikmeot study communities. Cloudberries (*Rubus chamaemorus)* were identified as being collected and consumed in large amounts and mountain sorrel (*Oxyria digyna)*, or sweet leaves, were identified as being eaten raw, as fresh greens, or prepared as tea. Plants identified as having medicinal or other cultural value included cottongrasses (*Eriophorum* spp.) and willows (*Salix* spp.). Table 4.3-1 lists specific plants identified by the Cambridge Bay Land Users (Cambridge Bay Hunter Focus Group 2012) and the Omingmaktok/Bathurst Inlet Land Users (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012) with the utilized plant parts, where available. No comments pertaining to terrestrial ecology or vegetation were provided by the Kugluktuk Land Users (Kugluktuk Hunter Focus Group 2012).

**Table 4.3-1. Terrestrial Vegetation Identified through Traditional Knowledge**

| Inuinnaktun Name(s) | English Name | Latin Name(s) | Specific Use / Part of Plant |
|---|---|---|---|
| Kublak[2] | Bear berry | *Arctous rubra, A. alpina* | fruit |
| Kabluk | Bear berry | *Arctous rubra, A. alpina* | fruit |
| Kublakot | Bear berry | *Arctous rubra, A. alpina* | leaves |
| Akpik; Aaukpik[1] | Cloudberry | *Rubus chamaemorus* | fruit |
| Paungak; Paungan[1]; Paurngait[2] | Crowberry; Blackberries | *Empetrum nigrum* | fruit |
| Mahok | Liquorice root | *Hedysarum alpinum* | root |
| Qunguliit[2] | Mountain sorrel | *Oxyria digyna* | leaves |
| Kimminait[2] | Bog cranberry | *Vaccinium vitis-idaea* | fruit |
| Kigutangirnait[2] | Blueberries | *Vaccinium uliginosum* | fruit |
| | Willow | *Salix* spp. | bark |
| Qijuktaaqpait[2] (Baffin) | Labrador tea | *Ledum palustre* subsp. *decumbens* | |
| Kangayot[1] | Cottongrass | *Eriophorum* spp. | Seed heads |
| Kablakot[1] | Unknown; plant used for tea | Unknown | |

*(continued)*

**Table 4.3-1. Terrestrial Vegetation Identified through Traditional Knowledge (completed)**

| Inuinnaktun Name(s) | English Name | Latin Name(s) | Specific Use / Part of Plant |
|---|---|---|---|
| Avalakiak[1] | Unknown; low-growing plant for starting fires | Unknown | |
| Eehoktin[1] | Unknown; small plant for starting fires | Unknown | |
| Aatogoayak[1]; igloohoutinnik[1] | Unknown; mushrooms eaten by caribou | Unknown | |

*[1] From the vocabulary in Section 11 of the NTKP (KIA 2012). Where only the Inuinnaktun names are provided, it is difficult to correlate them with corresponding English or Latin names.*
*[2] Inuktitut names from Mallory and Aiken (2004).*

Reflecting the influence of a maritime climate and relatively nutrient rich soils (compared with tundra-dominated plateaus of the interior), land users from Kingaok/Omingmaktok describe vegetation at Bathurst Inlet as lush, green and much taller than vegetation elsewhere in the region.

## 4.3.2 Valued Components Included in Assessment

As described within the General Assessment Methodology Chapter (Volume 9, Chapter 1), the value of a component is considered in relation to its role in the ecosystem as a VEC, the value placed on it by humans for traditional use and to the inter-relationships between vegetation and other disciplines, including country foods, human health, and wildlife. Addressed in Section 4.2.2, TK information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC list.

### *4.3.2.1 Vegetation*

Within Nunavut, Inuit cultural heritage, government structure and current land-use policies are closely tied to wildlife and vegetation patterns. Having an understanding of existing vegetation assists the development of land-use and management decisions and enables modelling of future vegetation patterns and ecosystem properties related to climate change (Gould, Raynolds, and Walker 2003). Based on the results of community consultation and the ecological importance of vegetation in providing important habitat for wildlife species, including culturally significant species such as barren-ground caribou, terrestrial vegetation (hereafter called *vegetation*) has been selected as a terrestrial environment VEC. It is considered key to understanding northern ecosystems and forms the basis for determining terrestrial primary productivity and, therefore, food chains (Aiken et al. 2007). Described within the Socio-economic and Land Use Baseline (Rescan 2013b), and previously within Section 4.3.1, current and traditional harvesting of terrestrial vegetation was identified through a series of Land and Resource Use Focus Group meetings with hunters from Kitikmeot communities.

Vegetation provides habitat and forage for many life requisites for Arctic wildlife species, some of which preferentially select specific vegetation communities or structure types. Within the 2012 Wildlife Baseline (Rescan 2013d), lichen heath is described as one of the main vegetation cover types within the calving grounds of the Bathurst herd (Griffith et al. 2001; Johnson et al. 2005), one of the three barren-ground caribou herds overlapping the Project RSA. Wetlands (natingnak), described as being the most important habitat type in Kitikmeot territory for grazing caribou (KIA 2012), also represent important calving habitat for caribou, denning habitat for foxes, and nesting habitat for waterfowl and snowy owls (KIA 2012). Several upland breeding bird communities have been differentiated on the basis of their habitat preferences based on vegetation structure (Rescan 2013d).

Vegetation is assessed as discrete associations, or terrestrial ecosystems, which form the base unit in the terrestrial ecosystem mapping process. Arctic plant community composition appears to depend largely on six variables: climate, local microclimate, soil drainage, nutrient availability, local soil type, and snow cover (Aiken et al. 2007). Described in Rescan (2013a), mapped ecosystems have been grouped into vegetated ecosystems, sparsely-vegetated ecosystems and non-vegetated ecosystems, typically ponds and lakes. Sparsely-vegetated ecosystems are often mapped in association with marine beaches and old beach heads, exposed crests of glaciofluvial features such as eskers, exposed bedrock outcrops, blockfields and shallow veneers of glacial till. Non-vegetated ecosystems are excluded from further assessment. The results of ecosystem mapping are used to derive the habitat suitability estimates for the wildlife VECs in Volume 5, Chapters 5 through 10.

Individual plant and lichen species, with the exception of rare plants (Appendix 1 of Rescan 2013a), are not assessed. However, Appendix 3 of the same appendix provides a list of the dominant plant species occurring within each of the mapped ecosystems. Many of the species occur across a wide range of mapped ecosystems, with individual presence and cover often a function of site-specific parent material and soil properties. A list of all flora, rare and common, that were identified during the rare plant surveys is provided within Appendix 1 of Rescan (2013a).

#### *4.3.2.2 Special Landscape Features*

Special landscape features are also included as a terrestrial environment VEC, based on their limited representation on the landscape, their higher likelihood to support rare or unique plant species or communities, or their inherent value as wildlife habitat (Table 4.3-2).

**Table 4.3-2. Summary of Special Landscape Features**

| Special Landscape Feature | TEM Map Code(s) | Total Area in LSA (ha) | Rationale for Inclusion |
|---|---|---|---|
| Cliffs | Slopes > 25% (excluding TEM Esker ecosystems) BC | 1,367.5 | • Higher likelihood of supporting rare plants, plant communities[1]<br>• Nesting habitat for variety of raptors, colonial nesting birds (incl. gulls and cliff swallows), raven, geese and some ducks[2]<br>• Scavenging, denning, and security habitat for wildlife such as wolverine[2]<br>• Hunting habitat for predators such as grizzly bears[2]<br>• Thermoregulation and insect avoidance habitat[2] |
| Esker ecosystems | EC, EH, EW | 1,337.1 | • Denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels[2]<br>• Traveling and security habitat for caribou[2]<br>• Hunting habitat for predators such as grizzly bears and wolves[2]<br>• Winter foraging habitat for caribou due to reduced snow depths[2]<br>• Thermoregulation and insect avoidance habitat[2]<br>• Unique habitat for flora requiring either very little snow or, alternately, prolonged snowpack[1]<br>• Exposed crests possess higher cover of some culturally valued vegetation species such as blackberries, or crowberries |
| Bedrock-lichen and outcrop ecosystems | BL, BR | 10,086.2 | • Winter foraging habitat for caribou due to reduced snow depths[2]<br>• High forage suitability for caribou, given abundance of terrestrial lichens |

*(continued)*

**Table 4.3-2. Summary of Special Landscape Features (completed)**

| Special Landscape Feature | TEM Map Code(s) | Total Area in LSA (ha) | Rationale for Inclusion |
|---|---|---|---|
| Riparian ecosystems | RL, RM, RW, MR | 1,885.0 | • Nesting and security habitat within dense shrub cover<br>• Foraging habitat for ungulates |
| Wetland ecosystems | MF, MO, WA, WB, WC, WF, WS, WT, WO | 13,810.0 | • Foraging and calving habitat for caribou [2]<br>• Denning habitat for foxes [2]<br>• Nesting habitat for waterfowl and snowy owl[2]<br>• High cover of some culturally valued vegetation species, including cloudberries and bog cranberries |
| Marine Beaches (including old beach heads), Shores, Marshes and Estuaries | MB, ME, MH, MM | 792.1 | • Gentle terrain used for trapping of wolves, foxes and wolverine [2]<br>• Higher likelihood of supporting rare plants, plant communities [1]<br>• Between Bathurst Lake and Bathurst Inlet, old beach heads resemble exposed esker crests<br>• Exposed soils associated with active and old beaches can support a high cover of some culturally valued vegetation species |
| **Total** | | **29,277.9** | |

[1] *Source: Appendix 1 of Rescan (2013a)*
[2] *Source: KIA (2012)*

The unique landforms identified in Section 2.4 of the 2012 Terrain and Soils Baseline Report (Rescan 2013c) include eskers, moraines and boulderfields. As no large moraine features were identified within either the LSA or RSA, they are excluded from the assessment of special landscape features. Similarly, boulderfields were typically neither identifiable nor mappable at the mapping scale and are excluded from assessment of special landscape features. Landscape features mapped within the LSA and RSA, or that can reliably be estimated using TEM data, are outlined within Table 4.3-2.

Detailed in Appendix 1 of Rescan (2013a), the following common habitats, together constituting a large majority of the assessment area, were found to support almost exclusively common species:

- small lakes and ponds;
- rocky or wet depressions;
- tussock-dominated ground, heaths;
- areas of low-pH surficial bedrock and boulders; and
- drumlins and associated solifluction lobes.

Landscape types within which the majority of rare plant species were located (Appendix 1 of Rescan 2013a) included the following:

- cliffs;
- beaches;
- sparsely vegetated gravel and sand near-shore benches;
- marine and lake shorelines; and
- estuaries, including brackish marshes, open water channels and saline mudflats.

Reflecting the uniqueness of landforms and ecosystems towards the coast, nearly 60% of all rare plant identifications were located within one kilometre of Bathurst Inlet. The Inlet and surrounding landscape are described as a particularly high conservation priority for rare plants and lichens, due to the wide diversity of habitats, numerous identified rare plant and lichen populations, and overall high species diversity (Rescan 2013a). Described further in Section 4.5, the Marine Laydown Area (MLA) Potential Development Area (PDA) comprises a relatively small area of shoreline and marine-influenced ecosystems within the LSA and RSA.

Habitats in the vicinity of Bathurst Inlet meriting special note include estuaries, which were found to harbour significant numbers of rare vascular plant species, a narrow canyon on the west shore of the Inlet (south of the MLA PDA), which bore a significant percentage of the rare species found in the Project Area, and sparsely vegetated, gravelly and sandy benches, which were found to support a concentration of rare plant and lichen species. Although rare species (primarily vascular plants) were identified along the shore in the southwest corner of the MLA PDA, none of the specific population 'hotspots' identified within Appendix 1 of Rescan (2013a) occurred within the PDA. Rare plants were commonly observed along the length of the Inlet shoreline between the MLA PDA and the Western River estuary, to the southeast. Many of these occurrences were outside of the LSA, but within the RSA.

Consistent with the assessment of potential cliff locations within the assessment of raptor habitat, a slope theme was created with slopes greater than 25% considered potential cliff habitat. To avoid confusing cliff ecosystems with esker features, the TEM esker ecosystems are excluded from the slope theme.

Described within Appendix 1 of Rescan (2013a), cliffs and their associated ledge and talus features possessed the greatest number of identified rare plant and lichen species. Most sampled cliffs were located in the vicinity of Bathurst Inlet; occurrence of cliffs further inland is rare. Features of cliffs that contribute to the unique flora include:

- a concentration of different microhabitats, with significant differences in temperature, shade, aspect, and snow duration;
- enrichment with mineral nutrients, due to precipitation of solutes from seepage water, that creates small hotspots of species diversity;
- a dense cover of cyanobacteria on seepage cliffs, which are among the only organisms that can convert atmospheric nitrogen into compounds vital to plant growth; and
- concentrated guano associated with nesting and perch sites, which promotes unique conditions conducive to rare plant establishment and growth.

Summarized in Table 4.3-2 and within the 2012 Wildlife Baseline Report (Rescan 2013d; Appendix V5-5C), cliffs provide nesting, denning, foraging, hunting, thermal and security, and insect avoidance habitat for many bird and mammal species. As these features are often too small to identify within a TEM polygon, or are not visible at the mapping scale, potential cliff habitat within the LSA was estimated by theming of slopes in excess of 25%.

Esker ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels, and are used as movement corridors and security habitat for many wildlife species. During TEM field surveys, caribou were frequently observed travelling and resting upon esker crests. High land features such as eskers provide additional value to wildlife in the form of relief from heat and insects (KIA 2012). Although few rare plant species were identified in esker habitats, due to their well-drained sandy and gravelly soils, they represent a contrast to the dominant rocky or frost-heaved, poorly-drained soils that dominate much of the inland portion of the project area (Appendix 1 of Rescan 2013a).

They generally have frozen cores, consistent with the surrounding continuous permafrost environment. However, those that are hydraulically connected to surface waterbodies that do not freeze to the bottom in winter months have been shown to exhibit talik, or unfrozen ground, within and beneath their cores. Esker landforms in the vicinity of George, Bob and Dragon lakes may exhibit perennially non-freezing temperatures within and beneath their cores. Some plant species with berries of cultural value, such as Paungak (crowberries or blackberries), grow well on exposed esker soils.

Bedrock-dominated ecosystems are typically sparsely-vegetated, occurring within a matrix of bedrock outcrops and shallow, rapidly-drained soils. The vast majority of bedrock ecosystems occur within the George Property Area. Summarized in Appendix 4 of Rescan (2013a), the BL association is among the driest ecosystem type in the LSA. Restricted to crest positions on bedrock outcrops with very thin morainal or organic veneers, it is limited in extent. The dry, windswept areas associated with this ecosystem often support an abundance of lichens, providing an important forage resource for caribou.

Riparian shrub ecosystems provide an important food source for ungulates, nesting habitat for birds and security and thermal habitat for many wildlife species. The deciduous shrub layer associated with the marine riparian (MR) association, mapped in the Marine Laydown Area, is taller and more diverse than the riparian units within the George and Goose Property Areas. Shrubs in riparian ecosystems along slopes adjacent to Bathurst Inlet often reached two metres in height, much taller than the typical height throughout the inland George and Goose Property Areas, which rarely exceeded 1 metre.

Wetland ecosystems, in addition to providing an important forage source for caribou, represent calving habitat for caribou, denning habitat for foxes, and nesting habitat for waterfowl and snowy owls (KIA 2012). Described within Rescan (2013a), Nunavut does not presently have a defined site-level classification system for wetlands and it is therefore not possible to report on rarity of specific types. However, there are a number of wetland-related landscape features present within the Arctic that are considered uncommon or unique (NWT Department of Environment and Natural Resources 2012), including saline sulphur springs, pingos and karst wetlands.

Marine ecosystems, particularly estuaries, are recognized within Appendix 1 of Rescan 2013a as important habitat for rare vascular plants, some of which are ranked as globally rare. Species growing within estuarine marshes, open-water channels and saline mudflats are reliant upon the unique clayey, brackish estuarine soils. Other marine ecosystems near the Bathurst Inlet shoreline that support rare plant species include open and sparsely-vegetated gravelly and sandy benches, and eroding marine sediments. Beaches and old beach heads, the latter often possessing vegetation communities similar to exposed esker crests, are also assessed as special landscape features.

### 4.3.3 Supporting and Supplemental Information

A detailed report on rare plant and lichen species throughout the LSA and RSA is provided in Appendix 1 of Rescan (2013a), which can be found in Appendix V5-4A. Although potential effects on rare and culturally valued plants are not individually assessed, ecosystems or features with highest potential to support rare plant species, such as cliffs and marine beaches, shores and wetlands, are encompassed within the assessment of special landscape features. Table 4.3-2 identifies those features with highest likelihood of supporting rare and culturally valued plants. Section 4.3.1 discusses the plant species of traditional importance.

## 4.4 SPATIAL AND TEMPORAL BOUNDARIES

Spatial and temporal boundaries, as developed for the assessment of potential effects on vegetation and special landscape features, are outlined within Sections 4.4.1 and 4.4.2.

### 4.4.1 Spatial Boundaries

Terrestrial ecosystems are summarized and assessed within local and regional study areas.

#### *4.4.1.1 Local Study Area*

The vegetation Local Study Area (LSA), depicted in Figure 4.1-1, provides sufficient land base to effectively demonstrate the local context for baseline ecosystem distributions. It is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter access roads. To incorporate natural boundaries wherever possible, sub-watershed boundaries were retained as LSA boundaries where the watershed(s) encompassed the proposed Project components and were considered at least as large as the area of potential loss or degradation. A one-kilometre buffer was mapped surrounding the outer boundary of the Potential Development Areas associated with the Goose Property, George Property and Marine Laydown Areas.

Within the LSA, the project-related effects (Section 4.5) are assumed within the PDAs. Described within Section 4.5.2.1, the current footprints represent a small percentage of the respective PDA areas.

#### *4.4.1.2 Regional Study Area*

The vegetation Regional Study Area (RSA), depicted in Figure 4.1-3, is the same as the terrestrial wildlife RSA which is based on the expected regional use by wildlife species assessed as valued components.

### 4.4.2 Temporal Boundaries

The temporal boundaries used for the assessment are aligned with the Project phases, as follows:

- Site Preparation — 2 years;
- Construction phase — 2 years;
- Operational phase — 10 years;
- Reclamation and Closure phase — 10 years;
- Post-closure phase — 5 years;
- other potential phases:
  - Temporary Closure phase — less than 2 years,
  - Care and Maintenance phase — 2 to 10 years, and
  - Exploration — included in the Construction and Operational phases.

Each Project phase will likely have potential interaction with vegetation and special landscape features, including direct, indirect, short-term and long-term interactions. Direct, long-term effects are expected during the Site Preparation and Construction phases, while a variety of indirect short-term effects could occur throughout all phases.

## 4.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

### 4.5.1 Methodology Overview

Described in the General Assessment Methodology Chapter (Volume 9, Chapter 1), the effect assessment process comprises a number of steps that collectively assess the manner in which the

Project will interact with the terrestrial environment to produce effects on vegetation and special landscape features. The project-related effects assessment process can be summarized as follows:

1. Potential interactions between the Project, vegetation and special landscape features were identified.
2. Potential effects that could result from these interactions were characterized.
3. Mitigation or management measures that could eliminate or reduce the potential effects were identified.
4. Residual effects that remain after mitigation and management measures have been applied were characterized.
5. The significance of potential residual effects was determined.

The change between the mapped area (in hectares) of terrestrial ecosystems at baseline versus the area remaining after loss of the three Back River Project PDAs, formed the basis for the assessment of potential residual effects. Losses from vegetated ecosystems are reported as a percentage of their respective baseline distributions within the LSA.

Defined within Section 2.4.5 of the General Assessment Methodology Chapter (Volume 9, Chapter 1), attributes used to evaluate potential residual effects, including determination of significance, include the direction and nature, magnitude, geographic extent, frequency, timing, duration, and reversibility. The environmental sensitivity of the landscape that is subject to potential effects is also a consideration.

Defined magnitude or significance thresholds for vegetation and special landscape feature loss do not presently exist for Arctic ecosystems. Described within the assessment methodology sections for the wildlife VECs in Volume 5, Chapters 5 through 10, as vegetated ecosystems constitute habitat for wildlife, the magnitude rating scheme (Table 4.5-1) was developed through the use of threshold values derived from literature on wildlife habitat loss and disturbance.

**Table 4.5-1. Definitions of Magnitude Criteria for Vegetation and Special Landscape Features Residual Effects**

| Magnitude | Description |
|---|---|
| Negligible | Loss less than 1% of LSA availability |
| Low | Loss between 1% and 10% of LSA availability |
| Medium | Loss between 10.1% and 20% of LSA availability |
| High | Loss greater than > 20% of LSA availability, or loss between 10.1% and 20%, for ecosystems considered of Very Low resiliency |

Described in Price, Roburn, and MacKinnon (2009), habitat loss in excess of 30% was identified as a transition from low risk to a higher risk of uncertain magnitude within coastal forests of British Columbia. Consistent with the methodology for the wildlife habitat assessments, although 30-40% habitat loss can be defined as potentially causing unacceptable risks to species (Scrimgeour, Hvenegaard, and Tchir 2008; Price, Roburn, and MacKinnon 2009), a precautionary approach is adopted for this Project such that a high magnitude effect is predicted if the loss of vegetated ecosystems or special landscape features exceeds 20% of their respective distribution, or availability, within the LSA. High magnitude effects are also predicted for ecosystems of very low resiliency, such as esker-related ecosystems, where loss occurs in the range of 10.1% to 20%.

Potential effects range from negligible magnitude, where there is assumed to be no detectable change to baseline distributions, to high magnitude, where loss is assumed to result in a long-lasting effect on the distribution or availability of vegetation communities in the LSA.

The outcome of the significance determination indicates the effect on ecosystem integrity and function, on the sustainability of vegetation, or on its capacity to meet the present and future needs. Despite assessments of potential loss and magnitude determinations at the level of specific ecosystems or generalized classes, the final magnitude for significance determination is based upon the loss of vegetated ecosystems and special landscape features, as a whole, not by specific ecosystems or features.

### 4.5.2 Potential Interactions with Project and Characterization

Development of Project infrastructure within the George Property, Goose Property and Marine Laydown Area (MLA), as identified within the Project Description (Volume 2), will result in loss and degradation of vegetation and special landscape features, which are considered throughout the assessment to be of direct, long-term consequence.

To characterize and assess the potential effects, all potential effects were examine using two indicators:

1. Loss of vegetation and special landscape features; and
2. Degradation of vegetation.

Table 4.5-2 identifies the main Project components proposed within the George Property, Goose Property and MLA expected to result in the loss of vegetation and special landscape features or degradation of vegetation. A more detailed Project interaction matrix, provided in Volume 9, Chapter 1, identifies proposed Project facilities and activities with potential to interact with vegetation and unique landscape features, such as eskers. The activities are presented by Project phase.

**Table 4.5-2. Potential Effects on Vegetation and Special Landscape Features**

| | Loss | Degradation |
|---|---|---|
| **George Property Area** | | |
| Open pits (LCP North Pit, Locale 1 Pit, and Locale 2 Pit) | X | X |
| Haul and access roads | X | X |
| Winter roads | | X |
| Stockpiles | X | |
| Waste rock storage areas | X | |
| Explosives storage areas | X | |
| Landfill | X | X |
| Camp | X | X |
| Other infrastructure (i.e., water intake) | X | |
| **Goose Property Area** | | |
| Open pits (Main Pit, Umwelt Pit, and Llama Pit) | X | X |
| Haul and access roads | X | X |
| Winter roads | | X |
| Stockpiles | X | |
| Waste rock storage areas | X | |
| Explosives storage areas | X | |

*(continued)*

**Table 4.5-2. Potential Effects on Vegetation and Special Landscape Features (completed)**

| Loss | Degradation | |
|---|---|---|
| **Goose Property Area *(cont'd)*** | | |
| Tailings Impoundment Area | X | |
| Quarries | X | X |
| Landfill | X | X |
| Camp / Plant site | X | X |
| Airstrip | X | X |
| Other infrastructure (i.e., diversion channels, water intakes) | X | |
| **Marine Laydown Area** | | |
| Barge landing location | X | X |
| Haul and access roads | X | X |
| Winter roads | | X |
| Other infrastructure (i.e., interception ditch) | X | |

### *4.5.2.1 Loss of Vegetation and Special Landscape Features*

The vast majority of vegetation loss will occur from physical clearing during the Site Preparation, Construction and Operational phases, although small incremental losses could also occur during activity associated with the Reclamation and Closure phase. To maximize flexibility in infrastructure siting, this assessment assumes complete loss of vegetation within each of the Potential Development Areas (Goose Property, George Property and MLA PDAs). In actuality, development will be confined to the Project footprint, and the realized losses will be considerably less (Table 4.5-3).

**Table 4.5-3. Summary of Project Footprints within the Potential Development Areas**

| Potential Development Area | PDA (ha) | Footprint Area (ha) | % of PDA |
|---|---|---|---|
| Goose Property PDA | 5,358.3 | 669 | 12.5 |
| George Property PDA | 4,226.3 | 251 | 5.9 |
| Marine Laydown Area PDA | 546.2 | 150 | 27.5 |
| Total | 10,130.8 | 1,070 | 10.6 |

Summarized within Section 4.5.4, potential loss of vegetation and special landscape features is characterized and reported in relation to the distribution of vegetated ecosystems and special landscape features, and on the basis of their potential effect on vegetation diversity, productivity and resiliency. The latter three attributes may help predict how an ecosystem functions, for example, as wildlife habitat, and how readily an ecosystem is likely to respond to and recover from anthropogenic disturbances or other environmental stressors.

Within Section 4.5.4.1, the total loss of vegetation and special landscape features is assessed as a net change (in hectares) and expressed as a percentage of baseline distribution, or availability, within the LSA.

### *4.5.2.2 Degradation of Vegetation*

In assuming total loss within the PDA boundaries, estimates are assumed to also encompass areas adjacent to infrastructure that are subject to potential degradation. Forbes, Ebersole, and Strandberg (2001) describe disturbance as a reduction in vegetation species richness or biomass, or any other

sudden deviation from the normal state. Vegetation degradation can result from physical disturbances that produce patches of bare soil, thus enabling the establishment of invasive plant propagules and increasing potential for soil erosion. Recovery from any disturbance in Arctic environments is very slow (Miller 1989; Forbes, Ebersole, and Strandberg 2001). Disturbances that could result from the Project include trampling of vegetation, removal or disturbance of the organic layers, and rutting from vehicles and machinery. The introduction and spread of invasive or exotic plant species could occur as a result of equipment and vehicles, including from aircraft and marine vessels. As they can aggressively compete with and displace native vegetation when introduced into natural settings (Haber 1997), invasive plants pose a threat to the diversity and abundance of native baseline vegetation.

Vegetation could also be degraded from airborne fugitive dustfall, including from increases in metal concentrations or bio-availability; airborne contaminants from emission sources, including $NO_2$ and $SO_2$; and from acid (nitrogen) deposition. Other potential degradation effects could occur as a result of Project-related changes to water quality and quantity, permafrost, and snow accumulation. Although localized degradation could result from development and use of the winter roads, including damage to tussock tundra ecosystems and short-term reductions in the active growth layer thickness (Gary Schultz, Alaska Department of Natural Resources, in Bailey 2012), project design has incorporated the crossing of water features as much as possible to minimize potential effect on terrestrial ecosystems.

Given the importance of lichen-dominated ecosystems to caribou, the paragraphs below briefly highlight the higher sensitivity of lichens to potential degradation from fugitive dust deposition.

Fugitive dust can have various effects on the health of vegetation depending on the amount and frequency of dusting, the chemical properties of dust, and receptor plant species. Cited in Auerbach, Walker, and Walker (1997), Rao (1982) identifies nonvascular taxa as especially vulnerable to dust disturbance due to structural characteristics rendering them more susceptible to the effects of atmospheric pollutants. Described by Berryman, Straker, and Straker (2009), in studies near remote mining operations, lichens are one of the most sensitive ecosystem components and can serve as “early-warning” indicators in air quality and effects monitoring programs. They lack the ability to control the exchange of water, nutrients, gases and particles with the external environment and are not influenced by natural elements in soils, due to the lack of roots and a vascular system. As a result, sampling and monitoring of lichen tissue enables differentiation between natural soil-borne and anthropogenic airborne element enrichment Berryman, Straker, and Straker (2009).

In their assessment of dust effects along high-speed gravel highways in Arctic Alaska, Walker and Everett (1987) reported the band of snow-free vegetation within 30 m to 100 m of roads attracts waterfowl, ptarmigan, raptors, caribou, grizzly bears and other predators in early spring. Other dust-induced effects described by Walker and Everett (1987) include the development of roadside thermokarst features, or irregular patterns of slumps and depressions. Everett (1980), within Auerbach, Walker, and Walker (1997), reported a maximum dustfall zone of 300 metres from roads, beyond which remained essentially undisturbed by dust. This coincides well with the dustfall estimates for the Project, where the majority of dustfall is predicted within 100 m, with very little change beyond approximately 300 m.

Air quality modelling was conducted to predict the emissions and fugitive dust that could result from the Project (Volume 4, Chapter 3). Results from the air quality modelling were used for quantification of the potential effects of fugitive dust on vegetation and soils (see the Country Foods chapter (Volume 8, Chapter 5) and the Human and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Results of this quantitative modelling showed that fugitive dust will not change metal levels in vegetation or soils above baseline levels within the Country Foods study area (Volume 8, Chapter 5). A qualitative assessment was conducted on the potential effects of emissions on vegetation

(Volume 8, Chapter 5) and no residual effects were identified. Hence, vegetation is not expected to be degraded from the Project due to fugitive dust, airborne emissions, or other media, and potential degradation is not discussed further.

For potential effects on water quality and quantity, refer to Volume 6, Chapter 4 (freshwater quality) and Volume 6, Chapter 1 (surface hydrology).

### 4.5.3 Identification of Mitigation and Management Measures

To minimize potential for loss and degradation of vegetation and special landscape features, mitigation and management measures have been embedded throughout the Project design and others will continue throughout construction and operation. The need for specific adaptive management and monitoring activity will be determined by the results of many of the plans provided in Volume 10.

Specific Plans that will help minimize the loss or degradation of vegetation and special landscape features include the:

- Air Quality Monitoring and Management Plan (Volume 10, Chapter 17);
- Fuel Management Plan (Volume 10, Chapter 4);
- Spill Contingency Plan (Volume 10, Chapter 5);
- Site Water Monitoring and Management Plan (Volume 10, Chapter 7);
- Ore Storage Management Plan (Volume 10, Chapter 8);
- Mine Waste Rock and Tailing Management Plan (Volume 10, Chapter 9);
- Landfill and Waste Management Plan (Volume 10, Chapter 10);
- Incinerator Management Plan (Volume 10, Chapter 11);
- Hazardous Materials Management Plan (Volume 10, Chapter 12);
- Explosives Management Plan (Volume 10, Chapter 13);
- Road Management Plan (Volume 10, Chapter 14);
- Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16);
- Aquatic Effects Management Plan (Volume 10, Chapter 19);
- Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20);
- Metal Leaching and Acid Rock Drainage Management Plan (Volume 10, Chapter 22); and
- Mine Closure and Reclamation Management Plan (Volume 10, Chapter 29).

#### *4.5.3.1 Mitigation for Loss of Vegetation and Special Landscape Features*

The following mitigation measures and best management practices will reduce the potential for loss of vegetation and special landscape features:

- the Project has been designed to employ winter road-only access corridors that travel primarily over lakes and rivers, thereby minimizing potential negative effects on terrestrial vegetation and limiting dust emissions;
- infrastructure, waste rock storage areas, and the TIA at the Goose Property have been confined to the local watersheds where the deposits are located, and do not extend to the regional

Upper Back River Watershed, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment;

- infrastructure and waste rock storage areas at the George Property have been confined to the local watersheds where the deposits are located, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment;
- the clearing of vegetation and removal of soil from unique landscape features will be minimized, including eskers, wetlands, exposed bedrock, cliffs etc., which often provide high value habitat to wildlife and may support sensitive vegetation communities and growth forms. Exceptions to this management will only be considered after assessing and weighing all implications; and
- tailings disposal methods have been designed to reduce beach/dust sources and generation.

#### *4.5.3.2 Mitigation for Degradation of Vegetation*

The following mitigation measures and best management practices will reduce the potential for degradation of vegetation and special landscape features:

- the design of haul roads has been optimized to minimize the distance travelled which will minimize emissions associated with construction and operation;
- all vehicles and machinery will restrict travel to designated road surfaces; thus avoiding creation of ruts in vegetated ecosystems;
- the discharge heights from the crushers onto conveyers will be minimized, and the discharge heights from conveyors onto stockpiles will be minimized. The discharge from crushers onto conveyors or into other equipment will be enclosed as far as is practicable (e.g., free fall of materials from conveyors carrying material will be fitted with a full hood such as a plastic chute);
- loads carried by vehicles will be enclosed or covered when possible;
- storage areas will be kept in a condition that does not give rise to measurable dust emissions;
- windbreaks or fences may be installed around known problem areas or stockpiles to limit the dispersion of dust emissions from equipment and stockpiles, or activities likely to generate dust;
- regular wheel-cleaning will be undertaken of vehicles travelling around and leaving the site;
- all-weather roads (local site roads) will be regularly compacted and kept in good repair;
- vehicles will be driven at designated speeds on site roads;
- water or other dust suppressant (non-wildlife attracting) will be used for site roads if needed to minimize dust from ore and waste rock haulage and grading, when ambient air temperatures permit;
- water sprays or dust suppression fluids will be used to suppress dust generation from equipment in the crushing facility. Dust suppression methods will be approved by the Government of Nunavut as outlined in the Nunavut environmental guideline for dust suppression (Government of Nunavut 2002) and will be suitable for use at below freezing temperatures; and
- conditioning materials which are likely to generate dust will be sprayed with water prior to transfer.

#### *4.5.3.3 Adaptive Management*

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

- if results from the Site Water Monitoring and Management Plan show non-compliance related to tundra discharges; or
- if results from the Wildlife Mitigation and Monitoring Program, which will monitor select wildlife species and habitat around the mine infrastructure and activities, show adverse effects to wildlife or wildlife habitat.

#### *4.5.3.4 Monitoring*

Monitoring Plans, outlined in Section 4.5.3, outline programs to monitor air quality, water, and waste management, which will help eliminate or minimize effects to vegetation and special landscape features.

A Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) will be in place that outlines the Wildlife Mitigation and Monitoring Program (WMMP) that will be carried out during all phases of the Project. The WMMP will include monitoring select wildlife species.

### 4.5.4 Characterization of Residual Effects

Despite application of mitigation and management measures, and best management practices, presented in Section 4.5.3, loss of vegetation and special landscape features will result from construction and operation of Project facilities within the three PDAs. The estimated loss of vegetation and special landscape features is characterized and reported in relation to the distribution of vegetated ecosystems and special landscape features, and on the basis of their potential effect on:

1. distribution of vegetated terrestrial ecosystems;
2. distribution of special landscape features; and
3. vegetation diversity, productivity and resiliency.

#### *4.5.4.1 Loss of Vegetation and Special Landscape Features*

To enable flexibility in siting Project infrastructure, complete loss of vegetation is assumed within each of the three Potential Development Areas (Goose Property, George Property and MLA PDAs). Consequently, degradation effects are also assumed to occur throughout the entire PDA. The areas assessed within this section include the total area within which the effects of loss could occur. Although localized effects could occur, loss resulting from construction and use of the connecting winter roads is not assessed.

Direct loss of vegetation due to clearing activities within the footprint will result in local long-term decreases in the abundance, diversity and percent cover of vegetation. Project activities may also result in the disturbance and degradation of terrestrial vegetation adjacent to the cleared areas and adjacent to active infrastructure such as roads, camp / plant sites, waste rock storage areas etc. Depending on the nature of disturbance, they could include direct and indirect, short and long-term effects.

The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of availability within the LSA and RSA. In actuality, the area developed, and subject to loss, will be much smaller, however, as determined by the final Project design. Consequently, estimates throughout this section represent maximum values. Loss estimates are characterized and reported in relation to the distribution of vegetated ecosystems and special landscape features, and on the basis of their potential effect on vegetation diversity, productivity and resiliency.

Vegetated Terrestrial Ecosystems

Table 4.5-4 summarizes assumed areas of loss for each mapped ecosystem within the three PDAs. Although reported as loss in the text below, it is assumed that localized physical degradation resulting from compaction, loss of organic matter, erosion or the introduction of invasive plant species, could occur concurrently. Total loss estimates are expressed as a percentage of the mapped baseline distribution, or availability, within the LSA. Potential loss of vegetation from development and use of winter roads is assumed to be largely mitigated through proper design and seasonal use of winter roads, as summarized within Chapter 6 of the Project Description (Volume 2).

**Table 4.5-4. Summary of Loss within Potential Development Areas**

| Ecosystem Class | Ecosystem Name | TEM Map Code | LSA (ha) | Potential Development Areas | | | Total PDA Loss (ha) | % Loss within LSA |
|---|---|---|---|---|---|---|---|---|
| | | | | Goose Property (ha) | George Property (ha) | MLA (ha) | | |
| Bedrock | Cliff | BC | 8.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0% |
| | Bedrock - lichen veneer | BL | 6,704.4 | 51.8 | 309.5 | 0.0 | 361.3 | 5.4% |
| | Bedrock Outcrop | BR | 3,381.8 | 154.5 | 284.2 | 0.0 | 438.7 | 13.0% |
| | Talus | BT | 4.6 | 0.0 | 0.0 | 0.0 | 0 | 0.0% |
| | Blockfield/ Boulderfield | TB | 154.1 | 0.0 | 10.9 | 0.0 | 10.9 | 7.1% |
| Disturbed/ Barren | Existing Exploration Camp | DR | 10 | 6.8 | 3.2 | 0.0 | 10 | 100.0% |
| | Disturbed Vegetation | DV | 0.75 | 0.0 | 0.7 | 0.0 | 0.7 | 93.3% |
| | Road surface | DZ | 3.21 | 0.0 | 3.2 | 0.0 | 3.2 | 99.7% |
| | Exposed Soil | ES | 176.8 | 0.3 | 1.1 | 0.0 | 1.4 | 0.8% |
| Esker | Esker Crest | EC | 577.6 | 2.2 | 51.6 | 0.0 | 53.8 | 9.3% |
| | Dwarf Shrub Esker | EH | 570.2 | 8.6 | 43.8 | 0.0 | 52.4 | 9.2% |
| | Shrubby Esker | EW | 189.3 | 0.0 | 21.9 | 0.0 | 21.9 | 11.6% |
| Marine Beach | Marine beach | MB | 59.5 | 0.0 | 0.0 | 14.3 | 14.3 | 24.0% |
| | Old beach head | MH | 476.3 | 0.0 | 0.0 | 53.5 | 53.5 | 11.2% |
| Tundra | Dry-Sparse Tundra | TH | 22,876 | 563.4 | 966.1 | 0.0 | 1,529.5 | 6.7% |
| | Mesic Dwarf Shrub Tundra | TL | 40,373.2 | 2,322.3 | 833.0 | 0.0 | 3,155.3 | 7.8% |
| | Shrubby Tundra | TS | 11,144.4 | 910.8 | 249.9 | 0.0 | 1,160.7 | 10.4% |
| Tundra Marine | Marine shrubby tundra | MS | 1,831.1 | 0.0 | 0.0 | 10.1 | 10.1 | 0.6% |
| | Marine dwarf shrub tundra | MT | 5,447.3 | 0.0 | 0.0 | 275.5 | 275.5 | 5.1% |
| Riparian | Floodplain - Low | RL | 36.5 | 0.0 | 12.5 | 0.0 | 12.5 | 34.2% |
| | Floodplain - Middle | RM | 3.8 | 0.0 | 0.0 | 0.0 | 0 | 0.0% |
| | Willow Riparian | RW | 1,405.1 | 62.7 | 21.3 | 0.0 | 84 | 6.0% |
| Riparian Marine | Marine riparian shrub | MR | 439.6 | 0.0 | 0.0 | 89.8 | 89.8 | 20.4% |

*(continued)*

**Table 4.5-4. Summary of Loss within Potential Development Areas (completed)**

| Ecosystem Class | Ecosystem Name | TEM Map Code | LSA (ha) | Potential Development Areas | | | Total PDA Loss (ha) | % Loss within LSA |
|---|---|---|---|---|---|---|---|---|
| | | | | Goose Property (ha) | George Property (ha) | MLA (ha) | | |
| Wetland | Water Sedge Marsh | WA | 2,312.2 | 100.5 | 104.2 | 10.4 | 215.1 | 9.3% |
| | Raised Bog Complex | WB | 4,147.3 | 228.9 | 273.6 | 5.4 | 507.9 | 12.2% |
| | Cottongrass - Sedge Fen | WC | 3,263.6 | 128.5 | 160.7 | 0.0 | 289.2 | 8.9% |
| | Undifferentiated Fen | WF | 2,525.1 | 78.0 | 147.1 | 0.0 | 225.1 | 8.9% |
| | Shallow Open Water | WO | 81.2 | 4.5 | 0.0 | 0.0 | 4.5 | 5.5% |
| | Willow – Sedge Fen | WS | 366.8 | 23.2 | 14.5 | 0.0 | 37.7 | 10.3% |
| | Tussock Meadow | WT | 64.5 | 3.6 | 4.8 | 0.0 | 8.4 | 13.0% |
| Wetland Marine | Estuary marsh | ME | 4.2 | 0.0 | 0.0 | 0.0 | 0 | 0.0% |
| | Saline Fen | MF | 993.5 | 0.0 | 0.0 | 73.3 | 73.3 | 7.4% |
| | Saline Marsh | MM | 252.1 | 0.0 | 0.0 | 13.7 | 13.7 | 5.4% |
| | Saline shallow open water | MO | 55.8 | 0.0 | 0.0 | 0.0 | 0 | 0.0% |
| Freshwater | Lake | LA | 17,961.8 | 430.3 | 471.1 | 0.0 | 901.4 | 5.0% |
| | Pond | PD | 6,173.7 | 273.9 | 227.3 | 0.0 | 501.2 | 8.1% |
| | River | RI | 289.6 | 3.5 | 10.1 | 0.2 | 13.8 | 4.8% |
| Marine Ocean | Saltwater | MW | 4.1 | 0.0 | 0.0 | 0.0 | 0 | 0.0% |
| **Total** | | | **134,369.2** | **5,358.3** | **4,226.3** | **546.2** | **10,130.8** | |
| **% of LSA[1]** | | | | **4.2%** | **3.2%** | **0.5%** | **7.9%** | |

[1] *Excluding non-vegetated freshwater and saltwater areas (lakes, ponds, rivers and ocean), and existing roads and exploration camps.*

An estimated 8,714 ha of vegetated ecosystems would be lost from development of the three PDAs, representing nearly 8% of the availability within the LSA (Table 4.5-4). Of the vegetated ecosystems within the RSA (summarized in Table 4.1-2, excluding the Water Ecosystem Class), the loss of vegetation represents 0.9% of availability. These effects are considered of low and negligible magnitude within the LSA and RSA, respectively. Percentage losses due to loss of the PDAs within the Goose Property, George Property, and MLA represent 4.2%, 3.2%, 4.2% and 0.5%, respectively, of the distribution of vegetated ecosystems within the entire LSA.

Potential losses from specific ecosystems range from 0% (negligible effect) to 34% (high magnitude effect). Of the thirty-one vegetated ecosystems (Table 4.5-4), excluding waterbodies and ecosystems within the Disturbed/Barren Ecosystem Class, negligible effects are estimated for seven ecosystems, low magnitude effects are estimated for fourteen ecosystems, medium magnitude effects are estimated for seven ecosystems, and high magnitude effects are estimated for three ecosystems. The highest magnitude loss is estimated from the RL (Floodplain – Low) ecosystem within the George Property Area, with 12.5 ha (34%) loss of the mapped area in the LSA.

Table 4.5-5 summarizes areas of loss by ecosystem class. For each class, loss is expressed as total hectares lost within the three PDAs, and as a percentage of the total availability of each class within the LSA. Losses within most ecosystem classes are below 10% of their respective availability within the

LSA, within the range of low magnitude effect. Within the Wetland Ecosystem Class, estimated losses are slightly above 10%, at the bottom end of medium magnitude effect. Within the Marine Beach Ecosystem Class, the estimated loss of 12.7% is considered a high magnitude effect due to the very low resiliency of these sparsely-vegetated ecosystems.

**Table 4.5-5. Summary of Loss, by Ecosystem Class, within Potential Development Areas**

| | | Potential Development Area | | | | |
|---|---|---|---|---|---|---|
| Ecosystem Class | LSA (ha) | Goose Property (ha) | George Property (ha) | MLA (ha) | Total PDA Loss (ha) | % Loss within LSA |
| Bedrock | 10,253 | 206.3 | 604.6 | 0 | 810.9 | 7.9% |
| Disturbed / Barren | 190.76 | 7.1 | 8.2 | 0 | 15.3 | 8.0% |
| Esker | 1,337.1 | 10.8 | 117.3 | 0 | 128.1 | 9.6% |
| Marine Beach | 535.8 | 0 | 0.0 | 67.8 | 67.8 | 12.7% |
| Tundra | 74,393.6 | 3,796.5 | 2,049.0 | 0 | 5,845.5 | 7.9% |
| Tundra Marine | 7,278.4 | 0 | 0.0 | 285.6 | 285.6 | 3.9% |
| Riparian | 1,445.4 | 62.7 | 33.8 | 0 | 96.5 | 6.7% |
| Riparian Marine | 439.6 | 0 | 0 | 89.8 | 89.8 | 20.4% |
| Wetland | 12,760.7 | 567.2 | 704.9 | 15.8 | 1,287.9 | 10.1% |
| Wetland Marine | 13,05.6 | 0 | 0 | 87.0 | 87.0 | 6.7% |
| Freshwater | 24,425.1 | 707.7 | 708.5 | 0.2 | 1,416.4 | 5.8% |
| Marine Ocean | 4.1 | 0 | 0 | 0 | 0.0 | 0.0% |
| **Total** | **134,369.2** | **5,358.3** | **4,226.3** | **546.2** | **10,130.8** | |
| | **% of LSA[1]** | **4.2%** | **3.2%** | **0.5%** | **7.9%** | |

[1] *Excluding non-vegetated freshwater and saltwater areas (lakes, ponds, rivers and ocean), and existing roads and exploration camps.*

An estimated loss of 20.4% occurs from ecosystems within the Riparian Marine Ecosystem Class, within the range of high magnitude effect. This ecosystem class, influenced by a maritime climate and found on marine-derived soils adjacent to Bathurst Inlet, supports a taller deciduous shrub layer, with greater diversity of species, than does the Riparian Ecosystem Class. Summaries of estimated losses, specific to each PDA, are provided in the paragraphs below.

*George Potential Development Area*

Reflecting a greater abundance of bedrock-dominated ecosystems than occurs within the Goose PDA, the majority of vegetation loss (by percentage of total loss) within the George PDA is expected from the Tundra (49%), Wetland (17%) and Bedrock (14%) Ecosystem Classes (Table 4.5-5). Within the Tundra Ecosystem Class, largest areas of loss are estimated within the TH and TL ecosystems, representing 4% and 2% of their respective LSA distributions. Including all ecosystems within the Tundra Ecosystem Class, losses comprise 3% of their collective distribution within the LSA. Within the Wetland Ecosystem Class, largest losses are estimated within the WB and WC ecosystems, representing 7% and 5% of their respective LSA distributions. Slightly smaller losses of undifferentiated wetland (WF) ecosystems and WA ecosystems are estimated. Including all ecosystems within the Wetland Ecosystem Class (Table 4.5-3), losses comprise 6% of their collective distribution within the LSA. Within the Bedrock Ecosystem Class, largest losses are estimated within the BL and BR ecosystems, representing 5% and 8% of their respective LSA distributions. Including all ecosystems within the Bedrock Ecosystem Class, losses comprise 6% of their collective distribution within the LSA.

Collectively totaling less than 4% of the George PDA, small losses are expected within the Esker and Riparian Ecosystem classes. However, within the Esker Class, losses from the EC and EH ecosystems represent 9% and 8% of their LSA distributions. Reflective of the small amount of mapped riparian ecosystems, collective loss within the Riparian Ecosystem Class comprises just 2% of the LSA distribution. The existing George exploration camp facility accounts for most of the area mapped within the Disturbed / Barren Ecosystem Class.

*Goose Potential Development Area*

The majority of vegetation loss (by percentage) within the Goose PDA is expected from the Tundra (71%), Wetland (11%) and Bedrock (4%) Ecosystem Classes (Table 4.5-5). Within the Tundra Ecosystem Class, most loss is estimated within the TL, TS and TH ecosystems, representing 6%, 8% and 3% of their respective LSA distributions. Including all ecosystems within the Tundra Ecosystem Class, losses comprise 5% of their collective distribution within the LSA. Within the Wetland Ecosystem Class, the largest losses are estimated within the WB, WC and WA ecosystems, representing 6%, 4% and 4% of their respective LSA distributions. Including all ecosystems within the Wetland Ecosystem Class, losses comprise 4% of their collective distribution within the LSA. Within the Bedrock Ecosystem Class, largest losses are estimated within the BR and BL ecosystems, representing 5 % and 1% of their respective LSA distributions. Including all ecosystems within the Bedrock Ecosystem Class, losses comprise 2% of their collective distribution within the LSA.

Collectively totaling less than 2% of the Goose PDA, small losses are expected within the Riparian, Esker and Disturbed / Barren Classes. Within the Riparian Ecosystem Class, loss from the RW ecosystem represents 4% of its distribution within the LSA and, within the Esker Ecosystem Class, losses from the EC and EH ecosystems represent less than 2% of their LSA distribution. Including all ecosystems within the Riparian and Esker Ecosystem Classes, losses comprise 4% and 1% of their collective LSA distributions, respectively. The existing Goose exploration camp facility accounts for most of the area mapped within the Disturbed / Barren Ecosystem Class.

*MLA Potential Development Area*

Marine-influenced ecosystems dominate the Marine Laydown PDA. The majority of vegetation loss (by percentage) is expected from the Tundra Marine Ecosystem Class (44%), with relatively equal losses (14% and 13%, respectively) within the Riparian Marine and Wetland Marine classes (Table 4.5-5). Within the Tundra Marine Ecosystem Class, the vast majority of loss is estimated from the MT ecosystem, representing 5% of its LSA distribution. Including all ecosystems within the Tundra Marine Ecosystem Class, losses comprise 4% of their collective distribution within the LSA. Losses from the MR ecosystem, the sole representative of the Riparian Marine Ecosystem Class, represent 20% of its LSA distribution. Within the Wetland Marine Ecosystem Class, most loss is estimated from the MF ecosystem, with smaller loss from the MM ecosystems. Respective losses within these units represent 7% and 5% their LSA distributions. Loss within active beach shores and old beach heads (MB and MH ecosystems, respectively), comprising 10% of the PDA, represents 24% and 11% of their respective LSA distributions.

Collectively totaling just 2% of the MLA PDA, small losses are expected within the Wetland Ecosystem Classes, all within the WA and WB ecosystems. Respective losses within these units collectively represent 0.5% of their LSA distributions.

Special Landscape Features

Table 4.5-6 summarizes the potential loss of special landscape features resulting from development of the Goose Property, George Property and MLA PDAs. The final column represents the loss as a percentage of availability within the LSA.

**Table 4.5-6. Summary of Loss from Special Landscape Features within the Potential Development Areas**

| Special Landscape Feature | TEM Map Code(s) | LSA (ha) | Goose PDA (ha) | George PDA (ha) | MLA PDA (ha) | Total Loss (ha) | % of Availability in LSA |
|---|---|---|---|---|---|---|---|
| Cliffs[1] | BC + slope theme | 1,367.5 | 0.2 | 17.9 | 1.1 | 19.2 | 1.4 |
| Esker ecosystems | EC, EH, EW | 1,337.1 | 10.8 | 117.3 | 0 | 128.1 | 9.6 |
| Bedrock-lichen and outcrop ecosystems | BL, BR | 10,086.2 | 206.2 | 593.7 | 0 | 799.9 | 7.9 |
| Riparian ecosystems | RL, RM, RW, MR | 1,885.0 | 62.7 | 33.8 | 89.8 | 186.3 | 9.9 |
| Wetland ecosystems | MF, MO, WA, WB, WC, WF, WO WS, WT | 13,810.0 | 567.2 | 704.8 | 89.0 | 1,361.0 | 9.9 |
| Marine Beaches (including old beach heads), Shores, Marshes and Estuaries | MB, ME, MH, MM | 792.1 | 0 | 0 | 81.5 | 81.5 | 10.3 |
| **Total** | | **29,277.9** | **847.1** | **1467.5** | **261.4** | **2,576** | **8.8** |

[1] *As cliffs are often too small to be identified using TEM, potential cliff habitat is based upon modelling slopes > 25% (source: LiDAR data); consistent with wildlife habitat assessment for potential raptor nesting habitat.*

With the exception of the marine-associated features, with a collective medium magnitude loss of 10.3%, the potential losses of special landscape features, each below 10% of their respective LSA availabilities, are considered low magnitude (Table 4.5-6). By area, representing approximately 85% of total loss, effects are largely concentrated within wetland, bedrock-lichen and bedrock outcrop ecosystems. The largest area of loss within each of these landscape features occurs with the loss of the George PDA. Similarly, greater than 90% of the total loss estimated within esker ecosystems occurs with the loss of the George PDA.

Vegetation Diversity

Species richness is frequently used to characterize biodiversity across scales (Magurran 1988; Gould and Walker 1999). Vascular richness increases as the complexity of landscapes, and therefore number of plant communities, increases. As well, decreasing heterogeneity potentially results in reduction of overall biodiversity (Holmes et al. 2013). Using species richness as a parameter for diversity analysis is complicated by trend differences between vascular plants, lichens and bryophytes, when assessed along environmental gradients such as pH and moisture (Gould and Walker 1999). For example, whereas lichen richness decreased with increasing moisture, bryophyte richness generally increased and there was no significant difference between vascular plants.

To quantify the estimate of vegetation diversity loss, diversity estimates for each of the TEM-derived ecosystems within the LSA are adapted from the results of a multiple-scale vegetation analysis conducted by Gould (1998) along the Hood River valley, west of Bathurst Inlet. Gould's research was conducted within a relatively rich, riparian region, whereas the majority of the LSA (with exception of the marine-influenced ecosystems near Bathurst Inlet) occurs within nutrient poor, upland tundra-dominated ecosystems. As expected for poorer sites and colder continental climates, the total species recorded within equivalent TEM ecosystems are typically lower than reported by Gould within the Hood River region.

Gould (1998) summarizes the number of vascular plants, bryophytes and lichens within 24 unique vegetation communities that were derived through a supervised classification of Landsat TM data; species richness ranged from 5 (the "*wet sedge tundra 3"*) to 33 (the "*moist nonacidic shrub tundra*"). This range was used to derive arbitrary diversity class groupings for the Back River diversity assessment (Table 4.5-7). However, the relative proportions and richness estimates in Gould's assessment are assumed to be applicable within the LSA; based on the TEM diversity summary, albeit a comparatively smaller dataset, a similar trend was apparent indicating that higher relative diversity was associated with heath and shrub-dominated tundra units and lower diversity was associated with the wettest sedge-dominated units.

**Table 4.5-7. Diversity Class and Estimated Species Richness**

| Diversity Class | Species Richness Estimates[1] |
|---|---|
| Very Low | 5 to 11 |
| Low | 12 to 20 |
| Moderate | 20 to 25 |
| High | 26 to 33 |

[1] *adapted from Gould (1998)*

Based on the species richness results within Gould (1998), where applicable, Table 4.5-8 provides diversity class estimates for each TEM ecosystem, with the respective species richness values based on their ecosystems of nearest ecological equivalence.

**Table 4.5-8. Ecosystem Diversity Estimates within the LSA**

| Ecosystem Class | Ecosystem Name | TEM Map Code | Diversity Class | Species Richness (within Gould 1998) |
|---|---|---|---|---|
| Bedrock | Cliff | BC | Low | 14 |
| | Bedrock – lichen veneer | BL | Low | 14 |
| | Bedrock Outcrop | BR | Low | 14 |
| | Talus | BT | Low | 14 |
| | Blockfield / Boulderfield | TB | Low | 14 |
| | Disturbed Vegetation | DV | Low | 12 |
| | Exposed Soil | ES | Very Low | 9 |
| Esker | Esker Crest | EC | Moderate | 20 |
| | Dwarf Shrub Esker | EH | Moderate | 23 |
| | Shrubby Esker | EW | Moderate | 24 |
| Marine Beach | Marine beach | MB | Moderate | 20 |
| | Old beach head | MH | Moderate | 20 |
| Tundra | Dry-Sparse Tundra | TH | Moderate | 23 |
| | Mesic Dwarf Shrub Tundra | TL | High | 26 |
| | Shrubby Tundra | TS | Moderate | 24 |
| Tundra Marine | Marine shrubby tundra | MS | Moderate | 24 |
| | Marine dwarf shrub tundra | MT | High | 26 |
| Riparian | Floodplain - Low | RL | Low | 12 |
| | Floodplain - Middle | RM | Low | 12 |
| | Willow Riparian | RW | Low | 18 |

*(continued)*

**Table 4.5-8. Ecosystem Diversity Estimates (completed)**

| Ecosystem Class | Ecosystem Name | TEM Map Code | Diversity Class | Species Richness (within Gould 1998) |
|---|---|---|---|---|
| Riparian Marine | Marine riparian shrub | MR | Low | 18 |
| Wetland | Water Sedge Marsh | WA | Very Low | 9 |
| | Raised Bog Complex | WB | Moderate | 15 |
| | Cottongrass - Sedge Fen | WC | Low | 12 |
| | Undifferentiated Fen | WF | Low | 12 |
| | Shallow Open Water | WO | Low | n/a |
| | Willow - Sedge Fen | WS | Low | 12 |
| | Tussock Meadow | WT | High | 33 |
| Wetland Marine | Estuary marsh | ME | Low | n/a |
| | Saline Fen | MF | Low | 12 |
| | Saline Marsh | MM | Low | 12 |
| | Saline shallow open water | MO | Low | n/a |

Table 4.5-9 summarizes the results by Diversity Class, within each PDA, and for the sum of the PDA areas (10,238 ha). For each Diversity Class, the respective loss estimates are provided as a percentage of the total baseline distribution within the LSA. For example, development of the three PDAs results in the loss of 9.4% of the area rated as "Very Low" diversity within the total LSA. The results are depicted in Figures 4.5-1 to 4.5-3, for the Goose, George and MLA PDAs, respectively. Estimated losses within all diversity classes are less than 10% of their respective LSA availabilities, within the range of low magnitude effects.

**Table 4.5-9. Summary of Loss by Diversity Class within the Potential Development Areas**

| Diversity Class | Loss Estimates (ha) | | | | % of Availability (LSA) |
|---|---|---|---|---|---|
| | Goose PDA | George PDA | MLA PDA | Total PDA | |
| High | 2,325.9 | 837.7 | 275.5 | 3,439.1 (33.6%) | 7.5% |
| Moderate | 1,714.0 | 1,606.9 | 83.3 | 3,404.2 (33.3%) | 8.1% |
| Low | 498.7 | 961.4 | 163.1 | 1,623.2 (15.9) | 8.2% |
| Very Low | 105.3 | 105.2 | 24.0 | 234.6 (2.3%) | 9.4% |
| *Nil (Non-vegetated and Water)* | *714.6* | *714.9* | *107.5* | 1,537.0 (15.0%) | *6.3%* |
| **Total** | **5,358.4** | **4,226.2** | **653.4** | **10,238.0 (100.0%)** | |

Assessment of the Goose, George and MLA PDAs together, suggests approximately 67% of total vegetation loss occurs from ecosystems with high (34%) and moderate (33%) vegetation diversity. There are, however, notable differences between individual PDAs. Within the Goose PDA, 75% of loss occurs within ecosystems of moderate and high vegetation diversity, with just 11% loss within ecosystems of very low and low diversity. In contrast, within the George PDA, a smaller percentage (58%) of loss occurs within ecosystems of moderate and high vegetation diversity with a greater loss (25%) from ecosystems of very low and low diversity. Similar to the George PDA, 55% of loss in the MLA PDA occurs within ecosystems of moderate and high vegetation diversity with 29% loss within ecosystems of very low and low diversity.

Within the LSA, loss estimates within each diversity class are less than 10% of their respective baseline distributions, with largest losses estimated from ecosystems in the Very Low Diversity Class, at 9.4% of baseline distribution.

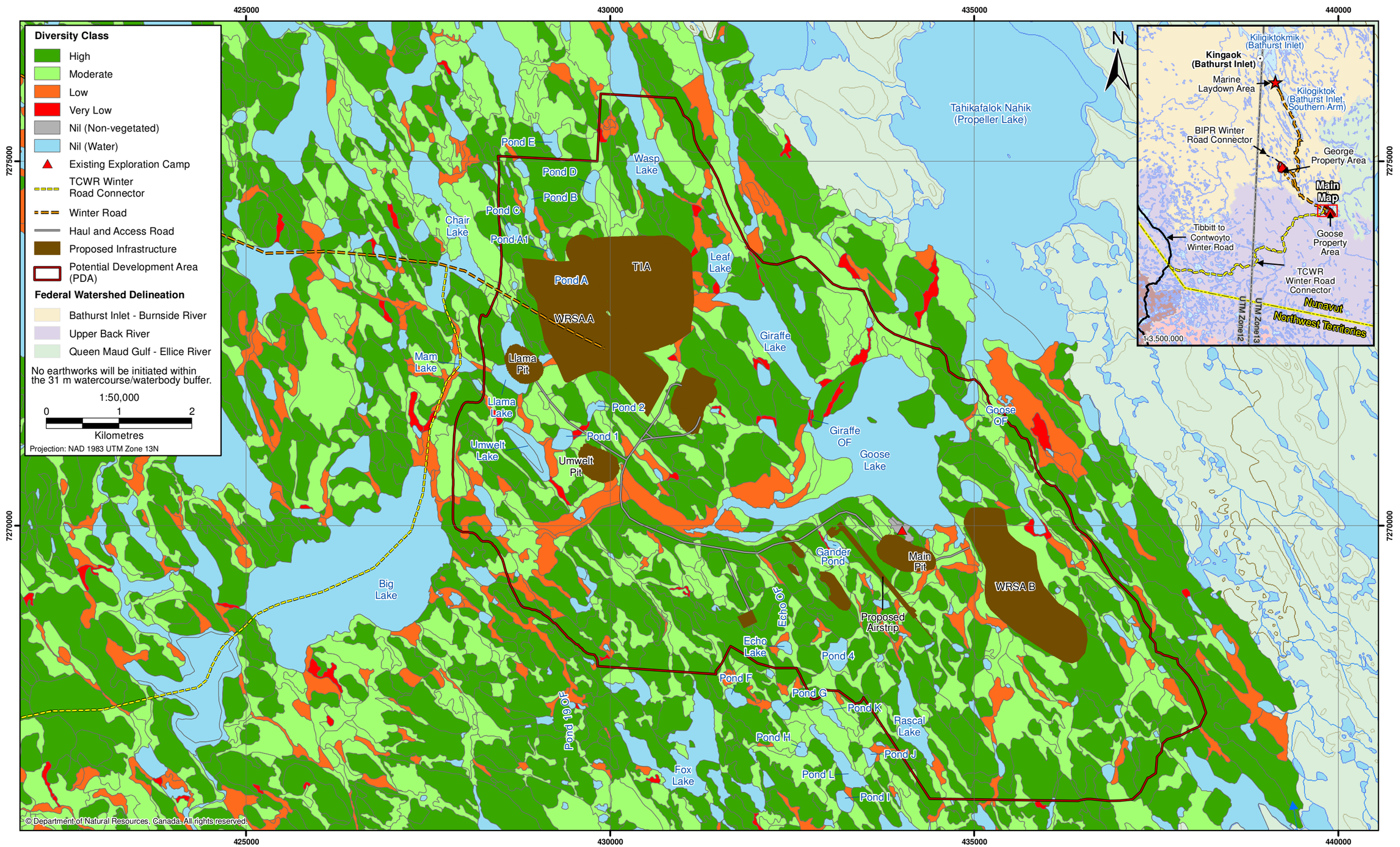
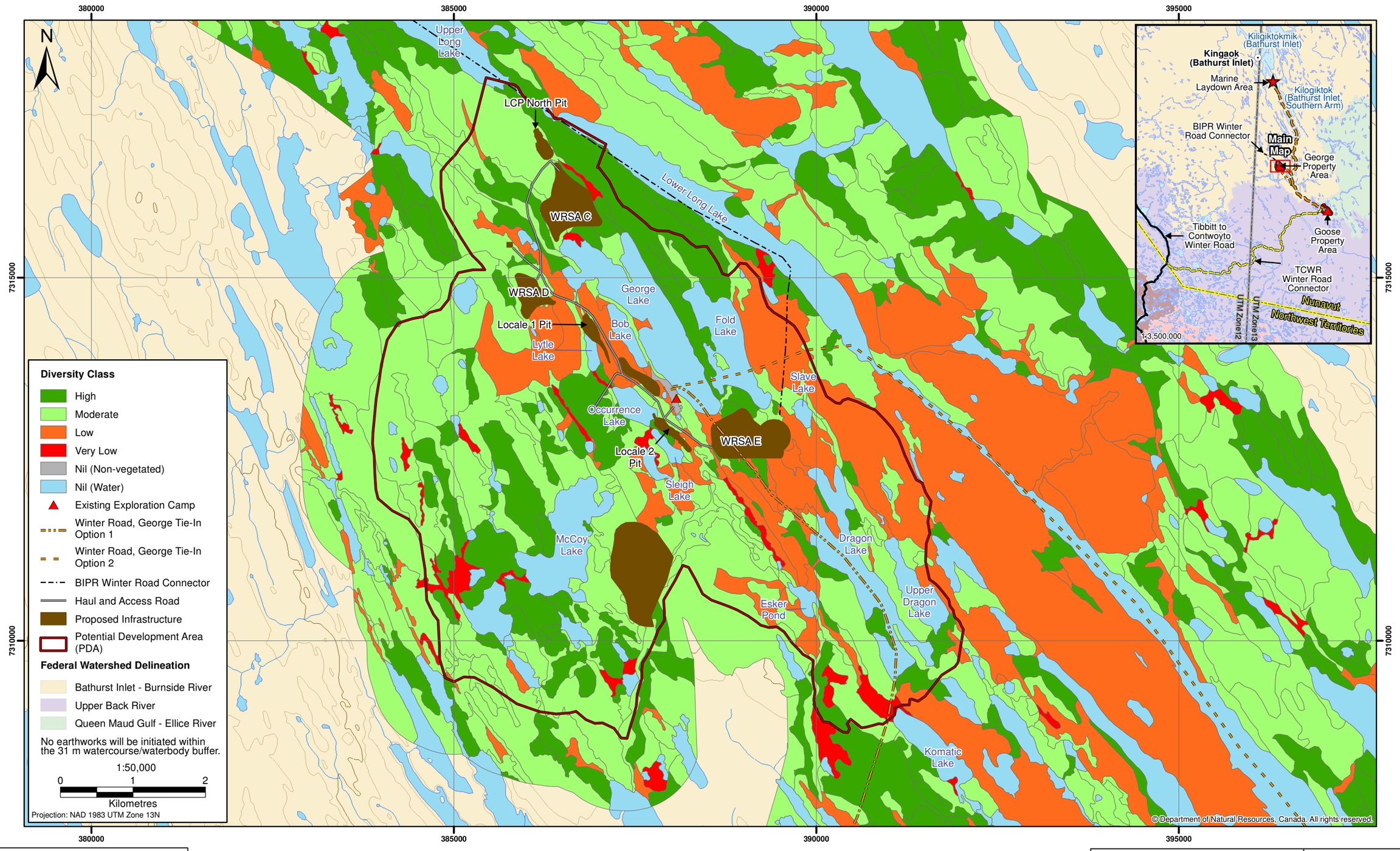



Figure 4.5-1

**Goose Potential Development Area - Terrestrial Ecosystem Mapping Diversity Class Summary**

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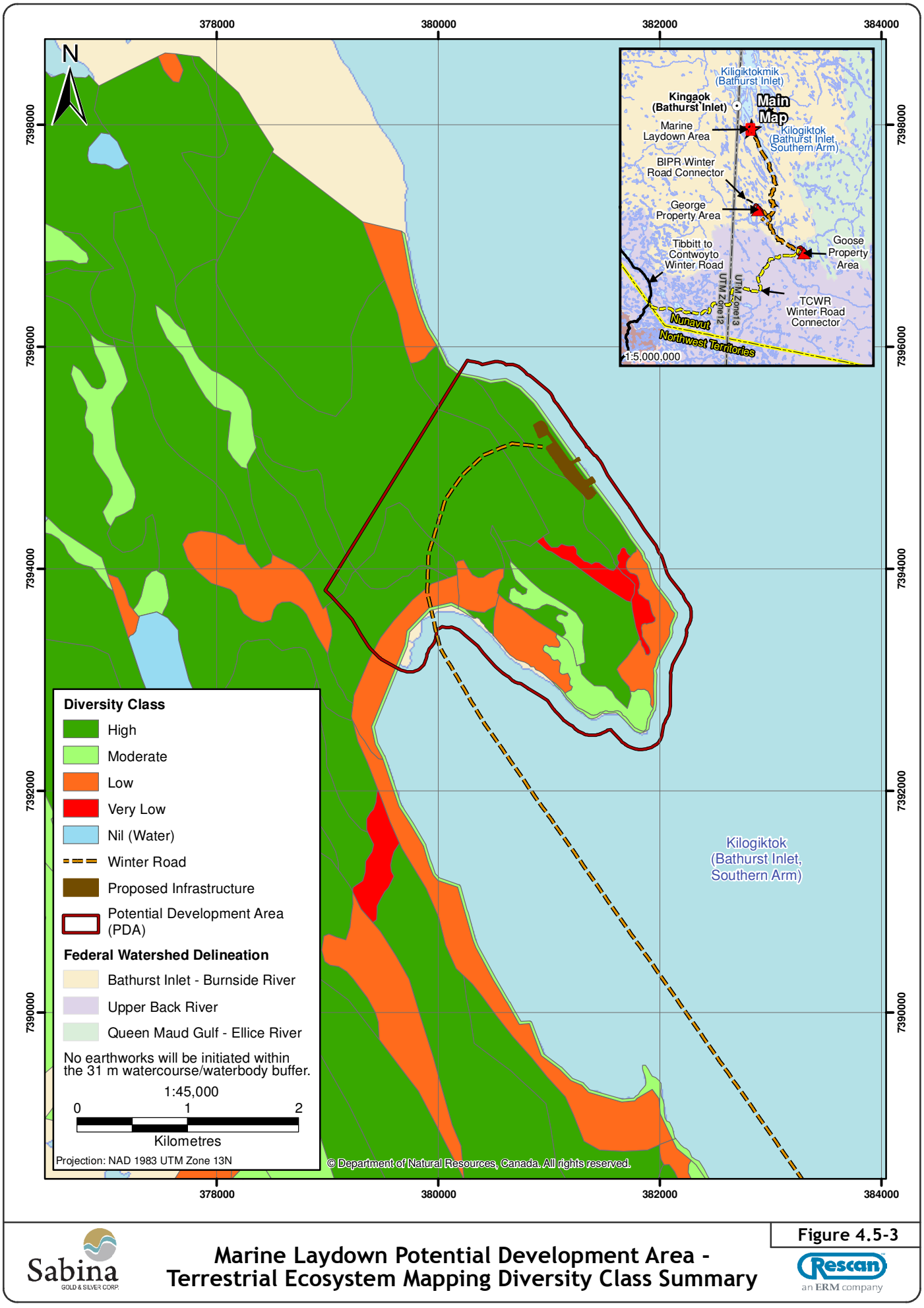
Rescan an ERM company

**Figure 4.5-2**

**George Potential Development Area - Terrestrial Ecosystem Mapping Diversity Class Summary**

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# Marine Laydown Potential Development Area - Terrestrial Ecosystem Mapping Diversity Class Summary

**Figure 4.5-3**

Rescan an ERM company

Vegetation Productivity

To quantify potential vegetation productivity loss, annual net primary productivity (ANPP) estimates, adapted from vegetation biomass and productivity mapping by Gould, Raynolds, and Walker (2003), are provided for each TEM ecosystem. Described within Gould, Raynolds, and Walker (2003), the ANPP categories are themselves modified from earlier research conducted by Walker (1999).

The estimates within Gould, Raynolds, and Walker (2003) were based on vegetation classes (grouped under broader headings of Dry, Mesic, Wet and Riparian) that were modified from Arctic vegetation mapping conducted by Gould et al. (2002). The TEM ecosystems were compared against the vegetation class descriptions within Gould et al. (2003), and the productivity estimate for the vegetation class with which each TEM ecosystem had closest "ecological equivalence" was applied.

Productivity classes ranging from Very Low through Very High (Table 4.5-10) were subjectively assigned to the range of ANPP values (in $g/m^2/y$). Based on the abundance of deciduous leaves, the highest values are applied to deciduous shrub-dominated tundra and riparian ecosystems in the TEM data, each rated as Very High productivity. In their study of carbon exchange among different Arctic ecosystem types, Williams et al. (2006) reported that leaf area index (LAI), measured in $1m^2$ chamber plots, tended to be highest in the *Salix*, *Rubus,* and *Betula* sites, on foot- and back-slopes with deeper soils and increased nutrient cycling. The LAI measurements were lowest in wet sedge, open tussock and hill-top tussock sites. Sparsely vegetated ecosystems, typically associated with exposed soil, bedrock or shallow till veneers, were estimated as Very Low productivity and sedge- or cottongrass-dominated wetlands were estimated as Low productivity.

**Table 4.5-10. Productivity Classes**

| Productivity Class | Annual Net Primary Productivity[1] Range ($g/m^2/y$) |
|---|---|
| Very Low | < 20 |
| Low | 20 - 50 |
| Moderate | 50 - 150 |
| High | 150 - 250 |
| Very High | 250 – 1,000 |

[1] *Source: Gould, Raynolds, and Walker (2003)*

Given the maritime influence and relatively richer soils in the vicinity of Bathurst Inlet, resulting in more extensive and lusher riparian shrub ecosystems, the MLA PDA likely has relatively higher ANPP values than the riparian counterparts within the Goose and George PDAs. Table 4.5-11 provides the net change in area for each of the mapped ecosystems and Table 4.5-12 summarizes the results by Productivity Class, within each PDA, and for the sum of the PDA areas (10,238 ha).

**Table 4.5-11. Ecosystem Productivity Estimates**

| Ecosystem Class | Ecosystem Name | TEM Map Code | Annual Net Primary Productivity[1] Range ($g/m^2/y$) | Productivity Class |
|---|---|---|---|---|
| Bedrock | Cliff | BC | < 20 | Very Low |
| | Bedrock – lichen veneer | BL | < 20 | Very Low |
| | Bedrock Outcrop | BR | < 20 | Very Low |
| | Talus | BT | < 20 | Very Low |
| | Blockfield / Boulderfield | TB | < 20 | Very Low |
| | Disturbed Vegetation | DV | < 20 | Very Low |
| | Exposed Soil | ES | < 20 | Very Low |

*(continued)*

**Table 4.5-11. Ecosystem Productivity Estimates (completed)**

| Ecosystem Class | Ecosystem Name | TEM Map Code | Annual Net Primary Productivity[1] Range ($g/m^2/y$) | Productivity Class |
|---|---|---|---|---|
| Esker | Esker Crest | EC | < 20 | Very Low |
| | Dwarf Shrub Esker | EH | 20 - 50 | Low |
| | Shrubby Esker | EW | 150 - 250 | High |
| Marine Beach | Marine beach | MB | < 20 | Very Low |
| | Old beach head | MH | < 20 | Very Low |
| Tundra | Dry-Sparse Tundra | TH | 20 - 50 | Low |
| | Mesic Dwarf Shrub Tundra | TL | 150 - 250 | High |
| | Shrubby Tundra | TS | 250 – 1,000 | Very High |
| Tundra Marine | Marine shrubby tundra | MS | 250 – 1,000 | Very High |
| | Marine dwarf shrub tundra | MT | 150 - 250 | High |
| Riparian | Floodplain - Low | RL | 20 - 50 | Low |
| | Floodplain - Middle | RM | 250 – 1,000 | Very High |
| | Willow Riparian | RW | 250 – 1,000 | Very High |
| Riparian Marine | Marine riparian shrub | MR | 250 – 1,000 | Very High |
| Wetland | Water Sedge Marsh | WA | 50 - 150 | Moderate |
| | Raised Bog Complex | WB | 20 - 50 | Low |
| | Cottongrass - Sedge Fen | WC | 20 - 50 | Low |
| | Undifferentiated Fen | WF | 20 - 50 | Low |
| | Shallow Open Water | WO | < 20 | Very Low |
| | Willow - Sedge Fen | WS | 50 - 150 | Moderate |
| | Tussock Meadow | WT | 20 - 50 | Low |
| Wetland Marine | Estuary marsh | ME | 20 - 50 | Low |
| | Saline Fen | MF | 20 - 50 | Low |
| | Saline Marsh | MM | 20 - 50 | Low |
| | Saline shallow open water | MO | < 20 | Very Low |

[1] *Source: Gould, Raynolds, and Walker (2003)*

**Table 4.5-12. Summary of Loss by Productivity Class**

| Productivity Class | Loss Estimates (ha) | | | | % of Availability (LSA) |
|---|---|---|---|---|---|
| | Goose PDA | George PDA | MLA PDA | Total PDA | |
| Very High | 973.6 | 271.1 | 100.0 | 1,344.7 (13.1%) | 9.1 |
| High | 2,322.3 | 854.8 | 275.5 | 3,452.6 (33.7%) | 7.5 |
| Moderate | 123.7 | 118.6 | 24.0 | 266.4 (2.6%) | 9.9 |
| Low | 1,011.1 | 1,609.4 | 78.7 | 2,699.1 (26.4%) | 7.8 |
| Very Low | 213.2 | 657.2 | 67.8 | 938.2 (9.2%) | 8.0 |
| *Nil (Non-vegetated and Water)* | *714.6* | *714.9* | *107.5* | *1,537.0 (15.0%)* | *6.3* |
| **Total** | **5,358.4** | **4,226.2** | **653.4** | **10,238.0 (100.0%)** | |

For each class, the respective loss estimates are provided as a percentage of the total baseline distribution within the LSA. For example, development of the three PDAs results in the loss of 7.5% of the area rated as "High" productivity within the total LSA. The results are depicted in Figures 4.5-4 to 4.5-6, for the Goose, George and MLA PDAs, respectively.

Assessment of the Goose, George, and MLA PDAs, together, suggests an approximate 47% loss within ecosystems having high (34%) and very high (13%) vegetation productivity. There are, however, notable

differences between individual PDAs. Within the Goose PDA, due primarily to the large amount of productive Mesic Dwarf Shrub Tundra mapped, 62% of loss occurs within ecosystems of high and very high productivity, with just 23% loss within ecosystems of very low (4%) and low (19%) productivity. In contrast, within the George PDA, due largely to the extent of shallow materials and sparsely-vegetated ecosystems, most loss (54%) occurs within ecosystems of very low (16%) and low (38%) productivity. At 16% loss, the effect on ecosystems with very low productivity is highest within the George PDA.

Similar to results within the Goose PDA, most loss (58%) in the MLA PDA occurs within ecosystems of high and very high vegetation productivity with 22% loss within ecosystems of very low (10%) and low (12%) productivity.

Within the LSA, loss estimates within each class are less than 10% of their respective baseline distributions (low magnitude), with largest losses estimated from ecosystems in the Moderate Productivity Class, at 9.9% of baseline distribution.

Vegetation Resiliency

Arctic ecosystems differ in resiliency to disturbance, with some describing them as having no real resilience in the ecological sense due to the harsh environmental conditions that places plants under extreme stress, and low productivity of vegetation (Miller 1989). Even low intensity disturbances can have lasting effects on Arctic vegetation due to low vegetation diversity, low productivity and simple structure (Forbes, Ebersole, and Strandberg 2001) and, consequently, ecosystems may be greatly affected by stresses from physical disturbance and chemical pollution (Miller 1989). For example, fruticose and crustose taxa failed to recolonize within light, low-intensity disturbances from trampling or single vehicle passes (Forbes, Ebersole, and Strandberg 2001).

Many factors contribute to the resistance and resilience of vegetation and to the possible recovery outcomes. This includes the type, severity and frequency of disturbance; natural vegetation composition; presence or absence of snow at the time of disturbance; soil moisture and biogeochemical properties; temperature regime; availability of native seed; and nature of re-vegetation effort. Native vegetation type represents the most important factor in predicting response to disturbance as, due to it being present, has inherently integrated responses to the existing temperature, nutrient regime, wind and snow, and natural disturbances (Walker and Walker 1991).

In a study of the circumpolar North, Forbes, Ebersole, and Strandberg (2001) described responses by type of disturbance, including trampling, removal of organic layers, mounding of soil and organic matter, and vehicle tracks. Each of these represents disturbances potentially resulting from each Project phase. Trampling resulted in soil compaction, leading to increased bulk density, increased decomposition, reduced moisture, and restriction of lateral and horizontal root penetration. Vegetation necrosis (premature death of plant tissue) resulted in decreased surface albedo, which increased the soil temperature and thaw depth (Forbes, Ebersole, and Strandberg 2001). Walker and Walker (1991) also report warmer surface soils, lower organic matter and higher nutrient regimes from disturbance. Vegetation regeneration within mounded areas was generally favourable, with development and richness dependent upon the amount of organic matter (Forbes, Ebersole, and Strandberg 2001). Within vehicle tracks, vascular plants were maintained in mesic areas with slight to moderate damage, and rhizomatous graminoids, willows, and horsetails increased in abundance. The recovery of vegetation was related to pre-disturbance soil moisture regime; recovery within small (less than 300 $m^2$) wet disturbances was evident within 20 to 75 years. It was not guaranteed within mesic sites and dry sites exhibited a reduction in vegetation cover, biomass and richness. Walker and Walker (2001) identified quicker recovery within wet tundra ecosystems than within mesic uplands, despite being more easily disturbed, a response related to the increased moisture and nutrient influx. Similarly, in a discussion on ice-road construction techniques (Bailey 2012), wet sedge vegetation was identified as especially resilient to ice road impacts, in contrast to the more sensitive tussock vegetation.

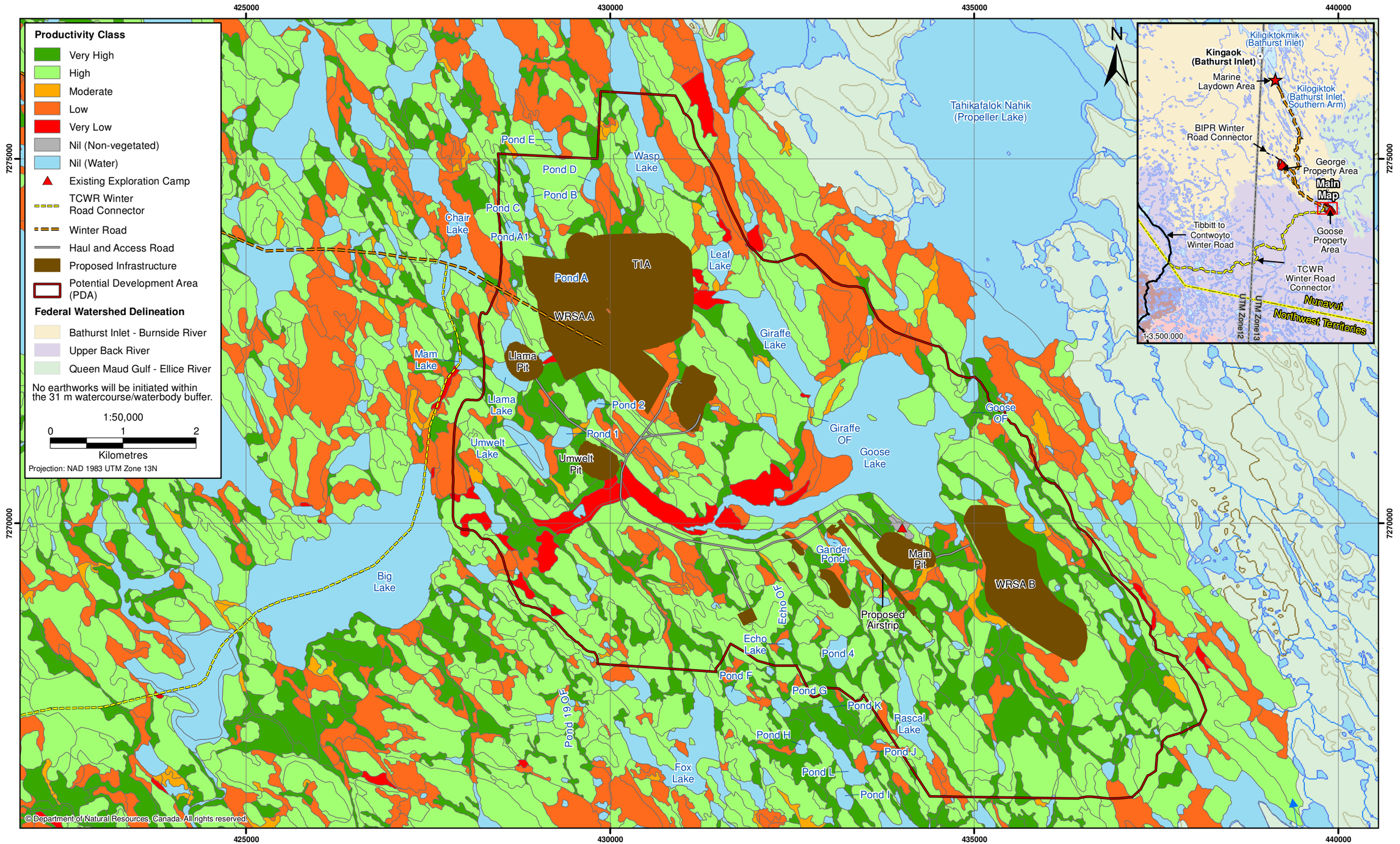


Figure 4.5-4

**Goose Potential Development Area - Terrestrial Ecosystem Mapping Productivity Class Summary**

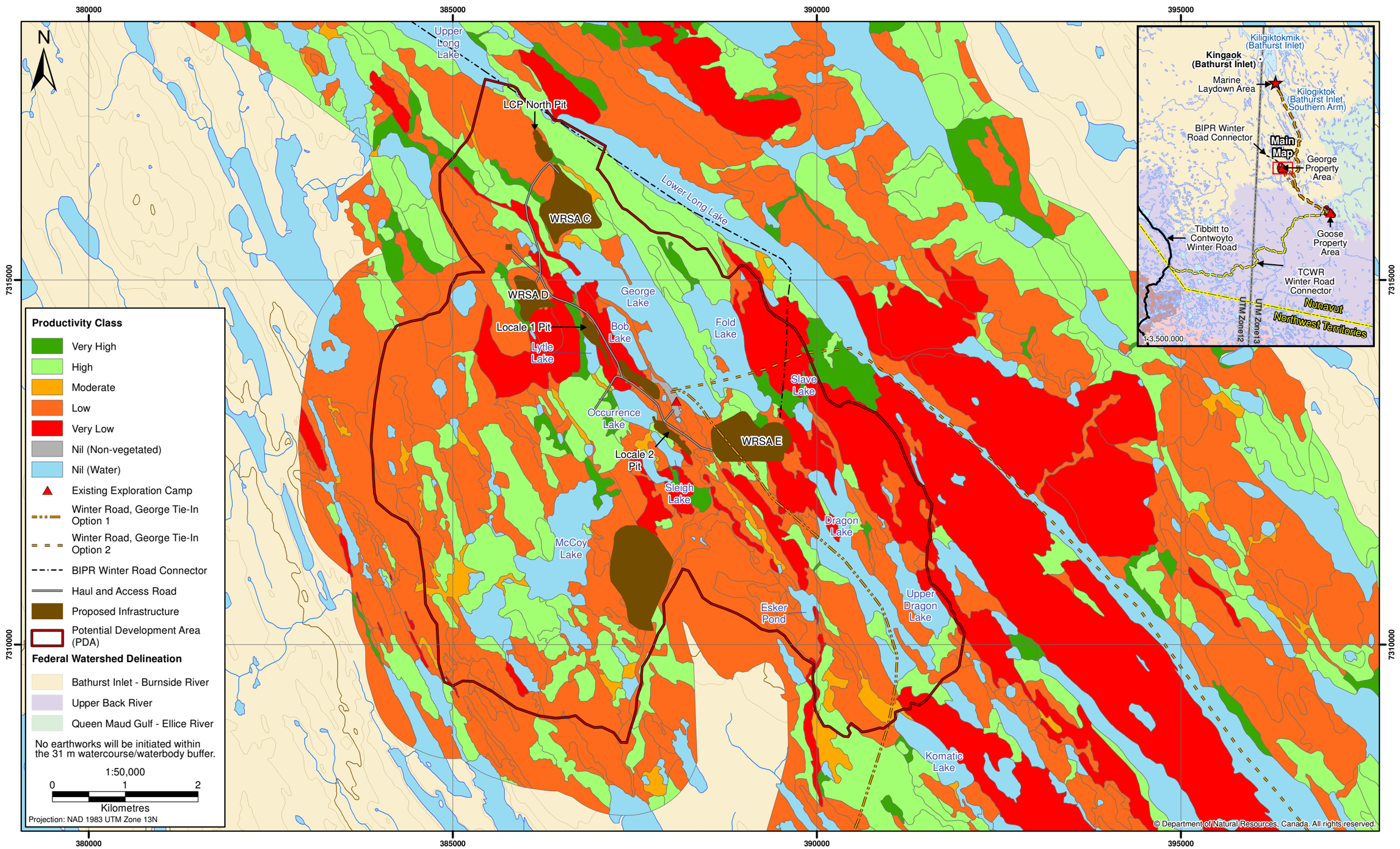


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Figure 4.5-5

**George Potential Development Area - Terrestrial Ecosystem Mapping Productivity Class Summary**

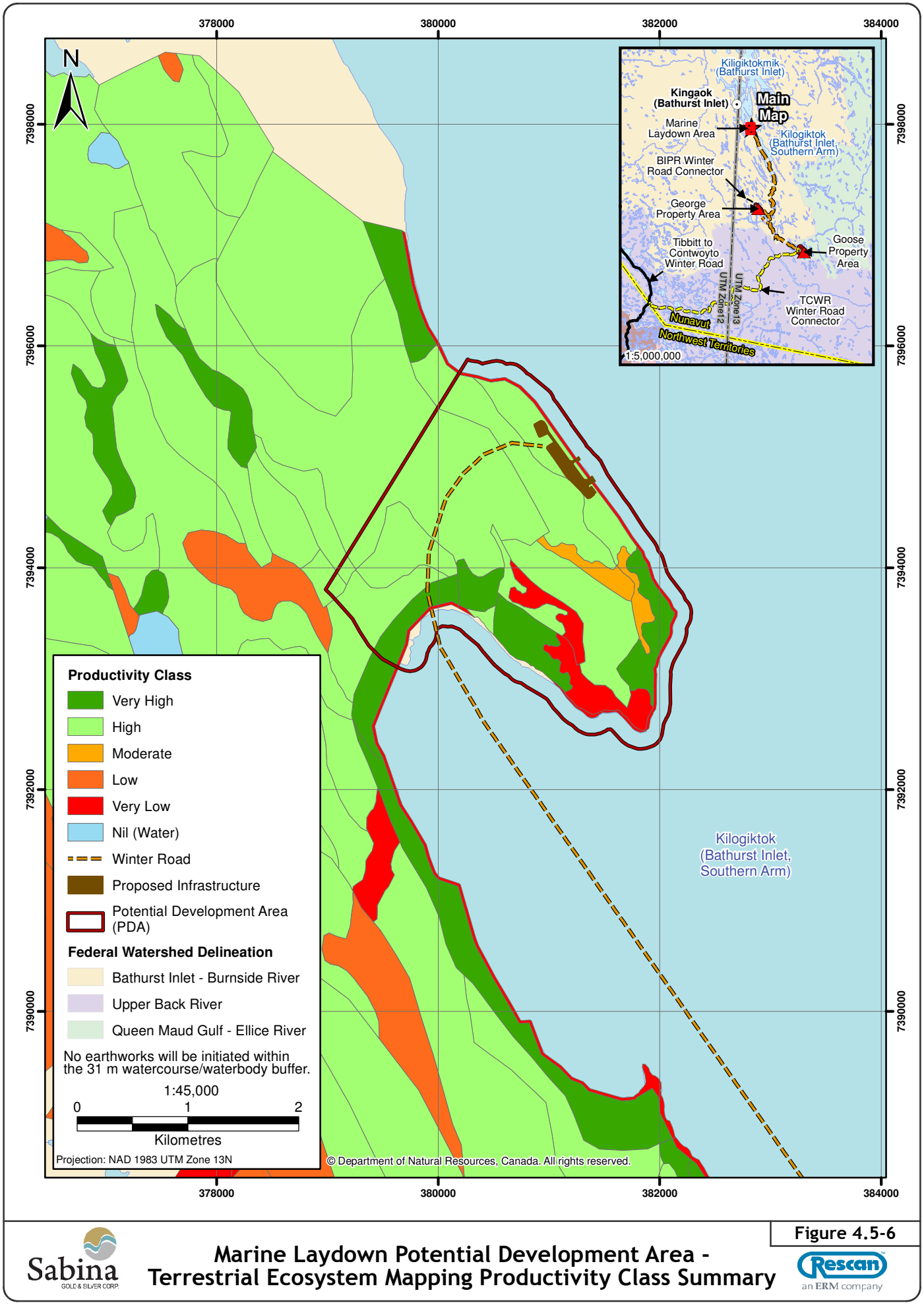

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Figure 4.5-6

# Marine Laydown Potential Development Area - Terrestrial Ecosystem Mapping Productivity Class Summary

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It is assumed that no ecosystems will be resilient to physical disturbances such as pits, rock storage facilities, camps, and buildings etc., all of which require clearing or removal of vegetation and/or organic matter. The resiliency estimates below are assumed to apply to potential degradation from activities or disturbances that do not physically remove vegetation or soil matter. Such effects could include trampling, soil compaction, deposition of fugitive dust, or introduction of invasive plant species. In this section, it is assumed that resiliency pertains largely to the relative ability to recover to anthropogenic disturbances within a short distance of infrastructure. Degradation due to compaction and trampling along road verges or from equipment and material traveling or stored upon non-designated surfaces will be minimized to the extent possible.

Table 4.5-13 provides the net change in area for each of the mapped ecosystems and Table 4.5-14 summarizes the results by Resiliency Class, within each PDA, and for the sum of the PDA areas (10,238 ha). For each class, the respective loss estimates are provided as a percentage of the total baseline distribution within the LSA. The results are depicted in Figures 4.5-7 to 4.5-9, for the Goose, George and MLA PDAs, respectively.

**Table 4.5-13. Ecosystem Resiliency Estimates**

| Ecosystem Class | Ecosystem Name | TEM Map Code | Resiliency Class |
|---|---|---|---|
| Bedrock | Cliff | BC | Very Low |
| | Bedrock – lichen veneer | BL | Low |
| | Bedrock Outcrop | BR | Low |
| | Talus | BT | Low |
| | Blockfield / Boulderfield | TB | Low |
| | Disturbed Vegetation | DV | Low |
| | Exposed Soil | ES | Very Low |
| Esker | Esker Crest | EC | Very Low |
| | Dwarf Shrub Esker | EH | Low |
| | Shrubby Esker | EW | Low |
| Marine Beach | Marine beach | MB | Very Low |
| | Old beach head | MH | Very Low |
| Tundra | Dry-Sparse Tundra | TH | Low |
| | Mesic Dwarf Shrub Tundra | TL | Moderate |
| | Shrubby Tundra | TS | Moderate |
| Tundra Marine | Marine shrubby tundra | MS | Moderate |
| | Marine dwarf shrub tundra | MT | Moderate |
| Riparian | Floodplain - Low | RL | High |
| | Floodplain - Middle | RM | High |
| | Willow Riparian | RW | High |
| Riparian Marine | Marine riparian shrub | MR | High |
| Wetland | Water Sedge Marsh | WA | Low |
| | Raised Bog Complex | WB | Low |
| | Cottongrass - Sedge Fen | WC | Low |
| | Undifferentiated Fen | WF | Low |
| | Shallow Open Water | WO | Low |
| | Willow - Sedge Fen | WS | Low |
| | Tussock Meadow | WT | Low |
| Wetland Marine | Estuary marsh | ME | Low |
| | Saline Fen | MF | Low |
| | Saline Marsh | MM | Low |
| | Saline shallow open water | MO | Low |

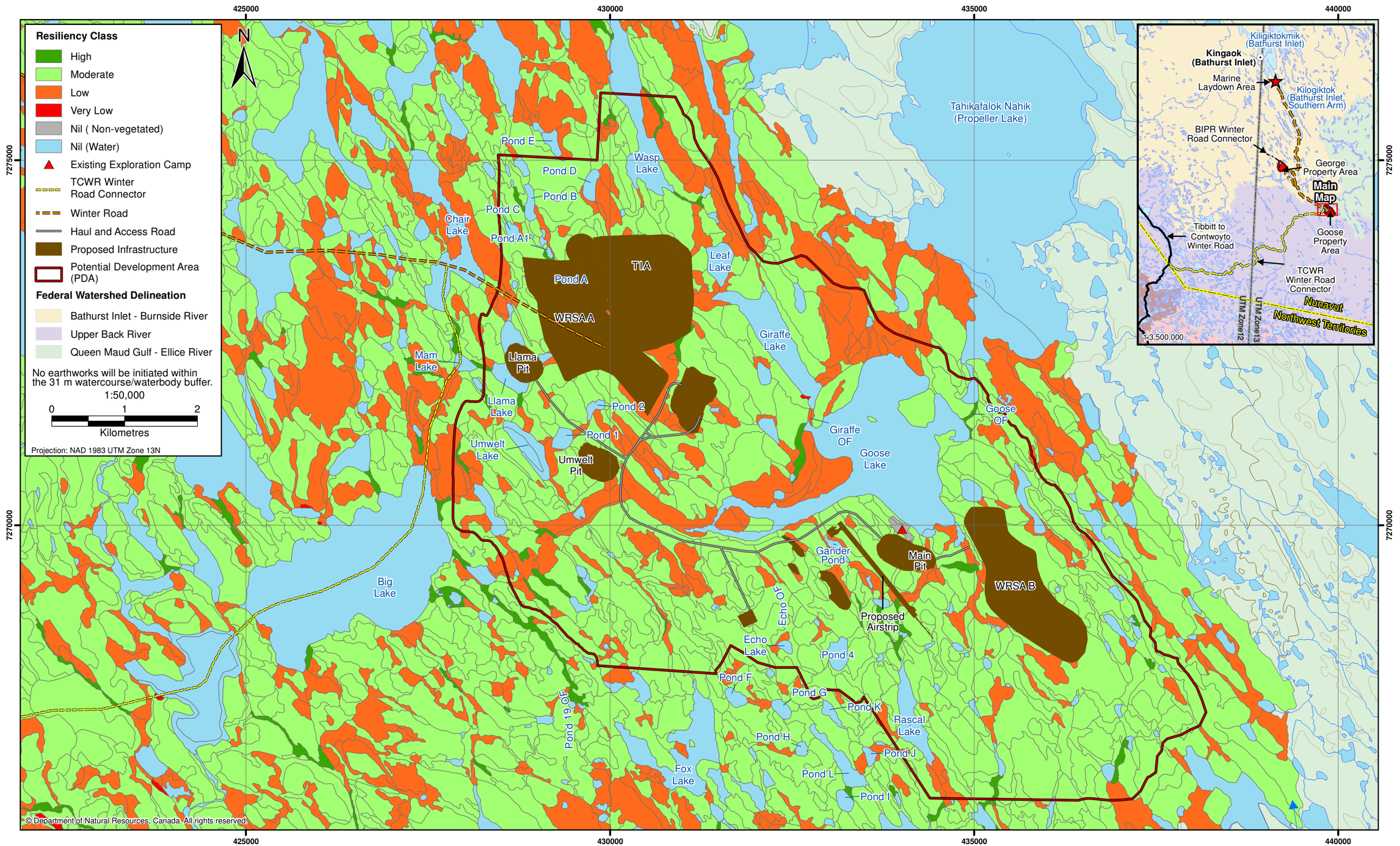


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Figure 4.5-7

**Goose Potential Development Area - Terrestrial Ecosystem Mapping Resiliency Class Summary**

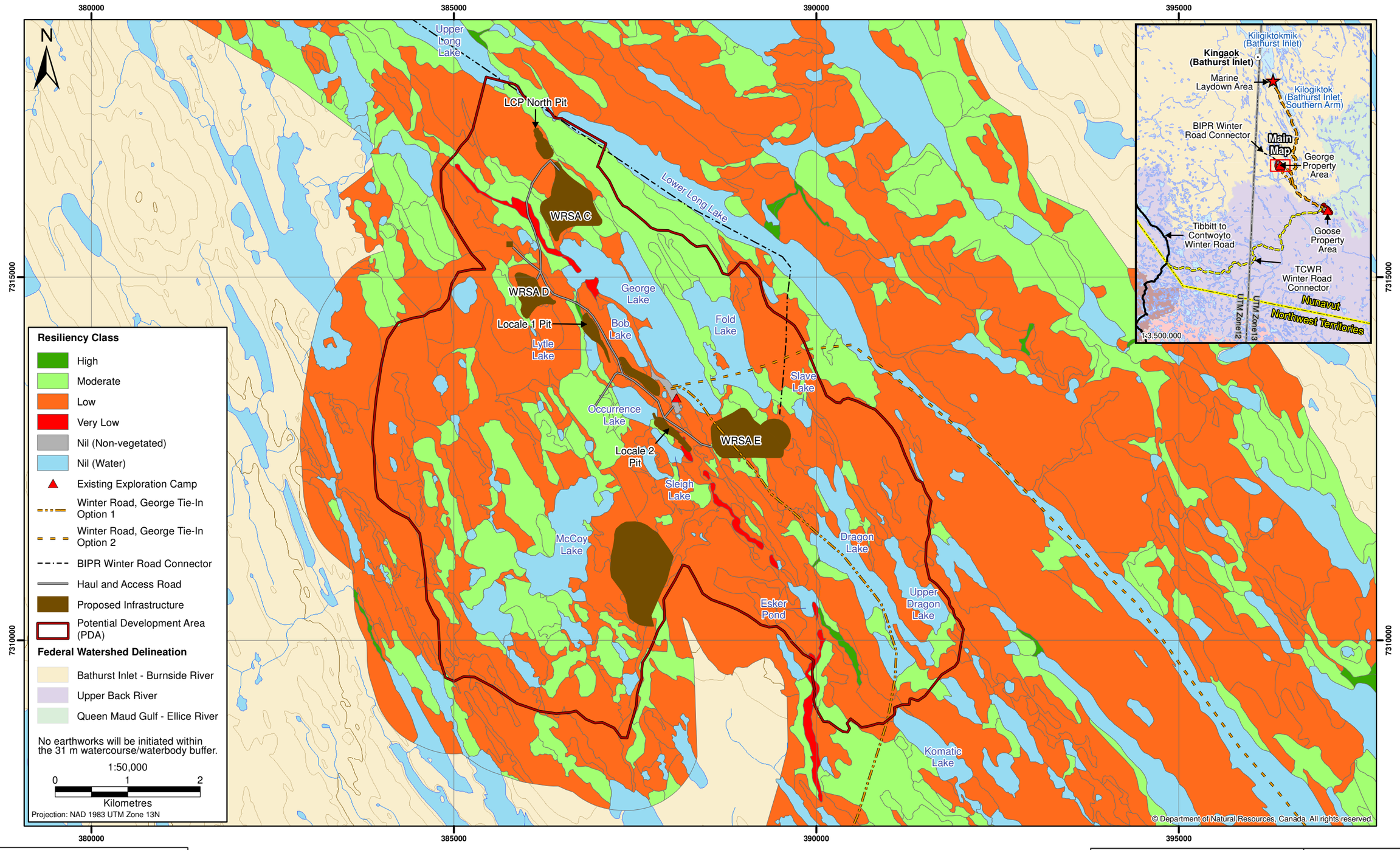


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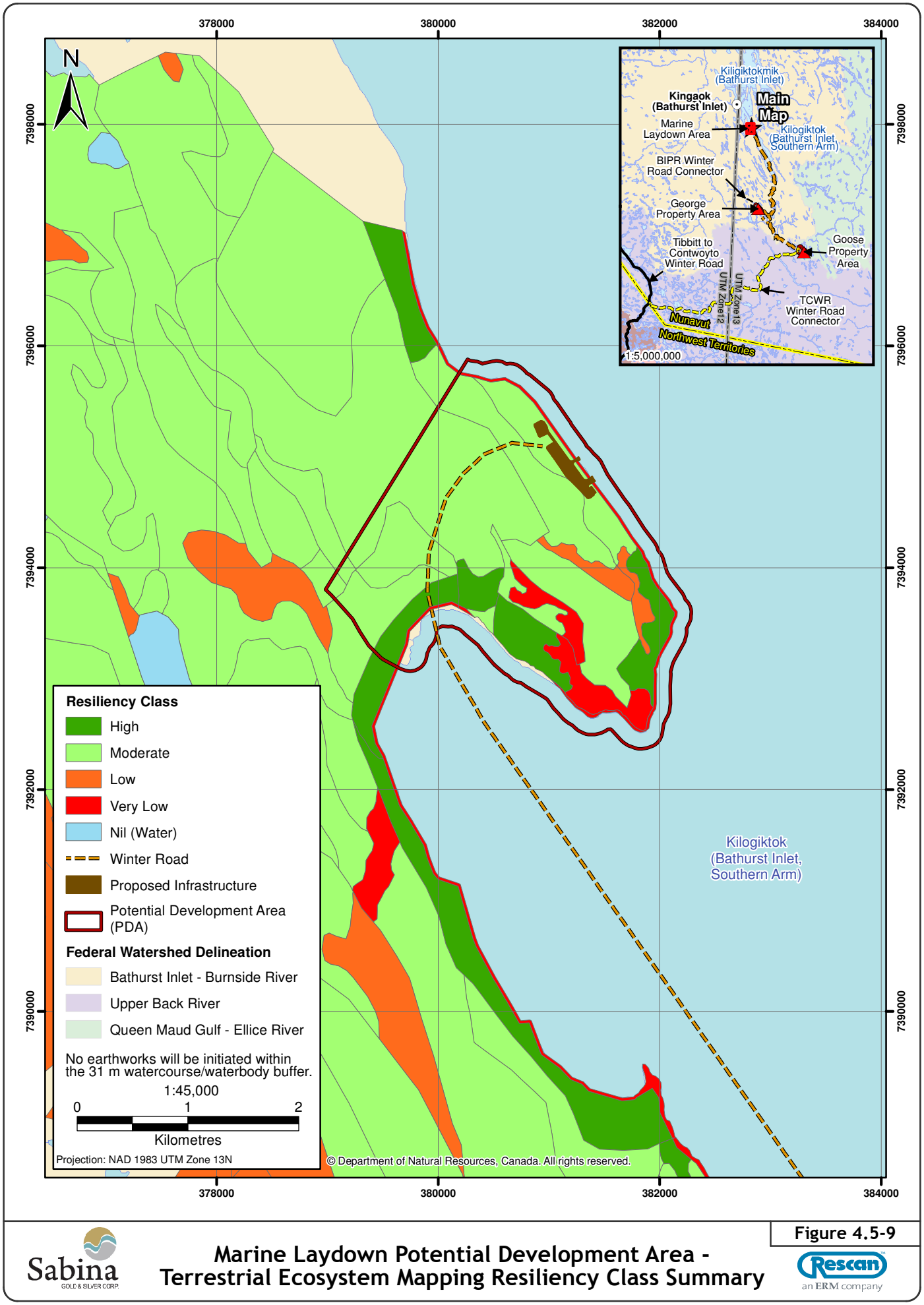
**Figure 4.5-8**

**George Potential Development Area - Terrestrial Ecosystem Mapping Resiliency Class Summary**

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# Marine Laydown Potential Development Area - Terrestrial Ecosystem Mapping Resiliency Class Summary

**Figure 4.5-9**

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**Table 4.5-14. Summary of Loss by Resiliency Class within the Potential Development Areas**

| Resiliency Class | Loss Estimates (ha) | | | | % of Availability (LSA) |
|---|---|---|---|---|---|
| | Goose PDA | George PDA | MLA PDA | Total PDA | |
| High | 62.7 | 33.8 | 89.8 | 186.4 (1.8%) | 9.9 |
| Moderate | 3,233.1 | 1,082.9 | 285.6 | 4,601.6 (44.9%) | 7.8 |
| Low | 1,345.5 | 2,341.9 | 102.7 | 3,790.0 (37.0%) | 7.9 |
| Very Low | 2.5 | 52.7 | 67.8 | 123.0 (1.2%) | 9.5 |
| *Nil (Non-vegetated and Water)* | 714.6 | 714.9 | 107.5 | 1,537.0 (15.0%) | 6.3 |
| **Total** | **5358.4** | **4226.2** | **653.4** | **10,238.0 (100.0%)** | |

Assessment of the Goose, George and MLA PDAs, together, suggests an approximate 45% loss within ecosystems having moderate resiliency. Slightly lower (37%) loss occurs within ecosystems classified as having low resiliency. Consistent with the diversity and productivity estimates, there are notable differences between individual PDAs. Within the George PDA, nearly 55% of loss occurs within ecosystems of low resiliency, by far the highest relative loss within this resiliency class. Due largely to the extent of deciduous riparian shrub, total loss from high resiliency ecosystems is greatest within the Marine Laydown PDA.

#### *4.5.4.2 Degradation of Vegetation*

As previously addressed in Section 4.5.2.2, degradation of vegetation was not identified as a residual effect for the following reasons:

- The assumption that the entire PDA will be lost, and that potential degradation of vegetation would occur within this area; and
- Potential degradation due to fugitive dust, airborne emissions, water quality and soil changes were assessed as part of the Country Foods VEC assessment (Volume 8, Chapter 5) and the environmental risk assessment (Volume 8, Chapter 6) and potential effects to vegetation were found to have no residual effects beyond the PDA boundaries (the Country Foods LSA).

For potential effects on water quality and quantity, refer to Volume 6, Chapter 4 (freshwater quality) and Volume 6, Chapter 1 (surface hydrology).

### 4.5.5 Significance of Residual Effects

Table 4.5-15 summarizes the residual effects and significance determination for loss of vegetation and special landscape features. The attributes used to evaluate significance are defined within the General Assessment Methodology in Volume 9, Chapter 1, and the Magnitude Table (Table 4.5-1 in Section 4.5.1). The final magnitude for significance determinations is based upon the loss of vegetated ecosystems and special landscape features, as collective units, not by specific ecosystems or landscape features.

Mitigation measures and best management practices (Section 4.6.3) will be implemented; however, residual loss of vegetation and special landscape features is anticipated. The entire PDAs were assumed to be lost for this assessment.

**Table 4.5-15. Summary of Residual Effects Significance Determination**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Certainty | Probability | Confidence | Rating |
| Vegetation Loss | Negative | Low | Long | Once | Footprint | Irreversible | High | Likely | Medium | Not Significant (N) |
| Special Landscape Feature Loss | Negative | Low | Long | Once | Footprint | Irreversible | High | Likely | Medium | Not Significant (N) |

Loss of terrestrial vegetation represents a negative effect that, given the harsh climate, short growing season and low resiliency of Arctic vegetation, is assumed to be of permanent (long-term) duration, and irreversible. Collective loss of vegetation is considered low magnitude, given the magnitude criteria definitions in Table 4.5-1. Although not assessed for specific ecosystems, highest relative effect is expected within the Riparian Marine and Marine Beach ecosystem classes, which are mapped in the vicinity of Bathurst Inlet. Project activities resulting in loss of vegetation will occur once, coinciding with the Project phase within which physical removal of vegetation and organic material occurs. Although total loss of vegetation is assumed throughout the Goose Property, George Property and MLA PDAs in order to calculate maximum potential effect, actual loss will be smaller than reported for the PDA, as determined by the final Project footprint, which is expected to comprise a small proportion of the total PDA.

There is high certainty, and likely probability, that loss of terrestrial vegetation will occur, as the effect relationship (loss due to physical clearing) is well understood and terrestrial ecosystem mapping reveals that most of the PDA, with the exception of water features and existing exploration infrastructure, is comprised of vegetated ecosystems. Ongoing baseline data collection and feasibility work will further refine the footprint of the Project within each PDA. The estimated vegetation losses and impact assessment will be updated, accordingly.

Considering the over-estimation of residual effects in assuming loss within entire PDAs, and that the effects are estimated to be primarily of low and negligible magnitude within the LSA and RSA, respectively, the overall significance of vegetation loss is considered **Not Significant**. Based on results of ecosystem mapping and the ecological classifications throughout the LSA and RSA, the mapped ecosystems, including those within the marine-associated riparian and beach ecosystem classes, within which local high magnitude effects are estimated, appear common throughout the surrounding region.

Similarly, loss of special landscape features represents a negative effect that is assumed to be of permanent (long-term) duration and irreversible. Project activities resulting in loss of special landscape features will occur once, coinciding with the Project phase within which physical removal of vegetation and organic material occurs. Although total loss of special landscape features is assumed throughout the Goose, George and MLA PDAs in order to calculate maximum potential loss, the actual extent of loss, for reasons explained above, will be smaller, as determined by the final Project footprint.

There is high certainty, and likely probability, that loss of special landscape features will occur from each PDA, given the abundance of landscape features such as wetlands and bedrock-dominated ecosystems. The effect relationship (loss due to physical clearing) is well understood. There is medium certainty regarding loss from specific features, however (Table 4.5-4), as the final infrastructure ultimately determines which features within the PDA are affected.

Given the small percentage of loss compared to the distribution of special landscape features within the LSA (8.7% loss), especially when considering the over-estimation of expected effects, the overall significance of loss is considered **Not Significant**. Based on results of ecosystem mapping and the ecological classifications throughout the LSA and RSA, the features mapped within the PDAs appear common throughout the region.

## 4.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

As residual effects are expected from the project, they are carried through the assessment of potential cumulative effects.

### 4.6.1 Methodology Overview

Described within Volume 9, Chapter 1, the cumulative effects assessment was conducted according to the General Assessment Methodology in Volume 9, Chapter 1. This included:

1. Undertaking scoping exercise to identify potential for Project-related residual effects to interact with other projects and human activities;
2. Identifying and predicting potential cumulative effects and implementing additional mitigation measures;
3. Identifying cumulative residual effects after implementation of additional mitigation measures; and
4. Determining the significance of any cumulative residual effects.

The two residual effects estimated from the effects assessment in Section 4.5 are:

1. Vegetation loss, and
2. Special landscape feature loss.

The potential cumulative losses of vegetation and special landscape features were assessed within the cumulative effects assessment boundary, which is the same as the vegetation and terrestrial wildlife RSA (Figure 4.6-1). Residual effects from the Back River Project were assessed against those past, present and reasonably foreseeable future projects listed within Volume 9, Chapter 1 that overlap the vegetation and terrestrial wildlife RSA. For each overlapping project, only the infrastructure proposed within the RSA is included in the cumulative effects assessment.

Defined within the General Assessment Methodology Chapter (Volume 9, Chapter 1), attributes used to evaluate potential cumulative effects, including determination of significance, include the direction and nature, magnitude, geographic extent, frequency, timing, duration, and reversibility. The environmental sensitivity of the landscape that is subject to potential effects is also a consideration.

Consistent with the assessment of residual effects, the magnitude rating scheme (Table 4.5-1) was developed through the adoption of threshold values derived from literature on wildlife habitat loss and disturbance. Effect magnitudes range from negligible, where there is assumed to be no detectable change to baseline distributions, to high magnitude, where loss is assumed to result in a long-lasting effect on the distribution of vegetation communities within the RSA.

### 4.6.2 Potential Interactions with Project and Characterization

Detailed in Section 4.5.4.1, residual effects resulting from the Project were identified and include the loss of vegetation and special landscape features, each of which can result in reductions to the natural baseline patterns of diversity, productivity and resiliency on the landscape. The loss of special landscape features such as cliffs, eskers, riparian and wetland ecosystems, marine beaches and shores etc., can affect unique habitats that have high likelihood of supporting rare plants and which provide important habitat features for wildlife.

Of the potential past, existing and reasonably foreseeable future projects summarized within Figure 3.4-1 and Table 3.4-1 of the General Assessment Methodology (Volume 9, Chapter 1), the reasonably foreseeable Hackett River Mine and Bathurst Inlet Port and Road (BIPR) have spatial and/or temporal overlap with the Back River Project vegetation and terrestrial wildlife RSA (Figure 4.6-1). Loss and/or degradation of vegetation resulting from these two projects would add to the respective loss estimates for the Back River Project, within the vegetation and terrestrial wildlife RSA. Each located well over 100 km from the Project, the other past and existing projects are assumed to have negligible cumulative contribution to the potential effects of the Project, however, and are excluded as projects of potential cumulative interaction in this assessment.

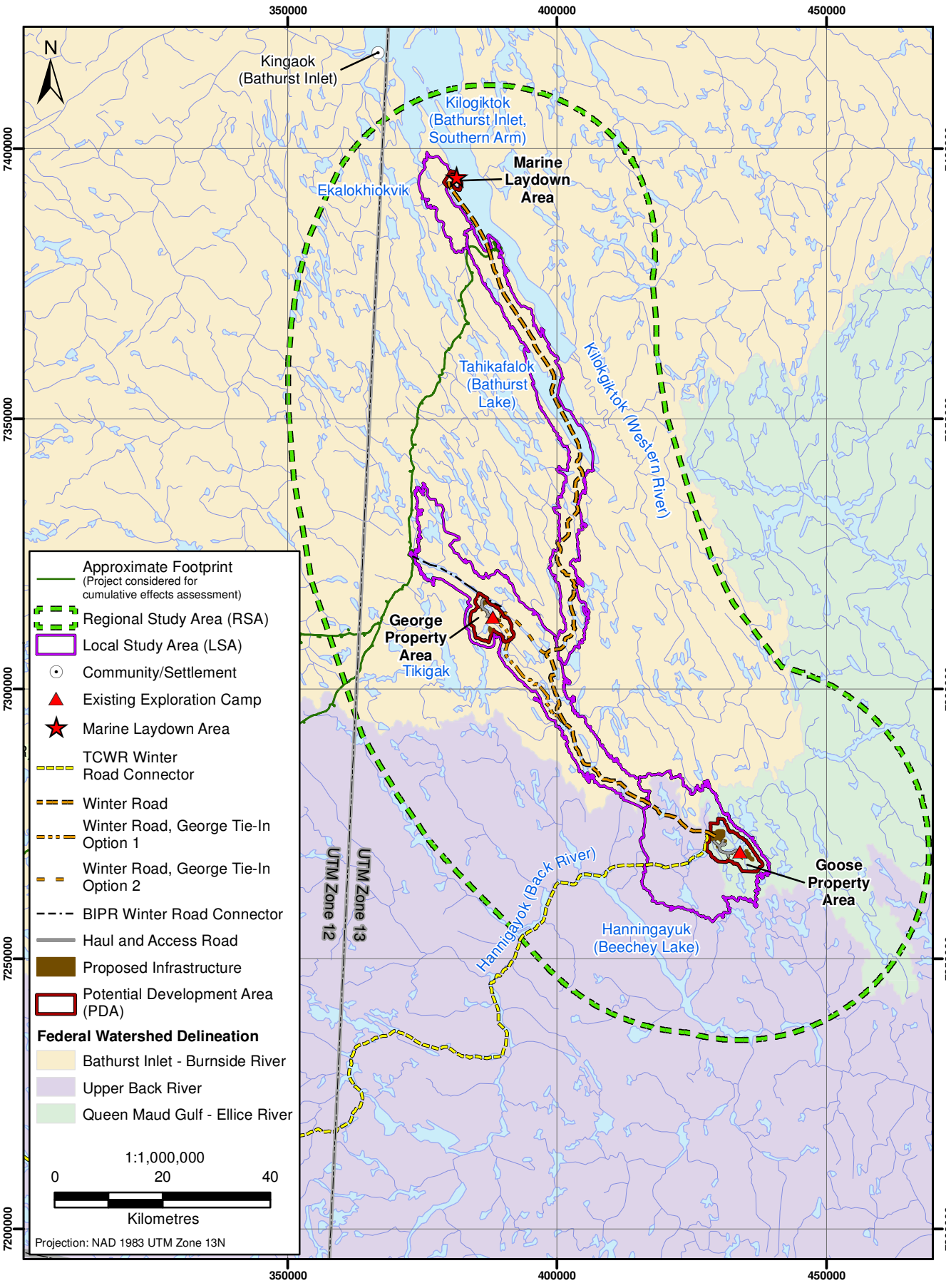


Figure 4.6-1

# Spatial Boundary for Vegetation and Special Landscape Feature Potential Cumulative Effects Assessment

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Summarized in Volume 9, Chapter 1, the Bathurst Inlet Port and Road (BIPR), presently on hold in the NIRB review process, is a proposed future project consisting of facilities at Bathurst Inlet (approximately 12 km southeast of the MLA) and an all-weather access road connection to the existing Tibbitt to Contwoyto winter road (TCWR), 211 km to the southwest. The proposed port facilities, including a wharf, 200-person camp, and 1,200 m airstrip, and portions of the proposed all-weather access road, overlap the Back River Project Vegetation LSA and RSA, but not the PDAs.

Should the BIPR project be approved, construction is scheduled to begin in 2017, with an estimated 20 year operational life (Volume 9). With this schedule, the BIPR Project would have spatial and temporal overlap with the Back River Project.

The proposed future Hackett River Project consists of a planned open pit and underground base metals mine with a spur road connection to the proposed BIPR road, 23 km to the east. Pre-feasibility and environmental baseline studies have been conducted, but the DEIS completion is presently on hold. Situated approximately 95 km northwest of the existing Goose exploration camp, small areas of proposed infrastructure and access road overlap the Back River Project Vegetation RSA. Should the Hackett River project proceed, it has an estimated operational mine life expectancy of 14 years.

Table 4.6-1 summarizes the potential loss resulting from each of the proposed projects with the estimated loss from the Back River Project.

**Table 4.6-1. Interactions of Residual Effects from Back River Project with Other Projects**

| | Description of Residual Effect | Proposed Infrastructure within CEA Boundary[1] |
|---|---|---|
| Back River Project | Vegetation Loss<br>Special Landscape Feature Loss | Pits, haul and access roads, waste rock and explosives storage areas, landfills, tailings impoundment area, camps, airstrips, barge landing location |
| BIPR | Vegetation Loss and Degradation | Port facilities (wharf, 200-person camp, airstrip) and quarry; 98 km of all-weather access road |
| Hackett River | Vegetation Loss and Degradation | Quarry and 10 km of all-weather access road |

[1] *The Back River Project vegetation and terrestrial wildlife RSA*

### 4.6.3 Identification of Mitigation and Management Measures

Although not available for the future Hackett River Project, which is presently on hold in the NIRB process, it is assumed that future mitigation and management measures to minimize the loss and degradation of vegetation and special landscape features will be consistent with those presented for the Back River Project in Section 4.5.3.

Described within Rescan (2007) for the future BIPR Project, a Vegetation Management Plan (VMP) and Invasive Plants Management Plan (IPMP) are proposed to help identify areas where vegetation and invasive plant management are required. The VMP outlines a series of general practices, such as minimizing footprints and optimizing infrastructure placement, to minimize loss and disturbance to vegetation and ecosystems. The objectives of the IPMP, which is proposed within the framework of the VMP, are to prevent the establishment of invasive plant species and to maintain healthy vegetative cover in, and around, development areas. Coordination of these plans with additional plans associated with the implementation of fugitive dust management and dustfall monitoring, soil management, spill management, hazardous materials, and closure and reclamation, will further minimize potential for adverse effects on vegetation.

### 4.6.4 Characterization of Cumulative Residual Effects

The two residual effects for the Back River Project, both of which are confined to the PDAs, include the loss of vegetation and loss of special landscape features.

In addition to the loss of vegetated ecosystems mapped within the three PDAs (approximately 8,700 ha, excluding water features, existing exploration camps and road surfaces), an estimated 370 hectares of cumulative loss within the vegetation and terrestrial wildlife RSA could result from development of infrastructure and roads associated with the proposed Hackett River Mine and BIPR projects (Table 4.6-2).

**Table 4.6-2. Summary of Potential Cumulative Interaction with the Back River Project**

| Project | Back River Project RSA | | Total RSA Overlap (ha) |
|---|---|---|---|
| | Infrastructure (ha) | Roads (ha)* | |
| Hackett River Mine | 19.3 | 20.6 | 39.9 |
| Bathurst Inlet Port and Road | 63.8 | 265.7** | 329.5 |
| **Total** | **83.1** | **286.3** | **369.4** |

** Area estimates based on 20 metre road widths.*
*** Area includes associated quarries.*

Within the RSA, cumulative loss and degradation of vegetation would result from development of both projects, with nearly 370 ha of incremental loss, the majority from the northern half of the proposed BIPR all-weather access road. There is no geographical overlap with the Back River Project PDAs, however. Within the RSA, the incremental loss represents a small fraction of the Back River PDA areas that are assessed as loss.

To represent maximum possible interaction, the assumption is that all areas in Table 4.6-2 overlap vegetated ecosystems. The BIPR-related infrastructure, with exception of the all-weather road connection to the TCWR, occurs within a region of marine-derived parent materials and losses are expected from marine beaches, shorelines and other marine-influenced riparian, wetland and tundra ecosystems. Described in the draft environmental impact assessment for the Bathurst Inlet Port and Road Project (Rescan 2007), heath tundra was the most common ecosystem affected by the proposed port and road footprints and was also the most abundant plant community in both the BIPR vegetation LSA and RSA. Despite estimated local high magnitude effects from loss of plant communities (including those of ecological interest), the loss was considered to have low influence on resource capacity as all of the plant communities that would be lost are identified throughout the surrounding area. Degradation of plant communities was considered low magnitude, also with a low influence on resource capacity. Residual loss and degradation were rated as moderate and low significance, respectively.

Within the RSA, similar to the George PDA, the proposed Hackett infrastructure occurs within a landscape supporting a relatively higher (than the Goose and MLA PDAs) proportion of sparsely-vegetated ecosystems on thin, rocky parent materials. Losses from vegetated ecosystems are assumed to occur from communities similar to those mapped within the George PDA, with most loss expected from mesic dwarf-shrub and dry-sparse tundra ecosystems.

The estimated cumulative loss of vegetated ecosystems within the 1,262,000-ha RSA represents less than 1 % of baseline availability.

### 4.6.5 Significance of Cumulative Residual Effects

Table 4.6-3 summarizes the residual cumulative effects and significance determination for loss of vegetation and special landscape features.

Despite the application of mitigation measures and best management practices, development of each project would result in incremental loss of vegetation and special landscape features, beyond the estimates for the Back River Project. Loss of Arctic vegetation and special landscape features represents a negative effect that is assumed to be of long-term (permanent) duration, and irreversible. Project activities resulting in loss will be limited to the project footprints and will occur once, coinciding with the Project phases within which physical removal of vegetation and organic material occurs.

**Table 4.6-3. Summary of Cumulative Residual Effects Significance Determination**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Direction | Magnitude | Duration | Frequency | Geographic Extent | Reversibility | Certainty | Probability | Confidence | Rating |
| Vegetation Loss | Negative | Low | Long | Once | Footprint | Irreversible | High | Likely | High | Not Significant (N) |
| Special Landscape Feature Loss | Negative | Low | Long | Once | Footprint | Irreversible | Medium | Likely | Medium | Not Significant (N) |

As reported in Section 4.5.4, loss of vegetation and special landscape features was assessed as low magnitude. Within specific ecosystems, highest losses, relative to their baseline distribution, were estimated in close proximity to Bathurst Inlet, which was identified within this assessment as unique due to the vigour and richness of vegetation and the higher likelihood of supporting rare plants. The importance of ecosystems near Bathurst Inlet, specific to their function as wildlife habitat, is detailed within Volume 5, Chapters 5 through 10.

Should one or both of the Hackett River Mine or BIPR projects proceed, there is high certainty that loss of vegetation will occur, as the effect relationship (loss from physical clearing) is well understood. There is less certainty regarding loss from specific ecosystems and special landscape features, however, without assessment of final infrastructure footprints and field confirmation of ecosystems underlying the proposed infrastructure. However, given the abundance of wetlands and other special landscape features, including marine beaches, shores and riparian shrub ecosystems near Bathurst Inlet, the probability of loss of special landscape features from the BIPR is considered likely.

Given the small areas of incremental loss expected from the proposed Hackett River Mine and BIPR projects, compared to the estimated losses within the Goose Property, George Property and MLA PDAs (collectively comprising 0.8% of vegetation within the RSA), the estimated cumulative loss remains less than 1% of the RSA. Consistent with the residual effects results, the tundra-dominated ecosystems, which are likely to be most affected from the proposed BIPR facilities and access roads, are relatively common throughout the surrounding region. Shrub-dominated riparian ecosystems and other marine beaches, shorelines, and wetland ecosystems, were also common throughout the RSA.

In summary, cumulative loss of vegetation and special landscape features from development of the proposed Back River Project, Hackett and BIPR projects is considered **Not Significant**.

## 4.7 TRANSBOUNDARY EFFECTS

As all potential Project and cumulative residual effects from loss and/or degradation of vegetation and special landscape features are expected to remain within the PDA, LSA or RSA, which are all within Nunavut, transboundary effects are not expected and are not further addressed.

## 4.8 MITIGATION AND ADAPTIVE MANAGEMENT

Section 4.6.3 previously identifies the recommended mitigation measures and best management practices pertaining to vegetation and special landscape features. To minimize potential for loss of vegetation and special landscape features, mitigation and management measures have been embedded throughout the Project design and others will continue throughout construction and operation. Table 4.8-1 summarizes the specific measures under each category below.

### 4.8.1 Mitigation by Project Design

The measures implemented during the design phase to minimize loss and disturbance to the terrestrial environment include maximizing the use of lakes and rivers for winter access roads and confining proposed infrastructure, waste rock storage areas and the tailing impoundment area to the local watersheds within which the deposits are located. The design of haul roads was optimized to minimize travel distances and associated emissions, and infrastructure such as stockpiles and windbreaks were proposed in locations that minimize potential for dustfall effects.

### 4.8.2 Best Management Practices

Best management practices to minimize loss and disturbance to the terrestrial environment include measures to minimize clearing of vegetation and soil from unique landscape features, reduce the potential for introduction and spread of invasive plants, minimize the potential for degradation from the creation of ruts, and minimize the potential for fugitive dust-related effects.

### 4.8.3 Adaptive Management and Monitoring

The need for specific adaptive management and monitoring activity will be determined by the results of many of the plans provided in Volume 10. Specific Plans that will help minimize the loss or degradation of vegetation and special landscape features include the:

- Air Quality Monitoring and Management Plan (Volume 10, Chapter 17)
- Fuel Management Plan (Volume 10, Chapter 4)
- Spill Contingency Plan (Volume 10, Chapter 5)
- Site Water Monitoring and Management Plan (Volume 10, Chapter 7)
- Ore Storage Management Plan (Volume 10, Chapter 8)
- Mine Waste Rock and Tailing Management Plan (Volume 10, Chapter 9)
- Landfill and Waste Management Plan (Volume 10, Chapter 10)
- Incinerator Management Plan (Volume 10, Chapter 11)
- Hazardous Materials Management Plan (Volume 10, Chapter 12)
- Explosives Management Plan (Volume 10, Chapter 13)
- Road Management Plan (Volume 10, Chapter 14)
- Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16)
- Aquatic Effects Management Plan (Volume 10, Chapter 19)
- Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20)
- Metal Leaching and Acid Rock Drainage Management Plan (Volume 10, Chapter 22)
- Mine Closure and Reclamation Management Plan (Volume 10, Chapter 29)

### 4.8.4 Summary Table of Mitigation and Adaptive Management Measures

Table 4.8-1 summarizes the mitigation and adaptive management measures applicable to vegetation and special landscape features.

**Table 4.8-1. Summary of Mitigation and Adaptive Management Measures for Vegetation and Special Landscape Features**

| Mitigation by Project Design |
|---|
| • The Project has been designed to employ winter road only access corridors that travel primarily over lakes and rivers thereby minimizing potential negative effects on terrestrial vegetation and limiting dust emissions.<br>• Infrastructure, waste rock storage areas, and the TIA at the Goose Property have been confined to the local watersheds where the deposits are located, and have stayed out of the regional Upper Back River Watershed, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment.<br>• Infrastructure and waste rock storage areas at the George Property have been confined to the local watersheds where the deposits are located, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment.<br>• The design of haul roads has been optimized to minimize the distance travelled which will reduce emissions associated with construction and operation. |

*(continued)*

**Table 4.8-1. Summary of Mitigation and Adaptive Management Measures for Vegetation and Special Landscape Features (completed)**

| **Mitigation by Project Design *(cont'd)*** |
|---|
| • Tailings disposal methods have been designed to reduce beach/dust sources and generation. |
| **Best Management Practices** |
| • The clearing of vegetation and soil from unique landscape features will be minimized to the extent possible, including eskers, wetlands, exposed bedrock, cliffs etc., which often provide high value habitat to wildlife and may support sensitive vegetation communities and growth forms.<br>• all vehicles and machinery will restrict travel to designated road surfaces; avoid creation of ruts in vegetated ecosystems.<br>• Best Management Practices to reduce dust and hence reduce influence of dust on vegetation will include:<br>– The discharge heights from the crushers onto conveyers will be minimized, and the discharge heights from conveyors onto stockpiles will be minimized. The discharge from crushers onto conveyors or into other equipment will be enclosed as far as is practicable (e.g., free fall of materials from conveyors carrying material should be fitted with a full hood such as a plastic chute).<br>– Loads carried by vehicles will be enclosed or covered when possible.<br>– Storage areas will be kept in a condition that does not give rise to visible dust emissions.<br>– Windbreaks or fences may be installed around known problem areas or stockpiles to limit the dispersion of dust emissions from equipment and stockpiles, or activities likely to generate dust.<br>– Regular wheel-cleaning of vehicles travelling around and leaving the site.<br>– Regular removal of dust deposits on external parts of the plant in order to minimize the potential for wind entrainment.<br>– All-weather roads (local site roads) will be regularly compacted and kept in good repair.<br>– Vehicles will be driven at designated speeds on site roads.<br>– Water or other dust suppressant (non-wildlife attracting) will be used for site roads if needed to minimize dust from ore and waste rock haulage and grading, when ambient air temperatures permit.<br>– Water sprays or dust suppression fluids will be used to suppress dust generation from equipment in the crushing facility. Dust suppression methods will be approved by the Government of Nunavut as outlined in the Nunavut environmental guideline for dust suppression (Government of Nunavut 2002) and will be suitable for use at below freezing temperatures.<br>– Conditioning materials which are likely to generate dust will be sprayed with water prior to transfer.<br>• The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:<br>– if results from the Site Water Monitoring and Management Plan show non-compliance related to tundra discharges; or<br>– if results from the Wildlife Mitigation and Monitoring Program, which will monitor select wildlife species and habitat around the mine infrastructure and activities, show adverse effects to wildlife or wildlife habitat. |
| **Monitoring** |
| • Monitoring Plans, indicated in Section 4.5.3, outline programs to monitor air quality, water, and waste management, which will help eliminate or minimize effects to vegetation and special landscape features.<br>• A Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) will be in place that outlines the Wildlife Mitigation and Monitoring Program (WMMP) that will be carried out during all phases of the Project. The WMMP will include monitoring select wildlife species and habitat. |

## 4.9 IMPACT STATEMENT

For the assessment of the vegetation and special landscape feature VECs, it was assumed that the entire Project Development Areas (PDAs) would be lost. This represents a worst case scenario, but provides flexibility in future Project siting. Direct loss from clearing activities within the PDAs will result in local long-term decreases in the abundance, diversity and percent cover of vegetation.

Although complete loss within the PDAs is assumed for the assessment, actual loss is dictated by the final Project design and will be localized to the actual footprint.

Collectively, loss of vegetated and sparsely-vegetated ecosystems within the three PDAs comprises nearly 8% of the baseline distribution for vegetated ecosystems within the LSA, and less than 1% within the RSA. Reflective of ecosystem distributions at baseline, the majority of loss within each PDA is expected from tundra ecosystems, with greatest loss (by area) within the Goose PDA from the Mesic Dwarf-Shrub Tundra ecosystem and, within the George PDA, from the Dry-Sparse Tundra ecosystem. Within the Marine Laydown Area PDA, greatest loss (by area) occurs from the Marine Dwarf Shrub Tundra ecosystem. Losses within Ecosystem Classes (Table 4.5-4) are typically below 10% of their respective baseline distributions in the LSA, with exception of the Marine Beach and Marine Riparian ecosystem classes within the Marine Laydown Area PDA. Losses from these two classes represent 13% and 20%, respectively, of their baseline distribution. Ecosystems within these classes include marine beaches, old beach heads, and shrub-dominated riparian ecosystems and were commonly observed beyond the LSA boundary and throughout the RSA.

Similarly, estimated loss of special landscape features within the three PDAs comprises approximately 9% of their collective baseline distribution within the LSA. For specific features, losses are also typically below 10% of their respective baseline distributions. The majority of loss within the Goose and George PDAs occurs from wetland and bedrock-dominated ecosystems (Table 4.5-5). Within the Marine Laydown Area PDA, losses are split nearly equally between riparian and wetland ecosystems, marine beaches and old beach heads.

Consistent with the small percentage of total loss of vegetation and special landscape features compared to their mapped distributions within the LSA (8% and 9%, respectively), residual vegetation loss is considered of low magnitude. Within specific ecosystems, the greatest change to baseline occurs within marine-influenced ecosystems near Bathurst Inlet. This is due to the higher proportion of deciduous shrub-dominated ecosystems that support greater species diversity, the importance of riparian ecosystems that provide wildlife habitat, and the special landscape features that create unique microsystems that support the majority of rare plants (most occur within a kilometre of the Inlet). Residual vegetation loss is assumed to be irreversible but Not Significant (Table 4.5-15) as ecosystems lost within each PDA are common beyond the LSA boundary and throughout the RSA.

The two project residual effects were included in a cumulative effects assessment, the boundary of which was the vegetation and terrestrial wildlife RSA. In addition to assumed losses within the three PDAs (approximately 8,700 ha, excluding water features, existing exploration infrastructure and road surfaces), a further 370 hectares of cumulative loss could occur within the RSA from developing roads and infrastructure associated with the future Hackett River Mine and Bathurst Inlet Port and Road (BIPR) projects (Table 4.6-2). Only the future BIPR project would result in cumulative loss within the LSA due to the proposed port location. Cumulative loss from the Hackett River project would occur from the RSA.

The cumulative loss and degradation of vegetation and special landscape features from development of the proposed Back River Project, Hackett and BIPR projects is considered **Not Significant.**

## 4.10 SUPPORTING AND SUPPLEMENTAL INFORMATION

A detailed report on rare plant and lichen species throughout the LSA and RSA is provided in Appendix 1 of Rescan (2013a), which can be found in Appendix V5-4A. Although potential effects on rare and culturally valued plants are not individually assessed, ecosystems or features with highest potential to support rare plant species, such as cliffs and marine beaches, shores and wetlands, are encompassed within the assessment of special landscape features. Table 4.3-2 identifies those features with highest likelihood of supporting rare and culturally valued plants. Section 4.3.1 discusses the plant species of traditional importance.

# 5. Caribou

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# 5. Caribou

## 5.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 5.1.1 Introduction

There are more than 2.4 million caribou in Canada and about half are barren-ground caribou comprising eight large migratory herds found across Nunavut, the Northwest Territories, and Yukon (Kelsall 1968; F.L. Miller, Rothfels, and Russell 2005). Distinct from woodland caribou that inhabit much of the boreal forest across Canada, barren-ground caribou (*Rangifer tarandus*) are smaller, lighter in colour, and spend much of the year on the tundra. Caribou herds are classified based on their calving ground fidelity and similar demographic characteristics (Fisher, Roy, and Hiltz 2009). Barren-ground caribou are a keystone species in the Arctic both biologically and culturally and are a main prey item for grizzly bears and wolves. Other carnivores such as wolverines, foxes, and golden eagles scavenge on the caribou remains left from grizzly bear and wolf predation on caribou. Inuit TK of the Kitikmeot region includes observations of close associations of the abundance of these carnivore species to caribou abundance at a local scale (KIA 2012). The barren-ground caribou alter the Arctic ecosystem by modifying the composition of plant communities and seasonal distribution of predators. In winter and fall, caribou feed primary on lichen and during the summer months, caribou feed on herbaceous vegetation, shrubs, flowers, and sedges on the tundra (F.L. Miller, Rothfels, and Russell 2005).

Most of the barren-ground caribou migrate annually between the calving grounds on the tundra and over-wintering grounds in the south. During winter, some herds migrate south below the treeline, such as the Bathurst herd, while other herds over-winter on the tundra including the Dolphin and Union herd (*Rangifer tarandus groenlandicus*), named after the Dolphin and Union Strait. The Peary caribou herd (*Rangifer tarandus pearyi*), a smaller distinct subspecies of barren-ground caribou, migrate on the sea ice between islands of the Arctic Archipelago.

Three barren-ground caribou herds have been identified, whose ranges overlaps the area of the Project. The Bathurst herd is found in the wildlife Regional Study Area (RSA), primarily during spring migration, post- calving and summer, with a peak during the post-calving period (Figure 5.1-1). The Beverly herd (also known as the Ahiak herd) is found in the wildlife RSA, primarily during the late summer. The winter distribution of Dolphin and Union caribou likely overlaps the marine wildlife RSA to a small extent during the winter. A fourth herd, the Peary caribou herd may overlap the commercial Northwest Passage shipping route outside of the marine wildlife RSA only (outside of assessment area) and is not discussed further in this assessment. The Dolphin and Union herd is SARA listed as a species of special concern while the Bathurst herd and the Beverly herd have not been assessed by COSEWIC.

The Beverly herd was formerly referred to as two separate herds; the Ahiak herd, which calved in the western Queen Maude Gulf area by the coast, and the Beverly herd, which calved on the tundra near Garry Lake, south east of the Ahiak calving grounds. Since 2002, the Beverly herd shifted its calving range to join the Ahiak herd in the western Queen Maude Gulf area. The two herds are referred to as the Beverly herd in Government of Nunavut reports and in this chapter (Nagy et al. 2011; Campbell et al. 2012; Nagy, Campbell, and Kelly 2012). Baseline reports and other parts of the DEIS may still refer to this herd as the Ahiak herd.

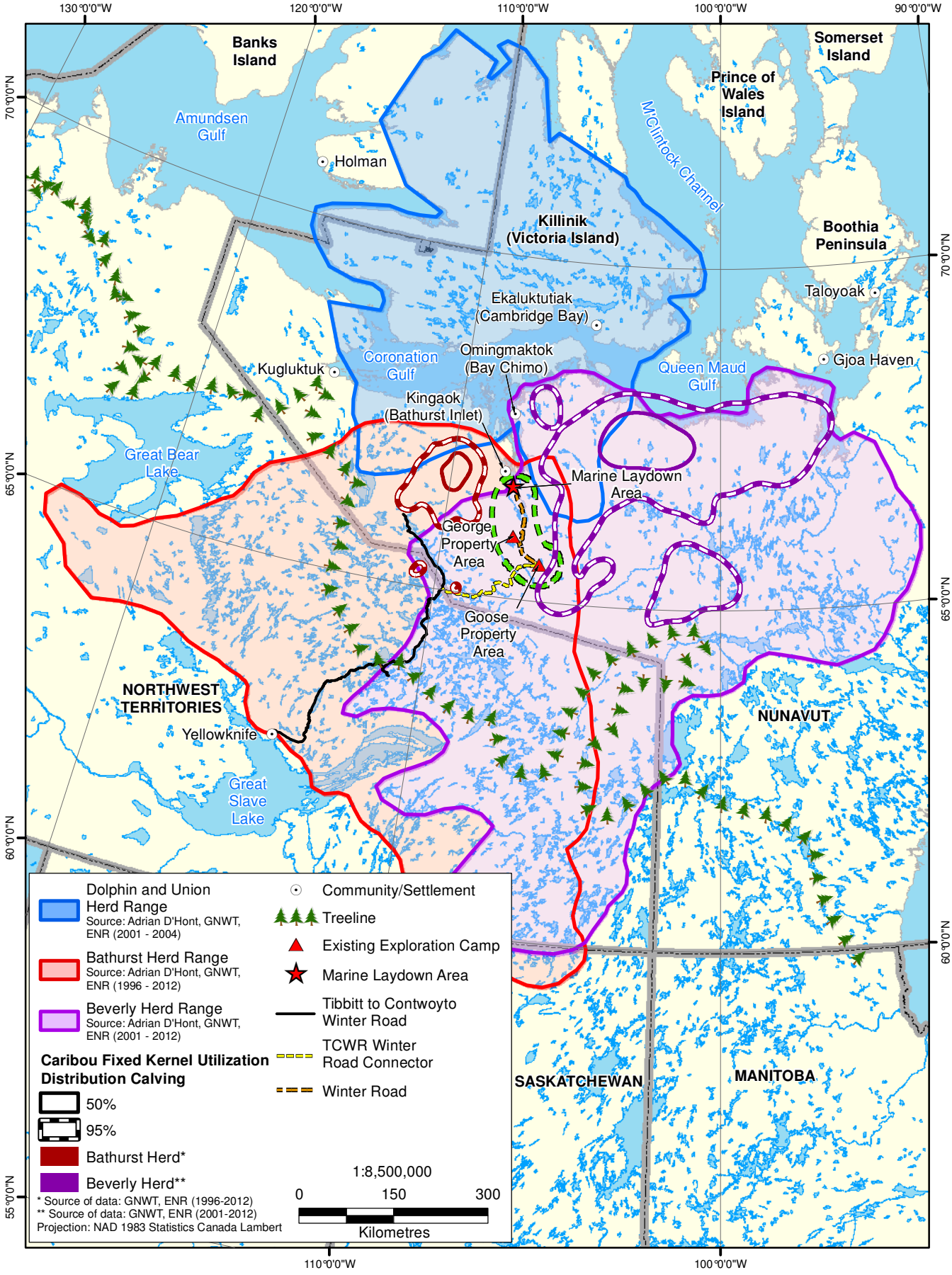


Figure 5.1-1

# Annual Ranges of the Bathurst, Beverly and Dolphin and Union Caribou Herds

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There are three additional herds that calve on the eastern edge of the Nunavut mainland; the Queen Maude Gulf herd, the Lorillard and Wager Bay herds. The Queen Maud gulf herd calves on the eastern Queen Maude Gulf area, adjacent to the Beverly herd, while the Lorillard and Wager Bay herds calve to the south-east of the Queen Maude Gulf herd. These three herds overwinter on the tundra and in some years the extreme western edge of their winter distribution overlaps with the south-east portion of the wildlife RSA. This effects assessment discusses potential effects due to the Project with reference to the Beverly herd, which has a portion of its summer, fall and winter ranges overlaps with the wildlife RSA in most years. The Beverly herd is therefore used as a proxy for the Queen Maude Gulf, Lorillard and Wager Bay herds, for whom any effects is anticipated to be smaller because they overlap with the wildlife RSA for fewer seasons, frequency and extent.

Caribou continue to be the lifeblood of many Inuit communities (KIA 2012). The life cycle of the caribou was a major influence on where Inuit travelled and lived as they relied on caribou for food and clothing. Caribou, and caribou hunting, are central to Inuit culture, identity, recreation, and kinship. The Inuit have a long history of observing caribou behaviour, movement, and life cycle during their hunting activities. Further information on Inuit and their reliance and relationship with caribou can be found in the socio-economic chapter (Volume 8, Chapter 3).

The following environmental setting provides background on the distribution, movement, habitat, and population viability and health of caribou in the Project area. Distribution and movement of caribou herds are described using Traditional Knowledge and baseline studies conducted over the Project area.

### 5.1.2 Bathurst Caribou

#### *5.1.2.1 Introduction*

The Bathurst caribou herd is named for Bathurst Inlet, where this herd has historically calved. The Bathurst herd moves yearly between calving grounds on the tundra and wintering range in the boreal forest. In the 1980s, the Bathurst herd was one of the largest migratory herds in Arctic Canada, estimated at approximately 450,000 animals in 1986 (Heard and Williams 1991; Boulanger et al. 2011). But like some other North American caribou herds, the Bathurst herd has declined (Vors and Boyce 2009; Boulanger et al. 2011), due, in part, to relatively high winter harvests of females (4,000 to 5,000 per year), which coincided with declines between 1986 and 2006 (Adamczewski et al. 2009). Since 2006, assessments of caribou body condition, pregnancy rates, and cow-calf ratios suggest improvements in breeding productivity, and the population appears to be stabilizing or increasing slightly (Adamczewski et al. 2009).

#### *5.1.2.2 Distribution and Migration Patterns*

Seasonal movements of the herd have been tracked from 1996 to 2012 using satellite collars on cows (between 8 and 35 animals per year; GNWT ENR unpublished data). The yearly distribution and movements of caribou can be classified into six distinct periods: spring migration, calving, post-calving, summer, fall migration, and winter (Table 5.1-1). The timing of each period was derived from published estimates of life cycle timing (see footnote in Table 5.1-1), which were primarily based on the movements of GPS collared cows.

Maps presented in the following sections were made from fixed kernel utilization distributions using satellite collar data. The methods for this analysis are presented in Section 5.1.2.5 (Baseline data for Bathurst Caribou Herd).

**Table 5.1-1. Timing of Life History Stages of Bathurst Caribou**

| Cycle Stage | Start Date | End Date |
|---|---|---|
| Spring Migration[1] | April 15 | June 4 |
| Calving[2] | June 5 | June 15 |
| Post-calving[3] | June 16 | July 20 |
| Summer[4] | July 21 | August 31 |
| Fall Migration[5] | September 1 | October 31 |
| Winter[6] | November 1 | April 14 |

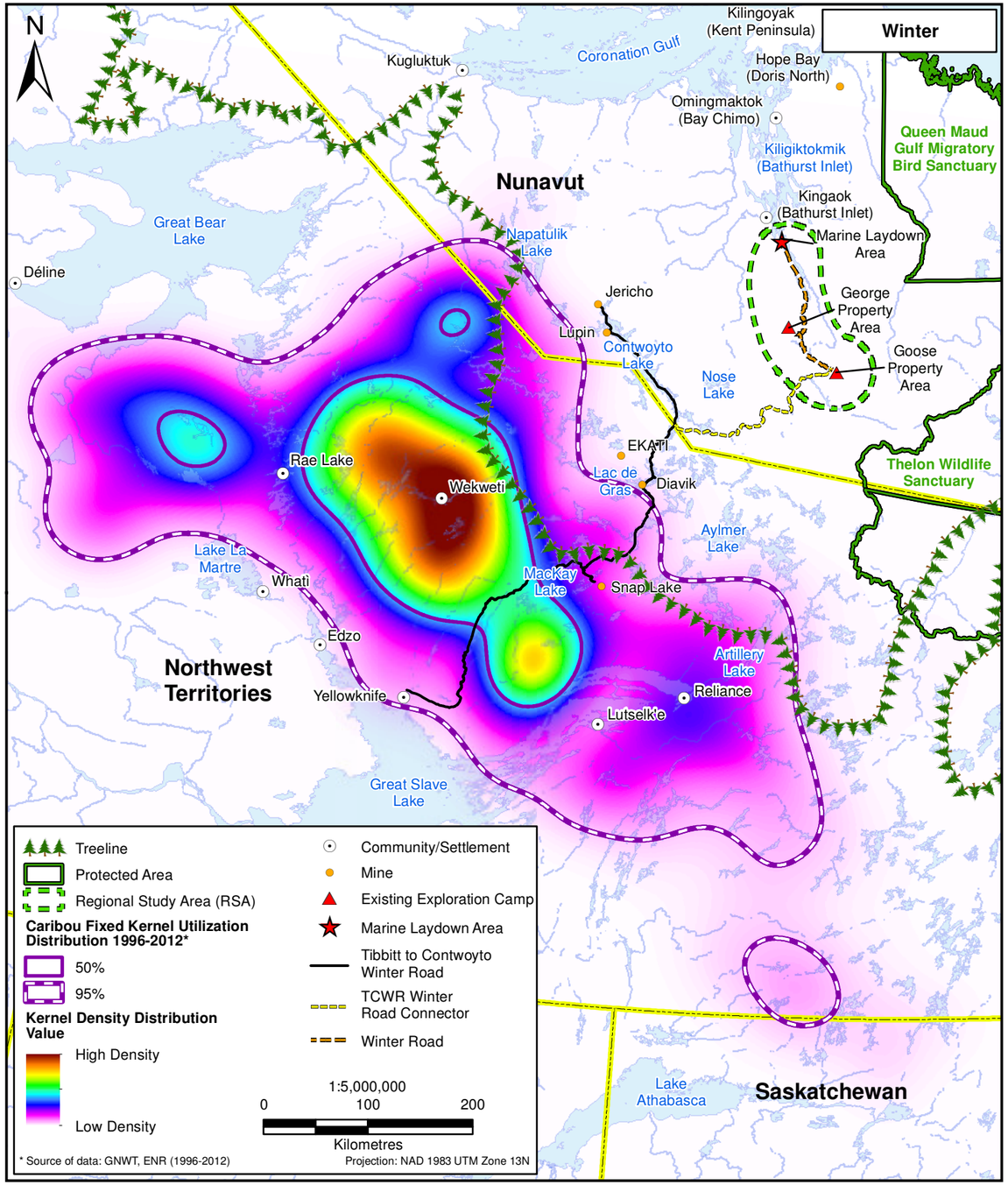
[1] *Gunn et al. (2008b); Johnson et al. (2005).*
[2] *Russell, Kofinas, and Griffith (2002); Gunn et al. (2008b); Gunn and Poole (2009).*
[3] *Five weeks post-calving, which includes post-calving and early summer periods defined in Gunn et al. (2008b); Russell, Kofinas, and Griffith (2002).*
[4] *Gunn et al. (2008b).*
[5] *Johnson et al. (2005); includes rut period defined in Gunn et al. (2008b).*
[6] *Includes late fall and winter periods defined in Gunn et al. (2008b).*

Spring Migration (April 15 to June 4)

In the spring, during a relatively short period of time, the Bathurst caribou herd migrates over a large area (275,000 km$^2$) from their wintering range below the tree line in the Northwest Territories to their calving grounds, which in recent years have been concentrated in the area between the James and Burnside Rivers, west of Bathurst Inlet (Figure 5.1-2; Gunn, Poole, and Wierzchowski 2008; Nishi et al. 2010). Pregnant cows are the first to migrate to the calving grounds, while bulls and juveniles follow later in the spring, but usually do not travel as far as the calving grounds. Movement corridors vary depending on the distribution of caribou on the wintering grounds (Gunn and D'Hont 2002; Gunn et al. 2008b). Cows usually arrive in late May, but sometimes as early as April, and calving begins in early June (KIA 2012). Non-parturient cows (not pregnant) can be identified by their lack of hard antlers during northern migration, and lack of distended udders and new antler growth during the calving period. These cows migrate more slowly than pregnant cows, but still reach calving grounds during peak calving (Figure 5.1-3; Gunn et al. 2008b). Bulls and juvenile caribou (born in the year previous) probably also follow females as some are present during calving, but generally north-bound males and juveniles are thought to meet females with calves in late June and early July, when females have begun their southward movement (Gunn and D'Hont 2002). It is thought that bulls and juveniles re-unite with female caribou by about mid-June onward (D.C. Heard, T.M. Williams, and D.A. Melton 1996).

Calving (June 5 to June 15)

The calving period refers to the time when cows are giving birth, which is defined both by the initiation of calving and the one week period of "peak calving", when 50% of cows have calved (D. E. Russell, Kofinas, and Griffith 2002; Gunn and Poole 2009). The dates for the peak calving period can be identified by the relatively slow movement rate of satellite-collared cows during calving (<4 km/day during calving versus 14-20 km/day before calving, and about 12 km/day after calving (Gunn and D'Hont 2002; Gunn, Dragon, and Boulanger 2002; Gunn and Poole 2009; Nishi et al. 2010). Calves have very limited movement ability in the first days of life (Gunn and Poole 2009). Between 1996 and 2007, peak calving has shifted later, from June 4 to June 14, except for 2005 when calving was one week later (Gunn, Poole, and Wierzchowski 2008). However, more recent estimates suggest a shift in peak calving to early June (Adamczewski et al. 2009). Calving grounds tend to be areas with few predators and with lichen cover to provide additional forage to support birthing females until vegetation greens (Griffith et al. 2001; Wilson et al. 2012). Cow density is usually concentrated within one to a few core areas within a larger area over which calving cows are found (Nishi et al. 2010). However, calving cows can be distributed at lower densities over more extensive areas in some years if snow cover is too deep or forage quality inadequate at preferred sites (D. E. Russell, Kofinas, and Griffith 2002).



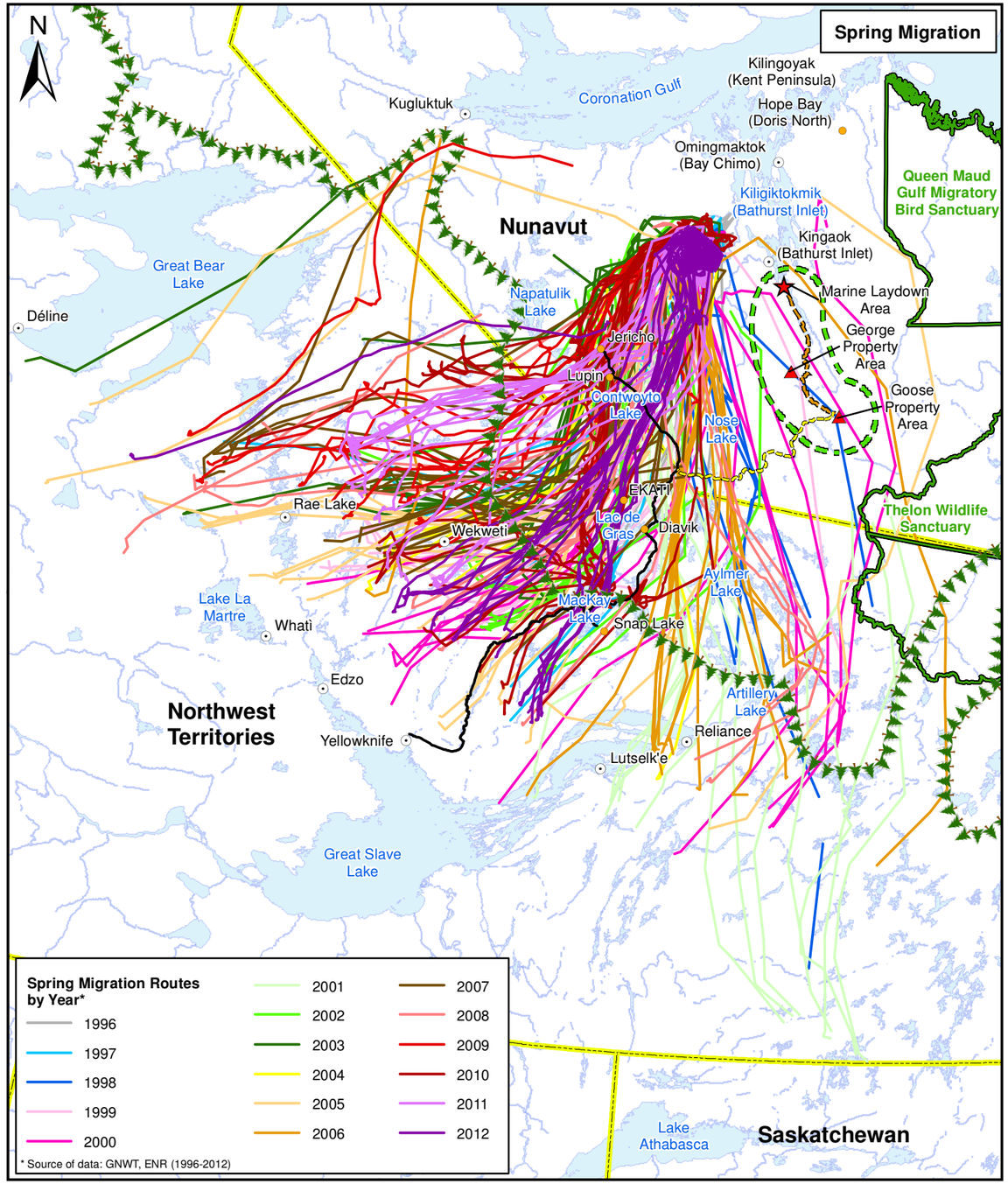
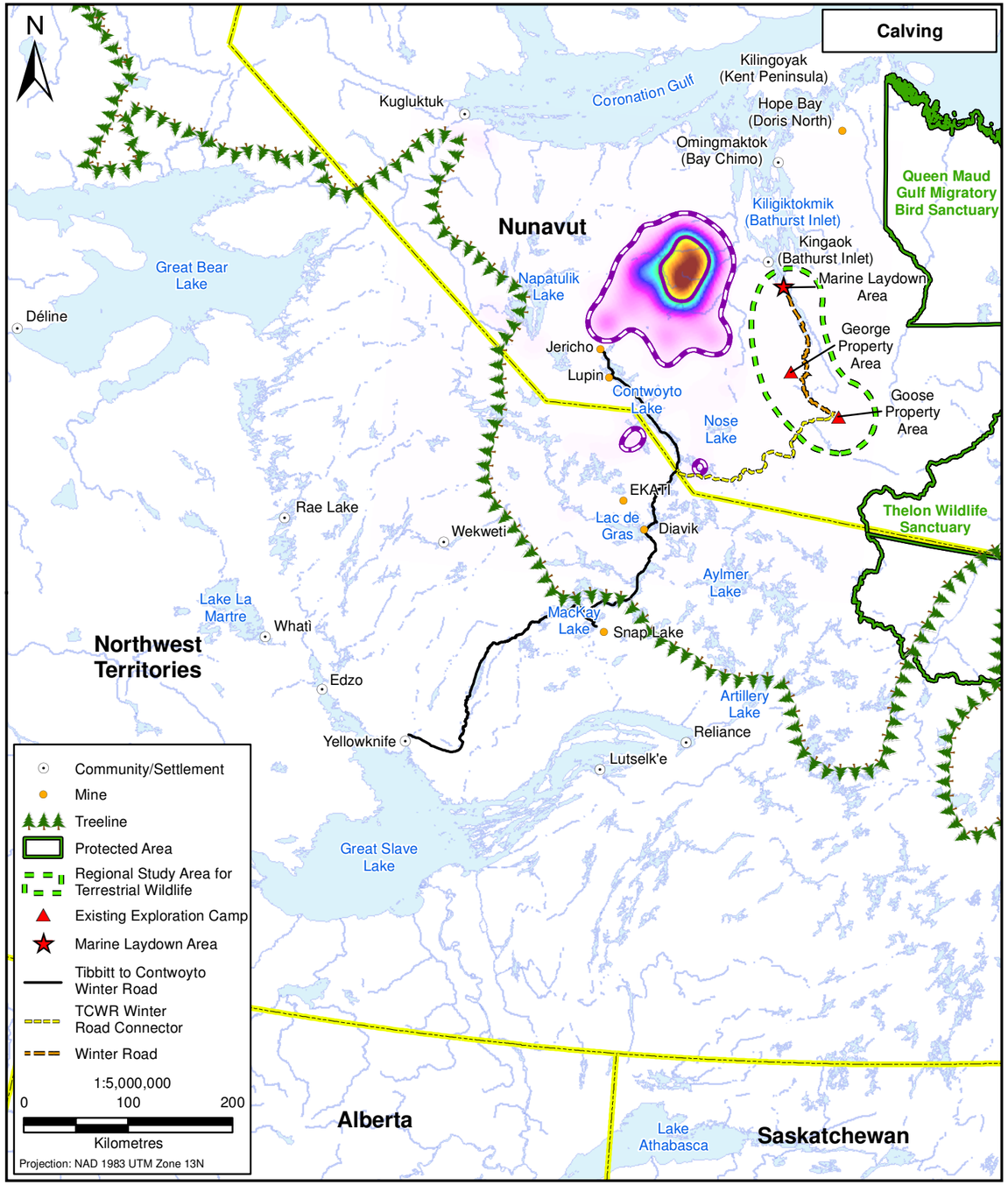




Figure 5.1-2

Locations of Satellite-collared Bathurst Caribou during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 1996 to 2012



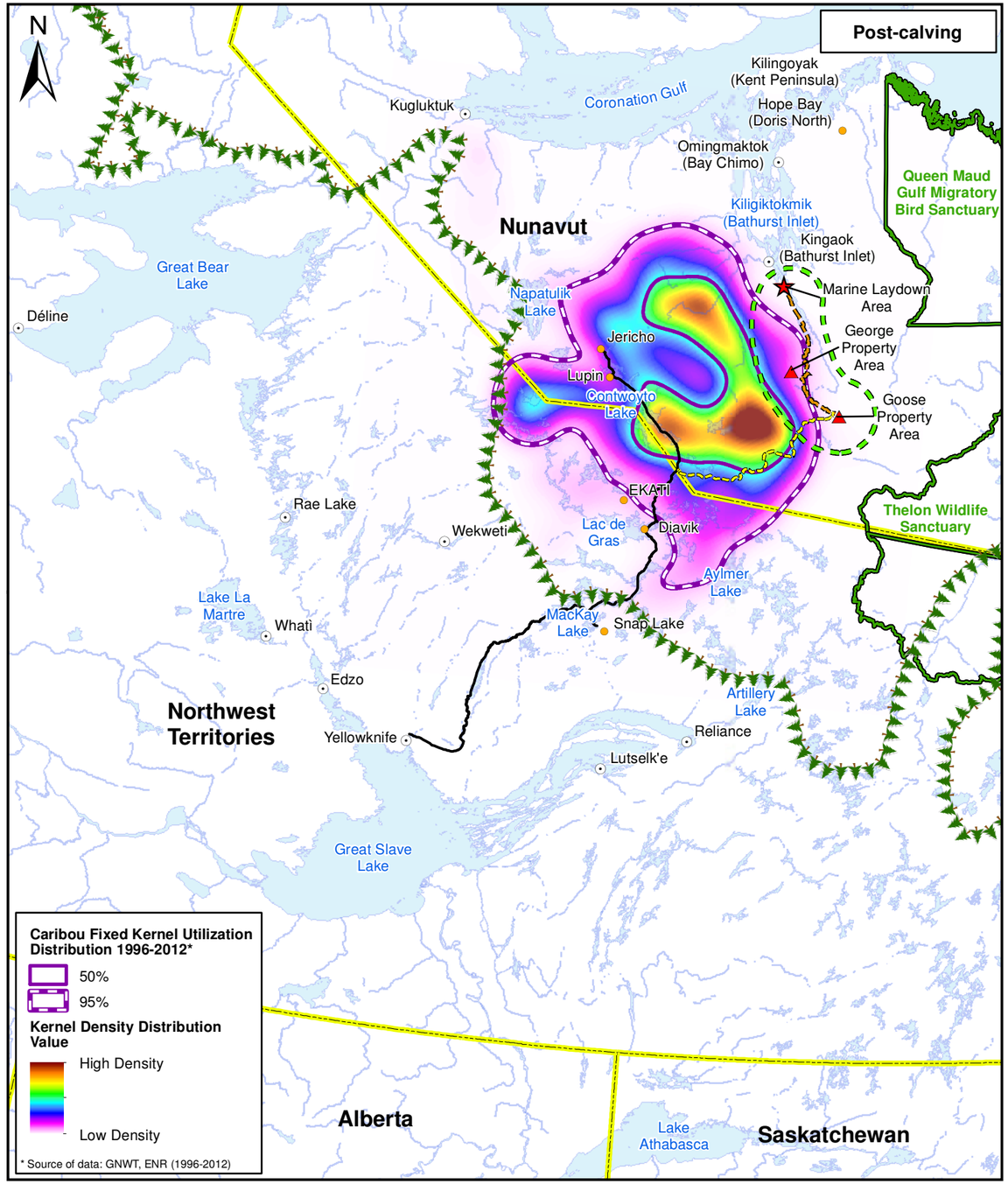




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**Figure 5.1-3**

**Locations of Satellite-collared Bathurst Caribou during Calving (5 June to 15 June) and Post-calving (16 June to 20 July), 1996 to 2012**

In addition, there exists year-to-year variation in the spatial extent of calving because cows sometimes calve en route to calving grounds, or calve over a wider area when snow cover is too deep or forage quality inadequate within the core calving area (D. E. Russell, Kofinas, and Griffith 2002). Both Bathurst and Beverly cows have been observed calving outside of core calving grounds in some years (e.g., Gunn and D'Hont 2002). Calving outside the calving area occurs during years with high snow cover or other unfavourable conditions (Gunn and D'Hont 2002).

Though caribou cows return to the same general area to calve every year, the spatial extent and location where most calving occurs is dynamic over longer periods (Figure 5.1-4; D. E. Russell, Kofinas, and Griffith 2002). Shifts in the location of calving grounds over several years have been observed for several barren-ground caribou herds, including the Bathurst herd (Gunn, Poole, and Wierzchowski 2008; Taillon, Festa-Bianchet, and Cote 2012). According to Inuit TK, distribution and movements of the Bathurst herd changes frequently, especially the spring migration, and the calving areas are located both inland and near the ocean around Bathurst Inlet (KIA 2012). Inuit TK indicates that the traditional calving grounds of Bathurst caribou are located near Bathurst Inlet (Thorpe et al. 2001), after which the herd is named (Figure 5.1-4). The "traditional calving grounds" is the area encompassed by yearly and long-term shifts in the calving grounds and so defines a larger area than core areas used in consecutive years.

Post-calving (June 16 to July 20)

Typically, the post-calving period is defined as the three week period following calving, which is the amount of time needed to wean calves from lactation (D. E. Russell, Kofinas, and Griffith 2002). The spatial extent of cows three weeks after peak calving has been suggested as a way to delineate annual calving grounds (Figure 5.1-3; D. E. Russell, Kofinas, and Griffith 2002). For the purposes of this assessment, a five week period is used to define the post-calving period, to accommodate years with late calving, such as the one that occurred in 2005. The calving and post-calving stages are defined separately because these periods occur in different areas, and can thus interact with the Project differently.

Summer (July 21 to August 31)

During the summer, most of the Bathurst caribou pass the southern end of Contwoyto Lake and move south, west, and then northwest in a clockwise direction across the summer range (Figure 5.1-5; Gunn, Poole, and Wierzchowski 2008; Gunn et al. 2008b). Movement rates of caribou are moderately paced at this time (Gunn, Poole, and Wierzchowski 2008; Gunn et al. 2008b). Annual fidelity to the summer range is high; the Bathurst herd has been found in the same general areas in summer from year to year (Gunn, Poole, and Wierzchowski 2008; Gunn et al. 2008b).

Fall Migration (September 1 to October 31) and Winter (November 1 to April 14)

During the fall, Bathurst caribou migrate towards the winter range, most of which is below the treeline (Figures 5.1-2 to 5.1-5). Bathurst caribou remain in the wintering grounds until mid-April when they begin their migration north to the calving grounds. Winter survival of Bathurst herd caribou calves is related to post-calving and summer range biomass availability. In years with poor biomass availability, the overwinter survival of calves the following winter is reduced and the growth rate of the herd declines or is negative (W. Chen, unpublished manuscript).

Bathurst Caribou Distribution and Movements from Inuit TK

The Inuit through their TK have identified historic patterns in caribou movements and distribution, which indicates that the location of calving and over-wintering areas shift through time (KIA 2012). Based on the predictability of finding caribou at various times of the year, Inuit TK suggests that calving ranges are more static over time than over-winter ranges (KIA 2012), an observation that fits with recent analyses based on collar data (e.g., Nagy and Campbell 2012).

Within the Kitikmeot region, three main areas were inhabited by Inuit because caribou were predictably found there in large numbers throughout the year: Contwoyto Lake, Beechey Lake, and Bathurst Inlet (KIA 2012). The abundance of caribou, and of their main predator wolves, was high enough around Beechey Lake to support a large winter camp, the settlement of families for multiple years, and two fur trading posts. Inuit TK includes reference to a community at Beechey Lake called Tudlak (KIA 2012).

Several historic calving areas are recognized for the Bathurst caribou, including a large calving ground east of Bathurst Inlet, in coastal areas around Bathurst Inlet, and two areas immediately to the north of Contwoyto and Nose Lakes (Thorpe et al. 2001; KIA 2012). Calving was also observed around Beechey Lake within the wildlife RSA (KIA 2012).

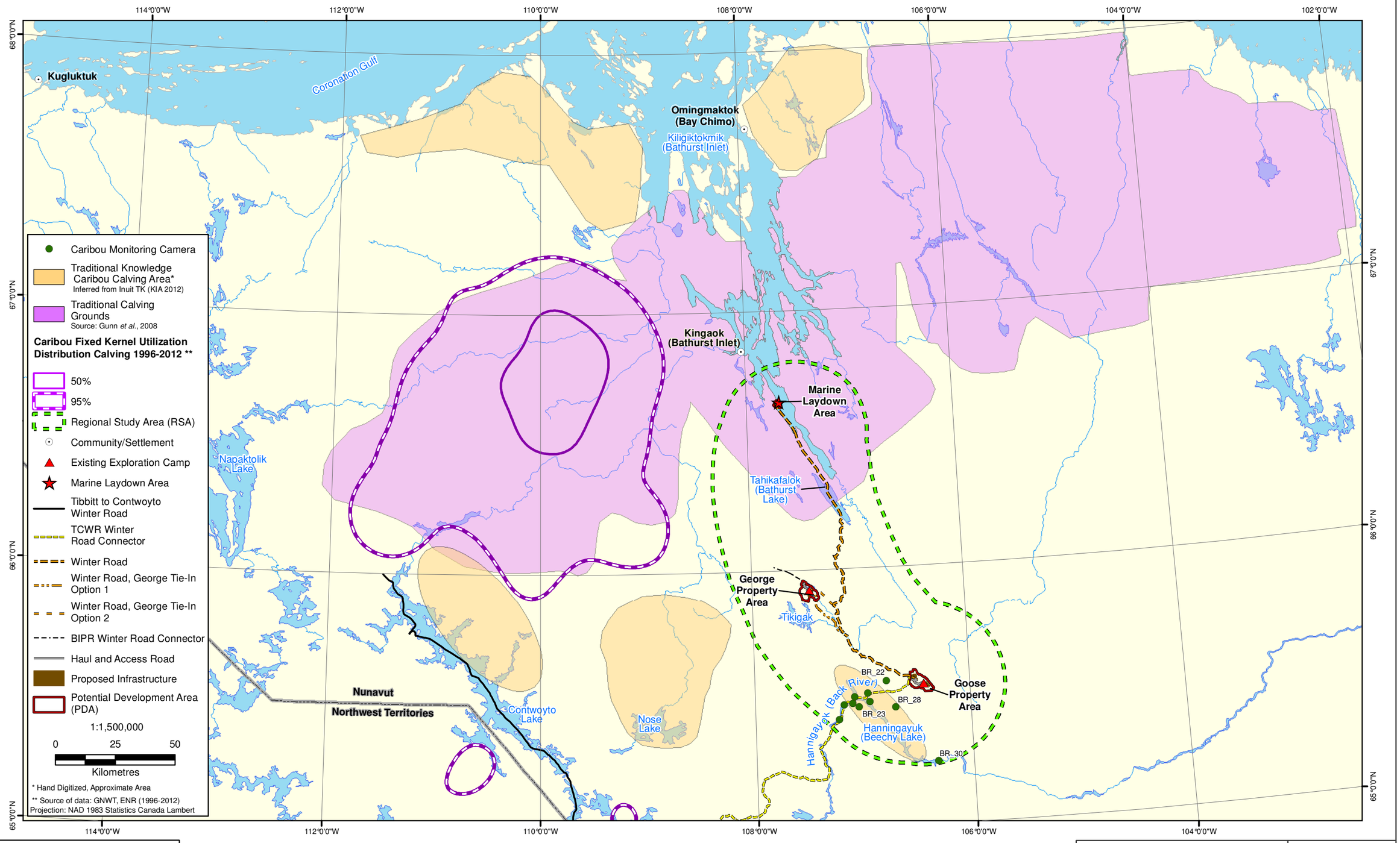
Inuit TK includes observations of large numbers of caribou migrating across Beechey Lake, across the Western River, and past the community of Kingaok (KIA 2012). The islands of Bathurst Inlet were considered to be good places to hunt caribou in the open water season, and several key nadlok (crossing places) were observed where caribou swam across Bathurst Inlet. Given the historic distribution of the Bathurst calving range on the eastern side of Bathurst Inlet, these observations likely indicate the migration route of the Bathurst herd during the periods when the calving range of the herd was centred on Bathurst Inlet. Caribou migrating across Beechey Lake were also likely to have been those of the Beverly herd.

Caribou freshwater crossings tend to occur where water crossing during summer and fall is easier, such as where lakes and rivers are narrowest. These are referred to as nadloks, and are places often evidenced by deeply rutted pathways in the tundra vegetation. Several key nadloks were identified along Beechey Lake (KIA 2012). Inuit TK has been used to identify designated crossings of migrating caribou across water and ice in the Kitikmeot Region (NPC 2005; Figure 5.1-6). These have been identified as key habitats for caribou (NPC 2005, 2012a). Caribou are thought to be particularly susceptible to disturbance at designated crossings, and mitigation measures have been proposed that include no blasting within 10 km of designated crossings (NPC 2005). Several designated crossings occur in the wildlife RSA on Contwoyto Lake, Nose Lake, the southern end of Bathurst Inlet, and across Bathurst Lake (Figure 5.1-6).

Caribou habitat is one of six main issues identified in the draft Nunavut Land Use Plan (NLUP) for environmental protection (NPC 2012a). In addition to calving areas, migration routes “especially at water crossings” have been identified as key aspects of caribou habitat. The plan stipulates that herds are vulnerable to ice breaking, and considerations for mitigation and management fall under Recommendation PSE-R3, which states “Project Proposals located in and/or near known caribou sea ice crossing areas should take into account impacts that may impede the ability of caribou to cross the ice.” Water crossings are also considered (NPC 2012b). The Nunavut Planning Commission (NPC) recommends that all land uses near caribou water crossings be permitted, and also recommends that regulators and project proponents should “consider potential impacts on caribou migration routes” (NPC 2012b). The Nunavut Planning Commission recognizes the Caribou Protection Measures designed and implemented by Aboriginal Affairs and Northern Development Canada (AANDC).

Summary of Bathurst Herd Movements and Distribution

Bathurst caribou overwinter in the boreal forest and in spring move relatively quickly to calving grounds to the northwest of the wildlife RSA. After calving, the herd moves south east to their summer range. Very low numbers of Bathurst caribou cross into the western portion of the wildlife RSA during this post-calving movement. Non-parturient females follow parturient females to calving grounds, and after calving, but most usually arrive about a week later than pregnant females. Because males and immature caribou follow females but also range more widely, it is hypothesized these caribou will likely interact with the wildlife RSA, primarily from mid-April to mid-October.

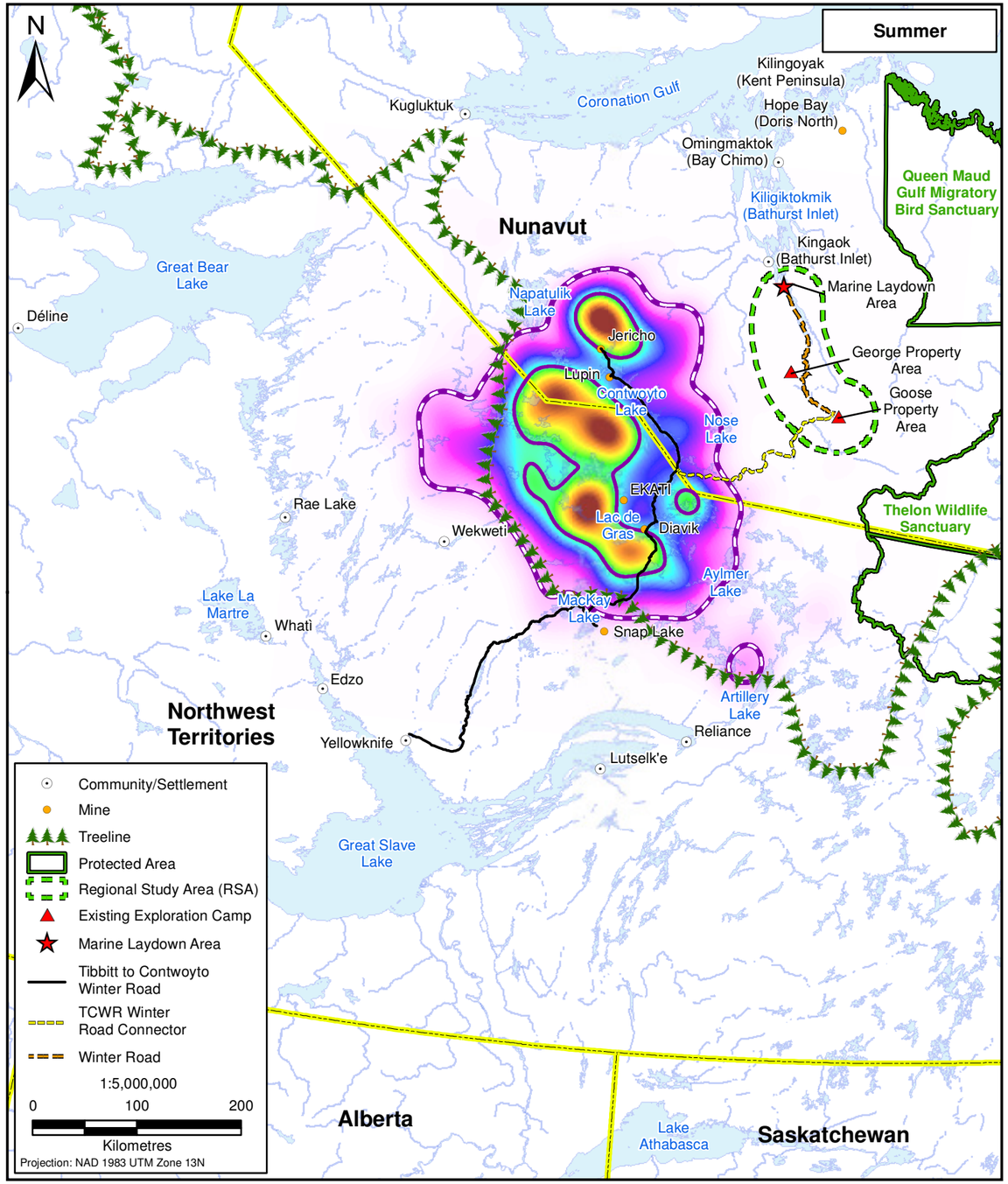



Sabina GOLD & SILVER CORP.

Rescan an ERM company

Figure 5.1-4

**Traditional Calving Grounds of Bathurst Caribou (1966 to 2012)**



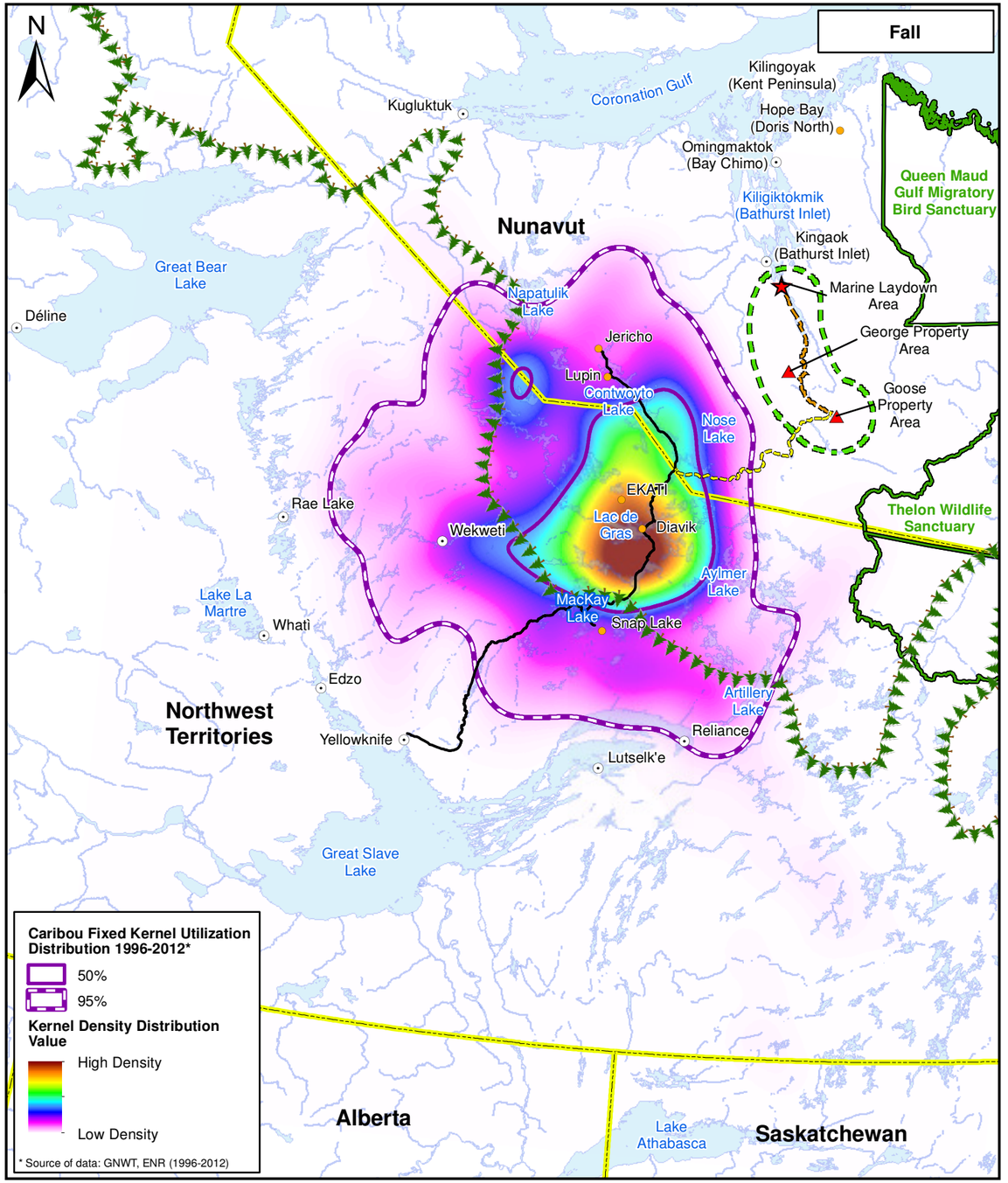




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**Figure 5.1-5**

**Locations of Satellite-collared Bathurst Caribou during Summer (21 July to 31 August) and Fall (1 September to 31 October), 1996 to 2012**

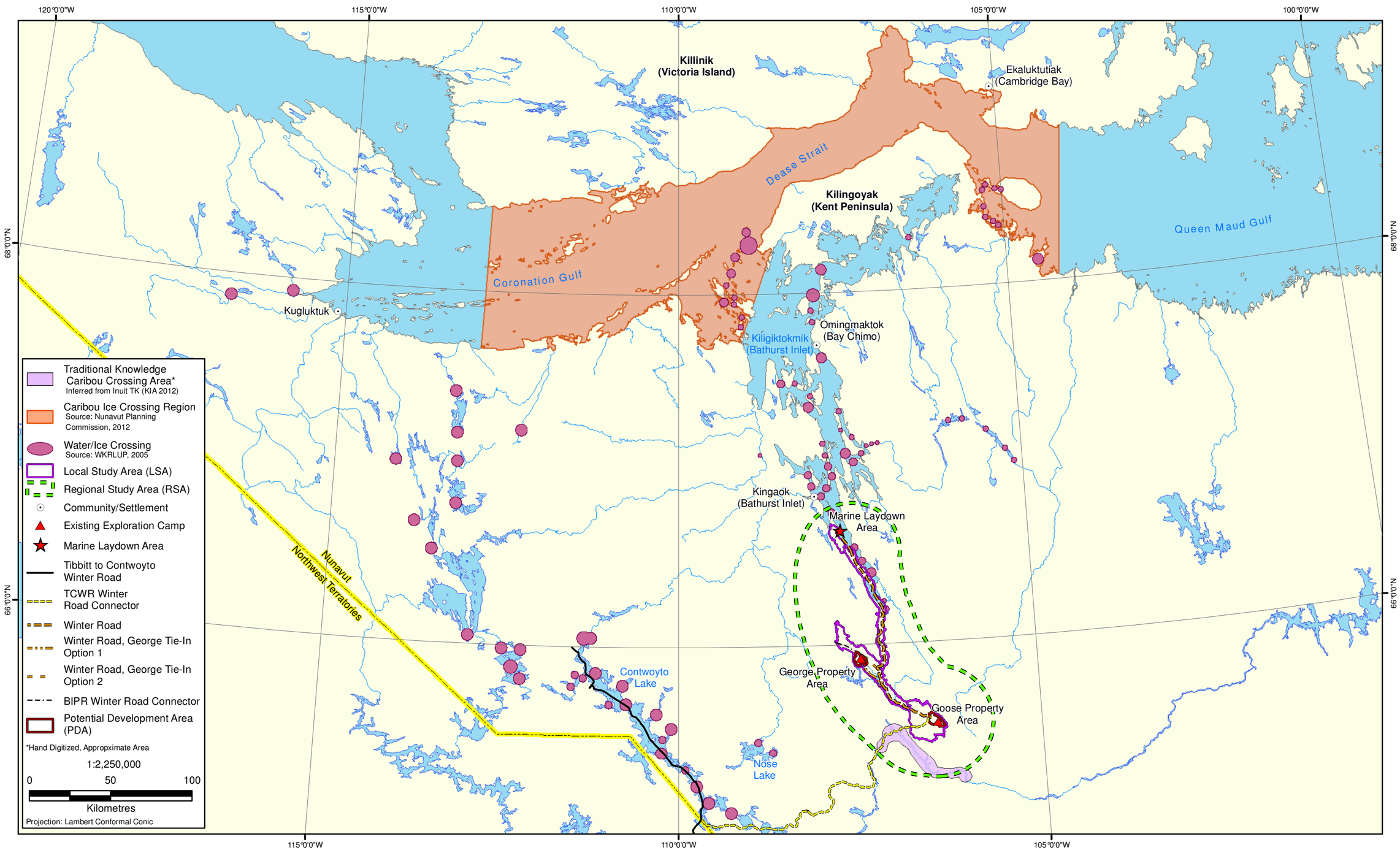


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**Figure 5.1-6**

## Designated Caribou Crossings

Bathurst caribou may cross the western portion of the wildlife RSA in small numbers. Throughout the rest of the summer and during fall, Bathurst caribou will not occur within the wildlife RSA.

#### *5.1.2.3 Population Trends and Conservation*

The Bathurst caribou population has declined from approximately 472,000 animals in 1986 to 31,900 animals in 2009 (Table 5.1-2). These estimates are based on calving ground surveys of breeding females. The data suggest an average annual population decline of about 6% per year from 1986 to 2006 (Boulanger et al. 2004; Gunn et al. 2005).

**Table 5.1-2. Bathurst Caribou Herd Population Numbers and Breeding Females from 1986 to 2009**

| Year | Total Population | Breeding Females |
|---|---|---|
| 1986 | 472,000 ± 72,900 SE[1] | 203,800 ± 12,696 SE[4] |
| 1996 | 349,000 ± 94,900 SE[2] | 151,393 ± 34,144 SE[4] |
| 2003 | 186,000 ± 40,100 SE[3] | 80,756 ± 13,167 SE[4] |
| 2006 | 128,000 ± 27,300 SE[1] | 55,593 ± 8,813 SE[4] |
| 2009 | 31,900 ±5.300 SE[1] | 16,604 ± 2,176 SE[5] |

[1] *GNWT ENR (2012)*
[2] *Gunn, Dragon, and Nishi (1997)*
[3] *Gunn et al. (2005)*
[4] *Nishi et al. (2007)*
[5] *Nishi et al. (2010)*

Boulanger et al. (2011) proposed that the population has likely declined due to decreasing calf survival, and concomitant reductions in female fecundity, and hunting. Annual monitoring of calf survival indicates that mean winter calf survival and calf-cow ratios for the Bathurst herd declined by almost 50% in 2001-2004 compared with 1985-1996 (Gunn, Boulanger, and Williams 2005a). Like other caribou herds, the size of the Bathurst herd has fluctuated with a periodicity between 40 and 70 years, likely dependent on weather and forage availability, which affect female fecundity and calf survival (Zalatan, Gunn, and Henry 2006; Beaulieu 2012). While initial declines in the Bathurst caribou numbers may have been a consequence of natural population cycles, biologists have proposed that relatively high winter mortality rates of females to hunting probably resulted in accelerated declines, especially between 2006 and 2009 (Adamczewski et al. 2009; Boulanger et al. 2011).

Recently (2007-2009), indicators of breeding productivity such as increased cow-calf ratios, high pregnancy rates, and good body condition suggest that the herd is experiencing better environmental conditions and may have stabilized or begun to increase (Adamczewski et al. 2009). Though the population appears to have stabilized since 2009 to about 35,000 individuals in 2012, the population is still low compared to its historic size, which can make the herd vulnerable to disturbance, weather and other factors (BCMPC 2004; GNWT ENR, pers. comm.).

Caribou are of economic and cultural importance to the Inuit and other residents of Nunavut. Most northern communities, including Bathurst Inlet, Kugluktuk and Omingmaktok, harvest Bathurst caribou during spring migration and post-calving (GNWT ENR 2012). Data from Inuit hunters indicates that between 1996 and 2001, the average number of caribou harvested annually by Inuit hunters (averaged by community) were: 93 in Bathurst Inlet (Bathurst Inlet Lodge 2007), 1,575 in Kugluktuk and 176 in the community of Omingmaktok (Priest and Usher 2004). However, these data include harvests of caribou from the Dolphin and Union herd and the Bluenose-east herd. Limits on the number of caribou that can be harvested for both traditional and commercial use have recently been implemented (GNWT ENR 2012). The annual harvest for the herd in Nunavut was set at 240 males and 60 females for the

2012-2013 winter hunting season (Adamczewski et al. 2009; Wek'èezhìi Renewable Resources Board 2012). The Bathurst herd has not yet been assessed by COSEWIC.

#### *5.1.2.4 Habitat Use and Diet*

Overview

Habitat selection and diet of barren-ground caribou on the tundra is thought to be similar among herds (Gustine et al. 2012). Thus, the information presented in this section pertains to all three herds in this assessment, with the exception of information on winter habitat use and diet, which is not relevant to the Bathurst herd. Caribou from the Bathurst herd are seldom found on the tundra during winter.

Habitat selection on the tundra by caribou is mainly dictated by predator and insect avoidance, and the distribution and availability of suitable forage (Calef 1981; D.C. Heard, T.M. Williams, and D.A. Melton 1996; J. H. Russell 1998; Wilson et al. 2012). Caribou also select travel routes during migration that provide easier movement, such as frozen lakes in winter, and sometimes eskers (Thorpe et al. 2001; KIA 2012).

The following sections outline habitat selection and diets of caribou during each of the six life history stages discussed in Section 5.1.2.2: spring migration, calving, post-calving, summer, fall migration and winter. The post-calving and summer periods have been combined because habitat selection by caribou is similar during these two periods.

Detailed habitat mapping and usage information for the Bathurst caribou herd is included in Section 5.1.2.5 in the sections on Habitat Suitability Ratings and Resource Selection Function for Bathurst Caribou Herd.

Spring Migration (April 15 to June 4)

During migration to calving grounds, female caribou move relatively quickly; Bathurst females were estimated to move about 14-20 km/day during the last three weeks of May (versus < 4 km/day during calving; Gunn and Poole 2009; Nishi et al. 2010). Pregnant females initiate migration to calving grounds, while non-parturient females follow at a slower rate (Gunn and D'Hont 2002). Because bulls are not satellite-collared, their movements are less well known but they, along with juvenile caribou, probably follow females; by mid-June bulls comprise up to 10% of caribou on the calving grounds (D.C. Heard, T.M. Williams, and D.A. Melton 1996; Gunn and D'Hont 2002; Gunn, Dragon, and Boulanger 2002). In years with delayed snow melt or deep snow that makes travel difficult, some females may calve before reaching calving grounds, while other females birth low weight calves with reduced chances of survival (Griffith et al. 2001).

Snow and ice remain on the tundra during spring migration and thus Bathurst and Beverly caribou use large frozen lakes and rivers as travel corridors, while the Dolphin and Union caribou travel across the frozen ocean. Caribou also use other areas that facilitate travel on the tundra, such as eskers and open snow-free upland, and follow the contours of steeper terrain before crossing it (LeResche and Linderman 1975; Thorpe et al. 2001). When travelling over tundra, caribou must also seek places where snow cover is shallow so they can readily dig for graminoids and lichen, which are their main foods during winter (D. E. Russell, Martell, and Nixon. 1993; Ferguson, L. Gauthier, and F. Messier 2001).

Calving (June 5 to 15-20)

Key characteristics of caribou calving grounds on the tundra are believed to be areas that facilitate predator avoidance, and where forage availability after snowmelt offers females the nutritional requirements they need for lactation (Griffith et al. 2001; Wilson et al. 2012). There appears to exist a trade-off between safety and forage availability; calving females may choose calving grounds that are

relatively safe from predators but are not necessarily places where snow melts earlier nor where vegetation biomass is greatest (Wilson et al. 2012). For example, though forage availability was higher for Bathurst bulls and juveniles still near treeline than for females that migrated to the calving grounds, wolf densities were much lower on calving grounds (D.C. Heard, T.M. Williams, and D.A. Melton 1996). During calving, females are relatively sedentary, and move on average less than 4-5 km/day (Gunn and Poole 2009; Nishi et al. 2010).

Though forage availability may be lower, it is thought that calving grounds generally are located in areas where forage quality is high (reviewed in Wilson et al. 2012; Griffith et al. (2001). Green foliage is rarely available during calving (e.g., in only three years between 1985 and 2006) on the Bathurst calving grounds (Chen et al. 2009). Lichen provides caribou with additional nutrients before green-up (Ferguson, L. Gauthier, and F. Messier 2001). Lichen heath is one of the main vegetation cover types for the Bathurst herd calving grounds (Griffith et al. 2001; C. J. Johnson et al. 2005). Bathurst cows appear to compensate for low nitrogen intake on the calving grounds by digging for nitrogen-rich *Oxytropis* rhizomes (Griffith et al. 2001; Thorpe et al. 2001).

Post-calving and Summer (June 16-21 to August 31)

Just after calving, female caribou and calves migrate from calving grounds toward summer ranges. During this time, cows and calves may aggregate into large groups, ranging from hundreds to even thousands at times when populations are large (Gunn and D'Hont 2002). From mid-June onward, most bulls and juveniles have joined females on summer ranges (D.C. Heard, T.M. Williams, and D.A. Melton 1996). Movement rates of collared females increase steadily from mid- to the end of June from about 5 to 12 km/day (Nishi et al. 2010).

Access to high quality forage is likely the key driver of habitat selection in the post-calving period (Witter et al. 2012), as females need to acquire adequate nutrient reserves for lactation, which provides all nutrient intake for calves until about three weeks of age when calves begin foraging on their own. Calf body condition at birth and in the first few weeks of life, and thus calf survival, are highly dependent on female nutritional status (reviewed in Couturier, Cote, Otto et al. 2009). Studies in Alaska show that female caribou with calves select areas with a high density of sedge meadows during the post-calving period, where they forage on highly nutritious *Eriophorum* spp. (cotton grass) and *Carex aquatilis* (Wilson et al. 2012).

During summer, after the post-calving period, insect harassment and forage quality are believed to be the two main drivers of habitat selection by caribou (Skarin et al. 2008). During the summer months, females must acquire adequate forage to store enough nutrient resources to survive, and to maintain pregnancy throughout the winter (Helle and Tarvainen 1984; Colman et al. 2003). Thus, access to high quality forage is not only important to calf survival within the year, but also to the survival of females and yearlings in the subsequent winter, and to the ability of females to birth healthy calves in the subsequent spring (White 1983; Couturier, Cote, Otto et al. 2009).

After the post-calving period, females expand their selection of vegetation from sedge meadows to include other vegetation types, but tend to remain in moist habitat where grasses, sedges, and willow and birch shrubs are abundant (Griffith et al. 2001; Thorpe et al. 2001; Wilson et al. 2012; Zamin and Grogan 2012). Inuit TK indicates that cotton grass is important forage for newly weaned calves (Thorpe et al. 2001), and that wetlands in general are important forage sites for cows and calves (KIA 2012). Despite a wider selection during the post-calving period, foraging throughout summer probably predominately occurs in sedge meadows, where caribou can graze up to 50% of the net primary productivity (Jefferies 1992).

Harassment by black flies and especially bot (oestrid) flies can cause significant disturbances to tundra caribou in July and August (Witter et al. 2012). Insects are abundant on warm days when wind speeds are low (Boulanger et al. 2004) especially for the two weeks spanning late June to early July (Thorpe et al. 2001). Caribou compensate for harassment by engaging in avoidance behaviours (on average 5% of the day) such as head tossing and erratic running when insects are active, from about 0800 to 2100 hours (Witter et al. 2012). Caribou are often seen swimming in lakes to escape the heat and insects (Thorpe et al. 2001), and standing under cliffs for shade (KIA 2012). Caribou also attempt to avoid insects by moving for some part of the daytime to windier, cooler places, such as on top of eskers and hills, at the edges of large rivers and lakes, and to higher elevation tundra where insects are less dense (D. E. Russell, Martell, and Nixon. 1993; Skarin et al. 2008; KIA 2012; Wilson et al. 2012; Witter et al. 2012). At night when there are few insects, caribou move downward to lower elevation sites where the forage quality is usually higher (Skarin et al. 2008). Caribou also make larger scale seasonal movements to areas with fewer insects (Wilson et al. 2012). Depending on topography and the location of large lakes, such movements may occur through relatively narrow travel corridors (Wilson et al. 2012).

Caribou often gather along lakeshores, especially late in the day, because they can enter the water to escape predators such as wolves when necessary (Thorpe et al. 2001). Habitats with extensive shrub cover (e.g., riparian shrub communities) may increase the vulnerability of caribou to predation because they conceal predators (J. A. Curatolo 1975; Heard and Gray 1989); however, caribou select these habitats for the relatively high quality of forage they provide (AXYS Environmental Consulting Ltd. and Penner and Associates Ltd. 1998).

Fall Migration (September 1 to October 31)

During the fall, caribou require habitats that provide abundant forage and facilitate travel. Caribou breed in the fall during the rut but implantation of the fertilized egg is delayed and can be aborted if animal condition is poor during the winter. Hence, high quality forage is important in the fall. Green forage becomes less available as the fall progresses and Bathurst caribou choose lichen veneer for foraging (C. J. Johnson et al. 2005). Sedge wetland and riparian tall shrub habitats may also be used depending on the availability of green forage. However, a habitat modelling study by Johnson et al. (2005) indicated that caribou may avoid areas dominated by sedge, peat bog, and heath tundra during the fall. Eskers, ridges, and other high points are selected for easy travel (Thorpe et al. 2001).

Winter (November 1 to April 14)

Bathurst caribou spend the winter within the boreal forest, in mature forest stands where their main forage item, mat-forming lichens, are most abundant (Chen et al. 2009; Barrier and Johnson 2012). Areas with deep snow are generally avoided by caribou because they are energetically costly to move through and also because deep snow makes lichens more difficult to access (Fancy and White 1985; Adamczewski et al. 1988). Due to snow depth, Bathurst caribou select windswept areas such as ridges and forest opening where lichens are more accessible (Barrier and Johnson 2012). The habitat preferences of caribou for old forest stands (80-150 years) is likely because lichens require 80 to 150 years of growth to reach sizes that are favorable to caribou as forage (reviewed in Barrier and Johnson 2012). Lichen biomass on the winter range of Bathurst caribou is relatively high compared to lichen in the winter range of caribou in Alaska and the Yukon, indicating the Bathurst herd is likely not limited by forage availability during winter (Barrier and Johnson 2012).

Caribou of the Bathurst herd overwinter in the boreal forest where they feed primarily on lichens. Climate change has causes an increase in the number of forest fires within the winter range of Bathurst caribou, resulting in decreased availability of lichen, which require many years to grow back after fire (Chen et al. 2013).

### *5.1.2.5 Baseline Data for Bathurst Caribou Herd*

The objectives of baseline studies were to highlight where the Bathurst caribou herd is located during each season and to what degree these movements overlapped with the Project area and how caribou use habitat within the wildlife RSA on a variety of scales. Several data sources are available from government agencies and other information was directly collected in the field. Five separate types of baseline studies were conducted, including:

1. Analysis of satellite collar data (1996–2012) to determine movement patterns and seasonal ranges;
2. Aerial surveys conducted in 2001, 2002, 2007, and 2010 in the wildlife RSA during key life history stages for caribou;
3. Remote motion-triggered cameras (2012 and 2013) for monitoring habitat use of certain habitat features and for determining detailed timing information for when caribou use these features;
4. Habitat suitability modelling to determine the location and abundance of various habitat type identified from literature review as important for caribou; and
5. A resource selection function for Bathurst caribou to determine detailed information on what habitat features this herd selects for and avoids, including vegetation types, landforms, lakes and waterbodies and industrial developments.

Full details for the results of caribou distribution and movements within the wildlife RSA can be found in the 2001-2002, 2007, 2010, and 2012 Wildlife Baseline Reports (Rescan 2007a, 2007b, 2011a, 2013d)

Specific sources of baseline terrestrial wildlife information used in this section include the following Back River reports:

- *Back River Project: 2010 Caribou and Muskox Baseline Report* (Rescan 2011a, Appendix V5-5E);
- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012a, Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013d, Appendix V5-5C);
- *Back River Project: 2013 Habitat Selection by Bathurst Caribou during the Post-calving and Summer Periods* (Rescan 2013c, Appendix V5-5B); and
- *Back River Project*: *2013 Wildlife Habitat Suitability Baseline* (Rescan 2013a, Appendix V5-5A).

Results from the *Back River Project: 2013 Wildlife Baseline Report* will be available in 2014.

Other sources of supplementary wildlife data used in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- Field Report – Back River Project Wildlife and Wildlife Habitat 2007 (Gartner Lee Ltd. 2008); and
- *Hackett River Project: Wildlife Baseline Report 2008* (Rescan 2008).

Satellite Collar Data

The satellite collar program was initiated by the governments of Northwest Territories and Nunavut in 1996 for the Bathurst and Beverly herds. Each year satellite collars are fitted on a group of female caribou during the winter. The data generated from these programs allow researchers to investigate

seasonal trends in habitat use as well as track real time movement patterns of caribou herds. Until 2008, all collars deployed on Bathurst and Beverly caribou were satellite collars, which typically provided one (fixed) location every one to five days (depending on programming and season), with each location having an associated error of between 150 m and 1,000 m depending upon the location class (C. J. Johnson and Gillingham 2005). Beginning in 2008, GPS collars with satellite uplink were deployed resulting in three to six locations provided daily with much greater location accuracy (generally < 15-25 m). Thus, analyses using collaring data are heavily weighted on the last five years as the contribution of location data is much greater between 2008 and 2012 relative to earlier years.

Caribou use of the land can broadly be classified into two groups: 1) migrations (spring and fall) when the animals are moving quickly across the landscape, and 2) sedentary periods (calving, post-calving, summer, and winter) when the daily movement rate of caribou is lower than migrations and the herd tends to occupy a distinct range of the landscape. In order to map habitat use by caribou during each season, two methods were used. Satellite collar data provides data on the movement of caribou during the migratory period and for the sedentary periods analysis of the habitat usage using fixed kernel utilization distributions provided information on areas of high usage.

During migrations, satellite collars provided point data on the movement of the caribou across the landscape. With these data, linear routes were created outlining key migration routes, corridors and river crossings.

During sedentary periods, satellite collared data were analysed using fixed kernel utilization distributions (UDs) indicating areas of high usage. These areas are associated with key habitats for caribou during winter, calving, post-calving and summer, where caribou movement is reduced and they occupy a definable range on the landscape (e.g., the summer range). Fixed kernel UDs were calculated for the core use areas (termed 50% kernel UD) as well as the areas of active use (termed 95% kernel UD). The 50% kernel UD represents an area with a 50% probability that an animal (or group of animals) is inside that area; the same is true for the 95% kernel UD.

Data was analyzed by season/life history stage. These stages vary between herds and are defined by movement rates for migrations vs. winter and summer ranges (C. J. Johnson et al. 2005). The peak of calving (the day when 50% of the caribou have calved) and the weaning of calves are used to define the calving period and post-calving periods, respectively. Calves are typically weaned three to five weeks after they are born (D. E. Russell, Kofinas, and Griffith 2002). These life history stages vary seasonally, particularly dates defining calving and post-calving; thus, a wider spread in dates is used here than in more recent studies (e.g., Flanders et al. 2009). Data were also separated by year to identify annual trends in habitat utilization.

The calculated fixed kernel UDs are based on the data from collared females. In some cases, males and juveniles lag behind the females as they move from seasonal range to range. Aerial surveys and motion-triggered cameras were used to identify additional time periods when caribou may be present in the Project area. Details of data analysis are reported in the 2012 Wildlife Baseline Report (Rescan 2013d, Appendix V5-5C).

The collar data from 1996 to 2012 indicate that the Bathurst herd move through the wildlife RSA during the post-calving period in late June to mid/late July; the herd may also pass through on their way north to the calving grounds in the spring (May), but this use is very infrequent based on the collar data. These data represent the current condition during the last 10 to 15 years.

Fixed kernel utilization distributions (UDs) for collared data from 1996 to 2012 indicated that the female Bathurst caribou move through the wildlife RSA predominantly during the post-calving period in

late June to mid/late July and to rarely during the spring, northern, migration and are absent from the wildlife RSA at other times of the year. Figures representing fixed kernel UDs are presented in Section 5.1.2.2 (Distribution and Migration Patterns).

During the spring, female Bathurst caribou move north from the wintering grounds to the calving grounds, following migratory routes to the west of the wildlife RSA (Figure 5.1-2). Very low numbers of Bathurst may also pass through on their way north to the calving grounds in the spring migration (May), but this use is very infrequent based on the collar data (Figure 5.1-2).

The calving range of collared Bathurst caribou from 1996 to 2012 were located between James River and Contwoyto Lake approximately 100 to 150 km northwest of the wildlife RSA, with the most concentrated use taking place between the Hood and Burnside Rivers (Figure 5.1-3). Shifts in calving grounds have been recorded in most Arctic caribou herds. These shifts may be a result from the overall habitat selection of females at this time. The calving ground of Bathurst caribou has gradually shifted from the western side of Bathurst Inlet (in the 1950s) to the eastern side (1960s to mid-1980s) and in recent years (since the late 1990s) has shifted back to the western side (Sutherland and Gunn 1996; Thorpe et al. 2001; Gunn and D'Hont 2002).

During the post-calving period, the Bathurst caribou migrate in a south-east direction, largely south of the wildlife RSA to their summering grounds (Figure 5.1-3). During the summer, caribou herds are relatively dispersed, as illustrated by the large spread of the summer range and associated core use areas to the south of the wildlife RSA (Figure 5.1-4).

For Bathurst caribou, the areas around Lac De Gras have been highlighted as an area that has been occupied by rutting caribou (GNWT ENR 2010). Following the reunion of bulls and immature caribou with the cows and calves in the late summer, caribou herds migrate southwards during the fall (Figure 5.1-4). During the winter, most caribou within the Northwest Territories and Nunavut are found below or at the treeline (Figure 5.1-2).

Aerial Surveys

Aerial surveys were conducted in 2001, 2002, 2007, 2008 and 2010 in the wildlife RSA using standard census techniques for large mammals (Rescan 2002, 2007a; Gartner Lee Ltd. 2008; Rescan 2011a, Appendix V5-5E). The timing of surveys corresponded with the spring and early fall migration, calving, and post-calving periods for caribou (Table 5.1-3). The aircraft followed transect lines using an onboard Garmin GPS at an elevation of 120 to 150 m and speed of approximately 150 km/h. Surveys were conducted along 20 pre-determined transect lines within the wildlife RSA; transect lines were parallel at a distance of 8 km apart. The width of the survey transect was 500 m on either side of the airplane. Each observer calibrated this distance before the survey by having the airplane fly over two markers at an elevation of approximately 122 m. The markers were spaced 500 m apart and the observers noted the angle of the outside marker against calibration markers that were placed on the aircraft wing struts.

During survey flights, observers noted the sex, if possible, and number of caribou observed and the approximate distance that the animals were from the aircraft in 100 m increments. When large groups of ungulates were observed, the airplane circled the group in order to achieve a more accurate count. Each observer counted the caribou independently and counts of each observer were averaged. Caribou were classified as bulls, cows or young; nursery groups were also identified. The location and habitat for each observation were also recorded. All caribou observed off-transect (greater than 500 m from the aircraft or during non-survey flights) were recorded as incidentals.

**Table 5.1-3. Aerial Survey Flights in the Regional Study Area**

| Survey Year | Spring Migration Survey Dates | Calving and Post-calving Survey Dates | Summer Survey Dates | Early Fall Survey Dates |
|---|---|---|---|---|
| 2001 | -- | -- | July 21 and 29 and August 9 and 21 | September 7 and 20 |
| 2002 | March 22 and May 28 | June 7 and July 7 | -- | -- |
| 2007 | May 16-18 | June 11-12 | July 12-13 and July 29-30 | September 7-12 |
| 2008 | May 8-9 | -- | July 15-16 | -- |
| 2010 | May 7-8 | June 7-8 | July 13-15 | -- |

*-- = no surveys were conducted.*

Survey conditions were noted for each survey flight, including the snow cover, air temperature, wind speed, visibility, and survey time. Incidental observations were also recorded for a variety of wildlife that could be identified from aircraft. Species, numbers of adults and/or offspring, GPS location, and habitats in which they were observed were documented whenever possible. Full details of the surveys are reported in the 2001-2002, 2007, and 2010 Wildlife Baseline Reports (Rescan 2002, 2007a, 2011a).

The locations of caribou observed in the wildlife RSA from aerial surveys during baseline studies confirm and improve knowledge of the distribution of caribou based on satellite collar data (Figure 5.1-7). A total of 3,153 caribou were observed during surveys conducted in 2001 and 2002 (Rescan 2002). In 2002, 103 caribou were observed during the post-calving and summer surveys (Rescan 2002).

In 2007, 401 caribou were observed between May and September during aerial surveys (Rescan 2007a). Only two caribou were recorded during two surveys in 2008 (not mapped). During the 2010 aerial surveys, 65 caribou were observed (Rescan 2011a, Appendix V5-5E). Caribou observed during surveys conducted in the spring were likely Beverly caribou migrating to calve near Queen Maud Gulf. Low numbers of caribou were observed during the calving period with the highest numbers observed during the post-calving and summer periods.

These data support the Kernel UD maps that indicate:

1. Few caribou during the spring migration, and those that were observed are likely Beverly caribou (Section 5.1.3).
2. Very few caribou in the wildlife RSA during calving, and those that were observed tended to be males and located on the western edge or incidental observations of caribou west of the wildlife RSA. This is consistent with the calving grounds being located outside and to the west of the wildlife RSA.
3. The majority of caribou observed were recorded during the post-calving period, principally at the southern and western edge of the wildlife RSA — this is consistent with the Bathurst herd movements from collar data.
4. Few observations of caribou during summer and fall, with the exception of a small number of large groups observed principally at the southern end of the wildlife RSA — this is consistent with summer use of the southern portion of the wildlife RSA by Beverly caribou.

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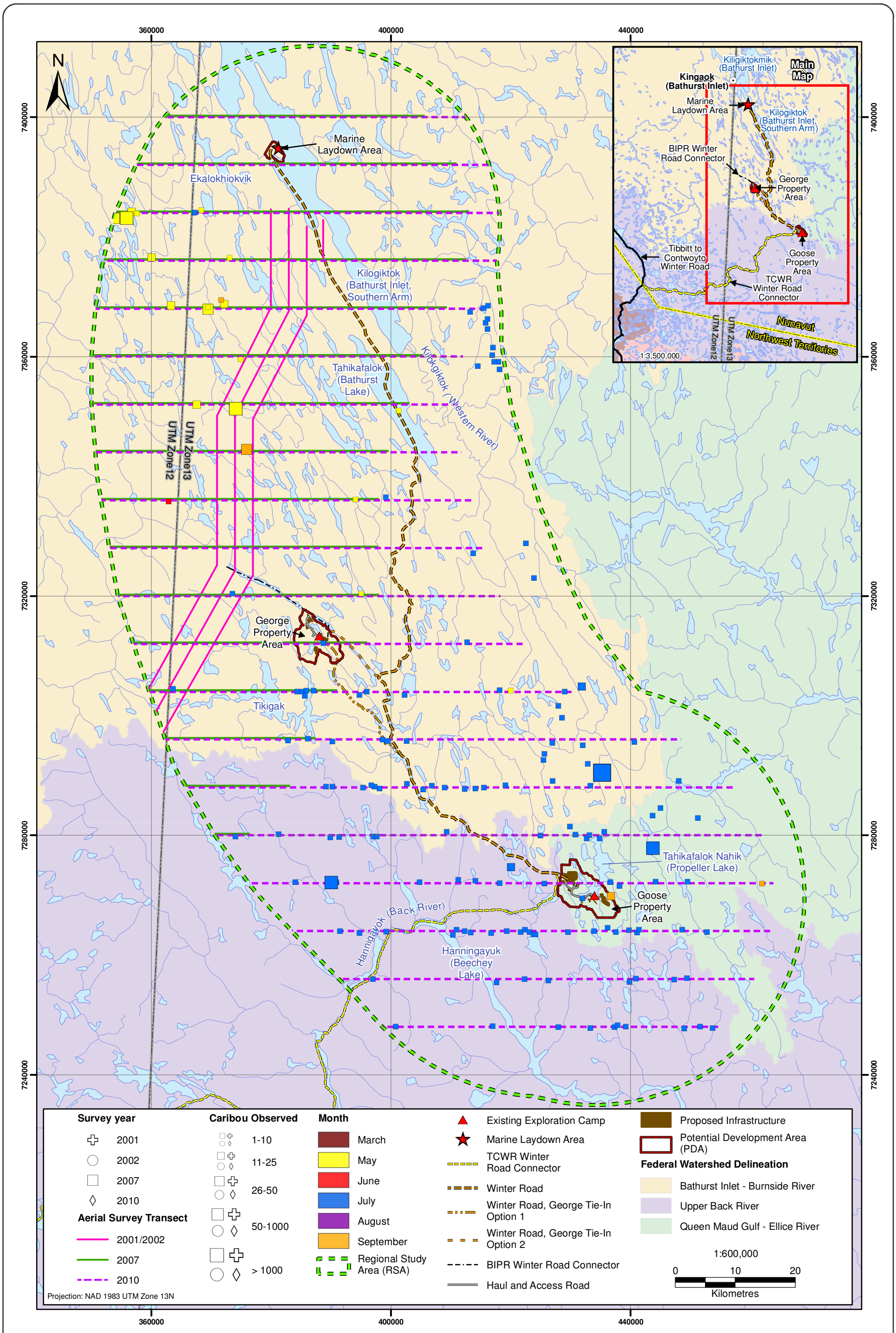


Figure 5.1-7

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## Caribou Observations during Aerial Surveys, 2001 to 2010

Figure 5.1-7

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Remote Cameras

In order to examine when caribou are using the Project area, and examine their use of selected features on the landscape, motion-triggered cameras were deployed in the wildlife RSA and in an area adjacent to and west of the wildlife RSA in order to look at spatial trends on a larger scale. Remote digital cameras are a reliable method for examining ungulate migratory timing and habitat associations given the landscape's short vegetation and features such as eskers and river crossings that direct caribou movement through the landscape (Cutler and Swann 1999; Noel et al. 2006).

Thirty cameras were deployed in the wildlife RSA and an additional 30 cameras in the area adjacent to the wildlife RSA in 2012, and an additional 30 cameras were added to each of these areas in 2013. Cameras were attached to tripods in early May 2012 and 2013 and memory cards collected and downloaded in July and August 2012, May, July, and August 2013. Cameras were programmed to take one photo every half hour and 10 photos when motion is detected (cameras are triggered).

For each photo that included a wildlife observation the following data were recorded: date, time, photo type (M = motion or T = timed (T) photos), photo number, number of photos, number of triggers, species, number of animals, and their behavior (i.e., resting, foraging, traveling). Individual caribou that were recorded 30 minutes apart in triggered photos were considered different individuals, unless behaviour suggested that they were the same individual (i.e., individuals resting on the tundra). Motion triggered photos detected individual caribou that were traveling, sometimes in small numbers and at other times in large herds of hundreds of individuals. For small numbers of caribou observed by motion triggered photos, the exact number of individuals was easily determined. For large numbers of caribou in herds, the number of individuals was determined over entire motion triggered photo set where the greatest number of individuals observed was recorded for that time period. All photo observations of caribou were checked by a second observer to ensure that the number of individuals was recorded accurately. Additional details can be found in the Back River 2012 Wildlife Baseline Report (Rescan 2013d, Appendix V5-5C).

To assess the temporal and spatial distribution of caribou in the wildlife RSA and western adjacent area, the data were pooled by day (temporal trends), camera (spatial trends) and within each season of caribou life history stages such as calving, post-calving, and summer. The size of caribou groups were characterized as large groups (> 100 caribou), medium groups (50 to 100 individuals) or small groups (1 to 49 individuals).

In order to compare the number of caribou observations between sites (e.g., on and off proposed infrastructure, and between various vegetation types) the number of caribou were calculated per day as the total number of caribou observed, compared to the number of days the camera had been active. Some cameras were obscured by snow, failed due to cold or were knocked over by bears. These periods of inactivity were removed prior to analysis.

To assess habitat use by caribou, mean caribou detection rates and associated standard errors were calculated for bedrock (n = 7 cameras), esker (n = 15 cameras), freshwater/riparian (n = 3), tundra (n = 31 cameras), and wetland (n = 4 cameras) habitats (n = 60 cameras total in 2012).

A total of 2,573 caribou were detected by camera in 2012 in the wildlife RSA and adjacent area, with approximately 2,000 likely belonging to the Bathurst herd observed outside the wildlife RSA (Rescan 2013d, Appendix V5-5C). The data generated by the cameras generally agreed with the movement patterns of the Bathurst and Beverly caribou mapped via collars (Figure 5.1-8):

1. No animals were observed in the wildlife RSA during the calving period, which is consistent with the calving grounds being outside of the wildlife RSA.

2. During the post-calving period, six large herds (N > 100) with the largest herd recorded at 300 individuals and 36 smaller herds (N = 2 to 99) were observed west of, and outside of the wildlife RSA. These observations are consistent with the movement of the Bathurst herd south east from their calving ground to the summer range.
3. Caribou were observed in the wildlife RSA between June 19 and August 22 2012. One large group (> 200) of caribou was photographed in the southern portion of the wildlife RSA on July 27 along with a smaller group (< 30 caribou) on August 1 (Figure 5.1-8). A large and small group were later observed on August 20 and 18, respectively, suggesting there may have been two migration "waves" through the southern portion of the wildlife RSA in 2012. Less than ten caribou were observed at the remaining cameras throughout the sampling period (Figure 5.1-8). These results are consistent with the known temporal and spatial distribution of Beverly caribou (see Section 5.1.3.2).

Cameras observed caribou in various habitats, with the majority of caribou observed during the post-calving period in areas of heath tundra and hummock-tussock. During the post-calving, caribou females are lactating and may be choosing areas of abundant vegetation rather than areas such as eskers that would provide easier movement. In addition to choosing areas with abundant green vegetation, caribou may have been avoiding eskers because wolves den in eskers in the wildlife RSA. Incidental observations indicated that the numbers of mosquitos were not high during the post-calving season of 2012 and 2013, which would have reduced the attractiveness of eskers to caribou.

Several of the cameras were placed at likely river crossing points, following direction from Inuit landusers who assisted in the placement of cameras. One of these crossing points was observed to be used by a large herd of caribou on August 20. The crossing, at the east end of Beechey Lake, is inside the wildlife RSA, but approximately 15 km south of the Project. Several important nadloks (crossings) along Beechey Lake were identified by Inuit TK (KIA 2012; Figure 5.1-6).

Habitat Suitability Modelling

Wildlife habitat suitability studies were conducted within the wildlife Local and Regional Study Areas (LSA and RSA) to inventory and rate the habitat types for caribou and quantify suitable habitat available for this species within the local and regional study areas. These data can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 $km^2$ of the West Kitikmeot / Slave Study Area, which stretches from the arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001).

For the purposes of this study, individual herds are not assessed separately as it is assumed that habitat requirements are similar, if not identical, for all individuals by season (Gustine et al. 2012). Caribou habitat suitability was assessed for calving (June 1 to ca. June 20), post-calving (ca. June 20 to July 15), summer (July 16 to August 31) and the fall rut (September 1 to October 31).

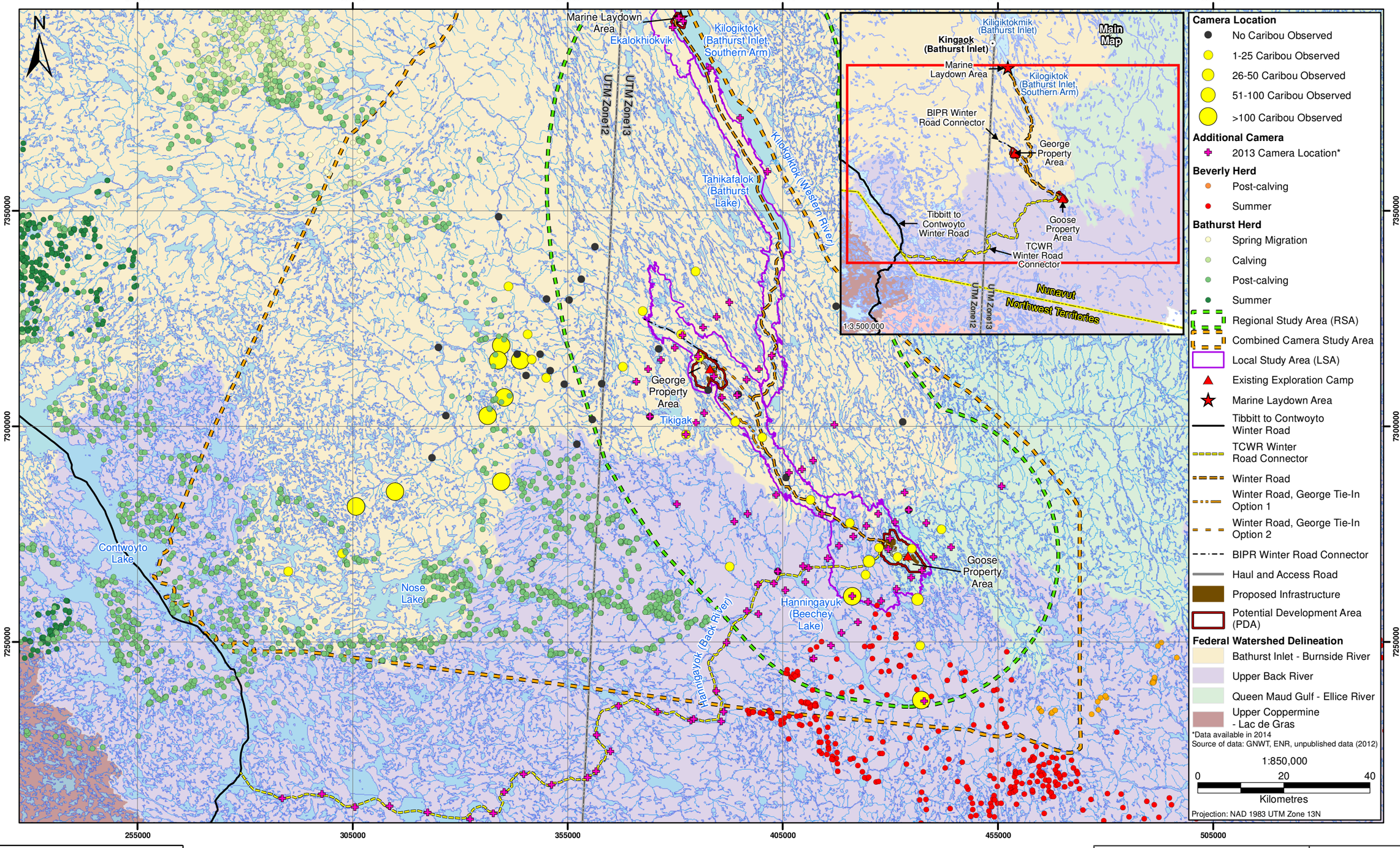


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**Figure 5.1-8**

# Caribou Recorded by Remote Camera and Collar Distribution Data, June to August, 2012

Habitat selection for each season was developed from literature searches, local knowledge, previous wildlife surveys, and project specific habitat assessments. Table 5.1-4 provides a summary of the seasons and life requisites that were assessed, with the following sections expanding on the habitat preferences for each season and HSR ratings for each vegetation association that occurs in the wildlife RSA.

**Table 5.1-4. Seasonal Life Requisites of Caribou**

| Season | Date | Life Requisite | Habitat Preference |
|---|---|---|---|
| Calving | June 1 to ca. June 20 | Reproduction and Living | Variable. Predator avoidance, lichen availability, and early vegetation growth is preferred. |
| Post-calving and Summer | ca. June 20 to July 15 (post-calving)<br>July 16 to August 31 (summer) | Living | Caribou use eskers for insect and heat relief, lakes for predator avoidance, insect, and heat relief, eat green plants from riparian and sedge communities. Cows require high quality forage to replenish fat reserves. |
| Fall (Rut) | September 1 to October 31 | Living, Reproduction, and Travel | Caribou travel to southern rutting areas selecting habitat for ease of travel, predator avoidance, and late season forage. |

The results of the caribou suitability modelling indicate that wildlife LSA contained a considerable amount of potential high value calving habitat (53%), while the wildlife RSA was evenly distributed between high, moderate, low and nil rated habitats. For the post-calving and summer season, the wildlife LSA contained proportionally less high value habitat (19%) relative to the wildlife RSA (27% high value habitat) and both the wildlife LSA and RSA were dominated by moderate value habitat (66% and 59%, respectively). The majority of the fall season was rated high in the wildlife LSA (75%), while the wildlife RSA had approximately 45% of the area rated high and 36% considered low. Table 5.1-5 contains the complete results of the modelling. Figures 5.1-9, 5.1-10, and 5.1-11 display the mapped results in the wildlife LSA and RSA.

**Table 5.1-5. Area and Proportion of Habitat within the LSA and RSA for Caribou**

| | Amount of Habitat in the LSA | | Amount of Habitat in the RSA | |
|---|---|---|---|---|
| Suitability Rating | Area (ha)[1] | % of LSA[2] | Area (ha)[1] | % of RSA[2] |
| *Calving* | | | | |
| High | 71,492.97 | 53 | 355,417.77 | 28 |
| Moderate | 30,436.22 | 22 | 300,905.11 | 24 |
| Low | 7,140.63 | 5 | 301,581.58 | 24 |
| Nil | 25,299.49 | 19 | 299,248.12 | 24 |
| *Post-calving and Summer* | | | | |
| High | 25,850.80 | 19 | 343,578.60 | 27 |
| Moderate | 88,824.94 | 66 | 738,800.73 | 59 |
| Low | 19,556.98 | 15 | 107,137.87 | 8 |
| Nil | 136.58 | 1 | 67,635.37 | 5 |
| *Fall (rut)* | | | | |
| High | 100,265.28 | 75 | 562,764.43 | 45 |
| Moderate | 9,795.05 | 7 | 178,261.57 | 14 |
| Low | 24,177.80 | 18 | 448,491.21 | 36 |
| Nil | 131.17 | < 1 | 67,635.37 | 5 |

*[1] LSA = 134,369.31 ha, RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*
*[2] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100% (e.g., 99% or 101%).*

Resource Selection Function for Bathurst Caribou Herd

Recent evidence suggests that over-winter survival may be related to forage conditions on the summer range. High leaf biomass, early start date and late end date of green leaf biomass, and high quality of leaf biomass in the summer range are generally believed to be beneficial to caribou growth and pregnancy rate during the summer-fall period and calf:cow ratio in the next year. By calculating a simple ratio vegetation index (SRVI) from broad scale advanced very high resolution radiometer data (AVHRR) over the summer range and correlating it to several demographic parameters of the Bathurst herd, Chen et al. (2013) demonstrated that productivity on the summer range explains a significant portion of the variation in caribou birth rate (86%), net productivity (56%), and calf survival rate (52%), but not cow survival rate. Lag times were found to be one year for birth rate and calf survival rate, and two years for net productivity.

Given the vulnerability of calves during the post-calving period and the relationship between habitat quality and caribou demographics, industrial activity on the post-calving and summer ranges may contribute additional pressures on caribou. Understanding the relative contributions of natural and anthropogenic factors to population level changes in the Bathurst caribou herd is the goal of cumulative effects assessment, and fundamental to developing sound management practices to promote the long-term sustainability of the herd.

Resource Selection Functions (RSFs) provide a means to describe the inherently complex patterns of habitat use by the Bathurst herd across spatial and temporal scales. To do this, data relating habitat characteristics within the extent of historic caribou migration patterns were acquired. These characteristics include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The data are a compilation of original data and data derived from pre-existing datasets. Vector data was downloaded from online repositories and AVHRR satellite data products were provided by the Canadian Centre for Remote Sensing under a data sharing agreement between Sabina and Natural Resources Canada. For each habitat characteristic, a spatial data layer was generated with coverage over the entire study area. Then, both caribou collar data points and a set of random points were overlain onto the data layers and extracted a value for each of the habitat characteristics for each of the data points. The motivation behind RSF modelling is to contrast environmental characteristics at locations where caribou were observed with characteristics at random points in the surrounding area. By comparing the habitat characteristics for these two datasets, models were developed which represent the best fit for the habitat use and thus identify habitat selection preferences using Akaike's Information Criterion ($AIC_c$). These models were then used to generate maps reflecting probability of habitat use over a relatively large spatial extent.

*Methods*

Resource Selection Functions (RSFs) provide a means to describe the inherently complex patterns of habitat use by the Bathurst herd across spatial and temporal scales. To do this data was acquired relating habitat characteristics within the extent of historic caribou migration patterns. These characteristics include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The data are a compilation of original data and data derived from pre-existing datasets. Vector data was downloaded from online repositories and AVHRR satellite data products were provided by W. Chen at the Canadian Centre for Remote Sensing under a data sharing agreement between Sabina and Natural Resources Canada.

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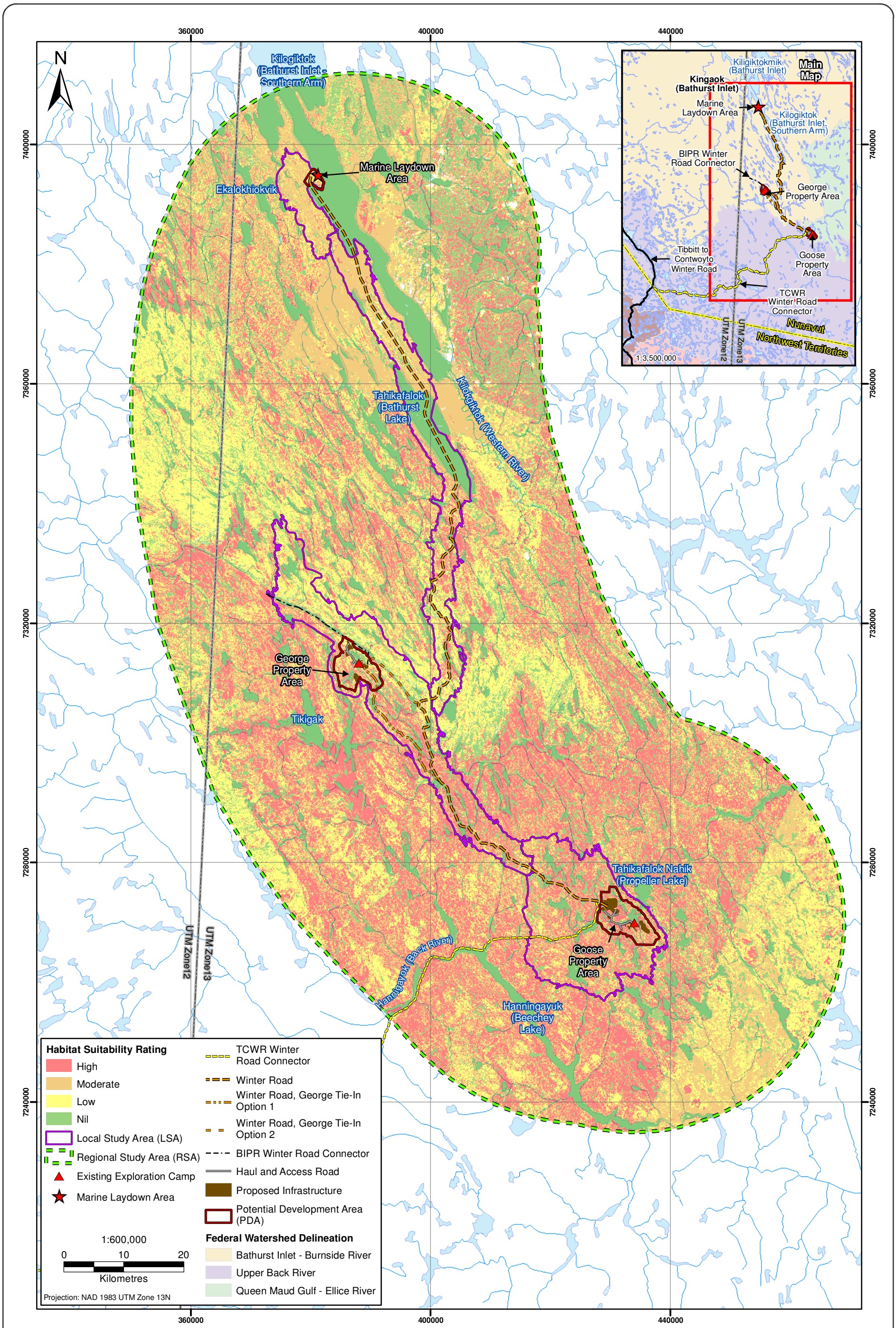


Figure 5.1-9

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# Caribou: Calving Habitat in the Local Study Area and Regional Study Area

Figure 5.1-9

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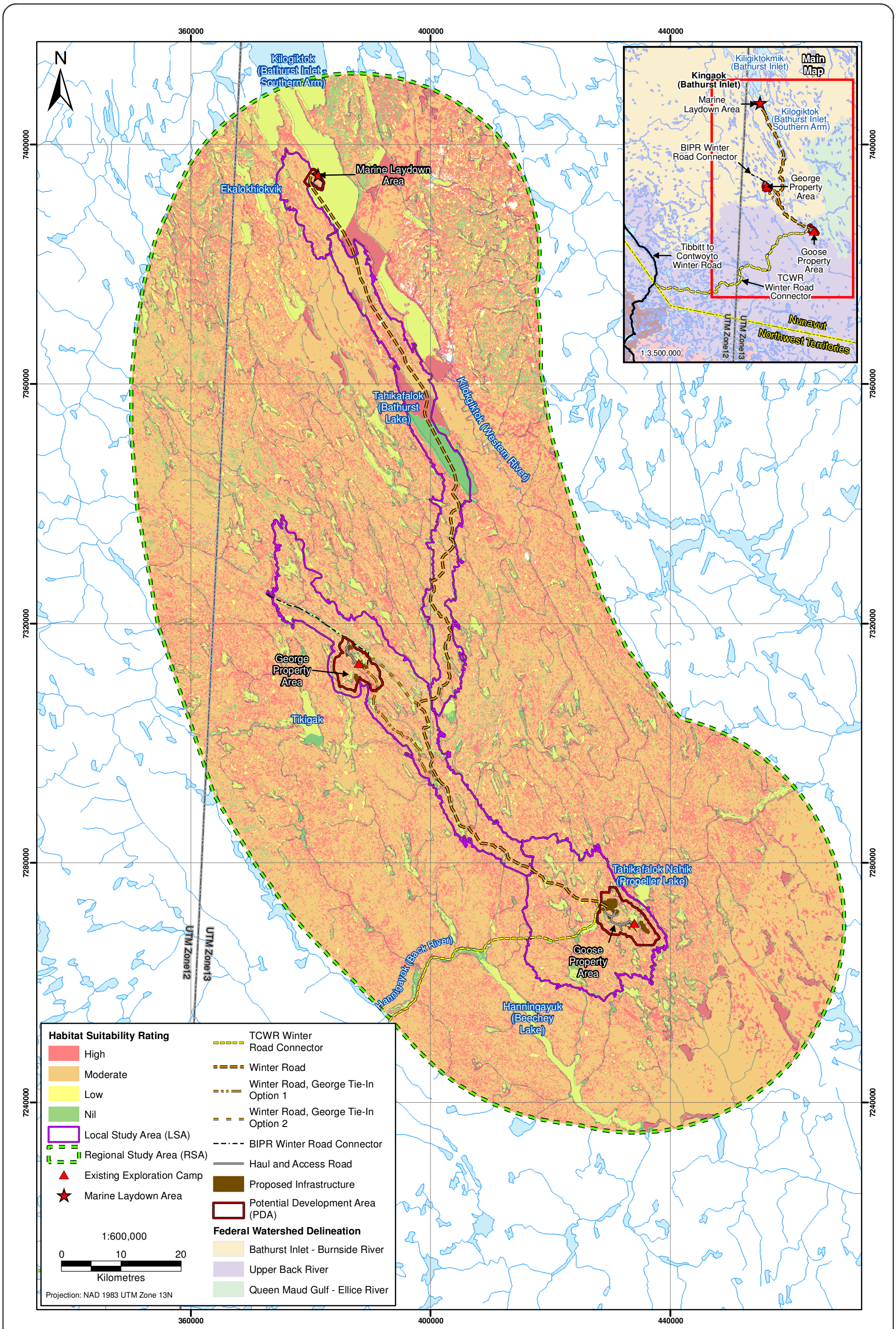


Figure 5.1-10

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# Caribou: Post-calving and Summer Habitat in the Local Study Area and Regional Study Area

Figure 5.1-10

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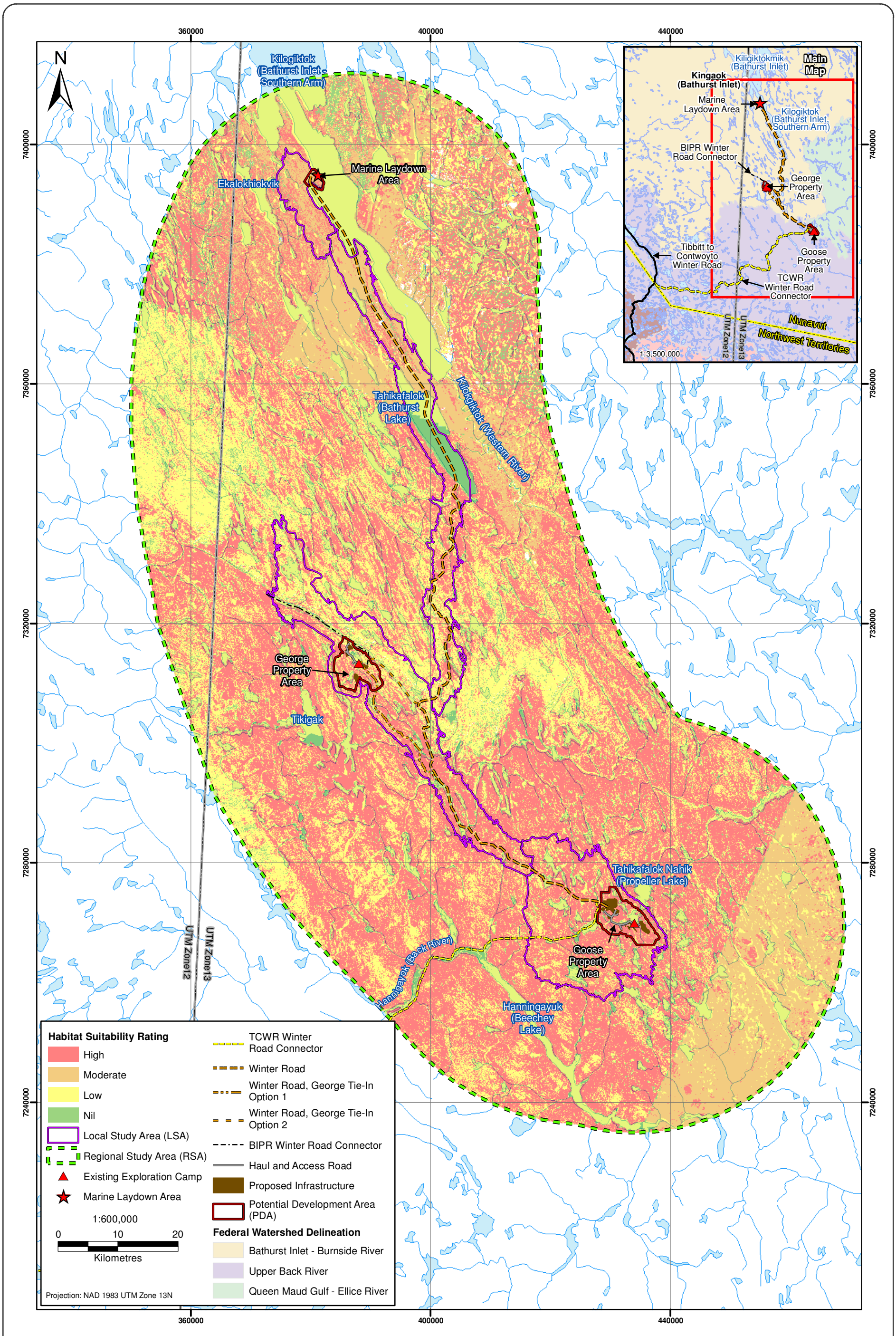


Figure 5.1-11

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# Caribou: Fall Habitat in the Local Study Area and Regional Study Area

Figure 5.1-11

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For each habitat characteristic, a spatial data layer was generated with coverage over the entire study area. These were then overlaid on both caribou collar data points and a set of random points onto the data layers and extracted a value for each of the habitat characteristics for each of the data points. The motivation behind RSF modelling is to contrast environmental characteristics at locations where caribou were observed with characteristics at random points in the surrounding area. By comparing the habitat characteristics for these two datasets, models were developed which represent the best fit for the habitat use and thus identify habitat selection preferences using Akaike's Information Criterion ($AIC_c$). These models were then used to generate maps reflecting probability of habitat use over a relatively large spatial extent.

*Study Area*

Resource selection functions were generated for the post-calving (Figures 5.1-12a and 6.1-12b) and summer (Figures 5.1-12c and 6.1-12d) seasons. GPS collar data suggests that these seasons are the time periods when caribou distributions are in relatively close proximity or overlap with the Project. Bathurst caribou tend to calve to the northwest of the Project, and that range tends to be more resticted than other parts of the year.

Pooled GPS collar data since 1996 provided the maximum extent to bound the analyses, and can apply to future modelling exercises irrespective of year. Models were developed by pooling GPS collar data from all individuals and across years between 2004 and 2010. Assessing variability or across years was not a component of this modelling exercise for the dEIS. Rather, the objective was to develop a probability surface that was proportional to the likelihood of encountering caribou relative to mining activities and the distribution of habitat features, and based on the most complete recent data available.

A use-availability design was employed with a third order selection strategy (selection within a home range). The seasonal models were bounded in two ways. The first was defined by the 95% fixed kernel using all collar locations since 1996 to bound the maximum spatial extent available to caribou. The second was the 50% fixed kernel that was assumed to represent the core seasonal habitat range. Use is defined by the GPS collar location. Availability was determined by pairing five random locations for each use location (C. J. Johnson et al. 2006).

*Model Inputs*

Inputs to the RSF are predictor variables hypothesized to relate to species abundance or those identified as important characteristics in the literature. These variables include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The layers are a compilation of original data and data derived from pre-existing datasets. Most layers were comprised of multiple scenes or panels which were stitched together into a single image to provide coverage over the entire area of interest. The collar data points were overlaid onto the data layers and a unique value was extracted for each data point for each layer; therefore, each collar data point is associated with a value for each predictor variable. Patterns of selection or avoidance are defined relative to what is available to an animal. Availability is determined by a series of random points that are similarly assigned a value for each of the same predictor variables. The use of resources proportionately more than might be expected based on availability is termed selection. The use of resources less than expected based on what is available is termed avoidance.

RVI

In order to assess habitat quality and forage availability, vegetation productivity was quantified using a vegetation index. The simple ratio vegetation index (SRVI) utilizes the spectral signature of healthy vegetation, which is characterized by high near-infrared reflectance and comparatively lower red reflectance. The SRVI is calculated as:

$$SRVI = \rho_{NIR} / \rho_R$$

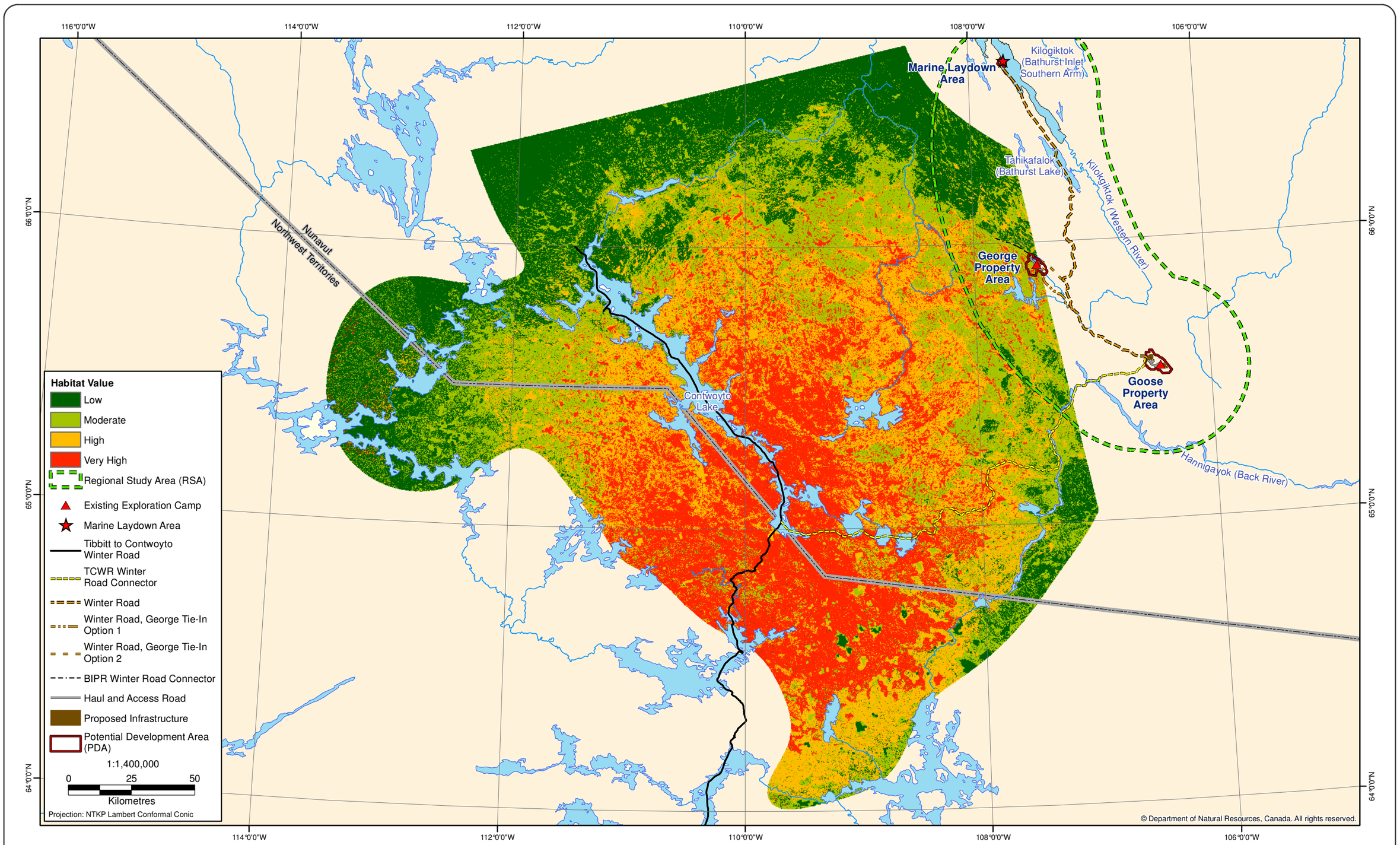
where $\rho_{NIR}$ is the near-infrared reflectance and $\rho_R$ is the red reflectance. Higher SRVI values correspond to pixels representing more dense, green vegetation while low values correspond to unvegetated or sparsely vegetated pixels.

SRVI maps were derived from Advanced Very High Resolution Radiometer (AVHRR) satellite imagery. AVHRR data has been widely used to monitor vegetation productivity and phenology due to its 1.1 km resolution and record dating back to the 1980s (Myneni et al. 1997; Tucker et al. 2001; Stow et al. 2007; Jia, Epstein, and Walker 2009; Beck and Goetz 2011). SRVI maps were generated from AVHRR imagery collected from 1996 to 2011 during post-calving and summer months (June to August). Image processing was carried out based upon methods described by Chen and others (Chen et al. 2009). To reduce errors associated with cloud and aerosol contaminated pixels, we set a cloud contamination threshold of 50% where pixels with cloud contamination probability of greater than 50% were removed (Chen et al. 2013). Collar data points were matched with the AVHRR scene corresponding to the closest time period. In many cases, AVHRR data was not available on the day the collar location was recorded due to removal of cloud contaminated pixels or as a result of the 10 day return interval of the AVHRR satellite. In these cases, collar data points were matched with SRVI values that corresponded to the nearest AVHRR time step at the pixel location.

#### LAND COVER

Though the SRVI provides information regarding the productivity of an area, it does not distinguish between different surface cover types that may influence caribou movements and habitat selection. As a result, land cover was also used as a predictor variable of caribou habitat use. Land cover information was generated from vectorized classification of Landsat satellite imagery collected in 2000. These land cover maps were generated by Agricultures and Agri-Food Canada (AAFC), Canada Center for Remote Sensing (CCRT), and Canadian Forest Service (CFS). Within the RSF study area, land cover for Nunavut and the northern regions of Northwest Territories was classified by the CCRT. Land cover in the forested regions of Northwest Territories was derived from forest cover mapping for the Earth Observation for Sustainable Development project (EOSD). Though a harmonized legend was created for the multiple data sources, some discrepancies and discontinuities exist due to differences in classification methods. A total of 12 broad land cover classes were generated from the above sources. These classes included:

- Barren/Non-vegetated;
- Sparsely vegetated;
- Bryoids;
- Tall Shrub;
- Short Shrub;
- Dwarf Shrub;
- Wetland;
- Tussock graminoid tundra;
- Moist to dry non-tussock graminoid tundra/dwarf shrub tundra;
- Forested (conifer);
- Forested (broadleaf);
- Forested (mixed).

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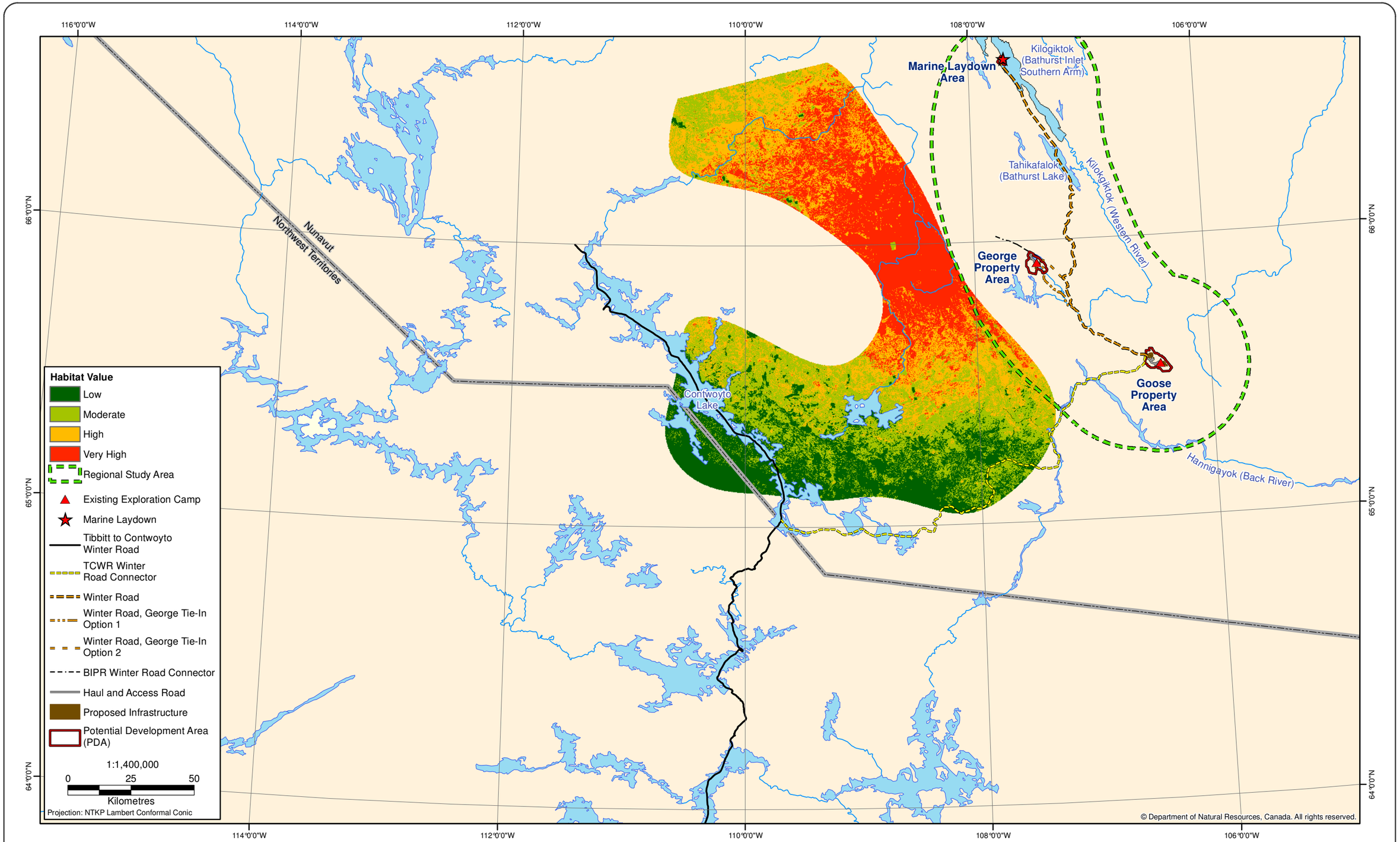
# Caribou Habitat Values in the Post-calving Range Based on Resource Selection Modelling, 95% Kernel

Figure 5.1-12a

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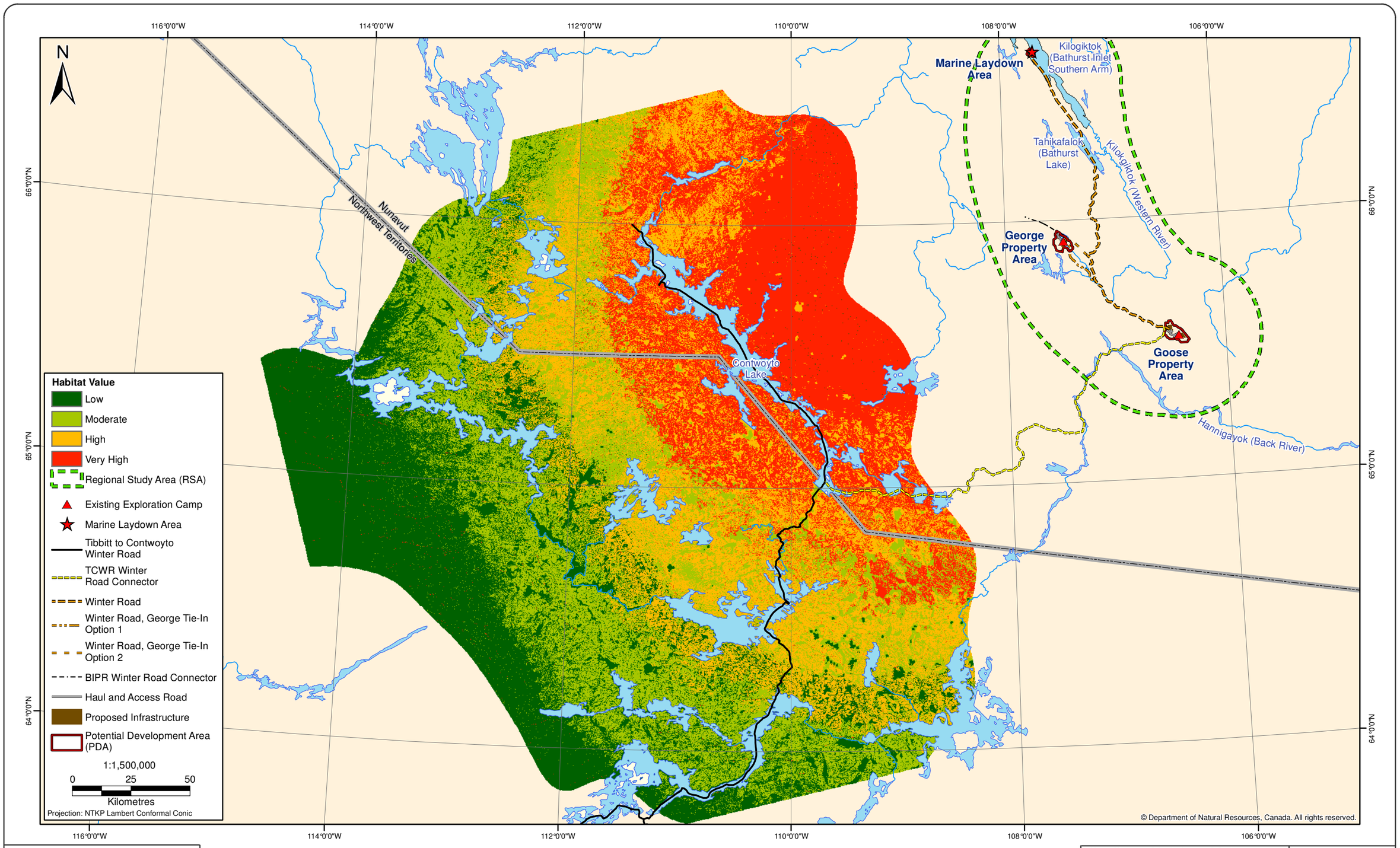
**Caribou Habitat Values in the Post-calving Core Use Area Based on Resource Selection Modelling, 50% Kernel**

**Figure 5.1-12b**

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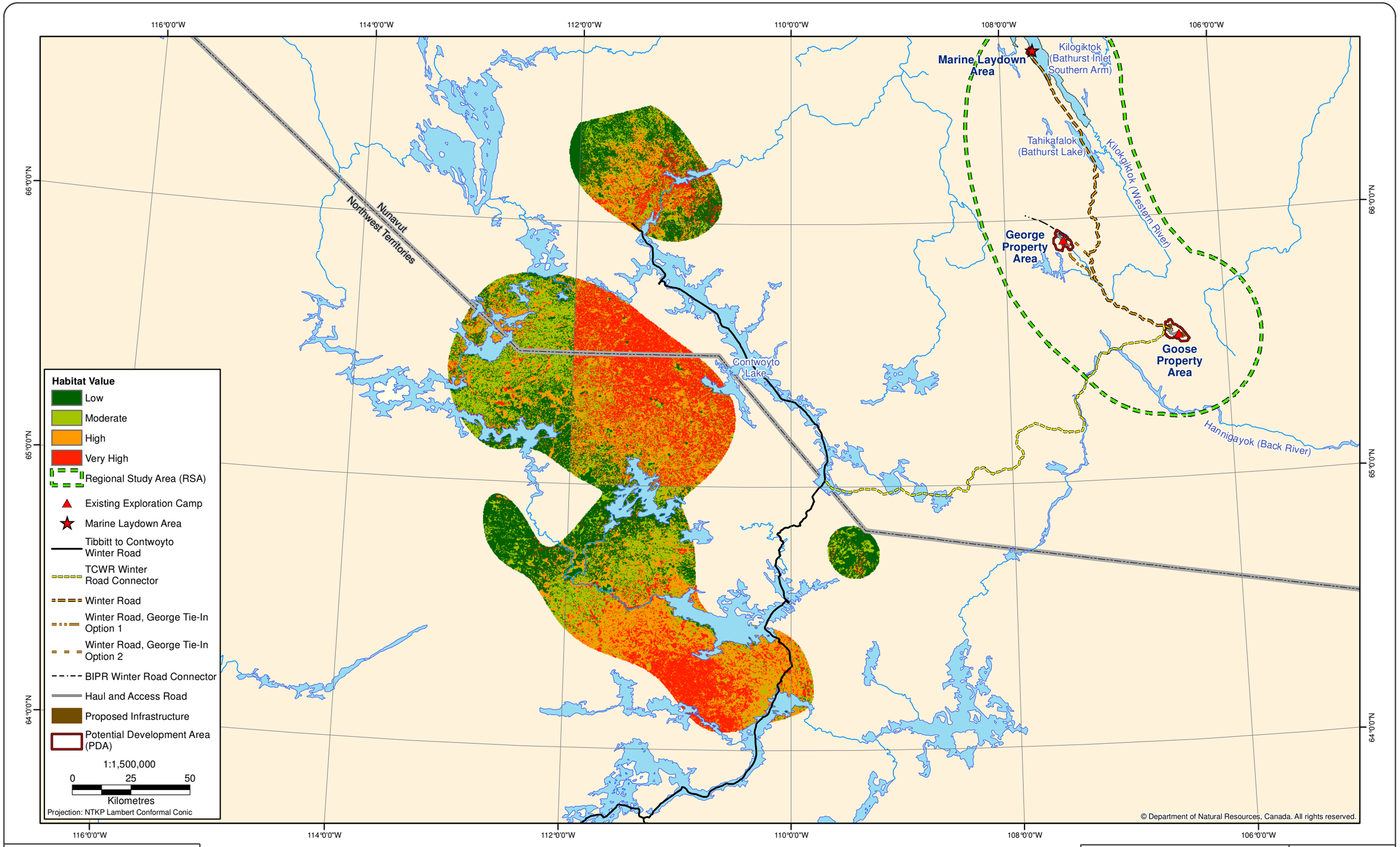
**Caribou Habitat Values in the Summer Range Based on Resource Selection Modelling, 95% Kernel**

Figure 5.1-12c

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**Caribou Habitat Values in the Summer Core Use Area Based on Resource Selection Modelling, 50% Kernel**

**Figure 5.1-12d**

#### TOPOGRAPHIC FEATURES

Topographic factors were also included that may influence the use of resources, including elevation, slope, and aspect. The elevation at each caribou observation was determined using digital elevation models (DEMs) from Canadian Digital Elevation Data. These were generated from 1:50,000 National Topographic Data Base maps and other available provincial and territorial data. Eighteen National Topographic Survey (NTS) map sheets were merged into a single DEM with spatial coverage over the area of interest and a spatial resolution ranging from 8 to 23 metres. On the merged DEM some seams are visible, particularly on lakes, as a result of differing data sources.

From the merged DEM we calculated slope, eastness, and northness using ArcGIS. Slope served as the basis for determining both eastness and northness which relate to slope aspect. Eastness was calculated as the sine of the aspect and northness the cosine of the aspect.

Preliminary analyses indicated that topographic features were not a significant component of resource use, likely due to the relatively uniform relief across the landscape; therefore topographic features were omitted from the final model iterations.

#### ESKER

Eskers were identified as a potentially important habitat feature due to their use a travel corridor and for insect and heat relief. Eskers are included in the relief and forms CanVec vector data produced by Natural Resources Canada. From the esker delineation, a binary esker mask was generated using a 75 metre buffer. Regions within 75 metres of a mapped esker were classified to be esker related while areas further than 75 metres from mapped eskers were classified as non-esker features.

Preliminary analyses indicated zero use of eskers by caribou during the post-calving and summer periods (consistent with camera monitoring data); therefore, eskers were omitted from the final model iterations.

#### WATER

Proximity to water is used as a predictor variable because lakes may provide relief from heat and insects. The availability of water across the landscape was quantified using the position and spatial extent of waterbodies defined in the land cover map water class. For each collar data point, the distance to the nearest body of water and its surface area was calculated using a spatial join. At locations where the collar location falls within a mapped body of water, the distance to water is zero.

#### PREDATORS

Predation is considered an important component of caribou population dynamics. To incorporate predation risk as a predictor of caribou habitat use across the landscape, 4-class habitat suitability indices (HSI) were generated for both wolves and grizzly bears during each modelled season.

#### MINES

A development layer was created to encompass influence of mining activities including drilling, camp, and helicopter disturbances. Development within the study region was divided into operating mines, closed mines, and exploration camps, based on the assumption that each type of development is likely to influence the herd in different ways. At each collar data point, the distance to the nearest mine or camp was calculated for each of these development classes.

### *Results*

During both the post-calving and summer periods, the region around Contwoyto Lake, Nose Lake, and the Mara and Hackett Rivers was identified as an area that is heavily used by caribou based on models that included habitat, RVI (an index of habitat productivity), distance to industrial activities, distance

to water, and habitat quality ratings for predators (used as an index of predation risk). This result assumes that the current post-calving and summer distributions can be explained by pooled GPS collar data spanning 2004-2010, and that changes in land cover types are unlikely to have changed significantly since the land cover classification developed in the late 1990s. The selection surfaces are consistent with current GPS collar data as well as anecdotal evidence collected during regional monitoring programs at other mining operations (e.g., Ekati, Rescan 2013f). Information from IQ/TK indicates the Contwoyto Lake region as an important foraging area.

Across the post calving range (Figure 5.1-12a), caribou tended to avoid barren and sparsely vegetated cover types, as well as prostrate dwarf shrub and tussock graminoid tundra areas, relative to the availability of these cover types. In contrast, caribou tended to select tall shrub and forested habitats. Habitat suitability for predators, used as an indicator of potential predation risk, was included in the final model. There was evidence for selection of low quality wolf habitat and avoidance of low quality grizzly bear habitat. There was zero use of high quality wolf habitat, which resulted in the removal of this parameter from the final model. In the post-calving core range (Figure 5.1-12b), caribou tended to select for highly productive areas, as indicated by the significant positive coefficient for RVI, and avoided prostrate dwarf shrub cover types.

Across the entire summer range (Figure 5.1-12c) caribou tended to select for areas with low lying vegetation relative to their availability across the landscape, such as barren and sparsely vegetated areas (which may include eskers) and shrub cover types. Caribou tended to avoid wetter areas, such as wetlands and moist non-tussock graminoid tundra, and forested cover types. In the core use area (50% UD; Figure 5.1-12d), caribou tended to avoid barren and bryoid cover types, low and dwarf shrub areas, and forested areas, but selected for sparsely vegetated (including eskers) cover types, tall shrub areas, and graminoid tundra cover types.

### 5.1.3 Beverly Caribou

#### *5.1.3.1 Introduction*

The Beverly herd (formerly known as the Ahiak and Beverly herds) were recognized as distinct herds in the 1980s (Gunn and D'Hont 2002). The calving grounds of the Ahiak herd extended over about 31,000 $km^2$ on the coast of the western Queen Maud Gulf, west of the Perry River in the Ahiak region. These are the largest calving grounds of any mainland barren-ground caribou herd in Nunavut and the Northwest Territories (Johnson, Nagy, and Williams 2008). The Beverly herd, calved to the south of the Ahiak herd near Garry Lake. Work by Nagy et al. (2011) has revealed that over many years beginning sometime prior to 2002, the Beverly calving herd has joined the Ahiak in the western Queen Maude Gulf calving area (Campbell et al. 2012). This combined herd is currently referred to as the Beverly herd by the Government of Nunavut (Campbell et al. 2012). Data from satellite collars indicates that some female caribou that calve on the coast of the western Queen Maud Gulf occur in the wildlife RSA during late summer, fall and winter and that the wildlife RSA is on the western edge of the distribution of these caribou. This herd is referred to as the Beverly herd in this assessment, except where data is presented from prior to 2002, where the two herds are referred to as Ahiak and Beverly herds.

#### *5.1.3.2 Distribution and Migration Patterns*

Data on the distribution and movements of Beverly caribou have been derived from Inuit TK (KIA 2012), aerial calving ground surveys in 1986, 1996 and 2002 (Gunn and Fournier 2000; Gunn and D'Hont 2002), satellite collar data from five cows between 1996 and 1998 (Gunn and Fournier 2000) and satellite collar data from 5 to 52 cows per year between 2001 and 2012 (GNWT ENR 2012). The following sections describe the Beverly herd's seasonal distribution and movements.

The Beverly herd winters over a broad area from Bathurst Inlet to northern Saskatchewan and migrates north to the Arctic coast on the Queen Maud Gulf for calving and summer foraging. The yearly distribution and movements of Beverly caribou can be classified into six distinct periods: winter, spring migration, calving, post-calving, summer, and fall migration (Table 5.1-6). The timing of migration and calving is thought to be similar to Bathurst caribou, although the calving period for Beverly females is thought to be about one week longer, ending around June 20th instead of June 15th (Gunn and Fournier 2000; Johnson, Nagy, and Williams 2008).

**Table 5.1-6. Timing of Life History Stages of Beverly Caribou**

| Cycle Stage | Start Date | End Date |
|---|---|---|
| Spring Migration[1] | April 15 | June 4 |
| Calving[2] | June 5 | June 203 |
| Post-calving[4] | June 21 | July 25 |
| Summer[5] | July 26 | August 31 |
| Fall Migration[6] | September 1 | October 31 |
| Winter[7] | November 1 | April 14 |

[1] *Gunn, Fournier, and Nishi (2000).*
[2] *Gunn, Fournier, and Nishi (2000).*
[3] *Gunn, Fournier, and Nishi (2000); Gunn and D'Hont (2002); Johnson et al. (2008); Campbell et al. (2012)*
[4] *Five weeks post-calving, which includes post-calving and early summer periods defined in Gunn et al. (2008b); Russell, Kofinas, and Griffith (2002).*
[5] *Gunn et al. (2008b).*
[6] *Johnson et al. (2005); includes rut period defined in Gunn et al. (2008b).*
[7] *Includes late fall and winter periods defined in Gunn et al. (2008b).*

Spring Migration (April 15 to June 4)

During spring migration, Beverly female caribou migrate northwards from their wintering grounds to the calving grounds along Queen Maud Gulf. Satellite collar data indicate that some Beverly females are found in the wildlife RSA during winter and spring migration (Figure 5.1-13). Bulls and juvenile Beverly caribou follow the females north (Gunn and D'Hont 2002; Johnson, Nagy, and Williams 2008). Beverly caribou are segregated by age and gender on the calving grounds, with bulls occurring mostly on the eastern edge, females with cows in the middle, and non-parturient females and yearlings on the western edge (Campbell et al. 2012).

Calving (June 5 to 20)

Beverly caribou calve along the Queen Maud Gulf coast, on the east side of Bathurst Inlet, in the Queen Maud Gulf Migratory Bird Sanctuary (Gunn, Fournier, and Nishi 2000; Gunn and D'Hont 2002; A. D'Hont, GNWT ENR, unpublished data). In recent years, the calving grounds of the Beverly herd have overlapped the traditional (but not current) calving grounds of the Bathurst herd on the east side of Bathurst Inlet (Gunn and Fournier 2000; Gunn and D'Hont 2002). Beverly female caribou are not expected to occur in the wildlife RSA during calving, as their calving grounds are located north east of the wildlife RSA (Figure 5.1-14), but bulls and juveniles will likely occur there as indicated by aerial surveys (Gunn and Fournier 2000; D. E. Russell, Kofinas, and Griffith 2002).

Post-calving and Summer (June 21 to August 31)

Beverly cows and calves disperse south and southwest after calving (Figures 5.1-14). Relative to Bathurst cows, Beverly cows may spend more time on calving grounds during the post-calving period such that areas used for calving and after calving overlap (Gunn and Fournier 2000; Gunn and D'Hont

2002). This appears to be the result of river systems that caribou are reluctant to cross until water levels have receded (Campbell et al. 2012). Along with bulls and juveniles, Beverly cows and calves are expected to occur in the wildlife RSA during summer. The summer range of the Beverly herd overlaps the southern half of the wildlife RSA (Figure 5.1-15).

Fall Migration (September 1 to October 31)

During the fall, Beverly caribou continue move south from the summer range (Figure 5.1-15) towards the Thelon Game Sanctuary, located on the Northwest Territories/Nunavut border east of Great Slave Lake, where the rut occurs (Gunn and Fournier 2000). A small number of collared caribou move through the southern portion of the wildlife RSA during the fall migration (Figure 5.1-15). Analysis of collar data supports these trends, with high kernel density of collar locations (i.e., high amounts of use) overlapping Lac de Gras for Bathurst caribou in the fall (Figure 5.1-5) and the eastern Thelon Wildlife Sanctuary for Beverly caribou (Figure 5.1-15).

Winter (November 1 to April 14)

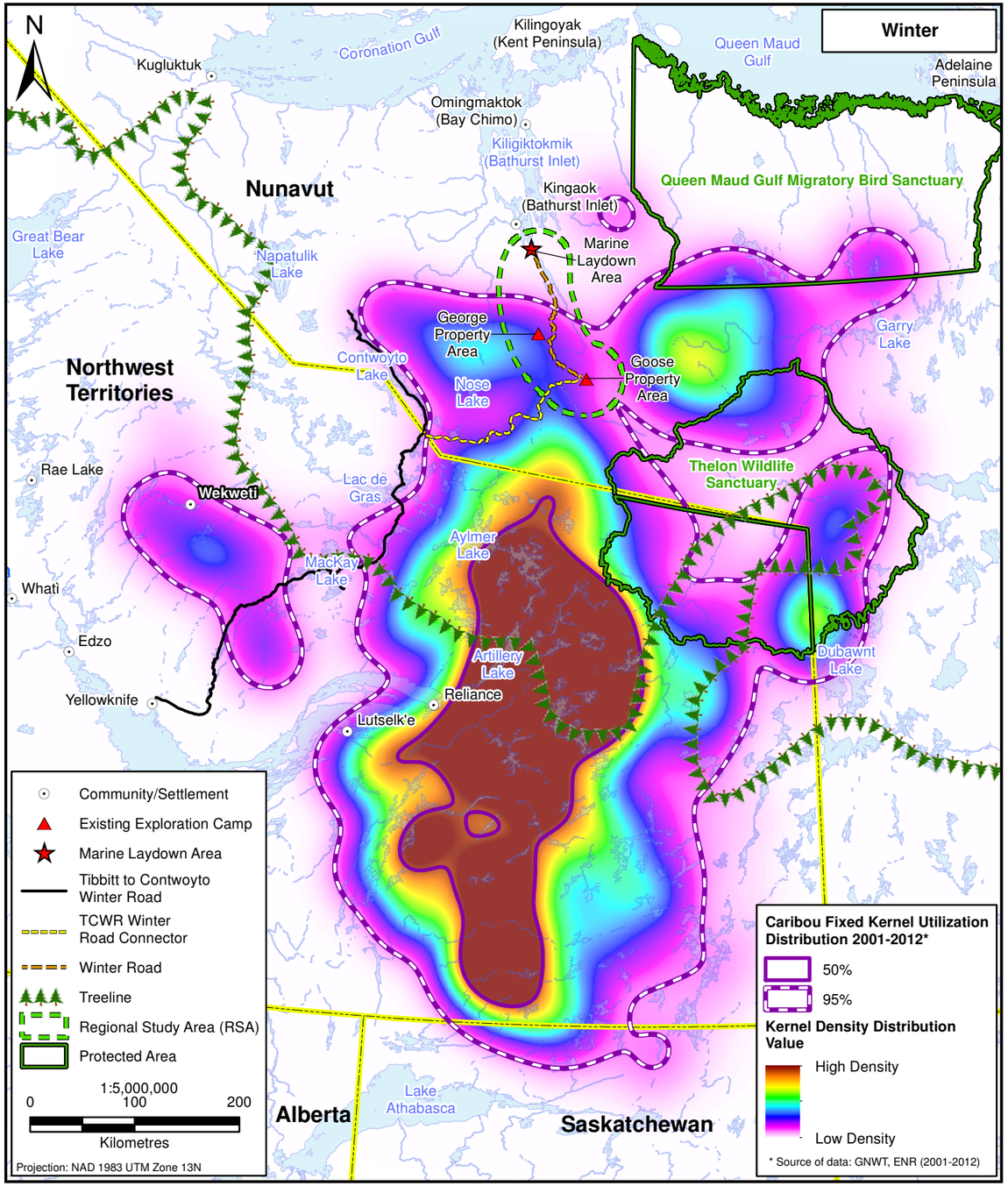
After rutting, Beverly caribou disperse south or northwest (a smaller portion) for the winter (Gunn and Fournier 2000). Beverly caribou, like Bathurst caribou have a large and variable winter range. In most years for which there is satellite collar data, Beverly females wintered on the tundra; in 1997 and 2001 Beverly females wintered in the taiga as far south as Saskatchewan (Gunn and D'Hont 2002; Gunn, Russell, and Eamer 2011). Beverly wintering grounds extend from Bathurst Inlet south to the area east of Great Slave Lake and the Saskatchewan border (Figure 5.1-13). The winter range of the Beverly herd overlaps that of the Bathurst herd. In some years, Beverly caribou were found in the southwestern portion of the wildlife RSA during winter; however, the core of the winter range does not overlap the wildlife RSA (Figure 5.1-13).

On the tundra, a key concern is that climate change may result in an increase in the number of rain-on-snow events, which can cause a hard crust to form on snow, sometimes making it more difficult for caribou to forage. Caribou, particularly Peary caribou, and muskox are thought to be susceptible to large-scale die-offs to starvation during arctic winters when ice layers form too thick for caribou and muskox to crater through the ice with their hoofs (reviewed in Jenkins et al. 2011). However, this hypothesis remains contentious; other factors like disease have yet to be tested for their role in die-offs of caribou and muskox in the arctic (Tyler 2010).

Beverly Caribou Distribution and Movements from Inuit TK

Inuit TK does not distinguish among caribou herds that occur on the mainland of Nunavut, but Dolphin and Union caribou were distinguished by their lighter color and were referred to as island caribou (KIA 2012). Membership to a particular herd can be inferred based on the location and timing of observations of mainland caribou recorded by Inuit TK. Inuit TK includes observations of large numbers of caribou migrating across Beechey Lake in historic times (KIA 2012). Based on the current migration route of the Beverly herd, it is likely that at least some of these caribou were of the Beverly herd.

Several key nadlok (caribou crossing places) were used along Beechey Lake, where Inuit were able to hunt enough caribou to support a large camp throughout the year (KIA 2012). Observations of mainland caribou inter-mixed with Dolphin and Union caribou in winter on either side of Bathurst Inlet may have been those of the Beverly herd. These results would indicate that the winter range of the tundra-wintering caribou, including some members of the Beverly herd, extended much further north in historic time than is indicated by recent collaring data (Nagy, Campbell, and Kelly 2012).



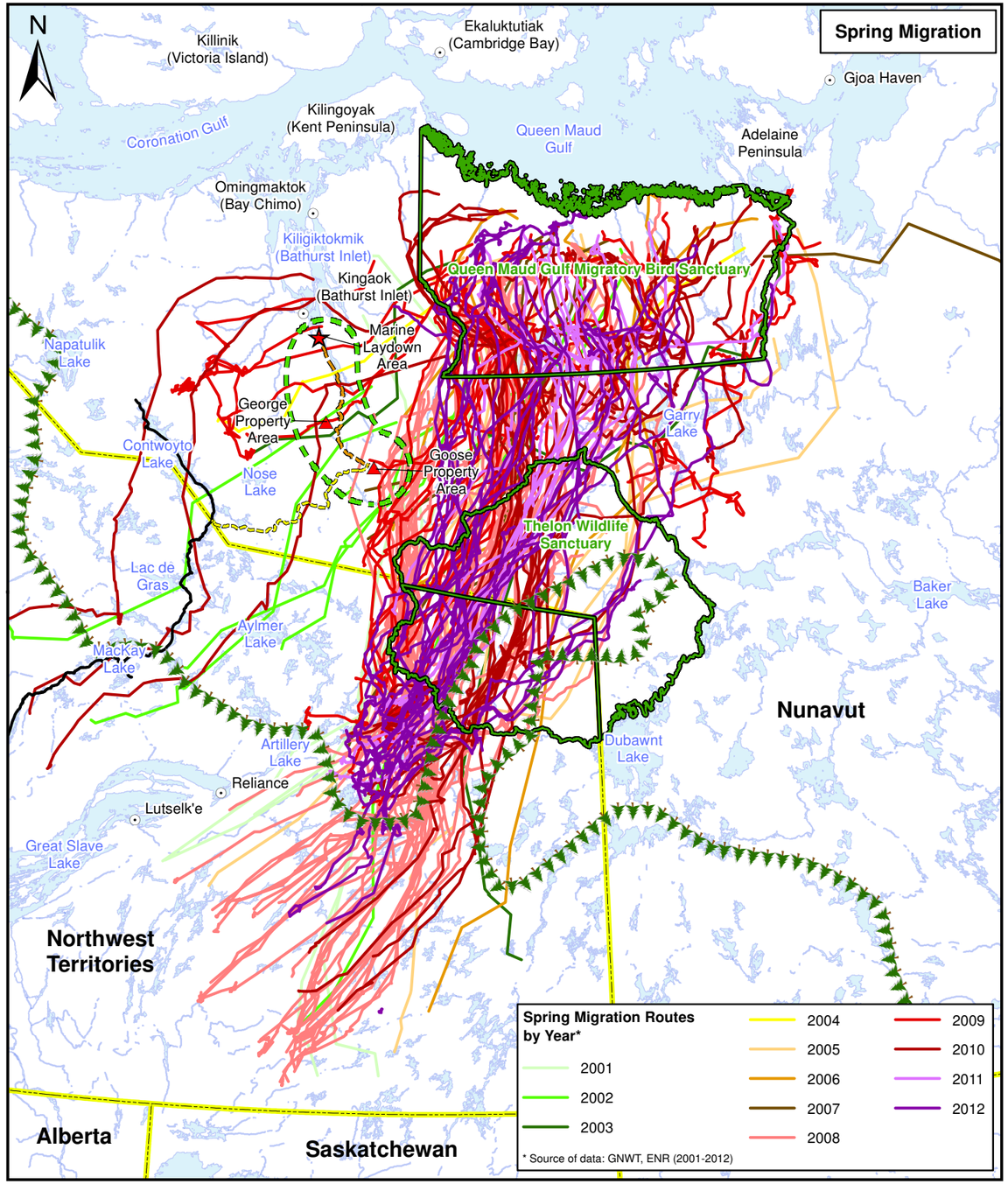




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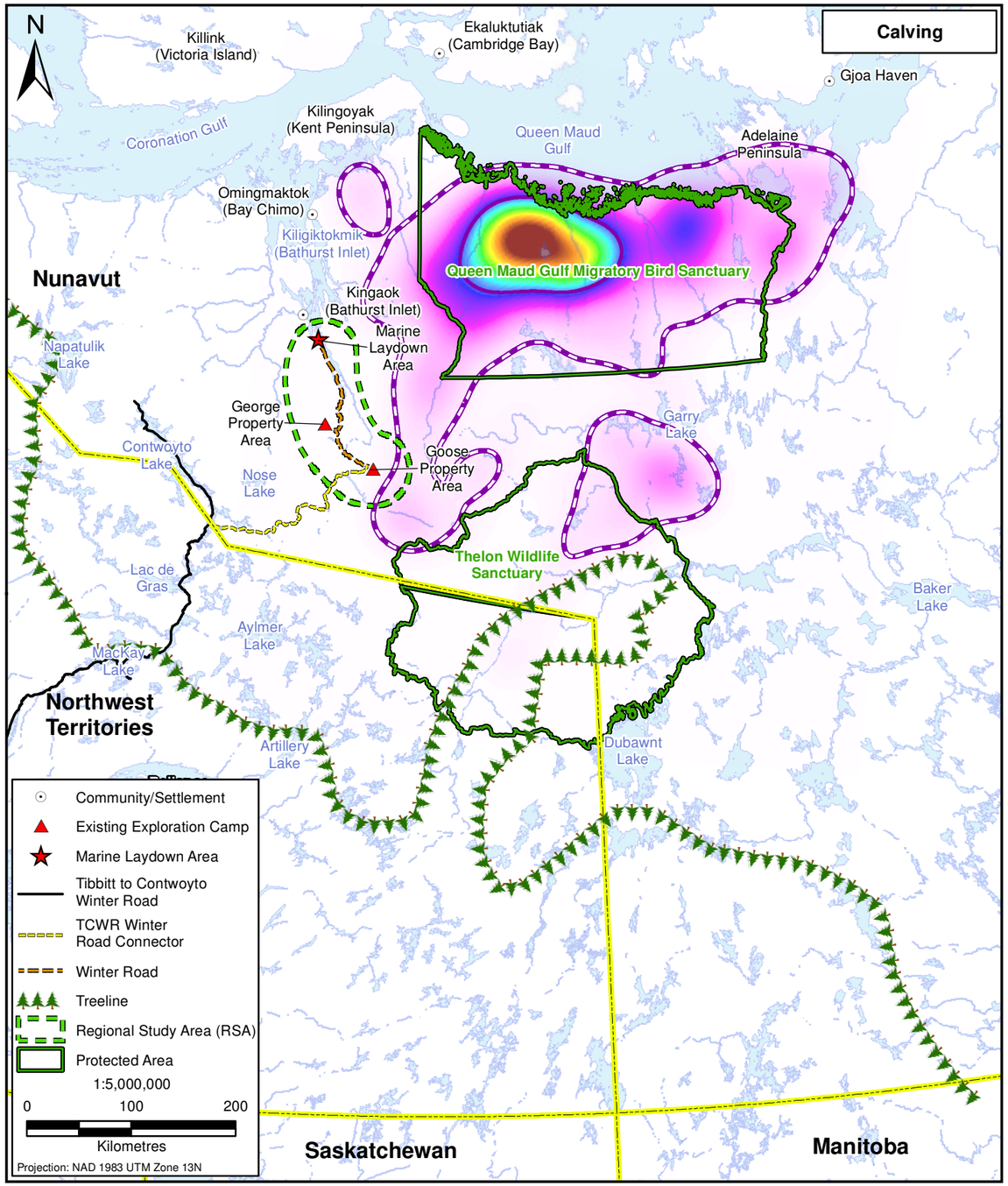
**Figure 5.1-13**

**Locations of Satellite-collared Beverly Caribou during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 2001 to 2012**



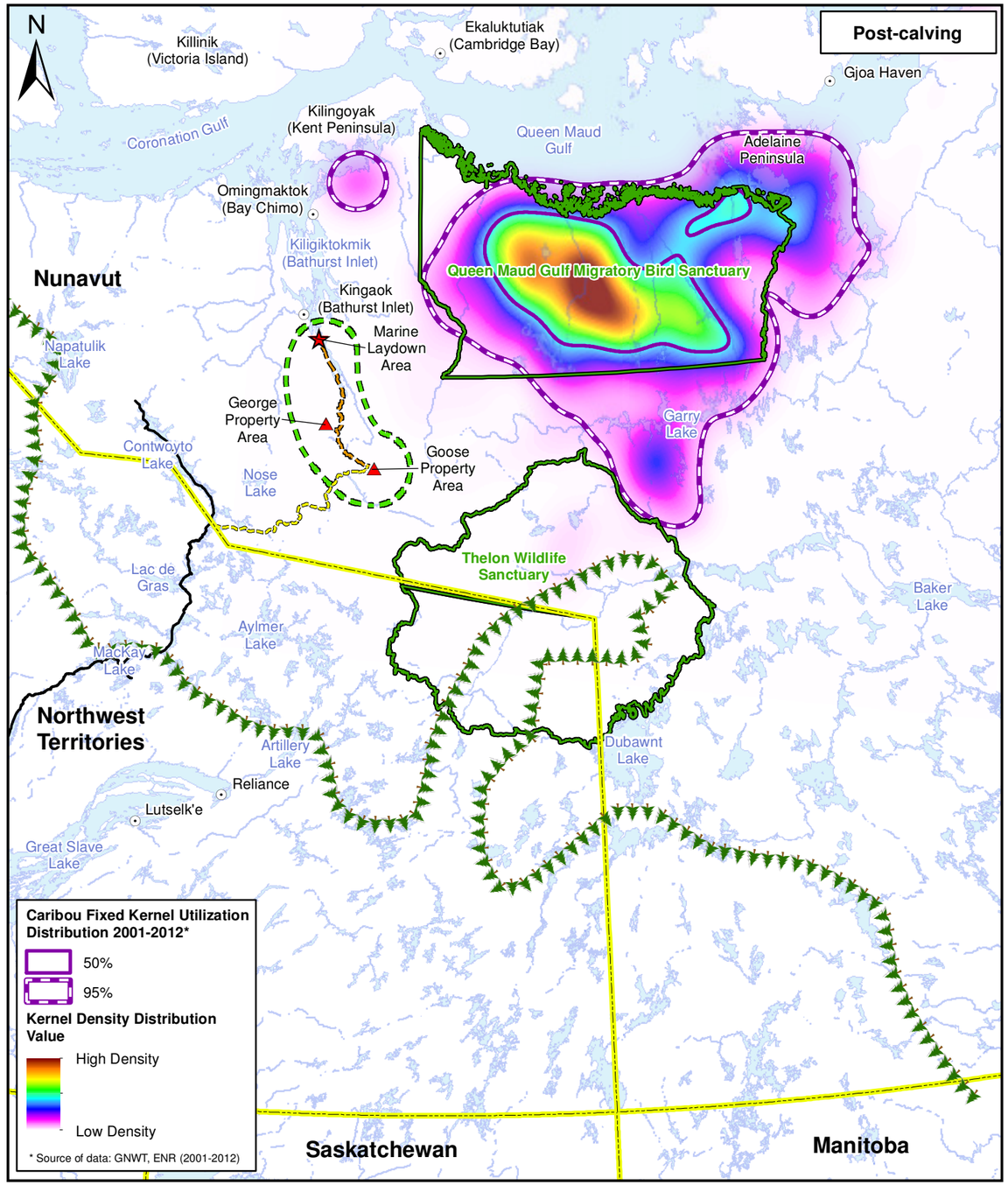




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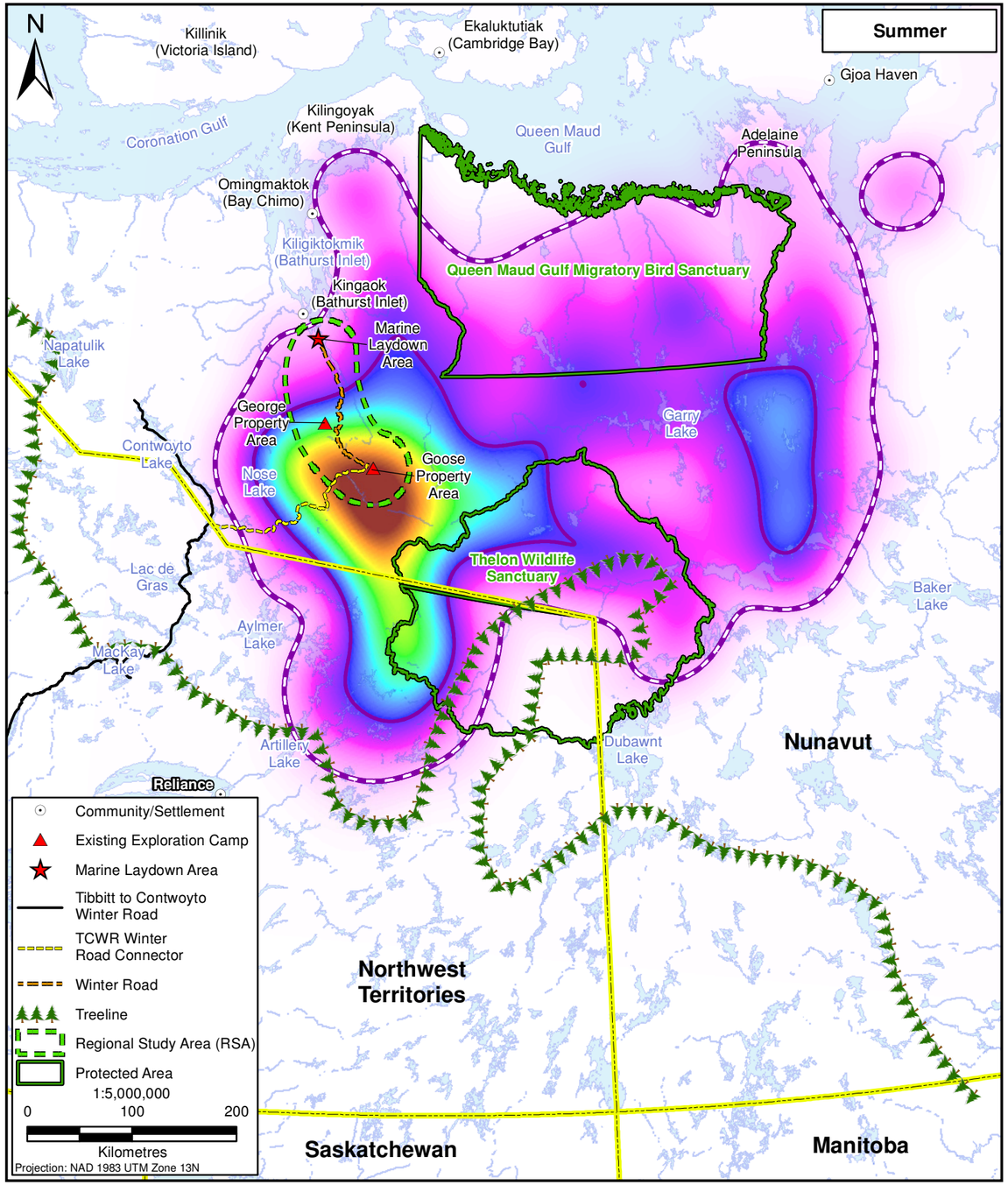
**Figure 5.1-14**

**Locations of Satellite-collared Beverly Caribou during Calving (5 June to 20 June) and Post-calving (21 June to 25 July), 2001 to 2012**



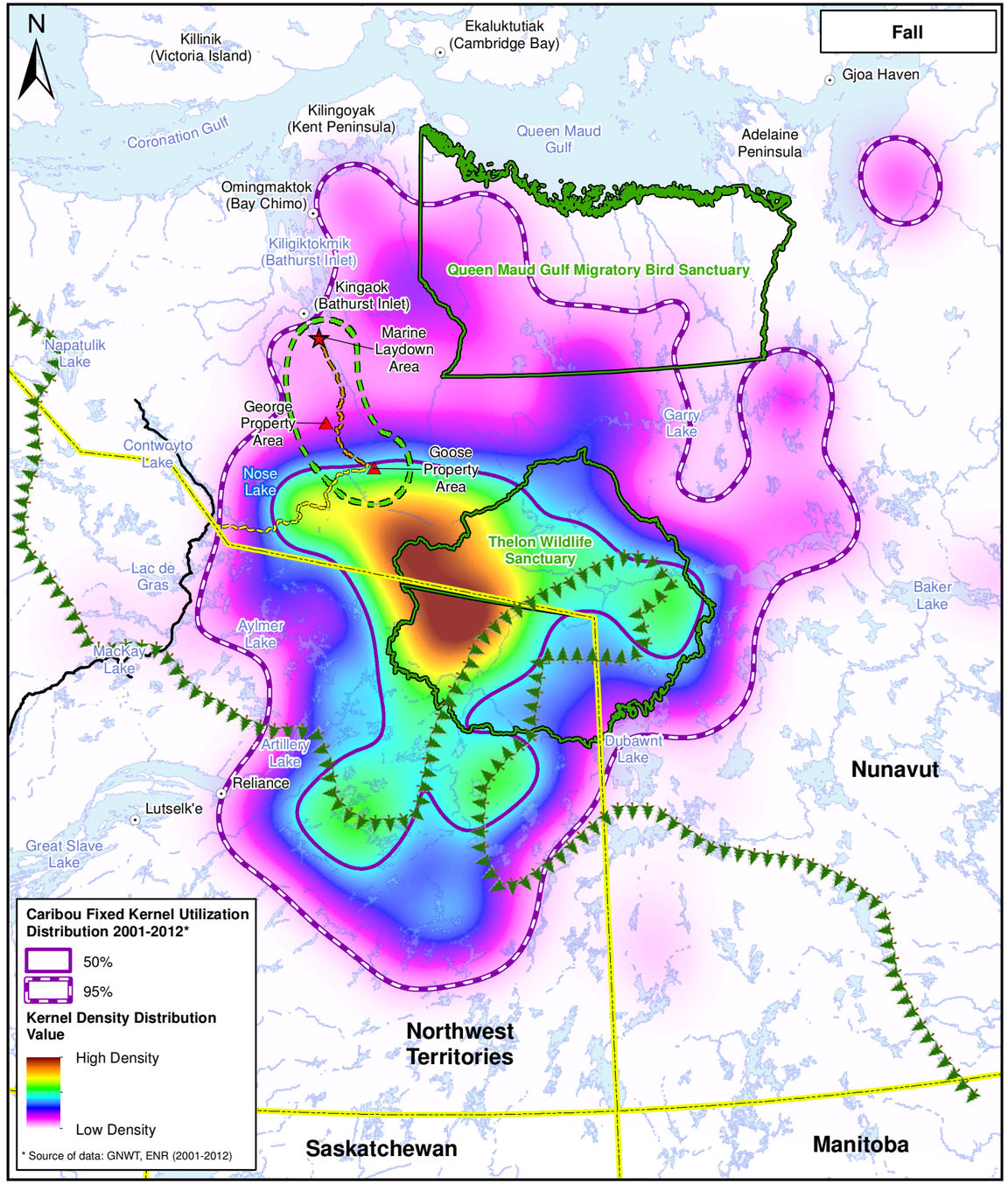




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**Figure 5.1-15**

**Locations of Satellite-collared Beverly Caribou during Summer (26 July to 31 August) and Fall (1 September to 31 October), 2001 to 2012**

Summary of Beverly Herd Movements and Distribution

Beverly caribou overwinter in the boreal forest and move relatively quickly to calving grounds to the northeast of the wildlife RSA. Caribou cross through the southern portion of the wildlife RSA near Goose Camp during the spring migration. During post-calving, females and calves remain in the Queen Maud Gulf Migratory Bird Sanctuary east of the wildlife RSA. During the summer and into the fall, a small proportion of the Beverly herd range overlaps the wildlife RSA, particularly around the southern half before migrating south towards the treeline.

#### *5.1.3.3 Population Trends and Conservation*

Based on aerial surveys of the calving grounds along the Queen Maud Gulf, the Beverly herd (at the time referred to as the Ahiak herd) increased from between 40,000 and 60,000 animals in 1986 to roughly 200,000 animals in 1996 (Gunn, Fournier, and Nishi 2000). In 2006, 123,000 caribou (mostly female) were estimated on the calving grounds, suggesting that the population increased again from 1996 to 2006 (Gunn, Russell, and Eamer 2011). However, data from satellite-collared cows has revealed that the former Beverly herd, which calved south of the Ahiak herd near Garry Lake, has gradually shifted their calving to the area used by the Ahiak herd (Nagy et al. 2011). Thus, the apparent population increase of the Ahiak herd has been a result of the gradual shift of the Beverly herd to the Ahiak calving grounds (Gunn, Russell, and Eamer 2011; Nagy et al. 2011). Aerial surveys conducted in June 2011 resulted in an estimated population size of 124,189 (± 13,996) caribou, of which 52,825 (± 2,638) were breeding females(Campbell et al. 2012). Note that these caribou are now collectively referred to as the Beverly herd. As a whole, it is likely that the Beverly herd has declined in abundance (Campbell et al. 2012).

Beverly caribou are harvested by people from the communities of Gjoa Haven, Omingmaktok, Cambridge Bay, and Lutsel K'e, and in winter by people from northern Saskatchewan when some of the herd overwinters there (Gunn, Russell, and Eamer 2011). Harvest rates are not known.

#### *5.1.3.4 Habitat Use and Diet*

Habitat selection and diet of barren-ground caribou on the tundra is thought to be similar among herds (Gustine et al. 2012). Information for the habitat use of Bathurst and Beverly caribou herds is presented in this section for the seasons where these herds are both on the tundra: spring migration, calving, post-calving, summer and fall migration. Unlike the Bathurst herd which overwinter below the tree line, a considerable proportion of the Beverly caribou overwinter on the tundra and are discussed separately below.

Detailed habitat mapping of habitat quality in the wildlife RSA for both Bathurst and Beverly caribou are described in Section 5.1.2.5; Habitat Suitability Modelling.

Winter (November 1 to April 14)

During winter, caribou are relatively sedentary, usually moving less than 2 km per day (Joly 2008). Key characteristics of high quality winter habitat for tundra-wintering caribou are low snow depth and abundant lichen, which comprises 10-60% of caribou diets during winter (reviewed in Ferguson, L. Gauthier, and F. Messier 2001; Joly, Chapin, and Klein 2010). Inuit TK includes observations of wintering caribou in areas where snow is relatively shallow, such as in rocky or elevated wind-swept areas where caribou could more easily crater for lichen (KIA 2012). Insufficient forage availability in winter can have a large impact on population dynamics of tundra-wintering caribou. Poor female body condition during winter can affect calf weights and survival, and thus population recruitment (Couturier, Cote, Otto, et al. 2009). Because of the energetic demands of their growing foetuses, female caribou may choose riskier habitats that provide good forage relative to bulls (Joly 2008).

In years with rain-on-snow events, which can cause a hard icy crust to form on snow, caribou must expend added energy to crater with their hooves to access lichen and graminoids (Fancy and White 1985; Adamczewski et al. 1988; D. E. Russell, Martell, and Nixon. 1993). This can result in caribou having to move to upland areas (Fancy and White 1985), and to places where lichens may be less abundant, thus compounding energetic imbalances caused by icing. When lichen become over-grazed on wintering grounds, caribou emigrate to other areas (Ferguson, L. Gauthier, and F. Messier 2001).

Caribou, particularly arctic-wintering caribou, and muskox are thought to be susceptible to large-scale die-offs to starvation during arctic winters when ice layers form too thick for caribou to crater through the ice with their hoofs (reviewed in Jenkins et al. 2011). However, this hypothesis remains contentious; other factors like disease have yet to be tested for their role in die-offs of caribou in the arctic (Tyler 2010).

#### *5.1.3.5 Baseline Data for Beverly Caribou Herd*

The objectives of baseline studies were to highlight where the Beverly caribou herd is located during each season and to what degree these movements overlapped with the Project area and how caribou use habitat within the wildlife RSA on a variety of scales. Several data sources are available from government agencies and other information was directly collected in the field. Four separate types of baseline studies were conducted, including:

1. Analysis of satellite collar data (1996-1998 and 2001-2012) to determine movement patterns and seasonal ranges;
2. Aerial surveys conducted in 2001, 2002, 2007, and 2010 in the wildlife RSA during key life history stages for caribou;
3. Remote motion-triggered cameras (2012 and 2013) for monitoring habitat use of certain habitat features and for determining detailed timing information for when caribou use these features; and
4. Habitat suitability modelling to determine the location and abundance of various habitat type identified from literature review as important for caribou.

The results of these baseline studies are presented for both Bathurst and Beverly caribou in Section 5.1.2.5. Highlights of these data which pertain to the Beverly herd are summarized below.

Satellite Collar Data

The distribution of satellite collar data was mapped using 50% and 95% fixed kernel utilization distributions (UD) for the Beverly herd. Collars were active from five Beverly (then known as Ahiak) cows between 1996 and 1998 (Gunn and Fournier 2000) and satellite collar data from 5 to 52 cows per year between 2001 and 2012 (GNWT ENR 2012). Maps of the 50% and 95% UD for Beverly caribou are presented in Figures 5.1-13, 5.1-14, and 5.1-15.

Seasonal ranges (as defined by the 95% kernel UDs) for Beverly caribou overlap with the wildlife RSA in all seasons except during post-calving. Thus, Beverly caribou are expected to be found in the wildlife RSA throughout the year. Overall, collar data suggests that Beverly caribou are most commonly present around the Goose Property in the summer (Figure 5.1-15) from mid-July to the end of August (Rescan 2013d, Appendix V5-5C). The wildlife RSA overlaps the western range extent of the Beverly herd. Most notably, collared Beverly caribou were present within the wildlife RSA around both the Goose and George properties during the summer (July 16 to August 31). Collared Beverly caribou passed through the eastern edge of the wildlife RSA on their way to the calving grounds located north-east of the wildlife RSA during spring migration (May).

Aerial Surveys

Aerial surveys were conducted in 2001, 2002, 2007, 2008 and 2010 in the wildlife RSA using standard census techniques for large mammals (Rescan 2002, 2007a, 2011a). The timing of surveys corresponded with the spring and early fall migration, calving, and post-calving periods for caribou (Table 5.1-3). Details of methods and results can be found in Section 5.1.2.5; Aerial Surveys.

Aerial surveys reported few caribou present in the wildlife RSA during the spring migration and very few during the calving periods; indicating that the calving areas for both Bathurst and Beverly caribou fall outside of the wildlife RSA. Groups of caribou were observed on the western side of the wildlife RSA during post-calving, which were consistent with the position of collared Bathurst herd. During the summer, caribou were observed, sometimes in large groups, in the southern area of the wildlife RSA, south of Goose PDA. The timing of these observations was consistent with the location of the Beverly herd in late summer.

Remote Cameras

Sixty cameras were placed in the wildlife RSA in 2012 and 2013 and another 60 cameras were placed in a matching area to the west of the wildlife RSA at the same time. The methods and locations of these cameras is described in Section 5.1.2.5; Remote Cameras.

As with aerial surveys, cameras reported information on caribou distribution that was corroborated by the collar data:

- few or no caribou in the wildlife RSA during spring migration and calving;
- large groups to the west of the wildlife RSA during post-calving which were attributed to the Bathurst herd; and
- several large and medium-sized groups in the southern portion of the wildlife RSA during the cusp between post-calving and summer and during the summer period, which were attributed to the Beverly herd.

Approximately 600 caribou likely belonging to the Beverly herd were recorded in the southeast sector of the wildlife RSA post-calving in July. Two large herds (N > 200) were observed in the south-east sector of the wildlife RSA; one on July 27, 2012 and the other on August 20, 2012 (Rescan 2013d, Appendix V5-5C) and 25 smaller herds (N = 2 to 49) were also observed (Figure 5.1-8). The spatial overlap is comprised of the south-east portion of the wildlife RSA and coincides with the summer range of the Beverly herd. Very low camera detections of caribou in the wildlife RSA during calving corroborate the observations of researchers that bulls and immature caribou generally follow females to calving grounds (D. C. Heard, T. M. Williams, and D.A. Melton 1996).

Several of the cameras were placed a likely river crossing points, following direction from Inuit landusers who assisted in the placement of cameras. One of these crossing points was observed to be used by several large groups of caribou during the late summer. The crossing, at the east end of Beechey Lake, is inside the wildlife RSA, but approximately 15 km south of the Project. Inuit through their TK have identified several important historic nadloks (crossings) along Beechey Lake (Figure 5.1-6).

Habitat Suitability Modelling

Habitat suitability modelling was conducted for the wildlife RSA for all caribou herds combined and is reported in Section 5.1.2.5: Habitat Suitability Modelling.

## 5.1.4 Dolphin and Union Caribou

### *5.1.4.1 Introduction*

Dolphin and Union caribou are named after the Dolphin and Union strait on which they migrate during their annual spring and fall migrations between the mainland and Victoria Island. Dolphin and Union caribou are genetically distinct from Peary caribou and barren-ground caribou (COSEWIC 2004). The herd is federally listed as "Special Concern" on Schedule 1 of SARA. (COSEWIC 2004). Major threats to this herd have been identified as climate change, and winter shipping activity along the herd's migration route (COSEWIC 2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (COSEWIC 2004). Climate change may shorten the time interval caribou have on the mainland between the fall and spring migrations, since this movement is dependent on ice formation. Since 1982, freeze-up has occurred 8-10 days later which may have affected the timing of fall migration (Poole et al. 2010). Concern has been raised about increased shipping activity which may break up the ice in Dease Strait or the Queen Maud Gulf, Dolphin and Union caribou migration may be blocked or animals may fall through the recently broken ice (COSEWIC 2004; Poole et al. 2010).

Caribou habitat is one of six main issues identified in the NLUP for environmental protection (NPC 2012a). In addition to calving areas, migration routes "especially at water crossings" have been identified as key aspects of caribou habitat. The plan stipulates that herds are vulnerable to ice breaking, and considerations for mitigation and management fall under Recommendation PSE-R3, which states "Project Proposals located in and/or near known caribou sea ice crossing areas should take into account impacts that may impede the ability of caribou to cross the ice." Water crossings are also considered (NPC 2012a).

Climate change has been identified as a major threat to some caribou herds, particularly to the Dolphin and Union herd which migrates from the mainland across sea ice to calve on Victoria Island (COSEWIC 2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (COSEWIC 2004). Climate change may shorten the time interval caribou have on the mainland between the fall and spring migrations, since this movement is dependent on ice formation. Since 1982, freeze-up has occurred 8-10 days later which may have affected the timing of fall migration (Poole et al. 2010).

### *5.1.4.2 Distribution and Migration Patterns*

Dolphin and Union caribou winter on the Nunavut mainland and migrate over the sea ice during the annual spring migration to their calving and summering grounds on Victoria Island, returning to the mainland during the fall migration (KIA 2012). The yearly distribution and movements of Dolphin and Union caribou can be classified into six distinct periods: winter, spring migration, calving, post-calving, summer, and fall migration (Table 5.1-7). The following sections discuss the demography and distribution of the Dolphin and Union caribou herd with emphasis on timing and migratory routes across sea ice.

<u>Spring Migration (April 17 to June 29)</u>

The Dolphin and Union herd migrates from their wintering grounds on the northern coast of the mainland across the sea ice between April and June to its calving grounds that extend across the northwest portion of Victoria Island where they also spend the summer. During the spring migration, the majority of animals cross the sea ice northward from mid-May to late June (Figure 5.1-16; Poole et al. 2010). Analysis of satellite collar data (1999-2004) from Dolphin and Union caribou indicates that spring migration occurs from between 17 April to 29 June (Figure 5.1-16; M. Dumond, GN DOE, unpublished data).

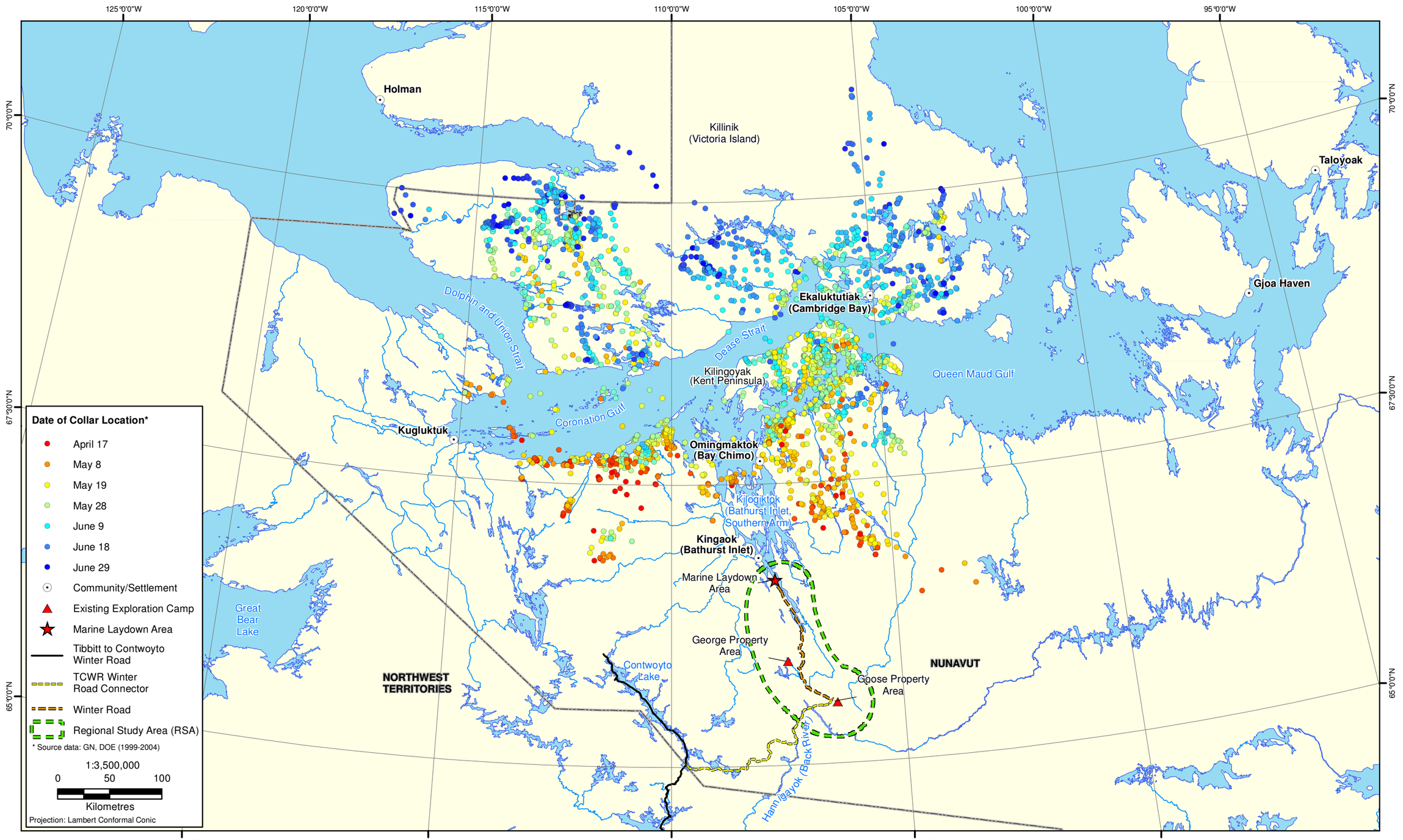


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**Figure 5.1-16**

**Locations of Satellite-collared Dolphin and Union Caribou during the Northward Spring Migration (17 April to 29 June), 1999 to 2004**

**Table 5.1-7. Timing of Life History Stages of Dolphin and Union Caribou**

| Cycle Stage | Start Date | End Date |
|---|---|---|
| Spring Migration | April 17[1] | June 29 |
| Calving | June[2] | June[2] |
| Post-Calving and Summer | July 1[3] | October 19 |
| Fall Migration | October 20[1] | December 8 |
| Winter | December 8[4] | April 16 |

*[1] Spring and fall migration dates defined as the periods when satellite-collared Dolphin and Union caribou crossed the Coronation Gulf, Dease Strait, and the Queen Maud Gulf from 1999 to 2004.*
*[2] General calving period (Gunn and Fournier 2000; Nishi 2000); specific dates not given due to limited data.*
*[3] Post-calving and summer defined as the period after calving and before fall migration.*
*[4] Winter defined as the period when satellite-collared caribou were located on the Nunavut mainland, between fall and spring migrations.*

The median date of crossing in the spring is 24 May; crossing initiation date is correlated with the timing of ice formation (Poole et al. 2010). The Kent Peninsula and islands in the Coronation and Queen Maud Gulf are important staging sites during crossing, especially during the north migration (Gunn et al. 1997; Poole et al. 2010). Satellite collar data do not show any locations of Dolphin and Union caribou within the wildlife RSA but some animals may have been observed during May, 2007 surveys at the northern extent of the survey area (M. Dumond, GN DOE, unpublished data).

Calving (June), Post-calving and Summer (July 1 to October 19)

Dolphin and Union caribou calve and summer on Victoria Island (Figure 5.1-17; COSEWIC 2004; Poole et al. 2010). Calving occurs in June (Gunn and Fournier 2000; Nishi 2000). There is overlap in dates for spring migration and calving because males and juveniles continue to migrate across the ocean after parturient and non-parturient females have arrived on Victoria Island.

Fall Migration (October 20 to December 8)

In the fall, the herd migrates to the southern coast of Victoria Island for the rut, before migrating back across sea ice between October and late November to over-winter on the mainland. During the fall migration and after the rut and a staging period along the south coast of Victoria Island, the majority of animals cross the sea ice southward from late October to mid-November. Analysis of satellite collar data (1999-2004) from Dolphin and Union caribou indicates that fall migration occurs between 20 October to 8 December (Figure 5.1-18; M. Dumond, GN DOE, unpublished data). Beginning as early as October 20, Dolphin and Union caribou migrate across the sea ice to over-winter on the mainland (Figure 5.1-18). The duration of time that caribou are travelling across sea ice in early winter is shorter than the spring migration. Though caribou travelled on sea ice as late as December 8, the median date of crossing in the fall is November 1 (Poole et al. 2010) and most of the caribou have crossed the straight by November 28.

Winter (December 8 to April 16)

Dolphin and Union caribou winter on the Nunavut mainland (Figure 5.1-19) along the Coronation Gulf, on the Kent Peninsula, and along the western extent of the Queen Maud Gulf (COSEWIC 2004; Poole et al. 2010). Inuit TK includes observations of some Dolphin and Union caribou over-wintering on Victoria Island prior to the 1950s, but not since then (KIA 2012). A minimal number of satellite-collared Dolphin and Union caribou have been found in the extreme northern tip of the wildlife RSA during winter suggesting that the majority of the wildlife RSA is south of the Dolphin and Union winter range (Figure 5.1-19).

Dolphin and Union Caribou Distribution and Movements from Inuit TK

Inuit TK distinguishes Dolphin and Union from mainland caribou by their light color, and refers to the Dolphin and Union herd as island caribou (KIA 2012). Inuit TK includes observations of the historical distribution of the Dolphin and Union herd in winter, primarily in two concentrations on the east and west of Bathurst Inlet, which corresponds with their current winter distribution based on collar data. However, Inuit TK also includes observations of Dolphin and Union caribou as far south as Bathurst Lake during winter (KIA 2012), which has not been observed by western scientists in at least the last decade. Based on these observations, and the much larger historical size of the Dolphin and Union herd, it is possible that the winter range of the Dolphin and Union herd has contracted along with its population abundance. Inuit TK also includes regular observations of caribou along the shoreline of Bathurst Inlet throughout the year (KIA 2012). In late fall and winter, at least some of these observations were likely of members of the Dolphin and Union herd.

Summary of Dolphin and Union Herd Movements and Distribution

The Dolphin and Union caribou herd crosses Dease Strait and Queen Maud Gulf during the spring and fall migrations between Victoria Island and the mainland (COSEWIC 2004; Poole et al. 2010). Dolphin and Union caribou travel across the sea ice twice as fast during the south migration to the mainland in the fall than during the north spring migration (Poole et al. 2010). The herd moved across the ice over an average of 48 days in the spring and 23 days in the fall, corresponding to mean times to cross and mean travel rates of 4 days and 12 km/day in the spring, and 1.7 days and 23 km/day in the fall (Poole et al. 2010).

Caribou cannot cross south to the mainland until ice has formed, and cannot cross north to Victoria Island once the sea ice has melted. Ice-breaking in Dease Strait or the Queen Maud Gulf has the potential to disrupt caribou migrations or cause caribou mortality (COSEWIC 2004).

Dolphin and Union caribou are outside of the wildlife RSA, except during winter, when the southern edge of their distribution intersects the northern tip of the wildlife RSA. The remainder of the wildlife RSA is considered outside of the range of the Dolphin and Union caribou.

#### *5.1.4.3 Population Trends and Conservation*

In the early 1900s, the Dolphin and Union caribou herd was estimated at 100,000 animals (COSEWIC 2004). Overhunting and possibly also rain-on-snow events caused a population decline between 1900 and 1920 to the point where caribou were not observed migrating between Victoria Island and the mainland after about 1930 (Gunn 2005). Beginning in the 1970s, the herd size increased, and in the late 1980s caribou resumed migration between Victoria Island and the mainland (Gunn et al. 1997). In spring 1993, approximately 7,200 Dolphin and Union caribou were counted on the mainland prior to migrating over the ice in spring (Gunn et al. 1997). In 1997, the Dolphin and Union herd was estimated at 28,000 ± 3,350 animals (Nishi and Gunn 2004), about one-third of its historic size. A population estimate of 28,000 ± 2,500 in 2007 suggests the population size is stable or declining slightly, though still only a third of its historic size (M. Dumond, GN , unpublished data, cited from Poole et al. 2010; COSEWIC 2004). Inuit TK parallels these findings; Dolphin and Union caribou were rarely observed in the 1950s, but observations had become regular by the 1990s (KIA 2012).

A key hypothesis to explain population declines of tundra-wintering caribou and muskox, including the Dolphin and Union herd, is high mortality due to starvation during winters with severe ice conditions (COSEWIC 2004). Large die-offs of muskox and Peary caribou occurred during winter on islands in the Canadian Arctic, which has been attributed to rain-on-snow events that make it difficult for caribou to crater through snow to reach forage (Gunn, Dragon, and Boulanger 2002; F. L. Miller and Barry 2009).

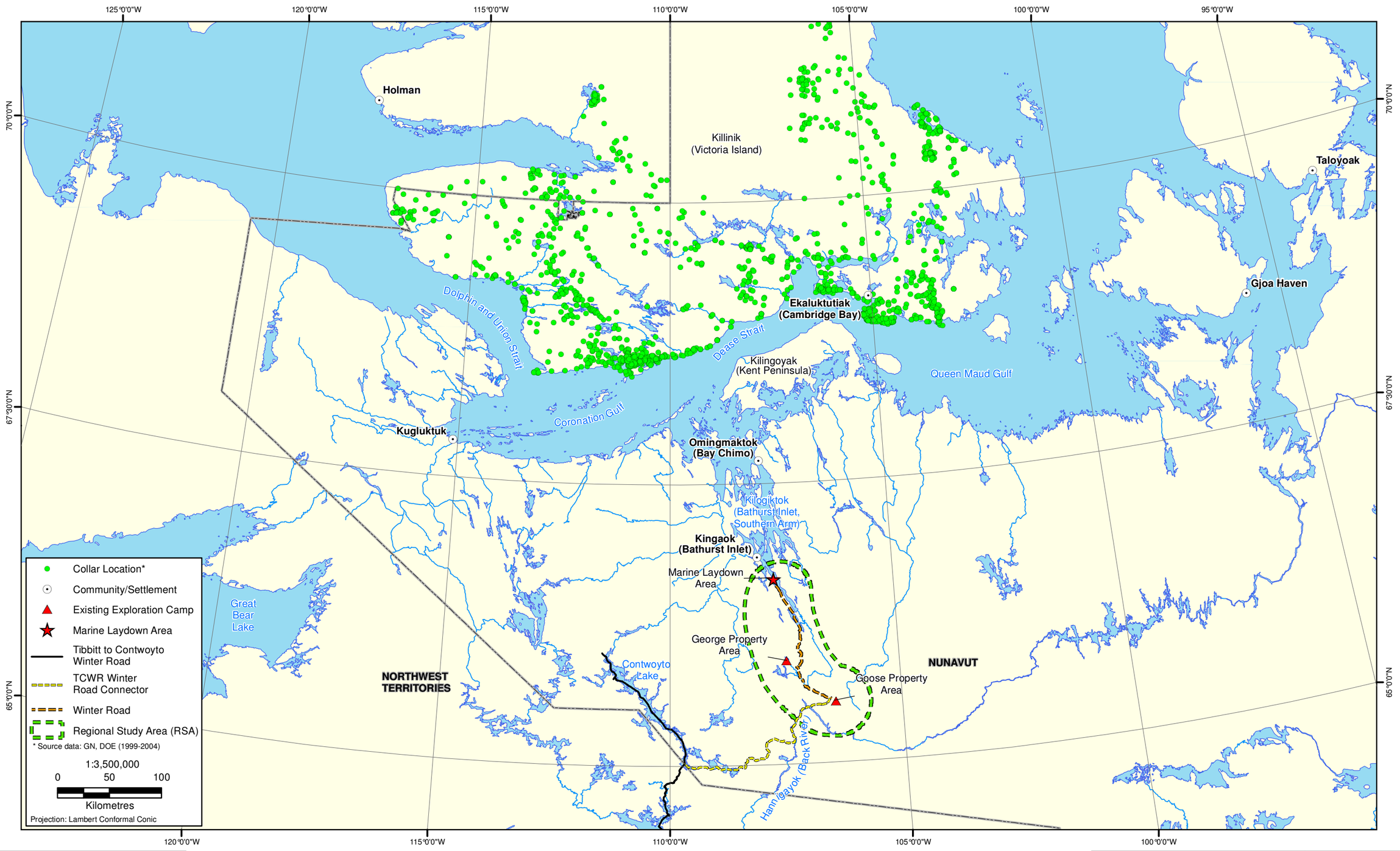


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**Figure 5.1-17**

**Locations of Satellite-collared Dolphin and Union Caribou during Calving and Summer (30 June to 19 October), 1999 to 2004**

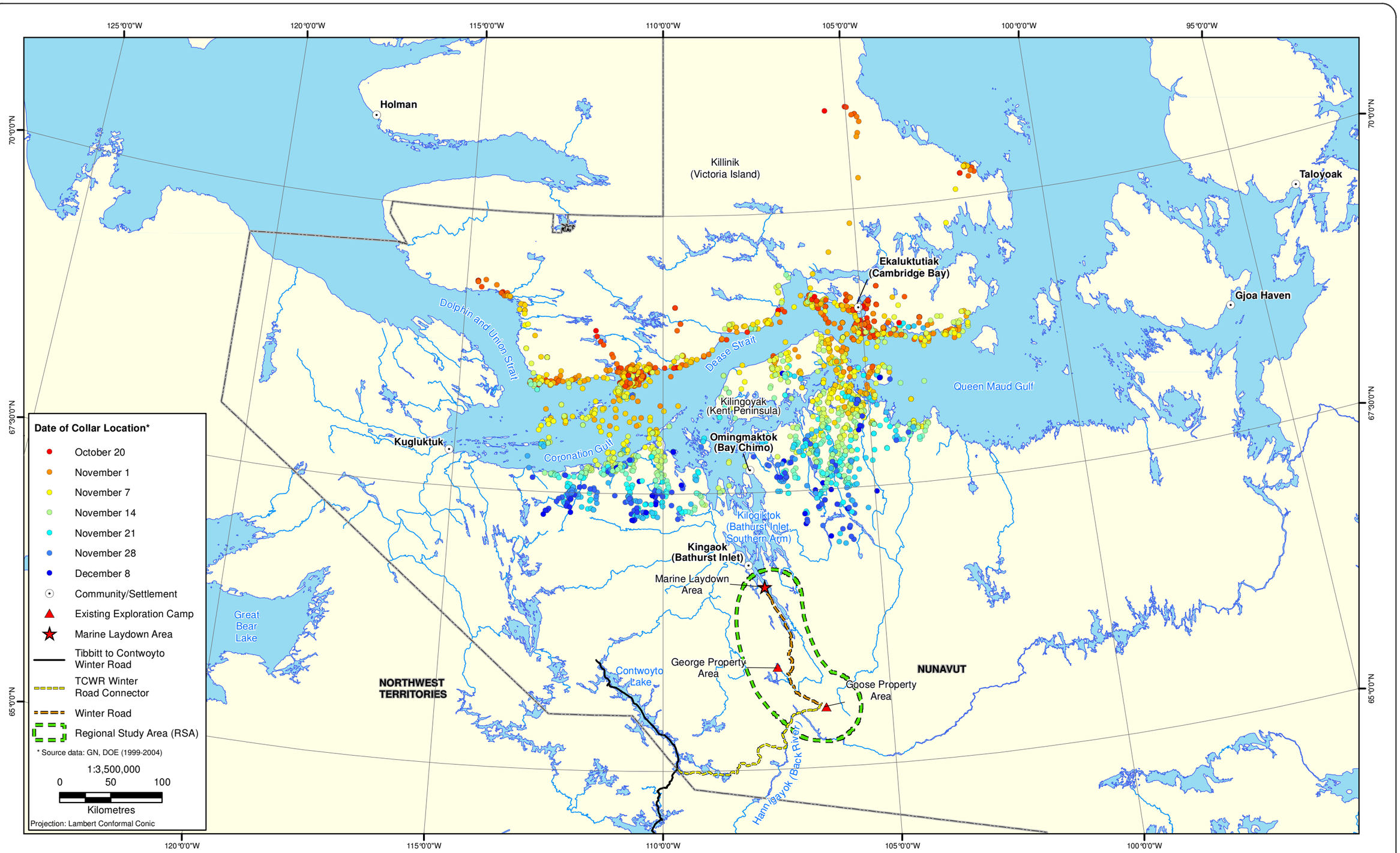


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**Figure 5.1-18**

**Locations of Satellite-collared Dolphin and Union Caribou during the Southward Fall Migration (20 October to 8 December), 1999 to 2004**

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**Figure 5.1-19**

**Locations of Satellite-collared Dolphin and Union Caribou during Winter (9 December to 16 April), 1999 to 2004**

While die-offs have been observed — scientists observed hundreds of caribou and muskox carcasses (Gunn, Dragon, and Boulanger 2002) — icing as the cause of the die-offs remains a hypothesis (Tyler 2010; Hansen et al. 2011). Data on icing is limited and accounts relating mortality to icing events have been mostly anecdotal (Tyler 2010). However, data from the Norwegian Arctic show low calf production following all but one winter with high ice cover (Stien et al. 2012), and strong correlation between icing and population size (Hansen et al. 2011).

Still relatively un-addressed by the scientific community, disease and parasites comprise a plausible alternative explanation for die-offs of tundra-wintering caribou. Parasites may also contribute to population decline — female Dolphin and Union caribou infected with high parasite loads had lower body condition and thus low probability of pregnancy (Hughes et al. 2009). Still another hypothesis is poisoning from naturally high heavy metals in vegetation.

Mortality during sea-ice crossings has been proposed as yet another explanation for population declines in the Dolphin and Union herd (Poole et al. 2010; Festa-Bianchet et al. 2011). Dolphin and Union caribou have been observed by hunters to die after breaking through newly-forming ice, and caribou have been observed with ice on their fur in December, possibly from falling through sea ice during southward migration (reviewed in Poole et al. 2010).

Caribou are of economic and cultural importance to the Inuit and other residents of Nunavut. Most northern communities, including Bathurst Inlet, Kugluktuk and Omingmaktok, harvest Bathurst, Dolphin and Union, and Bluenose East caribou (GNWT ENR 2012). Data from Inuit hunters indicates that between 1996 and 2001, the average number of caribou harvested annually by Inuit hunters (averaged by community) were: 93 in Bathurst Inlet (Bathurst Inlet Lodge 2007), 1,575 in Kugluktuk and 176 in the community of Omingmaktok (Priest and Usher 2004). These data include harvests of caribou from multiple herds.

Subsistence harvest rates of the Dolphin and Union herd are not known, but thought to be about 10% of the population mainly from Kugluktuk (Coppermine), Omingmaktok (Bay Chimo), and Kingaok (Bathurst Inlet; Nishi and Gunn 2004; Poole et al. 2010).

#### *5.1.4.4 Baseline Data for the Dolphin and Union Caribou Herd*

The objectives of baseline studies were to highlight where the Dolphin and Union caribou herd is located during each season and to what degree these movements overlapped with the Project area and how caribou use habitat within the wildlife RSA on a variety of scales. Several data sources are available from government agencies and other information was directly collected in the field. Four separate types of baseline studies were conducted, including:

1. Analysis of satellite collar data (1999-2004) to determine movement patterns and seasonal ranges;
2. Aerial surveys conducted in 2001, 2002, 2007, and 2010 in the wildlife RSA during key life history stages for caribou;
3. Remote motion-triggered cameras (2012 and 2013) for monitoring habitat use of certain habitat features and for determining detailed timing information for when caribou use these features; and
4. Habitat suitability modelling to determine the location and abundance of various habitat type identified from literature review as important for caribou.

The results of these baseline studies are presented for Bathurst and Beverly caribou in Section 5.1.2.5. Highlights of these data which pertain to the Dolphin and Union herd are summarized below.

Satellite Collar Data

Collaring programs for the Dolphin and Union herd began in the 80s (Gunn, Fournier, and Nishi 2000), these collars were not global position system (GPS) collars and the number of animals collared was minimal. No collars on Dolphin and Union caribou have been functioning since 2006. The Dolphin and Union herd has a minimal chance to interact with habitat in the wildlife RSA, however; analysis of satellite collar data was carried out to ensure that no interaction between this herd and the MLA in Bathurst Inlet could occur. Collaring data used for these analyses included that obtained between 1999 and 2004.

The distribution of satellite collar data was mapped using 50% and 95% fixed kernel utilization distributions (UD) for the Dolphin and Union herd. Maps of the 50% and 95% UD for Beverly caribou are presented in Figures 5.1-16, 5.1-17, 5.1-18, and 5.1-19.

Collaring data for Dolphin and Union caribou indicate that this herd has potential to interact with the wildlife RSA during winter only.

Aerial Surveys

Aerial surveys were conducted in 2001, 2002, 2007, 2008 and 2010 in the wildlife RSA using standard census techniques for large mammals (Rescan 2002, 2007a, 2011a). The timing of surveys corresponded with the spring and early fall migration, calving, and post-calving periods for caribou (Table 5.1-3). Details of methods and results can be found in Section 5.1.2.5; Aerial Surveys.

Caribou were observed in the northern section of the wildlife RSA during aerial surveys conducted in March 2010 and during those conducted in May in 2002 (Rescan 2002), 2007 (Rescan 2007a), and 2010 (Rescan 2011a, Appendix V5-5E). While it is likely that these caribou represent Beverly herd caribou during their spring migration to their calving grounds northeast of the wildlife RSA, there is some potential that these caribou are Dolphin and Union caribou on their migration north towards the sea ice.

Remote Cameras

Sixty cameras were placed in the wildlife RSA in 2012 and 2013 and another 60 cameras were placed in a matching area to the west of the wildlife RSA at the same time (Rescan 2013d, Appendix V5-5C; Rescan 2014). The methods and locations of these cameras is described in Section 5.1.2.5; Remote Cameras.

Motion triggered cameras were unlikely to have captured Dolphin and Union caribou in the wildlife RSA in 2012 as these cameras were deployed in late May long after the Dolphin and Union caribou have migrated north to their calving grounds on Victoria Island.

Habitat Suitability Modelling

Habitat suitability modelling was conducted for the wildlife RSA for all caribou herds combined and is reported in Section 5.1.2.5; Habitat Suitability Modelling.

## 5.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The following reports were reviewed for TK specific information related to caribou:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);

- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.

Information regarding caribou knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot study communities. Additional TK was adapted from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report, commissioned by Kitikmeot Inuit Association (KIA 2012).

Traditional knowledge, land user knowledge, and thoughts raised by the KIA and land users were incorporated into the effects assessment chapter in five primary ways:

1. Caribou were included as a VEC for a number of reasons (Section 5.3.2), including that they are a culturally and socially important species in the Project area.
2. Caribou distribution information from TK was incorporated in the existing environment and habitat suitability modelling report (Section 5.1.5) and effects assessment, including:
   - The location of the traditional calving ranges for the Bathurst herd, both east and west of Bathurst Inlet.
   - The location of an additional traditional calving area for the Bathurst herd, to the north of Nose Lake and around Beechey Lake.
   - The fact that the Bathurst herd calving grounds have changed frequently through time between their various traditional calving grounds.
   - The location of the Beverly calving ground.
   - The movement patterns of both Bathurst and Beverly caribou herds between their winter, calving, summer, and back to winter ranges.
   - The location of the Dolphin and Union herd calving ground.
   - Movement patterns of the Dolphin and Union herd on Bathurst Inlet and across the Dolphin and Union Straight.
   - The importance of Nose Lake and Contwoyto Lake for summering Bathurst Caribou.
3. Detailed habitat usage information for caribou, including:
   - The use of eskers and other elevated landforms during summer for ease of movement and relief from insects.
   - The use of wet foraging locations during the post-calving, including areas with cotton grass, as important forage for lactating females and newly weaned calves.
   - The use of lakeshores as travel corridors and for insect relief.
4. TK and landuser information were used to position the remote cameras at locations identified by TK as important to caribou. Elders and landusers also worked with Rescan biologists in the field to position and install cameras in high-quality foraging habitats and travel corridors.
5. TK information identified habitat loss and disturbance as concerns for caribou and these potential effects were subsequently added to the effects assessment for caribou.

6. TK, the KIA and landusers raised concerns about the effects of winter roads on caribou. Two potential effects were evaluated as a consequence: potential disruption of movement and effects of direct mortality in the effects assessment.
7. TK and landuser information was included in the preparation of management plans to reduce Project-related effects on caribou (Volume 10, Chapter 20).

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

### 5.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

### 5.2.2 Incorporation of TK for VEC and VSEC Selection

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

### 5.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013b). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit

cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

### 5.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

### 5.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities. Specific comments are summarized in Section 5.3.1.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air quality: Volume 4, Chapter 1;
- Freshwater water quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and fish habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial wildlife: Volume 5, Chapter 6 (caribou), Chapter 7 (grizzly bear), Chapter 8 (muskox), Chapter 9 (wolverine and furbearers), Chapter 10 (migratory birds), and Chapter 11 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

## 5.3 VALUED COMPONENTS

### 5.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the DEIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013) and other information and processes as described below. The VECs were selected based on the following information:

- potential interaction with the proposed Project;

- consultation with communities;
- available TK information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered and detailed in Chapter 1:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members.

### 5.3.2 Valued Components Included in Assessment

Caribou have been identified as a VEC due to their importance to Inuit people, scientific studies, and their federal, territorial, and regional conservation status. Inuit TK, academic and monitoring studies have shown that under certain circumstances caribou are susceptible to a variety of development-related disturbances, and these may result in shifts in distribution and possibly also population declines (R. D. Cameron et al. 1992; Nellemann and Cameron 1998; Thorpe et al. 2001; Dyer et al. 2002; C. J. Johnson et al. 2005; Boulanger et al. 2011). For these reasons, caribou were included in this assessment.

Six caribou herds have been identified with geographic ranges that overlap elements of the wildlife terrestrial Regional Study Area (RSA) or the wildlife marine RSA. A description of these herds and the justification for their inclusion or exclusion from the assessment is listed in the following section.

The Bathurst herd occurs in the wildlife terrestrial RSA during the post calving period, when the northern extent of their range overlaps the western and southern portion of the wildlife RSA (Figure 5.1-2). During this period, the caribou move from their calving areas between the Hood and Burnside Rivers and to their summer range surrounding and to the east of Contwoyto Lake (Section 5.1.2.2). The Bathurst herd has declined continuously since the late 1980s and declined quickly during the 2000s to < 10% of its size in the late 1980s. The Project Application Information Requirements (AIR) specified that the Bathurst herd be included in the DEIS assessment and this herd is included as a VEC in this assessment.

The Beverly herd occurs in the wildlife terrestrial RSA during the summer, fall and winter (Figures 5.1-13 to 5.1-15). This herd calves and spends its post calving period in western Queen Maude Gulf and both its summer and winter on the tundra. The Beverly herd is composed of the Ahiak herd, which calved on Queen Maude Gulf and the Beverly herd which calved at Garry Lake, to the south of the Ahiak calving grounds. Starting sometime before 2002, the Beverly herd moved their calving to join the Ahiak caribou on their calving ground. The combined herds are now known collectively as the Beverly herd. Because of the number of seasons that this herd overlaps the wildlife RSA, it is included as a VEC in the effects assessment.

Dolphin and Union caribou are named after the Dolphin and Union strait on which they migrate during their annual spring and fall migrations between the mainland and Victoria Island (Figures 5.1-16 to 5.1-19). Dolphin and Union caribou are genetically distinct from Peary caribou and barren-ground caribou (COSEWIC 2004). The herd is federally listed as "Special Concern" on Schedule 1 of SARA. (COSEWIC 2004). Major threats to this herd have been identified as climate change, and winter shipping activity along the herd's migration route (COSEWIC 2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (COSEWIC 2004). Concern has been raised about increased shipping activity which may break up the ice in Dease Strait or the Queen Maud Gulf, Dolphin and Union caribou migration may be blocked or animals may fall through the recently broken ice (COSEWIC 2004; Poole et al. 2010). The 95% fixed kernel UD distribution of this herd does not overlap with the wildlife terrestrial RSA, but it does overlap with the wildlife marine RSA with covers most of Bathurst Inlet. Shipping activity for the Project will occur only in the open water months, and so potential spatial or temporal overlap is not expected between the Project and this caribou herd, because caribou use the inlet as a migration corridor when the ice is frozen. Therefore, this herd was not included as a VEC in the effects assessment.

The Peary caribou herd may overlap the commercial Northwest Passage shipping route outside of the wildlife marine RSA only (outside of assessment area). Concerns have been raised for this herd about the potential effects of shipping if ice breaking is used — which may block movement patterns of this herd, or cause mortality when caribou break through thin ice (COSEWIC 2004). The Project is shipping during the open-water season only and will not, therefore, be ice breaking. Hence, the Project does not have a spatial-temporal overlap with this herd and they are not included in the assessment.

Three additional herds calve on the eastern edge of the Nunavut mainland: the Queen Maude Gulf herd, the Lorillard and Wager Bay herds whose distribution may overlap with the Project infrequently during the winter. The Queen Maud gulf herd calves on the eastern Queen Maude Gulf area, adjacent to the Beverly herd, while the Lorillard and Wager Bay herds calve to the south-east of the Queen Maude Gulf herd. These three herds overwinter on the tundra and in some years the extreme western edge of their winter distribution overlaps with the south-east portion of the wildlife RSA. For tundra-wintering caribou, this effects assessment discusses potential effects due to the Project with reference to the Beverly herd, which has a portion of its summer, fall and winter ranges overlaps with the wildlife RSA in most years. The Beverly herd is therefore used as a proxy for the Queen Maude Gulf, Lorillard and Wager Bay herds. Any effects that may occur for these three herds is assumed to be smaller than that for the Beverly herd, which has a longer duration, extent and frequency of overlap with the wildlife RSA. Hence, these three herds are not included in the effects assessment. If a significant effect were determined for the Beverly herd, then potential effects on these herds would be revisited.

The majority of caribou herds are declining across their circumpolar range (Vors and Boyce 2009). Researchers have proposed three key mechanisms causing declines in barren-ground caribou — high mortality rates of adult females from hunting and predation (Adamczewski et al. 2009; Boulanger et al. 2011), low survival through harsh winters (reviewed in Festa-Bianchet et al. 2011), and decreased birth rates and calf survival due to poor female body condition (Gaillard, Festa-Bianchet, and Yoccoz 1998; Griffith et al. 2002). These relationships may also be influenced by climatic oscillations or change, affecting forage availability (e.g., Joly et al. 2011). Project effects that result in stressors on the energy management of caribou and increase predation risk may affect caribou habitat selection, movement, and reproduction, and therefore population size.

## 5.4 SPATIAL AND TEMPORAL BOUNDARIES

### 5.4.1 Spatial Boundaries

The caribou effects assessment considered two study areas for wildlife inventory for the Project: a wildlife Local Study Area (LSA) and a wildlife Regional Study Area (RSA; Figure 5.4-1).

#### *5.4.1.1 Local Study Area*

The boundaries of the Local Study Area (LSA) for caribou were set to encompass the following:

- the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, George, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Chapter 4, Section 4.4.1) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property, George Property, and MLA. The wildlife LSA covers an area of approximately 134,369 ha (Figure 5.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

#### *5.4.1.2 Regional Study Area*

The wildlife RSA for caribou encompasses the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three potential development areas (Goose Property Area, George Property Area, and MLA). The wildlife RSA covers an area of approximately 1,262,005 ha (Figure 5.4-1). The wildlife RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

### 5.4.2 Temporal Boundaries

The temporal boundaries used for the caribou effects assessment align with the time periods of the phases of the Project as presented in Table 5.4-1.

**Table 5.4-1. Temporal Boundaries - Project Phase Durations**

| Activities | Duration |
|---|---|
| Site Preparation | 2 years |
| Construction phase | 2 years |
| Operational phase | 10 years |
| Reclamation and Closure phase | 10 years |
| Post-Closure phase | 5 years |
| *Other Potential Phases* | |
| Temporary Closure | Less than 2 years |
| Care and Maintenance phase | 2 to 10 years |

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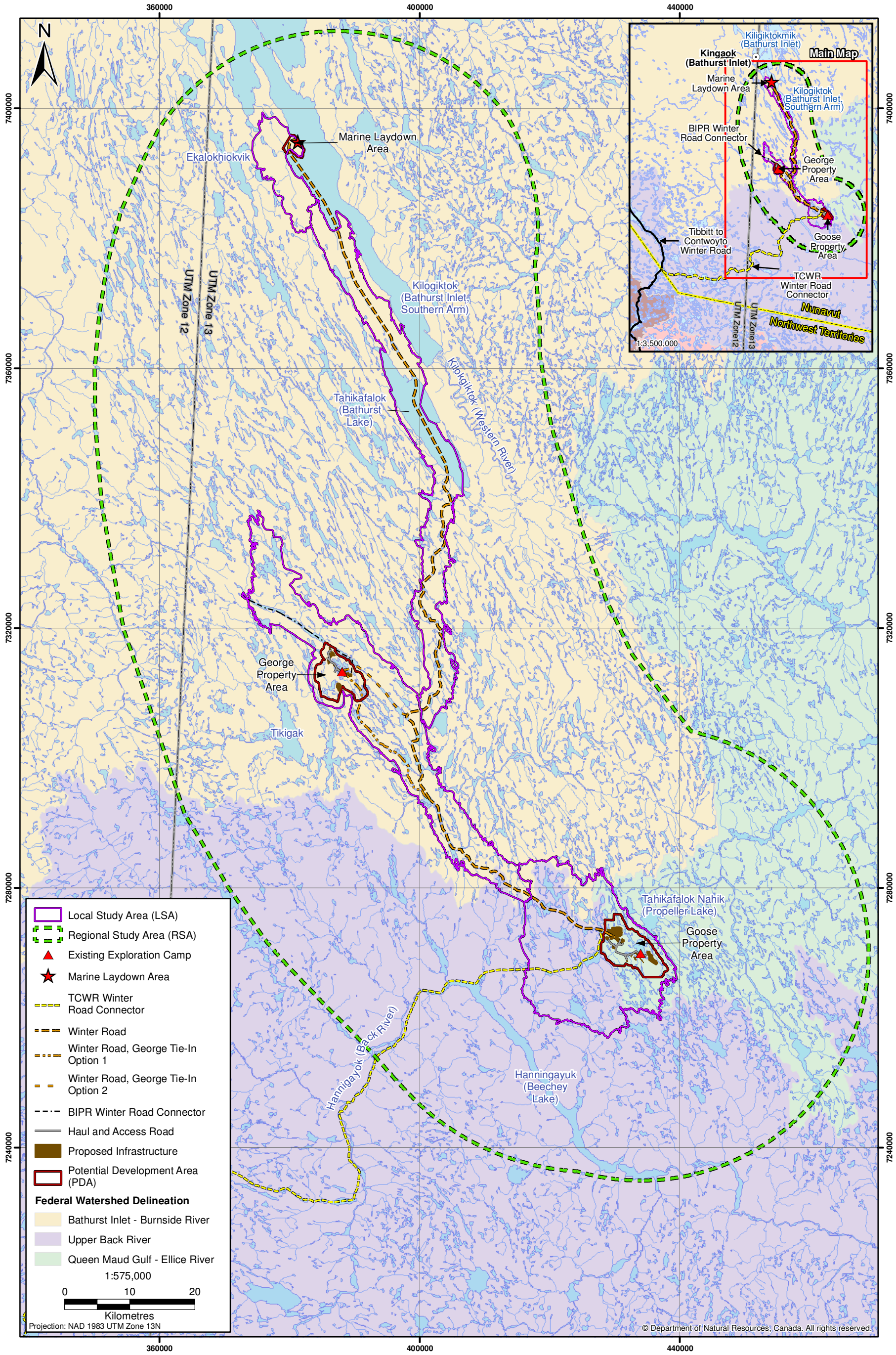


Figure 5.4-1

Sabina GOLD & SILVER CORP.

## Local Study Area and Regional Study Area for Caribou

Figure 5.4-1

Rescan an ERM company

## 5.5 PROJECT EFFECTS ASSESSMENT

### 5.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on caribou as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

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

The potential effects of the Project on caribou are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

#### *5.5.1.1 Indicators Used to Characterize Potential Residual Effects*

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 5.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of 'yes' or 'no' where triggering of residual effects assessment occurred if the indicator value was 'yes' (e.g., indirect mortality to caribou was triggered as a residual effect if the Socio-economic assessment indicated an increase in access to the wildlife RSA).

**Table 5.5-1. Criteria and Indicators Used to Characterize Potential Effects on Caribou**

| Potential Effect | Criteria | Indicator |
|---|---|---|
| Habitat Loss | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disturbance due to Noise | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disruption to Movement | Change in Population Health | Traffic timing, and traffic volume |
| Direct Mortality and Injury | Change in Population Health | Traffic timing, traffic volume, and vehicle speed |
| Indirect Mortality | Change in Population Health | Predicted increase in human access to wildlife RSA |
| Attraction | Change in Population Health | Attraction occurred at similar Projects in Nunavut and Northwest Territories |
| Exposure to Contaminants | Change in Population Health | Predicted Hazard Quotients for metals in environmental media and wildlife |
| Reduction in Reproductive Productivity | Change in Population Health | Literature suggests combined residual effects on caribou |

### *5.5.1.2 Magnitude Ratings for Residual Effects*

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 5.5-2).

**Table 5.5-2. Definitions of the Magnitude Ratings for Population Health Criterion**

| Magnitude Rating | Magnitude Descriptor of Criteria (Population Health) |
|---|---|
| Negligible | No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%. |
| Low | Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%. |
| Moderate | Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%. |
| High | Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%. |

*Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects professional judgment and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.*

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for caribou, which provide benchmark measures, as well as estimates of the natural variability. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

### *5.5.1.3 Overall Significance Ratings of Residual Effects*

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 5.5-2) and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 5.5-3). For example, a residual effect receives a rating of Not Significant if it is expected to be one of the following: negligible or low magnitude, confined to the LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

**Table 5.5-3. Definitions of Significance Ratings for Residual Effects on Caribou**

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

Finally, the degree of uncertainty in the rating was provided as a qualifier.

### 5.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VEC caribou and the Project is provided in Volume 9, Chapter 1. Potential Project-related effects on caribou and caribou habitat have been included in the assessment based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, Inuit TK and land user knowledge, and a review of scientific literature of the effects of developments on caribou. The effects of mining developments in the Arctic have been documented through monitoring programs at the Lupin gold Mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Doris North mine (Rescan 2011b, 2013e). Interactions of caribou with Project components were evaluated to determine which of the following potential effects may occur (Table 5.5-4):

- habitat loss;
- disturbance due to noise (e.g., displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g., due to increased access and associated increase in hunting);
- attraction (e.g., altered inter-species relationships);
- exposure to contaminants; and
- reduction in reproductive productivity due to all effects of the Project combined.

**Table 5.5.4. Potential Project-related Effects to Caribou in the Goose Property Area, the George Property Area, and the Marine Laydown Area**

| Potential Development Area | Project Component | Habitat Loss | Disturbance | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity |
|---|---|---|---|---|---|---|---|---|---|
| *Goose Property Area* | | | | | | | | | |
| | Open Pits (Main (Goose, Umwelt, and Llama) | X | X | X | X | | | | X |
| | Haul and access roads | X | X | X | X | X | | | X |
| | Winter roads | | | | | X | | | X |
| | Stockpiles | X | X | | | | | | X |
| | Waste rock storage areas | X | X | X | | | | X | X |
| | Explosives storage areas | X | | | | | | | X |
| | Tailings Impoundment Area | X | X | | | | X | X | X |
| | Quarries | X | X | | | | | | X |
| | Landfill | X | X | | | | X | | X |
| | Camp / Plant site | X | X | X | X | X | X | X | X |
| | Airstrip | X | X | X | X | | | | X |
| | Other infrastructure (diversion channels, water intakes) | X | | | | | | | X |
| *George Property Area* | | | | | | | | | |
| | Open Pits (LCP North, Locale 1,and Locale 2) | X | X | X | X | | | | X |
| | Haul and access roads | X | X | X | X | | | | X |
| | Winter roads | | | | | X | | | X |
| | Stockpiles | X | X | | | | | | X |
| | Waste rock storage areas | X | X | X | | | | X | X |
| | Explosives storage areas | X | | | | | | | X |
| | Landfill | X | X | | | | X | | X |
| | Camp | X | X | X | X | X | X | X | X |
| | Other infrastructure (water intake) | X | | | | | | | X |
| *Marine Laydown Area* | | | | | | | | | |
| | Camp | X | X | | | | X | X | X |
| | Barge landing location | X | X | | | | | X | X |
| | Haul and access roads | X | X | | X | | | | X |
| | Winter roads | | | | | X | | | X |
| | Other infrastructure (interception ditch) | X | | | | | | | X |

Caribou can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of high quality foraging habitat. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development. For these reasons, habitat loss was included and evaluated in this assessment.

Disturbances, including visual and auditory stimuli, can cause caribou to alter their regular behaviour patterns, resulting in lost feeding time, stress, reduced reproductive potential, or avoidance of disturbed areas (McLaren and Green 1985). Caribou may avoid infrastructure or may continue to use sites close to infrastructure but experience increased physiological stress and decreased feeding rates, especially when startled (C. A. Bradshaw, Boutin, and Hebert 1997; Wasser et al. 2011). Research and Inuit TK indicate that calving females and cow-calf groups are more susceptible to disturbance compared to mixed adult groups (Nellemann and Cameron 1996; Dyer et al. 2002; Nellemann et al. 2003; R. D. Cameron et al. 2005; Stankowich 2008). Ultimately, these effects, if chronic, have the potential to lower the energy balance of individuals, resulting in poor body condition. For these reasons, potential effects of disturbance on muskox were included in this assessment.

Caribou occupy large annual home ranges making long migrations between seasonal habitats. Linear developments and point sources can to alter the movements of caribou on the tundra. Caribou are particularly sensitive to linear traffic corridors, with moderate vehicle use and roads have been described as a "semi-permeable barrier" to caribou movement (Dyer et al. 2002). Linear developments such as roads have also been shown to fragment wildlife habitat across many taxa (Jalkotzy, Ross, and Nasserden 1997). The Goose and George Properties, the MLA, and the winter roads may disrupt movement of caribou by bisecting home ranges or impeding dispersal. For this reason, potential effects of disruption of movement on muskox were included in this assessment.

Direct mortality and injury can result from vehicle strikes with wildlife. Frequency of mortality and injury is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to caribou along these roads also increases. As some caribou overwinter on the tundra within the wildlife RSA and the Project will have all-weather site roads as well as winter road connecting the PDAs, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed Project roads. Roads increase access and can create opportunities for illegal hunting (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Project infrastructure such as winter road alignments may act as attractants to caribou for ease of travel during the winter, which could subsequently lead to increased vehicle-caribou interactions and caribou mortality. Thus, the effect of attraction is included as a potential effect in the assessment.

Wildlife can be exposed to contaminants due to the Project through ingestion of water or through the food chain. For this reason, exposure to contaminants was included as a potential effect in the assessment, and was evaluated through a formal risk assessment conducted as part of the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6).

Some of the environmental effects discussed above have the potential to affect the reproductive potential of caribou, particularly when they act in a synergistic fashion. For example, habitat loss and degradation, disturbance due to noise, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. This cascade of effects may be of the greatest concern during sensitive periods for

caribou (i.e., post-calving and summer foraging periods). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals. Therefore, the effect of reduction in reproductive productivity is included as a potential effect in the assessment.

Each potential effect is identified for each Project Development Area (PDA) and key infrastructure/ activity in Table 5.5-4.

#### *5.5.2.1 Habitat Loss*

As part of the development of the Project, wildlife habitat will be lost and potentially degraded. To minimize these effects, the location of Project infrastructure was planned to avoid caribou sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Caribou habitat may also be indirectly lost if caribou avoid the Project area due to disturbance, which is described in Section 5.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operation phases of the Project. Caribou habitat will be removed during Project development. Habitat degradation due to dust and compaction around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, and design of infrastructure to minimize dust generation are proposed for the Project. The assessment of habitat loss is based on the total area of lost and degraded habitat at the end of the Operation phase, which is the largest extent of the Project footprint.

To enable flexibility in siting of Project infrastructure, loss and degradation of caribou habitat is assumed within the entire area of each of the three PDAs (Goose Property Area, George Property Area and the MLA). These areas greatly overestimate habitat loss because only 10-15% of area within each PDA will be developed. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The operation of winter roads could result in alteration of vegetation due to soil compaction and could result in minor habitat degradation during the foraging season for caribou. However, the potential for soil compaction on the winter roads is anticipated to be relatively minor and is not assessed further.

Calculation of Habitat Loss

Habitat loss for caribou was calculated by first identifying three key indicators:

1. Total area: a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs);
2. High-quality habitat: a calculation of the area of high-quality habitat for caribou that will be lost in the PDAs; and
3. Crossing points for caribou: summer crossing points on lakes and river, identified from Inuit TK and baseline studies, were evaluated for whether they fell inside the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the RSA. To put the Project within the context of the use by individual caribou herds, the proportion of habitat loss was also compared to size of the 95% kernel distributions of collaring data and core habitat range (based on the 50% kernel distribution of collaring data) for caribou herds by season.

*Total Area of Loss*

The total expected area lost in the PDAs was calculated by summing the areas of loss (in hectares) due to the entire Goose, George, and MLA PDAs. These areas were then compared to the total area of the wildlife LSA and RSA. The actual area developed, is expected to be approximately 10-15% of the area of the PDAs.

In order to put the Project into the context of caribou habitat for each caribou herd that interacts with the Project (Bathurst Caribou and Beverly Caribou), the total area of loss is compared to the seasonal ranges for Bathurst and Beverly herd caribou for those seasons when Bathurst and Beverly caribou interact with the wildlife RSA.

*Area of High-quality Habitat Loss*

Habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A) for caribou based on a four class rating system (High, Moderate, Low, and Nil habitat). The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA using remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4).

The availability of suitable habitat for caribou varies between seasons and is detailed in the Habitat Suitability Baseline Report (Rescan 2013a, Appendix V5-5A) and summarized in the Existing Environment Section (Section 5.1). The same habitat suitability ratings were used for both Bathurst and Beverly herds. Habitat loss and degradation for caribou was assessed for calving, post-calving and summer combined, and fall. Habitat ranked as High or Moderate was considered the most suitable habitat and is referred to as high-quality habitat for caribou.

In order to calculate a realistic estimate of habitat loss for caribou herds that intersect the wildlife RSA, the total loss of high-quality habitat is compared to approximate area of available high-quality habitat within the seasonal ranges relevant for when the Bathurst or Beverly caribou could occur in the wildlife RSA with the assumption that the proportion of high-quality habitat in the seasonal ranges for caribou are similar to that in the wildlife RSA during those seasons.

*Crossing Points*

Several points where caribou cross lakes and rivers during the open water season were identified for caribou from Inuit TK and baseline studies. Baseline studies examined crossing points identified by Inuit TK and land users who worked with biologists in the field using motion-triggered cameras. Cameras recorded use of several crossing locations in the wildlife RSA and to the west of the wildlife RSA (Section 5.1.2.5; Rescan 2013d, Appendix V5-5C; 2014). The locations of these crossing points were compared to the PDA areas to examine if there are any overlaps.

BATHURST CARIBOU

Bathurst caribou overwinter in the northern portion of the boreal forest (Section 5.1.2). Moving relatively quickly during the last two weeks in late May to calving grounds to the northwest of the wildlife RSA, the majority of the herd migrates to the west of the wildlife RSA, although a very small proportion may cross through the wildlife RSA (mainly on the western side). Calving occurs over 100 km to the north-west of the wildlife RSA between the Hood and Burnside Rivers. During the post-calving period, a proportion of the Bathurst herd caribou cross through the western portion of the wildlife RSA from north-west to south-east during a relatively short period of time (June and July). Caribou then

spend the summer to the west and south of the wildlife RSA. The removal and degradation of caribou habitat is therefore evaluated for the post-calving period.

BEVERLY CARIBOU

Most Beverly caribou overwinter on the tundra (Section 5.1.3); some portion of the herd spends the winter in the forest, with a small proportion (3.7% of the winter range, based on the 95% Kernel distribution of collaring data) overlap the wildlife RSA. In spring, Beverly caribou migrate relatively quickly to their calving grounds to the northeast of the wildlife RSA near the Queen Maud Gulf, and stay in the vicinity of the Queen Maud Gulf during post-calving. During the summer and fall (end of July to end of October), the wildlife RSA overlaps the western edge of the Beverly summer, and fall ranges (based on the 50 and 95% kernel distributions determined using the collaring data). Thus, habitat loss is evaluated for summer, fall, and winter seasons for Beverly caribou.

Evaluating Habitat Loss for Caribou

*Total Area of Loss within RSA*

The total area lost due to the construction of the Goose and George Properties and the MLA is 10,237 ha (Table 5.5-5). The majority of this area is contained within the wildlife LSA and represents 7.5% of the wildlife LSA. This area accounts for 0.8% of the wildlife RSA. However, the actual area lost will be much smaller as the design of the Project footprint is much smaller (10 to 15% of the PDAs) than the PDAs assessed as lost (i.e., 1,024 to 1,535 ha; 0.12% of the RSA).

**Table 5.5-5. Habitat Loss and Degradation within the Project Development Areas (PDAs)**

| Project Development Area (PDA) | Area (ha) | Proportion of LSA (%)[1] | Proportion of RSA (%)[1] |
|---|---|---|---|
| George | 4,226 | 3.1 | 0.3 |
| Goose | 5,358 | 4.0 | 0.4 |
| Marine Laydown Area | 653 | 0.4 | <0.1 |
| Winter Roads[2] | 5,040 | 3.8 | 0.4 |
| TCWR Winter Road Connector Outside RSA | 3,404 | - | - |
| **Total[3]** | **15,278** | **11.3** | **1.2** |
| **Total without Winter Roads** | **10,237** | **7.5** | **0.8** |

*[1] LSA = 134,369 ha, RSA = 1,262,005 ha*
*[2] Represents area of habitat loss during the winter, and habitat degradation during the snow free periods.*
*[3] Total does not include portion of the TCWR Winter Road Connector that falls outside of the RSA but includes all other winter roads.*

The total area lost due to winter roads is 5,040 ha, assuming a 100 m buffer area lost and degraded around the road centre line. The combined area of habitat loss due to the Goose, George and MLA PDAs and the area of potential degradation due to the winter roads is 15,278 ha which is equivalent to approximately 11% of the wildlife LSA and 1% of the wildlife RSA (Table 5.5-5). An additional 3,404 ha of habitat degradation will potential occur as a result of the portion of the TCWR Connector that falls outside of the wildlife RSA.

BATHURST CARIBOU

The core range of the Bathurst caribou during post calving (based on the 50% kernel distribution of the collaring data) falls outside of the areas lost to the PDAs, but the eastern edge of the 95% kernel distribution for post calving overlaps the George PDA, thus the majority of caribou will not be affected by the loss of this habitat (Section 5.1).

The area of George PDA that will be removed from the Bathurst post calving range is 4,226 ha. Both the Goose Property PDA and the MLA PDA fall outside of the Bathurst herd post-calving range, thus do not contribute to habitat loss for this herd.

The area of the post-calving range (based on the 95% kernel distribution of the collaring data) is 6,083,786 ha. The total area of habitat loss due to the Project is anticipated to be < 0.1% of this range using the area of the George PDA, and < 0.01% assuming only 10-15% of the PDA will be developed.

BEVERLY CARIBOU

Beverly caribou have the potential to intersect the wildlife RSA during three seasons including: summer, fall, and winter. The core range for each herd was defined as the 50% kernel distribution of satellite collar positions, and the range as the 95% kernel distribution.

*Summer:* The summer range of the Beverly herd is 12,937,264 ha and encompasses the entire terrestrial wildlife RSA. The area of habitat loss for Beverly caribou from their summer range is 10,238 ha (< 0.1%). The core summer range of Beverly caribou is 5,395,822 ha encompasses the Goose and George Property PDAs but not the MLA. Habitat loss within the core summer range for Beverly caribou will be 9,584 ha (0.2%, or 0.02% if it is assumed that only 10-15% of the PDAs will be developed).

*Fall:* The fall range of Beverly caribou is 29,254,251 ha and encompasses the entire terrestrial wildlife RSA. The area of habitat loss for Beverly caribou from their fall range is 10,238 ha (< 0.1%). The core fall range of Beverly caribou is 7,697,205 ha and encompasses most of the Goose Property PDA. The habitat loss within the core fall range for Beverly caribou is equivalent to 4,886 ha (< 0.1% of the fall range, or 0.01% if it is assumed that only 10-15% of the PDAs will be developed.

*Winter:* The winter range of Beverly caribou is 21,231,234 ha and encompasses the Goose and George Property PDAs. The MLA PDA falls outside of the winter range for Beverly caribou. The area lost from the winter range is 9,584 ha due to the Goose and George PDAs and 6,710 ha from the winter road PDA (including the TCWR connector), for a total of 16,294 ha (< 0.1% of winter range). The core winter habitat range falls outside of the terrestrial wildlife RSA, and the majority of Beverly caribou will not be affected by the loss of this habitat on their winter range.

*Loss of High Quality Habitat within RSA*

Some of the habitat removed in the Goose and George PDAs and the MLA was rated as high-quality habitat (high or moderate habitat suitability rating) for caribou. The proportion of high-quality habitat loss for caribou changes by season and is summarized below and in Table 5.5-6.

*Calving*: Baseline habitat suitability modelling in 2013 identified 656,323 ha of high-quality calving habitat in the wildlife RSA and 73,450 ha in the wildlife LSA. The proportion of high-quality calving habitat lost to development of the PDAs is approximately 1% of the wildlife RSA and approximately 8.6% of the wildlife LSA.

*Post-calving and summer*: A total of 1,082,379 ha of high-quality post-calving and summer habitat was identified during baseline studies in the wildlife RSA. In the wildlife LSA a total of 114,008 ha exist at baseline. The proportion of high-quality post-calving and summer habitat loss in the wildlife RSA after development of the PDAs is approximately 0.8% while the proportion lost in the wildlife LSA is 7.9%.

*Fall*: Within the wildlife RSA, 741,026 ha of high-quality fall habitat was identified, 78,245 ha of which falls within the wildlife LSA. The proportion of high-quality fall habitat lost in the wildlife RSA is approximately 0.9%, while the proportion lost in the wildlife LSA was approximately 9.2%.

**Table 5.5-6. High-quality Caribou Habitat Lost (or Degraded) in the LSA and RSA due to Development of the Back River Project**

| | | High-quality Habitat (HQH) | | High-quality Habitat Lost or Altered due to Project Potential Development Areas | |
|---|---|---|---|---|---|
| Area | Season | Area (ha) | % Total Area | Area (ha) | % HQH |
| *Local Study Area* | | | | | |
| | Calving (and Winter) | 73,450 | 54.7 | 6,350 | 8.6 |
| | Post-calving and Summer | 114,008 | 84.8 | 8,980 | 7.9 |
| | Fall | 78,245 | 53.8 | 6,653 | 8.5 |
| | All Seasons | 114,126 | 84.9 | 8,990 | 7.9 |
| *Regional Study Area* | | | | | |
| | Calving (and Winter) | 656,323 | 52.0 | 6,352 | 1.0 |
| | Post-calving and Summer | 1,082,379 | 85.8 | 8,991 | 0.8 |
| | Fall | 741,026 | 58.7 | 6,655 | 0.9 |
| | All Seasons | 1,087,291 | 86.2 | 9,001 | 0.8 |

*All Seasons combined*: When considering the total amount of high-quality habitat for caribou, regardless of season, a total of 1,087,291 ha of high-quality habitat was identified in the wildlife RSA, 114,126 ha of which falls within the wildlife LSA. The proportion of total high-quality habitat lost in the wildlife RSA is approximately 0.8% and that in the wildlife RSA is 7.9%.

BATHURST CARIBOU

The Bathurst herd occurs within the western portion of the wildlife RSA during the post-calving season and the range encompasses the George PDA. The total amount of high-quality post-calving habitat that is lost due to the development of the George PDA is 3,647 ha. Assuming that the Post-calving range for Bathurst herd caribou has the same approximate proportion and distribution of high-quality habitat as the wildlife RSA for the post-calving season (85.8%), the total amount of high-quality habitat in the post-calving range is anticipated to be 5,219,888 ha. Thus, the amount of high-quality habitat lost due to the Project within the post-calving range for Bathurst herd caribou accounts for < 0.1% of this range.

BEVERLY CARIBOU

The 95% kernel distribution of satellite collar positions was used to define the range of the Beverly herd for each season. The proportion of high-quality habitat in the range was assumed to be the same as that within the wildlife RSA for summer (85.8%), Fall (58.7%) and winter (52.0%), as defined by habitat suitability modelling (Section 5.1.2.5).

*Summer:* The amount of high-quality habitat lost as a result of the development of the PDAs that fall within the summer range for Beverly caribou is 8,990 ha. The total amount of high-quality habitat in the Beverly summer range is 12,937,264 ha, of which < 0.1% will be lost. The amount of high quality habitat lost due to the Goose and George PDAs that falls inside the core summer range for Beverly caribou is 8,449 ha (0.2% of high-quality habitat assumed available in the core summer range).

*Fall:* The amount of high-quality habitat lost as a result of the development of the PDAs that fall within the fall range for Beverly caribou is 6,654 ha. The total amount of high-quality habitat in the Beverly fall range is 17,172,245 ha of which < 0.1% will be lost. A total of 3,684 ha of high quality habitat will be lost due to the Goose PDA inside the core fall range for Beverly (< 0.1%).

*Winter:* The amount of high-quality habitat lost as a result of the development of the PDAs that fall within the winter range for Beverly caribou is 8,449 ha. In addition, a total of 3,752 ha of high-quality habitat will be lost due to the winter roads within this range for a total of 12,201 ha of total high-quality habitat loss. The total amount of high-quality habitat in the winter range is estimated to be 11,040,242 ha, of which 0.1% will be removed by the Project. However, the core winter habitat range falls outside of the terrestrial wildlife RSA, and the majority of Beverly caribou will not be affected by the loss high-quality habitat that falls within the wildlife RSA during winter.

*Crossing points*

The closest crossing point to any Project infrastructure was the river crossing point at the east edge of Beechey Lake, which is > 15 km to the south from the Goose PDA. Thus, no direct effect is expected on crossing points for caribou due to habitat removal. Potential effects on disruption of movement are evaluated in Section 5.5.2.3.

Despite mitigation, a residual effect of habitat loss on caribou is predicted.

### *5.5.2.2 Disturbance due to Noise*

This section evaluates the effects of Project-related disturbance on caribou, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise.

Noise affects caribou species in three primary ways: acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). The source, duration, and intensity of noise all influence the nature and magnitude of wildlife response. First, an acute effect of noise — brief, intense, localized noise (such as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997; AMEC Americas Limited 2005), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

A behavioural response can also occur when animals avoid the source of disturbance resulting in the functional loss of habitat (Gibeau et al. 2002). Mild habitat loss due to disturbance can reduce the amount of energy that an animal can intake and result in low level effects. Alternatively, larger scale range shifts can result in large reduction in energy intake and in extreme cases mortality due to unfamiliarity with new habitat and reduced resource base.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment. Attraction of caribou to camp infrastructure and roads is described in Section 5.5.2.6.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a "threshold level."

Studies on the effects aircraft noise on wildlife indicate that "fright" is a common response (Bond et al 1974), whereby the animal attempts to escape the noise by either running away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or

covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to disturbances than wildlife occupying forested habitats (McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend energy to escape the perceived threat.

Potential sources of sensory disturbance for caribou associated with Project activities include:

- blasting noise and ground vibrations from mining and construction;
- general Project noise (e.g., camp noise, human presence, and vehicle traffic); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the Umwelt open pit while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the Construction and Operational phases. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned, while at the MLA, while it is active, a maximum of six flights per week are planned.

Disturbances from visual and auditory stimuli can cause caribou to alter their normal behavioural patterns. Such disturbances may alter caribou foraging and movement rates. In some cases, disturbances may ultimately affect energetic balance, and thus reproductive productivity and even survival (C. A. Bradshaw, Boutin, and Hebert 1997; C. J. A. Bradshaw, Boutin, and Hebert 1998). These effects will likely be greatest when caribou are energetically stressed — during winter, and for both lactating females and their calves during the post-calving period.

Female body condition, which is primarily affected by forage availability, appears to be the main determinant of reproductive productivity of barren-ground caribou (Gerhart et al. 1997; Couturier, Cote, Huot et al. 2009; Couturier, Cote, Otto et al. 2009). Thus, access to sufficient food by females and calves during summer, and by female caribou in winter is thought to be one of the major drivers of caribou population size on the tundra (reviewed in Festa-Bianchet et al. 2011; Gunn, Russell, and Eamer 2011).

Caribou may avoid infrastructure or may continue to use sites close to infrastructure but experience increased physiological stress and decreased feeding rates, especially when startled (C. A. Bradshaw, Boutin, and Hebert 1997; Wasser et al. 2011). Research and Inuit TK indicate that calving females and cow-calf groups are more susceptible to disturbance compared to mixed adult groups (Nellemann and Cameron 1996; Dyer et al. 2002; Nellemann et al. 2003; R. D. Cameron et al. 2005; Stankowich 2008). Ultimately, these effects, if chronic, have the potential to lower the energy balance of individuals, resulting in poor body condition.

Calculating Disturbance to Caribou

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose and George Properties rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence. Habitat “loss” will occur indirectly for caribou that avoid the zone of influence because they are disturbed within it. Some caribou may continue to use habitat within the zone of influence. The “true” amount of indirect habitat loss will depend on the proportion of caribou that avoid the zone of influence, and the amount of disturbance experienced by caribou that continue to use habitat within the zone of influence.

The potential effect of disturbance on caribou was evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise modelling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be the worst case (year 3 of Operations at Goose and year 7 of Operations at George). The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance. The area of affected habitat was calculated by using specific noise level contours from the literature where bears are shown to have behavioural effects from the noise.

Threshold noise values were determined from the literature, above which caribou are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for caribou. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported and are typically small, since the PDAs (already considered as lost habitat in Section 5.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modelling (see Baseline Habitat Suitability Modelling; Section 6.1.5).

Three common sources of noise were chosen for modelling include: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (Lpeak) or higher for instantaneous noise effects on muskox during Construction and Operations phases. Blasting noise models were conducted during peak noise levels for each of the PDAs: year 3 at the Goose PDA and year 7 at the George PDA.

General Project-related, or equivalent noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The threshold for general Project noise was 45 dBA. This noise level value was selected based upon the criteria outlined in the Environment Code of Practice for Metal Mines (Environment Canada 2010), which recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas. Specifically, the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night (Environment Canada 2010). Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in caribou habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft and helicopter noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) caribou seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 5.5.2.1), but within the noise level contours for blasting noise (≥ 120 dB representing functionally lost habitat; or ≥108 dB representing disturbed habitat), general Project noise (≥ 45 dBA) or noise generated from aircraft (≥ 80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each season within the wildlife RSA and LSA after accounting for habitat loss (Section 5.5.2.1).

Bathurst caribou are expected to occur in the wildlife RSA during post-calving, in the western portion of the wildlife RSA. Beverly caribou are expected to occur during summer, fall, and winter, and mostly in the southern half of the wildlife RSA. Thus, indirect loss of caribou habitat was calculated for these periods for the respective herds. Indirect habitat loss for both herds was compared to the area of the wildlife RSA and to the seasonal ranges for each herd.

Evaluation of Disturbance to Caribou

Once mitigated, disturbances during construction activities are expected to be short-term in duration and localized in extent. Continuous disturbance of wildlife VECs will occur due to traffic throughout the life of the Project, beginning at Construction and continuing throughout the life of the Project. Other sources of disturbance include human presence and aircraft noise. The potential effects of these disturbances to behaviour and habitat use were assessed within the relevant spatial scale for caribou.

*Blasting Noise*

A total of 35 ha that falls outside the Goose and George PDAs is evaluated as functionally lost due to noise from blasting above an Lpeak of 120 dB, and an additional 982 ha will be disturbed outside of the Goose and George PDAs due to noise from blasting with an Lpeak above 108 dB. During year 3 of the operation phase, blasting from the construction of the Umwelt, Llama and Main pits at the Goose Property Area will result in 18 ha of habitat (<0.1% of the wildlife LSA and RSA) functionally lost and an additional 283 ha of habitat (0.2% of the wildlife LSA; or <0.1% of the wildlife RSA) disturbed outside of the Goose PDA by noise due to blasting activities (Figure 5.5-1). Starting at year 7 of the operation phase, blasting from the open pit at Locale 1 will result in 17 ha of habitat functionally lost (< 0.1% of the wildlife LSA and RSA), and an additional 359 ha of habitat disturbed (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) outside of the George PDA due to noise from blasting activities (Table 5.5-7). It is assumed that blasting in year 8 and 9 at the open pits at LCP North and Locale 2 will be similar to or less than the noise levels due to blasting in year 7 at the open pit at Locale 1.

The amount of high-quality habitat within the area that is evaluated as functionally lost in the wildlife RSA ranges between 19 and 26 ha (< 0.1% of the available high-quality habitat in the wildlife LSA and RSA after habitat loss due to the PDAs; Section 5.5.2.1) and the area where caribou may be disturbed is 408 to 800 ha (up to 0.7% and < 0.1% of the available high-quality habitat in the wildlife LSA and RSA, respectively after accounting for habitat loss) depending on the season (Table 5.5-8). The total amount of high quality habitat that is functionally lost or disturbed due to blasting is mapped in Figure 5.5-1 for all seasons combined.

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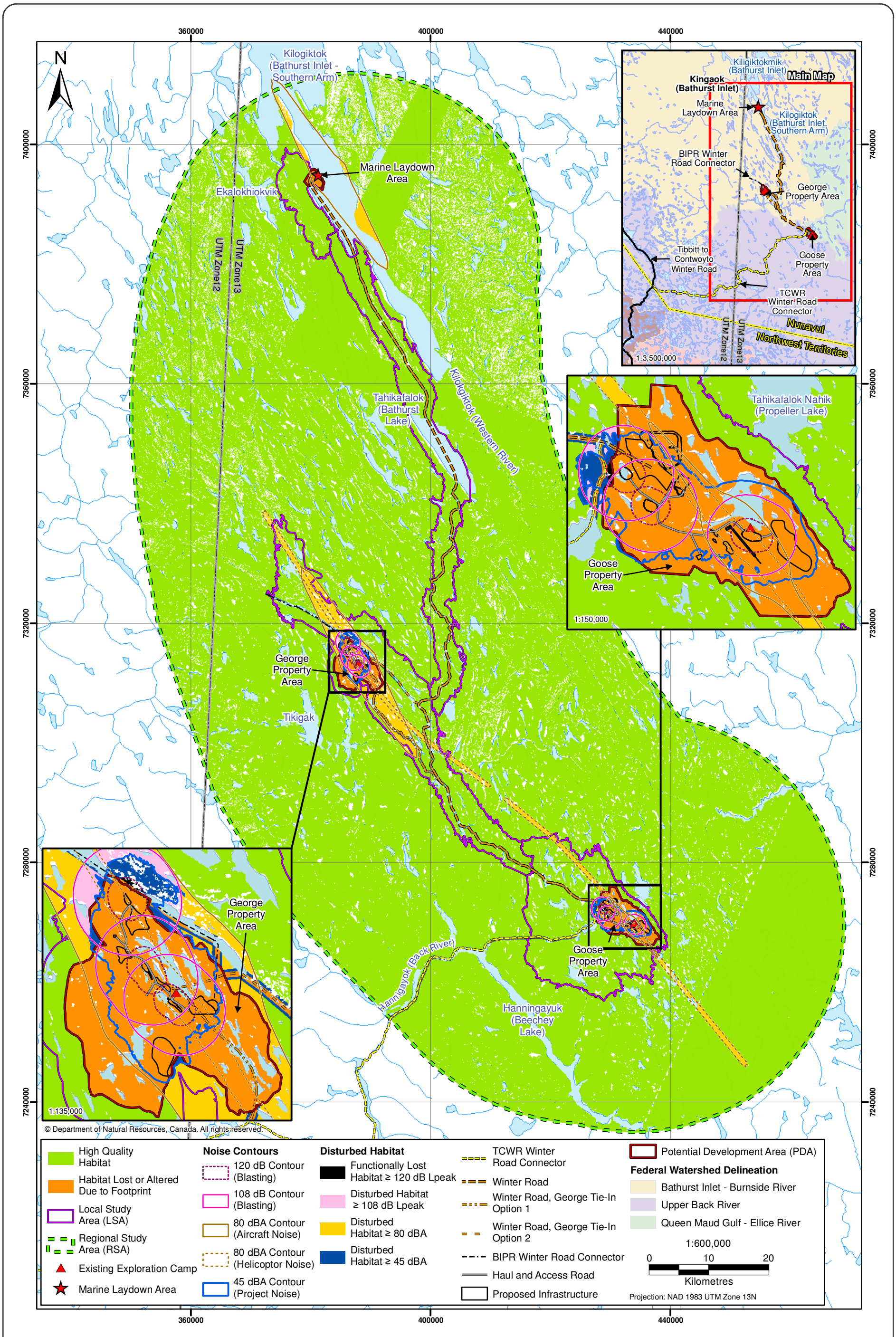


Figure 5.5-1

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# Caribou High-quality Habitat Lost, Altered or Disturbed due to the Project

Figure 5.5-1

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**Table 5.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise**

| Project Development Area (PDA) | Area Already Considered Lost to Project Footprint (Section 7.5.3.1) | | | Areas Lost or Disturbed due to Noise outside of the PDA Areas | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Additional Area Functionally Lost due to Blasting (120 dBA) | | | Additional Area Disturbed due to Blasting (108 dBA) | | | Additional Area Disturbed due to General Project Noise (45 dBA) | | | Additional Area Disturbed due to Aircraft Noise (80 dBA) | | |
| | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA* | % RSA |
| George | 4,226 | 3.1 | 0.3 | 17 | <0.1 | <0.1 | 699 | 0.5 | <0.1 | 359 | 0.3 | <0.1 | 11,278 | 8.4 | 0.9 |
| Goose | 5,358 | 4 | 0.4 | 18 | <0.1 | <0.1 | 283 | 0.2 | <0.1 | 262 | 0.2 | <0.1 | 3,495 | 2.6 | 0.3 |
| MLA | 653 | 0.4 | <0.1 | - | - | - | - | - | - | - | - | - | 12,367 | 9.2 | 1 |
| **Total** | **10,237** | **7.5** | **0.8** | **35** | **<0.1** | **<0.1** | **982** | **0.7** | **<0.1** | **621** | **0.5** | **<0.1** | **27,140** | **17.1** | **2.2** |

**Some of the area of disturbance falls outside of the LSA but within the RSA (Figure 5.5-1).*

**Table 5.5-8. Expected Caribou High-quality Habitat Functionally Lost or Disturbed due to Noise outside of the Project Potential Development Areas**

| Area | Season | High-Quality Habitat (HQH) Available Area (ha) | HQH Lost or Altered due to the Project PDAs | | Additional Area Functionally Lost[1] due to Blasting (120 dBA) | | Additional Area Disturbed[1] due to Blasting (108 dBA) | | Additional Area Disturbed[1] due to General Project Noise (45 dBA) | | Additional Area Disturbed[1] due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH |
| *Local Study Area* | | | | | | | | | | | | |
| | Calving | 73,450 | 6,350 | 8.6 | 19 | <0.1 | 408 | 0.6 | 2,053 | 2.8 | 5,023 | 6.8 |
| | Post-calving and Summer | 114,008 | 8,980 | 7.9 | 26 | <0.1 | 800 | 0.7 | 3,340 | 2.9 | 9,203 | 8.1 |
| | Fall | 78,245 | 6,653 | 8.5 | 19 | <0.1 | 415 | 0.5 | 2,142 | 2.7 | 5,080 | 7.0 |
| | All Seasons | 114,126 | 8,990 | 7.9 | 26 | <0.1 | 800 | 0.7 | 3,269 | 2.9 | 9,203 | 8.1 |
| *Regional Study Area* | | | | | | | | | | | | |
| | Calving | 656,323 | 6,352 | 1.0 | 19 | <0.1 | 408 | <0.1 | 2,387 | 0.4 | 8,724 | 1.3 |
| | Post-calving and Summer | 1,082,379 | 8,991 | 0.8 | 26 | <0.1 | 800 | <0.1 | 3,898 | 0.4 | 14,733 | 1.4 |
| | Fall | 741,026 | 6,655 | 0.9 | 19 | <0.1 | 278 | <0.1 | 2,511 | 0.3 | 9,391 | 1.3 |
| | All Seasons | 1,087,291 | 9,001 | 0.8 | 26 | <0.1 | 485 | <0.1 | 3,858 | 0.4 | 14,776 | 1.4 |

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Appendix V4-2B) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 5.5.2.1).*

*General Project Noise*

The total amount of area affected by elevated noise levels due to general Project noise (exceeding 45 dbA; outside of the Goose and George PDAs and the MLA that are already considered to be lost (Section 5.5.2.1) is 621 ha. A total of 262 ha (0.2% of wildlife LSA and < 0.1% of wildlife RSA) in year 3 near the Goose PDA, and 359 ha (0.3% of wildlife LSA and <0.1% of wildlife RSA) in year 7 near the George PDA will be degraded (Table 5.5-7). A breakdown of the percentage of high quality habitat lost due to noise disturbance in each season outside of the PDAs can be found in Table 5.5-8. In all seasons, the percentage of high-quality habitat lost outside of the PDAs is small (2.7% to 2.9% of the wildlife LSA; 0.3% to 0.4% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife LSA and RSA (Table 5.5-8; Figure 5.5-1). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise*

The total amount of area affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project PDAs (Section 5.5.2.1) is 27,140 ha (2.2% of wildlife RSA). Approximately 3,495 hectares outside of the Goose PDA will be affected by aircraft accessing the Goose Property (Table 5.5-7). An additional 11,278 hectares that falls outside the George PDA will be disturbed by aircraft accessing the George Property (Table 5.5-7). This area is larger than that outside of the Goose Property Area as the aircraft used for the George Property (Twin Otter Aircraft) is noisier than that used for the Goose Property (Dash 7 or equivalent).

At the MLA, an additional 12,367 ha of area will be disturbed due to Twin Otter aircraft landing on Bathurst Inlet near the MLA if needed when the MLA is active (Table 5.5-7), however, much of this area consists of the Inlet itself. A breakdown of the percentage of high quality habitat disturbed due to aircraft noise in the wildlife RSA can be found in Table 5.5-8. In all seasons, the percentage of additional high-quality habitat in the wildlife RSA disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (6.8% to 8.1% of wildlife LSA; 1.3% to 1.4% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife LSA and RSA (Table 5.5-8).

Two important elements influencing aircraft noise exposure to wildlife include overhead distance from wildlife and the frequency of overflights. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned in the “worst case” years used for noise modelling (during operations), while at the MLA, when it is active, a maximum of six flights per week are planned during the “worst case” scenario. In addition, areas of disturbance are expected to be localized near the landing strips at the Goose and George Properties and within Bathurst Inlet at the MLA. A delineated flight path between the Goose and George Properties may be disturbed by helicopter overflights approximately once a day (Figure 5.5-1). Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

BATHURST CARIBOU

The total amount of habitat that is functionally lost or disturbed due to Project-related noise outside of the Project PDAs and within the Bathurst herd post-calving range is 11,141 ha. This area accounts for 0.1% of this range. The amount of high-quality habitat that is functionally lost or disturbed due to Project related noise within the post-calving range for Bathurst caribou is 4,793 ha. Assuming that the post-calving range for Bathurst caribou has the same approximate proportion and distribution of high-quality habitat as the wildlife RSA for the post-calving season (85.8%), the total amount of high-quality habitat in the post-calving range is anticipated to be 5,219,888 ha. The proportion of high-quality habitat functionally lost or disturbed, due to Project-related noise, accounts for < 0.1% of the post-calving range for Bathurst caribou. However, the core post-calving range occurs outside of the

wildlife RSA, thus most Bathurst caribou on this range would be unaffected. A residual effect of disturbance due to noise is anticipated for caribou, albeit minimal.

BEVERLY CARIBOU

For the range and core range of each herd, the proportion high-quality habitat in the wildlife RSA was uses; summer (85.8%), fall (58.7%) and winter (52.0%).

*Summer:* The total amount of habitat that is lost or disturbed due to Project-related noise outside of the Project PDAs and within the Beverly herd summer range is 57,489 ha (0.4% of the summer range) of which 15,156 ha will be disturbed in the core summer range (0.3% of core summer range). High quality summer habitat in the Beverly herd summer range was calculated to be 11,100,173 ha, of which 35,627 ha will be removed (0.3% of available high-quality habitat in the summer range). The core summer range for Beverly caribou was calculated to contain 4,629,615 ha of high quality summer range, of which 12,947 ha (0.3% of available high-quality habitat in core summer range) may be disturbed due to Project noise. A residual effect of disturbance on the summer range of Beverly caribou is expected.

*Fall:* The total amount of habitat that is lost or disturbed due to Project-related noise within the Beverly herd fall range is 59,545 ha (0.2% of the fall range) of which 2,315 ha is disturbed in the core fall range (< 0.1% of core fall range). High-quality fall habitat in the Beverly herd fall range was calculated to be 17,172,245 ha, of which 25,799 ha will be removed (0.2% of Beverly fall range). The core fall range for Beverly caribou was calculated to contain 4,518,259 ha of high-quality fall habitat, of which 1,581 ha (< 0.2%) may be disturbed due to Project noise. A residual effect of disturbance due to noise on the fall range of Beverly caribou is anticipated, albeit small.

*Winter:* The total amount of habitat that is lost or disturbed due to Project-related noise within the Beverly herd winter range is 18,878 ha (< 0.1% of the winter range) and includes disturbance due to noise on winter roads. High-quality habitat in the winter range was predicted to be 11,042,912 ha, of which 8,871 ha (< 0.1% of high-quality habitat in the winter range) will be functionally lost or disturbed due to Project. However, the core winter range occurs outside of the wildlife RSA, thus most Bathurst caribou on this range would be unaffected. A residual effect of disturbance on the winter range is not anticipated to occur.

Overall, disturbance due to noise for Beverly herd caribou is anticipated to result in a residual effect in summer and fall seasons.

#### *5.5.2.3 Disruption to Movement*

Disruption to movement of caribou is evaluated for: 1) linear corridors such as roads which may isolate seasonal habitats and, 2) point sources of disturbance where caribou may avoid areas, and thus alter movement patterns due to human activities.

Roads have been described as a “semi-permeable barrier” to caribou movement (Dyer et al. 2002), with permeability depending on the amount and frequency of traffic. There is very little evidence that roads on the tundra without traffic act as barriers to caribou movement. Unlike early-constructed pipelines which had essentially vertical edges, winter roads are constructed by piling and flattening snow on the tundra and frozen lakes, and pumping water on top in order to make a compact and even surface. The majority of winter roads are constructed over frozen lakes for ease of maintenance. Thus, winter roads do not require berms or height for maintenance, and don’t deter wildlife from crossing them. Worldwide, there are few data suggesting that roads without traffic deter caribou from crossing them, or have any effect on migration routes (Wolfe, Griffith, and Wolfe 2000; Dyer et al. 2002). Thus, it is unlikely that the road without traffic will pose a barrier to caribou movement.

In the oil fields of Alaska, traffic was the most important factor affecting crossing of road-pipeline corridors (reviewed in Lawhead et al. 2006). Caribou crossed roads without traffic and elevated pipelines as frequently as control sites, but crossed a pipeline with nearby road traffic less than half the time (J. A. Curatolo and Murphy 1986). A traffic rate of 20 vehicles per hour was the likely cause of a low crossing rate for two large caribou groups trying to cross a road (Smith and Cameron 1985). Crossing success of a pipeline was significantly reduced when traffic averaged 32 vehicles per hour (Murphy and Curatolo 1984). The traffic rate along the proposed winter roads will be approximately 6.8 trucks per hour assuming that a total of 164 truck trips per day will occur for transport of materials and fuel and assuming vehicles will be in operations over the entire 24 hour period. Although migrating caribou move relatively quickly through the EKATI and Diavik diamond mine developments, which includes a 29 km all-weather road, preliminary data suggests that the frequency of caribou crossing this road may correlate with traffic volume (Rescan 2012a, Appendix V5-5D). Roads in Alberta were not a barrier to caribou movement unless traffic was present (Dyer et al. 2002).

Unless habituated to road traffic, caribou probably perceive road traffic as a predation risk which varies with vehicle speed and distance. In some cases, caribou may not run away from traffic, but may display heightened vigilance. When insects were absent, caribou spent about 25% more time moving than lying down near a road with traffic than one without, though foraging rates were similar (Murphy and Curatolo 1987). Reactions of caribou to traffic may vary with group size, group composition (i.e., presence of calves), and insect activity (reviewed in Wolfe, Griffith, and Wolfe 2000). Large groups may be more sensitive to traffic than small groups (J. A. Curatolo and Murphy 1986; Wolfe, Griffith, and Wolfe 2000), cows and cows with calves appear more sensitive to traffic than bulls (Horejsi 1981; Wolfe, Griffith, and Wolfe 2000), and insect-harassed caribou cross roads more frequently (J. A. Curatolo and Murphy 1986).

Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If Project sites are large enough relative to the habitat in which caribou use and cause noise and sensory disturbance to a level with which caribou will avoid these areas, movement of caribou may be inhibited. In these cases, caribou may need to expend additional energy to travel around Project developments during their large distance movements. The potential for project disturbance to affect known caribou crossing points and migratory pathways identified from Inuit TK and baseline surveys is also evaluated.

Potential Project infrastructure and activities that were evaluated for the potential disruption to movement of caribou include the PDAs for the Goose and George Property Areas and the MLA. Disruption to movement may begin during the Construction phase of the Project when infrastructure are built and continue during the Operational and Reclamation/Closure phases of the Project. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Calculation of Disruption to Movement

Disruption to movement due to Project-related activities was evaluated for caribou by the following key indicators: 1) the comparison of traffic timing and volume on the haul roads; 2) the comparison of the size of the Project development in relation to the average size of caribou seasonal ranges: post-calving range for Bathurst caribou, and summer core range (using 50% kernel distribution) for Beverly caribou; and 3) the distance of the Project from any important caribou crossing points or migratory routes, as defined by Inuit TK or baseline surveys.

The haul roads for the Project are designed as winter roads only. These roads will be constructed and used while Bathurst caribou are overwintering below treeline, south of the wildlife RSA. However, a

small proportion (3.7%) of Beverly herd caribou range, based on 95% kernel distribution collaring data occur in the wildlife RSA during the winter. Thus, the effect of disruption to movement due to linear corridors was assessed only for Beverly herd caribou during the winter season.

Evaluation of Disruption to Movement

BATHURST CARIBOU

The winter roads from the mine sites to the MLA, between the mine sites, and connecting the Project to the Tibbett to Contwoyto winter road will be active when Bathurst caribou are wintering below treeline and are not further considered for this herd.

The development of the Goose and George Properties within each respective PDA were evaluated for the potential for Bathurst caribou to avoid these areas where the open pits and camps are constructed. However, the facilities at the Goose and George Property Areas are unlikely to impede the movement of caribou in the area as Bathurst caribou occupy large ranges during the post-calving season (6,083,786 ha) and the Goose and George properties fall on the eastern most edge of the Bathurst herd post-calving range based on the 95% kernel distribution of collaring data and outside the 50% kernel distribution core range. The MLA falls outside of all seasonal ranges of Bathurst caribou. The Goose Property and George Property will occupy 5,358 ha and 4,226 ha, respectively. These areas are unlikely to disrupt movements of caribou within the wildlife LSA or RSA as they represent a small proportion (< 0.1% each) of the Bathurst herd post-calving range.

Several points where caribou cross lakes and rivers during the open water season were identified for caribou from Inuit TK and baseline studies. Baseline studies examined crossing points identified by Inuit TK and land users who worked with biologists in the field using motion-triggered cameras. Cameras recorded use of several crossing locations in the wildlife RSA and to the west of the wildlife RSA (Section 5.1.2.5; Rescan 2013d, Appendix V5-5C; Rescan 2014). The closest crossing point to any Project infrastructure was the river crossing point at the east edge of Beechey Lake, which is > 15 km to the south from the Goose PDA. Caribou were observed at this location during late summer and were likely Beverly caribou, but Bathurst caribou may also use this location during the post calving period. No effect of the Project is expected at this location because of the distance between the PDAs and the crossing point and due to helicopter management, which will exclude helicopters below a certain elevation at this and other areas important for caribou.

Several crossing points were identified by Inuit TK on the Back River at the western end of Beechey Lake where the winter road that will connect to the Tibbitt to Contwoyto road. However, no effect is expected at these sites because construction and use of the winter road will occur during the winter, while crossing points are used during the open water season (summer).

Thus, a residual effect of disruption to movement of Bathurst caribou is not anticipated, and is not assessed further for this herd.

BEVERLY CARIBOU

Baseline surveys and GPS collar data indicate that Beverly caribou occur in the southern portion of the wildlife RSA in the winter season. The northern extent of the Beverly winter range occurs on the southern portion of the wildlife RSA. Approximately, 3.7% of the Beverly winter range (based on a 95% kernel distribution) occurs where the winter road between the Goose and George Properties, and the eastern portion of the TCWR Connector are located. Winter is the season when caribou movement rates are lowest (Section 5.1.3.2), so the rate of caribou crossing the road is expected to be relatively low.

Mitigation and management of the road to reduce any effects of the road as a barrier to movement will include reduced speed limits (40 km/h) and vehicles will stop if groups of caribou (> 10 animals) are observed on the road and wait until caribou have moved off the road. Drivers will stop to allow caribou in close proximity to the road (within 250 m) to move across the road. When small groups (< 10) or individual caribou are standing on the road, drivers will stop for 20 minutes to allow caribou to move off the road. To ensure caribou movement is not impeded by accumulated snow along the road, snow banks and snowdrifts will be managed if these reach heights deemed to impair the ability of drivers to see wildlife and for wildlife to cross the road.

As only 3.7% of Beverly winter range occurs in the wildlife RSA and their winter ranges are quite variable (Section 5.1.3.2) and are often not found in the wildlife RSA during winter it is unlikely that the winter roads will act as a barrier to movement during the winter season when the roads are active. In addition, mitigation measures will further minimize the effect of disruption to movement. Thus, the construction and used of the winter roads is not anticipated to result in a residual effect.

Similar to the Bathurst herd caribou, the development of the Goose and George Properties are evaluated for the potential for caribou to avoid areas where the open pits and camps are constructed. The effect of disruption to movements from the development was evaluated for the summer season because the core range of Beverly caribou is approximately centered over the Goose Property at this time and is this core range represents the smallest core range relative to all other seasons. The MLA falls outside of the core range for Beverly caribou during all seasons, but within the 95% kernel distribution for summer and fall seasons. Thus a small portion of the Beverly herd may interact with the MLA during these seasons. The Goose Property, George Property, and MLA will occupy 5,357 ha and 4,226 ha, and 635 ha respectively. These areas are unlikely to disrupt movements of caribou within the wildlife LSA or RSA. In addition, these areas combined are a small proportion (< 0.1% of the Beverly herd summer, fall, and winter ranges which are > 20,000,000 ha for each of the summer, fall, and winter seasons and >5,000,000 ha for the core habitats in these seasons.

Crossing points identified by Inuit TK and used by caribou during the summer were evaluated in the previous section for Bathurst caribou and the Project is not expected to have an effect on these areas.

Thus, a residual effect of disruption to movement of Beverly caribou is not anticipated, and is not assessed further.

#### *5.5.2.4 Direct Mortality and Injury*

This section describes and evaluates the potential effects of the project to cause injury and/or mortality to caribou of the Bathurst and Beverly herds. Potential Project activities that may contribute to direct mortality and injury are generally anticipated to be a result of vehicle strikes. Indirect mortality due to increased access and increased hunting is evaluated in Section 5.5.2.5.

Calculation of Direct Mortality and Injury

To assess the likelihood and population-level significance of caribou mortality and injury resulting from interaction between caribou and the Project, three indicators were used to assess whether a residual effect was likely including: traffic timing (time of year of traffic relative to when caribou are present in the wildlife RSA), traffic volume and vehicle speed. The latter two indicators were used if caribou were present during the period of road construction and use (December through April). Literature from other projects in Nunavut or Northwest Territories (Ekati, Diavik, and Hope Bay) and from GN DOE was also reviewed, and estimates of wildlife mortality rates due to activities at these projects were summarized.

Evaluation of Direct Mortality and Injury

BATHURST CARIBOU

The Bathurst herd caribou are only in the wildlife RSA during the post-calving season. Project roads are designed as winter roads and will be constructed and used between December and April when Bathurst caribou do not occur in the wildlife RSA. Thus, no residual effect of direct mortality is anticipated for Bathurst herd caribou.

BEVERLY CARIBOU

Beverly caribou may be present in the wildlife RSA in the winter when the winter roads are constructed and used (December through April). During this time of year, the road will be used for hauling supplies, equipment and fuel to and from the Project PDAs. Traffic levels on the road are expected to be approximately 164 truck trips per day; 84 truck trips per day to transport supplies to and from the Goose and George Properties and an additional 80 truck trips per day to transport fuel to these properties. Assuming vehicles will be in operations over the entire 24 hour period, this equates to 6.8 trucks per hour on the ice road.

The northern extent of the Beverly winter range occurs on the southern portion of the wildlife RSA. Approximately, 3.7% of the Beverly winter range (based on a 95% kernel distribution) occurs where the winter road between the Goose to George Properties, and the eastern portion of the TCWR Connector are located. Winter is the season when caribou movement rates are lowest (Section 5.1.3.2), so the rate of caribou crossing the road is expected to be relatively low.

To further minimize the likelihood of collisions with Beverly caribou, truck speed will be limited to 60 km/h, and drivers will reduce speed to 40 km/h when caribou are observed within 250 m of the road to allow caribou to cross the road. Drivers will stop to allow caribou in close proximity to the road to move across the road. When small groups (< 10) or individual caribou are standing on the road, drivers will stop for 20 minutes to allow caribou to move off the road (Section 5.5.3). To ensure that driver visibility of caribou and other wildlife is not impeded by accumulated snow, snow banks and snowdrifts will be managed if these reach heights deemed to impair the ability of drivers to see wildlife.

During seven years of incidental observations (2000 to 2006) conducted at Ekati Mine, only one caribou with a broken hind leg was reported in the Long Lake Containment Facility of the EKATI mine — the cause of the broken leg was not known (BHP Billiton 2007). During fall migration 2010, 7-9 injured caribou were observed along EKATI's Misery Road, but there was no evidence to link the injuries with interactions of caribou with the mine activities or infrastructure (Rescan 2013f).

As only 3.7% of Beverly winter range occurs in the wildlife RSA and their winter ranges are quite variable (Section 5.1.3.2) and are often not found in the wildlife RSA during winter it is unlikely that the winter roads will result in mortality to Beverly caribou. In addition, mitigation measures will further minimize the effect of disruption to movement. Thus, the construction and used of the winter roads is not anticipated to result in a residual effect.

### *5.5.2.5 Indirect Mortality*

Indirect mortality to caribou was evaluated for the potential to increase hunting of caribou due to new road development. The socio-economic assessment reports that an increase in human immigration and hunting is unlikely in the Back River wildlife RSA (Volume 8, Chapter 3).

Mitigation measures are in place to prevent public access to Project roads (Section 7.5.3 and Volume 10, Chapter 20). In addition, a policy prohibiting hunting within a buffered area along all

infrastructure will be developed and enforced (Volume 10, Chapter 20). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees. Thus, construction and operation of the road is not expected to cause an increase in caribou mortality due to facilitation of hunter access (i.e., indirect mortality) and is therefore is not anticipated to result in a residual effect on caribou.

#### *5.5.2.6 Attraction*

This section describes and evaluates the likelihood that Bathurst and Beverly caribou will be attracted to the Goose and George PDAs for relief from. Use of the PDAs for insect relief will be limited to late June to August, when caribou are harassed by insects. The attraction of Beverly herd caribou to winter roads as movement corridor is also assessed for the winter season only (December through April) when roads will be constructed and used.

In the central Arctic, caribou travel along eskers, frozen lakes, ridges and high points, probably because these are places where snow is relatively shallow, and thus presents an easier route for travel (Thorpe et al. 2001; C. J. Johnson et al. 2005). Caribou of the Porcupine herd in the western Arctic travelled along roads, particularly when the roads paralleled migration routes (Banfield 1974). Caribou have been documented crossing roads and using roads as movement corridors at the EKATI Diamond Mine in the Northwest Territories (BHP Billiton 2007).

Bathurst herd caribou are below treeline during this time, thus are not assessed for attraction to winter roads. The frequency with which Beverly caribou will use the road as a travel corridor will likely depend on their direction of travel with respect to the road alignment, combined with the difficulty of surrounding terrain for travel.

Evaluation of Attraction

BATHURST CARIBOU

Bathurst caribou occur within the western portion of the wildlife RSA in low abundance during the post-calving season (June 16 to July 20). Caribou typically use lakeshores with a breeze and may use eskers and other high areas where wind may occur for insect relief (KIA 2012). While some insect relief may occur within the Project PDAs, it is more likely that caribou will avoid these areas due to noise disturbance and human activity in these areas. Thus, the effect of PDAs as attractants to caribou for insect relief is not anticipated to result in a residual effect to Bathurst caribou.

BEVERLY CARIBOU

Beverly caribou occur within the wildlife RSA during the summer season (July 21 to August 31) when insects are around. However, similar to Bathurst caribou, Beverly caribou will avoid the Project PDAs due to noise disturbance and human activity in these areas. Thus, the effect of PDAs as attractants to caribou for insect relief is not anticipated to result in a residual effect to Beverly caribou.

During the winter, Beverly caribou will likely occur in the vicinity of the proposed roads in relatively small numbers as the southern portion of the wildlife RSA falls within the northern most portion of the winter range. Approximately, 3.7% of the Beverly winter range (based on a 95% kernel distribution) occurs where the winter road from Goose to George Properties, and the eastern portion of the TCWR Connector are located. However, the winter ranges for Beverly caribou are variable and in some years caribou are not found within the wildlife RSA. Winter is also the season when caribou movement rates are lowest (approximately 2 km per day; Section 5.1.3.2), so the numbers of caribou anticipated to be attracted to the winter roads as travel corridors is anticipated to be small. Thus, it is unlikely that winter roads will result in a residual effect for Beverly caribou.

Overall, the effect of attraction to PDAs and winter roads by caribou is not anticipated to result in a residual effect.

#### *5.5.2.7 Exposure to Contaminants*

Exposure to contaminants in caribou due to the Project was evaluated in the Country Foods Effects Assessment (Volume 8, Chapter 5) and in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in caribou or its respective food chain components and surroundings (e.g., water, lichen, soil) were predicted to be below a value of one. A hazard quotient less than one indicates that an increase in contaminants in these media relative to baseline conditions is unlikely. Thus, a residual effect due to exposure to contaminants in caribou is not anticipated and is not considered further in the assessment.

#### *5.5.2.8 Reduction in Reproductive Productivity*

Female body condition, which is primarily affected by forage availability, appears to be the main determinant of reproductive productivity in caribou (Gerhart et al. 1997; Couturier, Cote, Huot et al. 2009; Couturier, Cote, Otto et al. 2009). The body condition of female caribou correlates with pregnancy and birth rates, calf weights and calf survival (R. D. Cameron et al. 1993; Gerhart et al. 1997). Thus, access to sufficient food by females and calves during summer, and by female caribou in winter is thought to be one of the major drivers of caribou population size on the tundra (reviewed in Festa-Bianchet et al. 2011; Gunn, Russell, and Eamer 2011).

Energetic stress is highest in female caribou during lactation and winter. Female caribou give birth at a time when they are protein deficient, because their primary winter food—lichen—is protein poor (Parker, Barboza, and Stephenson 2005). Consequently, females require abundant forage rich in protein during the post-calving period, in order to restore protein reserves and meet the protein demands of lactation (Barboza and Parker 2008; Parker, Barboza, and Gillingham 2009). In winter, female caribou must maintain sufficiently high fat reserves to avoid using protein reserves that are necessary for foetal growth and survival (Post and Klein 1999; Barboza and Parker 2008).

The major impact on caribou from mines and other industrial developments on the tundra is hypothesized to be reduced body condition, resulting from displacement from preferred habitat, and behavioral responses resulting in a negative energy balance (Gunn et al. 2001; Adamczewski et al. 2012). Thus, the greatest impact of industry would likely occur during lactation (the post-calving season) and late winter, when female caribou are energetically stressed (Gerhart et al. 1997). With the obvious exception of mortality, all of the preceding effects may result in energetic stress to female caribou, and subsequent reductions in body condition that negatively impact pregnancy rates (Quellet et al. 1991; Gerhart et al. 1997), birth rates (R. D. Cameron et al. 1993), and probably also calf survival.

Another factor that may affect reproductive productivity in caribou is the effects of climate change. With improved technology, changes in population structure and other ecological processes over time can be tracked which is particularly important considering anthropogenic disturbances and impacts of climate change (Nagy et al. 2011). In highly seasonal environments such as the Arctic, the timing of migration and breeding coincide with peak resource availability (Post and Forchhammer 2008). This is particularly important for caribou that exhibit highly synchronous parturition with the emergence of their forage plants (Post 2003; Post et al. 2003). In addition, other potential negative impacts include increased snowfall, insect harassment of caribou in the summer are possible scenarios (Brotton and Wall 1997). This shift in season could affect migration, calving and post-calving success for caribou.

A decline in caribou populations is most likely to be a result of multiple factors acting synergistically to cause stress in caribou and resulting in reductions in reproductive productivity. With the exception of

mortality, all of the preceding potential effects may result in declines in reproductive productivity of wildlife species. Habitat loss and degradation, disturbance, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. Individuals in poor body condition can fail to produce young, or produce young with lower survival potential. The body condition of parturient females of large mammal species is thought to be the main determinant of the health and survival of their young.

Bathurst caribou may interact with the western edge of the Project near George Property during the post-calving season, but are otherwise largely outside of the wildlife RSA. Beverly caribou occur in the wildlife RSA during summer, fall and winter.

Evaluation of Reduction in Reproductive Productivity

The potential for a reduction in reproductive productivity of caribou, and the significance of the reduction, depends on a number of factors, including the degree of disturbance, as well as the number, sex and age-class of individuals of each species killed as a result of direct mortality and the influence of these factors on the demographics of the local population. These potential effects may synergistically reduce caribou productivity. The potential effects of the Project on reproductive productivity of caribou are related to each residual effect listed in the potential effects above.

Mitigation measures are anticipated to mediate the effects of most potential Project-related effects. However, residual effects of habitat loss and disturbance as a result of Project-related activities are anticipated for a small number of individuals. In addition, an increase in energy requirement may occur for caribou in range of the disturbance due to blasting, thus reducing reproductive potential for these individuals. Therefore, there is some, albeit small, potential for a reduction in reproductive productivity in caribou due to the Project.

### 5.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including caribou. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on caribou is anticipated resulting from habitat loss, disturbance, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to caribou. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

#### *5.5.3.1 Mitigation for Habitat Loss*

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to caribou may include the following:

- Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as caribou calving grounds and caribou high use areas (Volume 10, Chapter 20);
- infrastructure designed to minimize the Project footprint to reduce habitat loss for caribou (Project Description; Volume 2, Chapter 2);

- consideration of the location of the stockpiles and windbreaks to minimize dustfall, to reduce habitat degradation for caribou (Volume 10, Chapter 17);
- infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located, thereby minimizing the Project footprint to reduce habitat loss for caribou (Project Description; Volume 2, Chapter 2).
- open-water season shipping only (no ice-breaking) to avoid loss of ice for migration of the Dolphin-Union herd that migrates across the ice (Project Description; Volume 2, Chapter 2); and
- winter only road access corridors proposed (no all-weather roads for re-supply routes or between the Goose and George Properties), to minimize direct habitat loss, and habitat degradation due to dust deposition for caribou (Project Description; Volume 2, Chapter 2).

#### *5.5.3.2 Mitigation for Disturbance*

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance to caribou may include:

- pre-construction ground clearing conducted outside of sensitive periods for caribou (i.e., spring migration [Beverly herd], calving or post-calving migration [Bathurst herd]) where possible to reduce disturbance to caribou;
- winter roads designed to minimize the distance travelled which will reduce the overall noise generated associated with construction and operation (Project Description; Volume 2, Chapter 2);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to caribou (Volume 10, Chapter 18);
- underground mining used, where possible, to reduce noise emitted by the Project for excavating and hauling waste rock, and minimize the effects of noise disturbance to caribou (Volume 10, Chapter 20);
- managing above ground blasting activities if large groups of female caribou with young (> 100 animals) occur within 500 m (or line of sight) of the site, until caribou pass through the area to minimize sensory disturbance to caribou (Volume 10, Chapter 20). Note: Caribou presence will be identified through daily, ground-based surveys during the peak periods when caribou are present in the area. Increasing this distance to > 500 m means that a helicopter must be used for observing caribou. The use of that helicopter is considered more disruptive than construction or operations disturbance;
- Ground-based observations for caribou conducted prior to blasting during the calving and post-calving periods if incidental observations from helicopters indicate that caribou are in the area (Volume 10, Chapter 20);
- above ground blasting scheduled outside of the peak periods of Bathurst caribou presence in the project area, where possible (Volume 10, Chapter 20);
- Infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to caribou (Volume 10, Chapter 18);

- vehicles restricted to site roads, winter roads and quarry footprints during construction and operations to avoid unnecessary disturbance to caribou habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- Helicopters will remain above prescribed flight altitudes when possible, as recommended in the draft caribou protection measure guidelines. Landing and takeoff will only be conducted when herds of caribou are not present in the immediate area (Volume 10, Chapter 20);
- Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

#### *5.5.3.3 Mitigation for Disruption to Movement*

The following mitigation measures and best management practices may be applied to minimize the effects of disruption to movement to caribou:

- winter access roads only, when the majority of caribou are not in the wildlife RSA to minimize disruption of movement for caribou (Volume 10, Chapter 20); and
- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce disruption of movement to wildlife (Volume 10, Chapter 20).

#### *5.5.3.4 Mitigation for Direct Mortality and Injury*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to caribou may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);
- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to caribou;
- caribou will be given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20);
- Stopping trucks when groups of caribou are crossing the road to allow small groups (< 10) or individual wildlife standing on the road to move off the road unalarmed (Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

#### *5.5.3.5 Mitigation for Indirect Mortality*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management

Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to caribou may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic, and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project staff and contractors while on site and enforced to prevent an increase in mortality to caribou (Volume 10, Chapter 23).

#### *5.5.3.6 Mitigation for Attraction*

The primary mitigation and management strategies to minimize effects of attraction to the Project to caribou and other wildlife are described in the Landfill and Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10, Chapter 11), and the Borrow Pits and quarry Management Plan (Volume 10, Chapter 16). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to caribou:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- the use of wildlife-attracting dust suppressants avoided, where possible (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20); and
- a protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers (Volume 10, Chapter 20).

#### *5.5.3.7 Mitigation for Exposure to Contaminants*

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to control the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to caribou.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including caribou from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD Cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);

- use of wildlife-attracting dust suppressants avoided wherever possible (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10 Chapter 20).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

### 5.5.4 Characterization of Residual Effects

In Section 5.5.4, eight potential effects were evaluated whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Three of these effects were identified as residual effects: 1) habitat loss, 2) disturbance from noise, and 3) reduction in reproductive productivity. The significance of residual effects are evaluated here for these three effects. Each residual effect is described in this section in terms of eight descriptors (see Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. The magnitude of the residual effect was evaluated by using the information in Table 5.5-2. Table 5.5-3 provides a description of the significance ratings used for residual effects.

#### *5.5.4.1 Habitat Loss*

The total area of habitat loss due to the Goose, George and MLA PDAs is equivalent to 10,237 ha. This area is equivalent to < 0.1% of the post-calving range for Bathurst caribou and < 0.1% of the summer and fall ranges for Beverly caribou and equivalent to 0.2% of the core summer range for Beverly caribou. An additional 8,444 ha of area is evaluated as lost due to the winter roads of which 3,404 ha falls outside the wildlife RSA. The total area lost due to the Project in the winter range for Beverly caribou is equivalent to < 0.1% of the winter range. The overall loss or degradation of high-quality caribou habitat in the wildlife RSA is between 6,352 ha and 8,991 ha (0.8% and 1.0% of available high-quality habitat in the wildlife RSA), depending on the season. The portion of high-quality habitat lost within the post-calving range for Bathurst caribou and the summer, fall and winter ranges of the Beverly caribou is < 0.1% of the assumed available high-quality habitat within these ranges. The proportion of high-quality habitat lost within the summer core range for Beverly caribou is 0.2% of the assumed available high-quality habitat in that range. The actual Project footprints which are designed to be as small as possible are anticipated to be 10-15% of the Project PDAs which have been assumed lost in this assessment. When the proportion of habitat loss is compared to the quantitative thresholds for magnitude of effect (Table 5.5-1), the magnitude of the effect is considered low.

The extent of the effect of habitat loss is footprint, the frequency is sporadic, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas within the PDAs will not be affected and may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during construction and operation. The confidence of the effect occurring is considered high, although confidence in the area and proportion removed is

considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose, George and MLA PDAs will not be developed. The residual effect of habitat loss for caribou is concluded to be Not Significant.

#### *5.5.4.2 Disturbance*

After considering the effects of habitat loss, the total area functionally lost due to blasting (≥ 120 dB) is 35 ha (or < 0.1% of the wildlife RSA). This area accounts for approximately 20 ha of high-quality habitat for caribou (< 0.1% of the available high-quality habitat after accounting for habitat loss). An additional 982 to 27,140 ha ranging between 408 and 14,773 ha of high-quality habitat (< 0.1 to 1.4% of available high-quality habitat in the wildlife RSA after accounting for habitat loss due to Project infrastructure and that which is functionally lost due to blasting) will be disturbed due to blasting (> 108 dB), general Project noise (> 45 dBA) or aircraft noise (> 80 dBA). However, disturbance due to blasting and aircraft noise will be intermittent, and up to 3,898 ha of high-quality habitat (due to general Project noise) will be continuously disturbed (0.4% of available high-quality habitat in the wildlife RSA). Within the Bathurst herd post-calving range, a total of 11,141 ha will be disturbed (0.1% of the range), of which 4,793 ha of high-quality habitat will be affected (< 0.1% of predicted high-quality habitat on the range). Within the Beverly herd summer, fall, and winter ranges a total of between 57,489 and 59,545 ha (0.2 to 0.4% of the ranges) will be disturbed due to noise, of which 25,799 to 35,627 ha of high-quality habitat (0.2 to 0.3% of the predicted high-quality habitat in these ranges) will be disturbed. Following the quantitative thresholds for magnitude listed in Table 5.5-1, the magnitude of the effect is considered low.

The extent of the effect of disturbance is local (i.e., extends beyond the footprint but is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for dB 108 and 120 Lpeak during blasting activities, and the duration is considered medium as the effect of disturbance is expected to subside at closure. The effect is considered to be reversible as caribou are anticipated to relocate to areas of disturbance once the effect subsides. The probability of the effect occurring is likely, and confidence is high, as caribou are known to be sensitive to blasting activities related to mining. The residual effect of disturbance on caribou is assessed as Not Significant.

#### *5.5.4.3 Reduction in Reproductive Productivity*

The potential for a reduction in reproductive productivity of caribou, and the significance of the reduction, depend on a number of factors, including the degree of habitat loss, the degree of disturbance, as well as other factors such as climate change, and the influence of these factors on the demographics of the local population. These effects may synergistically reduce caribou productivity. The effects of the Project on reproductive productivity of caribou are related to each effect listed above.

The residual effects of the Project on caribou include habitat loss, and disturbance. These effects combined can result in a reduction in reproductive productivity in caribou. The highest magnitude of any of the residual effects on caribou after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on caribou is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of caribou in the Project area. The duration of the effect is expected to be medium as habitat loss may be permanent and the effect of disturbance will last until Project-related activities cease. The frequency of the effect is anticipated to be sporadic as the likelihood of reduction in reproductive productivity are limited to events such as mortality which may cause declines in the caribou population, or on factors such as limited resources or disturbance events which may limit the success of reproduction, births and rearing of young. The effect of reduction of reproductive productivity is

anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the mine is closed. The geographic extent of this residual effect is anticipated to be regional.

However, the likelihood that a reduction in reproductive productivity on caribou will occur is uncertain. Caribou are expected for the most part to avoid contact with the mine and choose alternative habitat in areas that are not disturbed. The confidence in the effect rating is medium as it is unknown how the residual effects of the Project on reproduction of caribou may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the residual effect of reduction of reproductive productivity is concluded to be Not Significant.

### 5.5.5 Significance of Residual Effects

The effects assessment for caribou identified three residual effects as follows:

- habitat loss, rated Not Significant;
- disturbance, rated Not Significant; and
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Habitat loss and disturbance due to the Project leading to avoidance of habitat is anticipated to result in a small effect on the population of Bathurst and Beverly caribou herds as the total amount of habitat lost or altered due to disturbance is small relative to the size of the seasonal ranges for Bathurst and Beverly caribou herds. Thus, these effects will not significantly result in a decline in the caribou populations in the region. A summary of residual effects on caribou and overall significance ratings are presented in Table 5.5-9. Contingent on the implementation of mitigation measures outlined in the WMMP (Volume 10, Chapter 20), the combined significance of residual effects for caribou is predicted to be **Not Significant**.

## 5.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

### 5.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities.

The cumulative effect assessment (CEA) follows the methodology detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.

**Table 5.5-9. Summary of Residual Effects on Caribou and Overall Significance Rating**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Direction** *(positive, neutral, negative)* | **Magnitude** *(negligible, low, moderate, high)* | **Duration** *(short, medium, long)* | **Frequency** *(once, sporadic, continuous)* | **Geographic Extent** *(footprint, local, regional, beyond regional)* | **Reversibility** *(reversible, reversible with effort, irreversible)* | **Probability** *(unlikely, moderate, likely)* | **Confidence** *(low, medium, high)* | **Not significant** *(N)*; **Significant** *(S)*; **Positive** *(P)* |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | Medium | N |
| Disturbance | Negative | Low | Medium | Continuous | Local | Reversible | Likely | High | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Continuous | Regional | Reversible | Unlikely | Medium | N |

3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for characterizing potential effects were the same as those used for characterizing Project-related effects (Section 5.5.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 5.5.1) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for caribou.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 5.5.1). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for caribou and not the wildlife RSA.

#### *5.6.1.1 Spatial Boundary*

The cumulative effects assessment for caribou considers three spatial boundaries — one for Bathurst herd caribou, and two for Beverly herd caribou. These boundaries are based on the seasonal ranges of these herds and when they may come into contact with Project-related activities due to the Back River Project. The potential cumulative effects of Habitat Loss and Disturbance due to Noise were also considered on the annual herd ranges for Bathurst and Beverly herd caribou for completeness.

Bathurst Caribou

The spatial boundary for the Bathurst caribou is based on the post-calving and summer seasonal range of this herd (Section 5.1.2). Effects of other projects or anthropogenic activities that occur within the post-calving and summer range for the Bathurst caribou herd are used when considering the cumulative effects on this herd (Figure 5.6-1).

Recent research by the Canadian Centre for Remote Sensing has examined the food availability on the post-calving and summer range of the Bathurst herd. This research suggests that the forage availability on the post-calving and summer range may drive natural population change for the Bathurst herd. In years with poor biomass availability, the overwinter survival of calves the following winter is reduced and the growth rate of the herd declines or is negative (Chen et al. submitted). This work does not include the influence of hunting. The proposed BIPR road would occur on the north-western portion of this post-calving / summer range.

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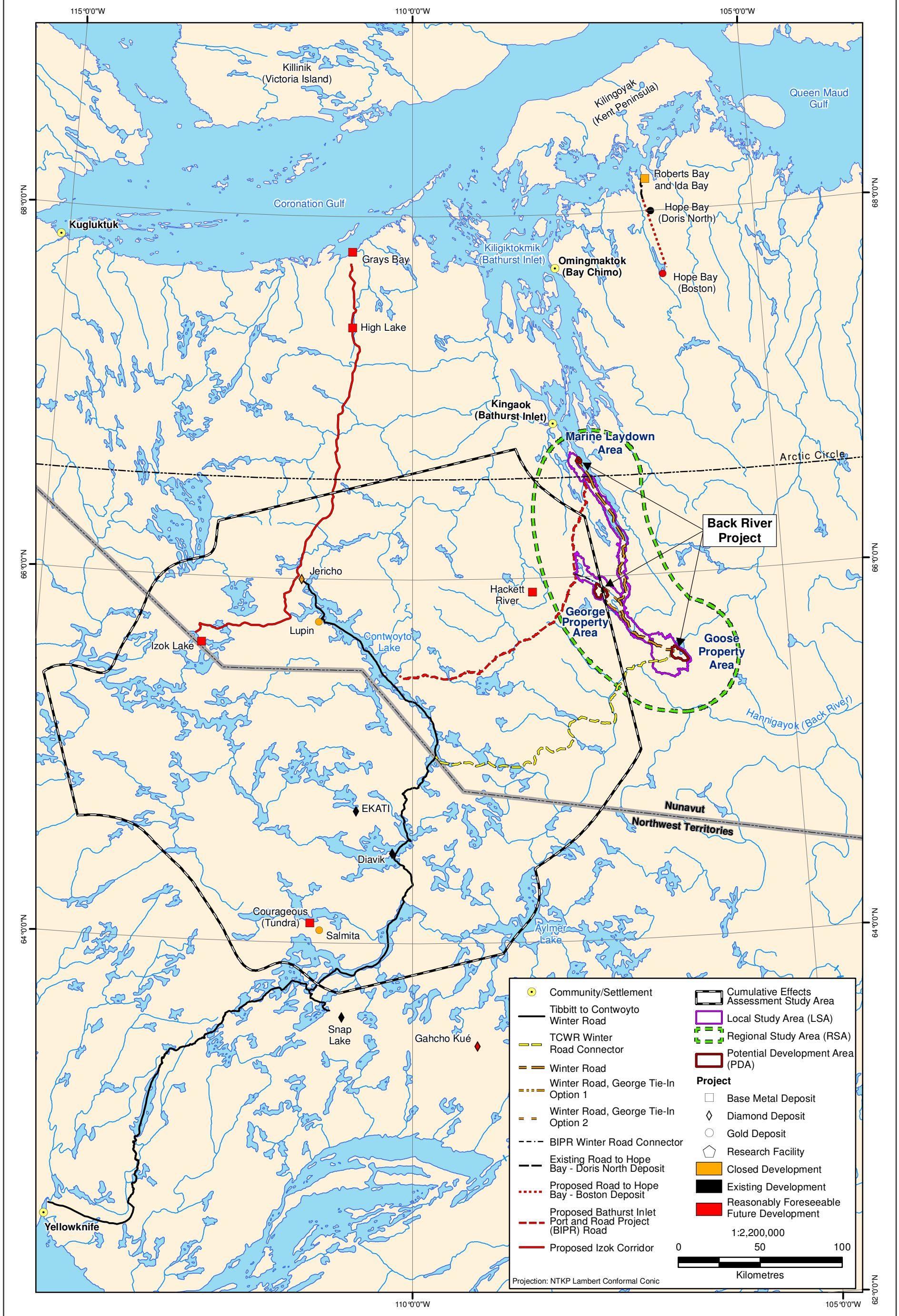


Figure 5.6-1

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# Spatial Boundary for Bathurst Caribou Cumulative Effects Assessment

Figure 5.6-1

Rescan an ERM company

In order to examine the effects of habitat removal, disturbance and other factors, the cumulative effects area was set to encompass the post-calving and summer range of the Bathurst herd (Figure 5.6-1). This area comprises approximately 8,100,050 hectares. With evidence that forage availability on the post-calving/summer range is driving the population growth rate of the Bathurst herd, this area was used to evaluate cumulative effects. If a larger area is chosen, more projects would be included, but the effects of projects (e.g., the proportion of habitat removed or affected) on the post-calving/ summer range would decline due to a dilution effect.

Beverly Caribou

The spatial boundary for the Beverly caribou is based on the seasonal ranges of this herd (Section 5.1.3). Effects of any other projects or anthropogenic activities that occur within the seasonal ranges for the Beverly caribou herd are used when considering the cumulative effects on this herd (Figure 5.6-2).

For the cumulative effects assessment, the information on the importance of the Bathurst herd post-calving and summer range is used to define the Beverly herd CEA spatial boundary. However, as no closed, existing, or foreseeable future developments are located within the post-calving range for Beverly herd caribou and the post-calving range falls in the same area as the calving range for Beverly caribou, only the summer range for Beverly herd caribou is used to define the Beverly herd CEA boundary during the foraging season.

The summer range of Beverly caribou based on collaring data is likely much smaller as the collaring data does not distinguish between the Beverly herd and Beverly herd caribou. Thus, an approximate summer range for the Beverly herd was defined (Figure 5.6-2) and was developed based on a buffer approximating the 95% kernel distribution that surrounds the inner 50% kernel distribution for this herd (Figure 5.1-12 in Section 5.1.3). This area comprises 12,937,264 hectares. With evidence that forage availability on the post-calving and summer range may drive the population growth rate of caribou, then it is important to rate the effects of the Project against this area. If a larger area is chosen, more projects would be included, but the effects of projects (e.g., the proportion of habitat removed or affected) on the post-calving/ summer range would decline due to a dilution effect.

The winter range of Beverly caribou was also chosen as a second cumulative effects assessment boundary for Beverly caribou. The winter range was also used for Beverly caribou as the residual effects due to the Back River Project may be greater during the winter, when the roads are active, relative to the summer foraging period and Beverly caribou may interact with the Project during the winter in some years.

Similar to the summer range of Beverly caribou, the winter range based on collaring data is likely much smaller than that based on the 95% kernel distribution of all collaring data between 2001 and 2012, as it does not distinguish between the Beverly herd and Queen Maud herd caribou. Thus, an approximate winter range for the Beverly herd was defined (Figure 5.6-2) and was developed based on a buffer approximating the 95% kernel distribution that surrounds the inner 50% kernel distribution for this herd (Figure 5.1-13 in Section 5.1.3). This area comprises 21,236,369 hectares.

#### *5.6.1.2 Temporal Boundary*

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

### 5.6.2 Potential Interactions of Residual Effects with Other Projects

Three residual Project-related effects were identified during the caribou effects assessment: habitat loss; disturbance due to noise; and reduction in reproductive productivity. Several additional projects

or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the seasonal ranges for Bathurst and Beverly caribou that interact with the Back River Project.

Figures 5.6-1 and 5.6-2 displays the past, present, and foreseeable future developments that could interact with caribou in the CEA boundaries for Bathurst herd and Beverly her caribou, respectively. Ten additional projects have been identified within the CEA spatial boundary for Bathurst herd caribou including four past developments which are now closed (Jericho Mine, Lupin Mine, Tundra Mine, and Salmita Mine), two existing developments (Ekati and Diavik Mines), and four reasonably foreseeable future projects (BIPR, Hackett River, Izok Corridor, and Courageous Lake projects) in addition to the Back River Project.

Five projects, in addition to the Back River Project have been identified within the summer CEA boundary for Beverly caribou including one past development (Roberts Bay project), one existing development (Doris North Project) and three future foreseeable projects (BIPR, Hackett River, and Hope Bay [Phase 2]). For the winter CEA boundary for Beverly caribou, projects have been identified in addition to the Back River Project including one current development (the Tibbitt to Contwoyto Winter Road [TCWR]), and two reasonably foreseeable projects (BIPR and Hackett River projects). A description of the type of potential cumulative effect due to all projects combined is listed in Table 5.6-1.

**Table 5.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Caribou in the Area**

| Residual Effect from Back River Project | Rating from Back River Project | Other Project or Activity | | | Type of Potential Cumulative Effect |
|---|---|---|---|---|---|
| | | Past | Existing | Reasonably Foreseeable Future | |
| Habitat Loss | Low | Jericho[1], Lupin[1], Tundra[1], Salmita[1], Roberts Bay[2] | Ekati[1], Diavik[1], Doris North[2], TCWR[3] | BIPR[*,1,2,3], Hackett River[1,2,3], Izok Corridor[1], Courageous Lake[1], Hope Bay (Phase 2)[2], Gahcho Kue[3] | Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities |
| Disturbance | Low | n/a | Ekati[1], Diavik[1], Doris North[2], TCWR[3] | BIPR[*,1,2,3], Hackett River[1,2,3], Izok Corridor[1], Courageous Lake[1], Hope Bay (Phase 2)[2], Gahcho Kue[3] | Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance |
| Reduction in Reproductive Productivity | Low | Jericho[1], Lupin[1], Tundra[1], Salmita[1], Roberts Bay[2] | Ekati[1], Diavik[1], Doris North[2], TCWR[3] | BIPR[*,1,2,3], Hackett River[1,2,3], Izok Corridor[1], Courageous Lake[1], Hope Bay (Phase 2)[2], Gahcho Kue[3] | Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects |

**BIPR = Bathurst Inlet Port and Road Project*
*[1] Projects that may interact with the Bathurst herd caribou post-calving CEA boundary*
*[2] Projects that may interact with the Beverly herd caribou summer CEA boundary*
*[3] Projects that may interact with the Beverly herd caribou winter CEA boundary*

Potential cumulative effects are assessed during the post-calving season (June 16 to July 20) for Bathurst herd caribou when they may interact with the Back River Project. Potential cumulative effects for Beverly caribou area assessed during the summer (July 26 to August 31), fall (September 1 to October 31) and winter seasons (November 1 to April 14) when Beverly caribou may interact with the Back River Project.

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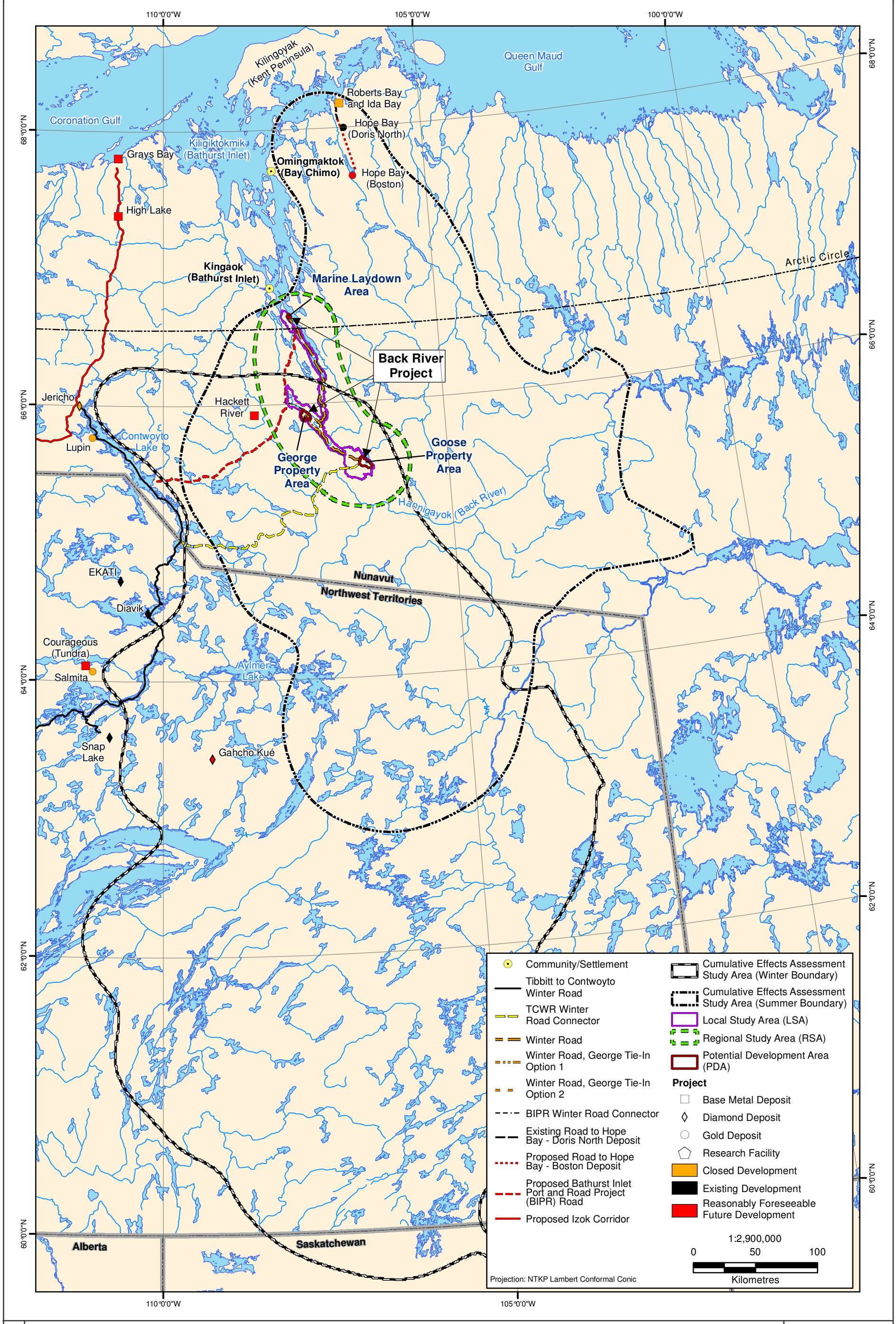


Figure 5.6-2

Sabina GOLD & SILVER CORP.

# Spatial Boundary for Beverly Caribou Cumulative Effects Assessment

Figure 5.6-2

Rescan an ERM company

Since the core summer range for Beverly caribou is roughly centered on the Goose Property, the summer and fall ranges greatly overall one another (Section 5.1.3), and the post-calving and summer season may represent a more sensitive period for caribou relative to fall, effects to caribou during the summer and fall are assessed using the summer spatial boundary for Beverly caribou. Potential cumulative effects to Beverly caribou are also assessed in the winter period as the use of winter roads during that time may act additively to these effects.

#### *5.6.2.1 Habitat Loss*

The Project effects assessment rated the residual effect of habitat loss from the Back River Project as Not Significant, with a low magnitude for both the Bathurst herd caribou during the post-calving and summer period and for the Beverly herd caribou during the summer season, fall season, and the winter season. Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible. While habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 5.5.4.1), additional habitat loss within the post-calving/summer range of Bathurst herd caribou and the summer/fall and winter ranges of Beverly herd caribou may contribute to a nibbling effect whereby the total amount of habitat lost to all potential and current projects is additive to the point where a significant loss in habitat can occur.

Calculation of Habitat Loss

Cumulative habitat loss was calculated in three ways for the Bathurst herd and two ways for the Beverly herd:

1. The total area removed by all projects, compared to the area of the study area (Bathurst and Beverly);
2. The area likely degraded by dust and disturbance surrounding each project (Bathurst and Beverly);
3. The area of high-use habitat, as calculated by a resource selection function for the Bathurst herd.

The amount of habitat removed ("area removed") was estimated from the generalized footprints of all projects and road corridors in the post-calving and summer combined CEA boundary for Bathurst herd caribou and the summer and winter (separate) CEA boundaries for Beverly herd caribou and used as a key indicator to determine potential cumulative effects. The fall boundary for Beverly herd caribou was not included in the cumulative effects assessment as habitat loss during the summer season would represent a worst case scenario during the foraging season. The Beverly herd winter cumulative effects assessment includes the calculation of potential effects due to the winter roads. Winter roads are not anticipated to result in an effect during the foraging season (post-calving through fall), thus are not assessed in these seasons. For all existing and future foreseeable projects, habitat within 100 m of footprints were considered degraded due to dust (Walker and Everett 1987; Rescan 2012b). Habitat loss for the Back River Project was calculated within the PDAs which already includes a dust-disturbance area.

The post-calving and summer ranges of the Bathurst herd have been stable and relatively predictable since 1996 (Gunn et. al. 2008). There is evidence that declines in the Bathurst herd are related to calf-survival, fecundity, and cow survival, and these may be influenced by several factors across the herd's range (Boulanger et. al. 2012). There is growing evidence that conditions (e.g., habitat productivity) on the post-calving and summer ranges influences body condition entering the rut and subsequent birth rates, net productivity, and calf survival rates (Chen et al. 2013). Large scale factors, such as expanding industrial activity and climate change, have the potential to influence habitat conditions across broad spatial and temporal scales. As a result, a resource selection function was developed to

spatially delineate habitat use by Bathurst caribou on the post-calving and summer ranges to explore underlying mechanisms in caribou distribution and identify key regions during these periods. Climate change was not implicitly included in the models, and remains a key uncertainty in the trajectory of all barren-ground caribou. The RSF models were used to determine which projects occur in the post-calving and summer ranges and core ranges and the habitat value at that location if the project is inside the range.

For Beverly herd caribou, an RSF model was not available for the summer and winter ranges for Beverly caribou, and since detailed habitat mapping does not exist for the entire summer or winter CEA boundaries for Beverly herd caribou, it was assumed that these CEA boundaries contain approximately the same proportion of high quality habitat as the wildlife RSA for each season. The percentage of high-quality habitat in the wildlife RSA during the summer season was equivalent to 85.8%. Habitat quality was not estimated for the winter season in the wildlife RSA, thus, the habitat quality for the calving season was used as it represents the season where lichens would be most important to caribou (similar to winter) and is equivalent to 52.0%, although this may be an overestimate the amount of high-quality habitat during the winter season. The total area of lost habitat from these calculations was compared to the area of the seasonal ranges used for the CEA assessment.

Evaluation of Habitat Loss

*Bathurst Herd*

A number of closed projects including Jericho Mine, Lupin Mine, Salmita Mine and Tundra Mine have already removed some habitat within the post-calving and summer CEA boundary for Bathurst herd caribou. Other existing developments including Ekati Mine and Diavik Mine overlap with the post-calving and summer CEA boundary for Bathurst herd caribou and may further decrease the available habitat or habitat quality (e.g., due to dust fall-out, etc.) for Bathurst caribou using this area. The proposed BIPR, Hackett River, Izok Corridor, and Courageous Lake projects have the potential to overlap with the post-calving CEA boundary for Bathurst herd caribou and may contribute to additional habitat loss if these projects are developed.

The post-calving and summer CEA boundary for Bathurst caribou is 8,100,050 ha. Within the CEA boundary (Post-calving/Summer Range) for Bathurst herd caribou, the cumulative effects assessment identified 13,430 ha of removed habitat, and 13,402 ha of degraded habitat (Table 5.6-2). These areas equate to a total of 26,835 ha (0.3% of Bathurst CEA boundary) after accounting for overlap between projects. The Back River Project alone will contribute 3,132 ha within the CEA boundary which is equal to approximately 12% of the total area of habitat loss within the CEA boundary for Bathurst herd caribou and < 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10-15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects. While the proportion of habitat loss within the post-calving and summer CEA boundary for Bathurst herd caribou is minimal, a residual effect, albeit small, is predicted.

A check was conducted to confirm that the proposed cumulative effects area for caribou provided a conservative assessment of the effects of industrial development. The proportion of area affected by industry on the CEA area was compared to the total area affected by all projects within the total annual range for all seasons combined for the Bathurst herd. The total annual range for Bathurst caribou approximates 44,325,144 ha. Within the total annual range, the cumulative effects of habitat loss due to all projects on this range is 32,539 ha of removed habitat and 16,947 ha of degraded habitat for a total of 52,476 ha (0.12% of the annual range for Bathurst herd caribou) after accounting for overlap between projects (Table 5.6-2). The proportion of habitat loss within the total annual range for Bathurst caribou was much less than that in the post-calving and summer range (0.12% relative to

0.3%), therefore the post-calving and summer range was used as a conservative approach to assessing the overall effects of cumulative habitat loss for Bathurst caribou.

**Table 5.6-2. Cumulative Habitat Loss in the Bathurst Caribou CEA Boundary**

| Caribou Range | Project | Habitat Removed due to Project Footprint (hectares) | Habitat Degraded due to Dust (100 m around infrastructure; hectares) | Total Habitat Lost or Degraded[1] (hectares) |
|---|---|---|---|---|
| *Post-calving & Summer Ranges*[2] | | | | |
| | Back River Project | 3,132 | NA | 3,132 |
| | Operating Developments | | | |
| | EKATI Mine | 3,156 | 2,057 | 5,213 |
| | Diavik Mine | 987 | 421 | 1,408 |
| | Reasonably Foreseeable Future Developments | | | |
| | BIPR | 503 | 4,113 | 4,616 |
| | Courageous Lake | 2,204 | 842 | 3,046 |
| | Izok Mine | 851 | 3,915 | 4,766 |
| | Hackett River | 1,454 | 2,057 | 3,511 |
| | Past Developments | | | |
| | Jericho Mine | 242 | | 242 |
| | Lupin Mine | 795 | | 795 |
| | Salmita Mine | 10 | | 10 |
| | Tundra Mine | 96 | | 96 |
| | Cumulative Area | | | |
| | Total | 13,430 | 13,405 | 26,835 |
| | Proportion of Range | 0.16% | 0.16% | 0.33% |
| *Annual Herd Range (Additional areas of habitat loss outside of post-calving and summer ranges)* | | | | |
| | Back River Project | 15,549 | NA | 15.549 |
| | Operating Developments | | | |
| | Ekati Mine | 66 | | 66 |
| | Snap Lake | 118 | 78 | 186 |
| | TCWR | 943 | | 943 |
| | Reasonably Foreseeable Future Developments | | | |
| | BIPR | 153 | 808 | 961 |
| | Courageous Lake | 53 | | 53 |
| | Gahcho Kué | 1,969 | 322 | 2,291 |
| | Izok Mine | 364 | 2,334 | 2,698 |
| | Cumulative Additional Area | | | |
| | Total | | | |
| *Annual Herd Range (Total area of habitat loss within the entire annual Bathurst herd range)* | | | | |
| | Grand Total[3] | 32,539 | 16,947 | 52,476 |
| | Proportion of Range | 0.07% | 0.04% | 0.12% |

*[1] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.*
*[2] Winter road calculations were excluded from post-calving and summer ranges but included under the Annual herd range.*
*[3]Total in Annual Herd Range includes all additional areas of habitat lost outside of the post-calving and summer ranges that fall within the annual herd range. Grand total accounts for areas of overlap.*

Inuit TK indicates that the Contwoyto Lake and Nose Lake regions have been important post-calving and summer ranges for the Bathurst herd since before development and prior to the deployment of radio collars on the Bathurst herd. The RSF model, which provides a spatial surface that indicates the likelihood of detecting caribou across the landscape, indicates that these areas continue to be important to the Bathurst herd (Figures 5.1-12a,b and 5.1-12c,d). The designation of habitat value is arbitrary and based on calculated probabilities of detections (low = 0 – 0.25; moderate 0.26 – 0.50; high = 0.51 – 0.75; very high > 0.75). A portion of the Back River wildlife RSA overlaps the eastern edge of the post-calving range, and only the George property is found at the edge of the range, which is comprised or primarily low and moderate value habitat (i.e., lower detection rates relative to the rest of the range). During summer there is no overlap by any components of the Back River Project, either in the total range or the core use area.

Other projects in the region have the potential to influence post-calving and summer habitat conditions and subsequent distribution and habitat use by caribou. Current ranges and habitat use are likely integrated over time by conditions on the landscape. The Ekati and Diavik diamond mines are the only operators in the region, and occur at the edge of very high value habitat (i.e., probability of detection > 0.75) during post-calving, and in the centre of moderate and high value habitat during summer, but falls outside the core use areas during both seasons. Amongst potential future developments, the neighboring Hackett River project is found within both the post-calving range and the post-calving core use area (i.e., in the Mara River and Hackett River movement corridors), but not in the summer range or core use area. The Courageous Lake project does not occur in the post-calving range or core use area. Both the Courageous Lake and Izok projects are located in low to moderate value habitat relative to the entire summer range, and only Izok is located in moderate valued core summer habitat (relative to the rest of the core use area).

The RSF model found a response curve (an increase in the probability of detection of caribou with distance from disturbance) of approximately 35 km from operating mines during the post-calving season, comparable to Johnson et al. (2005), and 50 km during the summer, which are likely beyond the sensory limits of caribou. While the direction of selection coefficients suggest some avoidance, the size of the selection coefficients and similar mean distances from disturbance between collar and random locations suggest that the response curves may be more a function of the number of collar locations combined with a low density of developments relative to the size of the study area. With a similar result, Johnson et al. (2005) concluded the influence with industry warranted further investigation; however, the possibility cannot be discounted that industrial development may influence the distribution of caribou at broad spatial scales (e.g., seasonal range). Habitat productivity and climate change may ultimately be the most important components that drive caribou distribution and habitat use (Joly et al. 2011). Under the current distribution of existing and proposed developments, impacts to habitat conditions on the post-calving and summer ranges are expected to be minimal provided that the integrity of the Contwoyto Lake and Nose Lake region is maintained, and that movements along the Burnside, Mara, and Hackett River corridors are not impeded.

*Beverly Herd*

*Summer*: The summer CEA boundary for Beverly caribou is 12,937,264 ha. Within the summer CEA boundary for Beverly herd caribou, the cumulative effects assessment identified 15,547 ha of removed habitat, and 7,991 ha of degraded habitat. These areas equate to a total of 23,538 ha (Table 5.6-3) and 0.18% of the summer CEA boundary for Beverly caribou. The Back River Project alone will contribute 10,238 ha (43.5%) of the total area of habitat loss within the summer CEA boundary for Beverly caribou and is equivalent to < 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10-15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

**Table 5.6-3. Cumulative Habitat Loss in the Beverly Caribou CEA Boundary**

| Caribou Range | Project | Habitat Removed due to Project Footprint (hectares) | Habitat Degraded due to Dust (100 m around infrastructure; hectares) | Total Habitat Lost or Degraded[1] (hectares) |
|---|---|---|---|---|
| *Summer Range* | | | | |
| | Back River Project | 10,238 | NA | 10,238 |
| | Operating Developments | | | |
| | Doris North | 279 | 533 | 812 |
| | Reasonably Foreseeable Future Developments | | | |
| | BIPR* | 578 | 4,337 | 4,915 |
| | Hackett River | 1,454 | 2,057 | 3,511 |
| | Hope Bay (Phase 2) | 2,995 | 1,064 | 4,059 |
| | Closed Developments | | | |
| | Roberts Bay | 3 | | 3 |
| | Cumulative Area | | | |
| | Total | 15,547 | 7,991 | 23,538 |
| | Proportion of Range | 0.12% | 0.06% | 0.18% |
| *Winter Range* | | | | |
| | Back River Project | 16,939 | NA | 16,939 |
| | Operating Developments | | | |
| | TCWR | 122 | 0 | 122 |
| | Reasonably Foreseeable Future Developments | | | |
| | BIPR* | 430 | 3,530 | 3,960 |
| | Hackett River | 1,454 | 2,057 | 3,511 |
| | Gahcho Kué | 1,969 | 322 | 2,291 |
| | Cumulative Area | | | |
| | Total | 20,914 | 5,909 | 26,823 |
| | Proportion of Range | 0.10% | 0.03% | 0.13% |
| *Annual Herd Range*[2] | | | | |
| | Back River Project | 18,681 | NA | 18,681 |
| | Operating Developments | | | |
| | Diavik Mine | 987 | 421 | 1,408 |
| | Doris North | 279 | 533 | 812 |
| | Ekati Mine | 306 | 358 | 616 |
| | Snap Lake | 112 | 78 | 190 |
| | TCWR | 463 | | 463 |
| | Reasonably Foreseeable Future Developments | | | |
| | BIPR | 656 | 4,921 | 5,577 |
| | Courageous Lake | 7 | | 7 |
| | Gahcho Kué | 1,969 | 322 | 2,291 |
| | Hackett River | 1,454 | 2,057 | 3,511 |
| | Hope Bay (Phase 2) | 2,998 | 1,072 | 4,070 |

*(continued)*

**Table 5.6-3. Cumulative Habitat Loss in the Beverly Caribou CEA Boundary (completed)**

| Caribou Range | Project | Habitat Removed due to Project Footprint (hectares) | Habitat Degraded due to Dust (100 m around infrastructure; hectares) | Total Habitat Lost or Degraded[1] (hectares) |
|---|---|---|---|---|
| *Annual Herd Range[2] (cont'd)* | | | | |
| | Closed Developments | | | |
| | Roberts Bay | 3 | | 3 |
| | Cumulative Area | | | |
| | Total | 27,809 | 9,762 | 37,523 |
| | Proportion of Range | 0.06% | 0.02% | 0.08% |

[1] *Habitat Loss includes total area lost and does not take into account habitat suitability within the area.*
[2] *Total area of habitat loss within the entire annual Beverly herd range including summer and winter.*

Assuming that approximately 85.8% of the area lost consists of high-quality habitat for Beverly herd caribou, a total of 20,196 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the summer CEA boundary for Beverly herd caribou are developed. While the proportion of habitat lost in the summer CEA boundary for Beverly caribou is small, a residual effect is anticipated.

*Winter:* The winter CEA boundary for Beverly caribou is 21,236,369 hectares. Within the winter CEA boundary for Beverly herd caribou, the cumulative effects assessment identified 20,914 ha of removed habitat, and 5,909 ha of degraded habitat (Table 5.6-3). These areas equate to a total of 26,823 ha after accounting for overlap between projects which is equal to approximately 0.13% of the winter CEA boundary for Beverly caribou. The Back River Project alone will contribute 16,939 ha (63%) of the total area of habitat loss within the winter CEA boundary for Beverly caribou. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10-15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

Assuming that approximately 52.0% of this area consists of high-quality habitat for Beverly herd caribou (similar to the proportion of high-quality winter habitat in the wildlife RSA), a total of 13,948 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the winter CEA boundary for Beverly herd caribou are developed. While the proportion of habitat lost in the winter CEA boundary for Beverly caribou is small, a residual effect is anticipated.

*Annual Beverly Herd Range*: A check was conducted to confirm that the proposed cumulative effects area for caribou provided a conservative assessment of the effects of industrial development. The proportion of area affected by industry on the CEA area was compared to the total area affected by all projects within the total annual range for all seasons combined for the Beverly herd. The total annual range for Beverly caribou approximates 48,205,783 ha. Within the total annual range, the cumulative effects of habitat loss due to all projects on this range is 27,809 ha of removed habitat and 9,762 ha of degraded habitat for a total of 37,523 ha (0.08% of the annual range for Beverly herd caribou) after accounting for overlap between projects (Table 5.6-3). The proportion of habitat loss within the total annual range for Beverly caribou was much less than that in the summer or winter ranges (0.08% relative to 0.18% on the summer range and 0.13% on the winter range), therefore the summer and winter ranges was used as a conservative approach to assessing the overall effects of cumulative habitat loss for Beverly caribou.

### *5.6.2.2 Disturbance*

The disturbance to Bathurst herd and Beverly herd caribou due to noise as a result of the Back River Project was rated as negligible in the effects assessment. A background on the potential effects of disturbance to caribou is presented in Section 5.5.2.2. This potential effect was evaluated for Bathurst caribou during the post-calving (June 16 to July 20) and summer (July 21 to August 31) seasons, and for the Beverly herd caribou during the summer/fall seasons (July 20 to October 31) and winter season (November 1 to April 15) when these herds may interact with the Back River Project.

Potential cumulative effects from existing and proposed projects within the seasonal CEA boundaries for Bathurst caribou and Beverly caribou were assessed (Section 5.6.2). Closed projects were excluded from the analysis as they are not anticipated to generate noise resulting in disturbance to caribou. Cumulative effects due to disturbance from other projects are predicted to increase the effects of disturbance on Bathurst and Beverly caribou. Disturbance could be considered an energetic cost to caribou that are trying to feed, since they may avoid or increase their movement rate through areas that may be influenced by visual or auditory effects by mines or mining-related activities (including road use). Disturbances to caribou may also result in indirect habitat loss or functionally lost habitat due to avoidance by caribou as a result of noise stimulation.

Calculation of Disturbance

Cumulative effects of disturbance on Bathurst and Beverly caribou were evaluated in four ways:

1. The area where disturbance may occur around active mines, all season roads and winter roads, compared to the caribou CEA areas for both Bathurst and Beverly caribou;
2. The area of high use, calculated from a resource selection function, for the Bathurst herd compared to the Bathurst CEA area;
3. For roads, two scenarios were evaluated — construction, with a 4 km buffer, and operations, with a 1.5 km buffer; and
4. For mines, two scenarios were evaluated — a 4 km buffer and a 14 km buffer — to encompass the variability in caribou responses reported in the literature.

To evaluate the potential cumulative effects of disturbance due to noise on caribou due to mines, the area in which caribou may be affected by disturbance was calculated and used as a key indicator of this potential effect. Noise modelling for the Back River Project has indicated that disturbance due to blasting noise will attenuate to below threshold values within 4 km from the source of blasting at quarries (Volume 4, Chapter 2). Thus, a 4 km buffer was applied to all projects to calculate the area lost due to blasting noise.

However, some studies show that caribou avoidance extends over relatively large distances — from 4 km up to 30 km (Dau and Cameron 1986; R. D. Cameron et al. 1992; Helle and Särkelä 1993; Nellemann and Cameron 1996, 1998; Dyer et al. 2001; Nellemann et al. 2001; UNEP et al. 2001; Vistnes and Nellemann 2001; Vistnes et al. 2001; Nellemann et al. 2003; Vistnes et al. 2004; R. D. Cameron et al. 2005; C. J. Johnson et al. 2005; Boulanger et al. 2012). These studies are incongruent with other studies that show no avoidance by caribou beyond a few hundred meters (Cronin et al. 1998; Noel et al. 1998; Noel, Parker, and Cronin 2004; Noel, Parker, and Cronin 2006; Reimers and Colman 2006; Reimers et al. 2007). A study at the EKATI-Diavik mine complex reported that caribou avoided the mine by approximately 14 km (Boulanger et al. 2012) and it was hypothesized that caribou may be avoiding the mine complex due to dust deposition. Thus, a 14 km buffer was also used around all mining projects to calculate a very conservative scenario. The 4 km scenario is a reasonable choice for noise effects as the majority of literature suggests that disturbance to caribou due to noise attenuates to

4 km. In addition, the 14 km scenario was hypothesized to be due to dust, from a large operating open pit mine. Therefore, the 4 km scenario seems reasonable to predict the effects of noise disturbance and indirect habitat loss on caribou.

For roads, noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km while that during construction would be similar to blasting at mine sites and would attenuate below threshold values at 4 km. Noise modelling on the winter roads for the Back River Project indicated that noise would attenuate to 200 m from vehicle traffic and activities on these roads (Volume 4, Chapter 2). Thus, a distance of 4 km or 1.5 km was used to measure habitat loss around all-weather roads during construction and summer operations, respectively. Constructions phase assumed all project roads were being built at the same time. The operations phase represents the scenario when all project roads are constructed. A 200 m buffer was used around winter roads only as traffic is anticipated to move close to the centerline of this feature (Figure 5.6-2).

Results are presented using two scenarios of habitat disturbance based on the 4 km and 14 km buffers around mine infrastructure during two phases:

1. A construction phases assuming that all all-weather roads for future foreseeable projects are built at the same time (4 km buffer around all-weather roads); and
2. An operations phase assuming that all-weather roads for future foreseeable projects have already been built and noise resulting from these roads is from vehicle traffic only (1.5 km buffer around all-weather roads).

All-weather roads for existing projects are assumed to be already built and in use under both scenarios (4 km or 14 km scenario). Buffers on winter roads are applied to the Beverly winter cumulative assessment only.

The total area of disturbance due to all projects was compared to the total area of the CEA boundaries for Bathurst and Beverly herd caribou. It is important to note that caribou are not predicted to be excluded from the areas within the ZOIs surrounding projects. The ZOI is indicative of an area of reduced caribou occupancy relative to natural occupancy rates in surrounding areas. Based on aerial survey data collected between 1998 and 2008 surrounding Ekati and Diavik mine sites, Boulenger et al. (2012) found that caribou were detected 4.2 times more at distances > 14.0 km from the mine sites compared with areas immediately surrounding the mine, and that detection increased between the mine site and the 14 km ZOI. Thus, they estimated that a 23.8% reduction of caribou habitat occurs within a 14 km ZOI surrounding the mines. If this effect is applied to other projects (e.g., the area within 4 km and 14 km is multiplied by 0.24, then the effective reduction in habitat would be 76% lower than reported. Thus, results for the two mine buffer scenarios (4 km and 14 km) during construction and operation phases are presented as total areas and adjusted areas based on a reduced occupancy approach.

Access to high quality forage is thought to be a key driver of caribou population demographics (Section 5.1.2.5). Given the vulnerability of calves during the post-calving period and the relationship between habitat quality and caribou demographics, industrial activity on the post-calving and summer ranges may contribute additional pressures on caribou. By calculating a simple ratio vegetation index (SRVI) from broad scale advanced very high resolution radiometer data (AVHRR) over the summer range and correlating it to several demographic parameters of the Bathurst herd, Chen et al. (2013) demonstrated that productivity on the summer range explains a significant portion of the variation in caribou birth rate (86%), net productivity (56%), and calf survival rate (52%), but not cow survival rate.

Based on these analyses, moderate to high SRVI values likely provide a reliable index of high quality forage, which are well correlated with the population dynamics of the Bathurst herd.

To provide an additional measure to evaluate potential cumulative effects of disturbance on the Bathurst herd, the amount of high quality forage within 4 km and 14 km ZOI was calculated as a proportion of the amount available within the post-calving and summer ranges. To identify high productivity areas, SRVI was calculated for two representative images from the post-calving and summer time periods. The representative images were the same as those used for the RSF modelling with the post-calving image acquired on June 21, 2006 and the summer image acquired on August 1, 2006. High productivity habitat was identified using a 5-class classification scheme based on natural breaks in the SRVI histogram. The top two classes, above 3.1 for post-calving and 3.0 for summer, were defined as high productivity areas, and thus high quality forage for caribou.

Evaluation of Disturbance

*Bathurst Herd*

*Post-calving and Summer Range*: The Bathurst herd post-calving and summer range, used for the cumulative effects assessment approximates 8,100,050 ha. The ZOI for each project and scenario is reported in Table 5.6-4 and the results of the two scenarios are presented in Table 5.6-5.

**Table 5.6-4. Zone of Influence due to Disturbance in the Bathurst Caribou CEA Boundary**

| Herd Range | Project | ZOI Winter Roads (200 m) | ZOI All-weather Roads Construction (4 km) | ZOI All-weather Roads Operations (1.5 km) | ZOI Mine Operations (4 km) | ZOI Mine Operations (14 km) |
|---|---|---|---|---|---|---|
| *Post-calving and Summer Ranges* | | | | | | |
| | Back River Project | | | | 12,971 ha | 44,763 ha |
| | Existing Developments | | | | | |
| | Diavik Mine | | | | 11,713 ha | 42,424 ha |
| | EKATI Mine | | | 8,408 ha | 30,985 ha | 114,029 ha |
| | Reasonably Foreseeable Future Developments | | | | | |
| | BIPR* | | 138,545 ha | 58,516 ha | 5,683 ha | 47,556 ha |
| | Courageous Lake | | | | 23,042 ha | 93,378 ha |
| | Izok Mine | | 123,328 ha | 52,920 ha | 16,606 ha | 74,396 ha |
| | Hackett River | | 8,748 ha | 6,693 ha | 23,653 ha | 80,055 ha |
| | Cumulative Disturbance | | | | | |
| | Total | | 270,621 ha | 126,537 ha | 124,653 ha | 496,601 ha |
| | Total Accounting for Overlap | | 265,414 ha | 124,537 ha | 124,653 ha | 496,601 ha |
| | Proportion of Range | | 3.3% | 1.5% | 1.5% | 6.1% |
| *Annual Herd Range (Total areas of habitat disturbance including that in the post-calving and summer ranges)* | | | | | | |
| | Back River Project | 16,875 ha | | | 43,502 ha | 281,623ha |
| | Operating Developments | | | | | |
| | Diavik Mine | | | | 11,959 ha | 84,206 ha |
| | Ekati Mine | 120 ha | | 7,284 ha | 33,048 ha | 183,026ha |
| | Snap Lake | 1,329 ha | | | 7,654 ha | 70,743 ha |
| | TCWR | 25,084 ha | | | | |

*(continued)*

**Table 5.6-4. Zone of Influence due to Disturbance in the Bathurst Caribou CEA Boundary (completed)**

| Herd Range | Project | ZOI Winter Roads (200 m) | ZOI All-weather Roads Construction (4 km) | ZOI All-weather Roads Operations (1.5 km) | ZOI Mine Operations (4 km) | ZOI Mine Operations (14 km) |
|---|---|---|---|---|---|---|
| | Reasonably Foreseeable Future Developments | | | | | |
| | BIPR | | 174,601 ha | 63,676 ha | 13,715 ha | 135,493 ha |
| | Courageous Lake | 1,404 ha | | | 23,038 ha | 116,410 ha |
| | Gahcho Kué | 4,385 ha | | | 14,193 ha | 92,157 ha |
| | Hackett River | | 20,860 ha | 6,789 ha | 23,038 ha | 125,386 ha |
| | Izok Mine | 3,396 ha | 220,128 ha | 80,260 ha | 20,910 ha | 137,652 ha |
| | Cumulative Area of Disturbance | | | | | |
| | Total | 52,593 ha | 415,588 ha | 158,064 ha | 192,602 ha | 1,226,697 ha |
| | Total Accounting for Overlap | 52,575 ha | 408,377 ha | 157,016 ha | 192,602 ha | 1,136,517 ha |
| | Proportion of Range | 0.12% | 0.92% | 0.35% | 0.43% | 2.5% |

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects during the construction phase would cover 398,475 ha or 4.9% of the total post-calving and summer range for Bathurst herd caribou and during operations phase would cover 249,190 ha or 3.1% of the range. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 770,423 ha, or 9.5% of the CEA boundary during construction, and 621,138 ha or 7.7% of the range during operations. Within these areas, caribou use is expected to drop by approximately 25% and are presented as adjusted areas in Table 5.6-5 for a total of 0.82% to 1.9% reduction in caribou habitat.

The Back River Project contributes 12,971 ha of disturbed habitat (in the 4 km scenario), equivalent to 3.2 to 5.2% of all disturbed habitat in the CEA boundary during construction and operations (Figure 5.6-3), respectively and 44,763 ha or 5.8 to 7.2% of all habitat disturbed using the 14 km scenario in the CEA boundary during construction and operations respectively.

*Annual Herd Range*: A check was conducted to confirm that the proposed cumulative effects area for caribou provided a conservative assessment of the effects of industrial development. The proportion of area affected by disturbance due to industry in the post-calving and summer CEA boundary was compared to the total area disturbed by all projects within the total annual range for all seasons combined for the Bathurst herd. The Bathurst annual range approximates 44,325,144 ha. The ZOI for each project and scenario is reported in Table 5.6-4 and the results of the two scenarios are presented in Table 5.6-5.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects during the construction phase would cover 660,838 ha or 1.5% of the annual range for Bathurst herd caribou and during operations phase would cover 402,193 ha or 0.9% of the range. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 1,604,753 ha, or 3.6% of the annual range for Bathurst caribou during construction, and 1,346,108 ha or 3.0% of the annual range during operations. Within these areas, caribou use is expected to drop by approximately 25% and are presented as adjusted areas in Table 5.6-5 for a total of 0.2% to 0.9% reduction in caribou habitat. The proportion of disturbed habitat within the total annual range for Bathurst caribou is much less than that in the post-calving and summer CEA boundary, thus the post-calving and summer CEA boundary was used as a conservative approach to assessing the overall effects of cumulative disturbance due to noise for Bathurst caribou.

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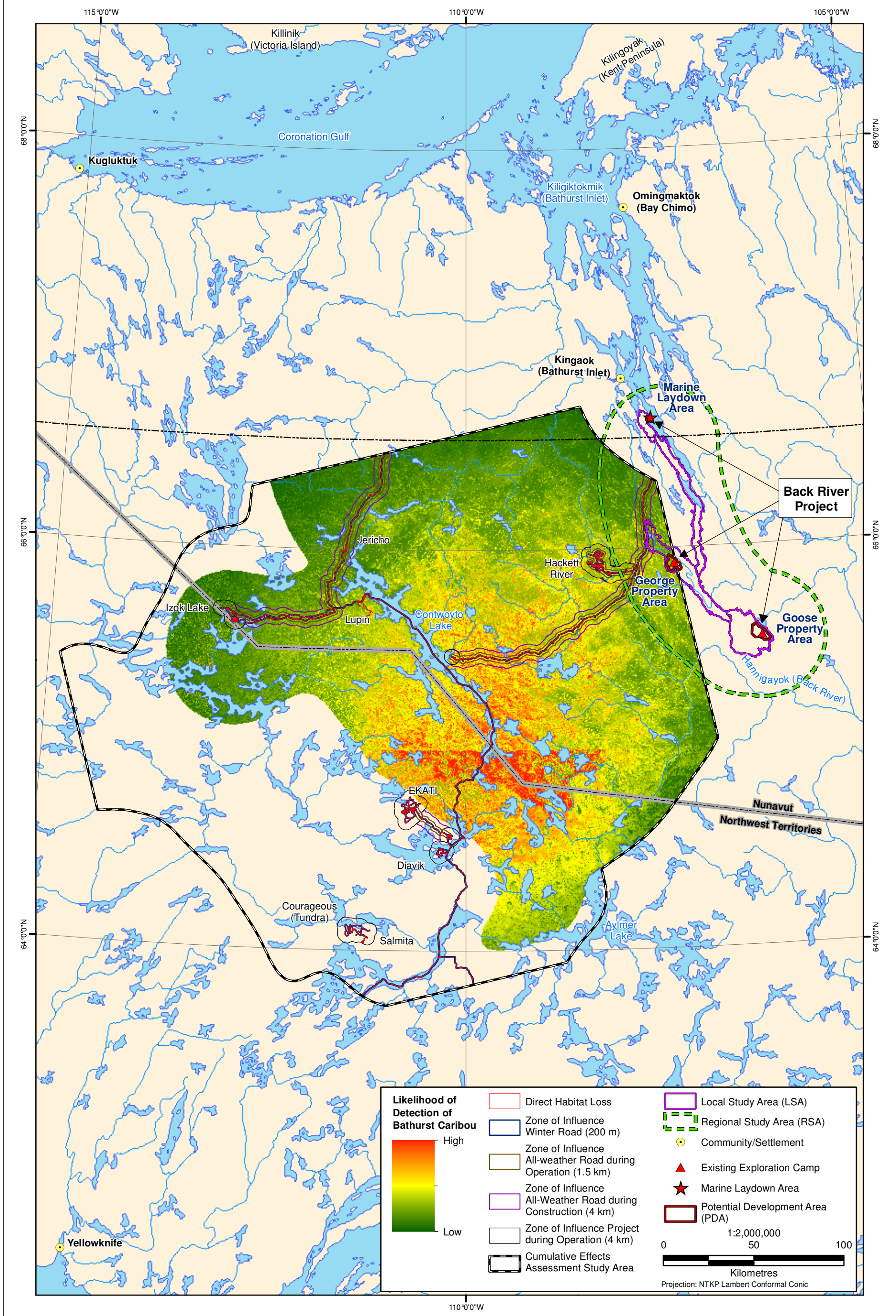


Figure 5.6-3

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## Habitat Lost or Altered due to All Project Footprints and Noise in the Bathurst Caribou Cumulative Effects Assessment Boundary during Post-calving

Figure 5.6-3

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**Table 5.6-5. Results of the 4 km and 14 km Scenarios for Bathurst Caribou Zone of Influence due to Disturbance**

| Range | Scenario[1] | Construction[2] | | | | Operations[3] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ZOI (ha) and % of Range | Adjusted Area[4] (ha) and % of Range | Post-Calving High Quality Forage and % in Range[5] | Summer High Quality Forage and % in Range[5] | ZOI (ha) and % of Range | Adjusted Area[4] (ha) and % of Range | Post-Calving High Quality Forage and % in Range[5] | Summer High Quality Forage and % in Range[5] |
| Post-calving and Summer | | | | | | | | | |
| | Scenario 1 (4 km Mine) | 398,475 (4.9) | 95,634 (1.2) | 102,974 (1.3) | 125,766 (1.6) | 249,190 (3.1) | 48,145 (0.6) | 66,195 (0.8) | 75,085 (0.9) |
| | Scenario 2 (14 km Mine) | 770,423 (9.5) | 184,902 (2.3) | 264,719 (3.3) | 286,772 (3.5) | 621,138 (7.7) | 138,792 (1.7) | 232,394 (2.9) | 243,735 (3.0) |
| Annual Herd Range | | | | | | | | | |
| | Scenario 1 (4 km Mine) | 660,838 (1.5) | 158,601 (0.4) | - | - | 402,193 (0.9) | 96,526 (0.2) | - | - |
| | Scenario 2 (14 km Mine) | 1,604,753 (3.6) | 385,141 (0.9) | - | - | 1,346,108 (3.0) | 323,066 (0.7) | - | - |

*[1]: Scenario 1 uses a 4 km buffer around mine infrastructure; Scenario 2 uses a 14 km buffer around mine infrastructure.*
*[2]: Construction phase habitat disturbance is calculated using a 4 km buffer around all-weather roads for reasonably foreseeable future developments and a 1.5 km buffer around all-weather roads for existing developments.*
*[3]: Operations phase habitat disturbance is calculated using a 1.5 km buffer around all-weather roads.*
*[4]: Adjusted area is calculated by assuming a 24% loss of habitat within the zone of influence.*
*[5]: Total area of high quality forage available in CEA boundary is 8,100,035 ha.*

These zones of disturbance were also mapped onto measures of vegetation quality within the post-calving and summer ranges of Bathurst caribou (Figures 5.6-3 and 5.6-4). Areas within the zones of disturbance with a high vegetation index, which indicates a higher quality of forage for caribou, were calculated as a portion of the amount available within each CEA boundary. The resulting analysis showed that in the 4 km scenario, the zone of disturbance would cover 1.3% of areas with high quality forage within the post-calving range during construction, and 0.8% during operations (Table 5.6-5). For the 14 km scenario, these amounts increase to 3.3% during construction and 2.9% during operations. For Bathurst caribou during summer given the 4 km scenario, the zone of influence is estimated to cover 1.6% and 0.9% during construction and operations, respectively. These amounts increase to 3.5% and 3.0% of available high quality forage during summer given the 14 km scenario.

A residual effect due to disturbance resulting from noise in the Bathurst CEA boundary is predicted to occur, albeit small.

*Beverly Herd*

*Summer*: The Beverly herd summer range, used for the cumulative effects assessment approximates 12,937,264 ha. The ZOI for each project and scenario is reported in Table 5.6-6 and the results of the two scenarios are presented in Table 5.6-7.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects during the construction phase would cover 294,918 ha or 2.3% of the total summer range for Beverly herd caribou and during operations phase would cover 200,605 ha or 1.6% of the range. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 672,611 ha, or 5.2 % of the CEA boundary during construction, and 578,298 ha or 4.5% of the range during operations. These numbers are decreased by 76% assuming that these areas would support a reduced occupancy and not total exclusion of animals, and are presented as adjusted areas in Table 5.6-7, equivalent to a 0.55% to 1.32% reduction in caribou range during operations.

The Back River Project contributes 53,817 ha of disturbed habitat (in the 4 km scenario), equivalent to 18.2 to 26.8% of all disturbed habitat in the Beverly summer CEA boundary during construction and operations, respectively and 236,776 ha or 35.2 to 40.9% of all habitat disturbed using the 14 km scenario in the Beverly summer CEA boundary during construction and operations respectively.

A residual effect due to disturbance resulting from noise in the Beverly summer CEA boundary is predicted to occur, albeit small.

*Winter*: The Beverly herd winter range, used for the cumulative effects assessment approximates 21,236,369 ha. The ZOI for each project and scenario is reported in Table 5.6-6 and the results of the two scenarios are presented in Table 5.6-7.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects during the construction phase would cover 228,562 ha or 1.1% of the total winter range for Beverly herd caribou and during operations phase would cover 157,900 ha or 0.7% of the range. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 477,746 ha, or 2.2 % of the Beverly winter CEA boundary during construction, and 407,084 ha or 1.9% of the range during operations. These numbers are decreased by 76% assuming that these areas would support a reduced occupancy and not total exclusion of animals, and are presented as adjusted areas in Table 5.6-7, equivalent to a 0.55% to 1.32% reduction in caribou range during operations.

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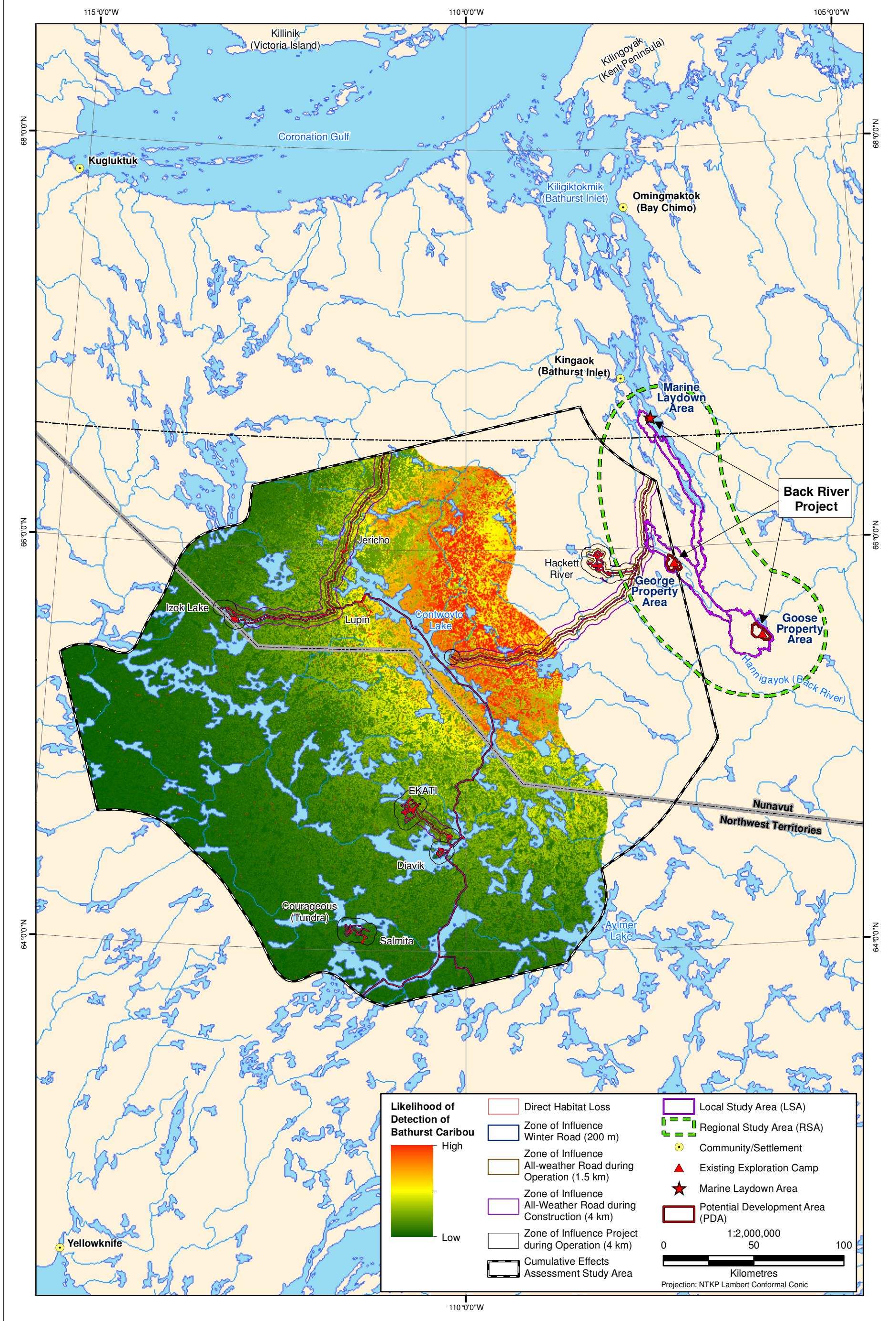


Figure 5.6-4

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# Habitat Lost or Altered due to All Project Footprints and Noise in the Bathurst Caribou Cumulative Effects Assessment Boundary during Summer

Figure 5.6-4

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**Table 5.6-6. Zone of Influence due to Disturbance in the Beverly Caribou Summer CEA Boundary**

| Herd Range | Project | ZOI Winter Roads (200 m) | ZOI All-weather Roads Construction (4 km) | ZOI All-weather Roads Operation (1.5 km) | ZOI Mine Operation (4 km) | ZOI Mine Operation (14 km) |
|---|---|---|---|---|---|---|
| Summer Range | | | | | | |
| | Back River Project | | | | 53,817 ha | 236,776 ha |
| | Existing Developments | | | | | |
| | Doris North | | | 6,460 ha | 17,152 ha | 88,660 ha |
| | Reasonably Foreseeable Future Developments | | | | | |
| | BIPR* | | 140,770 ha | 60,526 ha | 8,027 ha | 51,775 ha |
| | Hackett River | | 8,748 ha | 6,693 ha | 23,653 ha | 80,055 ha |
| | Hope Bay (Phase 2) | | 29,114 ha | 13,893 ha | 12,384 ha | 67,391 ha |
| | Cumulative Area of Disturbance | | | | | |
| | Total | | 178,632 ha | 87,572 ha | 115,033 ha | 524,657 ha |
| | Total Accounting for Overlap | | 173,425 ha | 85,572 ha | 115,033 ha | 492,726 ha |
| | Proportion of Range | | 1.3% | 0.66% | 0.89% | 3.8% |
| Winter Range | | | | | | |
| | Back River Project | 14,808 ha | | | 42,902 ha | 168,643 ha |
| | Existing Developments | | | | | |
| | TCWR* | 3,353 ha | | | | |
| | Reasonably Foreseeable Future Developments | | | | | |
| | BIPR* | | 121,901 ha | 50,087 ha | | 12,318 ha |
| | Hackett River | | 8,748 ha | 6,693 ha | 23,653 ha | 80,055 ha |
| | Gahcho Kué | 4,212 ha | | | 14,192 ha | 77,965 ha |
| | Cumulative Area of Disturbance | | | | | |
| | Total | 22,373 ha | 130,649 ha | 56,780 ha | 80,747 ha | 338,981 ha |
| | Total Accounting for Overlap | 22,373 ha | 125,442 ha | 54,780 ha | 80,747 ha | 329,931 ha |
| | Proportion of Range | 0.11% | 0.59% | 0.26% | 0.38% | 1.6% |
| Annual Herd Range (Total area of habitat loss within the entire annual Beverly herd range including summer and winter) | | | | | | |
| | Back River Project | 16,875 ha | | | 43,232 ha | 257,840 ha |
| | Existing Developments | | | | | |
| | Diavik Mine | | | | 10,741 ha | 55,241 ha |
| | Doris North | | | 5,648 ha | 17,167 ha | 98,017 ha |
| | Ekati Mine | 120 ha | | 1,957 ha | 9,510 ha | 56,307 ha |
| | Snap Lake | 1,175 ha | | | 7,654 ha | 70,743 ha |
| | TCWR | 12,299 ha | | | | |
| | Reasonably Foreseeable Future Developments | | | | | |
| | BIPR | | 174,601 ha | 63,730 ha | 13,715 ha | 135,493 ha |
| | Gahcho Kué | 4,385 ha | | | 14,193 ha | 92,157 ha |
| | Hackett River | | 20,860 ha | 6,789 ha | 26,543 ha | 125,386 ha |
| | Hope Bay (Phase 2) | | 37,331 ha | 11,957 ha | 12,387 ha | 87,843 ha |

*(continued)*

**Table 5.6-6. Zone of Influence due to Disturbance in the Beverly Caribou Summer CEA Boundary (completed)**

| Herd Range | Project | ZOI Winter Roads (200 m) | ZOI All-weather Roads Construction (4 km) | ZOI All-weather Roads Operation (1.5 km) | ZOI Mine Operation (4 km) | ZOI Mine Operation (14 km) |
|---|---|---|---|---|---|---|
| | Cumulative Area of Disturbance | | | | | |
| | Total | 34,854 ha | 232,791 ha | 82,477 ha | 153,182 ha | 979,027ha |
| | Total Accounting for Overlap | 34,836 ha | 225,580 ha | 81,429 ha | 163,767 ha | 868,441 ha |
| | Proportion of Range | 0.07% | 0.51% | 0.18% | 0.37% | 1.9% |

**Table 5.6-7. Results of the 4 km and 14 km Scenarios for Beverly Caribou Zone of Influence due to Disturbance**

| | | Construction[2] | | Operations[3] | |
|---|---|---|---|---|---|
| Range | Scenario[1] | ZOI (ha) and % of Range | Adjusted Area[4] (ha) and % of Range | ZOI (ha) and % of Range | Adjusted Area[4] (ha) and % of Range |
| Summer Range | | | | | |
| | Scenario 1 (4 km Mine) | 294,918 (2.3) | 70,780 (0.5) | 200,605 (1.6) | 48,145 (0.4) |
| | Scenario 2 (14 km Mine) | 672,611 (5.2) | 161,427 (1.2) | 578,298 (4.5) | 138,792 (1.1) |
| Winter Range | | | | | |
| | Scenario 1 (4 km Mine) | 228,562 (1.1) | 54,855 (0.3) | 157,900 (0.7) | 37,896 (0.2) |
| | Scenario 2 (14 km Mine) | 477,746 (2.2) | 114,659 (0.5) | 407,084 (1.9) | 97,700 (0.5) |
| Annual Beverly Herd Range | | | | | |
| | Scenario 1 (4 km Mine) | 431,788 (0.9) | 103,629 (0.2) | 280,032 (0.6) | 67,208 (0.1) |
| | Scenario 2 (14 km Mine) | 1,136,462 (2.4) | 272,751 (0.6) | 984,706 (2.0) | 236,329 (0.5) |

*[1]: Scenario 1 uses a 4 km buffer around mine infrastructure; Scenario 2 uses a 14 km buffer around mine infrastructure.*
*[2]: Construction phase habitat disturbance is calculated using a 4 km buffer around all-weather roads for reasonably foreseeable future developments and a 1.5 km buffer around all-weather roads for existing developments and a 200 m buffer around winter roads (for Winter and Annual Ranges).*
*[3]: Operations phase habitat disturbance is calculated using a 1.5 km buffer around all-weather roads and a 200 m buffer around winter roads (for Winter and Annual Ranges).*
*[4]: Adjusted area is calculated by assuming a 24% loss of habitat within the zone of influence.*

The Back River Project contributes 57,710 ha of disturbed habitat in the 4 km scenario, equivalent to 25.2 to 36.5% of all disturbed habitat in the winter CEA boundary (Figure 5.6-5), and 183,451 ha or 38.4 to 45.1% of all habitat disturbed using the 14 km scenario in the Beverly winter CEA boundary.

A residual effect due to disturbance resulting from noise in the Beverly winter CEA boundary is predicted to occur, albeit small.

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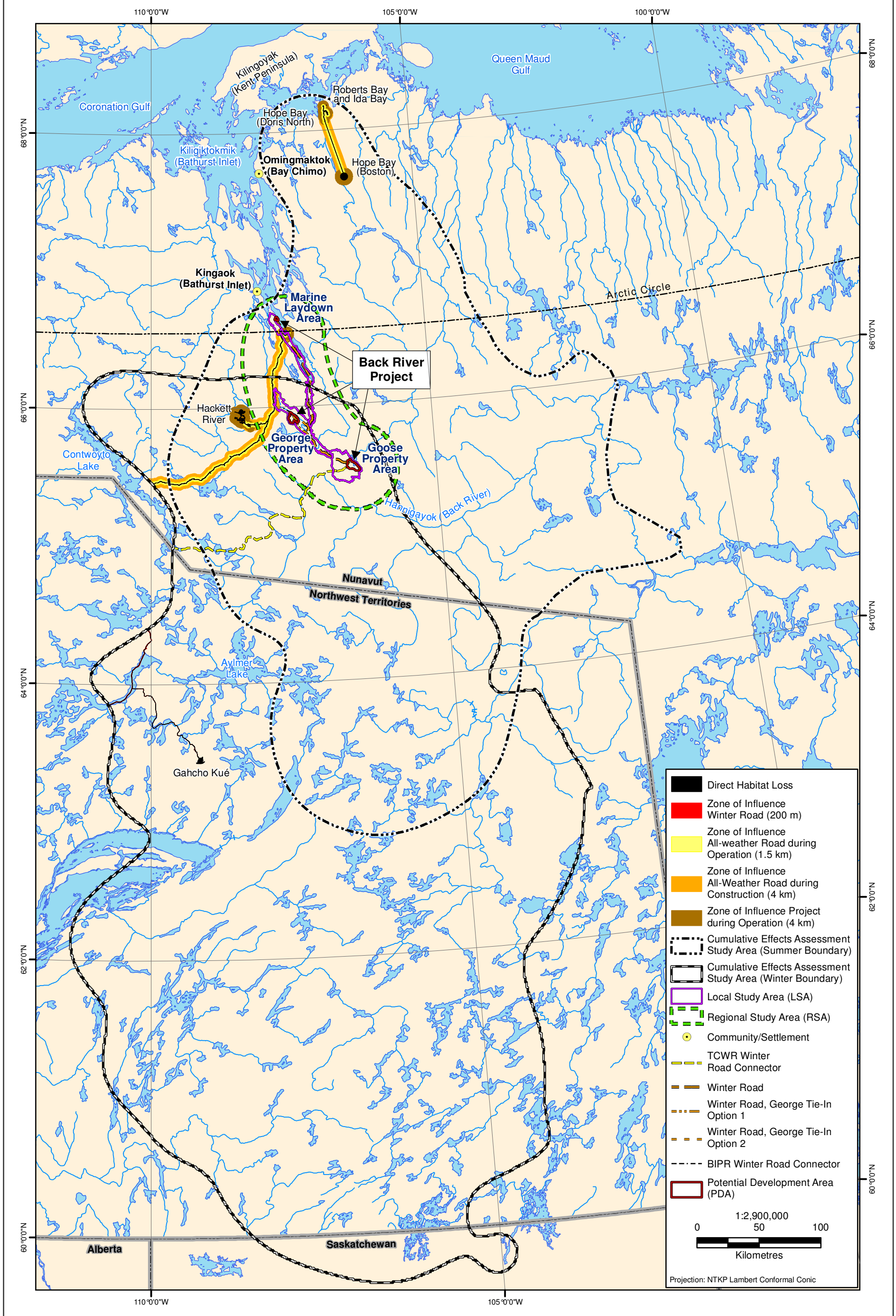


Figure 5.6-5

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# Habitat Lost or Altered due to All Project Footprints and Noise in the Beverly Caribou Cumulative Effects Assessment Boundaries

Figure 5.6-5

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*Annual Herd Range*: A check was conducted to confirm that the proposed cumulative effects area for caribou provided a conservative assessment of the effects of industrial development. The proportion of area affected by disturbance due to industry in the summer and winter CEA boundaries for Bathurst caribou was compared to the total area disturbed by all projects within the total annual range for all seasons combined for the Beverly herd. The Beverly herd annual range approximates 48,205,783 ha. The ZOI for each project and scenario is reported in Table 5.6-6 and the results of the two scenarios are presented in Table 5.6-7.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects during the construction phase would cover 431,788 ha or 0.9% of the annual range for Beverly herd caribou and during operations phase would cover 280,032 ha or 0.6% of the range. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 1,136,462 ha, or 2.4% of the annual range for Beverly caribou during construction, and 984,706 ha or 2.0% of the annual range during operations. Within these areas, caribou use is expected to drop by approximately 25% and are presented as adjusted areas in Table 5.6-7 for a total of 0.1% to 0.6% reduction in caribou habitat. The proportion of disturbed habitat within the total annual range for Beverly herd caribou is much less than that in the summer CEA boundary, thus the summer CEA boundary was used as a conservative approach to assessing the overall effects of cumulative disturbance due to noise for Beverly herd caribou.

#### *5.6.2.3 Reduction in Reproductive Productivity*

Reduction in reproductive productivity as a result of interactions between other effects was rated as negligible for both the Bathurst herd and Beverly herd caribou in the Project effects assessment.

Disturbances and displacement of caribou during sensitive periods such as calving and post-calving and summer feeding may alter the stress and nutritional status of females and cause a decreased reproductive success (Section 5.5.2.8).

The primary way in which mines and other industrial developments on the tundra is hypothesized to affect caribou is through reduced body condition, resulting from displacement from preferred habitat with high quality forage, and behavioral responses resulting in a negative energy balance (Gunn et al. 2001; Adamczewski et al. 2012). Researchers have historically surmised that the greatest effect of industry would likely occur during lactation (the post-calving season) and late winter, when female caribou are energetically stressed (Gerhart et al. 1997). More recent results by Chen et al. (2013) indicate that forage availability on the post-calving and summer ranges may be driving recruitment of new animals. This work implies that energetic balances during the post-calving and summer periods are likely the driving factor for changes in herd levels. Analyses of encounter rates between caribou and the buffered areas around developments were thus conducted for the post calving and summer ranges. Chen et al. (2013) Chen et al. (2013)

Computer models have been developed that combine knowledge on caribou metabolism, forage availability, foraging rates and activity levels to predict the body condition of female caribou, and subsequently, pregnancy rates and calf survival (Boertje 1985; D. E. Russell, White, and Daniel 2005). These models were summarized and applied to predict the effects on caribou productivity of increased encounter rates with the Gahcho Kué project (De Beers Canada Inc. 2010).

To measure exposure to disturbances, GPS collar data were used to map the movement paths of females to calculate caribou encounter rates with active mine sites, mining exploration camps, and other developments (De Beers Canada Inc. 2010). Each day that a collared caribou spent within 15 km from active mines, and 5 km from other developments including roads, exploration camps, and ports was assumed to result in a disturbing encounter.

Encounter rates were used to estimate decreases in the energetic balance of caribou resulting from additional movements and excitation (Boertje 1985), from which changes in productivity were predicted. It was assumed that females travelled about 2 km after being disturbed, and were energetically excited for 12 hours for which the total energetic cost was calculated as 1.69 MJ per disturbance. Results showed that collared Bathurst caribou experienced on average 14 encounters with developments during summer and autumn.

With no encounters between caribou and mine sites, fecundity was predicted to decline by 8% in the absence of insect harassment, but to decline by 28% with insect harassment. In contrast, fecundity was predicted to change by less than 3% due to 19 predicted encounters per individual caribou with mine sites per year. Thus, insect harassment was predicted to have a much larger effect on reproductive productivity than did disturbance at mine sites.

The number of times individual caribou will interact with projects in the post-calving and summer CEA boundary was estimated based on tracks of satellite collared caribou. Individual caribou will likely encounter the zones of disturbance of projects within the CEA boundaries fewer than the 19 times per year. Thus, effects on fecundity from behavioural disturbances due to interaction between female caribou and the Project are predicted to be lower than predicted effects from insect harassment.

*Bathurst Caribou*

Several proposed projects may occur near the calving and post-calving ranges of this herd, including Hackett River, BIPR and Izok Corridor projects (Figure 5.6-1). Factors such as mortality from predators and hunters, and factors like forage availability are thought to strongly influence reproductive productivity for caribou.

The effects on reduced reproduction are expected to result mainly from other projects, with a relatively small influence of the Back River Project alone. Those projects that occur near the calving and rutting areas will likely have the largest influence on this herd. Thus, the Back River Project is not anticipated to contribute to the cumulative effects of reduced reproduction of the Bathurst herd caribou and only those projects that may directly influence these areas are anticipated to pose an effect.

It is not clear how the Bathurst herd caribou will utilize the tundra with an increase in developments in Nunavut and Northwest Territories, and range shifts may occur which could push caribou out of ideal calving and post-calving areas. Thus, the combined effects of lost habitat and disturbance due to all projects in the post-calving and summer range for Bathurst caribou are predicted to result in a residual effect on Bathurst caribou reproductive productivity.

*Beverly Herd*

Several projects will overlap with the summer range of the Beverly caribou, including the Hope Bay, Hackett River and BIPR projects (Figure 5.6-2). Other projects such as Gahcho Kué and the Tibbett to Contwoyto Winter Road projects have the potential to overlap with the Beverly caribou as they move from their wintering grounds northward to their calving grounds.

With the exception of Hope Bay Project, these projects are on the western edge of the range of this herd and may interact with a small proportion of Beverly caribou population. Since the calving and post-calving grounds for Beverly caribou are northeast of all past, current, future foreseeable projects most of these projects will interact with Beverly caribou after the sensitive calving and post-calving periods.

The effect of the Back River Project along is anticipated to contribute to a relatively small influence on reduced reproduction as the effects of habitat loss and disturbance due to the Back River Project are small relative to the summer and winter ranges of Beverly caribou, and the Project is not anticipated

to result in an increase in mortality to the herd. The future foreseeable Hope Bay (Phase 2) project would likely have a greater effect on this herd as the proposed location of this project is closer to the post-calving grounds of the Beverly herd.

The combined effects of lost habitat, and disturbance due to all projects in the summer and the winter ranges for Beverly caribou are predicted to result in a reduction in reproductive productivity, albeit minimal, as it is unclear how this herd will utilize the tundra with an increase in developments in Canada's North.

### 5.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for grizzly bears will be similar to those implemented for the Back River Project and will meet or exceed best management practices. For a list of mitigation and management measures applied for grizzly bears at the Back River Project see Section 7.5.3, and Volume 10.

### 5.6.4 Characterization of Cumulative Effect

After the application of mitigation and management measures, there are three residual effects predicted in the caribou cumulative effects assessment areas: habitat loss, disturbance, and reduction in reproductive productivity.

#### *5.6.4.1 Habitat Loss*

The overall loss or degradation of area due to all projects in the Bathurst herd CEA boundary is 26,835 ha (approximately 0.3 % of the Bathurst caribou post-calving/summer CEA boundary). The overall loss or degradation of habitat in the Beverly herd summer CEA boundary is 23,538 ha (0.2% of boundary) and is 26,823 ha in the winter CEA boundary (0.1% of boundary). The proportion attributed to the Back River Project alone is equivalent to 12% of total habitat loss in the Bathurst CEA boundary, 43.5% in the Beverly summer CEA boundary, and 63% in the Beverly winter boundary. However, the actual areas of loss due to the Back River Project will be much lower as approximately 10 to 15% of the PDAs will result in habitat loss due to the placement of project infrastructure. The amount of habitat loss is minimal relative to the amount of habitat in each of the CEA boundaries assessed for caribou, thus, the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local as it will be contained close to project footprints. The frequency is sporadic, as habitat loss would occur during the construction periods for each Project and habitat degradation due to dusting would occur when blasting activities occur. The duration of the effect is long term (beyond the life of the projects) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline condition, although some area may be reclaimed. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss was converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible. Although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for both herds of caribou is concluded to be Not Significant.

#### *5.6.4.2 Disturbance due to Noise*

Using the likely 4 km ZOI disturbance scenario, the overall disturbance of habitat due to all projects in the Bathurst herd CEA boundary is 398,475 ha during construction and 249,190 ha during operations

(approximately 3.1 to 4.9% of the Bathurst caribou post-calving/summer CEA boundary). The overall loss or degradation of habitat in the Beverly herd summer CEA boundary is 294,918 ha during construction and 200,605 ha during operations (1.6 to 2.3% of the boundary) and in winter is 228,562 ha (construction) or 157,900 ha (operations) in the winter CEA boundary (0.7 to 1.1% of boundary) during the 4 km ZOI disturbance scenario. The proportion attributed to the Back River Project alone is equivalent to 3.2 to 5.2% of total habitat loss in the Bathurst CEA boundary, 18.2 to 26.8% in the Beverly summer CEA boundary, and 25.2 to 36.5% in the Beverly winter boundary during the 4 km ZOI disturbance scenario. However, this proportion is anticipated to be much smaller as only 10 to 15% of the Back River PDAs are expected to be developed. The amount of habitat degraded is small relative to the amount of habitat in each of the CEA boundaries assessed for caribou, thus, the magnitude of the cumulative residual effect is considered low.

The effect is considered negative as disturbance to habitat could push herds out of utilizing ideal habitat. The extent of the effect of habitat loss is regional (i.e., it extends beyond the wildlife RSA but is contained within the CEA boundaries for Bathurst and Beverly caribou. The frequency is sporadic, as habitat degradation would occur during the construction and operation periods for each Project during blasting events, vehicle use on roads and aircraft overflights. The duration of the effect is medium as the effect will discontinue when the projects are closed; and the effect is considered reversible, as areas will return to existing baseline condition and animals will likely return when the noise is ceased. The probability of the effect occurring is likely as habitat as noise will be created during Construction and Operation activities. The confidence of the effect occurring is considered high, as the effect of habitat disturbance was converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible. Although confidence in the area and proportion disturbed is considered medium as it is anticipated that a much smaller proportion of the area will be disturbed. The cumulative residual effect of disturbance due to noise for both herds of caribou is concluded to be Not Significant.

#### *5.6.4.3 Reduction in Reproductive Productivity*

The potential for a reduction in reproductive productivity in caribou depends on the magnitude of all other effects (disturbances) they experience. Disturbance leading to displacement of females with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young, would likely lead to the greatest effects on caribou populations in the region.

The residual effects of the Project on caribou include habitat loss and disturbance. These effects combined can result in a reduction in reproductive productivity in caribou if the magnitude of the effect is large enough. The highest magnitude of any of the residual effects on caribou after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on caribou is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of caribou in the regional area. The duration of the effect is expected to be medium term as decreases to population would be expected during poor years but anticipated to recover in good years. The frequency of the effect is anticipated to be sporadic. The effect of reduction of reproductive productivity is anticipated to be reversible as disturbances and other negative effects are reduced when the various mines are closed. The effect is anticipated to be regional as caribou have large home ranges and may come into contact with many of the Projects in the CEA boundary. The likelihood that a reduction in reproductive productivity on caribou will occur as a result of the cumulative effects of all projects is low as the overall percentage of high quality habitat lost as a result of industrial development is small. The confidence in the effect rating is low as it is

unknown how the effects of the projects on reproduction of caribou may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the cumulative residual effect of reduction of reproductive productivity is concluded to be Not Significant.

### 5.6.5 Significance of Cumulative Residual Effects

The cumulative effects assessment for caribou identified three residual effects as follows and in Table 5.6-8:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant; and
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Overall, the residual cumulative effect of caribou is **Not Significant**.

## 5.7 TRANSBOUNDARY EFFECTS

Residual effects of the Project on caribou are predicted to occur in both the Project effects assessment and the cumulative effects assessment. However, the CEA boundary is designed to encompass the seasonal ranges of Bathurst and Beverly caribou when they interact with the Back River Project, and includes habitat within the Northwest Territories; thus, the transboundary effects that cross jurisdictional boundaries are accounted for in the cumulative effects assessment for caribou.

## 5.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC caribou. The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including caribou. Mitigation measures specific to caribou for potential Project effects are listed in Section 5.5.3 and summarized in Table 5.8-1 in Section 5.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including caribou. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4.
- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18.
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11.
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

**Table 5.6-8. Summary of Cumulative Residual Effects to Caribou and their Significance**

| Cumulative Residual Effects | Evaluation Criteria | | | Likelihood of Occurrence of Cumulative Residual Effects | | | Significance of Cumulative Residual Effects | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not Significant (N), Significant (S), Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Local | Irreversible | Likely | High | N |
| Disturbance | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

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

- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock and Tailings Management Plan: Chapter 9.
- Landfill and Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosive Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21.
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

### 5.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as identified caribou crossing locations along their migratory routes. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of the PDAs after the redesign of Project elements. Table 5.8-1 in Section 5.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on caribou.

### 5.8.2 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) includes eight separate mitigation and management plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects on caribou are listed in Section 5.5.3, and summarized in Table 5.8-1 in Section 5.8.5.

### 5.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these will need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

### 5.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

### 5.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 5.8-1 includes all planned mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on caribou

**Table 5.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife (Including Caribou)**

| Mitigation Category | Mitigation Measures |
|---|---|
| **1. Mitigation by Project Design** | |
| | 1. Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as caribou calving grounds and caribou high use areas. |
| | 2. Infrastructure designed to minimize the Project footprint to reduce habitat loss for caribou. |
| | 3. Consideration of the location of the stockpiles and windbreaks to minimize dustfall. |
| | 4. Open-water season shipping only (no ice-breaking) to avoid potential negative effects on wildlife dependent on ice (e.g., Dolphin Union Caribou migrations) |
| | 5. Winter only road access corridors (no all-weather roads for re-supply routes or between the Goose and George Properties). |

*(continued)*

**Table 5.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife (Including Caribou; continued)**

| Mitigation Category | Mitigation Measures |
|---|---|
| | 6. Winter roads designed to minimize the distance travelled. |
| | 7. Infrastructure located close to deposits to keep activities confined to specific areas, in order to confine noise-generating activities. |
| | 8. Underground mining used, where possible. |
| | 9. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination. |
| | 10. Buildings designed and maintained to exclude wildlife. |
| | 11. WAD Cyanide destruction inside the mill. |
| **2. Best Management Practices** | |
| | 1. Pre-construction ground clearing will be conducted outside of sensitive periods for caribou (i.e., spring migration [Beverly herd], calving or post-calving migration [Bathurst herd]). |
| | 2. Above ground blasting scheduled outside of the peak periods of Bathurst caribou presence in the wildlife RSA, where possible. |
| | 3. Ground-based observations for caribou conducted prior to blasting during the calving and post-calving periods if incidental observations from helicopters indicate that caribou are in the area. |
| | 4. Noise disturbance minimized by managing blasting activities to reduce disturbance (e.g., limiting above ground blasts) if large herds of female caribou with young (>100 animals) occur within 500 m (or line of site) of the site, until caribou pass through the area. |
| | 5. All equipment maintained to reduce noise. |
| | 6. Vehicles restricted to site roads, winter roads and quarry footprints during construction and operations and not permitted on winter road corridors outside of the frozen ground period (December to April). |
| | 7. Aircraft to follow prescribed altitudes, when possible, as recommended in the draft caribou protection measure guidelines. Landing and take-off conducted only when herds of caribou are not present in the immediate area. |
| | 8. Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats. |
| | 9. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed. |
| | 10. Berms or other markers built at high walls of quarries. |
| | 11. Truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits. |
| | 12. Wildlife given the right-of-way on all roads at all times. |
| | 13. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic, and road use restricted only to persons required for Project construction, operations and maintenance. |
| | 14. The use of wildlife-attracting dust suppressants avoided, where possible. |
| | 15. Wildlife exclusion measures implemented to exclude wildlife from areas where water or waste could pose a risk to health of wildlife. |
| | 16. A policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees during employee orientation and enforced. |
| | 17. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continue throughout the life of the Project, and enforced. |

*(continued)*

**Table 5.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife (Including Caribou; completed)**

| Mitigation Category | Mitigation Measures |
|---|---|
| | 18. A policy prohibiting hunting from and within a buffered area along all Project infrastructure developed and enforced to prevent an increase in mortality to caribou.<br>19. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers.<br>20. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures, and participation by all contractors and employees working on the Project during orientation. |
| **3. Adaptive Management** | |
| | 1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included:<br>• if negative wildlife interactions become a concern, or<br>• if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.<br>2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies. |
| **4. Monitoring** | |
| | Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on caribou. This plan will include:<br>1. footprint monitoring to monitor habitat loss;<br>2. human activity monitoring of Project site roads and winter roads;<br>3. noise monitoring to monitor disturbance to wildlife;<br>4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes;<br>5. fence and skirting monitoring to ensure that fences are operational and effective at excluding wildlife from hazardous areas without causing them harm;<br>6. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and<br>7. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible.<br>Focal-species monitoring program to monitor Project-related effects on specific terrestrial wildlife species including:<br>1. a monitoring program for caribou using remote cameras in the wildlife RSA to assess the zone of influence of the Project on caribou;<br>2. participation in governmental-based caribou monitoring program if one exists, such as a regional-habitat selection assessment program; and<br>3. incidental reporting of caribou observations during other wildlife and environmental monitoring programs. |

## 5.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - Monitor wildlife interactions with Project Infrastructure;
   - Monitor mitigation actions and their efficacy; and
   - Identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to caribou are summarized in the following sections.

### 5.9.1 Wildlife Mitigation and Monitoring Plan

#### *5.9.1.1 Facility-specific Monitoring*

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area and George Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human activity monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;

- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

#### *5.9.1.2 Focal-species Monitoring*

The proposed focal-species monitoring program will include monitoring caribou through collaborative programs with GN DOE, analyzing GPS collar data and monitoring caribou by remote motion-triggered cameras.

Collaborations with GN DOE Caribou Programs

During February, 2013, meetings were held in Yellowknife at the invitation of GNWT ENR wildlife research, and including representatives from GN DOE and industry representatives, to decide the course of caribou research to investigate cumulative effects on the Bathurst caribou herd. The results of this meeting indicated that collaborative research projects between industry partners and government biologists was the path forward, in lieu of project-specific regional monitoring activities.

To that end, Sabina is proposing to work collaboratively with wildlife biologists from GN DOE and GNWT ENR (included because of the co-management of the Bathurst herd) to conduct collaborative regional research on cumulative effects. The format of this collaboration has yet to be formalized but could include contributing funds (e.g., purchasing collars or funding calving ground surveys), in-kind funds (fuel and accommodation) and/or consultant time to work with the GN and GNWT on government-lead research projects (e.g., continued resource selection function modelling, or vegetation monitoring on the summer range).

This proposed research collaboration, along with analysis of satellite collar data, is meant to satisfy the Government of Nunavut Department of the Environment requirements to monitor caribou on a regional scale. This work would also replace more traditional regional-scale monitoring such as aerial surveys.

Satellite Collar Program

The analysis of satellite collar data during baseline studies revealed that the wildlife RSA occurs to the north-east of the Bathurst post-calving and summer ranges and on the western edge of the Beverly summer range. Caribou herds have moved their calving and summer ranges over the past 30 years (e.g., the Bathurst caribou herd used to calve to the east of Bathurst Inlet in the 1980s) and may move again in response to climate, vegetation, or population triggers. The baseline satellite program used 50% kernel UD and 95% kernel UD measures to evaluate the location of the core habitat and areas of active use, respectively. Monitoring of caribou movement using satellite collaring data will be conducted as part of the focal-species monitoring for the WEMP. This analysis may be repeated periodically (every 3 years) to evaluate whether the primary herds in the Project area (Bathurst and Beverly caribou) have altered their use of the tundra and changed the timing or extent of use of the wildlife RSA.

Remote Motion-triggered Cameras

Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013d, Appendix V5-5C; 2014). The use of remote cameras for annual monitoring of caribou is currently proposed for the focal-species monitoring of caribou as part of the WEMP (Volume 10, Chapter 20). Caribou use of the Project facilities will continue to be monitored every three years during Construction, and annually during all other phases using motion-triggered, all-weather cameras. A passive monitoring system was set up in 2012 and 2013 with the deployment of 60 motion-triggered cameras (Reconyx PC800 HyperFire™ Professional Semi-Covert Infrared) in the wildlife RSA to document caribou (and other wildlife) activity around camp

infrastructure, and on the tundra. Cameras were positioned at key proposed infrastructure locations, such as the proposed tailings impoundment area and at the various camp infrastructure locations of the Goose and George Properties and proposed Marine Laydown Area. Control areas will also be monitored to evaluate the use of the Project locations compared to undisturbed areas of the tundra near the camp. Finally, areas predicted to be important for caribou were also monitored – such as river crossings, lake shores, eskers, and locations with abundant caribou trails on the tundra. Cameras will be checked twice per year at minimum by on-site environment technicians. Cameras may be repositioned as deemed necessary pending results of the photo data.

The five objectives of this monitoring program are to:

1. Monitor the Project site to examine how caribou interact with Project facilities (e.g., on roads, pits);
2. Monitor the Project site at areas with and without mitigation structures or activities to evaluate the efficacy of mitigation activities (e.g., in areas with dust, vs. without);
3. Monitor areas identified as important for caribou from land user knowledge (e.g., eskers, river crossings) and at points with high number of caribou identified during baseline studies (e.g., the river crossing at the east end of Beechey Lake);
4. Monitor control areas distant from the mine and away from areas identified in 3); and
5. Record the times at which caribou use the wildlife RSA during the year.

The existing cameras in the wildlife RSA will be re-evaluated for how they address the five objectives above and re-deployed, if necessary. Methods for data management and analysis will follow those outlined in Volume 10, Chapter 20; Section 7.3.1 of the WMMP Plan.

## 5.10 IMPACT STATEMENT

Caribou, including Bathurst herd and Beverly herd were included as a valued ecosystem component for the DEIS. A review of the potential Project iterations with caribou identified eight potential effects that may occur. These eight potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions among all potential effects.

The effects assessment included the identification of key indicators and quantitative thresholds for evaluation of potential effects. The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on caribou and concluded that three of the potential effects would remain as residual effects after mitigation: habitat loss, disturbance, and reduction in reproductive productivity. Using the key indicators and thresholds, each of these residual effects were rated with a low magnitude and overall were rated as Not Significant, contingent on the implementation of mitigation measures outlined in the WMMP (Volume 10, Chapter 20).

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. The residual effect anticipated to contribute the most to effects on the population is attributed to disturbance due to noise. While the most current mitigation measures are proposed for the Project, effects of disturbance

due to noise have been recorded at other existing projects with similar mitigation measures. Thus, it is anticipated that despite the best mitigation measures, disturbance due to the Project is likely to result in caribou avoiding these areas and potentially moving to habitats of lesser quality leading to range shifts and potential reduction in reproductive productivity.

A cumulative effects assessment was conducted because residual Project effects were predicted and other projects occur within the movement area defined for caribou that interact with the Project. Three potential cumulative effects were evaluated for the cumulative effects assessment: habitat loss, disturbance due to noise, and reduction in reproductive productivity. Key indicators were calculated for those where data was available and residual cumulative effects were predicted for all three potential effects. Each residual cumulative effect was rated by using threshold values and determined to have a low magnitude effect on the caribou populations within the cumulative effects assessment boundaries.

It is anticipated that all projects within the CEA boundary will likely have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of Not Significant was concluded for residual cumulative effects on caribou in the CEA boundaries. The overall effect of the Project on the VEC caribou is **Not Significant**.

# 6. Grizzly Bear

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# 6. Grizzly Bear

## 6.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 6.1.1 Introduction

Barren-ground grizzly bears (*Ursus arctos horribilis*), inhabit the northern edge of the grizzly bear range in North America. Habitats at these high latitudes are relatively low in forage productivity. As a result, barren-ground grizzly bears have large home ranges and exist at low densities compared to other grizzly bear populations in more productive ecosystems (McLoughlin 2000).

Inuit Traditional Knowledge indicates that barren-ground grizzly bears (hereafter, grizzly bears) are found throughout the Back River Project (the Project) wildlife Regional Study Area (RSA), especially in association with major river systems, watersheds and coastal areas (KIA 2012). Grizzly bears were hunted for meat and fat (food and oil) typically in spring or fall before denning. These mammals are also important and respected by Inuit as many legends and stories exist about them (KIA 2012).

### 6.1.2 Population Trends and Conservation

In the Canadian Arctic, the most recent surveys of population trends for the grizzly bears in 2003, indicated a stable or slightly increasing population (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Barren-ground populations of grizzly bears are listed as a species of "Special Concern", but are not yet listed under *The Species at Risk Act* (SARA; COSEWIC 2012). In the Northwest Territories and Nunavut, the Canadian Endangered Species Conservation Council lists grizzly bears as Sensitive (CESCC 2005; Working Group on General Status of NWT Species 2006; CESCC 2010).

There is no official estimate on grizzly bear population sizes for the West Kitikmeot region of Nunavut where the Project is located. However, a rough estimate of 800 grizzly bears was determined for a 200,000 $km^2$ portion of the northwestern mainland of Nunavut, which includes the wildlife RSA (Ross 2002). This estimate assumed a density of 4 bears per 1,000 $km^2$ based on grizzly bear densities in nearby areas (Ross 2002). Grizzly bear mark-recapture population studies conducted in the wildlife RSA in 2012 resulted in a rough estimate of 5 bears per 1,000 $km^2$ in the wildlife RSA (Rescan 2013b, Appendix V5-6A).

The life history traits of grizzly bears generally limit the resilience of populations threatened by human disturbance (McLoughlin et al. 2003). Grizzly bears are long lived animals characterized by low reproductive rates due to a late age of maturity, small litter sizes, and long intervals between litters (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Barren-ground grizzly bears are expected to have relatively lower reproductive rates relative to their southern counterparts because they occupy areas of low productivity and high seasonality (Ferguson and McLoughlin 2000; McLoughlin, Ferguson, and Messier 2000). In addition, barren-ground grizzly bears have a later age of maturity, smaller litter sizes, and lower birth rates relative to southern populations of grizzly bears (McLoughlin, Taylor, Cluff, Gau, Mulders, Case, Boutin, et al. 2003). This work implies that barren-ground grizzly bears may be more susceptible to population declines when disturbed by human-related activities as well as longer periods of population recovery after disturbance events are removed. The stability of grizzly bear populations in the Arctic may be dependent on several criteria including mortality due to hunting and human-related activities, low reproductive productivity, and general health of individuals. Reproductive productivity and general health of grizzly bears may in turn be influenced by access to resources such as habitat and nutritional sources, exposure to contaminants, and climate change.

Grizzly bear populations in the central Canadian Arctic are structured into three spatially distinct groups; the Kugluktuk region, Bathurst Inlet region, and the North Slave region (McLoughlin et al. 2002). Traditional knowledge and baseline studies conducted in the wildlife RSA indicate that grizzly bears are found throughout the wildlife RSA (Gartner Lee Ltd. 2008; Rescan 2011a, Appendix V5-5E; KIA 2012; Rescan 2012a, Appendix V5-5D; 2013b, Appendix V5-6A; 2013d; 2014, Appendix V5-5E). Grizzly bears in the wildlife RSA are part of the Bathurst Inlet population (GN DOE 2005). There are few genetic differences between individuals among the three groups, thus it has been suggested that these populations be managed as one continuous population (McLoughlin et al. 2002).

It has been suggested that the barren-ground grizzly bear is at risk of decline if annual harvests and human activity are increased, which may have considerable negative effects on the population (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). An average of 13.4 bears per year was reported as harvested between 1958 and 2000 in the central Canadian Arctic (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). The locations and causes of 265 grizzly bear kills were recorded in the West Kitikmeot region between 1981 and 2004, and indicate an annual known harvest of 11 bears per year (Dumond and Campbell in prep). These data indicate that 29% of the reported kills, or 3.2 bears kills per year occurred in the Bathurst Inlet area of the West Kitikmeot Region (Dumond and Campbell in prep) which is close to where the Back River Project is located.

The Nunavut Department of Environment (GN DOE 2005) recommends a total annual harvest (TAH) of six grizzly bears, including problem kills, from the Bathurst Inlet population. Grizzly bears may be harvested in a ratio of two males to one female, but harvest is not recommended for females accompanied by cubs given poor survival rates of orphaned cubs (GN DOE 2005). The majority of bears killed in the Bathurst Region were killed by sport hunting (36%), or as problem kills (34%; (Dumond and Campbell in prep). Twenty-six percent were harvested for subsistence (no tag required) or for the sale of the hide with a tag. The remainder (4%) died of natural or unknown causes. Most problem kills occurred in June, July, or August, whereas most sport hunts occurred in May. The majority of bears killed (41%) were adult males. The recorded kills in the Bathurst Inlet Region are below the recommended TAH for the Region. However, this estimate does not include unreported kills.

Decreases in reproductive productivity may also result from declines to general health of terrestrial wildlife. Health of wildlife can be influenced by a number of factors including exposure to contaminants. Baseline concentrations of contaminants in grizzly bear tissues is generally lacking in the Arctic. However, evidence from literature suggests that persistent organic pollutants are of most concern to Arctic carnivores, and the majority of literature relevant to Arctic carnivore species pertains to discussion of these types of contaminants. While some data for metals exists (e.g., Gamberg, Palmer, and Roach 2005), it suggests that metal concentrations are well below threshold values for adverse health effects in other carnivore species.

Climate change or climate warming may also affect populations of barren-ground grizzly bears. One of the most important changes in the Arctic as a result of recent warming trends, is an increase in the biomass of shrub species, such as birch, willow, and alder (Myers-Smith et al. 2011; Tremblay, Lévesque, and Boudreau 2012; Frost et al. 2013). The increase in these species will have important implications for the structure and function of Arctic ecosystems. The increase in plant cover may provide additional nutritional resources for ungulates and other species on which grizzly bears prey. However, the effects of climate warming on wildlife populations are not clear, and populations of important grizzly bear prey species may be controlled by additional factors such as extreme weather events (Parmesan, Root, and Willig 2000; Parmesan 2006).

Grizzly bears have recently been spotted in areas beyond their typical northern range including on Banks and Victoria islands (in the Canadian Arctic islands north of Bathurst Inlet) and on the sea ice northwest

of Banks Island and as far north as Melville Island (Doupé et al. 2007). In 2006, a grizzly-polar hybrid was shot by a sport hunter near Sachs Harbour (Gormezano) on Banks Island and hybrids have been observed in other areas (Schliebe et al. 2006), potentially including Kugluktuk northwest of the wildlife RSA (Darwin). However, it is unclear how climate change may interact with other human-related activities such as industrial development, changes in contaminant exposures and reproductive viability of barren-ground populations of grizzly bears.

### 6.1.3 Distribution and Movement Patterns

The historic range of the grizzly bear extended along the western half of North American as far south as Mexico. The grizzly bear has been extirpated from much of their former southern range; however; the barren-ground grizzly bear population exists throughout northwestern Canada because it has not been subjected to the same intensity of exploitation and habitat changes (McLoughlin 2000).

Between 1995 and 1999, across the Southern Arctic Terrestrial Ecozone, which spans the northern coast of Mainland Northwest Territories, most of northern mainland Nunavut, and a portion of northwestern Quebec, a total of 81 grizzly bears were captured and fitted with satellite radio-collars and over 8,000 telemetry locations were recorded from collared animals (McLoughlin, Ferguson, and Messier 2000). The locations of these collared bears occurred mostly to the east and west of the wildlife RSA, however some collar locations were detected within the boundary of the wildlife RSA (Figure 6.1-1). These bears represent a small portion of the grizzly bears which may reside in the vicinity of the wildlife RSA. Average home range sizes derived from the satellite collaring study varied from 210,000 ha for females to 724,500 ha for males, and home ranges of individuals overlapped more than those reported in southern latitudes (McLoughlin, Ferguson, and Messier 2000; McLoughlin, Taylor, Cluff, Gau, Mulders, Case, Boutin, et al. 2003).

During baseline studies conducted in 2012, a total of 61 grizzly bears were detected in the wildlife RSA and an additional 62 bears detected in an identically-sized study area from another project directly west of the wildlife RSA. The average distance travelled by these bears during the entire study period (May through August) was 25.7 km for female grizzly bears, 42.5 km for a male bears, and 32.6 km for bears travelling in family units (Rescan 2013b, Appendix V5-6A). The maximum detected distance travelled during the study period by male bears (138 km) was over double that travelled by female bears (65 km). Detections of grizzly bears mainly occurred in the eastern portion of the wildlife RSA and along major river systems. During the summer and fall, bear detections were evenly distributed throughout the wildlife RSA. Traditional knowledge also indicates that major grizzly bear movements occur in the wildlife RSA, especially in association with major river systems, watersheds and coastal areas (Thorpe et al. 2001; KIA 2012).

### 6.1.4 Habitat Use and Diet

Habitat selection by grizzly bears mainly reflects spatial and temporal patterns in forage availability and abundance (McLoughlin et al. 2002). Habitat selection has been measured at two spatial scales; landscape and home range. At the landscape scale, grizzly bears select home ranges that have a higher proportion of eskers, tussock/hummock tundra, lichen veneer, birch seep, and riparian tall shrub habitat than surrounding areas. At the smaller home range scale, habitat selection varies by season, sex and reproductive status (McLoughlin et al. 2002). Habitat suitability modelling of the wildlife RSA (see Section 6.1.5) indicated that the habitat contained within the wildlife RSA contains a variety of suitable foraging habitat during the snow free season. However, modelling indicated that denning habitat within the wildlife RSA was in very low quantity, largely a result of the rarity of eskers and lacustrine deposits, habitat where bears may easily excavate den sites (Rescan 2013a, Appendix V5-5A).

Research on the dietary patterns of barren-ground grizzly bears indicates that five time periods correlate with seasonal changes in resource selection (Table 6.1-1; Gau et al. 2002): spring, summer, late summer, fall and denning.

**Table 6.1-1. Seasonal Periods for Grizzly Bear**

| Season | Start Date | End Date |
|---|---|---|
| Spring | May 14 | June 20 |
| Summer | June 21 | July 31 |
| Late Summer | August 1 | September 9 |
| Autumn | September 10 | October 15 |
| Denning | October 16 | May 15 |

*Note: Dates used in habitat suitability modelling by Johnson et al. (2005). Dates reflect shifts in grizzly bear diet throughout the season.*

Spring (May 14 to June 20)

Forage in spring is important for grizzly bears to recover from weight loss during winter hibernation. Upon emerging from dens, barren-ground grizzly bears feed on a variety of food, including caribou migrating north to their calving grounds (Gau et al. 2002). Overwintered berries and Arctic ground squirrels are also important food sources during this period (Gau et al. 2002).

Grizzly bears show the greatest preference for esker habitat during the spring, perhaps because ground squirrel burrows are abundant and more easily accessible there in spring than elsewhere (McLoughlin et al. 2002; Johnson et al. 2005). Male grizzly bears also show a preference for tussock/hummock tundra, while females without cubs show a preference for riparian tall shrub habitat (McLoughlin et al. 2002; Johnson et al. 2005). Habitat suitability modelling in the wildlife RSA indicated that approximately half of the wildlife RSA and a small portion of the wildlife Local Study Area (LSA) contained high or moderately suitable spring habitat for grizzly bears (Rescan 2013a, Appendix V5-5A). The largest concentrations of highly rated grizzly bear spring habitat was located northwest portion of the wildlife RSA (Rescan 2013a, Appendix V5-5A).

Summer and Late Summer (June 21 to September 9)

The summer diet of barren-ground grizzly bears is highly variable. Early in the summer season when caribou are not as abundant in the wildlife RSA compared to other seasons, grizzly bears feed primarily on horsetails, Arctic cottongrasses, and sedges. Gau et al. (2002) studied food choice by grizzly bears in a study area to the south of the wildlife RSA, in an area used by the Bathurst caribou herd during summer. Gau et al. (2001) reported that by mid-summer, caribou become a more important component of the grizzly bear diet as post-calving herds of Bathurst caribou move southeast. Use of caribou in the wildlife RSA by grizzly bears would happen early in the season, since the Bathurst herd is present in the wildlife RSA only during post calving. This heard then moves further south to their summer range. Vegetation is still an important source of food during the summer. Grizzly bears resume consumption of Arctic ground squirrels in when the caribou leave the area (Gau et al. 2002).

During the summer, female grizzly bears (with and without cubs) show preference for eskers and riparian tall shrub habitat (McLoughlin et al. 2002). Females with young also prefer heath tundra. The majority of tall shrub habitat in the wildlife RSA occurs in the northern and western portion of the wildlife RSA near Bathurst Inlet and the Western River and along other major river systems. Males continue to show preference for tussock/hummock tundra in the summer (McLoughlin et al. 2002).

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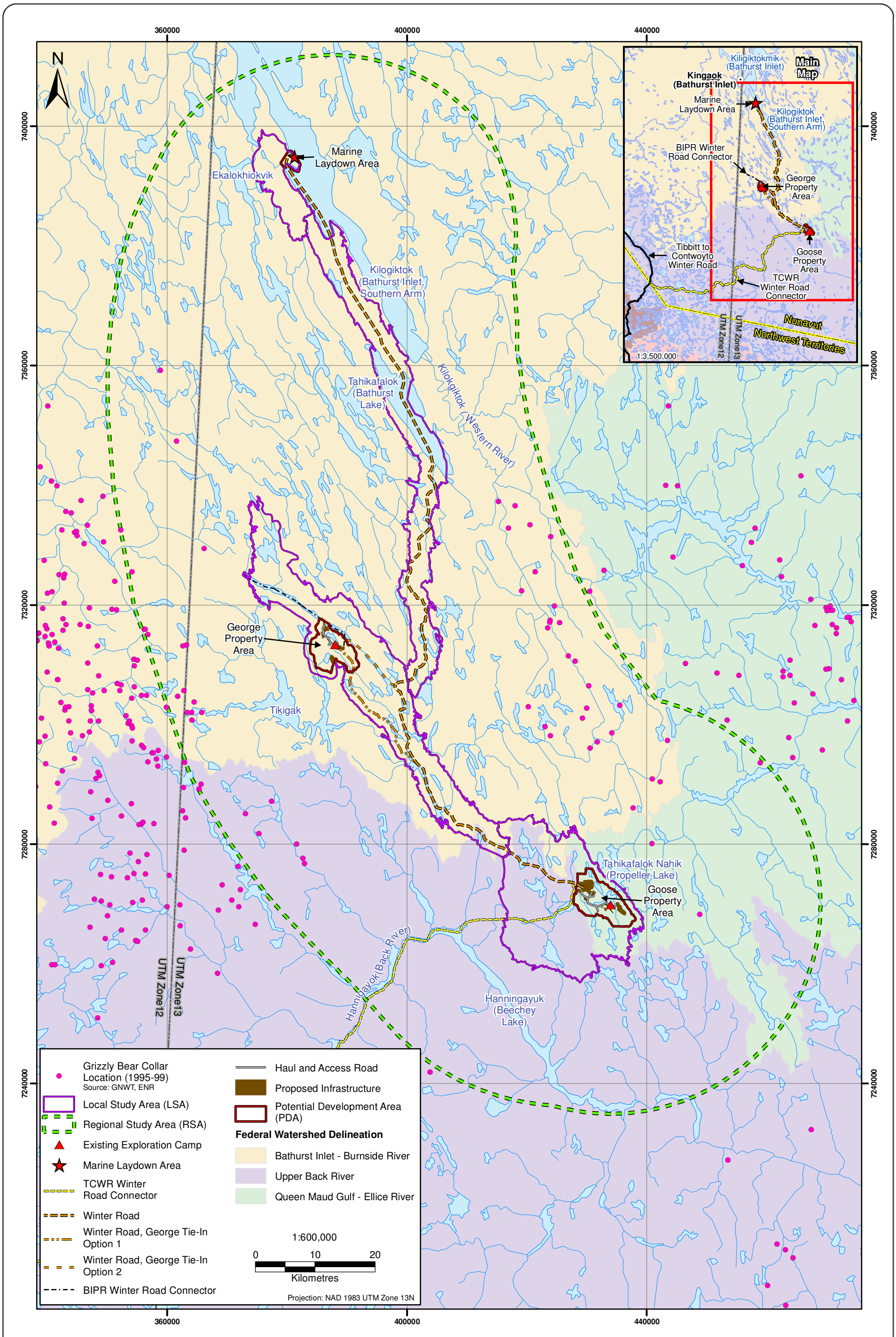


Figure 6.1-1

Sabina GOLD & SILVER CORP.

## Grizzly Bear Satellite Collar Locations, 1995 to1999

Figure 6.1-1

Rescan an ERM company

A habitat modelling study by Johnson et al. (2005) that overlaps the wildlife RSA shows that grizzly bears in the area select esker and low shrub habitats in the summer.

In late summer, barren-ground grizzly bears increase foraging in order to fatten up for the winter denning season (Gau 1998). During this time, berries are the primary component of the grizzly bear diet and are essential for fat deposition. Caribou continue to be an important source of food during the late summer, where they are available, and Arctic ground squirrels are consumed to some extent (Gau et al. 2002). The Ahiak caribou herd occurs in the wildlife RSA at low numbers during the fall, and grizzly bears likely prey on these animals.

Grizzly bears prefer eskers and riparian tall shrub habitat in late summer (McLoughlin et al. 2002; Johnson et al. 2005). These habitats provide an abundance of fresh berries and caribou. Differences in habitat use among males, females with cubs and females without cubs are pronounced in late summer. Females with cubs select heath bedrock and tussock/hummock tundra, while males and females without cubs avoid these habitats preferring eskers (McLoughlin et al. 2002). Therefore, females with cubs are segregated from other demographic groups during the late summer period.

Habitat suitability modelling conducted during baseline studies in the wildlife RSA (see Section 6.1.5) indicated that approximately 50% of the wildlife RSA and 75% of the wildlife LSA consisted of high-quality (habitat rated as high or moderate suitability) summer habitat (Rescan 2013a, Appendix V5-5A). High quality habitat was distributed fairly evenly throughout the wildlife RSA (see figures in Section 6.1.5).

Autumn (September 10 to October 15)

Autumn is a critical season for barren-ground grizzly bears because individuals must gain weight rapidly in order to survive winter hibernation (Zager and Jonkel 1983). The autumn diet of grizzly bears is similar to their spring diet. Depending on their location, grizzly bears feed primarily on caribou that are migrating south towards the treeline for winter. Arctic ground squirrels are also an important food source. However, fewer berries are consumed in autumn compared to the spring and summer seasons (Gau et al. 2002).

Important grizzly bear habitat in autumn includes riparian tall shrub habitat, lichen veneers and heath tundra. Habitat selection is strongly influenced by the occurrence of caribou during fall (Johnson et al. 2005). However, females with cubs significantly avoid riparian tall shrub habitat and select bedrock habitats, which are avoided by males. Females without young continue to prefer eskers in autumn (McLoughlin et al. 2002). A habitat modelling study by Johnson et al. (2005) shows that fall habitat selection by grizzly bears is strongly influenced by the presence esker, heath rock, low shrub, and peat bog vegetation types.

Habitat suitability modelling conducted during baseline studies in the wildlife RSA (see Section 6.1.5) indicated that approximately 50% of the wildlife RSA and the wildlife LSA consisted of high-quality (habitat rated as high or moderate suitability) summer habitat (Rescan 2013a, Appendix V5-5A). High quality habitat was concentrated in the northern portion of the wildlife RSA and along the major river systems in the wildlife RSA (Section 6.1.5).

Denning (October 16 to May 15)

In general, denning lasts from late October to early May for most bears; some bears, males in particular, may den for shorter periods of time (McLoughlin, Cluff, and Messier 2002). Dens have been found in a wide variety of habitat types.

A satellite-collaring study was conducted in the West Kitikmeot region (McLoughlin et al. 2002) to determine the denning ecology of grizzly bears in the area. This research indicated that most dens sites (60%) were located in heath tundra and heath-boulder habitats, with most of the remaining dens located in riparian tall shrub and birch seep habitats (McLoughlin et al. 2002). Although eskers accounted for only seven of 56 den sites studied, this habitat type was selected more than expected, given its low availability in the central Arctic.

Several characteristics such as aspect, and slope appear to influence selection of den sites. Grizzly bear den sites most commonly faced south (H. V. Reynolds, Curatalo, and Quimby 1976; Banci and Moore 1997; McLoughlin et al. 2002). The benefit of a southern exposure may be insulation (i.e., warmth) at emergence in the spring (and possibly at denning in the fall) or the accumulation of an insulating layer of snow that would result from the prevailing northerly winds. Grizzly bears also selected den sites on relatively steep slopes, averaging 25° (McLoughlin, Cluff, and Messier 2002). Steep slopes may permit the bears to construct horizontal or even upward-sloping tunnels, which would result in a warm air "trap" in the hibernation chamber (L. E. Harding 1976).

The substrates of den sites are typically well-drained and contain a large amount of sand and coarse material, including cobble and boulder sized stones. The structural integrity of den sites is maintained through root mats from dwarf birch and other shrubby vegetation located in the ceilings of dens. Often grizzly bear dens in the Arctic do not last long; by mid-summer, most partially or completely collapse (McLoughlin, Cluff, and Messier 2002). Thus, it appears that bears usually dig new dens each year. This is important for mitigation and management of Project activities, because identified dens are likely ephemeral.

During baseline studies conducted in the wildlife RSA, four grizzly bear dens have been observed. Two dens were detected in 2007; one of which was located 18 km northwest of the George Property near the proposed BIPR road, and the other located approximately 10 km southeast of the George Property (Gartner Lee Ltd. 2008). Both dens were shallowly dug into moderately sloped, heath tundra habitat and had root mats of heather and dwarf birch shrubs at the den entrances. Two additional grizzly bear dens were observed in 2012 and were dug into sandy soil in moderately sloped, glacial-fluvial habitat along the Western River and had south facing aspects (Rescan 2013d, Appendix V5-5C). One of these dens was determined to have been active in 2012 but was recently collapsed, so was unlikely to be used in subsequent years.

### 6.1.5 Baseline Data for Grizzly Bears

Three types of baseline surveys were conducted for grizzly bears in the wildlife RSA including: i) population-estimation using DNA mark-recapture; ii) den surveys; and iii) incidental observations. In addition, habitat suitability modelling was conducted in the wildlife RSA to evaluate the quality of habitat in the study area for grizzly bears foraging and denning.

Specific sources of baseline terrestrial wildlife information used in this section included the following reports:

- *Back River and Hackett River Projects: 2010*: *Caribou and Muskox Baseline Report* (Rescan 2011a, Appendix V5-5E).
- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012a, Appendix V5-5D);
- *Back River Project: 2012 Wildlife Baseline Report* (Rescan 2013d, Appendix V5-5C);
- *Back River Project: 2012 Grizzly Bear and Wolverine DNA Baseline Report* (Rescan 2013b, Appendix V5-6A); and
- *Back River Project: 2013 Wildlife Habitat Suitability Baseline* (Rescan 2013a, Appendix V5-5A).

The results of the 2013 wildlife baseline program will be available in 2014.

Other sources of supplementary wildlife data used in this section include:

- *Bathurst Inlet Port and Road Project: Caribou and Muskox Baseline Study* (Rescan 2007a);
- *Bathurst Inlet Port and Road Project 2001-2002: Wildlife Baseline Studies* (Rescan 2007b).
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008); and
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012).

### *6.1.5.1 Methods*

DNA Mark-Recapture

The DNA based mark-recapture program was conducted over two years; 2012 and 2013, in an area of approximately 17,300 km$^2$ surrounding the Project location (Rescan 2013b, Appendix V5-6A). The program was conducted in a grid that included the wildlife RSA as well as an area of equal size adjacent to and west of the wildlife RSA. These areas, combined, were roughly triangular in shape, and stretched from Nose Lake in the south west, to Beachy Lake in the south east, and Bathurst inlet in the north (Figure 6.1-2).

The grizzly bear DNA study was carried out to calculate the total number of grizzly bears that currently use the wildlife RSA. In addition, overall results of the program will generate a super-population estimate, spatial and temporal distributions, calculate demographic variables and identify individuals outside of the study area observed by other surveys.

Grizzly bear DNA fingerprinting using hair has been used previously to mark and recapture bears (Woods et al. 1999; Mowat and Strobeck 2000; Poole, Mowat, and Fear 2001; Apps et al. 2004; Boulanger et al. 2004; M. F. Proctor et al. 2005; Rescan 2011b). This method provides several benefits because live capture of bears is unnecessary, individuals can be identified with a small risk of error, and hair removal sites are faster to set up and are checked less often than live-capture sites (Woods et al. 1999; Mowat and Strobeck 2000; Poole, Mowat, and Fear 2001; Apps et al. 2004; Boulanger et al. 2004; Rescan 2012a, Appendix V5-5D). Roots of mammalian hair contain sufficient DNA for analysis (Higuchi et al. 1988). For free-ranging bears, hair is an attractive DNA source because bears frequently leave hair on rub trees, in beds, and at foraging sites (Taberlet et al. 1993). Bears are readily attracted by scent lures, thus, permitting methods to obtain hair samples from free-ranging bears using systematic sampling regimes necessary for many ecological studies, such as animal censuses (Woods et al. 1999). In mark-recapture studies, an initial population sample is “marked”, which corresponds to the bears detected in the first round of hair sampling. The population is then resampled during ≥ 1 additional sessions (Woods et al. 1999). The ratio of newly captured animals to recaptures is then used to compute a population estimate (White et al. 1982).

Bears traverse in and out of the study area during sampling, which violates the assumption of geographic closure in most studies that use mark-recapture or related methods (Miller et al. 1997). Abundance estimates derived from mark-recapture correspond to the “super-population” if movement is random across grid boundaries (Kendall 1999). In the context of mark-recapture DNA studies, the super-population is defined as the number of animals that inhabit the sampling grid and surrounding area (as opposed to the grid alone; Boulanger et al. 2004). While the super-population estimate represents the number of animals that traverse an area, the estimate is compromised by the undefined sampling area and therefore cannot be used to estimate density (Boulanger et al. 2004). Under a trend monitoring objective, however, an absolute abundance or density estimate is not necessary, and the

assumptions of population closure can be relaxed (Apps 2010). In this case, the initial super-population estimate can be used as the basis for monitoring relative changes over the long term.

The grizzly bear DNA program included a 130 cell grid of 12 × 12 km cells; which included 65 cells in the wildlife RSA and 65 cells in an area directly adjacent and west of the wildlife RSA. Each cell contained a baited post to attract bears which would investigate the post and leave hairs on barbed wire wrapped around the post. The posts were checked six to eight times during the summer, every 9 to 12 days. Bears were identified from their hairs and a population estimate was calculated from the proportion of bears that return to the posts during the summer (Rescan 2013b, Appendix V5-6A). Details of the methods are reported in the 2012 Grizzly Bear and Wolverine DNA Baseline Report (Rescan 2013b, Appendix V5-6A).

Den Surveys

Den surveys for bears were carried out as part of surveys for wolf dens via low level aerial surveys in esker and glacial-fluvial habitat during the end of May or early June, and July of 2007, 2011, 2012, and 2013 (Gartner Lee Limited 2007; Rescan 2012a, Appendix V5-5D; 2013d, Appendix V5-5C). During these surveys, any grizzly bear dens observed were recorded. Surveys were flown at an altitude of 50 to 100 m above the terrain and at ground speeds between 30 to 80 km/h to minimize disturbance to other carnivores in the area but to maintain an effective height and speed for observers to effectively discern dens. Full details of the den survey methodology can be found in the 2007, 2011, and 2012 Wildlife Baseline Reports (Gartner Lee Limited 2007; Rescan 2012a, Appendix V5-5D; 2013d, Appendix V5-5C).

Incidental Observations

Incidental observations of grizzly bears were recorded in the wildlife RSA when observed on the tundra during other wildlife and environmental baseline surveys conducted between 2001 and 2012 and when captured by the 60 remote cameras distributed throughout the wildlife RSA for caribou studies (Volume 5, Chapter 5) and used to supplement grizzly bear DNA studies. Remote cameras for the caribou baseline studies recorded observations from late May to August 2012. Images from these cameras were quality checked to remove duplicate images of the same individual and documented. Details of the methodology for remote cameras can be found in the 2012 Wildlife Baseline Report (Rescan 2013d, Appendix V5-5C).

Habitat Suitability Modelling

Wildlife habitat suitability studies were conducted within the wildlife Local Study Area (LSA) and the wildlife Regional Study Area (RSA) to inventory and rate the habitat types for grizzly bears and quantify suitable habitat available for this species within the local and regional study areas. These data can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 $km^2$ of the West Kitikmeot / Slave Study Area, which stretches from the Arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001).

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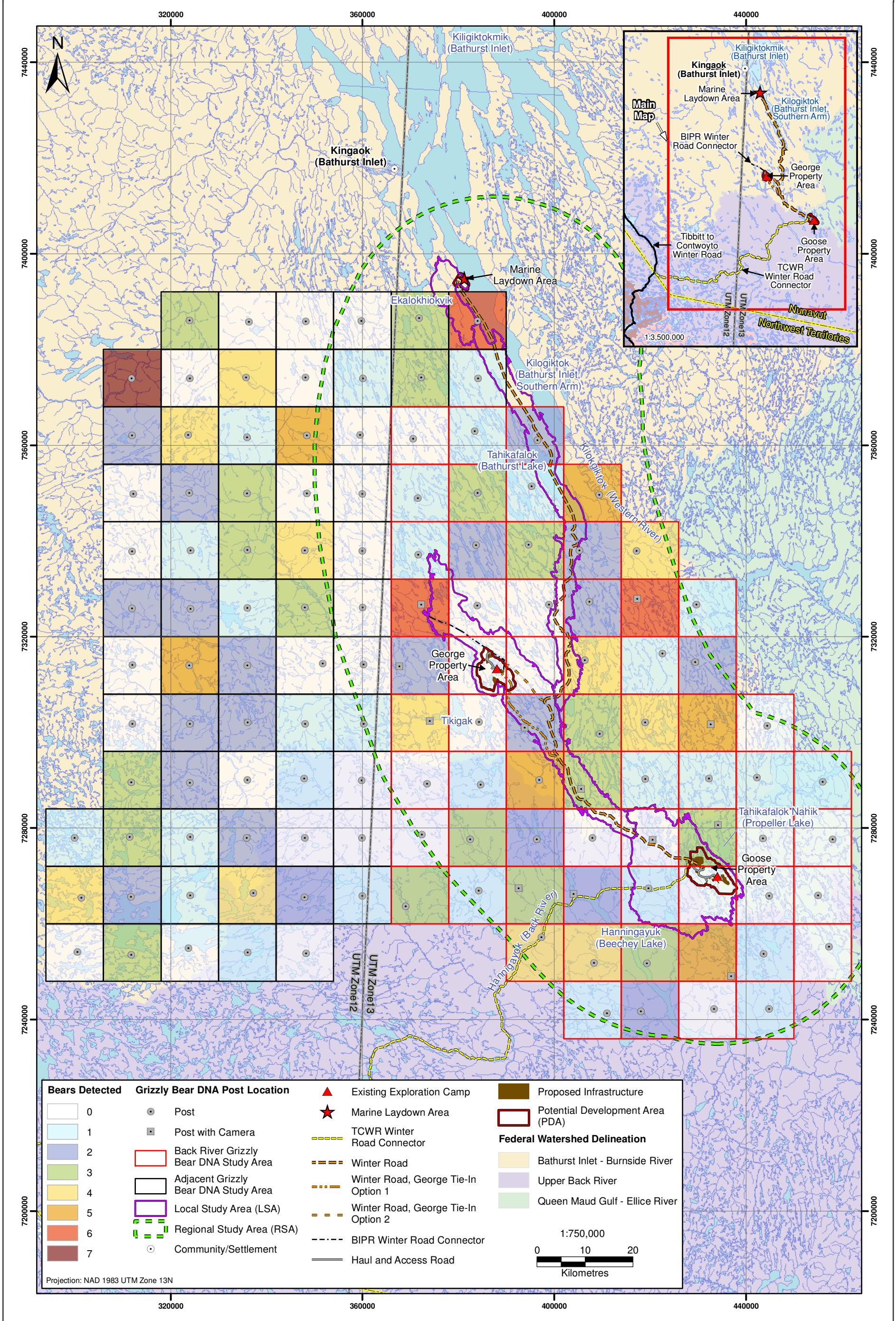


Figure 6.1-2

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# Grizzly Bear DNA Grid, Post Locations and Capture Frequency, 2012

Figure 6.1-2

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Grizzly bears are omnivorous and opportunistic feeders that select habitat largely based on seasonal availability of forage (B. N. McLellan et al. 1999; Wellwood 2003). Table 6.1-2 presents the seasonal life requisites for grizzly bears used to develop habitat suitability ratings (HSRs). Habitat suitability ratings focused on living requisites for spring, summer, fall, and denning seasons, based on an assessment of the ecosystem units' abilities to produce forage species and/or denning habitat. Vegetation phenology was used to rate ecosystem units for target forage species for a given season (e.g., blueberries are absent in the spring, ripen during the summer, and die off during the fall). Prey sources, mainly Arctic ground squirrel (*Spermophilus parryii*), that are strongly associated with specific ecosystem units were included in the ecosystem unit habitat suitability ratings (HSRs).

**Table 6.1-2. Seasonal Life Requisites of Grizzly Bear**

| Season | Date | Life Requisite | Habitat Preference |
|---|---|---|---|
| Spring | May - June | Living | Esker, crowberry, blueberry, sedge, riparian shrub, caribou, ground squirrel |
| Summer | June - September | Living | Esker, blueberry, sedge, riparian shrub, ground squirrel |
| Fall | September - October | Living | Esker, blueberry, sedge, riparian shrub, caribou, ground squirrel |
| Denning | October to May | Reproduction | Lacustrine (lakeside) deposits, eskers |

### *6.1.5.2 Results*

Grizzly bears were detected in the wildlife RSA between 2001 and 2013. Of the three methods used to detect grizzly bears (DNA mark-recapture, den surveys, and incidental observations during other baseline studies including remote camera studies), DNA mark recapture detected the largest number of bears and gives the best approximation of the number of bears that occur in the wildlife RSA.

DNA Mark-Recapture

A total of 2,340 grizzly bear hair samples were collected during 2012 and submitted for DNA analysis from the 130 cell grizzly bear study grid. Results from the 2012 grizzly bear DNA study indicated that 1,053 (45%) of the 2,340 samples were successfully extracted and assigned to 111 independent individuals, 46 males and 65 females (Rescan 2013b, Appendix V5-6A). This total represents the number of bears within the entire grizzly bear study grid that includes both those in the wildlife RSA and those detected in the cells adjacent to and west of the wildlife RSA (Figure 6.1-2). Twelve of the bears detected in the entire study area overlapped both the wildlife RSA and the cells to the west. Of the total number of bears, eight family units totaling 20 grizzly bears were identified through mapping bear movements. Two of these family units were confirmed by remote cameras.

Grizzly bears identified in this study area have not been detected in other DNA study areas to the east and west of the grizzly bear study grid; however, four grizzly bears were detected in a DNA study area to the south of the Project. The results for bears detected in the study grid suggest 61 individual grizzly bears detected by mark-recapture in the wildlife RSA of which 27 are male and 34 are female (Rescan 2013b, Appendix V5-6A). An additional 62 bears were detected in the cells directly west of the wildlife RSA.

Samples were collected from 2013 and results will be available in 2014.

Grizzly bears exhibited a temporal distribution throughout the study grid (Figure 6.1-3). Grizzly bears were detected mainly in the eastern half of the study grid between late-May and mid-June and in the western half between mid- to late-June. In July and August detection of grizzly bears was fairly evenly distributed within the grid. A total of 29 bears were detected at greater than three tripods, including 11 males, 7 females, and 11 bears from six potential family groups.

The average distance travelled during any one session, by grizzly bears that were recorded at multiple stations, was 42.5 km for male bears, 25.7 km for female bears, and 32.6 km for bears potentially travelling as a family group (Table 6.1-3). A full description of the position and distance movements of individuals can be found in the 2012 Grizzly Bear and Wolverine DNA Baseline Report (Rescan 2013b, Appendix V5-6A). These distances were similar to those calculated during the entire survey period. The longest distance movement recorded was by a male bear at 138 km.

**Table 6.1-3. Distance Travelled and Area Used by Grizzly Bears, 2012**

| | Parameter | Average | Range |
|---|---|---|---|
| Distance travelled by an individual bear per session | Female | 25.7 km | 9.7 km – 54.9 km |
| | Male | 42.5 km | 11.5 km – 89.9 km |
| | Potential family unit | 32.6 km | 10.9 km – 84.8 km |
| Distance travelled during entire survey period | Female | 24.6 km | 10.9 – 64.6 km |
| | Male | 58.6 km | 10.9 - 137.9 km |
| | Potential family unit | 46.3 km | 24.6 - 84.8 km |
| Area used during entire survey period | Female | 250.8 $km^2$ | 30.7 - 496.0 $km^2$ |
| | Male | 431.3 $km^2$ | 2.6 - 1,278.6 $km^2$ |
| | Potential family unit | 305.6 $km^2$ | 0.5 – 462.2 $km^2$ |

For animals that were captured more than twice, a polygon of their capture locations was used to calculate an area of use for each bear (minimum convex polygon). On average, female bears used an area of 250.8 $km^2$, males used an average of 431.3 $km^2$, and family groups used an average of 305.6 $km^2$ (Table 6.1-3). The largest area recorded to be used during the survey period by an individual male grizzly bear was 1,278.6 $km^2$ while the largest area used by an individual female grizzly bear and by a family group was much smaller (496.0 $km^2$ and 462.2 $km^2$ respectively).

Den Surveys

In 2007 and 2011, no grizzly bear dens were recorded during aerial surveys conducted in the wildlife RSA (Gartner Lee Limited 2007; Rescan 2012a, Appendix V5-5D). However, two dens were observed incidentally (Figure 6.1-4) during breeding bird surveys conducted in 2007, one of which was located 18 km northwest of George Property Area near the proposed BIPR road, and the other located approximately 10 km southeast of George Property Area (Gartner Lee Ltd. 2008). Both dens were shallowly dug into moderately sloped, heath tundra habitat and had root mats of heather and dwarf birch shrubs at the den entrances (Gartner Lee Limited 2007). In 2012, two additional grizzly bear dens were observed (Figure 6.1-4), one observed during the July Den survey, while the other den was recorded incidentally in June (Rescan 2013d, Appendix V5-5C). Both of the dens found in 2012 were situated along the Western River corridor in sandy glacial fluvial habitat with southerly aspects.

Incidental Observations

Incidental observations of grizzly bears were recorded between 2001 and 2012 during environmental baseline studies conducted in the wildlife RSA. Twelve incidental sightings of grizzly bears were observed in 2001 during aerial surveys conducted for caribou and muskox in the wildlife RSA (Rescan 2007b). No grizzly bears were observed during aerial surveys conducted in spring 2002 (Rescan 2007b). Eleven bears including two cubs were observed incidentally in 2007 (Gartner Lee Limited 2007). During the 2010 baseline field studies, four grizzly bears were recorded during the caribou and muskox aerial surveys (Rescan 2011a, Appendix V5-5E).

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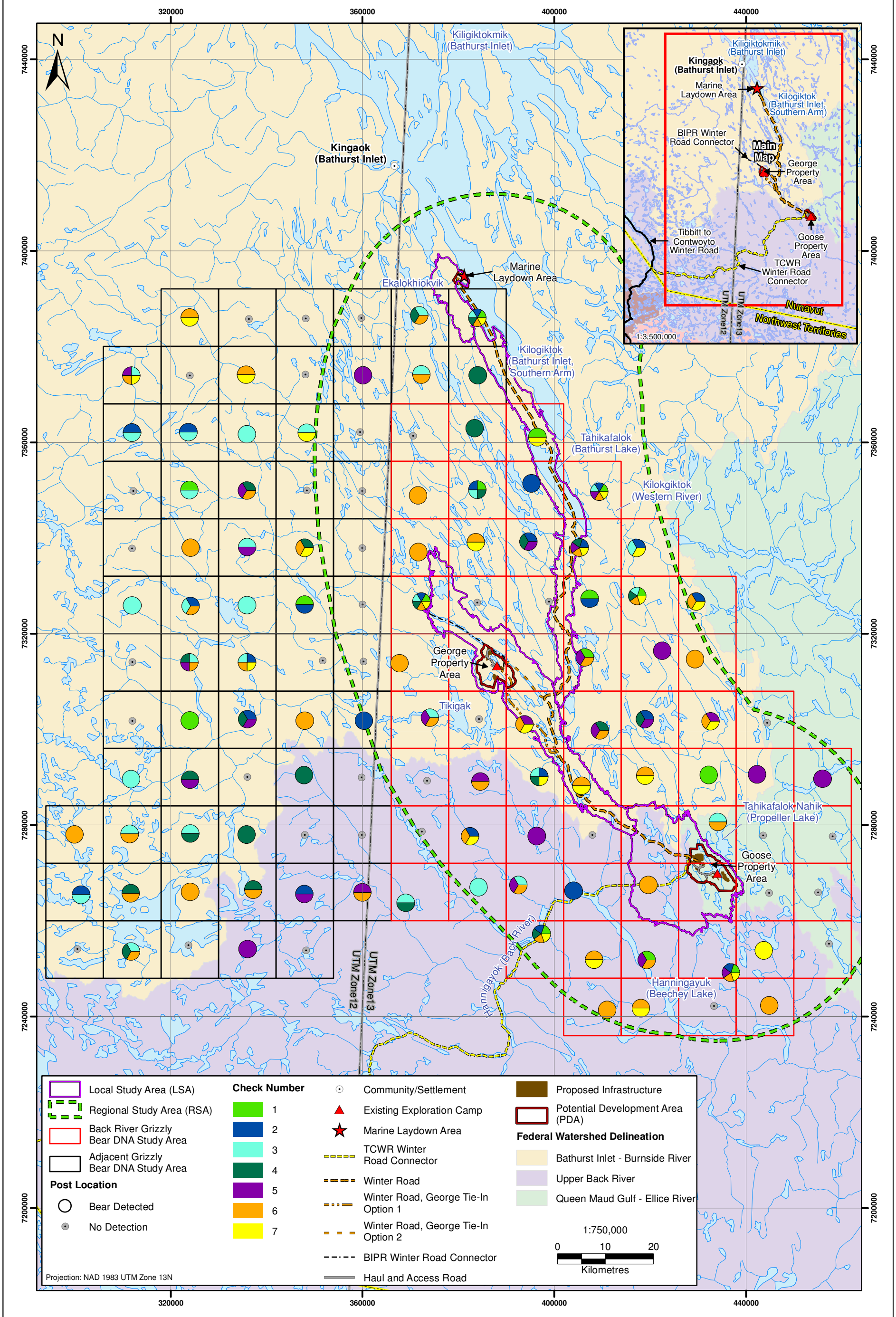


Figure 6.1-3

Sabina GOLD & SILVER CORP.

# Temporal Distribution of Grizzly Bears in the DNA Study Area, 2012

Figure 6.1-3

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PROJECT #0194096-0040 GIS # BAC-23-170 December 18 2013

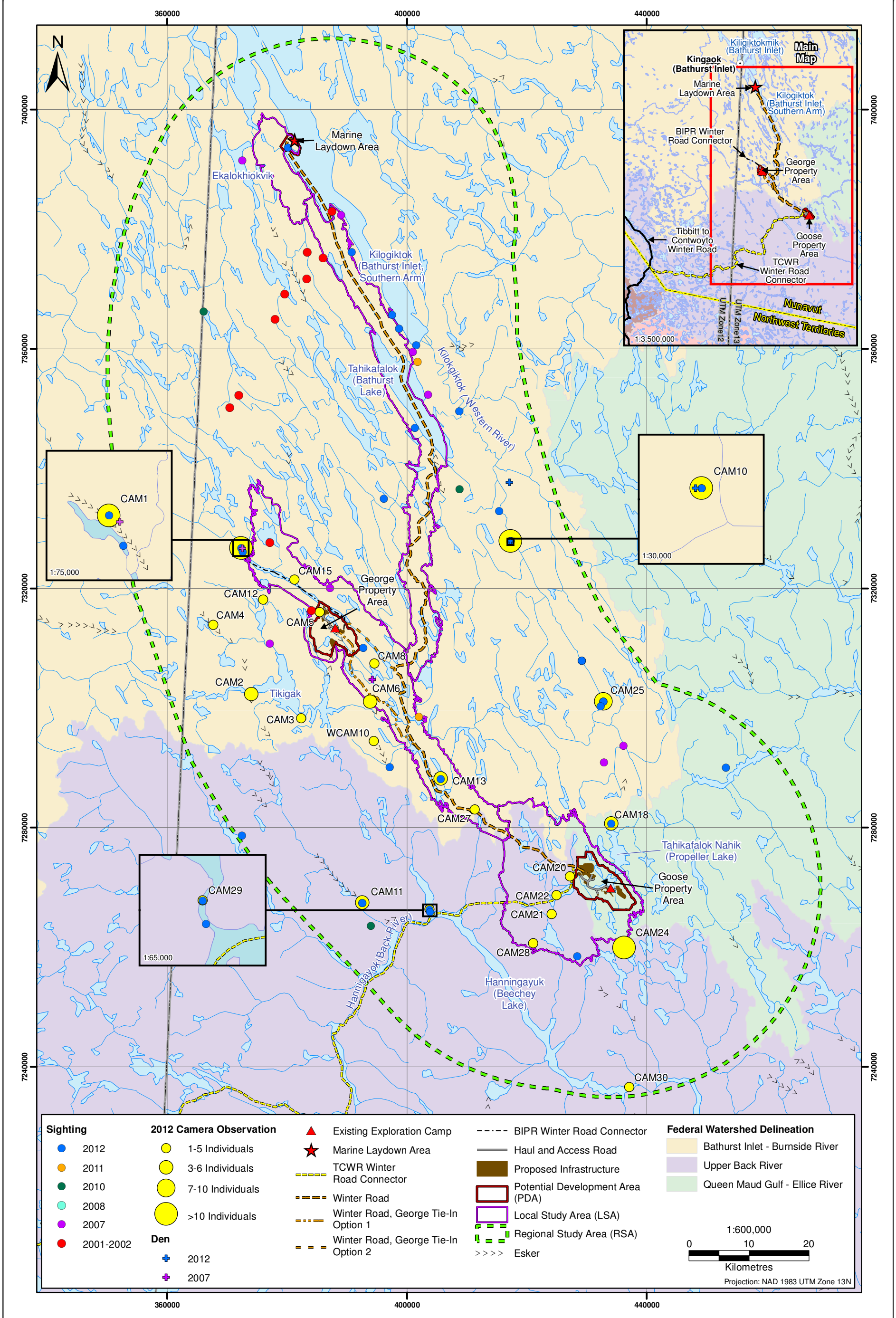


Figure 6.1-4

Sabina GOLD & SILVER CORP.

## Incidental Observations of Grizzly Bears in the Regional Study Area, 2001 to 2012

Figure 6.1-4

Rescan an ERM company

In addition, a total of 19 adults and 16 cubs were observed incidentally during the baseline studies conducted in 2012 and by the 60 remote cameras in the wildlife RSA. Many of these observations were along major river systems and in the northern portion of the wildlife RSA. One observation in 2012 was located at the proposed MLA and in 2001, one bear was observed near the George Property Potential Development Area (PDA). In addition, one camera placed near the George Property PDA and one camera placed near the Goose Property PDA recorded between one and five bears (Figure 6.1-4), however no bears were observed at the camps or inside the Goose and George PDAs.

Habitat Suitability Modelling

The results of the grizzly bear habitat suitability mapping are similar between the wildlife LSA and RSA for all seasons and suitability ranks (Table 6.1-4). High value spring habitat was limited in both the wildlife LSA and RSA (Figure 6.1-5), with moderate habitat comprising the majority of these study areas (Table 6.1-4). Summer habitat in the wildlife LSA and RSA was largely mapped as moderate and low value (Table 6.1-4; Figure 6.1-6). Fall habitat was also predominantly rated as moderate and low in both the wildlife LSA and the RSA (Figure 6.1-7). Table 6.1-4 contains the complete results for the wildlife LSA and RSA. The results of the denning potential indicated that in both the wildlife LSA and RSA high value denning was very limited, as was moderate value habitat (Table 6.1-4; Figure 6.1-8). This was an expected result due to the limited extent of eskers and lacustrine deposits, and the dominance of bouldery tundra and rocky areas.

**Table 6.1-4. Area and Proportion of High, Moderate, Low, and Nil-rated Habitat within the LSA and RSA for Grizzly Bear**

| | Habitat in the LSA | | Habitat in the RSA | |
|---|---|---|---|---|
| **Suitability Rating** | **Area (ha)[1]** | **% of LSA[2]** | **Area (ha)[1,3]** | **% of RSA[2]** |
| *Spring* | | | | |
| High | 3,182 | 2 | 5,457 | < 1 |
| Moderate | 87,405 | 65 | 637,045 | 51 |
| Low | 19,075 | 14 | 412,168 | 33 |
| Nil | 24,707 | 18 | 202,483 | 16 |
| *Summer* | | | | |
| High | 11,888 | 9 | 137,717 | 11 |
| Moderate | 90,219 | 67 | 540,367 | 43 |
| Low | 31,740 | 24 | 506,522 | 40 |
| Nil | 518 | < 1 | 72,547 | 6 |
| *Fall* | | | | |
| High | 7,348 | 5 | 5,457 | < 1 |
| Moderate | 70,012 | 52 | 542,692 | 43 |
| Low | 56,449 | 42 | 636,456 | 51 |
| Nil | 557 | < 1 | 72,547 | 6 |
| *Denning* | | | | |
| High | 942 | < 1 | 5,457 | < 1 |
| Moderate | 532 | < 1 | 0 | 0 |
| Low | 2,243 | 2 | 49,678 | 4 |
| Nil | 130,652 | 97 | 1,202,017 | 96 |

*[1] LSA = 134,369.31 ha, RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.*
*[2] For ease of presentation, hectares are presented as whole numbers and percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
*[3] Includes area of Local Study Area (LSA).*

## 6.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Inuit TK was adapted from the Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012). Traditional Knowledge indicates that grizzly bears were important animals for Inuit and there were many legends about them (KIA 2012). Information regarding grizzly bear knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot study communities.

Traditional knowledge, land user knowledge and thoughts raised by the KIA and land users were incorporated into the effects assessment chapter in six primary ways:

1. Grizzly bear were included as a VEC for a number of reasons (Section 6.3.2), including that they are a culturally and socially important species in the Project area.
2. Land users were consulted and included on the positioning of the posts used for the DNA mark-recapture study. Land users provided insights on grizzly bear behaviour and habitat use and directed the installation of hair-capture posts in the best possible locations to attract grizzly bears (Section 6.1.5).
3. Traditional Knowledge and land user information were used to position the remote cameras to maximize capture of passing caribou and grizzly bears. Land users worked with Rescan biologists in the field to position and install cameras in high-quality foraging habitats and travel corridors (Section 6.1.5).
4. Habitat usage and foraging information from TK and land users was incorporated in the habitat suitability modelling report and therefore included in the environmental setting (Section 6.1.5) and effects assessment where habitat loss (Section 6.5.2.1) and disturbance (Section 6.5.2.2) is evaluated.
5. Concerns that were raised by the KIA and land users about whether bears would be affected by roads were addressed by the inclusion of the "Effects of Disruption of Movement" (Section 6.5.2.3) and "Effects of Direct Mortality" (Section 6.5.2.4) sections.
6. Traditional Knowledge and land user information was included in the preparation of management plans to reduce the attractiveness of the camps and other infrastructure (Volume 10, Chapter 20 - Incorporation of TK). As part of this process, grizzly bears were included as a VEC for the DEIS.

The following reports were reviewed for TK specific information related to grizzly bears:

- *Inuit TK of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report;
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

PROJECT # 0194096-0040 GIS # BAC-23-201a November 08 2013

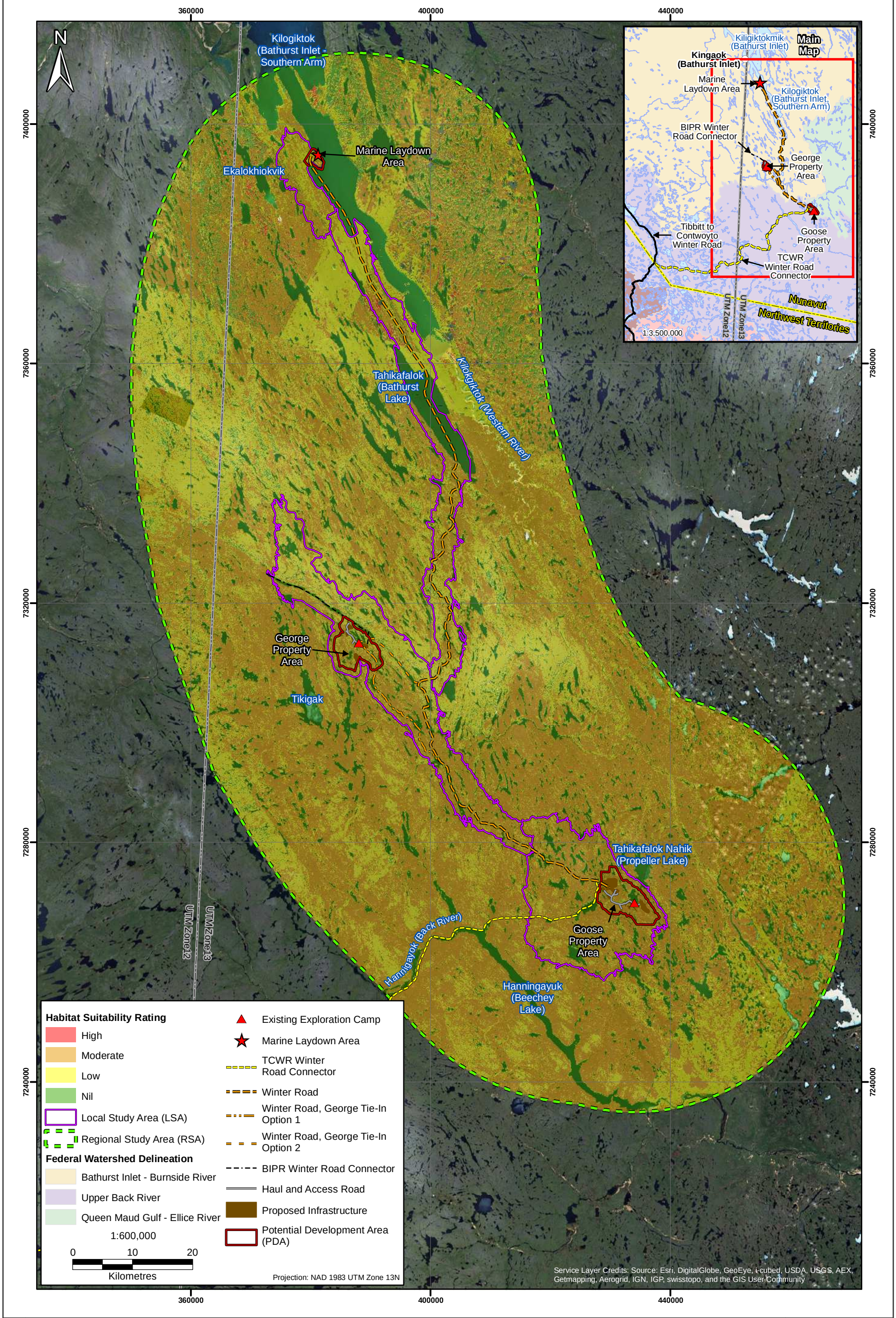


Figure 6.1-5

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# Grizzly Bear: Spring Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-5

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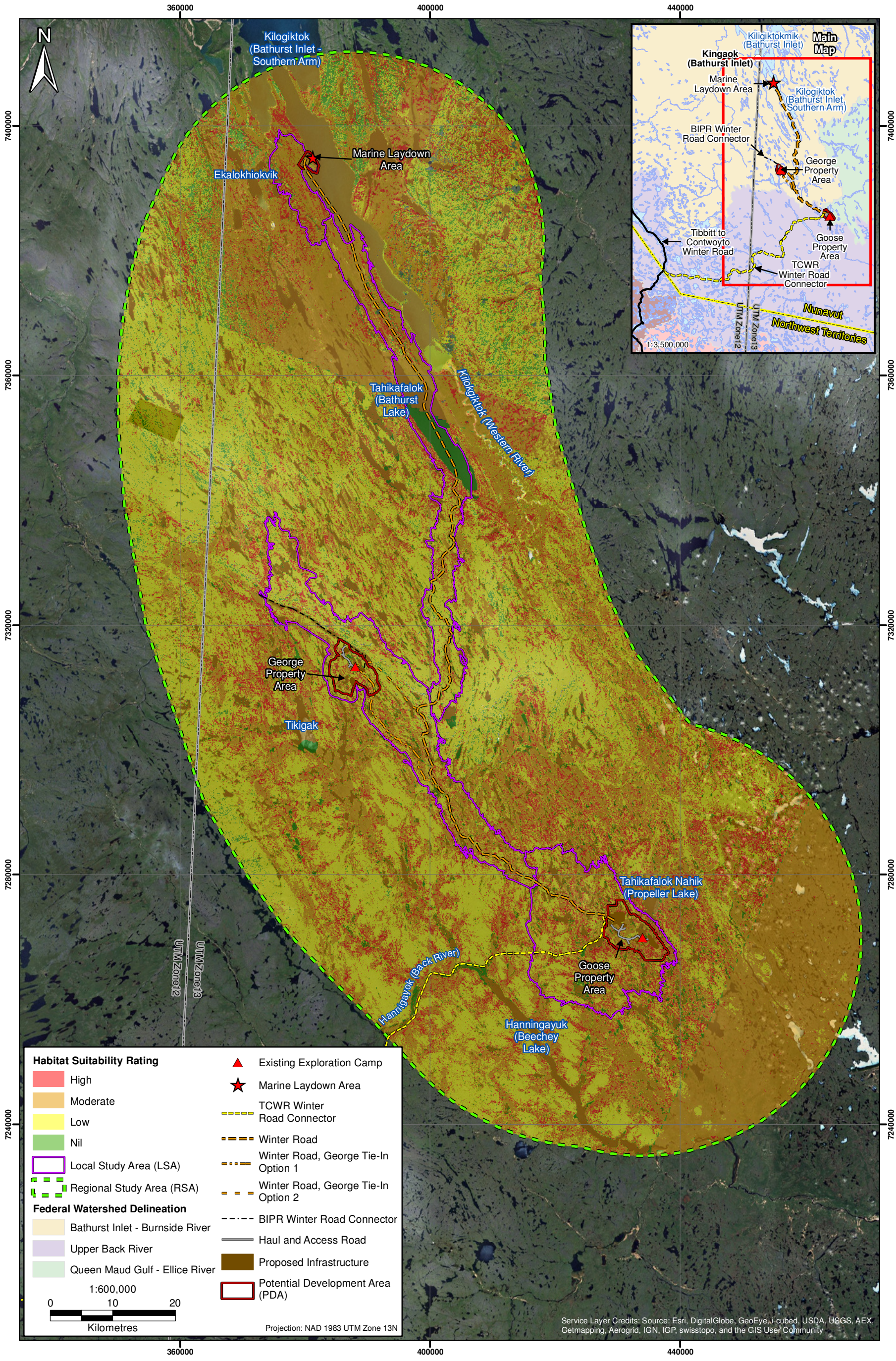


Figure 6.1-6

Sabina GOLD & SILVER CORP.

# Grizzly Bear: Summer Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-6

Rescan an ERM company

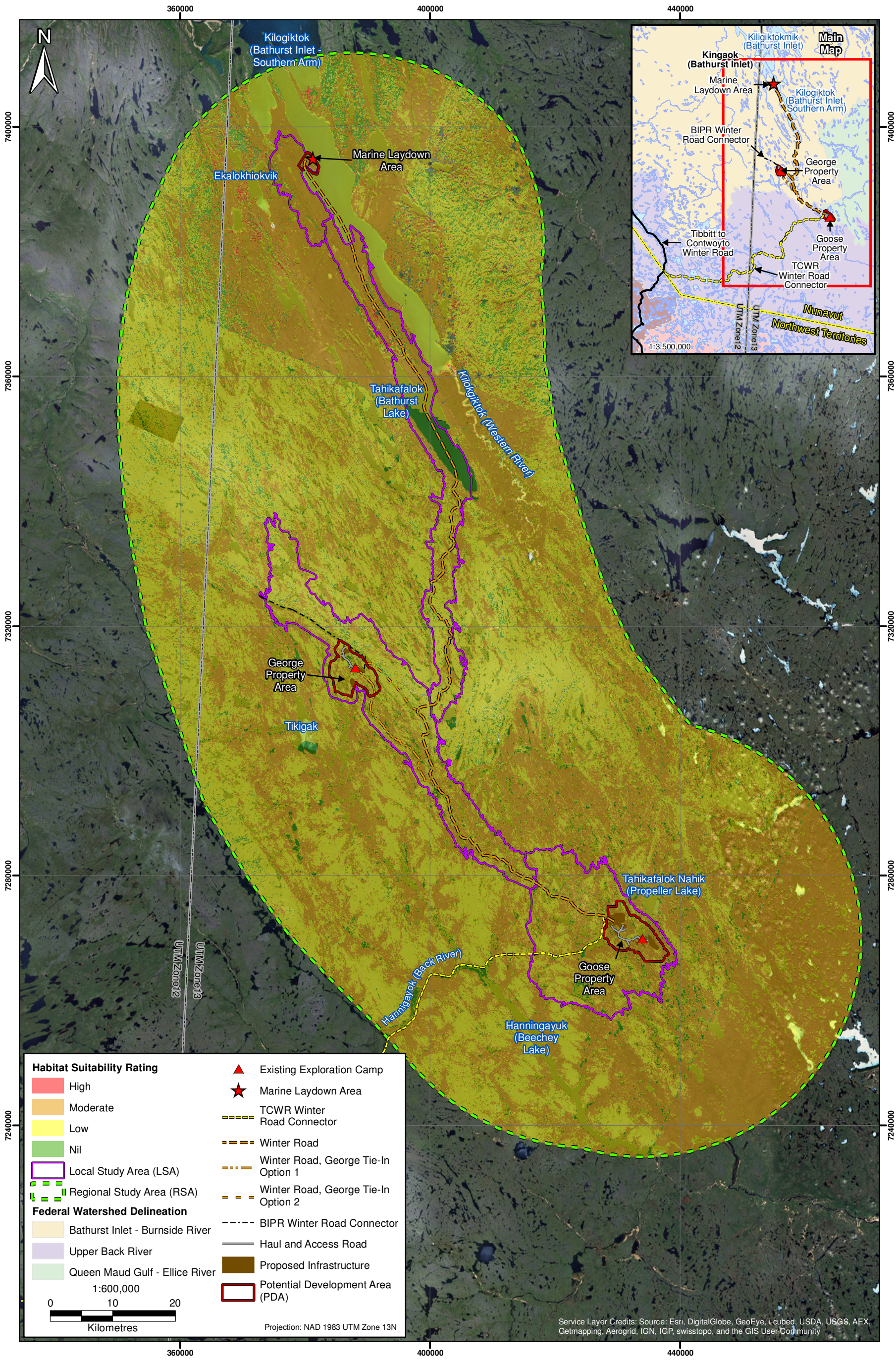


Figure 6.1-7

Sabina GOLD & SILVER CORP.

# Grizzly Bear: Fall Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-7

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-201d November 12 2013

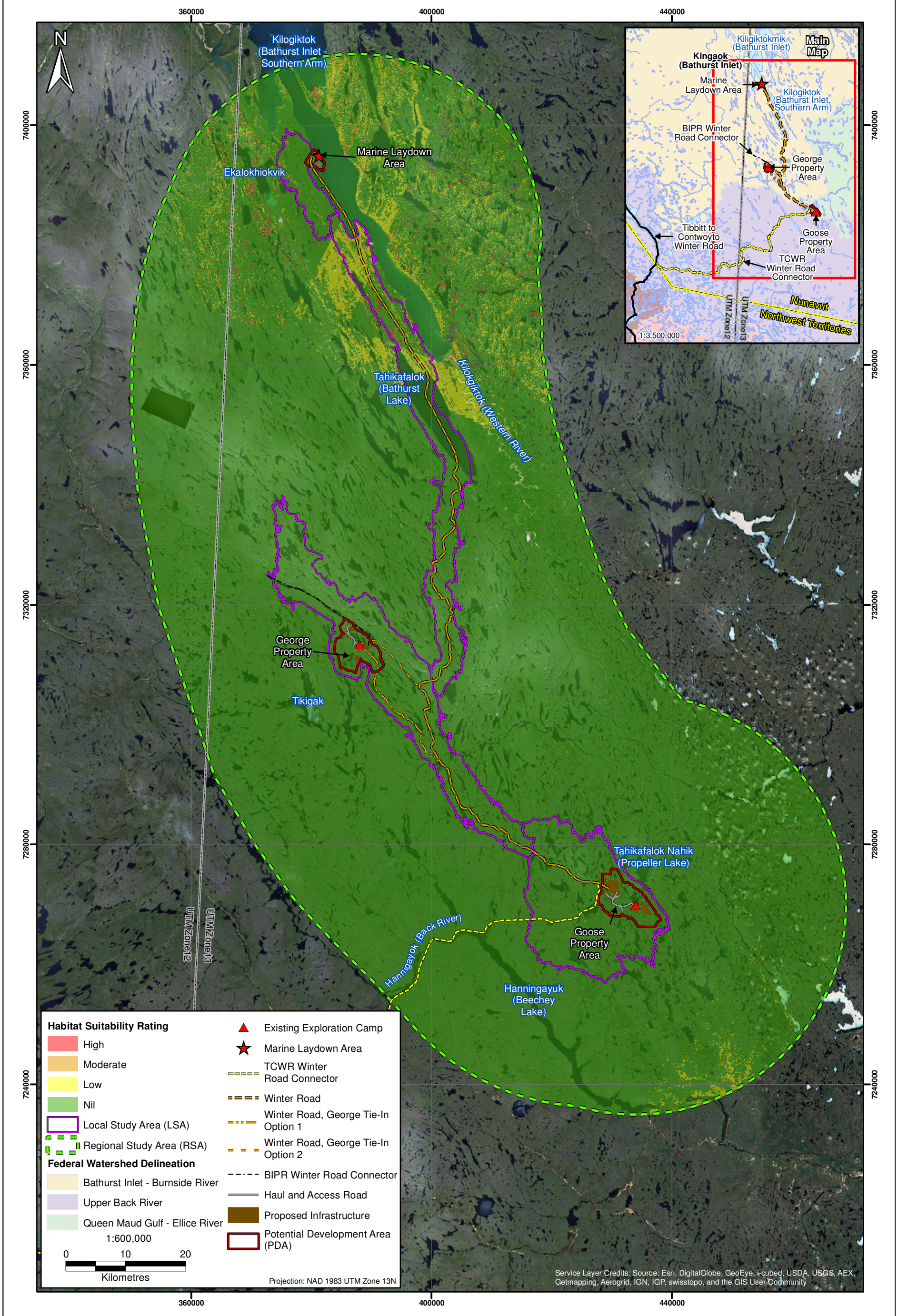


Figure 6.1-8

Sabina GOLD & SILVER CORP.

# Grizzly Bear: Denning Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-8

Rescan an ERM company

### 6.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of land users in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

### 6.2.2 Incorporation of TK for VEC and VSEC Selection

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

### 6.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modeling, were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods: Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

### 6.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap with the Project in these areas.

### 6.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013c), thoughts from Inuit people regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation and Special Landfeatures: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

## 6.3 VALUED COMPONENTS

### 6.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the DEIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013) and other information and processes as described below. The VECs were selected based on the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially, and economically important to the Inuit and other community members through TK.

### 6.3.2 Valued Components Included in Assessment

Each potential VEC was screened for inclusion in the environmental assessment through an evaluation of the results of baseline studies, conservations status, biological importance, regulatory, cultural, social, and economic significance and the potential for each to be affected by the Project (Volume 9, Chapter 1).The following bear species were included in the potential VEC list: brown bear, grizzly bear, and polar bear.

Polar bears were scoped out of the assessment. While polar bears do occur in other parts of Nunavut, they have no geographic interaction with the Project as they are not found on the mainland near or within the wildlife RSA.

The brown bear (*Ursus arctos*) is a holoarctic species that occurs in northern Asia, northern Europe and North America. Three sub-species of brown bear occur in North America, the mainland grizzly (*Ursus arctos horriblis*), the Kodiak (*Ursus arctos middendorffi*) and the peninsular grizzly (*Ursus arctos gyas*). Grizzly bears that live on the tundra are frequently referred to as “barren-ground grizzlies” because this sub-group has characteristic range use patterns and ecology and fall under the mainland grizzly sub-species. Barren-ground grizzly bears are the only subspecies of brown bears to occur in the Project area and are referred to as grizzly bears in this assessment.

Grizzly bears were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, grizzly bears were selected as a VEC for the effects assessment.

Grizzly bears are listed as a species of “Special Concern”; but are not yet listed under *The Species at Risk Act* (COSEWIC 2012). In the Northwest Territories and Nunavut, the Canadian Endangered Species Conservation Council lists grizzly bears as Sensitive (CESCC 2005; Working Group on General Status of NWT Species 2006; CESCC 2010).

Grizzly bears also serve as umbrella species, because their large home range sizes and core habitat requirements typically captures a broad suite of ecosystem types and functions important to other fauna and flora (Simberloff 1998; Cluff and Paquet 2003). While decreases in populations of grizzly bears may not necessarily indicate decreases in other species, the protection of grizzly bears and their habitat ensures protection of habitat for a number of other species with smaller home ranges in various habitat types.

## 6.4 SPATIAL AND TEMPORAL BOUNDARIES

### 6.4.1 Spatial Boundaries

The grizzly bear effects assessment considered two study areas for wildlife inventory for the Project: a local study area (LSA) and a regional study area (RSA; Figure 6.4-1).

#### *6.4.1.1 Local Study Area*

The boundaries of the Local Study Area (LSA) for grizzly bear were set to encompass the following:

- the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, George, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5; Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property, George Property, and MLA. The LSA covers an area of approximately 134,369 ha (Figure 6.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

#### *6.4.1.2 Regional Study Area*

The RSA for grizzly bears encompasses the PDAs, the LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three Project areas (Goose Property Area, George Property Area, and MLA). The RSA covers an area of approximately 1,262,005 ha (Figure 6.4-1). The RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

### 6.4.2 Temporal Boundaries

The temporal boundaries used for the grizzly bear effects assessment follow the time periods of the phases of the Project as presented in Table 6.4-1.

**Table 6.4-1. Temporal Boundaries – Project Phase Durations**

| Activities | Duration |
|---|---|
| Site Preparation | 2 years |
| Construction phase | 2 years |
| Operational phase | 10 years |
| Reclamation and Closure phase | 10 years |
| Post-closure phase | 5 years |
| *Other Potential phases:* | |
| Temporary Closure | Less than 2 years |
| Care and Maintenance phase | 2 to 10 years |

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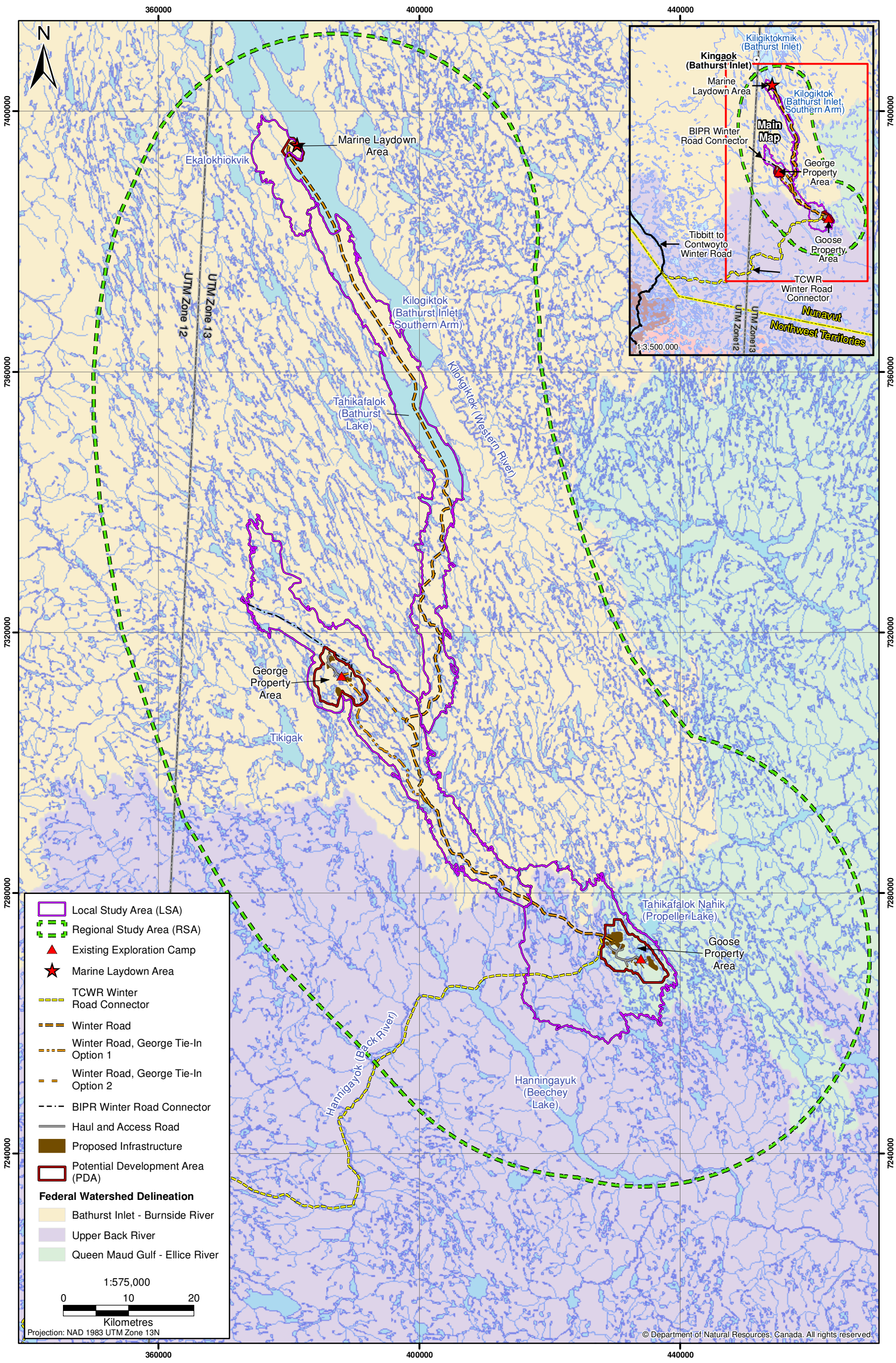


Figure 6.4-1

Sabina GOLD & SILVER CORP.

# Local Study Area and Regional Study Area for Grizzly Bear

Figure 6.4-1

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## 6.5 PROJECT EFFECTS ASSESSMENT

### 6.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on grizzly bears as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

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

The potential effects of the Project on grizzly bear is evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

#### *6.5.1.1 Indicators Used to Characterize Potential Effects*

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 6.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of potential residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of “yes” or “no” where triggering of residual effects assessment occurred if the indicator value was “yes” (e.g., attraction of grizzly bears to mining projects has occurred elsewhere at similar projects in Nunavut or the Northwest Territories).

**Table 6.5-1. Criteria and Indicators Used to Characterize Potential Effects on Grizzly Bears**

| Potential Effect | Criteria | Indicator |
|---|---|---|
| Habitat Loss | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disturbance due to Noise | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disruption to Movement | Change in Population Health | Traffic timing, and traffic volume |
| Direct Mortality and Injury | Change in Population Health | Traffic timing, traffic volume, and vehicle speed |
| Indirect Mortality | Change in Population Health | Predicted increase in human access to wildlife RSA |
| Attraction | Change in Population Health | Attraction occurred at similar Projects in Nunavut and Northwest Territories |
| Exposure to Contaminants | Change in Population Health | Predicted Hazard Quotients for metals in environmental media and wildlife |
| Reduction in Reproductive Productivity | Change in Population Health | Literature suggests combined residual effects on grizzly bears |

### *6.5.1.2 Magnitude Ratings for Residual Effects*

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 6.5-2).

**Table 6.5-2. Definitions of the Magnitude Ratings for Population Health Criterion**

| Magnitude Rating | Magnitude Descriptor of Criteria (Population Health) |
|---|---|
| Negligible | No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%. |
| Low | Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%. |
| Moderate | Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%. |
| High | Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%. |

*Note: Quantitative indicator thresholds for Habitat Loss and Disturbance due to Noise were included for determining the effect on the sub-population. For all other effects professional judgement and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.*

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for grizzly bears, which provide benchmark measures, as well as estimates of the natural variability.

Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

### *6.5.1.3 Overall Significance Ratings for Residual Effects*

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 6.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as Positive, Not Significant, or Significant (Table 6.5-3). For example, a residual effect receives a rating of "Not Significant" if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

**Table 6.5-3. Definitions of Significance Ratings for Residual Effects on Grizzly Bears**

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

Finally, the degree of uncertainty in the rating was provided as a qualifier.

### 6.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VEC grizzly bear and the Project is provided in Volume 9, Chapter 1. Potential effects on grizzly bear and grizzly bear habitat from the Project have been included in the assessment based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, Inuit Traditional Knowledge and land user knowledge, and a review of scientific literature of the effects of developments on grizzly bear. The effects of mining developments in the Arctic have been documented through monitoring programs at the Lupin gold mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Hope Bay mine (Rescan 2011c, 2013e).

Interactions of grizzly bears with Project components were evaluated to determine which of the following potential effects may occur (Table 6.5-4):

- habitat loss;
- disturbance due to noise (e.g. displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g. due to increased access and associated increase in hunting);
- attraction (e.g., altered inter-species relationships);
- exposure to contaminants; and
- reduction in reproductive productivity due to all effects of the Project combined.

**Table 6.5-4. Potential Project-related Effects to Grizzly Bear in the Goose Property Area, the George Property Area, and the Marine Laydown Area**

| Potential Development Area | Project Component | Habitat Loss | Disturbance due to Noise | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity |
|---|---|---|---|---|---|---|---|---|---|
| *Goose Property Area* | Open Pits (Main, Umwelt, and Llama) | X | X | X | X | | | | X |
| | Haul and access roads | X | X | X | X | X | | | X |
| | Winter Roads | | | | | X | | | X |
| | Stockpiles | X | X | | | | | | X |
| | Waste rock storage areas | X | X | X | | | | X | X |
| | Explosives storage areas | X | | | | | | X | X |
| | Tailings Impoundment Area | X | X | | | | | X | X |
| | Quarries | X | X | | | | | | X |
| | Landfill | X | X | | | | X | X | X |
| | Camp / Plant site | X | X | X | X | X | X | X | X |
| | Airstrip | X | X | X | X | | | | X |
| | Other infrastructure (diversion channels, water intakes) | X | | | | | | | X |
| *George Property Area* | Open Pits (LCP North, Locale 1,and Locale 2) | X | X | X | X | | | | X |
| | Haul and access roads | X | X | X | X | | | | X |
| | Winter Roads | | | | | X | | | X |
| | Stockpiles | X | X | | | | | X | X |
| | Waste rock storage areas | X | X | X | | | | X | X |
| | Explosives storage areas | X | | | | | | X | X |
| | Landfill | X | X | | | | X | X | X |
| | Camp | X | X | X | X | X | X | X | X |
| | Other infrastructure (water intake) | X | | | | | | | X |

*(continued)*

**Table 6.5-4. Potential Project-related Effects to Grizzly Bear in the Goose Property Area, the George Property Area, and the Marine Laydown Area (completed)**

| Potential Development Area | Project Component | Habitat Loss | Disturbance due to Noise | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity |
|---|---|---|---|---|---|---|---|---|---|
| *Marine Laydown Area* | Camp | X | X | | | | X | X | X |
| | Barge landing location | X | X | | | | | | X |
| | Haul and access roads | X | X | | X | | | | X |
| | Winter Roads | | | | | X | | | X |
| | Other infrastructure (interception ditch) | X | | | | | | | X |

Grizzly bears can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of suitable denning and foraging habitat. For this reason, habitat loss was included and evaluated in this assessment. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development.

Potential effects due to disturbance were evaluated for grizzly bears because research indicates that grizzly bears can be particularly sensitive to anthropogenic disturbance (B. N. McLellan 1990; Weaver, Paquet, and Ruggiero 1996; Ross 2002). It has been proposed that bears living in the central Canadian Arctic area a higher risk of effects due to disturbance because they naturally occur at low densities and the open tundra landscape (Ross 2002).

Grizzly bears are resident on the tundra, and maintain large home ranges that may contain separate seasonal habitats in which they move throughout the year. Juvenile bears may make long distance movements when dispersing from home ranges where they were born, to establish their own home range territories elsewhere. Disruption to movement was evaluated for its potential effect on bears because some researchers have reported that population-level consequences to grizzly bears may arise when movements on home ranges, and movements for dispersal, are disturbed or impeded (M.F. Proctor, McLellan, and Strobeck 2002; M. Proctor et al. 2012).

Direct mortality is typically a result of vehicle strikes with wildlife. Frequency of mortality is often related to specific locations, traffic volume, and speed (Jalkotzy et al. 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to grizzly bears also increases. Since the Project will have all-weather site roads, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed roads. In southeastern Alaska, where grizzly bears are legally hunted, there was a direct positive correlation between bear kills by hunters and cumulative kilometers of constructed roads (Titus and Beier 1991). Roads increase access and can create opportunities for illegal hunting (B.N. McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Camps and landfills may act as attractants to grizzly bears, which could subsequently lead to increased human-bear interactions and grizzly bear mortality. Both scientific studies (Herrero 1985) and the TK information (KIA 2012) indicate that grizzly bears can be attracted to human settlements in search of food. Benn and Herrero (2002) reported that over 70% of bear mortality were destruction of problem bears. Bears are particularly attracted to landfills, as well as aromatic waste material such as oils and aerosols. This attraction to project sites increases the potential for wildlife-human interaction and therefore an increased potential for grizzly bears to become nuisance animals, and resulting mortality. The barren ground population of grizzly bears is considered to be most susceptible to direct mortality as a result of human activity (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Thus, the effect of attraction is included as a potential effect in the assessment.

Wildlife can be exposed to contaminants through ingestion of water or through the food chain. A formal risk assessment was undertaken as part of the effects assessment for wildlife including grizzly bear and detailed in the Human Health and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Results of the risk assessment of contaminants in grizzly bears were summarized in the assessment of the VEC grizzly bear for determining the overall significance of Project-related residual effects to grizzly bears.

Each potential effect is identified for each Potential Development Area (PDA) and key infrastructure/activity in Table 6.5-4.

### *6.5.2.1 Habitat Loss*

As part of the development of the Project, wildlife habitat will be lost and potentially degraded. To minimize these effects, the location of Project infrastructure was planned to avoid wildlife sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Wildlife habitat may also be indirectly lost if wildlife species avoid the Project area due to noise disturbance, which is described in Section 6.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operation phases of the Project. Wildlife habitat will be removed and degraded during Project development. Habitat degradation due to dust and compaction around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation are proposed for the Project. The assessment of habitat loss is based on the total area of lost and degraded habitat at the end of the Operation phase, which is the largest extent of the Project footprint.

To enable flexibility in siting of Project infrastructure, loss and degradation of grizzly bear habitat is assumed within the entire area of each of the three PDAs (Goose Property Area, George Property Area and the MLA). These areas greatly overestimate habitat loss as the entire area within each PDA will not be developed. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The operation of winter roads could result in habitat compaction to vegetation due to compressed snow and ice and could result in minor habitat degradation during the foraging season. However, compaction is anticipated to be relatively minor and is not assessed further. In addition, the timing of construction and use of winter roads (January through April) corresponds to when grizzly bears are hibernating in winter dens, and would not result in a direct loss of habitat during the winter season. Thus, for the purposes of this assessment, winter roads are not considered for the assessment of habitat loss for grizzly bears.

Calculation of Habitat Loss

Habitat loss for grizzly bear was calculated by first identifying two key indicators:

1. Total area — a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs).
2. High-quality habitat — a calculation of the area of high-quality habitat for grizzly bears that will be lost in the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the RSA. The RSA provides the more representative comparison for the total habitat loss for grizzly bears, as the home range of a grizzly bear is, on average, larger than the LSA. To put the Project within the context of grizzly bear habitat use, these indicators were also compared to the average home range size of a grizzly bear.

*Total Area of Loss*

The total expected area lost in the PDAs was calculated by summing the areas of loss due to the entire Goose, George, and MLA PDAs.

The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary (the wildlife LSA and RSA). The actual area developed, and subject to loss, will be much smaller, as determined by the final design infrastructure and placement.

In order to put the Project into the context of grizzly bear habitat, the total area of loss is compared to home range sizes for male and female grizzly bears with the assumption that the area lost falls entirely within the home range sizes of these territories. Results of the assessment are presented as a proportion of an average bear's (male and female) home range that is lost due to Project-related activities.

*Area of High-quality Habitat Loss*

Habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A) for grizzly bears based on a four class rating system (High, Moderate, Low, and Nil habitat). The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA using remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4).

The availability of suitable habitat for grizzly bears varies between seasons and is detailed in the Habitat Suitability Baseline Report (Rescan 2013a, Appendix V5-5A) and summarized in the Existing Environment Section (Section 6.1.5). Habitat loss and degradation for grizzly bear was assessed for spring, summer, fall, and winter denning habitat separately. Habitat ranked as High or Moderate was considered the most suitable habitat and is referred to as high-quality habitat for grizzly bears. The proportion of high-quality habitat lost due to mine development in the wildlife RSA was calculated to assess the extent of the effect of high-quality habitat loss for grizzly bears.

In order to calculate a conservative estimate of habitat loss, the total loss of high-quality habitat is compared to home range sizes for male and female grizzly bears with the assumption that the area lost falls entirely within the home range sizes of these territories and that the proportion of high-quality habitat within the male and female grizzly bear home ranges is similar to that in the wildlife RSA (approximately 50% of the area during the foraging season). Results of the assessment are presented as a proportion of an average bear's (male and female) home range that is lost due to Project-related activities.

Evaluating Habitat Loss for Grizzly Bears

*Total Area of Loss*

The total area lost due to loss of the entire PDAs at the Goose and George Properties and the MLA is 10,237 ha (Table 6.5-5). The PDAs are contained within the wildlife LSA and represents 7.5% of the wildlife LSA. This area accounts for 0.8% of the wildlife RSA. However, the actual loss will be much smaller as the design of the Project footprint is much smaller (approximately 10 to 15% of the PDAs) relative to the PDAs assessed as lost. The wildlife RSA provides the more representative comparison for the total habitat loss for grizzly bears, as the home range of a grizzly bear is, on average, larger than the wildlife LSA.

The average size of a male and female grizzly bear home range is 724,500 ha and 210,000 ha, respectively. Habitat loss in the wildlife RSA is equivalent to 1.4% of a male grizzly bear's home range and 4.8% of a female grizzly bear's home range. These areas represent a small fraction of habitat loss for both male and female grizzly bears.

**Table 6.5-5. Habitat Loss due to the Potential Development Areas**

| Potential Development Area (PDA) | PDA Area Assumed to be Lost (ha) | Proportion of LSA (%)[1] | Proportion of RSA (%)[1] |
|---|---|---|---|
| George Property Area | 4,226 | 3.1 | 0.3 |
| Goose Property Area | 5,358 | 4.0 | 0.4 |
| Marine Laydown Area | 653 | 0.4 | <0.1 |
| **Total** | **10,237** | **7.5** | **0.8** |

[1] *LSA = 134,369 ha; RSA = 1,262,005 ha*

*Loss of High Quality Habitat*

Some of the habitat removed in the Goose Property and George Property PDAs and the MLA was rated as high-quality habitat (high or moderate habitat suitability rating) for grizzly bears. The proportion of high-quality habitat loss for grizzly bears changes by season and is summarized below and in Table 6.5-6:

- *Spring* — Baseline habitat suitability modeling in 2013 identified 67,728 ha of high-quality spring habitat in the wildlife LSA and 642,502 ha in the wildlife RSA. The proportion of high-quality spring habitat lost to development in the wildlife LSA is approximately 9.4% while that in the wildlife RSA was approximately 0.9%.
- *Summer* — A total of 73,903 ha of high-quality summer habitat was identified during baseline studies in the wildlife LSA. In the wildlife RSA, a total of 678,085 ha exists at baseline. The proportion of high-quality summer habitat loss in the wildlife LSA after development is approximately 8.3% while the proportion lost in the wildlife RSA is approximately 0.9%.
- *Fall* — Within the wildlife RSA, 548,149 ha of high-quality fall habitat was identified, 61,443 ha of which falls within the wildlife LSA. The proportion of high-quality fall habitat lost in the wildlife LSA is approximately 8.7%, while the proportion lost in the wildlife RSA is approximately 1.0%.
- *Winter* — Denning habitat represents the limiting habitat for grizzly bears in the wildlife RSA. Within the wildlife RSA, 5,457 ha of high-quality winter denning habitat was identified, 386 ha of which is within the wildlife LSA. The proportion of high-quality denning habitat lost after development of the PDAs is approximately 0.4% of the wildlife RSA and is approximately 5.7% of the wildlife LSA. These areas represent a relatively small proportion of the available suitable habitat within the wildlife RSA and LSA.

**Table 6.5-6. High-quality Grizzly Bear Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project**

| | | High-quality Habitat (HQH) | | High-quality Habitat Lost[1] due to Potential Development Areas | |
|---|---|---|---|---|---|
| **Area** | **Season** | **Amount (ha)** | **% Area** | **Area (ha)** | **% HQH** |
| *Local Study Area* | Spring | 67,728 | 50.4 | 6,386 | 9.4 |
| | Summer | 73,903 | 55.0 | 6,096 | 8.3 |
| | Fall | 61,443 | 45.7 | 5,354 | 8.7 |
| | Denning | 386 | 0.2 | 22 | 5.7 |
| | All Seasons | 90,588 | 67.4 | 7,384 | 8.2 |

*(continued)*

**Table 6.5-6. High-quality Grizzly Bear Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project (completed)**

| Area | Season | High-quality Habitat (HQH) | | High-quality Habitat Lost[1] due to Potential Development Areas | |
|---|---|---|---|---|---|
| | | Amount (ha) | % Area | Area (ha) | % HQH |
| *Regional Study Area* | Spring | 642,502 | 50.9 | 6,388 | 0.9 |
| | Summer | 678,085 | 53.7 | 6,194 | 0.9 |
| | Fall | 548,149 | 43.4 | 5,357 | 1.0 |
| | Denning | 5,457 | 4.3 | 23 | 0.4 |
| | All Seasons | 866,050 | 68.6 | 7,483 | 0.9 |

[1] *Includes area of habitat loss due to entire PDA areas and not facility specific habitat loss thus overestimating actual habitat loss.*

Habitat loss of high-quality habitat in the wildlife RSA is equivalent to 0.9% of a male grizzly bear's home range and 3.2% of a female grizzly bear's home range during the active foraging periods, with summer habitat representing the higher percentage of lost high-quality habitat. However, assuming that the home ranges are not entirely made up of high-quality habitat and that they consist of approximately 50% high quality habitat (similar to that in the wildlife RSA during foraging periods) the proportion of high-quality habitat lost due to the Project within a typical male and female home range is doubled (e.g., approximately 2% of a male grizzly bear's home range and approximately 6.5% of a female grizzly bear's home range). This estimate of high-quality habitat loss is fairly small.

For denning, the loss of high-quality habitat is minimal and equivalent to less than a percent of both a male and female grizzly bear home range (< 0.1%). Even when considering that the proportion of high quality habitat in these home ranges is likely similar to that in the wildlife RSA (4.3%), the percent loss is still equivalent to less than one percent (> 0.1% and 0.3% for male and female ranges, respectively).

Overall, the estimated number of grizzly bears in the wildlife RSA is 61 bears (Rescan 2013b, Appendix V5-6A). Grizzly bears move seasonally over large home ranges during the growing seasons. Based on the estimated grizzly bear in the wildlife RSA (61 bears), an average of 151 ha of high-quality habitat (9,258 ha total) per bear may be altered. The amount of high-quality grizzly bear habitat that will be lost as a result of Project development represents a small portion of the total amount of high-quality habitat available in the wildlife RSA and that of the home range of male and female grizzly bears. The carrying capacity of the habitat for grizzly bear at the landscape level is therefore unlikely to be affected either during construction, operations or upon reclamation after closure. However, despite this a residual effect is anticipated, albeit minimal.

### *6.5.2.2 Disturbance due to Noise*

This section evaluates the effects of Project-related disturbance on grizzly bears, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise.

Noise affects wildlife species in three primary ways: acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). The source, duration, and intensity of noise all influence the nature and magnitude of wildlife response. First, an acute effect of noise — brief, intense, localized noise (such as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997; AMEC Americas Limited 2005), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

A behavioural response can also occur when animals avoid the source of disturbance resulting in the functional loss of habitat (Gibeau et al. 2002). Mild habitat loss due to disturbance can reduce the amount of energy that an animal can intake and result in low level effects. Alternatively, larger scale range shifts can result in large reduction in energy intake and in extreme cases mortality due to unfamiliarity with new habitat and reduced resource base. If disturbance from the mine decreases the quality of potential den sites near the mine, bears may suffer stress over the winter in these dens.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment. Attraction of bears to camp infrastructure is described in Section 6.5.2.6.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a “threshold level.”

Studies on the effects aircraft noise on wildlife indicate that “fright” is a common response (Bond et al. 1974), whereby the animal attempts to escape the noise by either running or flying away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to disturbances than wildlife occupying forested habitats (B. N. McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend large amounts of energy to escape the perceived threat.

Potential sources of sensory disturbance for grizzly bears associated with Project activities include:

- blasting noise and ground vibrations from mining and construction;
- general Project noise (e.g. camp noise, human presence, and vehicle traffic); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the Umwelt open pit while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the Construction and Operational phases. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned, while at the MLA, while it is active, a maximum of six flights per week are planned.

Sensitive periods for grizzly bears include denning periods in the winter. Disturbance during denning periods may result in bears abandoning their dens (H. V. Reynolds, Curatalo, and Quimby 1976) and potentially their young (Schoen et al. 1987), as well as potential displacement from high-quality denning habitats (Craighead Jr. and Craighead 1972; Linnell et al. 2000). Females in particular are

vulnerable to the effects of disturbance at their den sites (Linnell et al. 2000). Reduced reproductive success of pregnant females has been documented as a result of den disturbance and den abandonment and has been linked to a greater probability of death for dependent offspring (Linnell et al. 2000; Ross 2002). Other research has shown that hibernating bears are unlikely to be disturbed by anything but extreme noise events (Amstrup 1993; Linnell et al. 2000). Even the noise resulting from blasting may have a limited effect on hibernating grizzly bears, as the dens are usually acoustically isolated when covered with snow (Linnell et al. 2000). As the wildlife LSA and RSA do not contain much high-quality denning habitat for grizzly bears, and the majority of high-quality grizzly bear denning habitat occurs in the northern portion of the wildlife RSA near Bathurst Inlet, but south of the MLA and in along the Western River, disturbance due to Project-related activities conducted during the denning period (November to May) is not anticipated to result in a residual effect to grizzly bears and is not discussed further.

Calculating Disturbance to Grizzly Bears

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose and George Properties rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence. Habitat 'loss' will occur indirectly for grizzly bears that avoid the zone of influence because they are disturbed within it.

The potential effect of disturbance on grizzly bear was evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case (year three of Operations at Goose and year seven of Operations at George). The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance. The area of affected habitat was calculated by using specific noise level contours from the literature where bears are shown to have behavioural effects from the noise.

Threshold noise values were determined from the literature, above which grizzly bears are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for grizzly bears. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 6.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling; Section 6.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Blasting noise models were conducted during peak noise levels as identified in Volume 4, Chapter 2 (worst case scenario) for each of the PDAs: year three at the Goose PDA and year seven at the George PDA.

General Project-related noise levels, or continuous noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft and helicopter noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) grizzly bear seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 6.5.2.1), but within the noise level contours for blasting noise (≥120 dB representing functionally lost habitat; or ≥108 dB representing disturbed habitat), general Project noise (≥45 dBA) or noise generated from aircraft (≥80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each season within the wildlife RSA and LSA after accounting for habitat loss (Section 6.5.2.1).

Evaluation of Disturbance to Grizzly Bears

Once mitigated, disturbances during construction activities are expected to be short-term in duration and localized in extent. Continuous disturbance of wildlife VECs will occur due to Project-activities throughout the life of the Project, beginning at Construction. Other sources of disturbance include human presence and aircraft noise. The potential effects of these disturbances to behaviour and habitat use were assessed within the relevant spatial scale for grizzly bear.

*Blasting Noise*

Grizzly bears are known to avoid areas or to alter their behaviour, e.g., increase nocturnal activity, in response to the presence of roads, seismic blasting and other industrial activities (L. Harding and Nagy 1980; Archibald, Ellis, and Hamilton 1987; B.N. McLellan and Shackleton 1988; Mace and Waller 1996; Mueller 2001; Gibeau et al. 2002; Wielgus, Vernier, and Schivatcheva 2002).

A total of 35 ha that falls outside the Goose and George PDAs will be functionally lost due to noise from blasting above an Lpeak of 120 dB, and an additional 982 ha will be disturbed outside of the Goose and

George PDAs due to noise from blasting with an Lpeak above 108 dB. During year 3 of the operation phase, blasting from the construction of the Umwelt, Llama and Main pits at the Goose Property Area will result in 18 ha of habitat (< 0.1% of the wildlife LSA and RSA) functionally lost and an additional 283 ha of habitat (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) disturbed outside of the Goose PDA by noise due to blasting activities (Table 6.5-7; Figure 6.5-1). Starting at year 7 of the operation phase, blasting from the open pit at Locale 1 will result in 17 ha of habitat functionally lost (<0.1% of the wildlife LSA and RSA), and an additional 359 ha of habitat disturbed (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) outside of the George PDA due to noise from blasting activities (Table 6.5-7). It is assumed that blasting in year 8 and 9 at the open pits at LCP North and Locale 2 will be similar to or less than the noise levels due to blasting in year 7 at the open pit at Locale 1.

The amount of high-quality habitat within the area that is functionally lost in the wildlife RSA ranges between 0 and 19 ha (< 0.1% of the available high-quality habitat in the wildlife LSA and RSA after habitat loss dues to the PDAs — Section 6.5.2.1) and that which is disturbed ranges between 0 and 415 ha (up to 0.6% and 0.1% of the available high-quality habitat in the wildlife LSA and RSA, respectively after accounting for habitat loss) depending on the season (Table 6.5-8). The total amount of high quality habitat that is functionally lost or disturbed due to blasting is mapped in Figure 6.5-1 for all seasons combined.

*General Project Noise*

Grizzly bears frequently alter their behaviour and avoid areas with human activity (such as high-use roads) and periods when human-related activities are most active (Mueller 2001). Grizzly bears may avoid habitat up to 900 m of high-use areas (Mattson, Knight, and Blanchard 1987; B.N. McLellan and Shackleton 1988; Kasworm and Manley 1990), particularly where there are new disturbances and areas where crews are working.

The total amount of area affected by elevated noise levels due to general Project noise (outside of the Goose and George PDAs and the MLA that are already considered to be lost (Section 6.5.2.1) is 621 ha. A total of 359 ha (0.3% of wildlife LSA and < 0.1% of wildlife RSA) in year three near the Goose PDA, and 262 ha (0.2% of wildlife LSA and < 0.1% of wildlife RSA) in year seven near the George PDA will be degraded (Table 6.5-7). A breakdown of the percentage of high quality habitat lost due to noise disturbance in each season outside of the PDAs can be found in Table 6.5-8. In all seasons, the percentage of high-quality habitat lost outside of the PDAs is small (<0.1% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 6.5-8; Figure 6.5-1). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise*

Several studies indicate that grizzly bears are highly responsive to aircraft overflights (kucera 1974; Mccourt K. H. et al. 1974; L. Harding and Nagy 1980; P. E. Reynolds, Reynolds, and Follmann 1986) and have indicated that repeated flyovers of aircraft at 300 m may alter their home range, foraging patterns and breeding behaviour. Other studies suggest that bears do not generally respond to aircraft if flights remain above 200 m above ground level (B.N. McLellan and D.M. Shackleton 1989; B.N. McLellan and D.M. Shackleton 1989).

The total amount of area affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project footprint (Section 6.5.2.1) is 27,140 ha (2.2% of the wildlife RSA). This area is equivalent to 12.9% to 3.7% of a female and male grizzly bear home range, respectively. Approximately 3,495 hectares outside of the Goose PDA will be affected by aircraft accessing the Goose Property (Table 6.5-7). An additional 11,278 hectares that falls outside the George PDA will be disturbed by aircraft accessing the George Property (Table 6.5-7). This area is larger than that outside of the Goose Property Area as the aircraft used for the George Property (Twin Otter Aircraft) is noisier than that used for the Goose Property (Dash 8 or equivalent).

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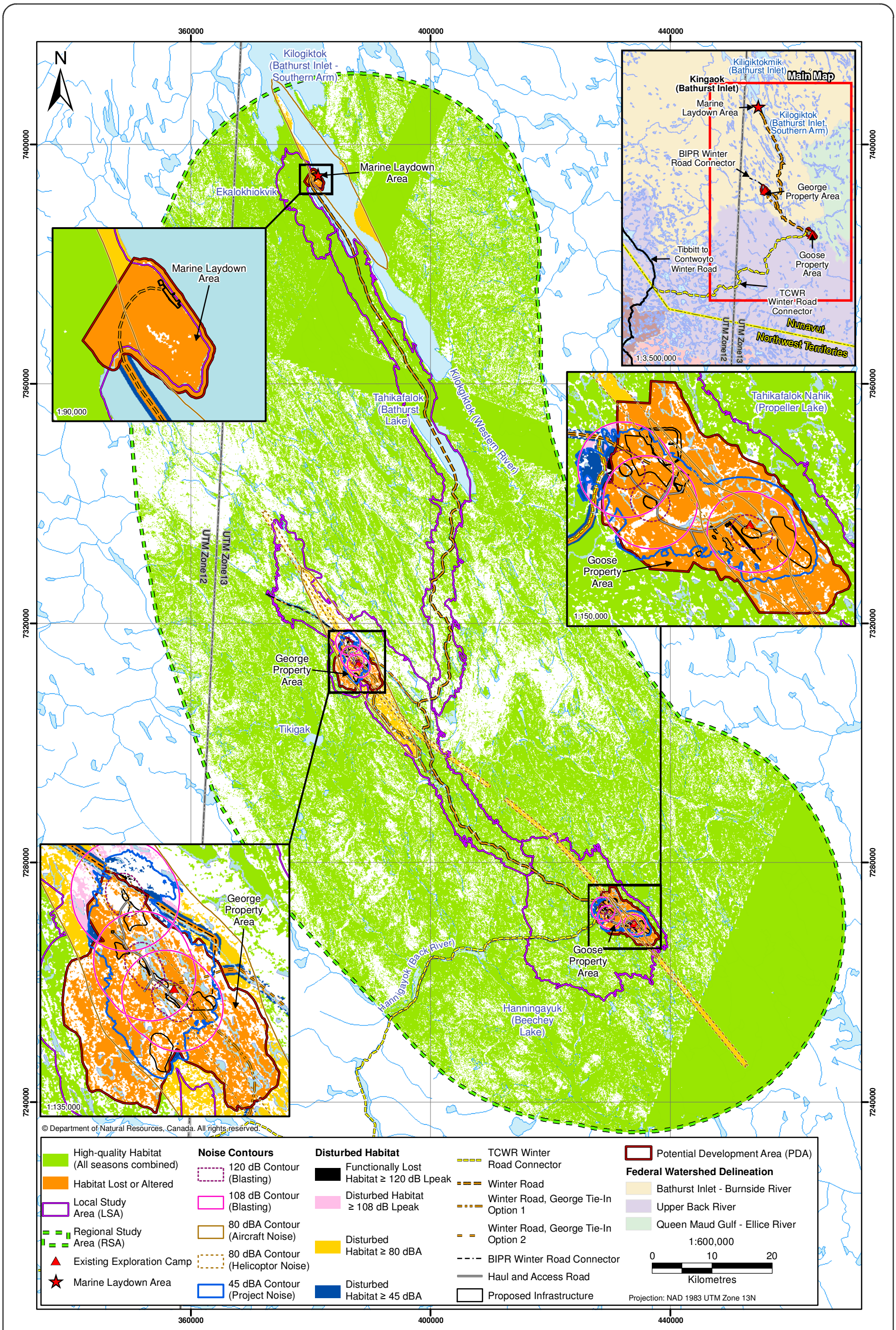


Figure 6.5-1

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# Grizzly Bear High-quality Habitat Lost, Altered or Disturbed due to the Project

Figure 6.5-1

Rescan an ERM company

**Table 6.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise**

| Project Area | Area Already Considered Lost due to PDAs (Section 6.5.3.1) | | | Areas Lost or Disturbed due to Noise outside of the PDA Areas | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Additional Area Functionally Lost due to Blasting (120 dBA) | | | Additional Area Disturbed due to Blasting (108 dBA) | | | Additional Area Disturbed due to General Project Noise (45 dBA) | | | Additional Area Disturbed due to Aircraft Noise (80 dBA) | | |
| | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA[1] | % RSA |
| George Property Area | 4,226 | 3.1 | 0.3 | 17 | < 0.1 | < 0.1 | 699 | 0.5 | < 0.1 | 359 | 0.3 | < 0.1 | 11,278 | 8.4 | 0.9 |
| Goose Property Area | 5,358 | 4 | 0.4 | 18 | < 0.1 | < 0.1 | 283 | 0.2 | < 0.1 | 262 | 0.2 | < 0.1 | 3,495 | 2.6 | 0.3 |
| MLA | 653 | 0.4 | < 0.1 | - | - | - | - | - | - | - | - | - | 12,367 | 9.2 | 1 |
| **Total** | **10,237** | **7.5** | **0.8** | **35** | **< 0.1** | **< 0.1** | **982** | **0.7** | **< 0.1** | **621** | **0.5** | **< 0.1** | **27,140** | **17.1** | **2.2** |

[1]*Some of the area of disturbance due to noise falls outside of the wildlife LSA but within the wildlife RSA (see Figure 6.5-1).*

**Table 6.5-8. Expected Grizzly Bear High-quality Habitat Functionally Lost or Disturbed due to Noise Outside of the Project Potential Development Areas**

| Area | Season | High-quality Habitat (HQH) Available Area (ha) | HQH Lost or Altered due to the Project Footprint | | Additional Area Functionally Lost[1] due to Blasting (120 dBA) | | Additional Area Disturbed[1] due to Blasting (108 dBA) | | Additional Area Disturbed[1] due to General Project noise (45 dBA) | | Additional Area Disturbed[1] due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH |
| *Local Study Area* | Spring | 67,728 | 6,386 | 9.4 | 19 | < 0.1 | 415 | 0.7 | 285 | 0.4 | 5,034 | 8.4 |
| | Summer | 73,903 | 6,096 | 8.3 | 16 | < 0.1 | 347 | 0.5 | 232 | 0.3 | 4,310 | 6.6 |
| | Fall | 61,443 | 5,354 | 8.7 | 16 | < 0.1 | 278 | 0.5 | 199 | 0.3 | 3,656 | 6.7 |
| | All Seasons | 90,588 | 7,384 | 8.2 | 20 | < 0.1 | 485 | 0.6 | 285 | 0.3 | 5,734 | 7.1 |
| *Regional Study Area* | Spring | 642,502 | 6,388 | 0.9 | 19 | < 0.1 | 415 | 0.1 | 285 | < 0.1 | 8,065 | 1.3 |
| | Summer | 678,085 | 6,194 | 0.9 | 16 | < 0.1 | 347 | 0.1 | 232 | < 0.1 | 8,665 | 1.3 |
| | Fall | 548,149 | 5,357 | 1.0 | 16 | < 0.1 | 278 | 0.1 | 199 | < 0.1 | 7,355 | 1.4 |
| | All Seasons | 866,050 | 7,483 | 0.9 | 20 | < 0.1 | 485 | 0.1 | 285 | < 0.1 | 10,658 | 1.2 |

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project PDAs (Section 6.5.2.1).*

At the MLA, an additional 12,367 ha of area will be disturbed due to Twin Otter aircraft landing on Bathurst Inlet near the MLA if needed when the MLA is active (Table 6.5-7), however, much of this area consists of marine habitat in the Inlet itself. A breakdown of the percentage of high quality habitat disturbed due to aircraft noise in the wildlife RSA can be found in Table 6.5-8. In all seasons, the percentage of additional high-quality habitat in the wildlife RSA disturbed by aircraft noise after accounting for habitat lost within the PDAs is small relative to the amount of available high-quality habitat in the wildlife RSA (Table 6.5-8).

Two important elements influencing aircraft noise exposure to wildlife include overhead distance from wildlife and the frequency of overflights. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned in the "worst case" years used for noise modelling (during operations), while at the MLA, when it is active, a maximum of six flights per week are planned during the "worst case" scenario. In addition, areas of disturbance due to noise are expected to be localized near the landing strips at the Goose and George Properties and within Bathurst Inlet at the MLA. A delineated flight path between the Goose and George Properties may be disturbed by helicopter overflights approximately once a day (Figure 6.4-1). Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

Overall, an estimated 61 grizzly bears use the wildlife RSA (Rescan 2013b, Appendix V5-6A). Grizzly bear home ranges cover a large area. The maximum amount of functionally lost habitat due to blasting outside of the area already accounted for from habitat loss (Section 6.5.2.1) is 35 ha. The overall maximum disturbed grizzly bear habitat is approximately 27,140 ha and is primarily disturbed due to aircraft noise which is intermittent. General Project noise, which is anticipated to be continuous noise, accounts for approximately 621 ha of disturbed habitat outside of the Projects footprint (<0.1% of the available habitat in the wildlife RSA).

The area of continuous noise disturbance corresponds to roughly 0.3% of the home range of a female bear, and <0.1% of the home range of a male grizzly bear. The majority of the area assessed as being above noise guidelines for grizzly bears is within the Goose Property and George Property PDAs which are assessed as lost or degraded habitat in Section 6.5.2.1. Despite the result of the low proportion of area disturbed compared to the area available within the wildlife RSA (< 1%) after accounting for habitat loss, the effect of sensory disturbance is anticipated to result in a residual effect on grizzly bears, albeit small.

#### *6.5.2.3 Disruption to Movement*

Disruption to movement by grizzly bears can result from 1) linear corridors such as roads which may isolate seasonal habitats and from 2) point sources of disturbance where grizzly bears will avoid areas, and thus displace movement due to human activities. The haul roads for the Project are designed as winter roads only. These roads will be constructed and used while grizzly bears are hibernating. Thus, the effect of disruption to movement due to linear corridors was not assessed further.

Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If Project sites are large enough relative to the habitat in which bears use and cause noise and sensory disturbance to a level with which bears will avoid these areas, movement of bears may be altered. In these cases, bears may need to expend additional energy to travel around Project developments during their large distance movements. Disruption to movement may begin during the construction phase of the Project when infrastructure are built and continue during the operation and reclamation/closure phases of the Project. Potential Project infrastructure and activities that were evaluated for the potential disruption to movement of grizzly bears include the PDAs for the Goose and George Property Areas and the MLA. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Calculation of Disruption to Movement on Grizzly Bears

Disruption to movement due to Project-related activities was evaluated for grizzly bears by the following key indicator: the comparison of the size of the Project development in relation to the average daily distance movements of grizzly bears on the tundra.

Evaluation of Disruption to Movement on Grizzly Bears

The development of the Goose and George Properties within each respective PDA may result in grizzly bears avoiding these areas where the open pits and camps are constructed. However, the facilities at the Goose and George Property Areas are unlikely to alter the movement of grizzly bears in the area as these bears occupy large territories (range 195,500 to 724,500 ha) and make large daily distance movements (10.9 to 137.9 km). The Goose Property, George Property, and MLA PDAs will occupy 5,358 ha, 4,226 ha and 546 ha, respectively. These areas are unlikely to disrupt movements of grizzly bears within the wildlife LSA or RSA. The development of the MLA may result in bears avoiding the peninsula where the proposed site is planned, but the MLA facility is unlikely to alter the movement of bears within the Bathurst Inlet area. The MLA will occupy approximately 546 ha, and is unlikely to disrupt movements of grizzly bears.

Thus, a residual effect of disruption to movement of grizzly bears is not anticipated, and is not assessed further.

#### *6.5.2.4 Direct Mortality and Injury*

Mortality and injury to grizzly bears may result from development activities and is thus evaluated in this assessment. Potential Project activities that may contribute to direct mortality and injury are generally anticipated to be a result of vehicle strikes. Mortality to grizzly bears may also result when wildlife attracted to Project infrastructure become human habituated and aggressive, and thus pose a threat to human safety. The resulting effects of attraction to the Project are evaluated in Section 6.5.2.6.

Calculation of Direct Mortality and Injury on Grizzly bears

To assess the likelihood and population-level significance of grizzly bear mortality and injury resulting from interaction between grizzly bear and the Project, literature from other projects in Nunavut or Northwest Territories (Ekati, Diavik, and Hope Bay) and/or from GN-DOE was reviewed, and estimates of wildlife mortality rates due to Project activities were summarized.

Evaluation of Direct Mortality and Injury on Grizzly bears

Grizzly bear mortality and injury due to development activities is most often a result of vehicle collisions (Benn, Jevons, and Herrero 2005). Frequency of road mortality is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to grizzly bears also increases. However, all of the Project roads, except for local site roads are winter roads, and will be constructed and used between January and April when grizzly bears are hibernating in their dens. Grizzly bear typically enter their dens in late October to early-November (before construction of the winter road has begun) and emerge in late-April to early-May (McLoughlin 2000), after the winter road has closed. Thus, winter roads are not further assessed.

The all-weather local site roads within the PDAs will be restricted to 60 km/h. Direct mortality rates of wildlife species have been shown to drop dramatically below 70 km/h. Trucks will stop for 20 minutes whenever a bear is located on the road, to allow the animal time to move away from the road. In addition, there have been no reports of mortality to grizzly bear on site roads at other larger developments in the

Arctic including Ekati (Rescan 2013f), Diavik (RioTinto 2012) and Hope Bay (Rescan 2013e). Thus, mortality due to vehicle strikes is not anticipated to result in a residual effect on grizzly bears.

#### *6.5.2.5 Indirect Mortality*

Indirect mortality to grizzly bears may result if public access is facilitated by the proposed roads. Indirect mortality from increased hunting pressure resulting from Project-related activities is assessed based on the results the socio-economic assessment (Volume 8, Chapter 3) which reports that an increase in human immigration and hunting is unlikely in the Back River area.

Mitigation measures are in place to prevent public access to Project roads (Section 6.5.3 and Volume 10, Chapter 20). A policy prohibiting hunting within a buffered area along all infrastructure may be developed and enforced (Volume 10, Chapter 20). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees. Thus, construction and operation of the road is not expected to cause an increase in grizzly bear mortality due to facilitation of hunter access (i.e., indirect mortality) and is therefore not anticipated to result in a residual effect on grizzly bear.

#### *6.5.2.6 Attraction*

Wildlife attractants refer to Project-related human activities, infrastructure, or environmental changes that are of interest or provide resources to wildlife. Changes in spatial distribution and habitat selection have been observed for species attracted to anthropogenic activity, but mortality is perhaps of greater concern.

Grizzly bears may be attracted and become habituated to the Project due to the camps and other facilities that could create odours. Habituated bears can pose a threat to the safety of both humans which often necessitates relocation or destruction of these animals (Gibeau and Herrero 1998). While relocation of habituated or food-conditioned bears reduces the chances of an immediate negative attraction, bears are moved into territories that are either occupied by other bears or have relatively less suitable habitat which may lead to decreased survival (Blanchard and Knight 1995). In many cases, bears that are attracted to human activity centres and are perceived as a threat to life or property are destroyed.

The effect of attraction is anticipated to commence upon construction when the camps are in use and continue throughout operation and reclamation/closure phases of the Project while odourous materials are present on site.

Evaluation of Attraction for Grizzly Bears

Mitigation measures will be implemented at all Project facilities in order to limit the attractiveness of the sites to bears using standard mitigation techniques such as: incinerating food wastes, managing garbage and scents, etc. Project activities will adhere to a Landfill and Waste Management Plan (Volume 10, Chapter 10), Incineration Management Plan (Volume 10, Chapter 11), and waste and wildlife attractant management protocol in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) which may include mitigation measures to store and remove all food wastes and wildlife attractants, erect bear fences in appropriate areas, remove carrion from roads, and monitor the waste management facilities. In addition, the Fuel Management Plan (Volume 10, Chapter 4), and the Hazardous Materials Management Plan (Volume 10, Chapter 12) ensures that all chemicals will be contained and properly stored so that grizzly bears will not have access to these substances. Mitigation measures such as employee education in wildlife awareness and protocols in dealing with nuisance bears may also be implemented in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

While mitigation measures will greatly decrease the potential for grizzly bears to be attracted to the Project, there is still some possibility that despite mitigation, a small number of bears may continue to be attracted to the Project. Thus, there is some potential for a small number of bears to become habituated to the Project site.

Of the documented grizzly bear mortalities in Nunavut in the 16 years between 1986 and 2002; 168 were legal kills, 3 were illegal kills, 5 were of natural cause, 121 were problem bears at outfitter camps/communities, 17 were problem bears at mines and exploration camps and 4 were of unknown causes (McMullen 2002, pers. comm.). Nuisance bears have been documented at several operational mines and exploration camps where mitigation measures are in place. Several problem grizzly bears have been destroyed in the West Kitikmeot Region (34% of bear kills between 1980 and 2004) as a result of human related activities and industrial developments (Dumond and Campbell in prep) This equates to approximately four bears per year in the West Kitikmeot Region during that time. In addition, several grizzly bears have been reported as problem bears at various developments (Rescan 2013e) and one bear cub became habituated to the landfill site at Misery camp had to be destroyed (BHP 2001). Thus, despite mitigation measures, the effect of attractants is predicted to result in a residual effect on grizzly bears, albeit small.

#### *6.5.2.7 Exposure to Contaminants*

Exposure to contaminants in grizzly bears due to the Project was evaluated in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in grizzly bear or its respective food chain components and surroundings (e.g., water, fish, sediment etc.) were predicted to be below a value of one. A hazard quotient less than one indicates that an increase in contaminants in these media relative to baseline conditions is unlikely. Thus, a residual effect due to exposure to contaminants in grizzly bear is not anticipated and is not considered further in the assessment.

#### *6.5.2.8 Reduction in Reproductive Productivity*

A reduction in reproductive productivity can result for some species due to project developments and be a factor that connects individual-level effects to population-level effects. With the exception of mortality, all of the preceding potential effects may result in declines in reproductive productivity of wildlife species. Habitat loss and degradation, disturbance, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. Individuals in poor body condition can fail to produce young, or produce young with lower survival potential. The body condition of parturient females of large mammal species is thought to be the main determinant of the health and survival of their young.

Barren-ground grizzly bears spend between 6.5 and 7.5 months each year in hibernation. This restricts their foraging time to find enough food to store energy reserves in order to make it through to the following winter. Additionally, there are energy costs associated with reproduction, foraging movements, and exposure to weather. Grizzly bears maintain large home ranges in the Arctic, thus require larger energy costs associated with these movements. However, it is hypothesized that their home ranges are large in the tundra to meet their nutritional and energetic requirements in an environment that is relatively less productive compared to coastal and alpine areas. Therefore, the benefits of maintaining these large home ranges must outweigh the costs of energy expenditure in order to reproduce.

Evaluating Reduction in Reproductive Productivity in Grizzly Bears

The potential for a reduction in reproductive productivity of grizzly bears, and the significance of the reduction, depends on a number of factors, including the degree of disturbance, as well as the number, sex and age-class of individuals of each species killed as a result of direct mortality and the influence of these factors on the demographics of the local population. These potential effects may synergistically reduce grizzly bear productivity. The potential effects of the Project on reproductive productivity of grizzly bear are related to each effect listed above.

Mitigation measures are anticipated to mediate the effects of most potential Project-related effects. However, residual effects of attraction (mortality of nuisance bears) as a result of Project-related activities are anticipated for a small number of individuals. In addition, an increase in energy requirement may occur for bears with territories in range of the disturbance due to blasting, which could reduce reproductive potential for these bears. Therefore, there is a small potential for a reduction in reproductive productivity in grizzly bears due to the Project, albeit minimal.

### 6.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Management Plan (Volume 10, Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including grizzly bears. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on grizzly bears is anticipated resulting from habitat loss, disturbance due to noise, attraction, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to grizzly bears. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

#### *6.5.3.1 Mitigation for Habitat Loss*

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to grizzly bears may include the following:

- Project infrastructure designed to avoid, where possible, identified grizzly bear sensitive habitat such as identified denning habitat (Volume 10, Chapter 20);
- infrastructure designed to minimize the Project footprint to reduce habitat loss for grizzly bears (Project Description; Volume 2, Chapter 2);
- consideration of the location of the stockpiles and windbreaks to minimize dustfall, to reduce habitat degradation for grizzly bears (Volume 10, Chapter 17);
- infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located, thereby minimizing the Project footprint to reduce habitat loss for grizzly bears (Project Description; Volume 2, Chapter 2); and
- winter-only road access corridors proposed (no all-weather roads for re-supply routes or between the Goose and George Properties), to minimize direct habitat loss, and habitat degradation due to dust deposition for grizzly bear (Project Description; Volume 2, Chapter 2).

#### *6.5.3.2 Mitigation for Disturbance due to Noise*

The primary mitigation and management strategies to minimize the effects of disturbance due to noise to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance due to noise to grizzly bears may include:

- winter roads designed to avoid known grizzly bear dens within 1 km of the proposed alignment to ensure that works and activities do not disturb grizzly bears during hibernation (Volume 10, Chapter 20);
- pre-construction ground clearing conducted outside of denning periods for grizzly bears, where possible, to reduce disturbance to grizzly bears (Volume 10, Chapter 20);
- underground mining used, where possible, to reduce noise emitted by the Project for excavating and hauling waste rock, and minimize the effects of noise disturbance to grizzly bears (Volume 10, Chapter 20);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to grizzly bears (Volume 10, Chapter 18);
- vehicles restricted to site roads, winter roads and quarry footprints during construction and operations to avoid unnecessary disturbance to grizzly bear habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude when possible wherever wildlife species are observed (Volume 10, Chapter 20).

#### *6.5.3.3 Mitigation for Disruption to Movement*

The following mitigation measures and best management practices may be applied to minimize the effects of disruption to movement to grizzly bears:

- winter access roads only, when grizzly bears are hibernating, so access roads will not cause disruption of movement for bears (Volume 10, Chapter 20); and
- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce the disruption of movement to wildlife (Volume 10, Chapter 20).

#### *6.5.3.4 Mitigation for Direct Mortality and Injury*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to grizzly bears may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);

- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to grizzly bears;
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

#### *6.5.3.5 Mitigation for Indirect Mortality*

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to grizzly bear may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by employees while on site. (Volume 10, Chapter 23).

#### *6.5.3.6 Mitigation for Attraction*

The primary mitigation and management strategies to minimize effects of attraction to the Project to grizzly bears and other wildlife are described in the Landfill and Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10 Chapter 11) and employee education plan, described in the Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to grizzly bears:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- bear-proof receptacles used for all waste and wildlife attractants, where possible, to ensure bears do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- a waste and wildlife attractant management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- the use of wildlife-attracting dust suppressants avoided, where possible (Volume 10, Chapter 20);
- relevant employees and contractors trained in bear safety procedures to minimize risk to humans and wildlife (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20); and
- a protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers (Volume 10, Chapter 20).

#### *6.5.3.7 Mitigation for Exposure to Contaminants*

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to control the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to grizzly bears.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including grizzly bears from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- the use of wildlife-attracting dust suppressants avoided wherever possible (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20);
- wildlife exclusion measures implemented if wildlife are frequently accessing or attempting to access waste storage areas (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

### 6.5.4 Characterization of Residual Effects

In Section 6.5.3, eight potential effects were evaluated whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Four of these effects were rated as having the potential for residual effects: 1) habitat loss, 2) disturbance from noise, 3) attraction, and 4) reduction in reproductive productivity. The significance of residual effects is evaluated here for these four effects. Each residual effect is described in this section in terms of eight descriptors (see Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. The magnitude of the residual effect was evaluated by using the information in Table 6.5-2. Table 6.5-3 provides a description of the significance ratings used for residual effects.

#### *6.5.4.1 Habitat Loss*

The total area of habitat loss due to the Goose, George and MLA PDAs is equivalent to 10,237 ha. This area is 0.8% of the RSA and roughly equivalent to the loss or alteration of 1.4% of the home range of a male grizzly bear or 4.8% of a home range of a female grizzly bear. The overall loss or degradation of high-quality grizzly bear habitat is 7,384 ha (0.9% of the wildlife RSA). The actual Project footprints which are designed to be as small as possible are anticipated to be much smaller than the Project PDAs which have been assumed lost in this assessment. When the proportion of habitat loss is compared to the quantitative thresholds for magnitude of effect (Table 6.5-1), the magnitude of the effect is considered low.

The extent of the effect of habitat loss is confined to the Project footprint (within the PDAs), the frequency is sporadic, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas within the PDAs will not be affected and may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during construction and operation. The confidence of the effect occurring is considered high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose, George and MLA PDAs will not be developed. The residual effect of habitat loss for grizzly bears is concluded to be Not Significant.

#### *6.5.4.2 Disturbance due to Noise*

After considering the effects of habitat loss, the total area functionally lost due to blasting (≥ 120 dB) is 35 ha (or < 0.1% of the wildlife RSA). This area accounts for approximately 20 ha of high-quality habitat for grizzly bears (< 0.1% of the available high-quality habitat in the wildlife RSA after accounting for habitat loss). An additional 621 to 27,140 ha ranging between 285 and 10,658 ha of high-quality habitat (<0.1 to 1.2% of available high-quality habitat in the wildlife RSA after accounting for habitat loss due to Project infrastructure and that functionally will be lost due to blasting) will be disturbed due to blasting (> 108 dB), general Project noise (> 45 dBA) or aircraft noise (> 80 dBA). However, disturbance due to blasting and aircraft noise will be intermittent, and 285 ha (due to general Project noise) will be continuously disturbed. This area of continuous disturbance is equivalent to <0.1% of the home range of a male grizzly bear or 0.1% of a home range of a female grizzly bear. Following the quantitative thresholds for magnitude listed in Table 6.5-1, the magnitude of the effect is considered low.

The extent of the effect of noise disturbance is local (i.e., extends beyond the footprint but is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for dB 108 and 120 Lpeak during blasting activities, but overall, sporadic as aircraft and blasting noise are anticipated to have a greater effect, and the duration is considered medium as the effect of disturbance due to noise is expected to subside at closure. The effect is considered to be reversible as grizzly bears are anticipated to relocate to areas of disturbance once the effect subsides. The probability of the effect occurring is moderate, and confidence is high, as bears are known to be sensitive to blasting activities related to mining. The residual effect of sensory disturbance on grizzly bears is assessed as Not Significant.

#### *6.5.4.3 Attraction*

With mitigation measures, the magnitude of the effect of attractants on grizzly bear is rated as low, following the guidance on determining qualitative magnitude in Table 6.5-1. The geographic extent is contained to the Project footprint. This effect is anticipated to be a negative effect as bears that become habituated to Project-related attractants may have to be destroyed if they become nuisance bears. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being

used, but not after closure. The frequency of bears being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is high, and confidence is medium, as bears are known to be attracted to mining camps, but with effective mitigation the potential to attract bears and cause problem bears is medium. The residual effect of attractants on grizzly bears is concluded to be Not Significant.

#### *6.5.4.4 Reduction in Reproductive Productivity*

The potential for a reduction in reproductive productivity of grizzly bears, and the significance of the reduction, depend on a number of factors, including the degree of noise disturbance, as well as the number, sex and age-class of individuals of each species killed as a result of direct mortality and the influence of these factors on the demographics of the local population. These effects may synergistically reduce grizzly bear productivity. The effects of the Project on reproductive productivity of grizzly bear are related to each effect listed above.

The residual effects of the Project on bears include habitat loss, disturbance due to noise, and attraction. These effects combined can result in a reduction in reproductive productivity in bears. The highest magnitude of any of the residual effects on bears after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on grizzly bears is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of grizzly bears in the Project area. The duration of the effect is expected to be medium. The frequency of the effect is anticipated to be sporadic as the likelihood of reduction in reproductive productivity are limited to events such as mortality which may cause declines in the grizzly bear population, or on factors such as limited resources or disturbance events which may limit the success of reproduction, births and rearing of young. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the mine is closed. The geographic extent of this residual effect is anticipated to be regional.

There were 61 bears that used the wildlife RSA in 2012 and may at any one time be affected by Project related activities. However, the likelihood that a reduction in reproductive productivity on grizzly bears will occur is unlikely as the Kitikmeot region supports a moderate grizzly bear population and habitat is fairly evenly dispersed throughout the region, thus bears are expected for the most part to avoid contact with the mine and choose alternative habitat in areas that are not disturbed. The confidence in the effect rating is medium as it is unknown how the residual effects of the Project on reproduction of grizzly bears may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the residual effect of reduction of reproductive productivity is concluded to be Not Significant.

### 6.5.5 Significance of Residual Effects

The effects assessment for grizzly bear identified four effects as residual after mitigation as follows:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- attraction, rated Not Significant;
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have

population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. The residual effect anticipated to contribute the most to effects on the population is those attributed to attraction. Habitat loss and disturbance due to the Project leading to avoidance of habitat is anticipated to result in less of an effect on the population of grizzly bears as the total amount of habitat lost or altered due to disturbance is small relative to the size of a grizzly bear home range. Thus, these effects will not result in a decline in the grizzly bear population in the region.A summary of residual effects on grizzly bear and overall significance ratings are presented in Table 6.5-9. Contingent on the implementation of mitigation measures outlined in the WMMP (Volume 10, Chapter 20), the combined significance of residual effects for grizzly bear is predicted to be **Not Significant**.

## 6.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

### 6.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities.

The Cumulative Effect Assessment (CEA) follows the methodology as described in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 6.5.1.1). Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 6.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for grizzly bears.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 6.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for grizzly bear and not the wildlife RSA.

**Table 6.5-9. Summary of Residual Effects on Grizzly Bear and Overall Significance Rating**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Direction** *(positive, neutral, negative)* | **Magnitude** *(negligible, low, moderate, high)* | **Duration** *(short, medium, long)* | **Frequency** *(once, sporadic, continuous)* | **Geographic Extent** *(footprint, local, regional, beyond regional)* | **Reversibility** *(reversible, reversible with effort, irreversible)* | **Probability** *(unlikely, moderate, likely)* | **Confidence** *(low, medium, high)* | **Not Significant (N); Significant (S); Positive (P)** |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | High | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | N |
| Attraction | Negative | Low | Medium | Sporadic | Footprint | Reversible | Moderate | High | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

#### *6.6.1.1 Spatial Boundary*

Grizzly bear female and male adults can range over 210,000 to 724,500 ha, and sub-adult male grizzly bears can range over 4,000,000 ha (McLoughlin et al. 2002). The spatial boundaries for grizzly bears include the area within which a sub-adult male may travel and interact with existing and proposed developments. This area was defined using the diameter of a 4,000,000 ha home range (approximately 226 km) as well as the longest straight line distance travelled by an individual male. The maximum grizzly bear movement recorded during the Project baseline was approximately 140 km straight line distance by a male grizzly bear moving between hair snag stations. The CEA spatial boundary is a relative average of these values resulting in a CEA area extending 200 km from the Back River Project Infrastructure and consists of 18,726,990 hectares (Figure 6.6-1). Note that the CEA boundary is different for each VEC species for which a CEA assessment was conducted – in each case based on the movement patterns and/or home range size for that species.

The relative scale of the CEA boundary for grizzly bears was then checked against data from grizzly studies in Nunavut and Northwest Territories. During 2012 and 2013, four exploration or operating mines were conducting grizzly bear work: Back River Project, Hackett River Project, Izok Corridor Project, and Ekati/Diavik Operating Diamond Mines. Grizzly bears detected at the Back River Project were also detected at Hackett River, and Izok, while Izok bears were also detected at Ekati/Diavik. This suggests that the CEA spatial boundary is appropriately sized for the Project and includes the appropriate neighbouring projects.

#### *6.6.1.2 Temporal Boundary*

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

### 6.6.2 Potential Interactions of Residual Effects with Other Projects

Four residual Project-related effects were identified during the grizzly bear effects assessment: habitat loss; disturbance due to noise; attractants; and reduction in reproductive productivity. Several additional Projects or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the range of grizzly bears that interact with the Back River Project.

Figure 6.6-1 displays the past, present, and foreseeable future developments that could interact with grizzly bears in the CEA boundary. Eleven projects have been identified within the CEA spatial boundary for grizzly bears including three past projects which are closed (Roberts Bay/Ida Bay, Jericho, and Lupin), four existing developments (Doris North Project (Hope Bay Phase I), Ekati, Diavik, and the Tibbett to Contwoyto Winter Road), and four foreseeable future projects (Hope Bay Belt Doris North and Phase II Project, BIPR, Hackett River, and Izok Corridor Project) in addition to the Back River Project.

A description of the type of potential cumulative effect due to all projects combined is listed in Table 6.6-1.

Potential cumulative effects are assessed for April to November when grizzly bears are active; effects relating to winter dens will be addressed where applicable. Denning bears are still susceptible to effects that occur in close proximity to den sites, such as disturbance due to noise during construction.

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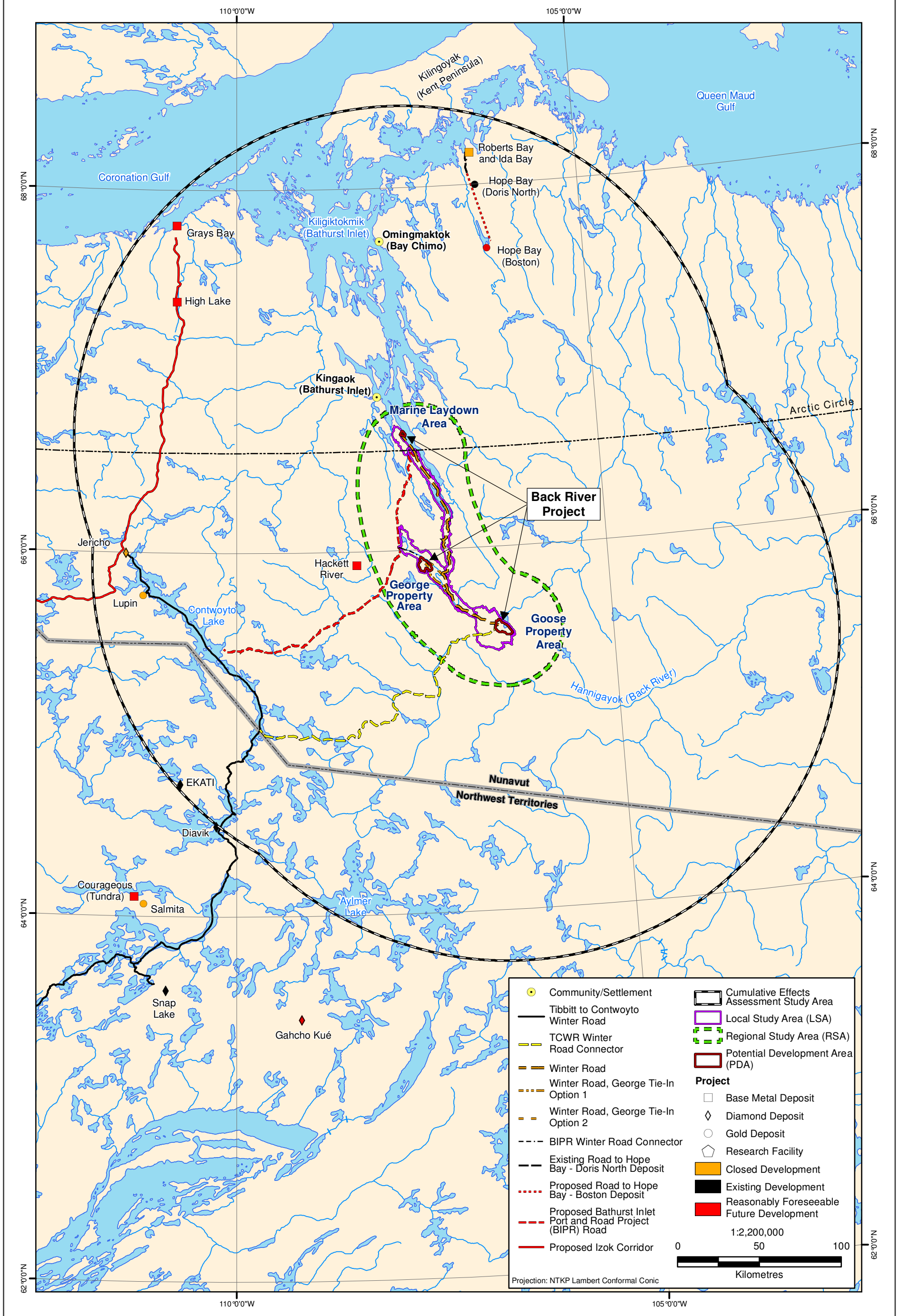


Figure 6.6-1

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## Spatial Boundary for Grizzly Bear Cumulative Effects Assessment

Figure 6.6-1

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**Table 6.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Grizzly Bears in the Area**

| Residual Effect from Back River Project | Magnitude of Residual Effect Rating from Back River Project | Other Project or Activity | | | Type of Potential Cumulative Effect |
|---|---|---|---|---|---|
| | | Past | Existing | Reasonably Foreseeable Future | |
| Habitat Loss | Low | Roberts Bay and Ida Bay, Lupin, Jericho | Doris North, Ekati, Diavik | Hope Bay Belt, BIPR*, Hackett, Izok Corridor | Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities |
| Disturbance due to Noise | Low | N/A | Doris North, Ekati, Diavik | Hope Bay Belt, BIPR*, Hackett, Izok Corridor | Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance |
| Attractants | Low | Roberts Bay and Ida Bay, Lupin, Jericho | Doris North, Ekati, Diavik | Hope Bay Belt, BIPR*, Hackett, Izok Corridor | Additive attraction to foods and wastes resulting in attraction and negative human-wildlife interactions and destruction of nuisance bears |
| Reduction in Reproductive Productivity | Low | Roberts Bay and Ida Bay, Lupin, Jericho | Doris North, Ekati, Diavik | Hope Bay Belt, BIPR*, Hackett, Izok Corridor | Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects |

** BIPR = Bathurst Inlet Port and Road Project*

### *6.6.2.1 Habitat Loss*

The Project effects assessment rated the residual effect of habitat loss from the Back River Project as Not Significant, with a low magnitude. Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible. While habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 6.5.4.1), additional habitat loss within the range of a grizzly bear may contribute to a nibbling effect, whereby the total amount of habitat lost to all potential and current projects is additive, resulting in larger habitat loss for grizzly bears.

A number of closed projects including Roberts Bay and Ida Bay, Lupin, and Jericho have already removed some habitat within the CEA boundary for grizzly bear. Other existing developments including Doris North, Ekati, and Diavik, overlap with the CEA boundary for grizzly bear and may further decrease the available habitat or habitat quality (e.g., due to dust fall-out, etc.) for grizzly bears using this area. The proposed Hope Bay Belt, BIPR, Hackett River, and Izok Corridor projects have the potential to overlap with the CEA boundary for grizzly bear and may contribute to additional habitat loss if these projects are developed. The Tibbett to Contwoyto Winter Road was not considered in the assessment for grizzly bears as it is constructed and used only when grizzly bears are anticipated to be hibernating.

Calculation of Cumulative Habitat Loss

The amount of habitat removed (“area removed”) was estimated from the generalized footprints of all projects and road corridors in the CEA boundary for grizzly bears and used as a key indicator to determine

potential cumulative effects. For all existing and future foreseeable projects, habitat within 100 m of footprints were considered degraded due to dust (Walker and Everett 1987; Rescan 2012b). Habitat loss for the Back River Project was calculated within the PDAs which already includes a dust-disturbance area.

Detailed habitat mapping does not exist for the entire CEA boundary for bears. Hence, it was assumed that the CEA boundary contains approximately the same proportion of high quality habitat as the wildlife RSA (approximately 50%). The total area of lost habitat from these calculations was compared to the area of the CEA boundary and to the home range sizes for male and female grizzly bears with the assumption that the area lost falls entirely within the home range size of a male or female territory.

Evaluation of Cumulative Habitat Loss

Within the CEA boundary for grizzly bear, the cumulative effects assessment identified 20,187 ha of removed habitat, and 17,325 ha of degraded habitat (each 0.1% of the total area in the CEA boundary). These areas account for a total of 36,912 ha after accounting for overlap between projects. The Back River Project alone will contribute 10,237 ha (28%) of the total area of habitat loss within the CEA boundary for grizzly bears which is equivalent to less than 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10-15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

Assuming that approximately 50% of this area consists of high-quality habitat for grizzly bears, a total of 18,403 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the CEA boundary for grizzly bears are developed.

The average size of a grizzly bear home range is 724,500 ha and 210,000 ha, for male and female grizzly bears, respectively. Thus, total habitat loss from all projects in the CEA boundary is 5.1% of a male grizzly bear's home range and 17.5% of a female grizzly bear's home range, assuming that all of the habitat lost or degraded would fall within one home range of a bear. If it is assumed that the density of grizzly bears in the CEA boundary is similar to that in a study which encompasses the CEA boundary of four bears per 100,000 ha (Ross 2002), approximately 750 grizzly bears would be expected to frequent the CEA boundary. Based on this estimate, and assuming an even distribution of habitat loss in the CEA boundary, an average of approximately 49 ha of habitat per bear (36,912 ha total) may be altered, which is equivalent to < 0.1% of a home range of a male or female grizzly bear home range per bear.

The amount of grizzly bear habitat that will be lost as a result of Project development represents a small portion of the total amount of habitat available in the CEA boundary (Table 6.6-2) and that of the home range of male and female grizzly bears. The carrying capacity of the habitat for grizzly bear at the landscape level is therefore unlikely to be affected due to the cumulative habitat loss of all Projects in the CEA boundary. It is concluded that the potential cumulative effect of habitat loss, while small, will result in a residual effect to grizzly bears.

#### *6.6.2.2 Disturbance due to Noise*

The residual effect of disturbance due to noise to grizzly bears due to Project auditory stimuli from the Back River Project was rated as Not Significant, with a low magnitude in the effects assessment. Habitat lost or disturbed due to Project-related noise resulting from activities at the Back River Project and other projects in the CEA boundary is discussed in this section.

Potential cumulative effects from existing and proposed projects was assessed; including Doris North, Ekati, and Diavik, and the proposed Hope Bay Belt, BIPR, Hackett River, and Izok Corridor Projects

(Figure 6.6-1). Closed projects were excluded from the analysis. A background on the potential effects of disturbance due to noise to grizzly bears is presented in Section 6.5.2.2.

**Table 6.6-2. Cumulative Habitat Loss in the Grizzly Bear CEA Boundary[1]**

| Project | Habitat Lost due to Project Infrastructure (hectares) | Habitat Degraded due to Dust (hectares) | Total Habitat Lost or Degraded[2] (hectares) |
|---|---|---|---|
| Back River Project[3] | 10,237 | NA | 10,237 |
| *Past Developments* | | | |
| Roberts Bay and Ida Bay | 3 | NA | 3 |
| Jericho Mine | 242 | NA | 242 |
| Lupin Mine | 795 | NA | 795 |
| Cumulative Area | | | |
| *Present Operating Developments* | | | |
| Doris North | 279 | 533 | 812 |
| Ekati Mine | 2,632 | 1,920 | 4,552 |
| Diavik Mine | 80 | 32 | 112 |
| *Reasonably Foreseeable Future Developments* | | | |
| Hope Bay Belt | 2,992 | 1,071 | 4,064 |
| BIPR[4] | 656 | 4,921 | 5,577 |
| Hackett River | 1,454 | 2,057 | 3,511 |
| Izok Corridor Project[5] | 818 | 6,802 | 6,901 |
| *Totals* | | | |
| Total Area | 20,188 | 17,336 | 36,912 |
| Total Accounting for Area of Overlap | 28,832 | 17,325 | 36,912 |

[1] *Grizzly Bear Cumulative Effects Assessment boundary approximates 18,726,990 hectares.*
[2] *Habitat Loss includes total area lost and does not take into account habitat suitability within the area.*
[3] *Habitat Removed due to the Back River Project includes the Goose Property, George Property and MLA PDAs.*
[4] *Bathurst Inlet Port and Road Project*
[5] *Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.*

Calculation of Cumulative Disturbance due to Noise on Grizzly Bears

To evaluate the potential cumulative effects of disturbance due to noise on grizzly bear, the area in which grizzly bear may be affected by disturbance was calculated and used as a key indicator of this potential effect. Noise modelling for the Back River Project has indicated that disturbance due to blasting noise will attenuate to below threshold values within 4 km from the source of blasting at quarries (Volume 4, Chapter 2). Thus, a 4 km buffer was applied to all projects to calculate the area lost due to blasting noise.

Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km while that during construction would be similar to blasting at mine sites and would attenuate below threshold values at 4 km.

The total area of indirect habitat loss due to all projects was compared to the total area of the CEA boundary for grizzly bears and to the average home range size of a male and female grizzly bear.

Evaluation of Cumulative Disturbance due to Noise on Grizzly Bears

The CEA boundary for grizzly bear is approximately 18,726,990 ha. During the operation phase of the Back River Project disturbance was calculated based on a worst case scenario whereby the disturbed habitat at the Back River Project for year three at the Goose Property Area and year seven at the George Property Area are combined to calculate the maximum possible disturbance due to noise for grizzly bears.

The area of habitat altered due to disturbance from the Back River Project would cover 53,817 ha, or 0.4% of the CEA boundary for grizzly bears (Figure 6.6-2). The area of habitat loss for the cumulative effects of noise due to all existing and proposed projects in the CEA boundary for grizzly bears, assuming a worst case scenario whereby the construction of all-weather roads due to all additional projects would occur at the same time, would result in 568,416 ha of disturbed habitat, or 3.2% of the CEA boundary. During the operational phase, assuming all proposed projects are operational, the effect of all projects combined would result in 375,185 ha of disturbed habitat (2.1% of the CEA boundary). Estimated areas of disturbance due to noise for each project are reported in Table 6.6-3.

**Table 6.6-3. Total Area of Habitat affected due to Disturbance[1] by Noise in the Grizzly Bear CEA Boundary[2]**

| Project | Areas of Grizzly Bear Habitat Disturbed | | | | |
|---|---|---|---|---|---|
| | All-weather Roads Construction (4 km) | All-weather Roads Operation (1.5 km) | Mine (4 km) | Total during Construction | Total during Operation |
| Back River Project[3] | | | 53,817 ha | 53,817 | 53,817 |
| *Present Developments* | | | | | |
| Ekati Mine | | 8,408 ha | 23,388 ha | 23,388 | 31,796 |
| Diavik Mine | | | 4,069 ha | 4,069 | 4,069 |
| Doris North | | 6,460 ha | 17,152 ha | 17,152 | 23,612 |
| *Reasonably Foreseeable Future Developments* | | | | | |
| BIPR[4] | 157,337 ha | 68,776 ha | 13,710 ha | 171,047 | 82,486 |
| Hackett River | 384 ha | 16,445 ha | 36,098 ha | 36,482 | 52,543 |
| Hope Bay Belt | 29,114 ha | 13,893 ha | 12,384 ha | 41,498 | 26,277 |
| Izok Corridor[5] | 206,027 ha | 85,649 ha | 15,027 ha | 221,054 | 100,676 |
| *Totals* | | | | | |
| Total Area | 392,863 ha | 199,631 ha | 175,645 ha | 568,507 | 375,276 |
| Total Area Accounting for Overlap | 392,863 ha | 199,631 ha | 175,645 ha | 568,416 | 375,185 |

*[1] Disturbed habitat includes total area disturbed and does not take into account habitat suitability within the area.*
*[2] Grizzly Bear Cumulative Effects Assessment boundary approximates 18,726,990 hectares.*
*[3] Disturbance calculations due to the Back River Project includes disturbance due to all PDAs (Goose and George Properties, and the MLA).*
*[4] BIRP = Bathurst Inlet Port and Road Project*
*[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.*

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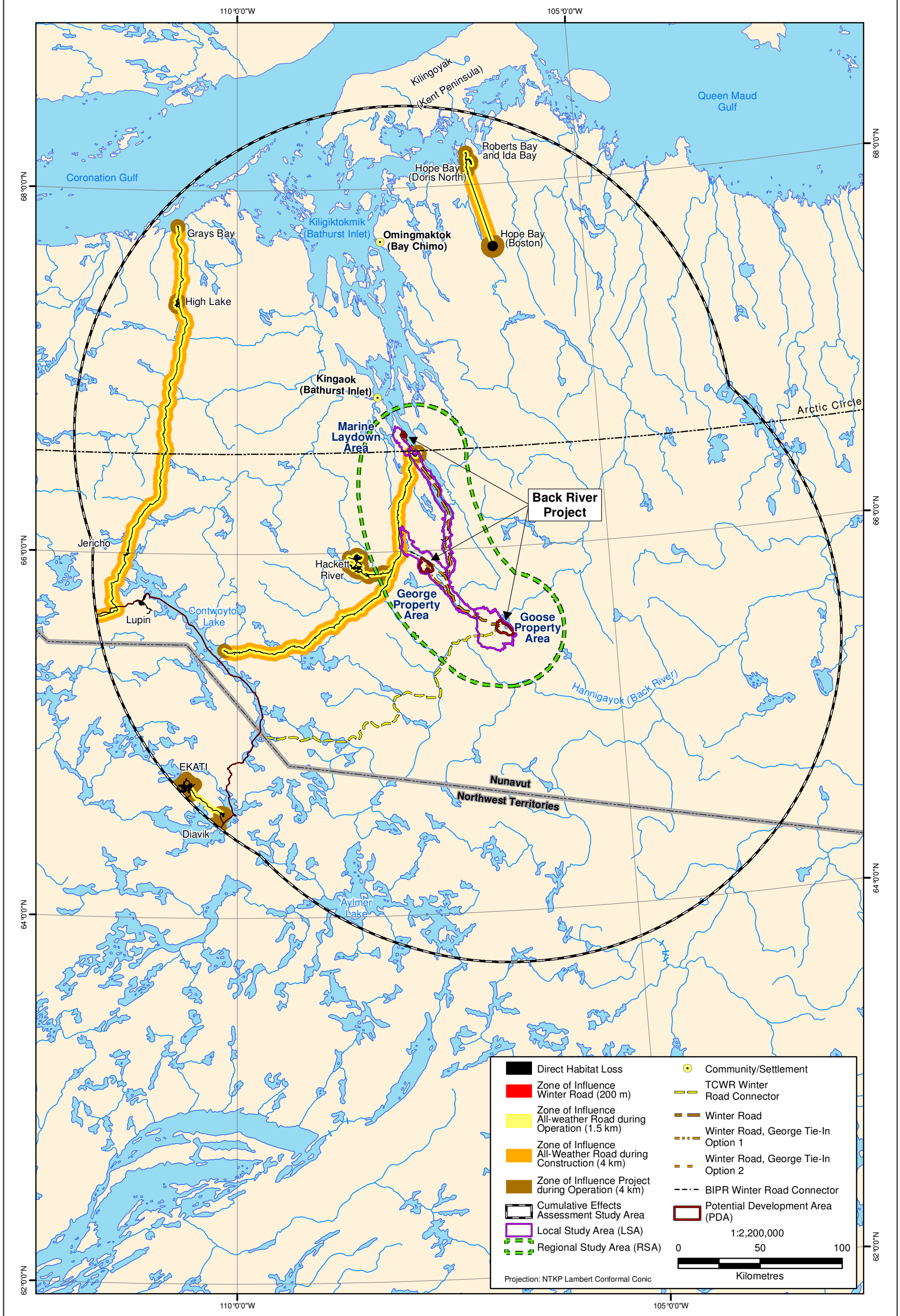


Figure 6.6-2

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# Habitat Lost or Altered due to All Project Footprints and Noise in the Grizzly Bear Cumulative Effects Assessment Boundary

Figure 6.6-2

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The cumulative effect of noise disturbance due to all projects assuming a worst-case scenario (during construction of all future-foreseeable projects at the same time) results in the equivalent of 80% of a male grizzly bear home range size or approximately 2.8 female grizzly bear home ranges, respectively. Assuming a similar density of bears in the CEA boundary as reported in the literature which includes the CEA boundary area of four bears per 100,000 ha (Ross 2002), approximately 750 grizzly bears would be expected to frequent the CEA boundary. Based on this estimate, an average of approximately 758 ha of habitat per bear (568,416 ha total) may be altered which is equivalent to < 0.1% of a home range of a male grizzly bear and 0.4% of a female grizzly bear home range per bear. Thus, only a small proportion of each of the 750 grizzly bear's home range, assuming an even distribution of noise, is anticipated to be altered due to noise disturbance. Despite mitigation measures, a residual effect is anticipated for disturbance due to noise to grizzly bears.

#### *6.6.2.3 Attractants*

Grizzly bears are often attracted from long distances to a human settlement in search of food. Additional present developments and future foreseeable projects in the CEA boundary for grizzly bears will increase the probability of attraction of bears (same projects as in Table 6.6-2).

Once a bear becomes habituated to either humans or food, the probability of a human-bear interaction increases (Herrero 1985; Peine 2001). Conflicts often negatively affect the survival of bears. In Yellowstone National Park, bears that came into conflict with humans had a higher probability of dying within a year of the conflict (Haroldson, Schwartz, and White 2005). If problem grizzly bears avoid conflict with humans for more than two years, their survival rate returns to that of bears with no known history of conflict with humans (Haroldson, Schwartz, and White 2005).

Evaluation of Attraction for Grizzly Bears

Best management practices for reducing the attractiveness of camps and infrastructure are anticipated to be implemented at all project sites. However, existing mines and camps in Nunavut and Northwest Territories still report problem bears in low number despite implementing these best management practices. Therefore a residual effect is predicted for the cumulative assessment of attractants for bears.

#### *6.6.2.4 Reduction of Reproductive Productivity*

The residual effect for a reduction in reproductive productivity in grizzly bears was rated as Not Significant with a low magnitude in the Project effects assessment.

The contribution of the Back River Project to cumulative effects of reduction of reproductive productivity on grizzly bear is anticipated to be small relative to other projects in the CEA boundary. While the effect of attraction is anticipated to be similar to other developments where human development wastes and attractants will be present, the Back River Project does not include linear corridors that will be present when grizzly bears are using the tundra to hunt and forage, thus does not have a residual effect of disruption to movement on grizzly bears. Other projects in the CEA boundary will have linear developments including all-weather roads, which may contribute to the effect of disruption to movement on grizzly bears. This effect may have higher consequences on the reduction of reproductive productivity on grizzly bears relative to the residual effects of habitat loss, disturbance due to noise, and attraction anticipated from the Back River Project. Reduction in reproductive productivity is expected to be small and very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

### 6.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for grizzly bears will be similar to those implemented for the Back River Project and will meet or exceed best management practices. For a list of mitigation and management measures applied for grizzly bears at the Back River Project see Section 6.5.3, and Volume 10.

### 6.6.4 Characterization of Cumulative Residual Effects

After the application of mitigation and management measures, there are four residual effects predicted in the grizzly bear cumulative effects assessment area: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity.

#### *6.6.4.1 Habitat Loss*

The overall loss or degradation of area due to all projects in the grizzly bear CEA boundary is 36,912 ha (approximately 0.2% of the CEA boundary) which is roughly equivalent to the loss or alteration of 5.1% of the home range of a male grizzly bear or 17.5% of a home range of a female grizzly bear assuming all habitat lost falls within one bear's home range. Assuming a grizzly bear density estimate similar to that within an area encompassing the CEA boundary of four bears per 100,000 ha, and an even distribution of habitat loss or alteration within the CEA boundary, an average of approximately 49 ha of habitat per bear may be altered which is equivalent to < 0.1% of home range of a male or female grizzly bear per bear. As this amount of habitat loss is small relative to the amount of habitat in the CEA boundary the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local , the frequency is sporadic, as habitat loss would occur during construction periods for each Project, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss were converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for grizzly bears is concluded to be Not Significant.

#### *6.6.4.2 Disturbance due to Noise*

The total additional area of habitat disturbed by noise created by all projects within the CEA boundary is 375,185 ha and 568,416 ha. These areas are equivalent to 2.0% and 3.2% of the CEA boundary for grizzly bears. The maximum area of disturbance is equivalent to 80% of one male grizzly bear home range size or approximately 2.8 female grizzly bear home ranges, respectively. However, the area of disturbance is somewhat spread out over the CEA boundary and assuming a similar density of bears in the CEA boundary to that reported in the literature in an area which contains the CEA boundary (four bears per 100,000 ha; Ross 2002) a total of 758 ha per bear is disturbed. This area is equivalent to < 0.1 to 0.4% of a home range for male and female bears, respectively. These areas represent a small amount of habitat disturbed relative to that available in the CEA boundary for grizzly bears, thus, the magnitude of the effect is considered low.

The extent of the effect of disturbance due to noise is local, the frequency is expected to be continuous for general Project noise and sporadic for noise during blasting activities (dB 108 and

120 Lpeak), but overall, sporadic as aircraft and blasting noise are anticipated to have a greater effect. The duration is considered medium as the effect of disturbance due to noise is expected to subside at closure of the projects. The effect is considered to be reversible as grizzly bears are anticipated to relocate to areas of disturbance once the effect subsides. The probability of the effect occurring is moderate. The confidence in the effect of disturbance due to noise is high, as the effect of disturbance was converted to area calculations and these calculations are conservative as to not dilute the effect in the large CEA boundary and as literature suggests that grizzly bears are known to be sensitive to blasting activities related to mining. However, the confidence in the actual proportion of the area that will be affected is considered medium, as it is anticipated that a much small proportion of the area will be disturbed due to noise. The cumulative residual effect of disturbance due to noise on grizzly bears is concluded to be Not Significant.

#### *6.6.4.3 Attractants*

With mitigation measures applied and assumed similar among projects, the magnitude of the effect of attractants on grizzly bear is determined from the definitions of qualitative effects (Table 6.5-1) is rated as low. The geographic extent is local as the effect will occur close to camps and other infrastructure. The effect of attraction is anticipated to result in a negative effect as bears that become habituated to Project-related attractants may have to be destroyed if they become nuisance bears. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used. The frequency of bears being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is moderate, and confidence is high, as bears are known to be attracted to mining camps, but with effective mitigation the potential to attract bears and cause problem bears is medium. The cumulative residual effect of attractants on grizzly bears is concluded to be Not Significant.

#### *6.6.4.4 Reduction in Reproductive Productivity*

The potential for a reduction in reproductive productivity in grizzly bears depends on the magnitude of all other effects (disturbances) they experience. Disturbance due to noise leading to displacement of female grizzly bears with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young due to bears becoming nuisance animals as a results of being attracted to projects, would likely lead to the greatest effects on grizzly bear populations in the region.

The residual effects of the Project on bears include habitat loss, disturbance due to noise, and attraction. These effects combined can result in a reduction in reproductive productivity in bears. The highest magnitude of any of the residual effects on bears after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on grizzly bears is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of grizzly bears in the regional area. The duration of the effect is expected to be medium term as the effects of reduction in reproductive productivity are anticipated to occur in bad foraging years and recover in good years. The frequency of the effect is anticipated to be sporadic. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the various mines are closed. The effect is anticipated to be regional as grizzly bears have large home ranges and may come into contact with many of the Projects in the CEA boundary. The likelihood that a reduction in reproductive productivity on grizzly bears will occur is unlikely as the Kitikmeot region supports a moderate grizzly bear population and habitat is fairly evenly dispersed throughout the region, thus bears are expected for the most part to avoid contact with the mine and choose alternative habitat in areas that are not disturbed. The confidence in the effect rating is medium as it is unknown how the effects of the

Project on reproduction of grizzly bears may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the cumulative residual effect of reduction of reproductive productivity is concluded to be Not Significant.

### 6.6.5 Significance of Cumulative Residual Effects

The cumulative effects assessment for grizzly bear identified four effects as residual after mitigation as follows and in Table 6.6-4:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- attraction, rated Not Significant;
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Overall, the residual cumulative effect of grizzly bears is **Not Significant**.

## 6.7 TRANSBOUNDARY EFFECTS

Residual effects of the Project on grizzly bears are predicted to occur in both the Project effects assessment and the cumulative effects assessment. However, the CEA boundary is designed to encompass the range of a male grizzly bear and includes habitat within Northwest Territories; thus, the transboundary effects that cross jurisdictional boundaries are accounted for in the cumulative effects assessment for grizzly bear. The overall residual cumulative effect on grizzly bears predicted in the cumulative effects assessment was Not Significant, thus transboundary effects are predicted to be **Not Significant**.

## 6.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC grizzly bear. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) contains the wildlife mitigation and management plans that will be in place to reduce or eliminate potential effects to wildlife including grizzly bears. Mitigation measures specific to grizzly bears are listed in Section 6.5.3 and summarized in Section 6.8.5, Table 6.8-1.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including grizzly bears. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2 — the Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1 — the Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7 — the Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

**Table 6.6-4. Summary of Cumulative Residual Effects to Grizzly Bear and their Significance**

| | Evaluation Criteria | | | Likelihood of Occurrence of Cumulative Residual Effects | | | Significance of Cumulative Residual Effects | | |
|---|---|---|---|---|---|---|---|---|---|
| **Cumulative Residual Effects** | **Direction** *(positive, neutral, negative)* | **Magnitude** *(negligible, low, moderate, high)* | **Duration** *(short, medium, long)* | **Frequency** *(once, sporadic, continuous)* | **Geographic Extent** *(local, regional, beyond regional)* | **Reversibility** *(reversible, reversible with effort, irreversible)* | **Probability** *(unlikely, moderate, likely)* | **Confidence** *(low, medium, high)* | **Not Significant (N), Significant (S), Positive (P)** |
| Habitat Loss | Negative | Low | Long | Sporadic | Local | Irreversible | Likely | High | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | N |
| Attraction | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

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

- Risk Management and Emergency Response Plan: Chapter 3;
- Fuel Management Plan: Chapter 4;
- Spill Contingency Plans: Chapter 5;
- Oil Pollution Emergency Plan: Chapter 6;
- Site Water Monitoring and Management Plan: Chapter 7;
- Ore Storage Management Plan: Chapter 8;
- Mine Waste Rock and Tailings Management Plan: Chapter 9;
- Landfill and Waste Management Plan: Chapter 10;
- Hazardous Materials Management Plan: Chapter 12;
- Explosive Management Plan: Chapter 13;
- Road Management Plan: Chapter 14;
- Shipping Management Plan: Chapter 15;
- Borrow Pits and Quarry Management Plan: Chapter 16;
- Draft Conceptual Fish Offseting Plan (No Net Loss Plan): Chapter 21;
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22;
- Socio-economic Monitoring Plan: Chapter 23; and
- Mine Closure and Reclamation Plan: Chapter 29.

### 6.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of grizzly bear dens. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of the PDAs after the redesign of Project elements. Table 6.8-1 in Section 6.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on grizzly bears.

### 6.8.2 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes eight separate mitigation and management plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to grizzly bears are listed in Section 6.5.3, and listed in Table 6.8-1 in Section 6.8.5.

### 6.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and

scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

### 6.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal-species monitoring.

### 6.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 6.8-1 includes all planned mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on grizzly bears.

**Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Grizzly Bears**

| Mitigation Category | Mitigation Measures |
|---|---|
| **1. Mitigation by Project Design** | |
| | 1. Project infrastructure designed to avoid, where possible, identified grizzly bear sensitive habitat such as identified denning habitat. |
| | 2. Project infrastructure designed to minimize the footprint of infrastructure. |
| | 3. Consideration of the location of the stockpiles and windbreaks to minimize dustfall. |
| | 4. Infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located. |
| | 5. Winter road access corridors only (no all-weather roads for re-supply routes or between the Goose and George Properties). |
| | 6. Winter roads designed to avoid known grizzly bear dens within 1 km of the proposed alignment. |
| | 7. Underground mining, where possible, to reduce noise emitted by the Project for excavating and hauling waste rock. |
| | 8. Infrastructure located close to deposits to keep activities confined to specific areas, and minimize noise-generating activities. |
| | 9. Winter road access only, when grizzly bears are hibernating. |
| | 10. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination. |
| | 11. Berms or other markers built at high walls of quarries to deflect grizzly bear movement. |

*(continued)*

**Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Grizzly Bears (continued)**

| Mitigation Category | Mitigation Measures |
|---|---|
| **1. Mitigation by Project Design (cont'd)** | |
| | 12. Buildings designed and maintained to exclude wildlife to minimize exposure to chemicals that may be stored inside. |
| | 13. Cyanide destruction conducted in the mill. |
| **2. Best Management Practices** | |
| | 1. Pre-construction ground clearing conducted outside of denning periods for grizzly bears, where possible. |
| | 2. Vehicles restricted to site roads, winter roads and quarry footprints during construction and operations outside of the frozen ground period (December to April). |
| | 3. Pre-determined flight paths developed to provide horizontal and vertical buffer distances between flight paths and sensitive grizzly bear habitats (e.g. denning areas), where possible. |
| | 4. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude when possible wherever grizzly bears are observed. |
| | 5. Truck speed limits developed, signage installed to alert drivers of speed limits, and speed limits enforced. |
| | 6. Wildlife will be given the right-of-way on all roads at all times (including within camp and marine laydown area). |
| | 7. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic. Road use restricted only to persons required for Project construction, operations and maintenance. |
| | 8. Bear-proof receptacles used for all waste and wildlife attractants, where possible. |
| | 9. A waste and wildlife attractant management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants. |
| | 10. The use of wildlife-attracting dust suppressants avoided, where possible. |
| | 11. All employees and contractors trained in bear safety procedures. |
| | 12. A policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation, and enforced. |
| | 13. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced. |
| | 14. A policy prohibiting hunting from and within a buffered area along all infrastructure developed and enforced. |
| | 15. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers. |
| | 16. Wildlife exclusion measures implemented if grizzly bears are frequently accessing or attempting to access waste storage areas. |
| | 17. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to grizzly bears. |
| | 18. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures. |

*(continued)*

**Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Grizzly Bears (completed)**

| Mitigation Category | Mitigation Measures |
|---|---|
| **3. Adaptive Management** | |
| | 1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included:<br>• if negative wildlife interactions become a concern, or<br>• if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.<br>2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies. |
| **4. Monitoring** | |
| | A facility-specific monitoring program will assess the effectiveness of mitigation measures used to minimize effects of the Project on grizzly bears. This plan may include:<br>1. footprint monitoring to monitor habitat loss;<br>2. human activity monitoring of Project site roads and winter roads;<br>3. noise monitoring to monitor disturbance to wildlife;<br>4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes;<br>5. fence and skirting monitoring to ensure that fences are operational and effective at excluding grizzly bears without causing them harm;<br>6. wildlife-vehicle interaction monitoring to document grizzly bear-vehicle collisions, to identify sections of road where grizzly bears might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and<br>7. incidental wildlife reporting to record grizzly bear activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible.<br>Focal-species monitoring program to evaluate predictions in the effects assessment on grizzly bears. This plan may include:<br>1. a monitoring program using remote cameras in the wildlife RSA to assess the zone of influence of the Project on grizzly bears; and<br>2. incidental reporting of grizzly bear observations during other wildlife and environmental monitoring programs |

## 6.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.

2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to grizzly bears are summarized in the following sections.

### 6.9.1 Wildlife Mitigation and Monitoring Plan

#### *6.9.1.1 Facility-specific Monitoring*

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area and George Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human Activity Monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

The objective of the waste management monitoring is to reduce the effects of attraction to grizzly bear and other wildlife. Waste disposal facilities will be monitored frequently to ensure that wastes are being properly disposed of. Waste facilities will be inspected for signs of wildlife activity (e.g., chew marks on waste, wildlife mediated waste dispersion, wildlife scat or tracks). Any incidents where wildlife have been observed to interact directly with wastes, or observations of habituated wildlife (particularly bears) will be reported to Project Environment Team and the Department of Environment,

Nunavut. Problem wildlife will be evaluated by Environment Team and corrective measures implemented in consultation with the Nunavut Department of Environment.

#### *6.9.1.2 Focal-species Monitoring*

The proposed focal-species monitoring program will include monitoring grizzly bear by remote motion-triggered cameras. Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013c, 2014b). Grizzly bears along with other wildlife are often recorded by these cameras. The use of remote cameras for annual monitoring of caribou is currently proposed for the focal-species monitoring of grizzly bears, and part of the Cumulative Wildlife Effects Monitoring Program in the WEMP (Section 8.3.1 of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20)). Incidental observations of grizzly bears detected by remote camera along with incidental observations during other wildlife monitoring surveys will continue to be recorded.

The four objectives of this monitoring program are to:

1. monitor the Project site to examine how grizzly bear interact with Project facilities (e.g., on roads, pits);
2. monitor the Project site at areas with and without mitigation structures or activities to evaluate the efficacy of mitigation activities;
3. monitor areas identified as important for grizzly bears from land user knowledge (e.g., eskers) and at points with high number of grizzly bears identified during baseline surveys (e.g., the habitat along the shoreline of Bathurst Inlet near the MLA); and
4. record the times at which grizzly bear use the wildlife RSA during the year.

Methods for data management and analysis will follow those for caribou detailed in the WEMP (Section 8.3.1 of the Wildlife Mitigation and Monitoring plan (Volume 10, Chapter 20)).

## 6.10 IMPACT STATEMENT

Grizzly bears were included as a valued ecosystem component for the DEIS. A review of the potential Project iterations with grizzly bears identified seven potential effects that may occur. These seven potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct and indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other proposed effects.

The effects assessment included the identification of key indicators and quantitative thresholds for evaluation of potential effects. The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on bears and concluded that four of the potential effects would remain as residual effects after mitigation: habitat loss, disturbance due to noise, attraction and reproductive productivity. Using the key indicators and thresholds, each of these effects were rated with a low magnitude and overall were rated as **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20).

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population

decline. The residual effects anticipated to contribute the most to a negative effect on the grizzly bear population are those attributed to attraction. While the most current mitigation measures are proposed for the Project, effects of attraction on grizzly bears have been recorded at other existing projects with similar mitigation measures. However, with proper follow-up through adaptive mitigation and management, the effect of attraction on grizzly bears is anticipated to be small.

A cumulative effects assessment was conducted because residual Project effects were predicted and other projects occur within the movement area defined for bears that interact with the Project. Four potential cumulative effects were evaluated for the cumulative effects assessment: habitat loss, disturbance due to noise, attraction and reproductive productivity. Key indicators were calculated for those where data was available and residual cumulative effects were predicted for all four potential effects. Each residual cumulative effect was rated by using threshold values and determined to have a low magnitude effect on the grizzly bear population within the cumulative effects assessment area.

It is anticipated that all projects within the CEA boundary will likely have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on grizzly bears in the CEA boundary. The overall effect of the Project on the VEC grizzly bear is **Not Significant**.

# 7. Muskox

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# 7. Muskox

## 7.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 7.1.1 Introduction

Muskox (*Ovibos moschatus*) and caribou are the only abundant ungulate species that live on the tundra year round (Larter and Nagy 2004). Muskox were close to extinction in the late nineteenth and early twentieth centuries due to overhunting (Fournier and Gunn 1998; Campbell and Setterington 2001). A hunting moratorium was enacted by the Canadian Government in 1917, and then lifted in 1969 (Giroux et al. 2012). The Inuit have remarked on the expansion in distribution and numbers of muskox since the 1960s. In the last three decades, muskox numbers have increased and most populations have recovered throughout the historic range (Fournier and Gunn 1998; Campbell and Setterington 2001).

Muskox are large herbivores and a key species in the tundra trophic food chain. Muskox feed on riparian shrubs, in wet meadows, and in winter dig craters to find willows and grasses. Muskox comprise an important food source for wolves and to a lesser degree, grizzly bears (Gunn and Miller 1982; Reynolds, Wilson, and Klein 2002; Wiebe et al. 2009; Mech 2010). Muskox are highly valued by the Inuit as a source of food, hides, horns, and wool, as well as for the commercial export of meat. These ungulates also attract tourists to Nunavut for guided sport hunting and wildlife viewing.

Inuit Traditional Knowledge indicates that muskox are sparely distributed within the Back River Project (the Project) wildlife Regional Study Area (wildlife RSA). Muskox were hunted by the Inuit when caribou and seals were not available. Inuit did not hunt muskox during the summer months as the meat is not as good to eat during this season and the pelts were poor quality. Besides meat, muskox provided bedding, dog mats, and the horns are made into a wide assortment of tools and crafts (KIA 2012).

### 7.1.2 Population Trends and Conservation

The population size in 1997 of muskox in Nunavut and the Northwest Territories was estimated as 140,000 animals, about 85% (119,000) of which occurred on the Canadian Arctic islands (Fournier and Gunn 1998). In 2001, muskox numbers in Canada were estimated as having increased to 166,000 animals (Gunn and Adamczewski 2003).

Though population size has been estimated, there has been no large scale assessment of muskox population trends in Nunavut. However, similar to caribou, the population size of muskox likely naturally fluctuates in response to snow depth (i.e., food availability) and predator numbers (Reynolds, Wilson, and Klein 2002). Like caribou, muskox populations periodically have large-scale die-offs, which may be due to starvation following rain-on-snow events that form ice crusts too thick to dig through (Nagy, Gunn, and Wright 2009a). On Banks Island, thousands of muskox died, resulting in a population decline of 50% between 2001 and 2005 (Nagy, Gunn, and Wright 2009b). This has been attributed to starvation following icing (Nagy, Gunn, and Wright 2009a, 2009b); however, the cause of Arctic ungulate die-offs has yet to be unequivocally related to icing (Tyler 2010). An alternative explanation is disease (Larter and Nagy 1999; Kutz et al. 2004). The Government of Nunavut estimates that there are 19 populations of muskox within Nunavut. Muskox that occur within the Project area are referred to as the central mainland population, which occur within the MX14 and MX19 management zones (Dumond 2006). Surveys were conducted for muskox in the MX14 and MX19 management zones in 1986, 1991, and 2005 (Dumond 2007). In 1986, the number of muskox between northeast Contwoyto Lake and southwestern Bathurst Inlet was estimated at $3,400 \pm 460$ animals from counts made during a

systematic strip transect survey (Gunn 1990) This 1986 survey area overlapped the northern wildlife RSA along the western shores of Bathurst Inlet south to Bathurst Lake, and in the southern wildlife RSA around the Back River and Beechey Lake. In August 2005, the Government of Nunavut extended the surveyed area to include the region between Coppermine River and Bathurst Inlet (Dumond 2007), which also covered areas in the wildlife RSA between Bathurst Lake and Beechey Lake not surveyed in 1986. During the 2005 survey, 732 adult muskox were observed along transects, which resulted in a population estimate of 2,560 ± 460 animals (Dumond 2007). On both population surveys, muskox were observed at densities much less than 1 animal per kilometre surveyed. Results indicate that between 1986 and 2005, muskox increased in the western extent of the survey area, but decreased significantly in the eastern extent. Thus, although the abundance of muskox in the Kitikmeot region has been increasing over the past three decades (Fournier and Gunn 1998), these survey data and observations from hunters suggest that mainland populations, including that within the area of the wildlife RSA, have been declining (Dumond 2007).

The Department of Environment in Nunavut recommends a total annual harvest (TAH) of 4% (240 adult muskox) for the muskox population in the MX14 management zone (Dumond 2006); Management Zone MX14 overlaps with much of the northern wildlife RSA surrounding Bathurst Inlet south to the George Property Area. On the West Kitikmeot mainland, Bathurst Inlet harvests of muskox for subsistence or sport hunts are between 20 and 30 animals annually (M. Dumond, GN DOE, personal comm.). Kugluktuk harvests of muskox are between 35 and 50 animals annually. Harvest statistics from Bathurst Inlet and Kugluktuk include muskox hunts near Contwoyto Lake and Pellat Lake, areas which are located approximately 150 to 175 km to the west of the Goose Property Area and roughly 125 to 150 km to the south-southwest of the George Property Area.

Muskox are presently designated as “Secure” in Nunavut (CESCC 2010). Muskox are sensitive to disturbance during the calving season (late March through May), disturbance to herds that culminates in stampeding behaviour can cause calves to be trampled or abandoned (Gunn 1984). Muskox is managed and protected as a big game species within the *Nunavut Wildlife Act*.

Impacts of climate change will have uncertain effects on muskox. Climatic shifts in winter weather have been known to affect muskox populations in Greenland (e.g., Forchhammer et al. 2002). Climate change in the last four decades appears to have accelerated the development of parasitic lungworms (*Umingmakstrongylus pallikuukensispallikuukensis*) in Arctic muskox populations (Kutz et al. 2005). Additional impacts of climate change are shifting vegetation communities. Some shifts in vegetation communities may be beneficial to muskox, particularly increases in shrubby vegetation which constitutes much of the muskox’s seasonal diet (Section 7.1.3).

### 7.1.3 Distribution and Migration Patterns

The global range of muskox extend across most Arctic islands, northern Greenland, and most of the Canadian tundra, including the Kitikmeot region of Nunavut (Gunn and Adamczewski 2003). Muskox are found throughout the Kitikmeot region at relatively low densities (Gunn 1990; Dumond 2007). Population surveys conducted in 2005 by Dumond (2007) suggest that muskox occur at low very densities near the Project. The number of individuals counted within Management Zone MX14, which overlaps with the northern wildlife RSA, was 103 (101 adults and 2 calves). The total survey coverage in Management Zone MX14 was 13,645 $km^2$, which results in a density of 7 muskox per 1,000 $km^2$. Inuit Traditional knowledge indicates that muskox are distributed around Contwoyto Lake, Nose Lake, northeast of Nose Lake, and at the south end of Bathurst Lake (KIA 2012).

These animals have relatively small seasonal home ranges, but sometimes can move relatively long distances, up to 140 km, between summer and winter ranges (Reynolds 1998; Gunn and Fournier 2000).

In the winter, muskox home range size varies from 27 to 70 $km^2$ and in the summer the average home range size is 223 $km^2$ (Reynolds 1998). Reflecting their small home ranges, muskox are relatively sedentary in winter, moving on average 1 to 1.5 km/day. Muskox move about twice that distance in summer (average of 2.6 km/day), and movement rates are highest when plant biomass is greatest (Reynolds 1998). A high degree of fidelity to geographic areas observed in Nunavut populations may explain the observation that range contraction does not appear to be correlated with large scale population declines. Muskox continue to occupy preferred sites even after population declines (Dumond 2007; Nagy, Gunn, and Wright 2009a). Muskox herds are larger in winter (average of 28 individuals) as compared to the summer (average of 12 individuals; Gunn and Fournier 2000), likely because suitable forage sites are limited by snow depth and as a defensive strategy against wolf predation (Heard 1992).

### 7.1.4 Habitat Use and Diet

Muskox primarily forage on sedges (*Carex* and *Eriophorum* spp.) and willows (*Salix* spp.) year round. Willows are most nutritious and valuable for muskox in spring when willow leaves are emerging and the plants are easily digested (Gunn and Sutherland 1997; Larter and Nagy 2004; Kristensen et al. 2011). Thus, muskoxen are usually found in moist areas where sedges and willow are abundant including riparian corridors (Reynolds, Wilson, and Klein 2002). Muskox generally birth calves very early in the year, between late March and late May, before vegetation has greened. Similar to caribou, muskox also show a high degree of selectivity for moist sedge meadow during the calving and post-calving periods; upland shrubs are also selected during this time, when emergent willow leaves are more nutritious than later in the season (Reynolds, Wilson, and Klein 2002). The summer and early fall seasons are critical for muskox, as they must accumulate sufficient fat reserves to survive the winter (Reynolds, Wilson, and Klein 2002). Furthermore, there is evidence that the likelihood of pregnancy and successful parturition are positively related to the fat reserves a female accumulates during the summer and early fall (Adamczewski et al. 1998). In the early spring, muskox need to ingest at least 2.58 kg/day of graminoid and forage material and 2.84 kg/day in the summer in order to maintain body weight (Adamczewski et al. 1998). Lactating cows need to eat approximately 48% more food in the summer months than non-breeding muskox due to the energetic costs of lactation (Adamczewski et al. 1998).

Survival and calf productivity of muskox is highly dependent on forage availability in winter (Reynolds, Wilson, and Klein 2002; Barboza and Reynolds 2004). To conserve energy, muskox are sedentary in winter, and thus, sites chosen for over-wintering must contain adequate forage to support the nutritional requirements of the herd. Forage availability depends on snow depth and hardness (Gunn and Adamczewski 2003; Barboza and Reynolds 2004). Key characteristics of over-wintering sites that improve nutritional status of muskox are sites where sedges and grasses are abundant but where snow depth is low (Heard 1992; Reynolds, Wilson, and Klein 2002; Gustine et al. 2011). Typically these sites are lower elevation riparian corridors with windblown vegetated bluffs (Reynolds, Wilson, and Klein 2002).

The major mortality source for muskox is predation by the grey wolf (Mech 2005). As with all Arctic mammals, disease and extreme weather events (icing) can cause local or regional die-offs (Nagy, Gunn, and Wright 2009a). To a lesser degree, grizzly bears will also prey on muskox in the summer (Heard 1992).

### 7.1.5 Baseline Data for Muskox

Two types of baseline data are available for muskox. Firstly, aerial surveys were conducted during baseline studies for the Project, and at nearby developments; these studies provide numbers and distribution of muskox in the area surrounding the Project during various times of the year. Secondly, habitat suitability mapping was conducted to evaluate the quality of habitat within and surrounding the Project for muskox throughout the year.

Baseline information for muskox used in this section included the following reports:

- *Back River and Hackett River Projects*: *2010 Caribou and Muskox Baseline Report* (Rescan 2011a, Appendix V5-5E).
- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012, Appendix V5-5D); and
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013d, Appendix V5-5C);
- *Back River Project: 2013 Wildlife Habitat Suitability Baseline* (Rescan 2013b, Appendix V5-5A).

The results of the 2013 wildlife baseline program will be available in 2014.

Other sources of supplementary wildlife data used for muskox in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *Bathurst Inlet Port and Road Project: Caribou and Muskox Baseline Study* (Rescan 2007b);
- *2008 Wildlife Baseline Report Hackett River Project* (Rescan 2008);
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008); and
- *Bathurst Inlet Port and Road Project: Wildlife Baseline studies, 2001-2002* (Rescan 2007c).

### *7.1.5.1 Aerial Surveys*

Aerial surveys were flown 2001, 2002, 2007, 2008, and 2010 during the spring and/or summer. The surveys in 2001 and 2002 were conducted along the Proposed Bathurst Inlet and Road (BIPR) project corridor and included much of the northern portion of the wildlife RSA for terrestrial wildlife (Figure 7.1-1). Surveys in 2007, 2008 and 2010 followed pre-determined parallel transect lines that were spaced 8 km apart within the wildlife RSA. Total survey length was approximately 1,400 transect km representing about 12.5% of the wildlife RSA. Duration of the surveys was between 14 to 15 hours over two days and there were three observers per survey flight. In 2007, five aerial surveys were conducted in May, June, early July, late July, and September. In 2008, two surveys were conducted in May and June and in 2010, aerial surveys were conducted on May, June, and July. These surveys were done in conjunction with the caribou surveys (Volume 5, Chapter 5). No aerial surveys were carried out in 2011 and 2012; however, incidental observations of muskox were recorded during all baseline studies. Full details on survey methodology can be found in the 2001-2002, 2007, 2008, and 2010 Wildlife Baseline Reports (Rescan 2007b, 2007c; Gartner Lee Ltd. 2008; Rescan 2008, 2011a, Appendix V5-5E).

Observations of muskox were made during nearly all of the aerial surveys. Wildlife biologists conducting the surveys noted that a large group of muskox (> 30 animals) were routinely observed on the low, shelving hills, to the west of Bathurst Inlet. The Inuit have also noted that muskox are present on western side of Bathurst Inlet, but that they are more common on the east side of Bathurst Inlet in comparison to the west side (KIA 2012). Most surveys also recorded one to two additional groups of muskox in the survey area, although their location was not consistent between surveys. Most muskox were observed in groups, with few animals observed in associations of less than 4 individuals.

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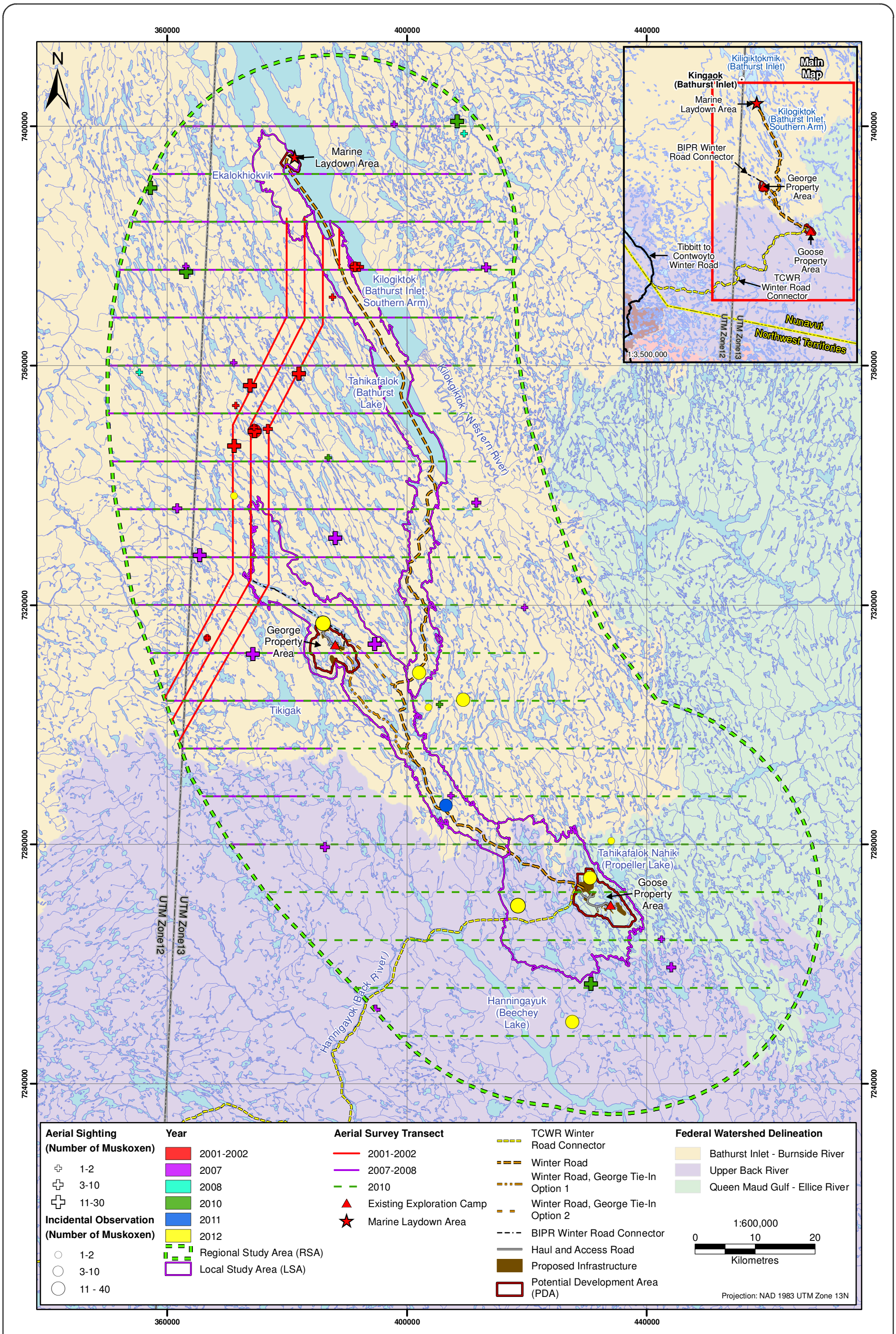


Figure 7.1-1

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# Muskox Observations in the Regional Study Area (2001 to 2012)

Figure 7.1-1

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During the aerial surveys, muskox were recorded throughout the wildlife RSA at relatively low densities during all years surveyed. In relation to Project areas, muskox have been observed within 2 km of the George Camp and near Project infrastructure sites at the Goose Property in 2012. Muskox have also frequently observed along the western shores of Bathurst Inlet within several kilometres of the Marine Laydown Area (MLA; Figure 7.1-1).

Baseline data collection consisted of both aerial surveys and incidental observations. Across surveys in 2001 and 2002, a total of 219 muskox were observed on transect along the BIPR road, with another 56 individuals recorded off transect. Muskox were also recorded during ground surveys; 106 individuals were recorded during the summer of 2001. While average densities within survey areas were low (less than one animal per square kilometre across surveys and years), the highest numbers of animals were detected near the Bathurst Inlet and Contwoyto Lake (Rescan 2007c). A total of 54 muskox were recorded in 2007 with an additional 147 observed off transect (> 500 m; Rescan 2007b; Gartner Lee Ltd. 2008). Of the 98 muskox observed in 2007, 84 were adults and 14 were calves; group size ranged from 1 to 18 individuals. In 2008, two groups of muskox consisting of two adults each, were recorded, one during each scheduled survey (Rescan 2008). In 2010, 87 were observed on transect during the aerial surveys with an additional 34 observed off transect mostly in the Bathurst Inlet area. Of the 87 muskox observed on transect, 82 adults and 5 calves were recorded; group size ranged from 1 to 34 individuals (Rescan 2011a, Appendix V5-5E).

Incidental observations in 2011 and 2012 recorded 3 and 114 muskox respectively in the wildlife RSA (Rescan 2012, Appendix V5-5D; Rescan 2013d, Appendix V5-5C). Ten separate incidental observations of muskox were observed in the wildlife RSA in 2012. Of these, five observations were made of herds with greater than 10 individuals. Calves, although low in number, were recorded in two of the herds observed. The large number of muskox in 2012 potentially represents repeated counts of the same herds as observations were made in relatively the same area within a few days. Two observations of herds of approximately 15 to 17 individuals were noted south-east of the George Property and several observations of herds of approximately 20 - 31 individuals were recorded near the Goose Property. There were no incidental observations of muskox captured during the remote camera surveys.

### *7.1.5.2 Habitat Suitability Ratings*

Overview

Wildlife habitat suitability studies were conducted within the wildlife Local Study Area (wildlife LSA) and wildlife RSA to inventory and rate the habitat types for muskox and quantify suitable habitat available for this species. These data can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Sciety (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA, with Geobase Land Cover data used to infill data gaps from the WKSS data set (Rescan 2013b, Appendix V5-5A). Ecosystems identified in this vegetation map were then rated for their value for wildlife within a specified season or for a specific use. Muskox habitat suitability was assessed for the summer and fall combined (June 1 to September 30) and the winter and early spring combined (October 1 to May 31).

The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 km$^2$ of the West Kitikmeot / Slave Study Area, which stretches from the Arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001). The GeoBase Land Cover data, circa 2000, was derived from multiple sources including Landsat 5 and 7 imagery from a partnership of provincial, territorial, and federal agencies (GeoBase 2009).

For continuity of habitat suitability results across the Project study areas, the regional ecosystem mapping was used to identify habitat quality for wildlife within both the wildlife LSA and RSA. Additional ecosystem mapping techniques were employed within the wildlife LSA (for more details, see the 2012 Ecosystems and Vegetation Baseline Report; Rescan 2013a, Appendix V5-4A). Full details of the wildlife habitat suitability mapping can be found in Rescan (2013b).

Results

The results of the habitat suitability modelling indicate that high value summer and fall habitat in both the wildlife LSA (18%) and wildlife RSA (13%) is less common than low value habitat, which comprises the majority of the wildlife LSA (55%) and wildlife RSA (56%; Figure 7.1-2; Table 7.1-1). During the winter and early spring months, 4% of the wildlife LSA and 6% of the wildlife RSA was mapped high value habitat (Figure 7.1-3). Low to Moderate habitat make up the majority of both the wildlife LSA and the wildlife RSA during the winter and early spring (Table 7.1-1). Nil rated habitat is considerably higher for both the wildlife LSA and wildlife RSA during the winter and spring season relative to the summer and fall, a result that may be expected given that much of the area in winter and early spring is covered in variable amounts of snow that limits foraging opportunities.

**Table 7.1-1. Muskox Seasonal Habitat within the Local Study Area and Regional Study Area**

| | Amount of Habitat in the LSA | | Amount of Habitat in the RSA | |
|---|---|---|---|---|
| **Suitability Rating** | **Area (ha)[1]** | **% of LSA[1]** | **Area (ha)[2]** | **% of RSA[1]** |
| ***Summer and Fall*** | | | | |
| High | 23,880 | 18 | 168,222 | 13 |
| Moderate | 25,921 | 19 | 314,381 | 25 |
| Low | 73,816 | 55 | 702,003 | 56 |
| Nil | 10,314 | 8 | 72,547 | 6 |
| ***Winter and Early Spring*** | | | | |
| High | 5,120 | 4 | 69,629 | 6 |
| Moderate | 34,840 | 26 | 340,442 | 27 |
| Low | 37,032 | 28 | 330,149 | 26 |
| Nil | 56,939 | 43 | 516,932 | 41 |

*Notes:*
*For ease of presentation, hectares are presented as whole numbers and percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.*
*[1] wildlife LSA = 134,369.3 ha, wildlife RSA = 1,262,004.6 ha. Approximately 439 ha of the wildlife LSA and 4,852 ha of the wildlife RSA fell in the Unclassified or No Data classes and was not included in modelling, thus the total amount of habitat modelled in the wildlife LSA is 133,930.3 ha and the total amount of habitat modelled in the wildlife RSA is 1,257,152.6 ha.*
*[2] The wildlife LSA is nested within the wildlife RSA; thus these values include the wildlife LSA.*

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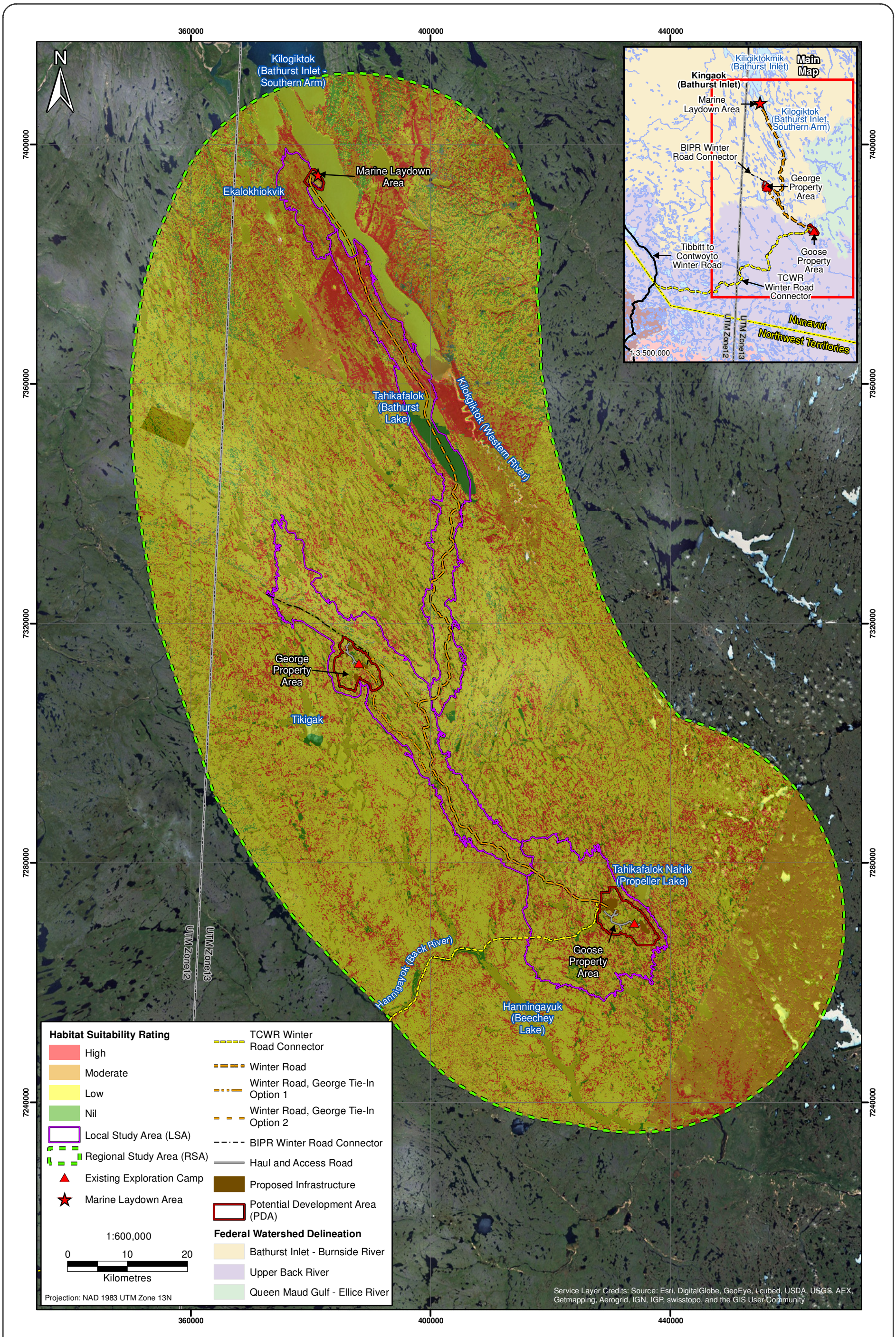


Figure 7.1-2

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# Muskox: Summer and Fall Habitat in the Local Study Area and Regional Study Area

Figure 7.1-2

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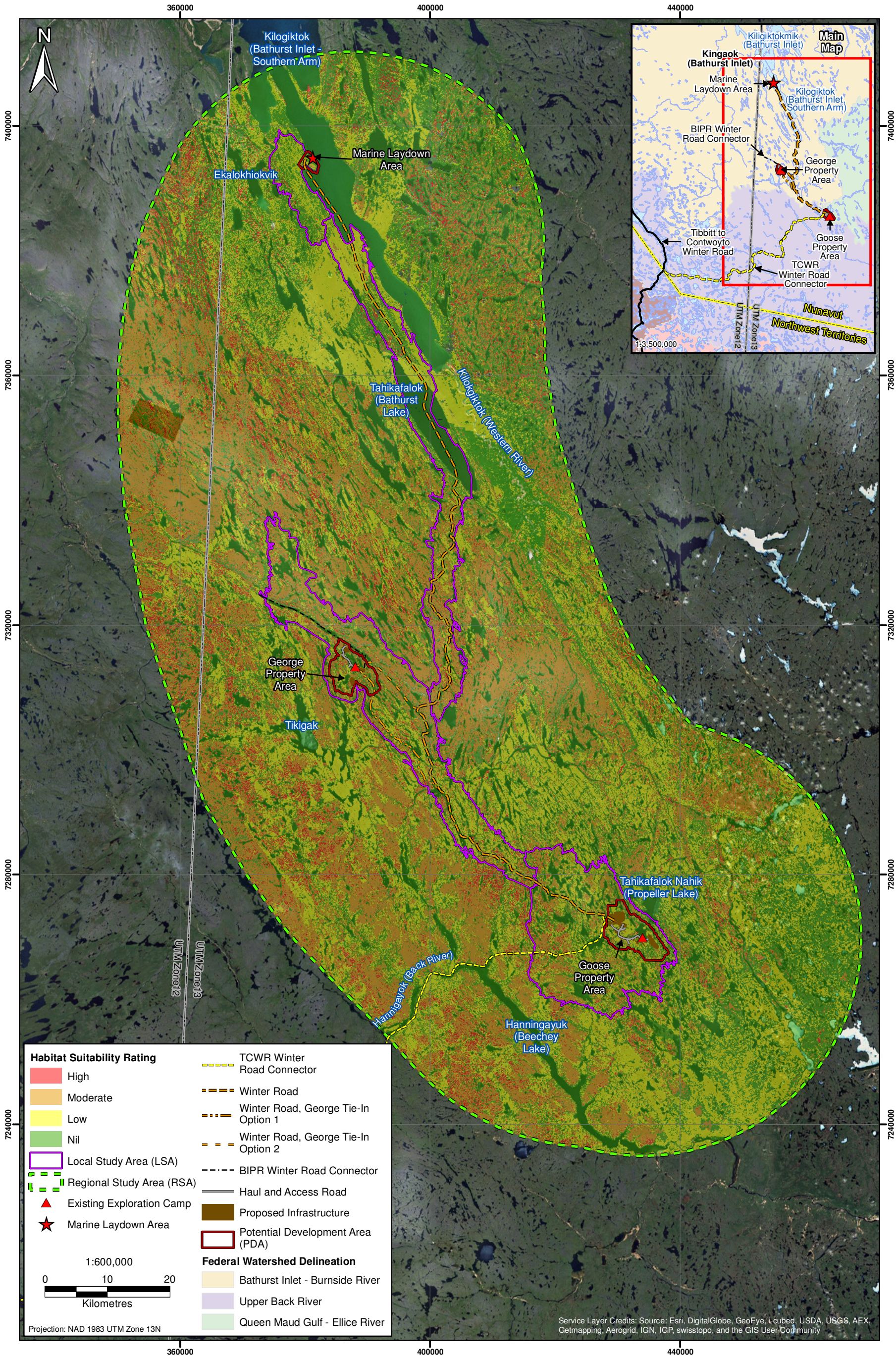


Figure 7.1-3

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# Muskox: Winter and Early Spring Habitat in the Local Study Area and Regional Study Area

Figure 7.1-3

Rescan an ERM company

## 7.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Inuit TK was adapted from the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report, commissioned by Kitikmeot Inuit Association (KIA 2012). Traditional Knowledge indicates that muskox were important animals for Inuit; muskox are hunted when preferred food sources (e.g., caribou, seal) are absent, such as in the winter when caribou are below the treeline (KIA 2012). TK also provided information on the distribution and abundance of muskox in the area of the Project. Muskox are distributed around Contwoyto Lake, Nose Lake, northeast of Nose Lake, and at the south end of Bathurst Lake. The Inuit have also noted that the local population has been rebounding from the population crash in the 1800's and that muskox are now common in areas that had been vacant for years (KIA 2012). Information regarding muskox knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot study communities. Landusers noted that muskox populations on the mainland and on Victoria island declined in 2012 (due to increased predation) and that hunters travelled farther to hunt muskox (Rescan 2013c). The following reports were reviewed for TK specific information related to muskox:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, effects assessment, and recommendations for mitigation and adaptive management.

### 7.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed. Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high-quality habitat, wherever applicable.

### 7.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping

and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As part of this process, muskox was identified as a VEC for the DEIS.

### 7.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modeling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

### 7.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

### 7.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013c), thoughts regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components VSECs that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes, which thereby reduces potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall, and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;

- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds and seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

## 7.3 VALUED COMPONENTS

### 7.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information:

- potential interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or under the NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator, and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members through TK.

### 7.3.2 Valued Components included in Assessment

Muskox were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, muskox were selected as a VEC for the effects assessment.

Muskox are an important food source for the Inuit when caribou or seals are scarce, particularly during the summer and fall (KIA 2012). Muskox are also an important prey species for grizzly bears and wolves. Muskox are particularly sensitive to disturbance during the late winter/calving season (April 1 to June 15; Gunn 1984).

## 7.4 SPATIAL AND TEMPORAL BOUNDARIES

### 7.4.1 Spatial Boundaries

The muskox effects assessment considered two study areas for wildlife inventory for the Project: a local study area (LSA) and a regional study area (RSA; Figure 7.4-1).

#### *7.4.1.1 Local Study Area*

The boundaries of the Local Study Area (LSA) for muskox were set to encompass the following:

- the Goose Property and George Property Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose Property, George Property, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property Area, George Property Area, and MLA. The wildlife LSA covers an area of approximately 134,369 ha (1,344 $km^2$; Figure 7.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

#### *7.4.1.2 Regional Study Area*

The wildlife RSA for muskox encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three Project areas (Goose Property Area, George Property Area, and MLA). The wildlife RSA covers an area of approximately 1,262,005 ha (12,620 $km^2$; Figure 7.4-1). The wildlife RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

### 7.4.2 Temporal Boundaries

The temporal boundaries used for the muskox effects assessment follow the time periods of the phases of the Project as presented in Table 7.4-1.

**Table 7.4-1. Temporal Boundaries — Project Phase Durations**

| Activities | Duration |
|---|---|
| Site Preparation | 2 years |
| Construction phase | 2 years |
| Operational phase | 10 years |
| Reclamation and Closure phase | 10 years |
| Post-closure phase | 5 years |
| *Other Potential Phases* | |
| Temporary Closure | Less than 2 years |
| Care and Maintenance phase | 2 to 10 years |

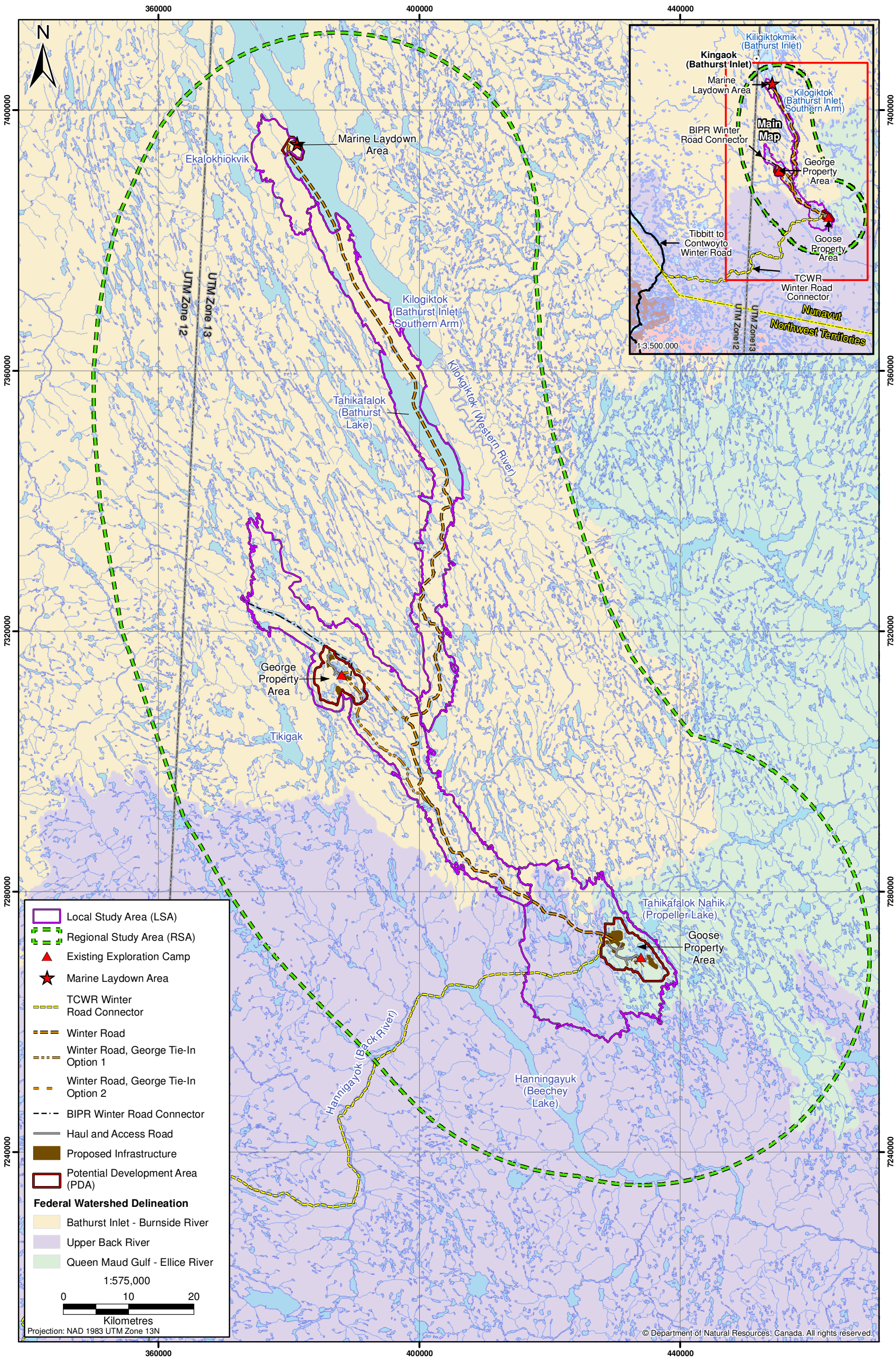


Figure 7.4-1

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## Local Study Area and Regional Study Area for Muskox

Figure 7.4-1

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## 7.5 PROJECT-RELATED EFFECTS ASSESSMENT

### 7.5.1 Methodology Overview

The effect assessment process comprises a stepwise method to assess the potential effects of the Project on muskox as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

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

The potential effects of the Project on muskox are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

#### *7.5.1.1 Indicators Used to Characterize Potential Effects*

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 7.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of potential residual effects. For other potential effects, indicator values were qualitative in nature in the form of 'yes' or 'no' where triggering of residual effects assessment occurred if the indicator value was 'yes'.

**Table 7.5-1. Criteria and Indicators Used to Characterize Potential Effects on Muskox**

| Potential Effect | Criteria | Indicator |
|---|---|---|
| Habitat Loss | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disturbance due to Noise | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disruption to Movement | Change in Population Health | Traffic timing, and traffic volume |
| Direct Mortality and Injury | Change in Population Health | Traffic timing, and traffic volume, and vehicle speed |
| Indirect Mortality | Change in Population Health | Predicted increase in human access to wildlife RSA |
| Attraction | Change in Population Health | Evidence collected at similar Projects in Nunavut and Northwest Territories |
| Exposure to Contaminants | Change in Population Health | Predicted Hazard Quotients for metals in environmental media and wildlife |
| Reduction in Reproductive Productivity | Change in Population Health | Literature suggests combined residual effects on muskox |

### *7.5.1.2 Magnitude Ratings for Residual Effects*

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 7.5-2).

**Table 7.5-2. Definitions of the Magnitude Ratings for Population Health Criterion**

| Magnitude Rating | Magnitude Descriptor of Criteria (Population Health) |
|---|---|
| Negligible | No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%. |
| Low | Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%. |
| Moderate | Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%. |
| High | Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was >20%. |

*Note: Quantitative indicator thresholds for Habitat Loss and Disturbance due to Noise were included for determining the effect on the sub-population. For all other effects professional judgment and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.*

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

### *7.5.1.3 Overall Significance Ratings for Residual Effects*

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 7.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria. Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 7.5-3). For example, a residual effect receives a rating of 'not significant' if it is expected to be one of the following: negligible or low magnitude, confined to wildlife LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

**Table 7.5-3. Definitions of Significance Ratings for Residual Effects on Muskox**

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

Finally, the degree of uncertainty in the rating was provided as a qualifier.

### 7.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VEC muskox and the Project is provided in Volume 9, Chapter 1. Potential effects on muskox and muskox habitat from the Project have been included based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, and a review of scientific literature of the effects of developments on muskox. The effects of mining developments in the Arctic have been documented through monitoring programs at the Lupin gold Mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Hope Bay mine (Rescan 2011b, 2013e).

Potential effects on muskox from the Project have been scoped based on NIRB guidelines. Interactions of muskox with Project components were evaluated to determine which of the following potential effects may occur (Table 7.5-4):

- habitat loss;
- disturbance due to noise (e.g., displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g., due to increased access and associated increase in hunting);
- attraction to infrastructure;
- exposure to contaminants; and
- reduction in reproductive productivity due to combined effects of the Project.

**Table 7.5-4. Potential Project-related Effects in Muskox in the Goose Property Area, the George Property Area, and the Marine Laydown Area**

| Potential Development Area<br>Project Component | Habitat Loss | Disturbance due to Noise | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity |
|---|---|---|---|---|---|---|---|---|
| ***Goose Property Area*** | | | | | | | | |
| Open Pits (Main (Goose, Umwelt, and Llama) | X | X | | | | | | X |
| Haul and access roads | X | X | X | X | X | | | X |
| Winter Roads | X | X | X | X | X | X | | X |
| Stockpiles | X | X | | | | | | X |
| Waste rock storage areas | X | X | | | | | X | X |
| Explosives storage areas | X | | | | | | X | X |
| Tailings Impoundment Area | X | X | | | | | X | X |
| Quarries | X | X | | | | | | X |
| Landfill | X | X | | | | | | X |
| Camp / Plant site | X | X | | | | | X | X |
| Airstrip | X | X | X | X | | | | X |
| Other infrastructure (diversion channels, water intakes) | X | | | | | | | X |
| ***George Property Area*** | | | | | | | | |
| Open Pits (LCP North, Locale 1,and Locale 2) | X | X | | | | | | X |
| Haul and access roads | X | X | X | X | X | | | X |
| Winter Roads | X | X | X | X | X | X | | X |
| Stockpiles | X | X | | | | | | X |
| Waste rock storage areas | X | X | | | | | X | X |
| Explosives storage areas | X | | | | | | X | X |
| Landfill | X | X | | | | | | X |
| Camp | X | X | | | | | X | X |
| Other infrastructure (water intake) | X | | | | | | | X |
| ***Marine Laydown Area*** | | | | | | | | |
| Camp | X | X | | | | | X | X |
| Barge landing location | X | X | | | | | X | X |
| Haul and access roads | X | X | X | X | X | | | X |
| Winter Roads | X | X | X | X | X | X | | X |
| Other infrastructure (interception ditch) | X | | | | | | | X |

Muskox can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of high-quality foraging habitat. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development. For these reasons, habitat loss was included and evaluated in this assessment.

Disturbances, including visual and auditory stimuli, can cause muskox to alter their regular behaviour patterns, resulting in lost feeding time, stress, reduced reproductive potential, or avoidance of disturbed areas (McLaren and Green 1985). For example, muskox herds often run from people on foot, snowmobiles or other vehicles (Gray 1973; Russell 1975). Very young calves can be left behind when muskox herds run from a disturbance (Gunn and Adamczewski 2003). For these reasons, potential effects of disturbance on muskox were included in this assessment.

Muskox are resident on the tundra and occupy small seasonal home ranges in comparison to other ungulates (e.g., caribou). Muskox can undergo movements up to 140 km between seasonal ranges used for calving and wintering, and areas used during the summer and fall rut (Reynolds 1998; Gunn and Fournier 2000). When dispersing, males may move short distances from the herd it was associated with (~38 km), or they may make a longer distance movement (~101 km; Smith 1989). The Goose and George Properties, the MLA, and the winter roads may disrupt movement of muskox by bisecting home ranges or impeding dispersal. Linear developments such as roads have been shown to fragment wildlife habitat across many taxa (Jalkotzy, Ross, and Nasserden 1997). For this reason, potential effects of disruption of movement on muskox were included in this assessment.

Direct mortality and injury can result from vehicle strikes with wildlife. Frequency of mortality and injury is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to muskox also increases. As muskox are year-round residents on the tundra and the Project will have all-weather site roads as well as winter road connecting the PDAs, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed Project roads. Roads increase access and can create opportunities for illegal hunting (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Project infrastructure such as winter road alignments may act as attractants to muskox for ease of travel during the winter, which could subsequently lead to increased vehicle-muskox interactions and muskox mortality. Thus, the effect of attraction is included as a potential effect in the assessment.

Wildlife can be exposed to contaminants due to the Project through ingestion of water or through the food chain. For this reason, exposure to contaminants was included as a potential effect in the assessment, and was evaluated through a formal risk assessment conducted as part of the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6).

Some of the environmental effects discussed above have the potential to affect the reproductive potential of muskox, particularly when they act in a synergistic fashion. For example, habitat loss and degradation, disturbance due to noise, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. This cascade of effects may be of the greatest concern during sensitive periods for muskox (i.e., calving in April and May, and rutting in the fall). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time

may have greater consequences on the overall fitness of individuals. Therefore, the effect of reduction in reproductive productivity is included as a potential effect in the assessment.

Each potential effect is identified for each Potential Development Area (PDA) and key infrastructure/ activity in Table 7.5-4.

#### *7.5.2.1 Habitat Loss*

As part of the development of the Project, wildlife habitat will be lost and potentially degraded. To minimize these effects, the location of Project infrastructure was planned to avoid wildlife sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Wildlife habitat may also be indirectly lost if wildlife species avoid the Project area due to noise disturbance, which is described in Section 7.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operational phases of the Project. Wildlife habitat will be removed and degraded during Project development. Habitat degradation due to dust around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987a). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation are proposed for the Project.

The assessment of habitat loss focuses on the total amounts of lost habitat at the end of the Operational phase, which is the largest extent of the Project footprint. To facilitate the analysis of habitat loss for muskox, the entire area of each PDA (Goose Property Area, George Property Area, MLA) is assumed to be lost. This analysis overestimates the true amount of habitat loss due to Project development, as the entire PDA will not be developed. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The winter roads were also considered for habitat loss for muskox during the winter, as this species is present in the wildlife RSA year round. The PDA for winter roads is designed to be very conservative area, and includes a 200 m corridor along each alignment (Volume 2). The operation of winter roads could also result in habitat compaction to vegetation due to compressed snow and ice and could result in habitat degradation during the foraging season. However, compaction is anticipated to be relatively minor and is not assessed further.

Calculation of Habitat Loss for Muskox

Habitat loss for muskox was calculated by first identifying two key indicators:

1. Total area: a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs); and
2. High-quality habitat: a calculation of the area of high-quality habitat for muskox that will be lost in the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the wildlife RSA. To put the Project within the context of muskox habitat use, these indicators were also compared to the average home range size of a muskox.

*Total Area of Loss*

The total expected area lost by the PDAs was calculated by summing the areas of loss within each of the PDAs (Goose Property, George Property, MLA, and Winter Road).

The total area of loss is assessed as the net change, in hectares, and expressed as a percentage of area within each spatial boundary. The actual area developed, and subject to habitat loss, will be much smaller, as determined by the final design infrastructure and placement.

In order to place the estimate of total habitat loss into a spatial context for the local muskox population, the area lost is presented as a proportion of an average muskox individual/herd's summer and winter home range that is lost due to Project-related activities. In addition, the area lost is presented in relation to the proportion of individuals that may be affected, assuming a density of 7 animals/1,000 $km^2$ (Dumond 2007).

For the purposes of this assessment, the calculation of total habitat loss and high-quality habitat loss (see following section) within the Winter Road PDA includes the winter roads within the wildlife RSA. The section of the TCWR Winter Road Connector that falls outside of the wildlife RSA is reported as total area only, as habitat suitability data is unavailable outside of the wildlife RSA, and represents an overestimate of habitat loss as lakes were not excluded from these calculations.

*Area of High-quality Habitat Loss*

Habitat loss was further evaluated in the context of the alteration of the high-quality habitat within the PDAs compared to the availability of high-quality habitat in the wildlife LSA and RSA. High-quality habitat is defined as habitat receiving a moderate or high habitat suitability rating (Rescan 2013b, Appendix V5-5A); the availability of high-quality habitat is summarized by season (summer and fall; winter and early spring) and by all seasons combined.

Similar to the total amount of habitat altered, the amount of high-quality habitat altered is presented as 1) the proportion of an average seasonal home range that is lost due to Project-related activities, and, 2) the number of individuals that may be affected by the loss, assuming a density of 7 animals/1,000 $km^2$ (Dumond 2007).

Evaluation of Habitat Loss for Muskox

*Total Area of Loss*

The total area considered as habitat loss within the Goose Property, George Property, and MLA PDAs is 10,237 ha; this area represents the largest anticipated area of habitat loss for muskox during the snow free periods. During the winter, additional habitat loss will take place within the Winter Road PDA. The area of the Winter Road PDA is 5,040 ha, which represents the largest anticipated area of habitat loss in the winter. Thus, the total habitat loss during the winter for muskox is evaluated at 15,277 ha.

The PDAs account for 11.3% of the wildlife LSA and 1.2% of the wildlife RSA (Table 7.5-5). However, the actual loss of habitat in the wildlife LSA and RSA will be much smaller as the design of the Project footprint is much smaller (10 to 15% of the PDAs) than the PDAs assessed as lost.

An additional 3,404 ha of habitat loss will potentially occur as a result of the portion of the TCWR Winter Road Connector that falls outside of the wildlife RSA.

**Table 7.5-5. Habitat Loss within the Project Potential Development Areas (PDAs)**

| Potential Development Area (PDA) | Area Lost (ha) | Proportion of Wildlife LSA (%)[1] | Proportion of Wildlife RSA (%)[1] |
|---|---|---|---|
| George Property Area | 4,226 | 3.1 | 0.3 |
| Goose Property Area | 5,358 | 4.0 | 0.4 |
| Marine Laydown Area | 653 | 0.4 | <0.1 |
| Winter Roads[2] | 5,040 | 3.1 | 0.4 |
| **Total** | **15,277** | **11.3** | **1.2** |

[1] *Wildlife LSA = 134,369 ha, wildlife RSA = 1,262,005 ha*
[2] *Represents area of habitat loss only during the winter.*

The average size of the core winter and summer home ranges for female muskox in Alaska are 7,000 and 22,300 ha, respectively (Reynolds 1998). These females were often in association with a number of other individuals in a herd; therefore, these home range estimates are representative of the size of a herd home range. Herd size is generally larger in the winter (28 individuals) in comparison to the summer (12 individuals; Gunn and Fournier 2000). The size of muskox ranges in Nunavut is not well known but are likely larger based on the research on several collared females in the areas west of Kugluktuk from 1988 to 1991 (Gunn and Fournier 2000). Multiple females were located across an area of over 3,000 $km^2$ during the winter; in the summer, the same individuals dispersed to coastal areas in the summer and were found across a total area of over 15,000 $km^2$ (Gunn and Fournier 2000). For the most part, winter and summer home ranges overlap (Gunn and Fournier 2000).

The total expected habitat loss is equivalent to 46% of the home range of a female/herd during the summer (based on 10,237 ha of habitat lost) and roughly two winter home ranges of a muskox female/herd (based on 15,277 ha of habitat lost). Given the spatial distribution of the PDAs and connecting winter roads, in that each is relatively segregated from one another, it is unlikely that the total habitat altered will take place within one home range of a muskox female/herd. There are likely several herds that are resident in areas surrounding the Project, such as the ones that have consistently been observed around Bathurst Inlet, to the south-east of the George Property, and near the Goose Property during baseline studies (Section 7.1.5.1). Therefore, habitat alteration due to the Project will likely take place within portions of multiple home ranges, and the total habitat alteration within one muskox female/herd's home range will be much less than calculated above.

The most recent population surveys (2005) conducted by Dumond (2007) suggest that muskox occur at low very densities near the Project (7 muskox/1,000 $km^2$; Section 7.1.4). Assuming the density of animals is similar within the wildlife RSA (12,620 $km^2$), approximately 95 muskox may be present in the wildlife RSA and the total habitat loss (15,277 ha; 152.7 $km^2$) may affect roughly 1 muskox that inhabits the area. Alternatively, based on the population estimate of 95 muskox within the wildlife RSA, approximately 161 ha of habitat per muskox may be altered; this alteration represents 2% of a winter home range and 0.7% of a summer home range of a muskox female/herd.

The overall alteration of 15,277 ha due to Project development and activities represents larger proportions of the seasonal home ranges for a muskox female/herd, which is a conservative estimate of the loss for muskox. Given the low numbers of animals observed in the wildlife RSA (Section 7.1.5.1) and the low density observed on recent, regional surveys near the Project, the loss is likely to affect low numbers of individuals.

*Loss of High-quality Habitat*

**Summer and Fall**: A total of 49,801 ha of high-quality summer and fall habitat for muskox was identified within the wildlife LSA (37% of LSA; Tables 7.1-1 and 7.5-5). Roughly 482,602 ha of high-quality summer and fall habitat was mapped within the wildlife RSA (38% of wildlife RSA). Project development within the Goose Property, George Property, and MLA PDAs will result in the direct loss of 3,578 ha of high-quality summer and fall habitat for muskox within the wildlife LSA; an additional 11 ha of habitat loss due to the Goose Property, George Property, and MLA PDAs occurs outside the wildlife LSA, but within the wildlife RSA. Cumulatively, this habitat loss equates to 7% of the habitat available within the wildlife LSA and less than 1% of that available in the wildlife RSA (Table 7.5-6). Comparatively, the total of amount of high-quality habitat altered relative to the wildlife RSA is just slightly less than the total amount of habitat altered relative to the wildlife RSA (1.2%, see above).

**Table 7.5-6. High-quality Muskox Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project**

| | High-quality Habitat (HQH) | | High-quality Habitat Lost or Altered due to Project Footprint[1] | | |
|---|---|---|---|---|---|
| Area/Season | Area (ha) | % Total Area | Potential Development Area without Winter Roads (ha) | Potential Development Area including Winter Roads (ha)[2] | % HQH[3] |
| ***Local Study Area***[4] | | | | | |
| Summer and Fall | 49,801 | 37.1 | 3,567 | 4,915 | 7.2 – 9.9 |
| Winter and Early Spring | 39,959 | 29.7 | 2,743 | 3,332 | 6.9 – 8.3 |
| **All Seasons** | **84,641** | **63.0** | **6,083** | **7,919** | **7.2 - 9.4** |
| ***Regional Study Area***[4] | | | | | |
| Summer and Fall | 482,602 | 38.2 | 3,578 | 5,069 | 0.7 – 1.1 |
| Winter and Early Spring | 410,072 | 32.5 | 2,744 | 3,394 | 0.7 – 0.8 |
| **All Seasons** | **823,045** | **65.2** | **6,094** | **8,121** | **0.7 - 1.0** |

*[1] Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.*
*[2] The inclusion of habitat loss due to winter roads accounts for winter roads that occur within the wildlife LSA or RSA and not the portion of the TWCR Winter Road Connector that falls outside of the wildlife RSA.*
*[3] Range in percent is due to the inclusion and exclusion of the Winter Road PDA.*
*[4] A small amount of the MLA PDA extends outside of the wildlife LSA, as well as portions of the Winter Road PDA. Therefore, the amount of high-quality habitat altered within a season will be slightly different within the wildlife LSA as compared to the wildlife RSA.*

*Winter and Early Spring*: Habitat suitability ratings for muskox identified 39,959 ha of high-quality winter and early spring habitat in the wildlife LSA (30% of wildlife LSA) and 410,072 ha within the wildlife RSA (33% of wildlife RSA; Tables 7.1-1 and 7.5-6). Project development (Goose Property, George Property, MLA, and Winter Road PDAs) will result in the direct loss of 3,332 ha of high-quality habitat within the wildlife LSA; an additional 62 ha of high-quality habitat loss will take place outside the wildlife LSA, but within the wildlife RSA. Cumulatively, this habitat loss is roughly 8% of habitat of equivalent value available in the wildlife LSA, and around 1% of that available in the wildlife RSA. Comparatively, the total of amount of high-quality habitat altered relative to the wildlife RSA is just slightly less than the total amount of habitat altered relative to the wildlife RSA (1.2%, see above).

The overall alteration of 3,578 ha of high-quality summer and fall habitat is equivalent to 16% of the summer home range of a muskox female/herd. However, the loss will likely affect less than one individual, assuming the density of animals within the wildlife RSA is roughly 7 muskox per 1,000 $km^2$.

Based on the population estimate of 95 muskox within the wildlife RSA, approximately 38 ha of high-quality summer and fall habitat per muskox may be altered; this alteration represents much less than 0.01% of a summer home range of a muskox female/herd.

The overall alteration of 3,394 ha of high-quality winter and early spring habitat is equivalent to 48% of the winter home range of a muskox female/herd. However, the loss will likely affect less than one individual, assuming the density of animals within the wildlife RSA is roughly 7 muskox per 1,000 $km^2$. Based on the population estimate of 95 muskox within the wildlife RSA, approximately 36 ha of high-quality winter and early spring habitat per muskox may be altered; this alteration represents 0.5% of a winter home range of a muskox female/herd.

Conservative estimates of the habitat loss for muskox suggest that the overall loss of high-quality habitat is equivalent to one-quarter to one-half of a seasonal home range of a muskox female/herd. However, as mentioned above, habitat alteration due to the Project will likely take place within portions of multiple home ranges of muskox herds that are resident in areas surrounding the Project, and the total habitat alteration within one muskox female/herd's home range will be much less than calculated above. In addition, muskox occur at low densities within the wildlife RSA and the numbers that may be affected by the loss of high-quality habitat are very low (~1 individual). Furthermore, the overall alteration in the context of the proportion of habitat altered per muskox within the wildlife RSA represents very small portions of the total summer and winter home ranges of a muskox.

The loss of habitat for muskox within the wildlife RSA is unavoidable and some of it will be permanent. Despite mitigation to design the mine footprint to be as small as possible, residual effects of habitat loss are expected and evaluated in Section 7.5.4.1.

#### *7.5.2.2 Disturbance due to Noise*

This section evaluates the effects of Project-related disturbance on muskox, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise. Noise affects wildlife species in three primary ways: acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). The source, duration, and intensity of noise all influence the nature and magnitude of wildlife response. First, an acute effect of noise — brief, intense, localized noise (such as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997; AMEC Americas Limited 2005), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

A behavioural response can also occur when animals avoid the source of disturbance sources resulting in the functional loss of that habitat (Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). Mild habitat loss due to noise disturbance can reduce the amount of energy that an animal can intake and result in low level effects. Alternatively, larger scale range shifts can result in large reduction in energy intake and in extreme cases mortality due to unfamiliarity with new habitat and reduced resource base.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a "threshold level".

Studies on the effects aircraft noise on wildlife indicate that "fright" is a common response (Bond et al. 1974), whereby the animal attempts to escape the noise by either running or flying away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to noise disturbances than wildlife occupying forested habitats (McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend large amounts of energy to escape the perceived threat. Potential sources of sensory disturbance for muskox associated with Project activities include:

- blasting noise and ground vibrations from mining and construction;
- General Project noise (e.g. camp noise, human presence, and vehicle traffic); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the Umwelt open pit while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the Construction and Operational phases. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned, while at the MLA, while it is active, a maximum of six flights per week are planned.

Sensitive periods for muskox occur during late winter/calving (April 1 to June 15) and rutting/autumn (August 15 to September 15) when animals are calving and developing fat reserves necessary for reproduction and survival. Late winter/calving is potentially one of the most sensitive period for muskox because animals are in their poorest condition at the end of winter and females have high energetic demands during calving.

Calculation of Area of Disturbance due to Noise for Muskox

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose and George Properties rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise, and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence. Habitat "loss" will occur indirectly for muskox that avoid the zone of influence because they are disturbed within it.

The potential effects of disturbance on muskox were evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case (year three of the Operational phase at the Goose Property and year seven of the Operational phase at the George Property). The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with

increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature where muskox or other wildlife are shown to have behavioural effects from noise.

Threshold noise values were determined from the literature, above which muskox are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for muskox. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 7.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling: Section 7.1.5).

Three types of noise were considered during the Construction and Operational phases: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (Lpeak) or higher for instantaneous noise effects on muskox during Construction and Operational phases. Blasting noise models were conducted during peak noise levels for each of the PDAs: year 3 at the Goose Property PDA and year 7 at the George Property PDA.

General Project-related, or equivalent noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The threshold for general Project noise was 45 dBA. This noise level value was selected based upon the criteria outlined in the Environment Code of Practice for Metal Mines (Environment Canada 2010), which recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas. Specifically, the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night (Environment Canada 2010). Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in muskox habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft and helicopter noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) muskox seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 7.5.2.1), but within the noise level contours for blasting noise (≥ 120 dB representing functionally lost habitat; or ≥ 108 dB representing disturbed habitat), general Project noise (≥ 45 dBA) or noise generated from aircraft (≥ 80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each season within the wildlife RSA and LSA after accounting for habitat loss (Section 7.5.2.1).

Evaluation of Disturbance due to Noise for Muskox

After mitigation, the potential effects of disturbance due to noise from blasing activites, general Project noise and aircraft noise is described below for muskox.

*Blasting Noise*

McLaren and Green (1985) suggested that muskox may be particularly sensitive to distinct changes in noise (e.g., snowmobile start up). Muskox reacted to the start-up and acceleration of snowmobiles at distance of over a kilometre; responses varied from becoming alert to moving away from the source of disturbance (McLaren and Green 1985). Therefore, blasting noises, which involves distinct changes in sound levels over a short time period, may produce similar responses.

A total of 35 ha that falls outside the Goose Property and George Property PDAs will be functionally lost due to noise from blasting above an Lpeak of 120 dB, and an additional 982 ha will be disturbed outside of the Goose Property and George Property PDAs due to noise from blasting with an Lpeak above 108 dB. During year 3 of the Operational phase, blasting from the construction of the Umwelt, Llama and Goose pits at the Goose Property Area will result in 18 ha of habitat (< 0.1% of the wildlife LSA and RSA) functionally lost and an additional 283 ha of habitat (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) disturbed outside of the Goose Property PDA by noise due to blasting activities (Table 7.5-7).

Starting at year 7 of the Operational phase, blasting from the open pit at Locale 1 will result in 17 ha of habitat functionally lost (< 0.1% of the wildlife LSA and RSA), and an additional 359 ha of habitat disturbed (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) outside of the George Property PDA due to noise from blasting activities (Table 7.5-7). It is assumed that blasting in year 8 and 9 at the open pits at LCP North and Locale 2 will be similar to or less than the noise levels due to blasting in year 7 at the open pit at Locale 1.

The amount of high-quality seasonal habitat in the wildlife RSA that is within the area that is functionally lost (≥ 120 dB Lpeak) ranges between 5 ha in the winter and early spring to 11 ha in the summer and fall (Table 7.5-8), which represents less than 0.1% of the available high-quality habitat in the wildlife LSA and RSA after accounting for habitat loss within the PDAs (Section 7.5.2.1). The amount of high-quality habitat that is disturbed (≥ 108 dB Lpeak) ranges between 222 ha in the winter and early spring and 437 ha in the summer and fall, which is equivalent to 0.8% and 0.1% of the available high-quality habitat in the wildlife LSA and RSA, respectively, after accounting for habitat loss. The total amount of high-quality habitat that is functionally lost or disturbed due to blasting is mapped in Figure 7.5-1 for all seasons combined.

*General Project Noise*

Muskox may alter their behaviour in areas with human activity (McLaren and Green 1985). However, some muskox can become tolerant of noise and related industrial activity as was shown by several muskox that spent time in the summer months in close proximity of Lupin mine (Gunn et al. 1997).

**Table 7.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise**

| Project Area | Area Considered Lost to PDAs | | | Additional Area Functionally Lost due to Blasting (120 dBA) | | | Additional Area Disturbed due to Blasting (108 dBA) | | | Additional Area Disturbed due to General Project Noise (45 dBA) | | | Additional Area Disturbed due to Aircraft Noise (80 dBA) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA* | % RSA |
| George Property Area | 4,226 | 3.1 | 0.3 | 17 | <0.1 | <0.1 | 699 | 0.5 | <0.1 | 359 | 0.3 | <0.1 | 11,278 | 8.4 | 0.9 |
| Goose Property Area | 5,358 | 4 | 0.4 | 18 | <0.1 | <0.1 | 283 | 0.2 | <0.1 | 262 | 0.2 | <0.1 | 3,495 | 2.6 | 0.3 |
| MLA | 653 | 0.4 | <0.1 | - | - | - | - | - | - | - | - | - | 12,367 | 9.2 | 1 |
| Winter Roads | 5,040 | 3.8 | 0.4 | - | - | - | - | - | - | 4,977 | 3.7 | 0.4 | - | - | - |
| Total | 15,277 | 11.3 | 1.2 | 35 | <0.1 | <0.1 | 982 | 0.7 | <0.1 | 5,598 | 4.2 | 0.4 | 27,140 | 17.1 | 2.2 |
| Total without Winter Roads | 10,237 | 7.5 | 0.8 | 35 | <0.1 | <0.1 | 982 | 0.7 | <0.1 | 621 | 0.5 | <0.1 | 27,140 | 17.1 | 2.2 |
| TCWR Winter Road Connector Outside Wildlife RSA | 3,404 | - | - | - | - | - | - | - | - | 3,404 | - | - | - | - | - |

**Some of the area of disturbance due to noise falls outside of the wildlife LSA but within the wildlife RSA (see Figure 7.5-1).*

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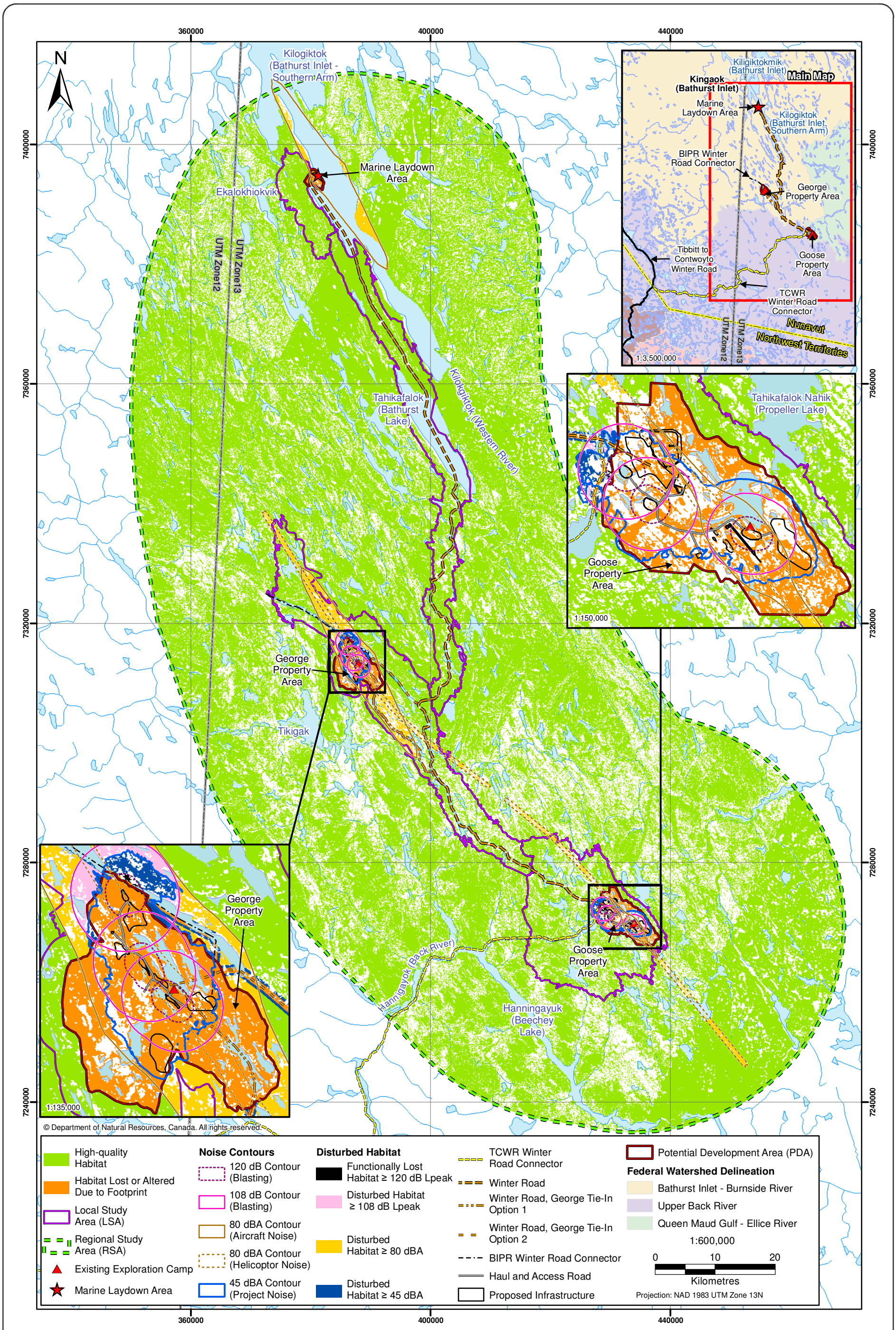


Figure 7.5-1

Sabina GOLD & SILVER CORP.

# Muskox High-quality Habitat Lost, Altered or Disturbed due to the Project

Figure 7.5-1

Rescan an ERM company

**Table 7.5-8. Expected High-Quality Habitat Functionally Lost or Disturbed due to Noise outside of the Project Potential Development Areas**

| Area/Season | High-Quality Habitat (HQH) Available Area (ha) | HQH Lost or Altered due to the Project Footprint | | | Additional Area Functionally Lost[1] due to Blasting (120 dBA) | | Additional Area Disturbed[1] due to Blasting (108 dBA) | | Additional Area Disturbed[1] due to General Project noise (45 dBA)[2] | | Additional Area Disturbed[1] due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area with Winter Roads (ha) | Area without Winter Roads (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH |
| ***Local Study Area*** | | | | | | | | | | | | |
| Summer and Fall | 49,801 | 4,915 | 3,567 | 7.2 - 10.0 | 11 | < 0.1 | 222 | 0.5 | 1,504 | 3.4 | 3,002 | 6.7 |
| Winter and Early Spring | 39,959 | 3,332 | 2,743 | 6.9 - 8.3 | 5 | < 0.1 | 437 | 1.2 | 1,075 | 2.9 | 4,613 | 12.6 |
| All Seasons | 84,641 | 7,919 | 6,083 | 7.2 - 9.4 | 14 | < 0.1 | 624 | 0.8 | 2,378 | 3.1 | 7,096 | 9.2 |
| ***Regional Study Area*** | | | | | | | | | | | | |
| Summer and Fall | 482,602 | 5,069 | 3,578 | 0.7 - 1.1 | 11 | < 0.1 | 222 | < 0.1 | 1,692 | 0.4 | 6,405 | 1.3 |
| Winter and Early Spring | 410,072 | 3,394 | 2,744 | 0.7 - 0.8 | 5 | < 0.1 | 437 | 0.1 | 1,151 | 0.3 | 5,873 | 1.4 |
| All Seasons | 823,045 | 8,121 | 6,094 | 0.7 - 1.0 | 14 | < 0.1 | 624 | 0.1 | 2,637 | 0.3 | 11,564 | 1.4 |

*[1] Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 7.5.2.1).*

*[2] Area of disturbance due to general Project noise (≥ 45 dBA) includes noise generated on winter roads.*

The total amount of area affected by elevated noise levels due to general Project noise (outside of the Goose Property, George Property, MLA, and Winter Road PDAs already considered to be lost; Section 7.5.2.1) is 5,598 ha (Table 7.5-7). A total of 262 ha (0.2% of wildlife LSA and < 0.1% of wildlife RSA) in year three near the Goose Property PDA, and 359 ha (0.3% of wildlife LSA and < 0.1% of wildlife RSA) in year seven near the George Property PDA will be degraded. An additional 4,977 ha of area within the wildlife RSA and 3,404 ha of area outside of the wildlife RSA will be affected by noise due to traffic when the winter roads are functional (Table 7.5-7). A breakdown of the percentage of high-quality habitat lost due to noise disturbance in each season outside of the PDAs can be found in Table 7.5-8. Between the winter and early spring period and the summer and fall period, the percentage of high-quality habitat disturbed outside of the PDAs is minimal (0.4 to 0.5% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 7.5-8; Figure 7.5-1). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise*

Distinct changes in sound have been shown to cause alert and avoidance behaviours in muskox (McLaren and Green 1985). Muskox generally become more alert during disturbance events caused by aircraft (e.g., aerial surveys), and several studies have documented a number of adverse responses to aircraft noise, including stampeding (Miller and Gunn 1979; Olesen 1986 cited in Aastrup and Mosbech 2000).

The total amount of area affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project footprint (Section 7.5.2.1) is 27,140 ha (2.2% of wildlife RSA). Approximately 3,495 hectares outside of the Goose Property PDA will be affected by aircraft accessing the Goose Property (Table 7.5-6). An additional 11,278 hectares that falls outside the George Property PDA will be disturbed by aircraft accessing the George Property (Table 7.5-6). This area is larger than that outside of the Goose Property Area as the aircraft used for the George Property (Twin Otter Aircraft) is noisier than that used for the Goose Property (Dash 8 or equivalent).

At the MLA, an additional 12,367 ha of area may be disturbed due to Twin Otter aircraft landing on Bathurst Inlet near the MLA, if an airstrip is required when the MLA is active (Table 7.5-6). However, much of this area is marine habitat within the Inlet itself. A breakdown of the percentage of high-quality habitat disturbed due to aircraft noise in the wildlife RSA can be found in Table 7.5-7. Across seasons, the percentage of additional high-quality habitat in the wildlife RSA disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (~1%) relative to the amount of available high-quality habitat in the wildlife RSA (Table 7.5-7).

Two important elements influencing aircraft noise exposure to wildlife include overhead distance from wildlife and the frequency of overflights. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned in the “worst case” years used for noise modelling (during the Operational phase), while at the MLA, when it is active, a maximum of six flights per week are planned during the “worst case” scenario. In addition, areas of disturbance due to noise are expected to be localized near the landing strips at the Goose and George Properties and within Bathurst Inlet at the MLA. A delineated flight path between the Goose and George Properties may be disturbed by helicopter overflights approximately once a day. Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

Overall, the effect of sensory disturbance is anticipated to result in a residual effect on muskox. Varying amounts of habitat outside of the PDAs considered to be lost will be subject to intermittent and continuous noise during Construction and Operational; muskox within these areas are expected to react with short-term responses (e.g., flight) and long-term responses (avoidance or habituation). In all

cases, this area that is functionally lost or disturbed by noise outside of PDAs represents less than 0.1% to 2.2% of the total habitat available in the wildlife RSA, and less than 0.1% to 1.4% of the high-quality habitat available in the wildlife RSA (Tables 7.5-7 and 7.5-8). As muskox are assumed to occur at low densities within wildlife RSA, few muskox may thus be exposed to Project noise.

#### *7.5.2.3 Disruption of Movement*

Disruption to movement for muskox can result from 1) linear corridors such as roads which may isolate seasonal habitats and from 2) point sources of disturbance where muskox may avoid areas, and thus displace movement due to human activities.

Linear developments, including roads, railways, and pipelines, have been shown to create temporary or permanent barriers to movement in many wildlife species (Jalkotzy, Ross, and Nasserden 1997). Muskox will be present and active on the tundra all year and thus may interact with both winter roads connecting the PDAs (used from January to April) and permanent site roads within the PDAs. Therefore, the effect of disruption to movement due to linear corridors is included in the assessment. However, muskox live in an environment where there are few temporary or permanent roads, and the effect of roads as barriers to movement in this species has not been studied. Therefore, the assessment for muskox relied on evaluations of disruption of movement for similar species. Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If Project sites are large enough relative to the habitat in which muskox use and cause noise and sensory disturbance to a level that results in muskox avoiding these areas, movement of muskox may be altered. In these cases, muskox may need to expend additional energy to travel around Project developments during their daily or seasonal movements.

Disruption to movement may begin during the Construction phase of the Project when roads and infrastructure are built and continuing during the Operational and Reclamation and Closure phases of the Project. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Evaluation of Disruption of Movement on Muskox

*Road Corridors*

Data collected from a variety of locations suggests that road traffic on the order of 4,000 to 10,000 vehicles per day begin to impose a barrier to movement to most large wildlife species, whereas roads with less than 1,000 vehicles a day are permeable to most species (Müller and Berthoud 1997). In Alaska and Arctic Canada, winter roads with high traffic volumes and a snow bank height of > 0.5 m have been found to deflect ungulate movements (Rescan 2007a).

The winter roads will be used for hauling equipment, fuel and cargo from January to April across an operating window of 75 days (Volume 2, Project Description). The projected traffic volumes to transport materials along winter roads are presented in Table 7.5-9. It was assumed that this level of traffic would be present within a day along all portions of the winter roads connecting the property areas. Traffic volumes along individual segments of the winter road have not been identified for the DEIS; however, volumes along some individual segments (e.g., BIPR Winter Road Connector) are expected to be much lower than those presented in Table 7.5-9.

Traffic volumes will be approximately 81.1 one way truck trips per day per day from January to April, of which the vast majority will be trucks transporting fuel (80 one-way truck trips per day per day; Table 7.5-9). These traffic volumes are well below the threshold value for roads that are permeable (1,000 vehicles per day; Müller and Berthoud 1997). Therefore, the traffic alone on winter roads are

not expected to create a permanent barrier to muskox movement, though muskox are may avoid road crossings during periods of hauling (temporary disruption).

**Table 7.5-9. Traffic Volumes along Winter Road Corridors**

| | No. of One-way Trips | | |
|---|---|---|---|
| | Trucks (non-fuel) | Fuel Trucks | Total |
| Trips per Year* | 84 | 6,000 | 6,084 |
| Trips per Day* | 1.1 | 80 | 81.1 |

**Based on 75 day operating window between January and April.*

To mitigate effects of road traffic on muskox, truck speed limits will be developed and drivers may also reduce speeds or stop completely when muskox herds are observed near or on the road to allow safe passage. See Section 7.5.2.4 for an evaluation of the effects of direct mortality due to vehicle strikes with muskox.

Snowbanks may disrupt movements should they increase to a height beyond which muskox cannot travel over, with 0.5 m being the threshold based on evidence from other studies (Rescan 2007). Winter roads in Nunavut typically have low height of snowbanks due to low snowfall during the winter, typically less than 0.5 m. Project winter roads are designed such that they will have minimal height above the tundra.

The Project design, as well as mitigation and adaptive management measures (Section 7.5.3) are all expected to lessen the effect of the Project roads acting as a barrier to movement in muskox and no residual effect is expected.

*Goose and George Properties and Marine Laydown Area*

The Goose Property, George Property, and MLA PDAs are unlikely to act as barriers to seasonal movements or dispersal of muskox because they represent point sources of disturbance rather than a linear feature acting as barrier. Therefore, no residual effect of disruption of movement in muskox resulting from the PDAs is expected.

Muskox may still avoid areas within each PDA where the proposed mine sites and camps are planned, thereby having to expend more energy travelling around the PDAs during daily or seasonal movements. Increases in energy expenditure may result in a lower overall fitness and may affect reproduction, which is evaluated in Reduction in Reproductive Productivity (Section 7.5.2.8).

### *7.5.2.4 Direct Mortality and Injury*

Muskox may be at risk of injury or mortality resulting from Project activities; therefore, this effect is included in this assessment. Specifically, potential sources of direct mortality and injury for muskox associated with Project activities include collisions with vehicles.

Evaluation of Direct Mortality and Injury on Muskox

Vehicle-muskox collisions are expected to be rare. Muskox are expected to avoid roads during periods of hauling (Disturbance due to Noise; Section 7.5.2.2), thereby limiting the potential for interactions between vehicles and muskox. In addition, truck speed limits will be developed. Studies have found that vehicle-ungulate collision rates fall sharply at or below 70 km/h (Seiler 2005; Ng, Nielson, and St Clair 2008). Wildlife, including muskox, on or near the road corridor may also be given the right-of-

way to safely cross and exit the road corridor to lessen the probability of vehicle strikes. Therefore, residual effects following mitigation are not expected.

#### *7.5.2.5 Indirect Mortality*

Indirect mortality to muskox may result if public access is facilitated by the proposed Project roads. Indirect mortality from increased hunting pressure resulting from Project-related activities is assessed based on the results of the socioeconomic assessment (Volume 8, Chapter 3), which indicate that an increase in human immigration and hunting is unlikely in the Back River area (Volume 8, Chapter 3).

Mitigation measures are in place to prevent public access to Project roads (Section 7.5.3 and Volume 10, Chapter 20). A policy prohibiting hunting within a buffered area along all infrastructure may be developed and enforced (Volume 10, Chapter 20). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees. Thus, construction and operation of the road is not expected to cause an increase in muskox mortality due to facilitation of hunter access (i.e., indirect mortality). Increased hunting is unlikely and is therefore is not anticipated to result in a residual effect on muskox.

#### *7.5.2.6 Attraction*

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. Potential Project infrastructure that may contribute to attraction for muskox include the winter roads. Plowed winter roads may be attractive for muskox as travel routes due the lower snow depths, thereby facilitating ease of travel.

Evaluation of Attraction for Muskox

For the most part, muskox are expected to avoid the Project as a result of the physical presence and noise associated with the Project infrastructure (Section 7.5.2.2). Therefore, use of winter roads for travel is more likely during periods of inactivity along the road routes. Mitigation measures for wildlife encounters on all Project roads, such as speed limits on site and winter roads, will ensure that, should muskox be attracted to winter roads for ease of travel, this should not result in an increase in vehicle-muskox interactions. Therefore, no residual effects of attraction are expected for muskox following mitigation.

#### *7.5.2.7 Exposure to Contaminants*

Exposure to contaminants in muskox due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in muskox or its respective food chain components and surroundings (e.g., water, sediment) were predicted to be below a value of one. A hazard quotient less than one indicates that an increase in contaminants in these media relative to baseline conditions is unlikely. Thus, a residual effect due to exposure to contaminants in muskox is not anticipated and is not considered further in the assessment.

#### *7.5.2.8 Reduction in Reproductive Productivity*

Some of the environmental effects discussed above have the potential to affect the reproductive potential of muskox, particularly when they act in a synergistic fashion. For example, habitat loss and degradation, disturbance due to noise, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. This cascade of effects may be of the greatest concern during sensitive periods for

muskox (i.e., calving in April and May, and rutting in the fall). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals.

Individuals in poor body condition often fail to produce young, or produce young that are more susceptible to mortality which may result in population decline. The body condition of parturient females of large mammal species is thought to be the main determinant of the health and survival of their young. The condition of muskox females during the summer through the early winter, particularly the body fat content, appears to be directly related to successful pregnancy; muskox females that have low fat mass during the summer and fall have a lower chance of having a successful pregnancy and calving the following spring (White, Rowell, and Hauer 1997; Adamczewski et al. 1998).

Evaluation of Reduction of Reproductive Productivity in Muskox

Reduction in productivity is likely a result of many of the potential effects of the Project acting in a synergistic fashion. Residual effects are expected for direct habitat loss and disturbance due to noise (Sections 7.5.2.1 and 7.5.2.2). The muskox population in the wildlife RSA is currently declining and reproductive rates are low (Dumond 2007); therefore, muskox have a limited capacity to buffer additional stresses. Therefore, a residual effect for reduction in reproductive productivity is expected for muskox.

### 7.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including muskox. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10. A residual effect of the Project on muskox is anticipated resulting from habitat loss, disturbance due to noise, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to muskox. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

#### *7.5.3.1 Mitigation for Habitat Loss*

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to muskox may include the following:

- Project infrastructure designed to minimize the Project footprint to reduce habitat loss for muskox (Project Description; Volume 2, Chapter 2);
- consideration of the location of the stockpiles and windbreaks to minimize dustfall, to reduce habitat degradation for muskox habitat (Volume 10, Chapter 17);
- infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located, thereby minimizing the Project footprint to reduce habitat loss for muskox (Project Description; Volume 2, Chapter 2); and
- winter only road access corridors proposed (no all-weather roads for re-supply routes or between the Goose and George Properties), to minimize direct habitat loss, and habitat degradation due to dust deposition for muskox (Project Description; Volume 2, Chapter 2).

#### *7.5.3.2 Mitigation for Disturbance due to Noise*

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife due to noise are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance due to noise to muskox may include:

- underground mining used, where possible, to reduce noise emitted by the Project for excavating and hauling waste rock, and minimize the effects of noise disturbance to muskox (Volume 2, Chapter 2);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to muskox (Volume 10, Chapter 18);
- vehicles restricted to site roads, winter roads and quarry footprints during the Construction and Operational phases to avoid unnecessary disturbance to muskox habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

#### *7.5.3.3 Mitigation for Disruption of Movement*

The following mitigation measures and best management practices may be applied to minimize the effects of disruption to movement to muskox:

- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce the disruption of movement to muskox (Volume 2, Chapter 2).

#### *7.5.3.4 Mitigation for Direct Mortality and Injury*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to muskox may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);
- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to muskox (Volume 10, Chapter 20);
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

#### *7.5.3.5 Mitigation for Indirect Mortality*

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of indirect mortality specific to muskox may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project employees and contractors while on site (Volume 10, Chapter 23).

#### *7.5.3.6 Mitigation for Attraction*

The primary mitigation and management strategies to minimize effects of attraction to the Project to muskox and other wildlife are described in the Landfill and Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10, Chapter 11), the Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16), and the Employee Education Program, described in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). There is no specific mitigation for the effect of attraction to roads in muskox. However, mitigation in place or other effects (e.g., Direct Mortality and Injury) will minimize effects of attraction to the Project in muskox.

#### *7.5.3.7 Mitigation for Exposure to Contaminants*

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to control the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to muskox.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including muskox, from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures could include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- the use of wildlife-attracting dust suppressants avoided, wherever possible (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);

- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

### 7.5.4 Characterization of Residual Effects

In Section 7.5.3, eight potential effects were evaluated for whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Three of these effects were rated as having the potential for residual effects: 1) habitat loss, 2) disturbance due to noise, and 3) reduction in reproductive productivity. The significance of residual effects are evaluated here for these three effects. Each residual effect is described in this section in terms of eight descriptors (Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability, and confidence. The magnitude of the residual effect was evaluated by using the information in Table 7.5-1. Table 7.5-2 provides a description of the significance ratings used for residual effects.

#### *7.5.4.1 Habitat Loss*

The total area of habitat loss due to the Goose Property, George Property, and MLA PDAs is equivalent to 10,237 ha. An additional 8,444 ha of area may be lost due to the Winter Road PDA, of which 3,404 ha fall outside the wildlife RSA. Within the wildlife RSA, approximately 5,069 ha of high-quality summer and fall habitat and 3,394 ha of high-quality winter and early spring habitat will be altered within the PDAs. The assessment assumed the entire area of the PDAs is lost. However, the actual Project footprint within the PDA will be much smaller than the PDA itself (infrastructure footprint accounts for 10 to 15% of the PDA), and the Project footprint has been designed to be minimal as possible. Therefore, the total area of habitat loss will be lower than the area evaluated in the assessment.

The direction of the effect is negative, as habitat will be lost. The alteration of habitat due to Project development represents a relatively small percentage of the available high-quality seasonal habitats for muskox in the wildlife RSA. In total, the Project will alter 1% or less of the available high-quality seasonal habitat. Thus, the magnitude of this effect is rated as low, using the quantitative thresholds for magnitude of effect in Table 7.5-2. The extent of the effect is confined to the Project footprint, as habitat loss is generally limited to PDAs. The effect of habitat loss on muskox will have a long term duration, as habitat will be lost for more than 24 years (life of the Project). However, the frequency of effect is sporadic, as the majority of habitat loss or degradation will occur during Construction. The effect is irreversible for muskox, as some area will not be reclaimed Post-Closure (e.g., pits, waste-rock storage) and thus will be permanently lost to the local muskox population. The probability of the effect occurring is likely, and the confidence in the significance rating is high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose Property, George Property, MLA, and Winter Road PDAs will not be developed.

Overall, the effect of habitat loss for muskox is assessed as Not Significant.

### *7.5.4.2 Disturbance due to Noise*

Indirect habitat loss is considered to be a residual effect with a negative direction as the development of the Project will result in noise disturbance that may cause muskox to avoid habitats near the Project. Specifically, blasting at pits and quarries and aircraft noise, as well as continuous Project noise, will affect an additional amount of high-quality habitat for muskox.

Elevated noise levels due to Project activities will affect high-quality habitat beyond the habitat that has already been evaluated as lost within the PDAs (Section 7.5.4.1). However, the majority of the disturbance (indirect habitat loss) will be caused by intermittent noises, i.e., due to blasting and aircraft noise. Blasting noises will results in the functional loss (noise ≥ 120 dB Lpeak) of less than 0.1% of the available high-quality seasonal habitat in the wildlife RSA; blasting noises will disturb (noise ≥108 dB Lpeak) roughly 0.1% to 0.8% of the available high-quality seasonal habitat in the wildlife RSA. Aircraft noise (≥ 80 dBA) accounts for the largest proportion of noise disturbance outside the PDAs, with 6,405 ha of high-quality summer and fall habitat and 5,873 ha of high-quality winter and early spring habitat disturbed (~1% of available high-quality seasonal habitat in the wildlife RSA). Continuous Project noise (≥ 45 dBA) will affect roughly 0.4 to 0.5% of the amount of available high-quality habitat in the wildlife RSA. Following the quantitative thresholds for magnitude listed in Table 7.5-2, the magnitude of the effect is considered low.

Disturbance effects due to noise will be, for the most part, local in extent, as general Project noise and blasting noises are confined within the wildlife LSA. Aircraft noise, which is intermittent will extend outside the wildlife LSA but be contained within the wildlife RSA (regional in extent). Overall, the extent of the majority of noise is determined to be local. The frequency is expected to be continuous for general Project noise and sporadic for blasting activities and aircraft noise throughout the life of the Project, but overall sporadic in nature. The duration of noise disturbance causing indirect habitat loss is medium as disturbance due to noise will cease following closure. Muskox are expected to resume normal behaviours following the cessation of noise disturbances, and may even begin to acclimatize to the presence of Project infrastructure and associated noise; therefore, the effect will be reversible for muskox. The probability that the effect will occur is moderate, as muskox aren't expected to occur near areas of noise disturbance most of the time and the confidence in the significance rating is medium as the confidence in the effect occurring to muskox when they are present in disturbed areas is high, but it is uncertain how frequently they will occur near areas of disturbance due to noise.

Overall, the effect of disturbance due to noise for muskox is assessed as Not Significant.

### *7.5.4.3 Reduction in Reproductive Productivity*

The combination of residual effects of the Project can negatively affect the reproductive success of females due to elevated stress or decreased feeding time, or may reduce survival of individuals, including females and young, thereby lowering the overall health of the local population. Therefore, a residual effect is expected with a negative direction.

Reduction in reproduction for muskox is expected to be of low magnitude. Mitigation for Project effects will greatly lessen the potential for reduced productivity, through Project design that limits noise disturbance and management practices that reduces incidences that may result in mortality of injury of individuals. Therefore, only a few individuals within the muskox population inhabiting areas surrounding the Project may experience lowered productivity in relation to Project development and associated activities. While the effect may only be experienced by a small proportion of local muskox

population, the extent of the effect is regional, as the home ranges of muskox extend beyond the boundaries of the Project footprint and wildlife LSA.

The effect will be of medium term duration, as the reproduction of individual muskox may be affected anytime during the life time of the Project. However, this effect will likely manifest on a sporadic basis, as females are not expected to consistently occupy habitat near the Project throughout the entire year. Muskox generally move between winter and summer ranges, which will limit the time when they may be present in the vicinity of the Project. Reduction in reproductive productivity is expected to be a reversible effect for muskox, though it may take a few years following the closure of the Project for muskox to return to their baseline reproductive potential.

The residual effect of reduction in productivity is unlikely to occur. Muskox are expected to avoid the PDAs for the most part during the Construction and Operational phases, thereby lessening the chances that individuals are disturbed on a regular basis. In addition, the amount of high-quality habitat that will be altered during Project development represents a very small portion of what is available in areas surrounding the Project. Therefore, some muskox may be displaced from habitats near the Project, but this displacement is not expected to lead to a reduction in productivity. The confidence in the significance rating is medium as it is unknown how the effects of the Project on reproduction of muskox may interplay with the effects of climate change and disease vectors that may be introduced or spread (e.g., muskox lungworm) within the Arctic environment and change habitat and habitat use within the area.

Overall, the effect of reduction of reproductive productivity for muskox is assessed as Not Significant.

### 7.5.5 Significance of Residual Effects

Three residual effects for muskox were assessed and resulted in the following significance ratings:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant; and
- reduced reproductive productivity due to a combination of the previous effects, rated Not Significant.

The overall residual effect of the Project on muskox is considered to be **Not Significant**.

The criteria used in the determination of the significance of each residual effect is detailed in Section 7.5.4 and summarized in Table 7.5-10.

## 7.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

### 7.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. Following the methodology outlined in Volume 9, Chapter 1, a cumulative effects assessment is conducted as there are residual effects for the VEC muskox. The following residual effects are included in the potential cumulative effects assessment: direct habitat loss, disturbance due to noise, reduction in reproductive productivity.

**Table 7.5-10. Summary of Residual Effects on Muskox and Overall Significance Rating**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (footprint, local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not significant (N); Significant (S); Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | High | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | Medium | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

The cumulative effect assessment (CEA) methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 7.5.1.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 7.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for muskox.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 7.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for muskox and not the wildlife RSA.

#### *7.6.1.1 Spatial Boundaries for the Cumulative Effects Assessment*

The spatial boundary for the cumulative effects assessment for muskox (referred to as the CEA boundary) was a 140 km buffer surrounding the Project (Figure 7.6-1). This distance represents the longest (straight line) distance travelled by a radio-collared muskox in the Rae Richardson river valley west of Kugluktuk. Radio-collared females travelled on average from 75 to 85 km from winter and summer ranges, but the longest distance travelled was 140 km (Gunn and Fournier 2000). Therefore, this distance is used to represent the longest distance that muskox that inhabit areas in the vicinity of the Project may travel and thus may interact with other developmental projects. The total area of the CEA boundary for muskox is 14,642,187 ha.

#### *7.6.1.2 Temporal Boundaries for Cumulative Effects Assessment*

The temporal boundaries used for the cumulative effects assessment are the timescale of past, existing, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

### 7.6.2 Potential Interactions of Residual Effects with Other Projects

Three residual Project-related effects were identified during the muskox effects assessment: habitat loss, disturbance due to noise, and reduction in reproductive productivity. Several additional projects or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the range of muskox that interact with the Back River Project.

A total of 12 projects have been identified within the CEA boundary for muskox, including four that are closed (past developments), three that are existing developments, and five that are reasonably foreseeable future projects (Figure 7.6-1; Table 7.6-1).

**Table 7.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Muskox in the Cumulative Effects Assessment Boundary**

| Residual Effects from Back River Project | Rating from Back River Project | Other Project or Activity | | | Type of Potential Cumulative Effect |
|---|---|---|---|---|---|
| | | Past | Existing | Reasonably Foreseeable Future | |
| Habitat Loss | Not Significant | Jericho, Lupin, Salmita, Tundra | EKATI, Diavik, Tibbitt to Contwoyto Lake Winter Road* | Courageous Lake, BIPR**, Hackett, Hope Bay – Boston, Izok Corridor | Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities |
| Disturbance due to Noise | Not Significant | n/a | EKATI, Diavik, Tibbitt to Contwoyto Lake Winter Road | Courageous Lake, BIPR*, Hackett, Hope Bay – Boston, Izok Corridor | Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance |
| Reduction in Reproductive Productivity | Not Significant | n/a | EKATI, Diavik, Tibbitt to Contwoyto Lake Winter Road | Courageous Lake, BIPR*, Hackett, Hope Bay – Boston, Izok Corridor | Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects |

** The Tibbitt to Contwoyto Lake Road was included as a source of habitat loss and disturbance due to noise for muskox during the winter.*
*** BIPR = Bathurst Inlet Port and Road Project*

#### *7.6.2.1 Habitat Loss*

The effects assessment rated habitat loss from the Back River Project as a Not Significant residual effect with a low magnitude. Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible. While high-quality habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 7.5.2.1), habitat alteration from past, existing, and potential projects within the range of a muskox that may interact with the Back River Project is expected to be an additive effect, and therefore a larger loss of high-quality habitat for muskox can occur at the cumulative scale.

Past projects considered to have already removed habitat within the CEA boundary for muskox include Jericho, Lupin, Salmita, and Tundra mine (Table 7.6-1). Other existing projects that overlap with the muskox CEA boundary, such as EKATI or Diavik, may further decrease the available habitat or habitat quality (e.g., due to dust fall-out) for muskox using habitat within the CEA boundary. The proposed Bathurst Inlet Port and Road (BIPR), Courageous Lake, Hackett River, Hope Bay – Boston, and Izok Corridor projects have the potential to overlap with the CEA boundary for muskox and may contribute to additional habitat loss if these projects are developed.

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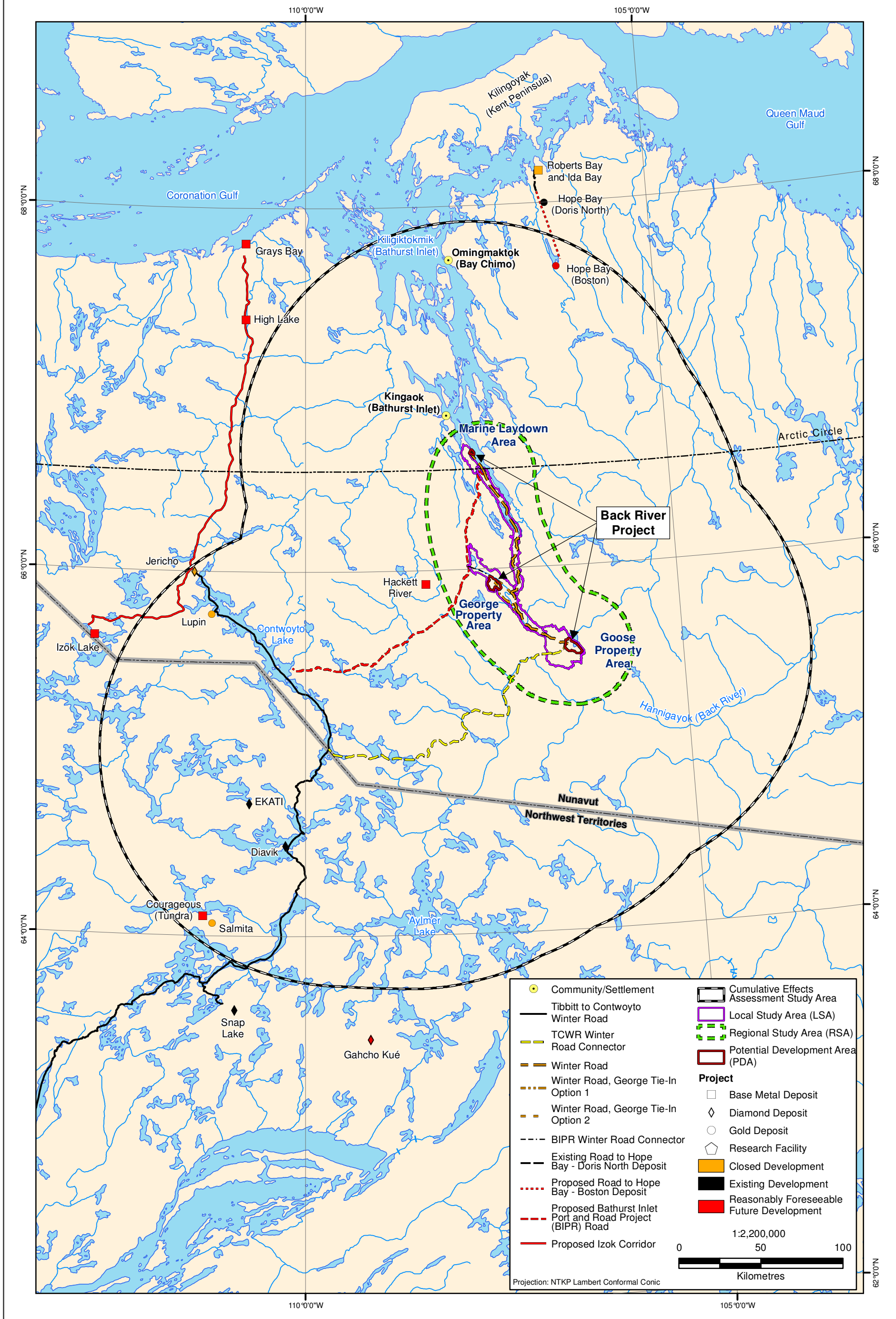


Figure 7.6-1

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## Spatial Boundary for Muskox Cumulative Effects Assessment

Figure 7.6-1

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Calculation of Cumulative Habitat Loss for Muskox

The amount of habitat removed ("area removed") was estimated from the generalized footprints of all projects and road corridors (including the Back River Project) in the CEA boundary for muskox and used as a key indicator to determine potential effects. For all existing and reasonably foreseeable future projects, habitat within 100 m of removed habitat (due to Project infrastructure) was considered to be degraded habitat because 100 m is the distance within which most effects of large dust particles extend from roads and other developments (Walker and Everett 1987b). Habitat loss for the Back River Project was calculated within the PDAs, which already includes a dust-disturbance area. The calculation of total habitat loss is presented with and without winter roads because winter roads will remove available habitat for muskox during the winter but not during the snow-free periods (summer and fall). In order to calculate a conservative estimate of habitat loss due to all projects (including the Back River Project) in the CEA boundary for muskox, the total loss of habitat calculated in this boundary are compared to summer and winter home range sizes for female muskox, with the area used by a female representing the estimation of the area used by a herd (Section 7.5.2.1). This is an overestimate of the amount of habitat loss within a home range of a muskox female/herd, but will enable a calculation of the maximum number of home ranges that could be potentially lost due to the cumulative effect of habitat loss within the CEA boundary. In addition, the area lost is presented in relation to the proportion of individuals that may be affected, assuming a density of 7 animals/1,000 $km^2$ within the CEA boundary (Dumond 2007).

Evaluation of Cumulative Habitat Loss for Muskox

Within the CEA boundary for muskox, the cumulative effects assessment identifies 29,650 ha (0.2% of total habitat in the CEA boundary) of removed habitat and 12,819 ha of degraded habitat (0.1% of total habitat in the CEA boundary; Table 7.6-2). These areas account for a total of 42,469 ha with the inclusion of winter roads, and 32,338 ha without the inclusion of winter roads. The Back River Project alone will contribute 31 to 44% of the total habitat loss within the CEA boundary for muskox (0.1% of the total CEA boundary). Note that the actual footprint of the Project is anticipated to be much smaller (10 to 15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

**Table 7.6-2. Cumulative Habitat Loss in the VEC Muskox CEA Boundary**

| Project | Habitat Removed due to Project Footprint (ha) | Habitat Degraded due to Dust (100 m around Infrastructure; ha) | Total Habitat Lost or Degraded[2] (ha) | Total Habitat Lost without Winter Roads (ha) |
|---|---|---|---|---|
| Back River Project[3] | 18,681 | n/a | 18,681 | 10,237 |
| ***Past Developments*** | | | | |
| Jericho Mine | 242 | n/a | 242 | 242 |
| Lupin Mine | 795 | n/a | 795 | 795 |
| Salmita Mine | 10 | n/a | 10 | 10 |
| Tundra Mine | 96 | n/a | 96 | 96 |
| ***Existing Developments*** | | | | |
| Ekati Mine | 3,222 | 2,118 | 5,340 | 5,274 |
| Diavik Mine | 987 | 421 | 1,408 | 1,408 |
| Tibbett to Contwoyto Winter Road | 454 | n/a | 454 | 0 |

*(continued)*

**Table 7.6-2. Cumulative Habitat Loss in the VEC Muskox CEA Boundary (completed)**

| Project | Habitat Removed due to Project Footprint (ha) | Habitat Degraded due to Dust (100 m around Infrastructure; ha) | Total Habitat Lost or Degraded[2] (ha) | Total Habitat Lost without Winter Roads (ha) |
|---|---|---|---|---|
| Back River Project[3] | 18,681 | n/a | 18,681 | 10,237 |
| ***Reasonably Foreseeable Future Developments*** | | | | |
| Hope Bay Belt | 2,925 | 496 | 3,421 | 3,421 |
| BIPR[4] | 656 | 4,921 | 5,577 | 5,577 |
| Hackett River | 1,454 | 2,057 | 3,511 | 3,511 |
| Izok Corridor Project[5] | 234 | 2,815 | 3,049 | 1,879 |
| ***Cumulative Area*** | | | | |
| Total Area | 29,756 | 12,828 | 42,584 | 32,450 |
| Total Accounting for Area of Overlap | 29,650 | 12,819 | 42,469 | 32,338 |
| % of CEA Boundary | 0.2 | 0.1 | 0.2 | 0.2 |

*[1] Muskox Cumulative Effects Assessment boundary approximates 14,642,187 hectares.*
*[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.*
*[3] Habitat Removed due to the Back River Project includes all winter roads including the TCWR Winter Road Connector and the BIPR Winter Road Connector.*
*[4] Bathurst Inlet Port and Road Project.*
*[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.*

The average size of the core winter and summer home ranges for female muskox/herd used in the effects assessment (Section 7.5.2.1) are 7,000 and 22,300 ha, respectively. Thus, total habitat loss from all projects in the CEA boundary is roughly equivalent to 1.5 to 1.9 summer home ranges for muskox and 5 to 6 winter home ranges for muskox, without and with the inclusion of winter roads in the calculation. Given the spatial distribution of projects across the landscape, it is more likely that individual projects remove small portions of habitat within seasonal home ranges of muskox herds in the vicinity of these projects. However, this may also mean that more individuals/herds may be affected by minor losses of seasonal habitat within their ranges due to project development than is calculated above.

If it is assumed that the density of muskox in the CEA boundary is similar to that recorded by Dumond (2007) in areas surrounding the Project (7 muskox/1,000 $km^2$), approximately 1,025 muskox would be expected to frequent the CEA boundary. Based on this estimate, and assuming an even distribution of habitat loss in the CEA boundary, an average of approximately 41 ha of habitat per muskox (42,469 ha total including area potentially degraded by winter roads) may be altered, which is equivalent to 0.2% of a summer home range of a muskox and 0.6% of a winter home range of a muskox.

The amount of muskox habitat that may be lost if all projects, including the Back River Project, are developed represents a small portion (0.2%) of the total amount of habitat available in the CEA boundary. The amount of habitat lost at the cumulative level does represent more than one summer and winter home range of a muskox, but very low proportions of these seasonal home ranges if each individual within the CEA boundary takes on a portion of the loss (0.2 to 0.6%). Evaluation by the total number of home ranges that may be affected by habitat loss is a conservative estimate of the cumulative habitat loss, while the proportion of a home range altered per individual underestimates the loss as muskox are not uniformly distributed across the landscape and occur in herds throughout most of the year. However, neither estimate suggests that the carrying capacity of the muskox habitat

at the landscape level will be affected due to the cumulative habitat loss of all projects (including the Back River Project) in the CEA boundary. As mitigation and reclamation activities cannot wholly eliminate habitat loss, a residual effect of habitat loss on muskox is predicted.

#### *7.6.2.2 Disturbance due to Noise*

The disturbance to muskox due to auditory stimuli from the Back River Project was rated as Not Significant with a low magnitude in the effects assessment. Habitat functionally lost or disturbed due to Project-related noise resulting from activities at the Back River Project and other projects in the CEA boundary is discussed in this section.

Potential disturbance effects from existing and reasonably foreseeable future projects was assessed; including Diavik, EKATI, Tibbitt to Contwoyto Lake Winter Road, and the proposed BIPR, Courageous Lake, Hope Bay - Boston, Hackett River, and Izok Corridor Projects (Figure 7.6-1). Past projects were excluded from the analysis. A background on the potential effects of disturbance due to noise to muskox is presented in Section 7.5.2.2.

Calculation of Cumulative Disturbance due to Noise

To evaluate the effects of noise disturbance on muskox, the area in which muskox may be affected by disturbance by noise was calculated and used as a key indicator of this potential effect.

Noise modelling for the Back River Project has indicated that disturbance due to blasting noise will attenuate to below threshold values within 4 km from the source of blasting at quarries. Thus, a 4 km buffer was applied to all projects to calculate the area lost due to blasting noise.

Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km while that during construction would be similar to blasting at mine sites and would attenuate below threshold values at 4 km. Noise modelling on the winter roads for the Back River project indicated that noise would attenuate to 45 dBA at roughly 200 m from vehicle traffic and activities on these roads. Thus, a distance of 1.5 km or 4 km were used to measure disturbance around all-weather roads during construction and operations, respectively, and a distance of 200 m was used around winter roads.

Evaluation of Cumulative Disturbance due to Noise

During the Operational phase of the Back River Project disturbance was calculated based on a maximum disturbance scenario whereby the disturbed habitat at the Back River Project for year three at the Goose Property Area and year seven at the George Property Area are combined to calculate a the maximum possible disturbance for muskox.

The area of habitat loss due to sensory disturbance from the Back River Project would cover 70,708 ha, or 0.5% of the CEA boundary for muskox (Figure 7.6-2). The area of habitat loss for the cumulative effects of noise due to all existing and reasonably foreseeable future projects in the CEA boundary for muskox (including the Back River Project), assuming a worst case scenario whereby construction of all-weather roads due to all additional projects would occur at the same time, would result in 413,959 ha of disturbed habitat, or 2.8% of the CEA boundary during the winter, and 385,059 ha of disturbed habitat (2.6% of the CEA boundary) when winter roads are not operational. During the operational phase, assuming all proposed projects are operational, the effect of all projects combined (including the Back River Project) would result in 334,952 ha of disturbed habitat (2.3% of the CEA boundary)

during the winter and 306,052 ha of disturbed habitat (2.1% of the CEA boundary) during the months when winter roads are not operational. Estimated areas of noise disturbance for each project including the Back River Project are reported in Table 7.6-3.

**Table 7.6-3. Total Area of Habitat Affected due to Disturbance[1] by Noise in the Muskox CEA Boundary[2]**

| Project | Areas (ha) of Muskox Habitat Disturbed | | | | | |
|---|---|---|---|---|---|---|
| | Winter Roads (200 m) | All-weather Roads Construction (4 km) | All-weather Roads Operations (1.5 km) | Mine (4 km) | Total During Construction | Total During Operations |
| Back River Project[3] | 16,891 | | | 53,817 | 70,708 | 70,708 |
| ***Existing Developments*** | | | | | | |
| Ekati Mine | | | 8,408 | 30,985 | n/a | 39,393 |
| Diavik Mine | | | | 11,713 | n/a | 11,713 |
| Tibbett to Contwoyto Winter Road | 11,781 | | | | n/a | 11,781 |
| ***Reasonably Foreseeable Future Developments*** | | | | | | |
| BIPR[4] | | 157,337 | 68,776 | 13,710 | 171,047 | 82,486 |
| Courageous Lake | | | | 23,042 | 23,042 | 23,042 |
| Hackett River | | 384 | 16,445 | 36,098 | 36,482 | 52,543 |
| Hope Bay Belt | | 8,901 | 4,846 | 12,384 | 21,285 | 17,230 |
| Izok Corridor[5] | 319 | 65,588 | 25,828 | | 65,588 | 26,147 |
| ***Cumulative Area*** | | | | | | |
| Total Area | 28,991 | 232,210 | 124,303 | 181,749 | 413,959 | 335,043 |
| Total Area Accounting for Overlap | 28,900 | 232,210 | 124,303 | 181,749 | 413,959 | 334,952 |
| % of CEA Boundary | 0.2 | 1.6 | 0.8 | 1.2 | 2.8 | 2.3 |

*[1] Disturbed habitat includes total area disturbed and does not take into account habitat suitability within the area.*
*[2] Muskox Cumulative Effects Assessment boundary approximates 14,642,187 hectares.*
*[3] Habitat Removed due to the Back River Project includes all winter roads including the TCWR Winter Road Connector and the BIPR Winter Road Connector.*
*[4] Bathurst Inlet Port and Road Project*
*[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.*

The cumulative effect of noise disturbance due to all projects, including the Back River Project, assuming a worst-case scenario (during construction of all reasonably foreseeable future projects at the same time) is anticipated to result in a residual effect on muskox. Similar to the assessment of Disturbance due to Noise (Section 7.5.2.2), varying amounts of habitat outside of the habitat lost due to the footprint of projects will subject to intermittent noises during construction, and both continuous and intermittent noises during the operations of the developments.

Muskox inhabiting areas near existing and reasonably foreseeable future projects may to react to these disturbances with short-term responses (e.g., flight) and long-term responses (avoidance or habituation). In all cases, this area that is functionally lost or disturbed by noise within the CEA boundary represents less than 3% of the habitat available to muskox. As muskox are assumed to occur at low densities within CEA boundary, few muskox may thus be exposed to noise from construction and operation activities.

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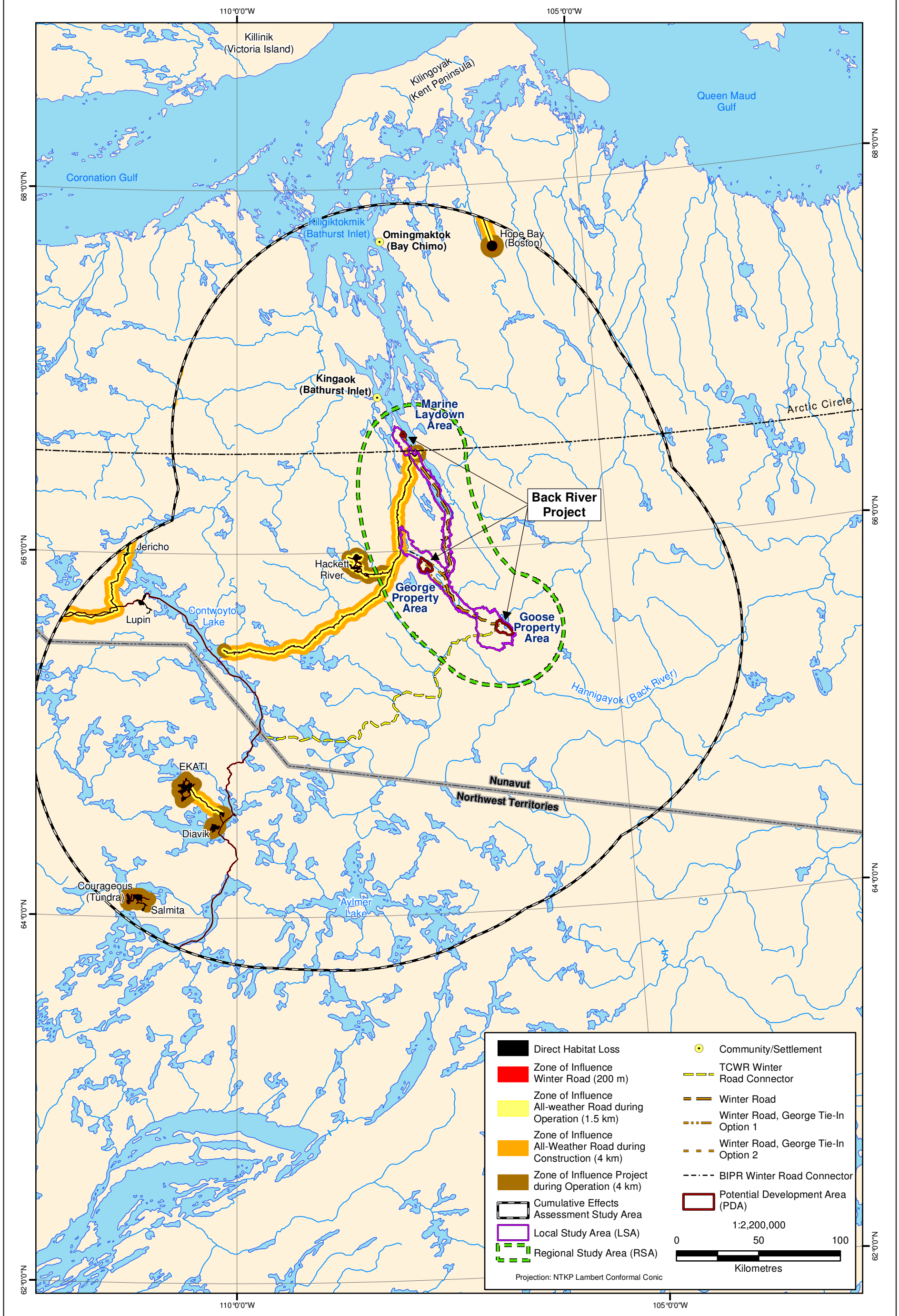


Figure 7.6-2

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## Habitat Lost or Altered due to All Project Footprints and Noise in the Muskox Cumulative Effects Assessment Boundary

Figure 7.6-2

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#### *7.6.2.3 Reduction in Reproductive Productivity*

The muskox population in the wildlife RSA is currently declining and reproductive rates are low (Dumond 2006, 2007); therefore, an increase in projects in this area may affect this population. The combined influence of the existing and reasonably foreseeable future projects has the potential to reduce muskox reproductive productivity. This effect is theoretical in nature is being qualitatively assessed based on best judgement.

Potential reduction in reproductive productivity is related to habitat loss and disturbance due to noise. The effects and how they may act in a synergistic fashion may be of the greatest concern during sensitive periods for muskox (i.e., calving in April and May, and rutting in the fall). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals.

The contribution of the Back River Project to cumulative effects of reduction of reproductive productivity on muskox is anticipated to be small relative to other projects in the CEA boundary. While the Project does remove proportionally more habitat than other existing or future developments and will disturb similar amount of habitats (Tables 7.6-2 and 7.6-3), the habitat loss due to the Project is overestimated as only a small proportion (10 to 15%) of the PDAs assumed to be lost will be developed. An important consideration in cumulative effects is that the Back River Project does not include linear corridors, and thus does not have a residual effect of disruption to movement on muskox. Other projects in the CEA boundary will have linear developments including all-weather roads, which may contribute to the effect of disruption to movement on muskox. If all-weather roads become a barrier to movement for muskox, then this effect will likely add to the effects of habitat loss and disturbance due to noise experienced from these projects. Thus, this synergy of project-related effects elsewhere may have higher consequences on the reduction of reproductive productivity on muskox relative to the residual effects of habitat loss and disturbance due to noise anticipated to result from the Back River Project.

Reduction in reproductive productivity is expected to be small and very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

### 7.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for muskox will be similar to those applied for the Back River Project and will meet or exceed best management practices. For a list of these mitigation and management measures applied for muskox at the Back River Project, see Section 7.5.3 and Volume 10.

### 7.6.4 Characterization of Cumulative Residual Effects

After the application of mitigation and management measures there are three residual effects predicted in the VEC cumulative effects assessment area, including habitat loss, disturbance due to noise, and reduction in reproductive reproductively.

#### *7.6.4.1 Habitat Loss*

The alteration of habitat due to all past, existing, and reasonably foreseeable future development represents a small percentage of the available habitat for muskox in the CEA boundary. The overall loss or degradation of area due to all projects in the muskox CEA boundary is between 32,338 to 42,469 ha (approximately 0.2 to 0.3% of the CEA boundary), which is roughly equivalent to the loss or alteration of 1.5 to 1.8 summer home ranges for muskox and 5 to 6 winter home ranges for muskox. However, given the spatial distribution of the Back River Project and other existing or reasonably foreseeable

future developments across the landscape, in that each is relatively segregated from one another, habitat loss is more likely to affect smaller portions of muskox home ranges. Assuming a muskox density within the CEA boundary of seven muskox per 1,000 $km^2$, and an even distribution of habitat loss or alteration within the CEA boundary, an average of approximately 41 ha of habitat per muskox may be altered, which is equivalent to 0.2% of a summer home range of a muskox and 0.6% of a winter home range. Comparing these values to the thresholds listed for quantitative key indicators in Table 7.5-2, the magnitude of the effect is considered low.

The extent of the effect is local, as habitat loss (both existing and future) will be contained near project infrastructure for all projects in the CEA boundary. The effect of cumulative habitat loss on muskox will have a long-term duration (beyond the life of the Back River Project) or may be permanent. However, the frequency of effect is sporadic and is mainly concerned with habitat loss for reasonably foreseeable future projects, which will occur mainly during the construction phases. By in large, habitat for past developments has already been lost and in some cases reclaimed, and habitat loss is minimal for existing projects given that the habitat loss or degradation took place during construction. The effect is irreversible for muskox, as some areas associated with past, existing, and reasonably foreseeable future projects, cannot not be reclaimed fully post-closure (e.g., pits, waste-rock storage) and thus will be permanently lost to the local muskox population. The probability of the effect occurring is likely, and the confidence in the significance rating is high.

Overall, the cumulative residual effect of habitat loss for muskox is assessed as Not Significant.

#### *7.6.4.2 Disturbance due to Noise*

The total cumulative area of habitat disturbed by noise created by all projects (including the Back River Project) within the CEA boundary is between 334,952 and 413,959 ha during the winter months and between 306,052 and 385,059 ha when winter roads are not active. These areas range between 2.1% and 2.8% of the CEA boundary for muskox. Comparing these values to the thresholds listed for quantitative key indicators in Table 7.5-2, the magnitude of the effect is considered low.

This effect will be localized in extent, as disturbance due to noise associated with the Back River Project and all other developments will occur near the sources of noise (near Project infrastructure). The general project noise associated with project activities will be continuous in nature, while events like blasting noise and aircraft noise will occur on a more sporadic basis, and overall these sporadic sources of noise will likely cause more disturbance to muskox. Noise disturbance causing indirect habitat loss at the cumulative scale will cease following closure of Back River Project; therefore, the effect has a medium-term duration. Muskox are expected to resume normal behaviours following the cessation of noise disturbances, and may even begin to acclimatize to the presence of infrastructure and associated noise; therefore, the effect will be reversible for muskox. The probability that the effect will occur is moderate, and the confidence in the significance rating is medium, as it is not certain to what extent muskox may avoid areas of noise disturbance.

Overall, the cumulative residual effect of disturbance due to noise for muskox is assessed as Not Significant.

#### *7.6.4.3 Reduction in Reproductive Productivity*

The culmination of potential and residual effects of development projects can negatively affect the reproductive success of females due to elevated stress or decreased feeding time, or may reduce survival of individuals, including females and young, thereby lowering the overall health of the local population. Therefore, a residual effect with a negative direction is expected.

Reduction in reproduction for muskox is expected to be of low magnitude. It is assumed that other existing and reasonably foreseeable future developments will mitigate for effects on muskox to a similar degree as the Back River Project. Therefore, only a few individuals within the muskox population inhabiting areas within the CEA boundary may experience lowered productivity in relation to construction and operations of projects. While the effect may only be experienced by a small proportion of local muskox population, the extent of the effect is regional, as effects are considered within the CEA boundary.

The effect will be of medium term duration. This effect will likely manifest on a sporadic basis, as females are not expected to consistently occupy habitat near developments throughout the entire year. Reduction in productivity is expected to be a reversible effect for muskox, though it may take a few years following the closure of developments for muskox to return to their baseline reproductive potential.

The residual effect of reduction in productivity is unlikely to occur. Muskox are anticipated to avoid areas near developments for the most part during the construction and operations of these developments, thereby lessening the chances that individuals are disturbed on a regular basis. In addition, the amount of habitat that has been altered already within the CEA boundary and the amount that will be altered during development of reasonably foreseeable future projects represents a very small portion of what is available within the CEA boundary. Therefore, some muskox may be displaced from habitats near projects, but this displacement is not expected to lead to a reduction in productivity. The confidence in the significance rating is medium as it is unknown how the effects of the Project on reproduction of muskox may interplay with the effects of climate change and disease vectors that may be introduced or spread (e.g., lungworm) within the Arctic environment and change habitat and habitat use within the area.

Overall, the cumulative residual effect of reduction in reproductive productivity for muskox is assessed as Not Significant.

### 7.6.5 Significance of Cumulative Residual Effects

Following methodology in Volume 9, Chapter 1 for determining significance, as well as the wildlife definitions for magnitude (Table 7.5-2) and significance (Table 7.5-3), the three residual cumulative effects on muskox are expected to have the following significance:

- direct habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

The overall residual cumulative effect of the Back River Project and all past, existing, and reasonably foreseeable future projects within the CEA boundary for muskox is considered to be **Not Significant**.

The criteria used in the determination of the significance of each cumulative residual effect is detailed in Section 7.5.4 and summarized in Table 7.6-4.

**Table 7.6-4. Summary of Cumulative Residual Effects to Muskox and their Significance**

| Cumulative Residual Effects | Evaluation Criteria | | | Likelihood of Occurrence of Cumulative Residual Effects | | | Significance of Cumulative Residual Effects | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not Significant (N), Significant (S), Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Local | Irreversible | Likely | High | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | Medium | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

## 7.7 TRANSBOUNDARY EFFECTS

No transboundary effects on muskox are expected; very rarely would muskox that inhabit areas surrounding the Project travel into the Northwest Territories. In addition, the cumulative effects assessment considered a large area that encompassed the maximum straight line distance recorded for a muskox female (140 km). This 140 km buffer was applied to all Back River Project infrastructure and extended into the Northwest Territories. Thus, the transboundary effects that cross jurisdictional boundaries are predicted to be accounted for in the cumulative effects assessment for muskox — all of which are rated as **Not Significant**.

## 7.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC muskox. The Wildlife Mitigation and Monitoring Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including muskox. Mitigation measures specific to muskox for potential Project effects are listed in Section 7.5.3 and summarized in Table 7.8-1 in Section 7.8-5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including muskox. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17, and the Incinerator Management Plan can be found in Volume 10, Chapter 11;
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effects Management Plan can be found in Volume 10, Chapter 19.

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

- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock and Tailings Management Plan: Chapter 9.
- Landfill and Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosive Management Plan: Chapter 13.

- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.
- Care and Maintenance Plan: Chapter 30.

### 7.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of the PDAs after the redesign of Project elements. Table 7.8-1 in Section 7.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on muskox.

### 7.8.2 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes eight separate mitigation and management plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to muskox are listed in Section 7.5.3 and summarized in Table 7.8-1 in Section 7.8.5.

### 7.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these will need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

### 7.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

### 7.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 7.8-1 includes all planned mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on muskox.

**Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Muskox**

| Mitigation Category | Mitigation Measures |
|---|---|
| **1. Mitigation by Project Design** | 1. Project infrastructure designed to minimize the footprint of infrastructure.<br>2. Consideration of the location of the stockpiles and windbreaks to minimize dustfall.<br>3. Infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located.<br>4. Winter road access corridors only (no all-weather roads for re-supply routes or between the Goose and George Properties).<br>5. Underground mining, where possible, to reduce noise emitted by the Project during excavating and hauling waste rock.<br>6. Infrastructure located close to deposits to keep activities confined to specific areas, and minimize noise-generating activities.<br>7. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination.<br>8. Berms or other markers built at high walls of quarries to deflect muskox movement.<br>9. Buildings designed and maintained to exclude wildlife.<br>10. WAD cyanide destruction conducted in the mill. |
| **2. Best Management Practices** | 1. Vehicles restricted to road, winter road and quarry footprints during Construction and Operational phases.<br>2. Pre-determined flight paths developed to provide horizontal and vertical buffer distances between flight paths and sensitive habitats, such as muskox calving areas, where possible.<br>3. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever muskox are observed.<br>4. Truck speed limits developed, signage installed to alert drivers of speed limits, and speed limits enforced.<br>5. Wildlife given the right-of-way on all roads at all times.<br>6. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic. Road use restricted only to persons required for Project construction, operations and maintenance. |

*(continued)*

**Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Muskox (completed)**

| Mitigation Category | Mitigation Measures |
|---|---|
| **2. Best Management Practices *(cont'd)*** | 7. Waste and wildlife attractant management measures developed.<br>8. The use of wildlife-attracting dust suppressants avoided, where possible.<br>9. A policy of no feeding and no intentional attraction of wildlife developed, disseminated to all Project and contractor employees during employee orientation, and enforced.<br>10. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.<br>11. A policy prohibiting hunting by Project employees and contractors while on site.<br>12. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers.<br>13. Appropriate measures taken to exclude muskox from areas where water or waste could pose a risk to the health of muskox.<br>14. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures. |
| **3. Adaptive Management** | 1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included:<br>• if negative wildlife interactions become a concern, or<br>• if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.<br>2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies. |
| **4. Monitoring** | A facility-specific monitoring program will assess the effectiveness of mitigation measures used to minimize effects of the Project on muskox. This plan may include:<br>1. footprint monitoring to monitor habitat loss;<br>2. noise monitoring to monitor disturbance to wildlife;<br>3. human activity monitoring of Project site roads and winter roads;<br>4. fence and skirting monitoring to ensure that fences are operational and effective at excluding muskox without causing them harm;<br>5. wildlife-vehicle interaction monitoring to document muskox-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and<br>6. incidental wildlife reporting to record general muskox activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to muskox and adaptively manage conflicts where possible.<br>A focal-species monitoring program will evaluate predictions in the effects assessment on muskox. This plan may include:<br>1. a monitoring program using remote cameras in the wildlife RSA to assess the zone of influence of the Project on muskox; and<br>2. incidental observations of muskox during other wildlife and environmental monitoring programs. |

## 7.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to muskox are summarized in the following sections.

### 7.9.1 Wildlife Mitigation and Monitoring Plan

#### *7.9.1.1 Facility-specific Monitoring*

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area, and George Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human activity monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;

- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

#### *7.9.1.2 Focal-species Monitoring*

The proposed focal-species monitoring program will include monitoring muskox by remote motion-triggered cameras. Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013d, Appendix V5-5C). Muskox are rarely detected by remote camera. The use of remote cameras for annual monitoring of caribou is currently proposed for the focal-species monitoring of caribou, and part of the Cumulative Wildlife Effects Monitoring Program in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Incidental observations of muskox detected by remote camera along with incidental observations during other wildlife monitoring surveys will continue to be recorded. The four objectives of this monitoring program are to:

1. Monitor the Project site to examine how muskox interact with Project facilities (e.g., on roads, pits);
2. Monitor the Project site at areas with and without mitigation structures or activities to evaluate the efficacy of mitigation activities (e.g., in areas with dust vs. without);
3. Monitor areas identified as important for muskox from landuser knowledge (e.g., eskers, windswept benches) and at points with high number of muskox identified during baseline studies (e.g., the hilly area west of the MLA); and
4. Record the times at which muskox use the area near the Project during the year in order to guide mitigation activities.

Methods for data management and analysis will follow those for caribou (Section 8.3.1 of Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20).

## 7.10 IMPACT STATEMENT

Eight potential effects on the VEC muskox due to the Project were identified. These eight potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction to infrastructure, exposure to contaminants, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of muskox was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on muskox resulted in the evaluation of three potential effects as likely having residual effects after mitigation: habitat loss, disturbance due to noise, and reduced productivity. These effects are rated with a low magnitude and are and the effects of the Project overall is considered to be **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

The residual effect on muskox due to the Project that is anticipated to contribute the most to effects on the population is attributed to reduction in reproduction, which may occur due to a number of other potential or residual effects interacting with one another. However, the overall likelihood of a reduction in reproductively in muskox is low because of the high availability of habitat of varying quality outside of the influence of the Project. It is not expected that muskox will be displaced into lower quality habitats as a result of the Project. Displacement could lead to lower productivity due to stress or reduced foraging success, particularly during sensitive periods such as calving.

The combined significance of residual effects due to the cumulative effects of the Back River Project and all past, existing and reasonably foreseeable future projects in the CEA boundary for muskox is anticipated to be **Not Significant**. There were several developments that were considered in the CEA boundary for muskox that could contribute to residual cumulative effects for muskox. Like the Project effects assessment, the cumulative effect on the reproductive output of muskox is the greatest concern, as this has the greatest potential to affect the muskox population on a whole. Mainland populations appear to be declining (Dumond 2006; Rescan 2013c), and thus, muskox population have a lower capacity to buffer additional stresses. However, all cumulative residual effects were rated as low magnitude and were reversible. Therefore, the cumulative effect of all past, existing, and reasonably foreseeable future projects (including the Back River Project) is not expected to affect muskox on a population level.

# 8. Wolverine and Furbearers

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# 8. Wolverine and Furbearers

## 8.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 8.1.1 Introduction

Arctic furbearers include wolverine, wolves, red and Arctic foxes, Arctic hare, and Arctic ground squirrels, and to a lesser degree lynx and marten which are found closer to the treeline. Hare and ground squirrels are considered to be small mammals, which are discussed separately in the Environmental Risk Assessment (Section Volume 8, Chapter 6). This chapter evaluates the potential effects of the Project on furbearers, using wolverines and grey wolves as representative furbearer species.

Wolverine

Wolverines (*Gulo gulo*) are members of the mustelid family, which includes weasels, badgers, and marten. Like other mustelids, wolverines are carnivorous, and are both scavengers and predators on a wide range of prey (COSEWIC 2003). Very large home ranges and low population densities are characteristic of this solitary species, which makes research on this species challenging (Persson, Wedholm, and Segerstrom 2010; Inman et al. 2012). However, recent advances in camera trapping and DNA analysis have resulted in new information on population dynamics, including more rigorous and potentially higher estimates of population densities (Mulders, Boulanger, and Paetkau 2007; Royle et al. 2011). Inuit have generally regarded wolverines as pests as they cause damage to caches, destroy property, and steal food (KIA 2012). Wolverine pelts were used as fur mats when hunting seals otherwise wolverines were seldom hunted. Their status as pests changed because of the fur trade as their pelts were highly valued and sought after (KIA 2012). This resource dramatically increased trapping and hunting of wolverines by Inuit. The use of wolverine fur as trim on parkas is a relatively recent custom, however, this local use by Inuit became very important (KIA 2012).

Grey Wolf

The grey wolf (Canis lupis) is the largest member of the Canis genus and was once abundant over much of North America and Eurasia. However, the range of the grey wolf has contracted due to habitat destruction and hunting. The wolf is still widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. Populations are stable or increasing within their Canadian range, except in northern Alberta and some parts of the Northwest Territories (Frame, Cluff, and Hik 2008). Wolf reproductive success and population trends are largely regulated by the availability of caribou (Frame, Cluff, and Hik 2008). Wolf pelts were highly valued and sought after by Inuit and the fur was used for trim on clothing, pups for sled dogs, and meat was either thrown away or used to feed dogs (KIA 2012).

### 8.1.2 Population Trends and Conservation

Wolverine

The wolverine is ranked as “Secure” in Nunavut (CESCC 2010), but the western Canadian population (which includes wolverine in Nunavut) was listed as a species of “Special Concern” by COSEWIC (2003). The population size for the western population, estimated as 15,000 to 19,000 individuals, is above the threshold of 10,000 individuals or less for designation as “Threatened” under COSEWIC’s ranking system (Slough 2007). The western population has not yet been listed under SARA. The geographically disjunct eastern population, extending across northern Quebec and Labrador, is listed as “Endangered” under Schedule 1 of SARA.

Wolverine populations in the central Arctic appear to be stable, the most recent estimate was in 1990 (COSEWIC 2003). Population density is thought to be relatively high in the western Arctic (e.g., Yukon and Northwest Territories), moderate in western Nunavut (including the Kitikmeot region), and low in eastern Nunavut and on Arctic islands (Slough 2007). The total population size of wolverines in Nunavut is estimated as 2,000 to 2,500 individuals (COSEWIC 2003; Slough 2007).

Due primarily to low reproductive rates and low population densities, wolverines are susceptible to population declines (Slough 2007; Inman et al. 2012). For example, the eastern Canadian population may be near extinction, and wolverines have likely been extirpated from Vancouver Island (Slough 2007). Despite high pregnancy rates, fewer than half of all pregnant females produce cubs — most females do not reproduce in consecutive years (Persson 2005; Inman et al. 2012). Reproductive failure occurs early, during gestation or just after birthing, and is thought to result primarily from poor nutritional status of females (Inman et al. 2012). Thus, food availability, especially during winter, is thought to be the main factor limiting reproduction and structuring the population dynamics of wolverines (Persson 2005). In some populations, mortality due to starving is also an important factor (Inman et al. 2012). Population modelling suggests that viable wolverine populations require at least 45 sexually mature females (> 3 years of age; Persson 2005).

The wolverine population in the wildlife RSA occurs within the W/01-KT management area, and is considered to be an abundant breeding population (GN DOE 2005). The Nunavut Department of Environment recommends a TAH of 160 wolverines for the W/01-KT management area. Between 1989 and 2004, 292 wolverines were reported as harvested in Nunavut; but reported harvest rates underestimate actual harvest rates by as much as 80% (Figure 8.1-1; COSEWIC 2003; Slough 2007). For example, the locations of 1,714 wolverine kills were recorded in the West Kitikmeot between 1986 and 2005, and indicate an annual known harvest of 85.7 wolverines per year (Mathieu Dumond, GN DOE, unpublished data). These data indicate that 4% of the kills occurred in the Bathurst Inlet region. Within the wildlife RSA, wolverine harvests were recorded near Bathurst Inlet (Figure 8.1-1).

The Nunavut Department of Environment has recommended that wolverines not be trapped after April 15 or shot after April 30 until October 31 to minimize the harvest of young wolverines (GN DOE 2005). Wolverines give birth in natal dens from late February to early April, young are weaned at 7 to 10 weeks of age, and begin to accompany the mother on foraging trips after late June (Mulders, Boulanger, and Paetkau 2007; Inman et al. 2012). Cubs are nearly full grown and independent by seven months of age (September to November) but stay on the mother's home range until about one year of age (Inman et al. 2012).

Grey Wolf

The *Canis lupis occidentalis* (northern timber wolf) and *nubilus* (plains wolf) subspecies are listed as "Not at Risk" by COSEWIC, while the *arctos* subspecies (Arctic wolf) is listed as "Data Deficient" (COSEWIC 2012). The wolf is listed as secure in Nunavut (CESCC 2010).

Wolves are still found in 90% of their original range in Canada, which is home to an estimated 60,000 individuals (Walton et al. 2001). In Nunavut and parts of the Northwest Territories, wolf populations were thought to be stable or increasing within their range to 1995 (Hayes and Gunson 1995). There are no recent estimates of population trends of wolves for Nunavut. However, wolf den surveys between treeline and Contwoyto Lake from 1996-2009 show declines since 2006 in the number of active dens in late August; Adamczewski et al. (2009) reports this is due to high levels of pup mortality. For this wolf population, reproductive success decreased with increasing distance from dens to migration routes of the Bathurst caribou (Frame, Cluff, and Hik 2008). Because of this relationship between wolves and caribou, in the spring when wolves are raising young, they must travel back and forth to the den site each day until early fall (Cluff, Walton, and Paquet 2002). Wolf productivity and population trends are largely regulated by the availability of ungulate prey. Thus, population decline in tundra wolves in recent years is plausible given high rates of population decline in caribou herds across the Arctic.

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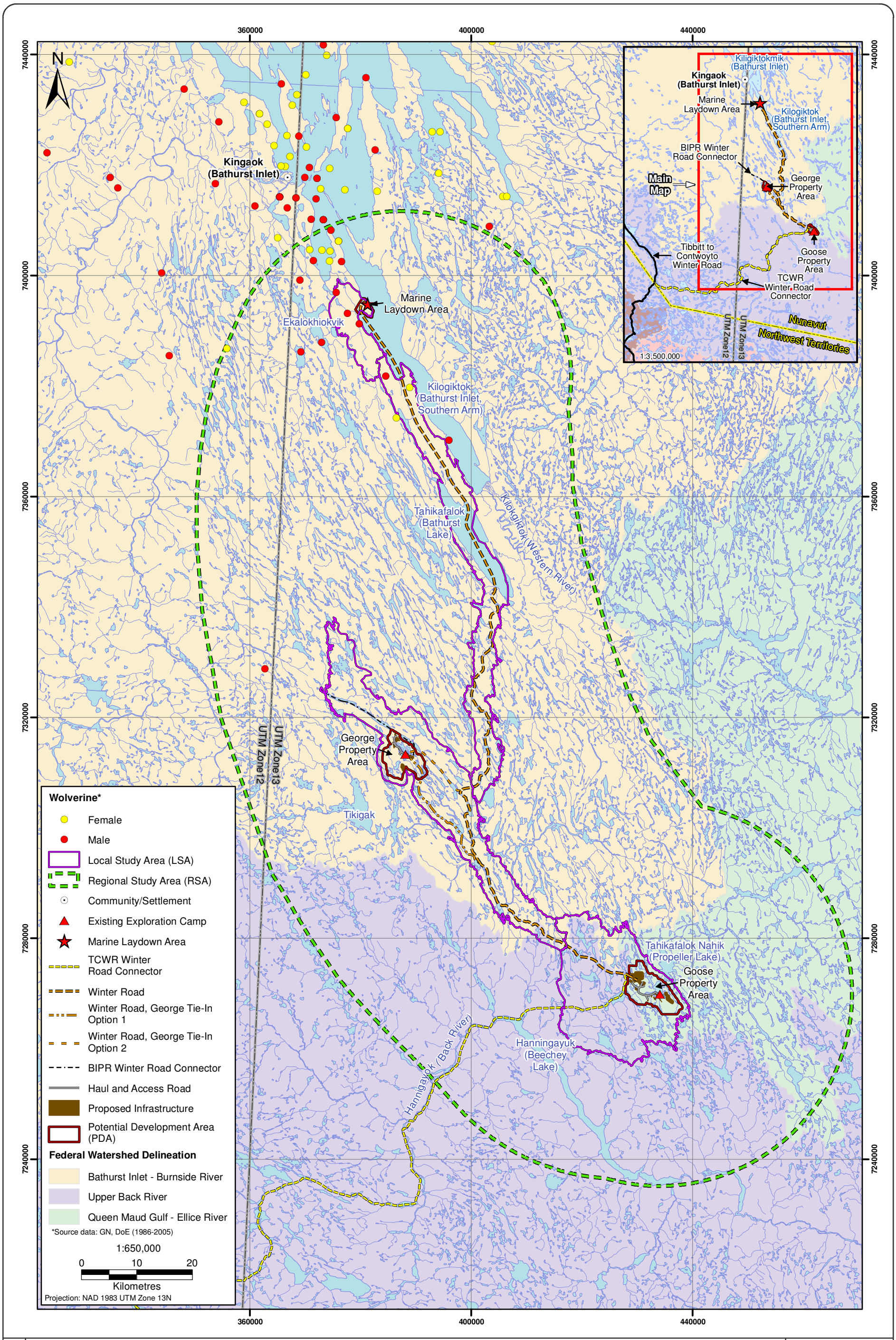


Figure 8.1-1

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## Wolverine Harvest Data (1986 to 2005)

Figure 8.1-1

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*Climate Change*

Potential direct effects of climate change on wolverine and furbearers include effects such as increasing temperatures and competition from new species. Increased temperatures and the onset of earlier spring melt will affect overall snow cover and persistence. This combination could have a negative effect on denning sites for wolverines as field observations indicate that all reproductive dens are located in areas that retain snow in the spring (Magoun and Copeland 1998; McKelvey et al. 2011). A low snow pack or early melt can may negatively impact the breeding success and restrict suitable habitat for wolverine. Other furbearers such as Arctic fox populations are declining due to the northward expansion of the competitively dominant range red fox. Another reason Arctic foxes could be declining is the possibly of lower winter survival of small mammals due to less stable winters leading to frequent thawing and icing (Killengreen et al. 2007 ; Post et al. 2009).

Potential indirect effects include changes to caribou populations. Both wolverine and in particular the Arctic grey wolf depend on caribou for sustenance, thus any effect on the caribou herds will have negative implications for both species. The timing of caribou migrations, size of the herd, and routes followed could be affected by earlier and/or warmer spring/summer seasons (see Volume 5, Chapter 5 on potential effects of climate change on caribou). Post and Stenseth (1999) observed that several ungulate populations were declining following warmer winters and Hinzman et al. (2005) suggest a warming climate will likely have a negative population effect on the health of caribou due to overheating and increased mosquito harassment. Any negative population effects on caribou will also have negative impacts on wolverines and furbearers.

### 8.1.3 Distribution and Migration Patterns

Wolverine

Wolverines are found throughout the Arctic and boreal forests of North America and Eurasia (Copeland and Whitman 2003). In North America, the geographic range of the wolverine extends from Alaska throughout most of northern and western Canada, including the West Kitikmeot region of Nunavut (COSEWIC 2003; Slough 2007).

There are two separate populations of wolverine: the endangered Eastern population is limited to Labrador and Quebec and the Western population (COSEWIC - Special Concern) ranges from Hudson Bay to Alaska with some small extensions into the western United States and into the Great Lakes area (van Zyll de Jong 1975). In the north, wolverines have very large territories ranging from 100 $km^2$ for an adult female to over 600 $km^2$ for an adult male (Copeland and Whitman 2003).

Population densities of wolverine are low, approximately one individual per 40 $km^2$ to one per 800 $km^2$, depending on habitat and the availability of prey (Persson, Wedholm, and Segerstrom 2010; Inman et al. 2012). Robust estimates of population density using remote cameras and DNA analysis have confirmed previous estimates of low densities derived from winter track counts in Northwest Territories and Nunavut (10 -15 wolverines per 1,000 km2; Mulders, Boulanger, and Paetkau 2007; Royle et al. 2011). Home ranges of male wolverine are on average at least four times larger than female home ranges (Mulders, Boulanger, and Paetkau 2007; Persson, Wedholm, and Segerstrom 2010). For example, estimates of average home range size on the tundra are 73 to 126 $km^2$ for breeding females and 404 to 666 $km^2$ for males (Magoun 1985; Mulders 2000). Male home ranges overlap those of several females, in accordance with a polygynous (multiple females per male) mating system, but adult male-male and female-female home ranges rarely overlap due to territorial behaviour (Persson, Wedholm, and Segerstrom 2010). Intra-sexual competitors avoid each other, and when in contact, aggressively defend resources, sometimes to the point of death (Persson, Wedholm, and Segerstrom

2010). These life history strategies indicate that resources — food for males and females, and sexually mature females for males — are very limiting for the wolverine.

Inuit traditional knowledge indicates that wolverines use the Project area (KIA 2012). Data from wolverine harvests indicate that Bathurst Inlet is a main site for wolverine hunting in the West Kitikmeot (Mulders 2000).

Grey Wolf

The wolf is still widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. There are three subspecies of the grey wolf in Canada — all three subspecies may be found within the wildlife RSA (Chambers et al. 2012): *occidentalis* (northern timber wolf), *nubilus* (plains wolf), and *arctos* subspecies (Arctic wolf). The Arctic grey wolf, because their main prey are the migratory caribou, the annual home ranges of Arctic wolves are much larger than those of wolves in more southern latitudes (Walton et al. 2001; Cluff, Walton, and Paquet 2002). Annual home-range sizes averages 63,000 ± 13,000 $km^2$ for males and 45,000 ± 7,500 $km^2$ for females (Walton et al. 2001).

During the spring, wolves follow the caribou herds north of the treeline and do not den near calving grounds selecting sites near the treeline south of the calving grounds (Heard and Williams 1992). Although the movement of wolves is localized, this strategy likely optimizes the availability of caribou and alternative food resources for rearing pups (Walton et al. 2001). Local or regional disturbances may affect reproductive success of wolves due to their localized movements during denning. According to Traditional Knowledge, wolves were found wherever there were caribou. Inuit generally hunted the two species together (KIA 2012). Hunting areas for wolves within the wildlife RSA included areas in Bathurst Inlet as well as areas south of Goose near Beechey Lake (KIA 2012). In addition, TK indicated that wolves make their dens where it is easier to dig, such as eskers and glacial deposits such as sandy areas along riverbanks (KIA 2012).

### 8.1.4 Habitat Use and Diet

Wolverine

Wolverines are unique among northern non-hibernating carnivores because they birth very early in the year (February to early April; Inman et al. 2012). Mating occurs during summer, but implantation of the embryo into the uterine wall, and thus gestation, is delayed until at least December. Gestation occurs over 45 days, and thus females may give birth as early as February, but most give birth from late March to early April (reviewed in Inman et al. 2012). Females usually move cubs from natal dens (where cubs were born) to one or more maternal dens (where cubs are nursed) until they are weaned at 7 to 10 weeks of age. Thus, den use may extend from February to early May. After weaning, females forage for cubs and leave them at rendezvous sites, until after late June when cubs are able to forage with females.

Wolverines usually choose den sites within rocky boulder fields in snowdrifts where a deep insulating layer of snow will be maintained throughout the denning period (February to April); dens and den sites are often used for consecutive years (Lee and Niptanatiak 1996; Magoun and Copeland 1998). Typically, wolverine dens are built under at least 1 to 5 m of snow and consist of long, complex snow tunnels that lead down to boulder fields, rock overhangs, or large cracks in rocks, which are large enough to allow kits to move around, and provide additional protection from predators (Magoun and Copeland 1998; Inman et al. 2012; May et al. 2012). The importance of sites with delayed snow melt in spring for denning is revealed by the strong relationship of wolverine distribution with snow cover — 100% of 562 den sites in North America and Fennoscandia were in sites where snow melted later during spring (Copeland et al. 2010). A den usually consists of snow tunnels within boulder fields terminating in a

crevice (Magoun and Copeland 1998). Proximity to habitat that provides small mammals prey for cubs may also an important factor in den site selection winter resting sites are an important aspect of mustelid habitat. There are few data of characteristics of resting sites on the tundra, but snow dens or burrows are probably used for resting.

Wolverines are both scavengers and predators, and feed on a wide variety of prey and carrion throughout the year. Food caching is an important survival strategy, especially in winter, and may drive reproductive rate (Magoun 1987; Mulders 2000; Thorpe et al. 2001; Inman et al. 2012). Characteristics of good cache sites are structures that prevent access by competitors, and allow cold storage to prevent rot in spring and summer. Though wolverines use a variety of habitats while ranging over large tracts of land in search of food (Mulders 2000; Thorpe et al. 2001; COSEWIC 2003), they are often associated with rocky boulder fields which provide good sites for caching food (Johnson et al. 2005; Inman et al. 2012).

Wolverines feed on ungulates, but mostly as scavengers. Scavenged caribou probably comprise a large portion of wolverine diets in the Arctic. The majority (62%) of wolverine stomachs from 277 carcasses collected in the Kitikmeot region contained caribou, while 11% of stomachs contained primarily muskox (Mulders 2000). Wolverine densities appear to be the highest where caribou are abundant and where wolf predation on caribou is high and creates scavenging opportunities (COSEWIC 2003). In fact, wolf kills appear to provide a preferred food source for wolverine, suggesting a close link between wolf and wolverine population dynamics (van Dijk et al. 2008). However, wolverines are the main predator of caribou calves in some regions (e.g. British Columbia; Gustine et al. 2006).

The summer diet of wolverines is more varied than their winter diet, and contains more freshly killed prey (Magoun 1987). It is thought that wolverine foraging strategies switch from mostly scavenging and caching during winter, to hunting for birds and small mammals during summer (Inman et al. 2012). However, scavenging likely remains a key foraging strategy during summer, and is not limited to wolf kills as wolverine have been observed stealing goose carcasses from fox dens (Samelius et al. 2002). On the tundra during the summer, wolverine hunt mainly ground squirrels, Arctic hare, ptarmigan, geese and their eggs (Magoun 1987; Samelius et al. 2002).

Female wolverine consume more small mammal prey than males during summer, possibly because their movements are more restricted due to cub-rearing (van Dijk et al. 2008). Small mammals may be especially important to females and cubs during cub-rearing; survival of young wolverines was significantly higher in years when small mammals were abundant (Pulliainen 1968). During the summer, wolverine occurrence is strongly related to the presence of sedge habitat, possibly because small mammals are usually abundant there (Johnson et al. 2005).

Grey Wolf

Wolves are the predominant predators of barren-ground caribou and rely primarily on adequate ungulate densities to maintain wolf population size (Walton et al. 2001; Paquette and Ludwig 2003; Frame 2005; Frame, Cluff, and Hik 2008; Wiebe et al. 2009). Wolves on the tundra are also the main predator of muskox. Alternative prey, such as birds and small mammals, can sustain wolves during periods of low ungulate availability (Heard 1992). Ducks and geese, especially during the moulting period when birds are flightless, can also comprise a significant portion (30%) of the diet of wolves (Wiebe et al. 2009). Despite being easily accessed, wolves rarely forage on goose eggs, likely because wolves can experience biotin (a B-vitamin) deficiency from consuming too much albumin in eggs (Wiebe et al. 2009).

Migratory wolves winter below the treeline and arrive at denning sites on the tundra in late April and give birth shortly thereafter (Walton et al. 2001). Less is known of the denning ecology of tundra-

wintering wolves, but the timing of denning is likely similar. Wolves are territorial during denning and migratory wolves in the Kitikmeot region show strong fidelity to den sites (Walton et al. 2001).

Pups are weaned in the den and the immediate area surrounding the den. Wolves leave the den site when the young are able to travel with adults, usually in September or October (Walton et al. 2001). Pups are usually cared for cooperatively at communal dens, thus dens usually represent the reproductive efforts of multiple wolf pairs (Frame et al. 2004).

Pups are often moved from natal den sites to rendezvous sites, which like natal dens are re-used in consecutive years (Frame, Cluff, and Hik 2007). Adults move pups when disturbed by approaching humans at the den sites; pup age is the strongest predictor of pup movement. Pups less than three weeks old are not moved, pups older than six weeks were always moved (Frame, Cluff, and Hik 2007).

Inuit TK indicates that most wolf dens are located on eskers (KIA 2012). Esker habitats are granular and sandy, likely facilitating soil excavation for dens in a landscape dominated by bedrock, boulders, standing water, and permafrost (McLoughlin et al. 2004). In the tundra of the Canadian Arctic, esker habitat only comprises 1-2% of the landscape (McLoughlin et al. 2004). Therefore, suitable denning habitat for wolves inhabiting northern tundra is likely a limiting factor and areas containing eskers should be considered particularly important (McLoughlin et al. 2004). Of the dens observed during den surveys for the Project, all 7 dens were located on eskers.

### 8.1.5 Baseline Data for Furbearers

Four types of baseline surveys were conducted for wolverine and grey wolf in the wildlife RSA including: 1) population-estimation using DNA mark-recapture; 2) den surveys; 3) incidental observations; and 4) habitat suitability modelling. The modelling was conducted in the wildlife RSA to evaluate the quality of habitat in the study area for wolverine habitat and grey wolf denning.

Baseline information for wolverine and grey wolf used in this section included the following reports:

- *Back River and Hackett River Projects: 2010 Caribou and Muskox Baseline Report* (Rescan 2011a; Appendix V5-5E).
- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012; Appendix V5-5D);
- *Back River Project: 2012 Wildlife Baseline Report* (Rescan 2013d; Appendix V5-5C);
- *Back River Project 2012: Grizzly Bear and Wolverine DNA Baseline Report* (Rescan 2013b, Appendix V5-6A); and
- *Back River Project: 2013 Wildlife Habitat Suitability Baseline* (Rescan 2013a; Appendix V5-5A).

The results of the 2013 wildlife baseline program will be available in early 2014.

Other sources of supplementary wildlife data used for wolverine and grey wolf in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *Bathurst Inlet Port and Road Project: Caribou and Muskox Baseline Study* (Rescan 2007a);
- *2007 Wildlife Baseline Report Hackett River Project* (Rescan 2008a);
- *2008 Wildlife Baseline Report Hackett River Project* (Rescan 2008b);
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008); and
- *Bathurst Inlet Port and Road Project: Wildlife Baseline Studies, 2001-2002* (Rescan 2007b).

#### 8.1.5.1 *Methods*

DNA Mark-Recapture

A wolverine DNA study was conducted in 2012 for the Back River Project (Rescan 2013d, Appendix V5-5C). The survey area in 2012 for the wolverine DNA hair study was a 1,692 $km^2$ grid, roughly centered between Goose Property Area and George Property Area, with no post closer than 5 km from either exploration camp for safety reasons. The survey grid was divided into 49 cells, with each cell being 6 × 6 km. Within each cell, a 1.5 m post wrapped with barbed wire was set and secured with rocks. A long-distance (strong-smelling) lure was used to draw in wolverines and a piece of fish was used as a food reward to provide incentive for wolverines to climb the posts. Three checks to collect hair samples were conducted: these were spaced a minimum of 10 days and a maximum of 14 days apart.

DNA extracted from samples went to a multi-locus analysis of individual identity; there was no initial single-locus pre-screen for sample quality or species. This analysis used eight markers, including a ZFX/ZFY gender marker and seven microsatellite markers; the standard for wolverine projects from the Arctic. An additional survey grid (approximately 2,000 $km^2$) was established in the northern extent of the wildlife RSA during 2013, roughly catering the proposed marine laydown area (Figure 8.1-2). Details of the methods are reported in the 2012 Grizzly Bear and Wolverine DNA Baseline Report (Rescan 2013b; Appendix V5-6A).

Carnivore Den Surveys

For carnivores including wolverine and wolves, den surveys were conducted to identify the number and distribution of existing dens within the wildlife RSA, to identify dens that are active, and to identify predominant resident carnivore species utilizing the wildlife RSA (Gartner Lee Limited 2007; Rescan 2012, Appendix V5-5D; 2013d). Two surveys were conducted, an occupancy survey (May/June) and a productivity survey (July). The occupancy survey identified that a den was "occupied" and used for breeding, while the productivity survey was conducted to examine if the den was successful (adults and young were present) or abandoned (indicating the pups died and the den failed for that year).

These surveys were carried out via low level aerial surveys in esker and glacial-fluvial habitat. Occupancy surveys were carried out in 2007 (Gartner Lee Limited 2007), while both occupancy and productivity surveys were conducted in 2011 (Rescan 2012, Appendix V5-5D) and 2012 (Rescan 2013d, Appendix V5-5C) throughout the wildlife RSA. Surveys were flown at an altitude of 50 to 100 m above the terrain and at ground speeds between 30 to 80 km/h to minimize disturbance to carnivores in the area but to maintain an effective height and speed for observers to effectively discern dens and signs of activity (i.e., animals, scat, tracks, or prey remains). Full details of the carnivore den survey methods can be found in the 2011 and 2012 Wildlife Baseline Reports (Rescan 2012, Appendix V5-5D; 2013d).

Incidental Observations

Incidental observations of wolverine and other furbearers were recorded in the wildlife RSA when observed on the tundra during other wildlife and environmental baseline surveys conducted between 2007 and 2012 and when captured by the 30 remote cameras distributed throughout the wildlife RSA for caribou studies (Chapter 5, Section 5.2.4.4) and to supplement the wolverine DNA studies (wolverine: Section 8.2.6). Remote cameras for the wolverine DNA study recorded observations from March to early May 2012 and cameras for the caribou baseline studies recorded observations from late May to August 2012. Images from these cameras were quality checked to remove duplicate images of the same individual and documented. Full details on data handling for the remote camera studies can be found in the 2012 Wildlife Baseline Report (Rescan 2013d, Appendix V5-5C) and the 2012 Grizzly Bear and Wolverine DNA Baseline Report (Rescan 2013b, Appendix V5-6A).

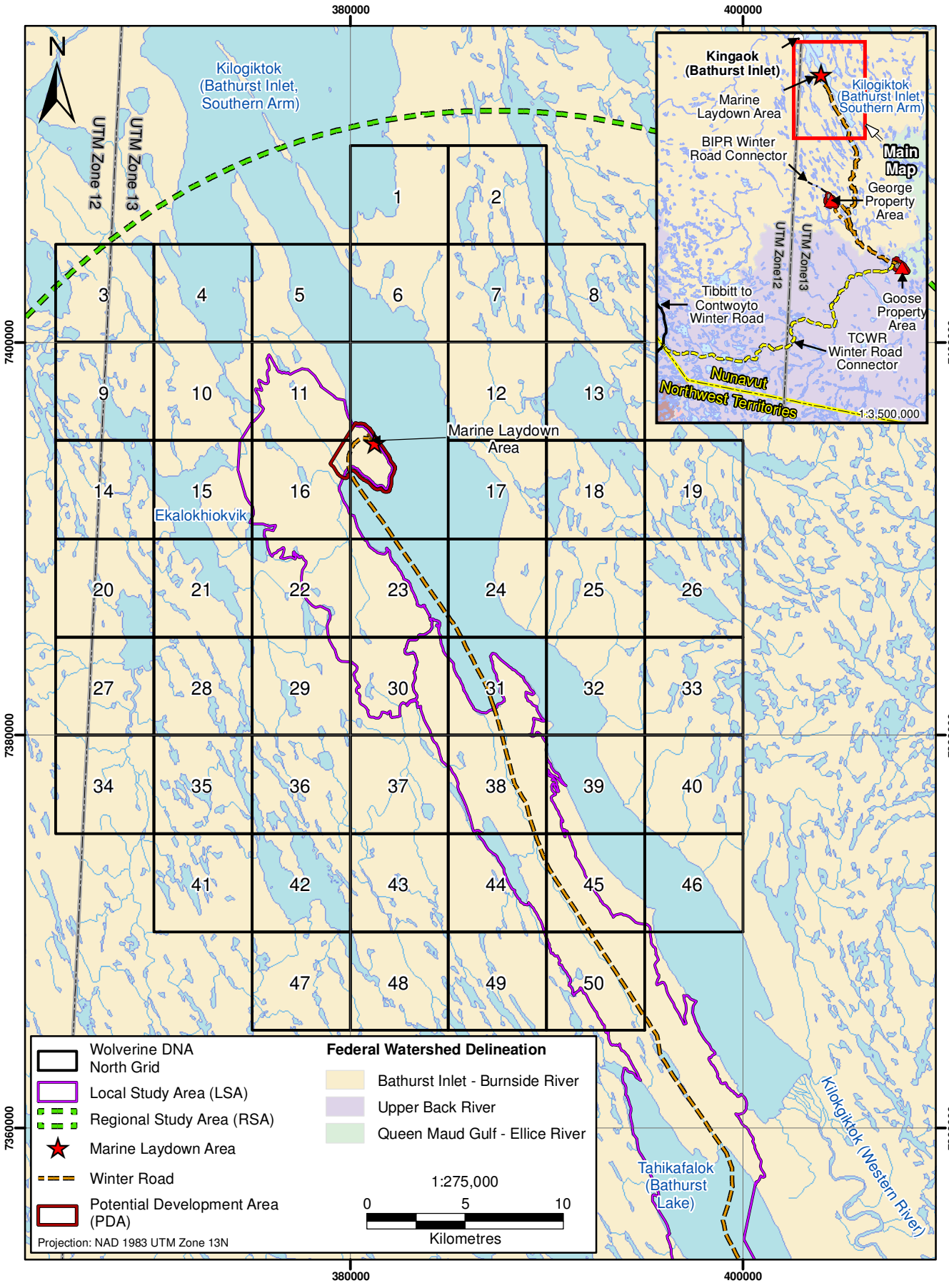


Figure 8.1-2

# Wolverine DNA North Study Grid, 2013

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Habitat Suitability

Wildlife habitat suitability studies were conducted within the wildlife LSA and RSA to inventory and rate the habitat types for wolverine and grey wolf which can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 $km^2$ of the West Kitikmeot / Slave Study Area, which stretches from the arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001).

### 8.1.5.2 *Results*

Wolverine

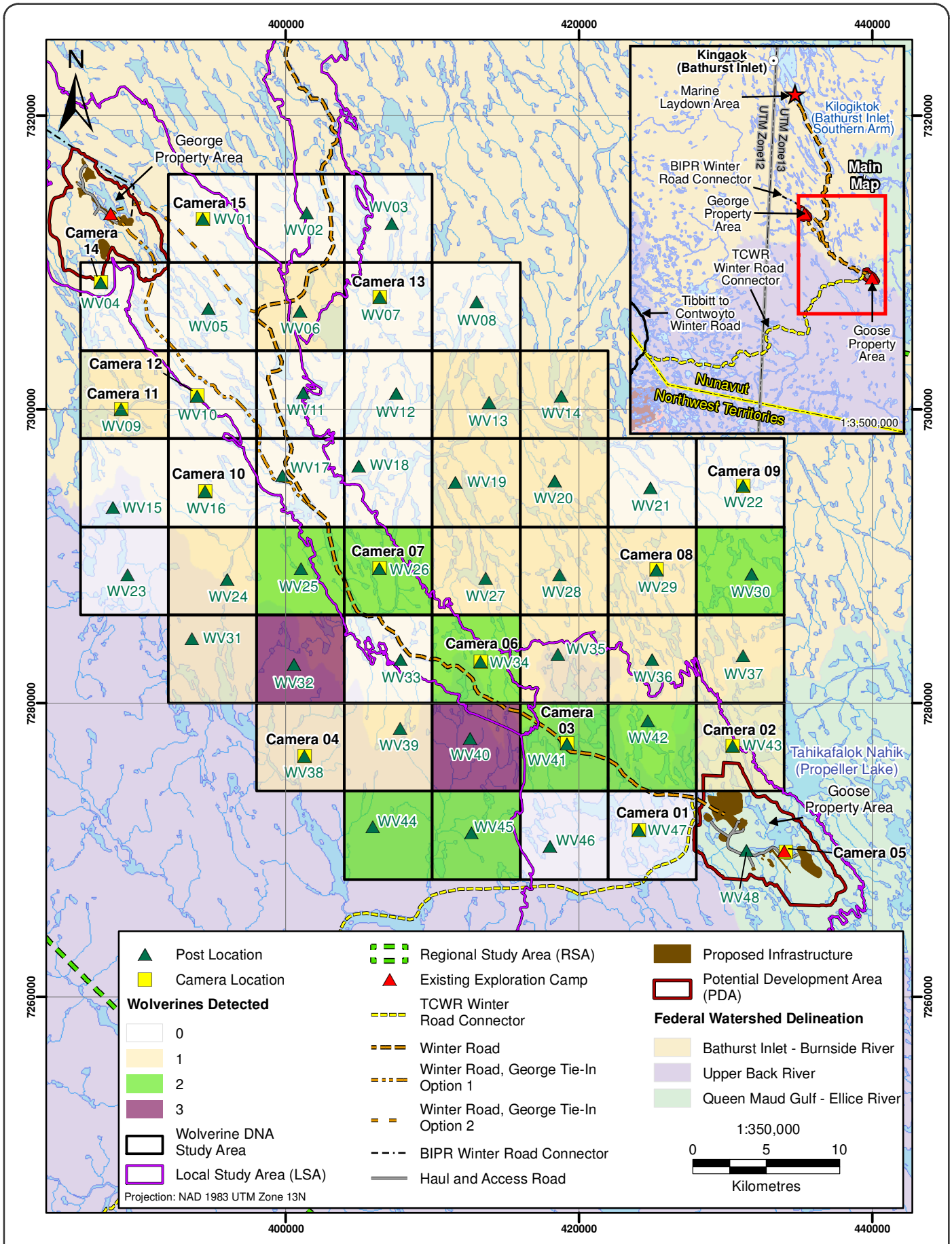
Wolverines have been detected in the wildlife RSA between 2001 and 2012 (Rescan 2002; Gartner Lee Limited 2007; Rescan 2013d, Appendix V5-5C; 2013b). Of the three methods used to detect wolverine (DNA Mark-recapture, Carnivore Den surveys, and incidental observations during other baseline studies including remote camera studies), DNA Mark Recapture detected the largest number of wolverines and gives the best approximation of the number of wolverines that occur in the wildlife RSA.

*DNA Mark Recapture*

A total of 196 wolverine hair samples were collected during 2012 and submitted for DNA analysis (Rescan 2013b, Appendix V5-6A). The majority of samples were collected in the southwest and central portion of the wolverine DNA grid along the proposed winter road connecting the George and Goose PDAs (Figure 8.1-3). Of the total number of hair samples collected, 74 (38%) were successfully extracted and assigned to 12 independent individuals, including 4 females and 8 males. One of these individuals was previously detected in a DNA study conducted at Ekati approximately 225 km to the southwest of the wolverine study area. While the wolverine study area does not represent a geographically closed population, in terms of individual detections, 2012 results of the wolverine DNA study indicate that the Back River Project area does appear to support a moderately sized wolverine population (Rescan 2013b, Appendix V5-6A).

Three males and two females were captured in more than one cell during a single 10-14 day sampling period. These capture events represent cumulative straight line distance movements ranging from 24 to 43 km for females and 12 to 36 km for males between multiple DNA posts. The longest single straight line distance between two posts visited by an individual during the entire survey was 22 km (Figure 8.1-4). Given the topography and presence of waterbodies between many of the cells, the actual distances travelled between points are likely considerably higher.

Minimum recorded area estimates for individual wolverines ranged from 89 $km^2$ and 264 $km^2$, with an average area of 162 $km^2$. Male wolverines had slightly larger areas of use than females (166 $km^2$ versus 157 $km^2$). There were several areas where individual wolverines overlapped one another. The largest spatial overlap was 129 $km^2$ between a male and a female.

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# Wolverine DNA Grid, Post Locations and Capture Frequency, 2012

Figure 8.1-3

Rescan an ERM company

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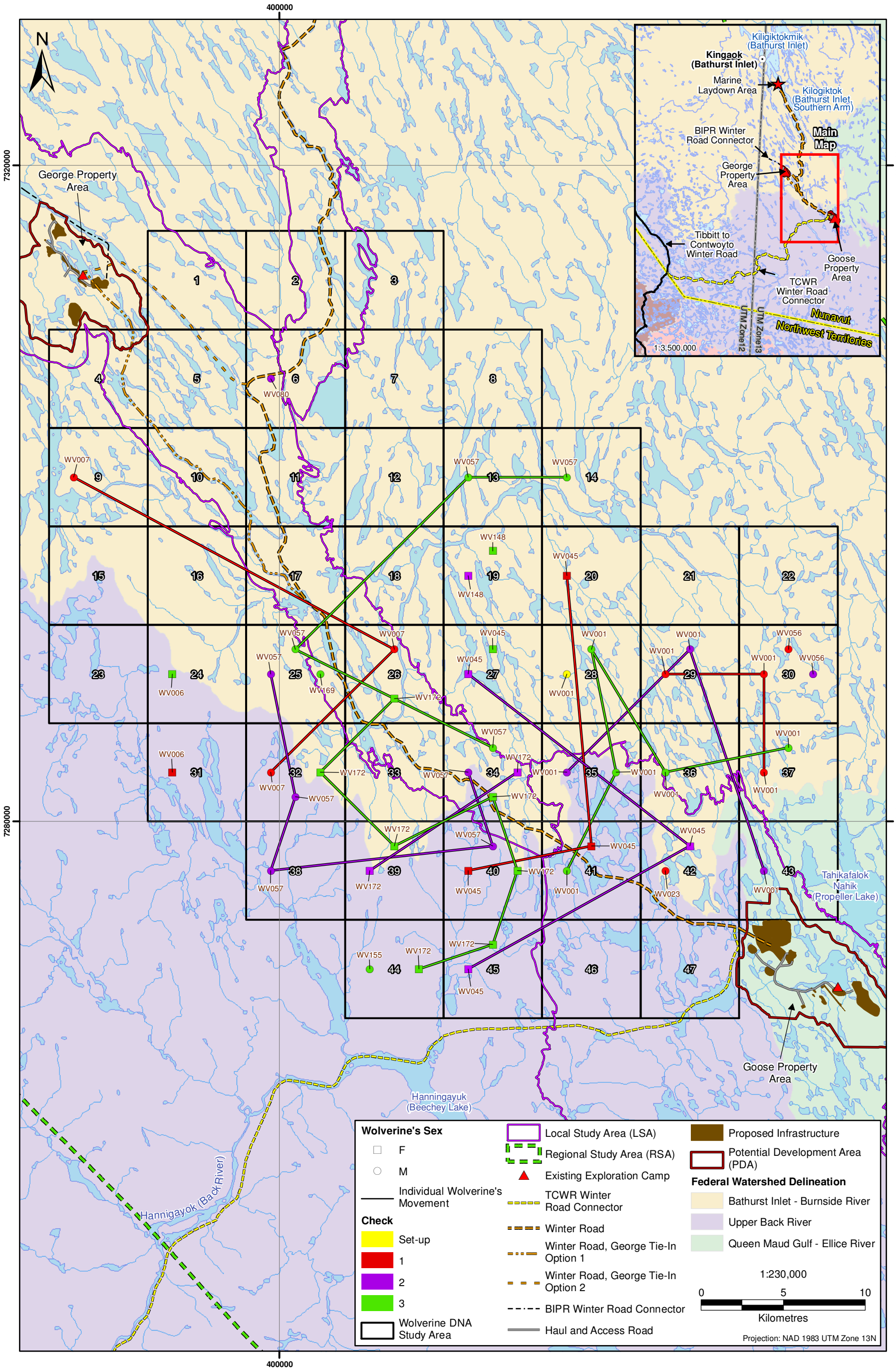


Figure 8.1-4

Sabina GOLD & SILVER CORP.

## Wolverine Distance Movements during DNA Surveys, 2012

Figure 8.1-4

Rescan an ERM company

Samples were collected in 2013 at both the northern wolverine DNA grid (roughly centred on the marine laydown area) and the southern area (also surveyed in 2012) and are currently being analyzed at Wildlife Genetics International. The results of both survey years and a combined mark-recapture estimate of wolverines in the study area will be available in 2014.

*Carnivore Den Surveys*

Den surveys for carnivore dens were carried out as part of surveys for wolf dens via low level aerial surveys in esker and glacial-fluvial habitat during the end of May or early June, and July of 2007, 2011, 2012, and 2013 (Gartner Lee Limited 2007; Rescan 2012, Appendix V5-5D; 2013d, Appendix V5-5C). Two active wolverine den sites were located near the Goose Property in 2012 (Figure 8.1-5; Rescan 2013d, Appendix V5-5C). Both wolverine dens were found in rocky boulder areas and located within 1 km of proposed site infrastructure (Figure 8.1-5). This wolverine was frequently observed near camp during the summer of 2013 and the den remained active (and likely successful) despite drilling, water pumping, and some snowmobile activity in the area within 200 to 300 m of the den. This suggests that wolverines which have built their dens near sources of long-term human activities can habituate to these activities. This result is important for later mitigation and management of wolverine in the Project area.

*Incidental Observations*

Wolverines have been rarely detected during aerial and ground surveys of the wildlife RSA between 2001 and 2013 (Figure 8.1-5). Because of their relatively small size, wolverines are probably difficult to detect from the air, except when the ground is snow-covered. Therefore, more wolverines were likely present, but not seen during aerial surveys. In 2001, one wolverine was observed near George Property and another observed south of the proposed marine laydown area (Rescan 2002). In 2007, two incidental observations of wolverines were recorded (Gartner Lee Limited 2007). In 2010, one wolverine was incidentally sighted east of the Goose Property Area (Rescan 2011a, Appendix V5-5E), and four wolverines were observed incidentally during the baseline studies conducted in 2012 (Figure 8.1-5; Rescan 2013d, Appendix V5-5C), one of which occurred in the Goose Property Area. No wolverines were observed in 2011 (Rescan 2012, Appendix V5-5D).

In addition to wolverines observed during other baseline studies conducted in the wildlife RSA, the 30 remote cameras distributed within the wildlife RSA, recorded 51 observations of wolverines between March and August 2012 (Rescan 2013d, Appendix V5-5C). Several of these observations are likely re-counted individuals (Figure 8.1-5).

*Habitat Suitability*

Habitat suitability is based on identify the life requisites for a particular species. These include specific activities of an animal that are critical for sustaining and perpetuating the species and that depend on particular habitat attributes or conditions. Life requisites include feeding, cover, breeding, migration, and hibernation. The life requisites assigned to wolverine were denning characteristics for reproducing (Table 8.1-1).

**Table 8.1-1. Seasonal Life Requisites of Wolverine Denning**

| Season | Date | Life Requisite | Habitat Preference |
|---|---|---|---|
| Denning | February to early May | Reproducing | Landscape features that provide deep, persistent snow packs. |

The results of the wolverine suitability modelling indicate that slightly less than half of the wildlife LSA and RSA contained habitat features that may offer denning opportunities (Table 8.1-2; Figure 8.1-6). Due

to the variable nature of wolverine denning preferences, this result should be assumed to be a coarse assessment of denning potential where the actual total area of the wildlife LSA and RSA is likely much lower.

**Table 8.1-2. Area and Proportion of Suitable and Not Suitable Habitat within the Wildlife LSA for Wolverine Denning**

| Suitability Rating | Amount of Habitat in the LSA[1] | | Amount of Habitat in the RSA[2] | |
|---|---|---|---|---|
| | Area (ha) | % of LSA | Area (ha) | % of RSA[2] |
| Suitable (Useable) | 61,366.5 | 45.8 | 562,221.4 | 44.7 |
| Not Suitable | 72,563.8 | 54.2 | 694,931.2 | 55.3 |

[1] *LSA = 134,369.3 ha, approximately 439 ha of the wildlife LSA fell in the unclassified class and was not included in modelling, thus the total amount of habitat modelled in the LSA is 133,930 ha.*
[2] *RSA = 1,262,004.6 ha, approximately 4,852 ha of the wildlife RSA fell in the unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,153 ha.*

Grey Wolf

*Carnivore Den Surveys*

Low level aerial surveys for wolf dens in esker and glacial-fluvial habitat were conducted during the end of May or early June, and July of 2007, 2011, 2012, and 2013 (Gartner Lee Limited 2007; Rescan 2012, Appendix V5-5D; 2013d). In 2007, five active wolf dens were located within the wildlife RSA with one or two adults observed at all active wolf dens and pups recorded at four of the den sites (Gartner Lee Limited 2007). One of these dens was located near (north of) the George Property, with the remaining four evenly dispersed throughout the wildlife RSA (Figure 8.1-7; Gartner Lee Limited 2007). No denning activity was found at six historic wolf den locations in the wildlife RSA that were revisited in 2007 (Gartner Lee Limited 2007).

During the 2011 field season, no grey wolf dens were found (Rescan 2012, Appendix V5-5D). In 2012, two active wolf dens were recorded during carnivore den surveys with adults observed at both sites (Rescan 2013d, Appendix V5-5C). One den was located on the west side of the wildlife RSA approximately 25 km from the winter road alignment between Goose and George Properties. The other den was located approximately 30 km northwest of Goose Property (Figure 8.1-7). Productivity was recorded as "unknown" at these two dens as no kits were observed. Abundant wolf scat, prey remains, and hair were observed near the entrance to the dens indicating recent activity and potential productivity. All den sites observed during 2007 and 2012 were located in eskers.

*Incidental Observations*

During baseline studies conducted between 2001 and 2012, 133 wolves were observed incidentally in the wildlife RSA. Four wolves were observed incidentally in 2001 and 2002 (Rescan 2002). Another nine wolves were observed incidentally outside of the den survey conducted in 2007 (Gartner Lee Limited 2007). Two wolves were observed during aerial surveys for ungulates conducted in 2010 (Rescan 2011a, Appendix V5-5E). During the 2011 field season, 10 wolves (including four yearling wolves) were observed during baseline surveys conducted in the wildlife RSA (Rescan 2012, Appendix V5-5D). In 2012, 16 wolves observed incidentally (Rescan 2013d, Appendix V5-5C). The 30 remote cameras located in the wildlife RSA recorded 92 additional wolves in 2012 (Rescan 2013d, Appendix V5-5C). However, these observations likely include individuals recorded more than once (Figure 8.1-7).

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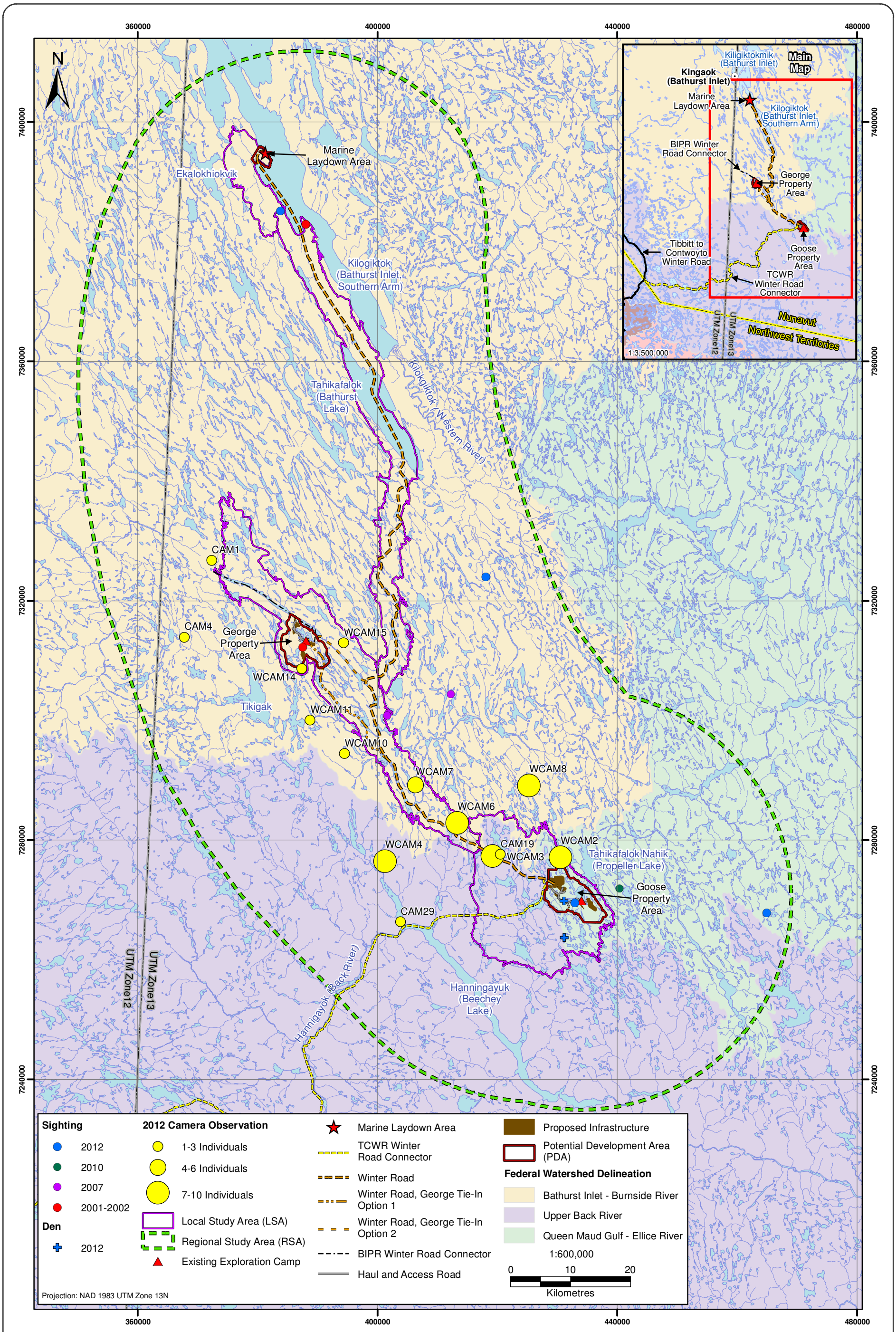


Figure 8.1-5

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# Den Locations and Incidental Observations of Wolverines, 2001 to 2012

Figure 8.1-5

Rescan an ERM company

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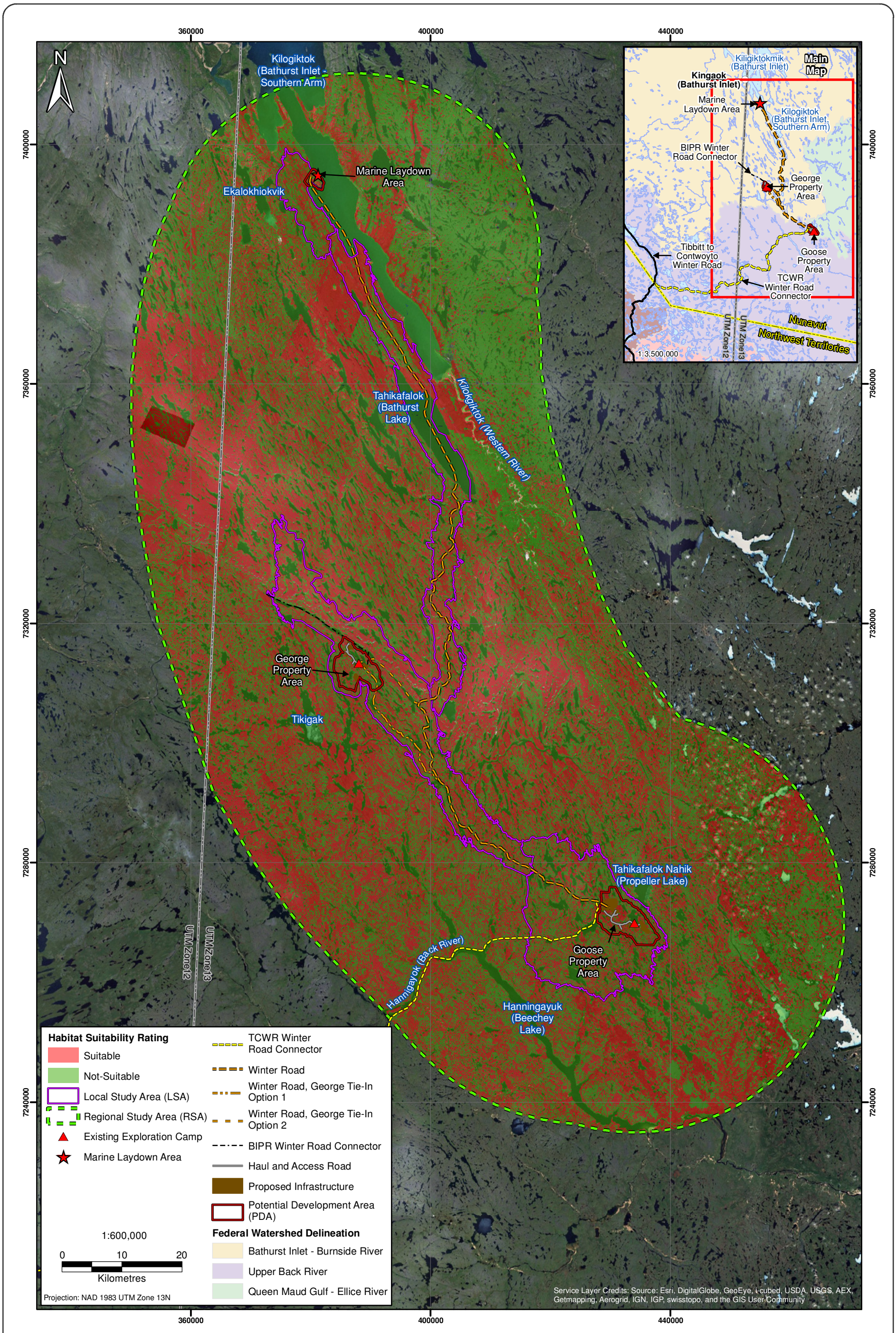


Figure 8.1-6

Sabina GOLD & SILVER CORP.

# Wolverine: Denning Habitat in the Local Study Area and Regional Study Area

Figure 8.1-6

Rescan an ERM company

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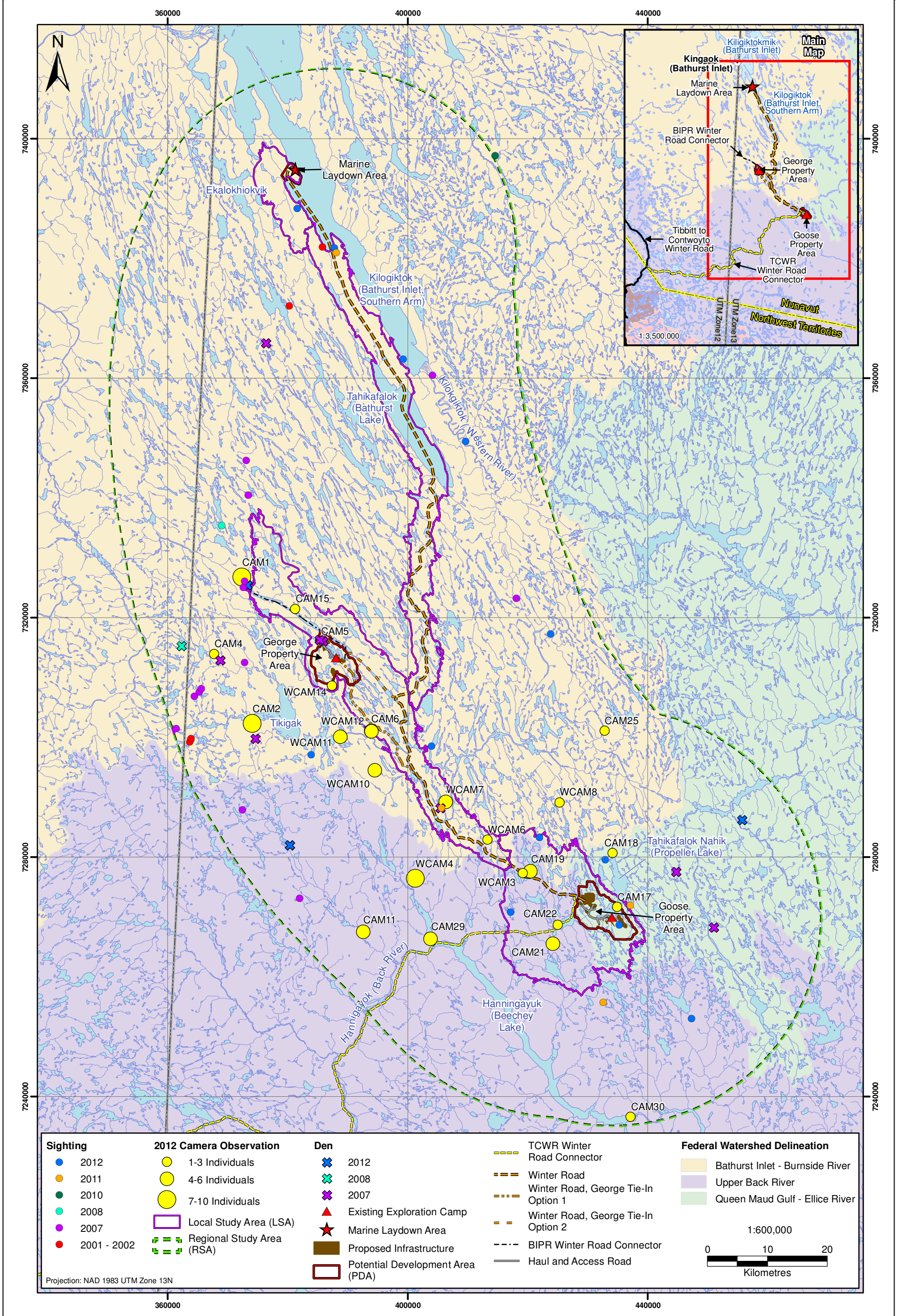


Figure 8.1-7

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# Wolf Sightings and Locations of Dens (2001 to 2012)

Figure 8.1-7

Rescan an ERM company

*Habitat Suitability*

The life requisites being rated for habitat suitability for the grey wolf in this report are living and reproducing and the respective seasons is spring - denning (Table 8.1-3). Wolves breed once per year, typically during March or April. After a nine-week gestation period, litters remain in dens for up to two weeks. Throughout the late spring and early summer pups remain close to dens, while adults hunt nearby. By late summer to early fall they join the pack as it follows caribou and begin to participate in hunting activities.

**Table 8.1-3. Seasonal Life Requisites of Grey Wolf**

| Season | Date | Life Requisite | Habitat Preference |
|---|---|---|---|
| Denning | Late April to September | Living and reproducing | Eskers, near prey |

The results of the modelling indicate that potential denning sites in both the wildlife LSA and RSA are scarce, even when including moderate and low value sites. The combined high, moderate and low value habitat for the wildlife LSA was approximately 3%, while the wildlife RSA was somewhat higher with a combined total of less than 4% (Table 8.1-4: Figure 8.1-8). While these results appear to be representative of the study areas (where eskers and other suitable terrain features are limited in extent), it likely underestimates the total potential. Additional denning opportunities may occur in both study areas. Traditional Knowledge indicates that wolves also den on lake banks (lacustrine materials), which were not included in the modelling due to the inability to differentiate between suitable lake banks and open water (with open water comprising the vast majority of the mapped lake polygons).

**Table 8.1-4. Area and Proportion of High, Moderate, Low, and Nil-rated Habitat within the Wildlife LSA and RSA for Grey Wolf**

| Suitability Rating | Amount of Habitat in the Wildlife LSA | | Amount of Habitat in the Wildlife RSA | |
|---|---|---|---|---|
| | Area (ha)[1] | % of LSA[2] | Area (ha)[1] | % of RSA[2] |
| High | 386.5 | 0.3 | 5,457.20 | < 1 |
| Moderate | 8,598.2 | 6.4 | 6,616.49 | < 1 |
| Low | 4,834 | 3.6 | 43,061.49 | 3.4 |
| Nil | 120,111.6 | 89.7 | 1,202,017.39 | 95.0 |

*[1] LSA = 134,369.31 ha, approximately 439 ha of the wildlife LSA fell in the unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife LSA is 133,930 ha.*
*[2] RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the wildlife RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,152.58 ha.*

## 8.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The report Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012) was reviewed for information on the ecology of wolverine and wolves (KIA 2012). All identified traditional knowledge regarding wolverine and grey wolf ecology and habitat has been addressed throughout this assessment. This section summarizes the process of incorporating TK throughout the baseline studies, selection of VECs, selection of assessment boundaries, assessment of potential effects, and recommendations for mitigation and adaptive management.

Traditional knowledge, land user knowledge and thoughts raised by Kitikmeot Inuit Association and land users were incorporated into the effects assessment chapter in five primary ways:

1. Wolverine and grey wolf were included as a VEC for a number of reasons (Section 8.3.2), including that they are a culturally and socially important species in the Project area.
2. Land users were consulted and included on the positioning of the posts used for the DNA mark-recapture study. Land users provided insights on wolverine behaviour and habitat use and directed the installation of hair-capture posts in the best possible locations to attract wolverines (Section 8.1.5).
3. Traditional Knowledge and land user information were used to position the remote cameras to maximize capture of passing caribou, wolverines, and grey wolves. Land users worked with Rescan biologists in the field to position and install cameras in high-quality travel corridors (Section 5.1.5).
4. Habitat usage and foraging information from TK and land users was incorporated in the habitat suitability modelling report and therefore included in the environmental setting (Section 8.1.5) and effects assessment where habitat loss (Section 8.5.2.1) and disturbance (Section 8.5.2.2) is evaluated.
5. Traditional Knowledge and land user information was included in the preparation of management plans to reduce the attractiveness of the camps and other infrastructure (Volume 10, Chapter 20).

The following reports were reviewed for TK specific information related to wolverine and wolves:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

### 8.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds were also documented. These studies were guided by TK including the help of land users in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and Environmental Risk Assessments (Volume 8, Chapter 6) were developed.

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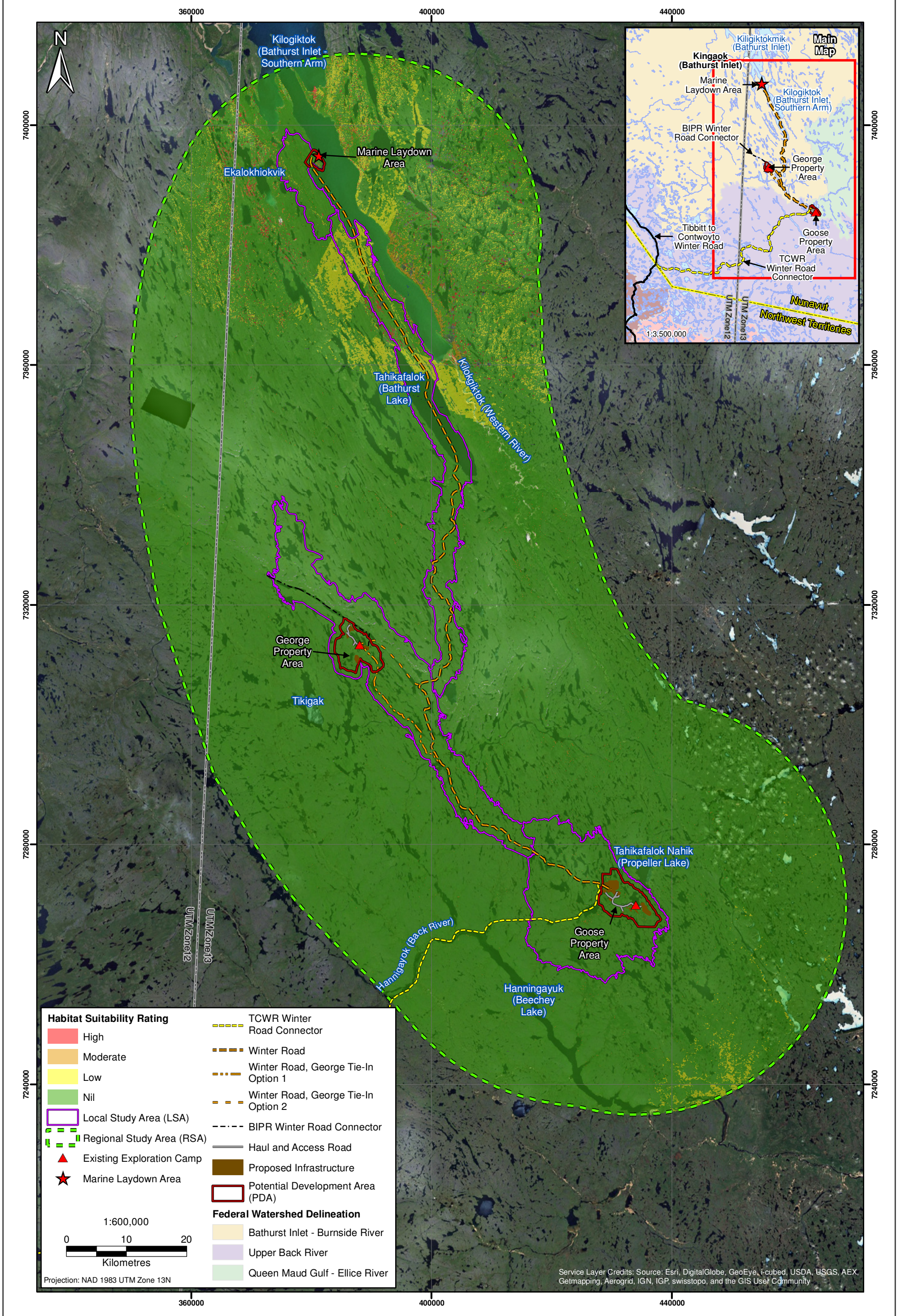


Figure 8.1-8

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# Grey Wolf: Denning Habitat in the Local Study Area and Regional Study Area

Figure 8.1-8

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Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, cliffs, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high-quality habitat, wherever possible.

### 8.2.2 Incorporation of TK for VEC and VSEC Selection

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

### 8.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

### 8.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

### 8.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013c), thoughts from Inuit people regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components VSECs that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

## 8.3 VALUED COMPONENTS

### 8.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the DEIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the DEIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information as described below. The VECs were selected based on the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members.

### 8.3.2 Valued Components included in Assessment

Each potential VEC was screened for inclusion in the environmental assessment through an evaluation of the results of baseline studies, conservations status, biological importance, regulatory, cultural,

social, and economic significance and the potential for each to be affected by the Project (Volume 9, Chapter 1). Furbearers were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, furbearers were selected as a VEC for the effects assessment. Wolverine and wolves were selected as representative furbearer species.

Wolverine and wolves provide an important ecological role as top predators in the Arctic food chain. Wolves are the main predator of caribou. Wolf kills provide a preferred food source for wolverine, suggesting a close link between wolf and wolverine population dynamics (van Dijk et al. 2008). Wolverine densities appear to be the highest where caribou are abundant and where wolf predation on caribou is high creates scavenging opportunities (COSEWIC 2003).

## 8.4 SPATIAL AND TEMPORAL BOUNDARIES

### 8.4.1 Spatial Boundaries

The wolverine and the grey wolf effects assessment considered two study areas for wildlife inventory for the Project: local study area (LSA) and regional study area (RSA; Figure 8.4-1).

#### 8.4.1.1 *Local Study Area*

The boundaries of the Local Study Area (LSA) for wolverine and grey wolf were set to encompass the following:

- the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, George, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property, George Property, and MLA. The wildlife LSA covers an area of approximately 134,369 ha (Figure 8.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

#### 8.4.1.2 *Regional Study Area*

The RSA for wolverine and grey wolf encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three potential development areas (Goose Property Area, George Property Area, and MLA). The wildlife RSA covers an area of approximately 1,262,005 ha (Figure 8.4-1). The wildlife RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

### 8.4.2 Temporal Boundaries

The temporal boundaries used for the wolverine and furbearers effects assessment follow the time periods of the phases of the Project as presented in Table 8.4-1.

**Table 8.4-1. Temporal Boundaries — Project Phase Durations**

| Activities | Duration |
|---|---|
| Site Preparation | 2 years |
| Construction phase | 2 years |
| Operational phase | 10 years |
| Reclamation and Closure phase | 10 years |
| Post-closure phase | 5 years |
| *Other potential phases:* | |
| Temporary Closure | Less than 2 years |
| Care and Maintenance phase | 2 to 10 years |

## 8.5 PROJECT-RELATED EFFECTS ASSESSMENT

### 8.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on wolverine and grey wolf as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

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

The potential effects of the Project on wolverine and grey wolf are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

#### 8.5.1.1 *Indicators used to Characterize Potential Residual Effects*

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 8.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of “yes” or “no” where triggering of residual effects assessment occurred if the indicator value was “yes” (e.g., attraction of wolverines and grey wolf to mining projects has occurred elsewhere at similar projects in Nunavut or the Northwest Territories).

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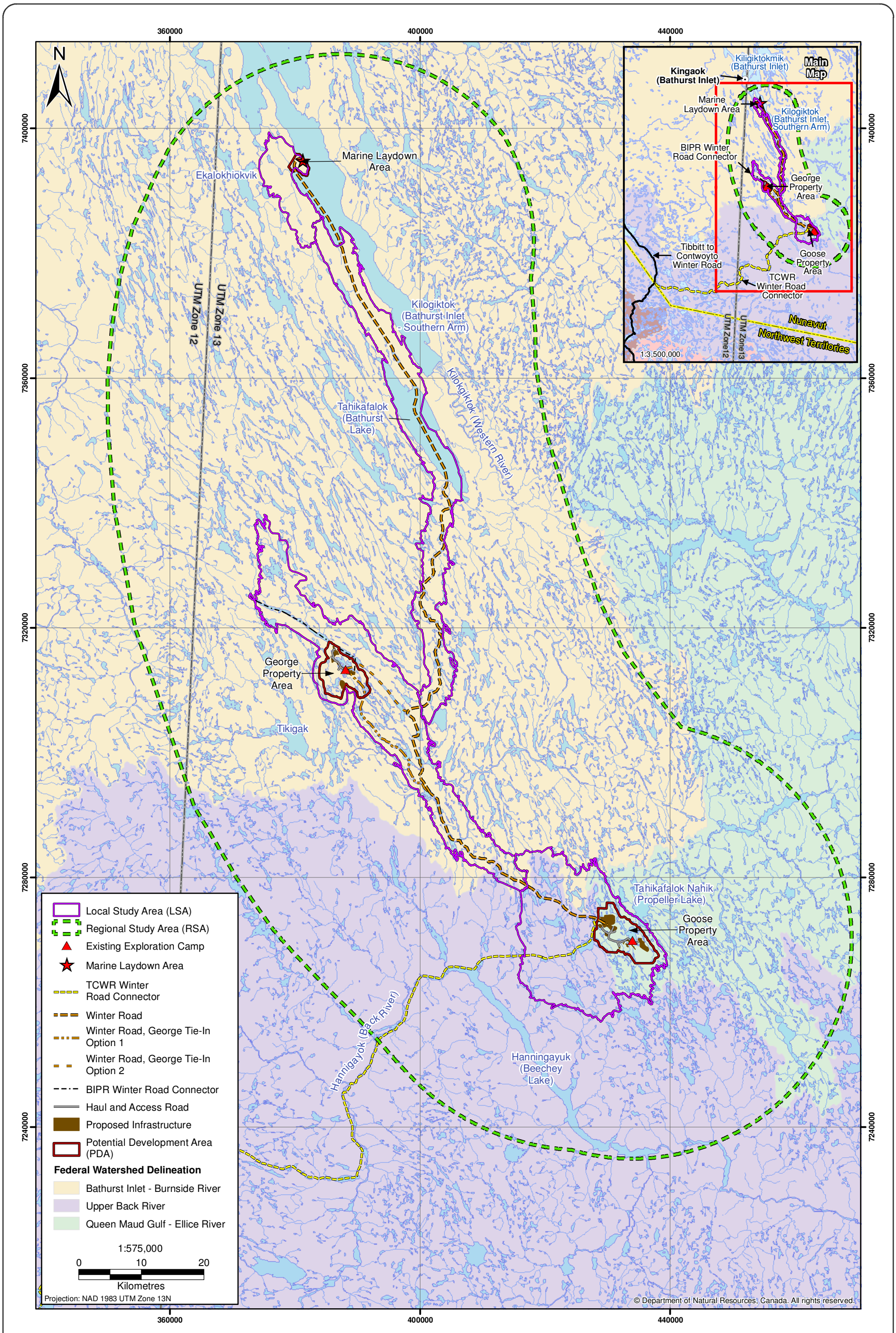


Figure 8.4-1

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# Local Study Area and Regional Study Area for Wolverine and Grey Wolf

Figure 8.4-1

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**Table 8.5-1. Criteria, Indicators and Triggers Used to Characterize Potential Residual Effects on Wolverine and Grey Wolf**

| Potential Effect | Criteria | Indicator |
|---|---|---|
| Habitat loss | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disturbance due to noise | Change in Population Health | Amount (ha) of high-quality habitat lost or altered |
| Disruption to movement | Change in Population Health | Traffic timing, and traffic volume |
| Direct mortality and injury | Change in Population Health | Traffic timing, traffic volume, and vehicle speed |
| Indirect mortality | Change in Population Health | Predicted increase in human access to wildlife RSA |
| Attraction | Change in Population Health | Attraction occurred at similar Projects in Nunavut and Northwest Territories |
| Exposure to contaminants | Change in Population Health | Predicted Hazard Quotients for metals in environmental media and wildlife |
| Reduction in reproductive productivity | Change in Population Health | Literature suggests combined residual effects on wolverine and grey wolf |

### 8.5.1.2 *Magnitude Ratings for Residual Effects*

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 8.5-2).

**Table 8.5-2. Definitions of the Magnitude Ratings for Residual Effects Based on Population Health Criterion**

| Magnitude Rating | Magnitude Descriptor of Residual Effects (Population Health Criterion) |
|---|---|
| Negligible | No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%. |
| Low | Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%. |
| Moderate | Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%. |
| High | Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%. |

*Note: Quantitative indicator thresholds for Habitat Loss and Disturbance due to Noise were included for determining the effect on the sub-population. For all other effects professional judgement and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.*

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for wolverine and grey wolf, which provide benchmark measures, as well as estimates of the natural variability. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

#### 8.5.1.3 *Overall Significance Ratings of Residual Effects*

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 6.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 8.5-3). For example, a residual effect receives a rating of "Not Significant" if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

**Table 8.5-3. Definitions of Significance Ratings for Residual Effects on Wolverine and Grey Wolf**

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

Finally, the degree of uncertainty in the rating was provided as a qualifier.

### 8.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VECs wolverine and grey wolf and the Project is provided in Volume 9, Chapter 1. Potential effects on wolverine and grey wolf and their

respective habitats by the Project have been scoped based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories and based on scientific literature review. The effects of mining developments in the Arctic have been well-documented through monitoring programs at the Lupin gold mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Hope Bay mine (Rescan 2011b, 2013e).

Interactions of wolverine and grey wolf with Project components were evaluated to determine which of the following potential effects may occur (Table 8.5-4):

- habitat loss;
- disturbance due to noise (e.g., displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g., due to increased access and associated increase in hunting);
- attraction (e.g., altered inter-species relationships);
- exposure to contaminants; and
- reduction in reproductive productivity due to all effects of the Project combined.

Wolverine and grey wolves can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of suitable denning and foraging habitat. For this reason, habitat loss was included and evaluated in this assessment. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development.

Potential effects due to sensory disturbance were evaluated for wolverine and grey wolves because noise may cause displacement of wildlife from important habitat, stress responses, and behavioural changes in some species. Researchers have documented avoidance responses of carnivores that may restrict the use of habitat that might otherwise confer reproductive or survival benefits (Thurber et al. 1994). Wolves are particularly sensitive to the effects of sensory disturbance and exhibit some of the strongest negative responses to disturbances relative to other species (Johnson et al. 2005).

Wolverines are resident on the tundra, and move within one home range throughout the year. The grey wolves are also residents have very large home ranges dictated by the movement and presence of the barren-ground caribou herds. Population-level consequences to wolverine or grey wolf may arise when movements on home ranges, and movements for dispersal, are disturbed or impeded. Disruption to movement was evaluated for its potential effect on wolverine and grey wolves because research has indicated that population-level consequences may arise when movements on home ranges, and movements for dispersal, are disturbed or impeded (Thurber et al. 1994; Alexander and Waters 2000; Frame, Cluff, and Hik 2007). For this reason, potential effects of disruption of movement on wolverine and grey wolf were included in this assessment.

Direct mortality is typically a result of vehicle strikes with wildlife. Frequency of mortality is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to wildlife also increases. Since the Project will have all-weather site roads, and winter haul roads, the potential effect of direct mortality is included in the assessment.

**Table 8.5-4. Potential Project-related Effects to Wolverine and Wolves in the Goose Property Area, the George Property Area, and the Marine Laydown Area**

| Potential Development Area<br>Project Component | Habitat Loss[1] | Disturbance due to Noise | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity[2] |
|---|---|---|---|---|---|---|---|---|
| *Goose Property Area* | | | | | | | | |
| Open Pits (Main, Umwelt, and Llama) | x | x | x | x | | x | | x |
| Haul and access roads | x | x | x | x | x | x | | x |
| Winter roads | x | x | | x | | | | x |
| Stockpiles | x | x | x | | | | | x |
| Waste rock storage areas | x | x | x | | | | x | x |
| Explosives storage areas | x | | x | | | | x | x |
| Tailings Impoundment Area | x | x | x | | | | x | x |
| Quarries | x | x | x | | | x | | x |
| Landfill | x | x | x | x | x | | x | x |
| Camp / Plant site | x | x | x | x | x | | x | x |
| Airstrip | x | x | x | x | | | | x |
| Other infrastructure (diversion channels, water intakes) | x | | x | | | | | x |
| *George Property Area* | | | | | | | | |
| Open Pits (LCP North, Locale 1,and Locale 2) | x | x | x | x | | x | | x |
| Haul and access roads | x | x | x | x | x | x | | x |
| Winter roads | x | x | x | x | | | | x |
| Stockpiles | x | x | x | | | | x | x |
| Waste rock storage areas | x | x | x | | | | x | x |
| Explosives storage areas | x | | x | | | | x | x |
| Landfill | x | x | x | | x | | x | x |
| Camp | x | x | x | | x | | | x |
| Other infrastructure (water intake) | x | | x | x | | | | x |
| *Marine Laydown Area* | | | | | | | | |
| Camp | x | x | x | x | x | x | x | x |
| Barge landing location | x | x | x | | | | | x |
| Haul and access roads | x | x | | x | x | x | | x |
| Winter roads | x | | x | | | | | x |
| Other infrastructure (diversion ditch) | x | | | | | | | x |

[1] *It was assumed that the entire PDA was lost for the effects assessment. All Project infrastructure lies within the PDA.*
[2] *Reduction in reproductive productivity is considered to be a synergistic effect resulting from all other potential effects.*

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed roads. Roads increase access and can create opportunities for illegal hunting of wildlife (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Camps and landfills may act as attractants to wildlife, particularly carnivores, which could subsequently lead to increased human interactions with wildlife, animals becoming nuisance wildlife, and subsequent wildlife mortality. Thus, the effect of attraction is included as a potential effect in the assessment.

Wildlife can be exposed to contaminants through ingestion of water or through the food chain. A formal risk assessment was undertaken as part of the effects assessment for wildlife including wolverine and furbearers (including wolves) detailed in the Human Health and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Results of the risk assessment of contaminants in wolverine and furbearers were summarized in the assessment of the each VEC (wolverine and wolves) for determining the overall significance of Project-related residual effects to wolverine and furbearers.

Some of the environmental effects discussed above have the potential to affect the reproductive potential of wolverine and furbearers, particularly when they act in a synergistic fashion. For example, habitat loss and degradation, disturbance due to noise, and disruption to movements may result in physiological stress, lower feeding and increased travel to manoeuvre around disturbed areas, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. This cascade of effects may be of the greatest concern during sensitive periods for wolverine and furbearers (i.e., denning periods). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals. Therefore, the effect of reduction in reproductive productivity is included as a potential effect in the assessment.

Each potential effect is identified for each Potential Development Area (PDA) and key infrastructure/activity in Table 8.5-4.

#### 8.5.2.1 *Habitat Loss*

As part of the development of the Project, wildlife habitat will be lost and potentially degraded. To minimize these effects, the location of Project infrastructure was planned to avoid wildlife sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Wildlife habitat may also be indirectly lost if wildlife species avoid the Project area due to noise disturbance, which is described in Section 8.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operation phases of the Project. Wildlife habitat will be removed and degraded during Project development. Habitat degradation due to dust and compaction around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation are proposed for the Project. The assessment of habitat loss is based on the total area of lost and degraded habitat at the end of the Operation phase, which is the largest extent of the Project footprint.

To enable flexibility in siting of Project infrastructure, loss and degradation of wolverine and grey wolf habitat is assumed within the entire area of each of the three PDAs (Goose Property Area, George Property Area and the MLA). These areas greatly overestimate habitat loss as the entire area within

each PDA will not be developed. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The winter roads connecting the Goose and George PDAs and the MLA as well as the winter road to the Tibbett Contwoyto Road are evaluated for habitat loss for wolverine. Wolverine will be active during the periods of the year when the roads are being used (January through April). The PDA for winter roads includes a 200 m corridor along each alignment (Volume 2). The grey wolf may be present in the Project area during winter. The potential effects of winter roads on wolverine were used as a proxy for effects on wolves. It was assumed that potential effects of winter roads on wolves would be less than for wolverine, because though wolves are present during winter in very low densities, the denning period of wolves does not overlap the timing of winter road operation.

Calculation of Habitat Loss

Habitat loss for wolverine and wolves was calculated by first identifying two key indicators:

1. Total area — a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs).
2. High-quality habitat — a calculation of the area of high-quality habitat for wolverine and wolves that will be lost in the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the RSA. The wildlife RSA provides the more representative comparison for the total habitat loss for wolves, as the home range size of wolves is, on average, larger than the wildlife LSA. To put the Project within the context of wolverine and grey wolf habitat use, these indicators were also compared to the average home range size of a wolverines and wolves.

Total Area of Loss

The total expected area lost in the PDAs was calculated by summing the areas of loss due to the entire Goose, George, and MLA PDAs.

The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary (the wildlife LSA and RSA). The actual area developed, and subject to loss, will be much smaller, as determined by the final design infrastructure and placement.

In order to put the Project into the context of wolverine and wolf habitat, the total area of loss is compared to home range sizes for each species with the assumption that the area lost falls entirely within one or multiple home ranges. Results of the assessment are presented as a proportion of an average home range that may be lost due to Project-related activities.

Area of High-quality Habitat Loss

Habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A) for wolverine and grey wolf. The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA based on remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4).

The availability of suitable habitat for wolverine and grey wolves is detailed in the Habitat Suitability Baseline Report (Rescan 2013a, Appendix V5-5A) and summarized in the Existing Environment Section (Section 8.1.5). Habitat loss and degradation for wolverine and grey wolves was assessed for denning habitat. A two-class rating system (suitable versus not suitable) was used to map wolverine habitat (Rescan 2013a, Appendix V5-5A) and a four class rating system (High, Moderate, Low and Nil habitat suitability) was used to rate habitat in the wildlife RSA for grey wolves. Denning habitat ranked as suitable is referred to as high-quality habitat for wolverine, whereas habitat ranked as High and Moderate was considered the most suitable habitat and is referred to as high-quality habitat for grey wolf. The proportion of high-quality habitat lost due to mine development in the wildlife RSA was calculated to assess the extent of the effect of high-quality habitat loss for wolverine and grey wolf.

Evaluating Habitat Loss

*Total Area of Loss in Wildlife RSA*

The total area lost due to loss of the entire PDAs at the Goose and George Properties and the MLA is 10,237 ha (Table 8.5-5). The PDAs are contained within the wildlife LSA and represents 7.5% of the wildlife LSA. This area accounts for 0.8% of the wildlife RSA. However, the actual loss will be much smaller as the design of the Project footprint is much smaller (approximately 10 to 15% of the PDAs) relative to the PDAs assessed as lost. The wildlife RSA provides the more representative comparison for the total habitat loss for wolverine and grey wolves, as the home range these species is, on average, larger than the wildlife LSA.

**Table 8.5-5. Habitat Loss due to the Potential Development Areas**

| Potential Development Area (PDA) | Area (ha) | Proportion of LSA (%)[1] | Proportion of RSA (%)[1] |
|---|---|---|---|
| George Property Area | 4,226 | 3.1 | 0.3 |
| Goose Property Area | 5,358 | 4.0 | 0.4 |
| Marine Laydown Area | 653 | 0.4 | < 0.1 |
| TCWR Winter Road Connector Outside RSA | 3,404 | - | - |
| Winter Roads[2] | 5,040 | 3.8 | 0.4 |
| **Total[3]** | **15,278** | **11.3** | **1.2** |
| **Total without Winter Roads** | **10,237** | **7.5** | **0.8** |

[1] *LSA = 134,369 ha, RSA = 1,262,005 ha*
[2] *Represents area of habitat loss during the winter, and habitat degradation during the snow free periods.*
[3] *Total does not include portion of the TCWR Winter Road Connector that falls outside of the wildlife RSA but includes all other winter roads.*

The average home range size of male wolverines is 40,000 ha, and 12,600 ha for females (Magoun 1985; Mulders 2000). Habitat loss in the wildlife RSA is predicted to be 15278 ha, which is equivalent to 38% of a male wolverine's home range and approximately equivalent to 1.2 home ranges of a female wolverine.

The average home range size of wolves that migrate between the boreal forest and tundra is 202,200 ha for males and 113,000 ha for females (Walton et al. 2001). Home range sizes of wolves are much larger in winter than summer (Walton et al. 2001), thus total habitat loss relative to summer home range sizes is evaluated as a worst-case scenario. Total habitat loss in the wildlife RSA is equivalent to 7.6% and 13.5% of the home range size of a male and female wolf, respectively.

*Loss of High-Quality Habitat*

Some of the habitat removed in the Goose Property and George Property PDAs, the MLA and winter roads was rated as high-quality habitat for wolverine and grey wolf. The proportion of high-quality habitat loss for wolverine and grey wolf is summarized below and in Table 8.5-6.

**Table 8.5-6. High-quality Wolverine and Grey Wolf Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project**

| | High-quality Habitat (HQH) | | High-quality Habitat Lost due to Potential Development Areas | | | |
|---|---|---|---|---|---|---|
| | | | Potential Development Area without Winter Roads | | Potential Development Area including Winter Roads | |
| Area | Amount (ha) | % Area | (ha) | % HQH | (ha) | % HQH |
| *Local Study Area* | | | | | | |
| Wolverine | 61,367 | 45.7 | 4,622 | 7.5 | 5,702 | 9.3 |
| Grey Wolf | 8,985 | 6.7 | 66 | 0.7 | 94 | 1.0 |
| *Regional Study Area* | | | | | | |
| Wolverine | 562,221 | 44.7 | 4,622 | 0.8 | 5,944 | 1.1 |
| Grey Wolf | 12,074 | 0.96 | 67 | 0.2 | 96 | 0.8 |

Wolverine

Of the 61,367 ha of suitable denning habitat for wolverine within the wildlife LSA (45.7% of the wildlife LSA), an estimated 4,622 ha will be lost and degraded within the three PDAs, and a total of 5,702 ha will be lost in areas inclusive of winter roads (Table 8.5-6). These areas represent 7.5% and 9.3% of the suitable habitat within the wildlife LSA, respectively. Of the 562,221 ha of suitable wolverine denning habitat in the wildlife RSA, 0.8% will be lost to the PDAs, and 1.1% will be lost to areas inclusive of winter roads. These amounts of habitat loss are rated as low magnitude (Table 8.5.6, Table 8.5-2).

Grey Wolf

Of the 8,985 ha of high-quality wolf habitat within the wildlife LSA (6.7% of the wildlife LSA), an estimated 66 ha will be lost and degraded within the three PDAs, and 95 ha will be lost in areas inclusive of winter roads (Table 8.5-6). These areas represent 0.7% and 1.0% of the suitable habitat within the wildlife RSA and LSA, respectively. Of the 12,074 ha of high-quality wolf habitat in the wildlife RSA, 0.6% will be lost to the PDAs, and 0.8% will be lost to areas inclusive of winter roads. These amounts of habitat loss are rated as low magnitude (Table 8.5.6, Table 8.5-2).

Mitigation measures to minimize habitat loss for wildlife include the design of Project infrastructure to avoid, where possible, identified wildlife sensitive areas such as identified denning habitat (e.g., eskers) and to minimize the Project footprint. Wherever possible, reclamation activities will be undertaken to restore habitat upon Project closure. Mitigation is expected to lower but not completely eliminate the effect of habitat loss for wolverine and wolves, and thus a residual effect is expected to occur.

#### 8.5.2.2 *Disturbance due to Noise*

This section evaluates the effects of Project-related disturbances on wolverine and grey wolf, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise.

Noise affects wildlife species in three primary ways. The source, duration, and intensity of noise all influence the nature and magnitude of observed effects and determine if wildlife exhibit an acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). First, an acute effect of noise — in rare cases, brief, intense, localized noise (such as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

A behavioural response can also occur when animals avoid important habitats near noise disturbance sources resulting in the functional loss of that habitat (Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). Mild habitat loss due to noise disturbance can reduce the amount of energy that an animal can intake and result in low-level effects. Alternatively, large scale range shifts can result in large reduction in energy intake and in extreme cases mortality due to unfamiliarity with new habitat and reduced resource base. If noise disturbance from the mine decreases the quality of potential den sites near the mine, wolverine and wolves may suffer stress over finding appropriate denning locations.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment. Both wolverine and wolves are known to acclimate to industrial projects in the Arctic and forage near projects. Attraction of wolverine and wolves to camp infrastructure is described in Section 8.5.2.6.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a "threshold level."

Studies on the effects aircraft noise on wildlife indicate that "fright" is a common response (Bond et al. 1974), whereby the animal attempts to escape the noise by either running or flying away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to disturbance due to noise than wildlife occupying forested habitats (McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend large amounts of energy to escape the perceived threat.

Potential sources of sensory disturbance to wolverine and grey wolves associated with Project activities include:

- blasting noise, and ground vibrations from mining and construction;
- general Project noise (e.g. camp noise, human presence, and vehicle traffic); and

- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the Umwelt open pit while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the Construction and Operational phases. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned, while at the MLA, while it is active, a maximum of six flights per week are planned.

Wolverine

The home range of wolverine can place them in contact with humans even when developments are at a considerable distance from the center of the home. Studies conducted near the Project area in the Kitikmeot region estimated that the home range of male wolverines average 400 $km^2$ (Magoun 1985; Mulders 2000). Disturbance due to noise during sensitive periods including the late winter denning period may result in females and their litters relocating or abandoning dens (Magoun and Copeland 1998; Heinemeyer, Aber, and Doak 2001). Disturbances during the construction and operation phases of this Project may influence the selection of wolverine denning areas over time. Data from Norway suggest that wolverines choose den sites away from human infrastructure, suggesting that wolverines may be sensitive to noise disturbance during denning (May et al. 2012).

Wolverine feeding behaviour may be affected in areas with relatively high Project related activities and/or vehicular traffic around all work sites. Wolverines have been found to avoid areas of high human activities, which reduce the amount of suitable foraging habitat (May et al. 2006). It is also important to note that ungulates are an important food source for wolverines and any disturbance to the behaviours and movements of caribou and muskox may result in negative effects on wolverines. Any disturbance that has a negative effect on prey populations will have a negative effect on the associated predator population.

Reduced reproductive success of pregnant females may be partially influenced by human activities resulting in den disturbance and den abandonment (Heinemeyer, Aber, and Doak 2001; May et al. 2012). Natal denning sites within 3 km of human activities including infrastructure and roads may experience a reduction in reproductive productivity (May et al. 2012).

Sensitive periods for wolverine occur during the denning period from February to early April (Inman et al. 2012). Wolverines usually have natal dens, where cubs are born and maternal dens, where cubs are nursed. Cubs are weaned by late June but will stay on the mother's home range until about one year of age (Inman et al. 2012).

Grey Wolf

The home range of grey wolf can place them in contact with humans even when developments are at a considerable distance from the center of the home range due to the size. Wolves have large home ranges, from 43,000 to 65,000 $km^2$, which vary between seasons (Walton et al. 2001). For seven months of the year, wolf movement patterns follow those of their primary prey, the caribou.

Auditory and visual disturbances caused by construction and operations, such as blasting, may cause stress for wolves in the vicinity of these activities and lead to reduction in hunting. Since wolves prey primarily on caribou, any disturbances that affect their primary food source will have a carry-over effect to wolves. Potential effects to caribou are discussed in Chapter 5.

Research has found that some wolves seem to be tolerant of human activity near dens (Thiel, Samuel, and Mech 1998; Frame 2005) whereas other research shows that wolves may move pups to secondary den sites in response to noise disturbance (Chapman 1979; Ballard 1987) . Wolves are most susceptible to disturbance during the denning period because movements are localized around den sites. Developments that disturb or displace denning wolves may have serious consequences for reproductive productivity of wolves (Walton et al. 2001). Given that the majority of pup mortalities occur within the first six months of life (Harrington, Mech, and Fritts 1983), females and pups are especially vulnerable to the effects of disturbance around their den sites. Disturbances that affect den site selection and activity around the den will affect reproductive success of the pack.

Breeding success in wolves is strongly related to prey availability (Fuller 1989; Frame 2005), and in the central Arctic prey availability is a function of caribou migration patterns (Frame 2005). Scarce prey will also influence reproductive success, so again, the state of the caribou are vital to the success of the wolf population. Developments that alter the distribution or timing of caribou migration may have profound effects on breeding success of wolves (Walton et al. 2001).

Sensitive periods for grey wolf coincide with wolf denning that occurs shortly after the wolves arrive at their denning sites on the tundra in April (Walton et al. 2001). Wolves are territorial during denning and migratory wolves in the Kitikmeot region show strong fidelity to den sites (Walton et al. 2001). Pups are weaned in the den and the immediate area surrounding the den. Wolves leave the den site when the young are able to travel with adults, usually in September or October.

Calculating Disturbance due to Noise

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose and George Properties rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence. Habitat 'loss' will occur indirectly for wolverine and grey wolves that avoid the zone of influence because they are disturbed within it.

The potential effect of disturbance due to noise on furbearers was evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case (year three of Operations at Goose Property and year seven of Operations and George Property). The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature where wildlife are shown to have behavioural effects from noise.

Threshold noise values were determined from the literature, above which wildlife (including wolverine and grey wolves) are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for wolverine and wolves. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are relatively small, since the PDAs (already considered as lost habitat in Section 8.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-

quality habitat disturbed during each season calculated by habitat suitability modelling (see Baseline Habitat suitability Modeling: Section 8.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Blasting noise models were conducted during peak noise levels as identified in Volume 4, Chapter 2 (worst case scenario) for each of the PDAs: Year 3 at the Goose PDA and Year 7 at the George PDA.

General Project-related noise levels, or continuous noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft and helicopter noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) wolverine and wolf seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 8.5.2.1), but within the noise level contours for blasting noise (≥120 dB representing functionally lost habitat; or ≥108 dB representing disturbed habitat), general Project noise (≥45 dBA) or noise generated from aircraft (≥80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each VEC season within the wildlife RSA and LSA after accounting for habitat loss (Section 8.5.2.1).

For the purposes of assessing impacts associated with the Project's noise emissions, a number of noise and vibration sources were also assessed using several ecological receptors in the region that may be classified as sensitive. Sensitive ecological receptors were identified as the closest and/or potentially most affected sites by noise in the vicinity to the site. For wolverines and grey wolves, known active den sites were used to act as sensitive receptors.

Evaluating Disturbance due to Noise for Wolverine

After mitigation, the potential effects of disturbances due to noise from blasting activities, general Project noise, and aircraft noise is described below.

*Blasting Noise*

A total of 35 ha that falls outside the Goose and George PDAs will be functionally lost due to noise from blasting above an Lpeak of 120 dB, and an additional 982 ha will be disturbed outside of the Goose and George PDAs due to noise from blasting with an Lpeak above 108 dB. During Year 3 of the operation phase, blasting from the construction of the Umwelt, Llama and Main pits at the Goose Property Area will result in 18 ha of habitat (< 0.1% of the wildlife LSA and RSA) functionally lost and an additional 283 ha of habitat (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) disturbed outside of the Goose PDA by noise due to blasting activities (Table 8.5-7; Figure 8.5-1).

Starting at Year 7 of the operation phase, blasting from the open pit at Locale 1 will result in 17 ha of habitat functionally lost (< 0.1% of the wildlife LSA and RSA), and an additional 359 ha of habitat disturbed (0.2% of the wildlife LSA; or < 0.1% of the wildlife RSA) outside of the George PDA due to noise from blasting activities (Table 8.5-7). It is assumed that blasting in Years 8 and 9 at the open pits at LCP North and Locale 2 will be similar to or less than the noise levels due to blasting in Year 7 at the open pit at Locale 1.

The amount of high-quality seasonal habitat in the wildlife RSA that is within the area that is functionally lost (≥ 120 dB Lpeak) is 20 ha (Table 8.5-8; Figure 8.5-1), which represents less than 0.1% of the available high-quality habitat in the wildlife LSA and RSA after accounting for habitat loss within the PDAs (Section 8.5.2.1). The amount of high-quality habitat that is disturbed due to blasting (≥ 108 dB Lpeak) is 554 ha, which is equivalent to 0.9% and 0.1% of the available high-quality habitat in the wildlife LSA and RSA, respectively, after accounting for habitat loss (Section 8.5.2.1).

*General Project Noise*

The total amount of area affected by elevated noise levels due to general Project noise (outside of the Goose, George, MLA, and Winter Road PDAs already considered to be lost; Section 8.5.2.1) is 5,598 ha (Table 8.5-7). A total of 262 ha (0.2% of wildlife LSA and < 0.1% of wildlife RSA) in year three near the Goose PDA, and 359 ha (0.3% of wildlife LSA and <0.1% of wildlife RSA) in year seven near the George PDA will be degraded. An additional 4,977 ha of area within the wildlife RSA and 3,404 ha of area outside of the wildlife RSA will be affected by noise due to traffic when the winter roads are functional (Table 8.5-7).

A breakdown of the percentage of high-quality habitat lost due to noise disturbance outside of the PDAs can be found in Table 8.5-8. The percentage of high-quality habitat lost outside of the PDAs is small (0.3% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 8.5-8; Figure 8.5-1). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise*

The total amount of area affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project footprint (Section 8.5.2.1) is 27,140 ha (2.2% of wildlife RSA). Approximately 3,495 ha outside of the Goose PDA will be affected by aircraft accessing the Goose Property (Table 8.5-7). An additional 11,278 ha that falls outside the George PDA will be disturbed by aircraft accessing the George Property (Table 8.5-7). This area is larger than that outside of the Goose Property Area as the aircraft used for the George Property (Twin Otter Aircraft) is noisier than that used for the Goose Property (Dash 8 or equivalent).

**Table 8.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise**

| Project Area | Area Considered Lost to PDAs | | | Additional Area Functionally Lost due to Blasting (120 dBA) | | | Additional Area Disturbed due to Blasting (108 dBA) | | | Additional Area Disturbed due to General Project Noise (45 dBA) | | | Additional Area Disturbed due to Aircraft Noise (80 dBA) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA[1] | % RSA |
| George Property Area | 4,226 | 3.1 | 0.3 | 17 | <0.1 | <0.1 | 699 | 0.5 | <0.1 | 359 | 0.3 | <0.1 | 11,278 | 8.4 | 0.9 |
| Goose Property Area | 5,358 | 4 | 0.4 | 18 | <0.1 | <0.1 | 283 | 0.2 | <0.1 | 262 | 0.2 | <0.1 | 3,495 | 2.6 | 0.3 |
| MLA | 653 | 0.4 | <0.1 | - | - | - | - | - | - | - | - | - | 12,367 | 9.2 | 1 |
| Winter Roads | 5,040 | 3.8 | 0.4 | - | - | - | - | - | - | 4,977 | 3.7 | 0.4 | - | - | - |
| Total | 15,277 | 11.3 | 1.2 | 35 | <0.1 | <0.1 | 982 | 0.7 | <0.1 | 5,598 | 4.2 | 0.4 | 27,140 | 17.1 | 2.2 |
| Total without Winter Roads | 10,237 | 7.5 | 0.8 | 35 | <0.1 | <0.1 | 982 | 0.7 | <0.1 | 621 | 0.5 | <0.1 | 27,140 | 17.1 | 2.2 |
| TCWR Winter Road Connector Outside Wildlife RSA | 3,404 | - | - | - | - | - | - | - | - | 3,404 | - | - | - | - | - |

[1] *Some of the area of noise disturbance falls outside of the wildlife LSA but within the wildlife RSA (see Figures 8.5-1 and 8.5-2).*

**Table 8.5-8. Expected Wolverine High-quality Habitat Functionally Lost or Disturbed due to Noise Outside of the Project Potential Development Areas**

| Area | High-quality Habitat (HQH) Available Area (ha) | HQH Lost or Altered due to the Project Footprint | | Additional Area Functionally Lost[1] due to Blasting (120 dBA) | | Additional Area Disturbed[1] due to Blasting (108 dBA) | | Additional Area Disturbed[1] due to General Project noise (45 dBA)[2] | | Additional Area Disturbed[1] due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH |
| *Local Study Area* | 61,367 | 5,704 | 9.3 | 20 | <0.1 | 554 | 0.9 | 1,848 | 3.0 | 5,605 | 9.1 |
| *Regional Study Area* | 562,211 | 5,944 | 1.1 | 20 | <0.1 | 554 | 0.1 | 2,093 | 0.4 | 8,602 | 1.5 |

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project PDAs (Section 8.5.2.1).* [2] *Area of disturbance due to general Project noise (≥45 dBA) includes noise generated on winter roads.*

PROJECT # 0194096-0040 GIS # BAC-23-241c November 21 2013

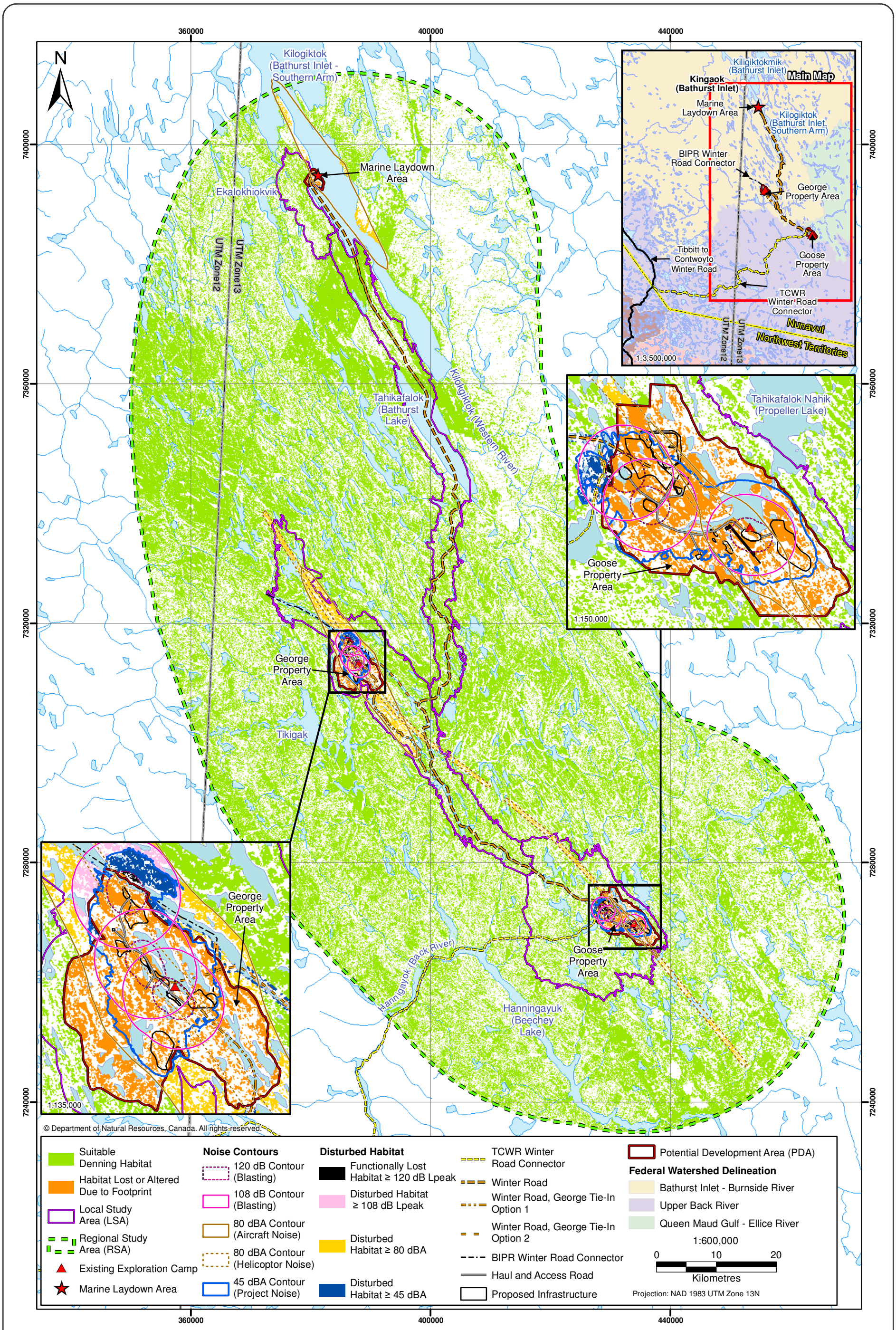


Figure 8.5-1

Sabina GOLD & SILVER CORP.

## Wolverine High-quality Habitat Lost, Altered or Disturbed due to the Project

Figure 8.5-1

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-241d November 26 2013

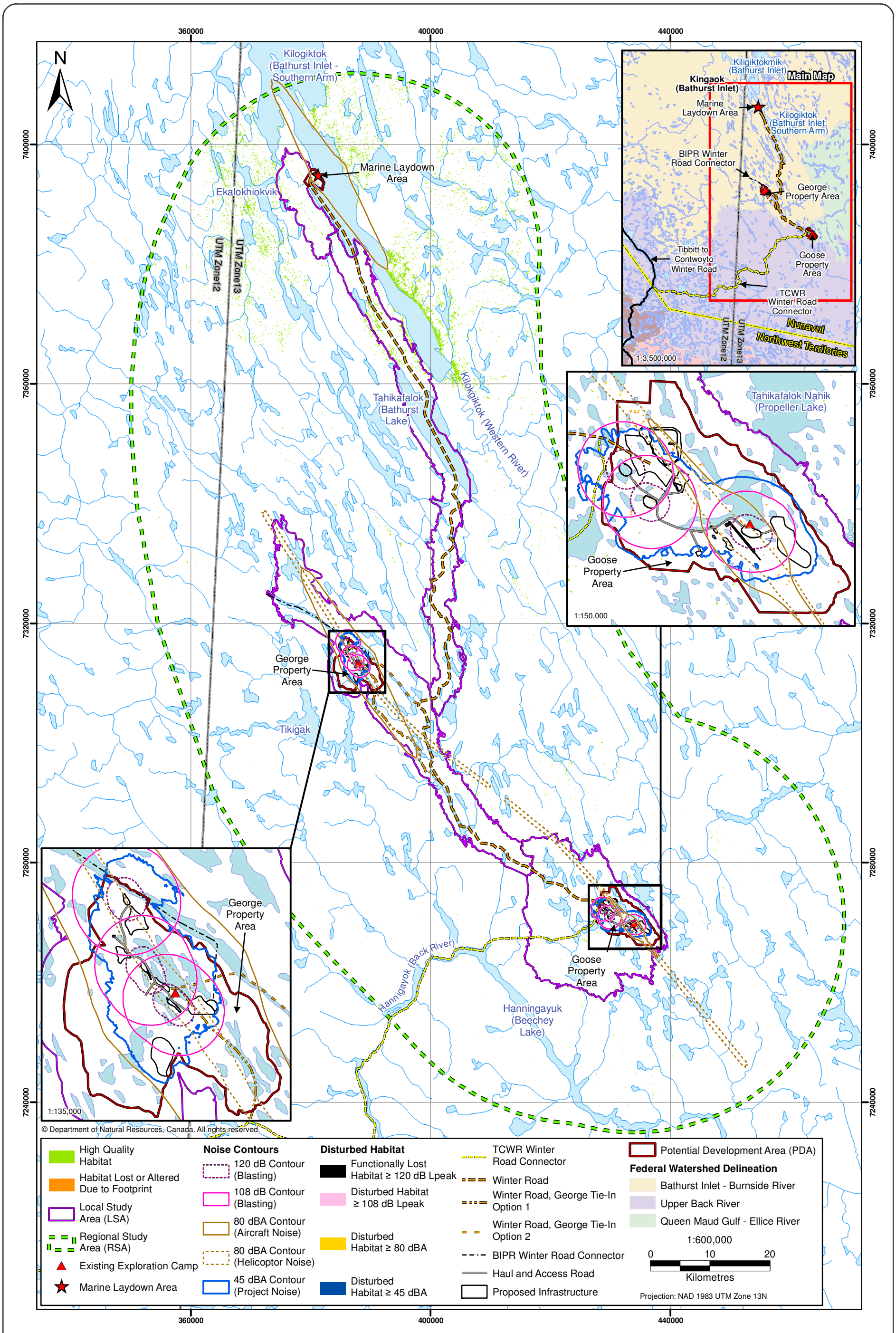


Figure 8.5-2

Sabina GOLD & SILVER CORP.

# Grey Wolf High Quality Habitat Lost, Altered or Disturbed due to the Project

Figure 8.5-2

Rescan an ERM company

At the MLA, an additional 12,367 ha of area may be disturbed due to Twin Otter aircraft landing on Bathurst Inlet near the MLA, if an airstrip is required when the MLA is active (Table 8.5-7). However, much of this area is marine habitat within the Inlet itself. A breakdown of the percentage of high-quality habitat disturbed due to aircraft noise in the wildlife RSA can be found in Table 8.5-8. Across seasons, the percentage of additional high-quality habitat in the wildlife RSA disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (~1%) relative to the amount of available high-quality habitat in the wildlife RSA (Table 8.5-8).

At the Goose and George Properties a maximum of three flights per day and one helicopter flight per day may occur, while at the MLA, when it is active, a maximum of six flights per week may occur during the Construction and Operations phases. Areas of disturbance due to noise are expected to be very localized near the landing strips at the Goose, George, and MLA Properties. A delineated flight path between the Goose and George Properties may be disturbed by helicopter overflights approximately once a day (Figure 8.5-1). Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

*Receptor Noise*

For wolverine, the sensitive receptors included known den sites located 700 m and 6,200 m from the nearest deposits (Volume 4, Chapter 2). The equivalent noise value during the day or night was 59 dBA and the day-night equivalent sound level was 65 dBA for the den at 700 m. For the den site at 6,200 m, the equivalent noise value during the day or night was 23 dBA and the day-night equivalent sound level (Ldn) was 30 dBA. Therefore, the noise level at the den site within 700 m of the George Property Area is above the noise threshold, whereas the noise at the den located 6,200 m away from the Goose Property is below the threshold.

The effect of sensory disturbance is not anticipated to have a residual effect on wolverine. Overall, an estimated 12 wolverine use the wildlife RSA (Rescan 2013b, Appendix V5-6A). Wolverine home ranges cover a large area. The maximum amount of functionally lost habitat due to blasting outside of the area already accounted for from habitat loss (Section 8.5.2.1) is 20 ha. General project noise, which is anticipated to be continuous noise, is approximately 2,093 ha or 0.3% of the available high-quality habitat in the wildlife RSA. The overall maximum disturbed wolverine habitat is approximately 8,602 ha (1.6% high-quality habitat) and is primarily disturbed due to aircraft noise which is intermittent.

Based on home range sizes of 12,600 ha for female and 40,000 ha for male wolverines, this corresponds to 16% of the home range of a female wolverine, or 5% of the home range of a male wolverine. Despite the result of the low proportion of area disturbed compared to the area available within wildlife RSA (< 1%) after accounting for habitat loss, the effect of sensory disturbance is anticipated to result in a residual effect on wolverine, albeit small.

Evaluating Disturbance due to Noise for Grey Wolves

The total amount of habitat outside of the Goose and George PDAs (already considered lost in Section 8.5.2.1) functionally lost due to blasting, or disturbed due to noise from blasting, general Project noise and aircraft noise is the same as for wolverine and detailed in the wolverine section. Loss of high-quality habitat outside of the Project PDAs due to blasting noise, general Project noise and aircraft noise is discussed below for grey wolves.

*Blasting Noise*

No high-quality seasonal habitat in the wildlife RSA outside of the Goose and George PDAs (already considered lost due to infrastructure – Section 8.5.2.1) that is functionally lost or disturbed (≥ 120 Db Lpeak; ≥ 108 dB Lpeak; Table 8.5-9; Figure 8.5-2).

**Table 8.5-9. Expected Grey Wolf High-quality Habitat Functionally Lost or Disturbed due to Noise Outside of the Project Potential Development Areas**

| Area | High-quality Habitat (HQH) Available Area (ha) | HQH Lost or Altered due to the Project Footprint | | Additional Area Functionally Lost[1] due to Blasting (120 dBA) | | Additional Area Disturbed[1] due to Blasting (108 dBA) | | Additional Area Disturbed[1] due to General Project noise (45 dBA) | | Additional Area Disturbed[1] due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH | Area (ha) | % HQH |
| *Local Study Area* | 8,985 | 94 | 9.3 | 0 | 0 | 0 | 0 | 24 | 0.3 | 7 | 0.1 |
| *Regional Study Area* | 38,813 | 96 | 1.1 | 0 | 0 | 0 | 0 | 26 | 0.1 | 146 | 0.4 |

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project PDAs (Section 8.5.2.1).*

*General Project Noise*

A breakdown of the percentage of grey wolf high-quality habitat lost due to noise disturbance outside of the PDAs can be found in Table 8.5-9. The percentage of high-quality habitat lost outside of the PDAs is small (0.1% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 8.5-9; Figure 8.5-2). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise*

A breakdown of the percentage of grey wolf high-quality habitat disturbed due to aircraft noise in the wildlife RSA can be found in Table 8.5-9. The percentage of additional high-quality habitat in the wildlife RSA disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (0.4% of the wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 8.5-9).

*Receptor Noise*

Very little wolf denning habitat is located within the area where noise levels exceed threshold values for wildlife for general project noise, blasting noise or aircraft noise, yielding values of 0 to 1 ha of disturbed habitat overall. One of the noise receptor locations (dens) was at, or slightly above, the threshold values for noise, while the other receptor locations were well below threshold values.

Sensitive receptors for grey wolf included one known den site located 1.6 km from the George Property Area. The equivalent noise value during the day or night was 53 dBA and the day-night equivalent sound level (Ldn) was 59 dBA. This den site located may be disturbed by noise levels as the noise level is above the threshold of 45 dBA during the day and below the threshold of 55 dBA during the night.

The effect of sensory disturbance is anticipated to have a small residual effect on grey wolf. Grey wolf summer home ranges cover a large area. There is no additional functionally lost habitat due to blasting outside of the area already accounted for from habitat loss (Section 8.5.2.1). General project noise, which is anticipated to be continuous noise, is approximately 26 ha or 0.1% of the available high-quality habitat in the wildlife RSA. The overall maximum disturbed wolverine habitat is approximately 146 ha (0.4% high-quality habitat) and is primarily disturbed due to aircraft noise which is intermittent.

Based on home range sizes annual home ranges, from 43,000 to 65,000 $km^2$ for female and male grey wolves respectively, this corresponds to < 0.01% of the home range of a female or male grey wolf. The low proportion of area disturbed compared to the area available within wildlife RSA after accounting for habitat loss, the effect of sensory disturbance is anticipated to result in a minimal residual effect on grey wolf.

### 8.5.2.3 *Disruption to Movement*

Physical barriers or human activities may disrupt or impede wildlife movements, migration, and dispersal. Disruption to movement to wolverine and furbearers can result from 1) linear corridors such as roads which may isolate seasonal habitat and from 2) point sources of disturbance where wolverine and furbearers may avoid areas, and thus displace movement due to human activities.

Linear developments, including roads, railways, and pipelines, have been shown to create temporary or permanent barriers to movement in many wildlife species (Jalkotzy, Ross, and Nasserden 1997). Wolverine will be present and active on the tundra all year and thus may interact with both winter roads connecting the PDAs (used from January to April) and permanent site roads within the PDAs. Therefore, the effect of disruption to movement due to linear corridors is included in the assessment.

Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If Project sites are large enough relative to the habitat in which bears use and cause noise and sensory disturbance to a level with which wolverine and wolves will avoid these areas, movement of wolverine and wolves may be altered. In these cases, wolverine and wolves may need to expend additional energy to travel around Project developments during their large distance movements. Disruption to movement may begin during the construction phase of the Project when infrastructure are built and continue during the operation and reclamation/closure phases of the Project. Potential Project infrastructure and activities that were evaluated for the potential disruption to movement of wolverine and wolves include the PDAs for the Goose and George Property Areas and the MLA. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure. Disruption to movement may begin during the construction phase of the Project when roads and infrastructure are built and continuing during the operation and closure phases of the Project. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Evaluation of Disruption to Movement for Wolverine

Wolverines prefer large, untouched areas, yet their home ranges have been found to overlap active traplines, busy logging roads and the edges of communities (COSEWIC 2003). Wolverine will also use roads to travel but avoid busy roads (Austin 1998) and generally select denning areas away from human infrastructure (May et al. 2012). Nonetheless, transportation corridors are a significant source of wolverine mortality and roads may act as semi-permeable barriers to movements and dispersal. In British Columbia, wolverines avoided areas within 100 m of the Trans-Canada Highway and preferred areas more than 1,100 m away (Austin 1998). This same study found that wolverines chose narrow crossings less than 100 m wide.

*Linear Road Corridors*

Data collected from a variety of locations suggests that road traffic on the order of 4,000 to 10,000 vehicles per day begin to impose a barrier to movement to most wildlife species, whereas roads with less than 1,000 vehicles a day are permeable to most species (Müller and Berthoud 1997). The winter roads will be used for hauling equipment, fuel and cargo from January to April across an operating window of 75 days. Traffic levels on each winter road ranges from 84 non-fuel truck trips to 6,000 fuel truck trips per year (Table 8.5.10).

**Table 8.5-10. Traffic Volumes along Winter Road Corridors**

| | No. of One-way Trips | | |
|---|---|---|---|
| | Trucks (non-fuel) | Fuel Trucks | Total |
| Trips per Year* | 84 | 6,000 | 6,084 |
| Trips per Day* | 1.1 | 80 | 81.1 |

** based on 75-day operating window between January and April.*

Traffic volumes will be approximately 81.1 one way truck trips per day per day from January to April, of which the vast majority will be trucks transporting fuel (80 one-way truck trips per day; Table 8.5-10). These traffic volumes are well below the threshold value for roads that are permeable (1,000 vehicles per day; Müller and Berthoud 1997). Therefore, the traffic alone on winter roads are not expected to create a permanent barrier to wolverine movement.

To mitigate effects of road traffic on wolverine, truck speeds will be developed and enforced, drivers will reduce speeds when wildlife are observed near the road, and drivers will stop on the road to allow passage across the road. Specific details of these mitigation measures are listed in the Wildlife

Mitigation and Monitoring Plan (Volume 10, Chapter 20). See Section 8.5.2.4 for an evaluation of the effects of direct mortality due to vehicle strikes with wolverine.

Traffic alone on winter roads are not expected to create a barrier to wolverine movement because the planned traffic is well below (< 10% of the traffic required to create a barrier). Thus, linear developments are not anticipated to result in a residual effect for the VEC wolverine.

*Point Source Disturbances*

The development of the Goose and George Properties within each respective PDA may result in wolverines avoiding these areas where the open pits and camps are constructed. However, the facilities at the Goose and George Property Areas are unlikely to alter the movement of wolverines in the area as they occupy relatively large territories (average 40,000 ha) and make large daily distance movements (up to 22 km). The Goose Property, George Property, and MLA PDAs will occupy 5,358 ha, 4,226 ha and 546 ha, respectively. These areas are unlikely to disrupt movements of wolverine within the wildlife LSA or RSA. The development of the MLA may result in wolverine avoiding the peninsula where the proposed site is planned, but the MLA facility is unlikely to alter the movement of wolverine within the Bathurst Inlet area. The MLA will occupy approximately 546 ha, and is unlikely to disrupt movements of wolverine.

Thus, a residual effect of disruption to movement of wolverine is not anticipated, and is not assessed further.

Evaluation of Disruption to Movement for Wolves

Wolves have large home ranges which vary between seasons (Walton et al. 2001). For seven months of the year, wolf movement patterns follow those of their primary prey, the caribou. Additionally, wolves follow caribou out the wildlife RSA in the winter and only occur in very low density in the wildlife RSA during the period when winter haul roads are constructed and used. Thus, linear road corridors are not anticipated to result in a residual effect on wolves, and are not assessed further.

*Point Source Disturbances*

The Goose and George Property PDAs are unlikely to impede the movement of wolves because this species occupies large, wide ranging territories. Wolverines occupy territories ranging from 10,000 ha for an adult female to over 60,000 ha for an adult male and make distance movements ranging from 12 to 43 km within a two week period (Rescan 2013b, Appendix V5-6A). Wolves have territories of 4,300,000 to 6,500,000 ha. The Project does not occupy an area which will bottleneck and prevent movement of wolves, nor is the Project large enough, compared to the home range sizes of this species, to impede their normal movements on the tundra. Therefore, no residual effect of disruption of movement in wolves resulting from the Project is expected.

### 8.5.2.4 *Direct Mortality and Injury*

Wolverine and grey wolf may be at risk of injury or mortality resulting from Project activities; therefore, this effect is included in this assessment. Direct mortality and/or injury to wolverine and wolves are generally anticipated to be a result of vehicle strikes. Mortality to wolverine and wolves may also result when wildlife attracted to Project infrastructure become human habituated and aggressive, and thus pose a threat to human safety. The resulting effects of attraction to the Project are evaluated in Section 8.5.2.6.

Evaluation of Direct Mortality to Wolverine

During baseline surveys, the locations of several wolverine and wolf dens have identified within the wildlife RSA. No infrastructure is planned on known den sites and it is expected that additional new dens would be detected during pre-construction surveys that may be conducted prior to construction of the Project PDAs and winter road corridors. Following these mitigation measures, no direct mortality is expected for wolverine or grey wolves during construction.

Vehicle–wildlife collisions are cited as a cause of direct mortality for a variety of wildlife species (Vieira 1996; Kerley et al. 2002; Deem and Emmons 2005). However, there are very few haul roads planned within the PDAs and all Project roads will be private and not for public use. In addition, truck speed limits will be developed. Direct mortality rates of wildlife species have been shown to drop dramatically below 70 km/h (Seiler 2005; Ng, Nielson, and St Clair 2008). Wildlife, including wolverines and wolves, on or near the road corridor may also be given the right-of-way to safely cross and exit the road corridor to lessen the probability of vehicle strikes. Therefore, mortality due to vehicle strikes is not anticipated to result in a residual effect on wolverine and grey wolf following mitigation.

#### 8.5.2.5 *Indirect Mortality*

Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the Back River area (Volume 8, Chapter 3). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees. Thus, construction and operation of the road is not expected to cause an increase in wolverine and grey wolf mortality due to facilitation of hunter access (i.e., indirect mortality). Increased hunting is unlikely and is therefore is not anticipated to result in a residual effect on wolverine or grey wolf.

#### 8.5.2.6 *Attraction*

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wolverine and grey wolf. Attractants may include physical structures that provide shelter or breeding habitat, or a travel corridor created by the road that facilitates movement through otherwise difficult terrain. Smells and food sources from incinerators, garbage, or sewage associated with the Project may also attract wolverines or wolves.

The presence of odours poses indirect risks as they can draw wolverine or grey wolves to camp areas where they come into contact with people. Habituated wildlife can pose a threat to the safety of both humans and wildlife (i.e., attacks). Nuisance animals are re-located but often if the problem persists, the animal is destroyed.

Potential project infrastructure that may contribute to attraction for wolverine and grey wolf includes:

- Camps located at the Goose, George and MLA PDAs;
- Landfill Areas; and
- Tailings Impoundment Area.

Evaluation of Attraction

Project activities will adhere to a strict Waste Management Plan detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), which will include mitigation measures. Mitigation measures will be implemented at all Project facilities in order to limit the attractiveness of the sites to

wolverines using standard mitigation techniques; installing and maintaining wolverine barriers/skirting on buildings and infrastructure, incinerating food wastes, and managing garbage and scents, etc.

Wolverines are curious and have been found to investigate and rob food from campsites, food caches and empty cabins (COSEWIC 2003) and have been reported at similar projects in Nunavut and Northwest Territories. Attraction to Project sites increases the potential for wildlife-human interaction and therefore an increased potential for individuals to become nuisance animals. Mortality of nuisance wolverines as a result of attraction to the Project-site and infrastructure is anticipated to result in a residual effect after mitigation on wolverine.

Camps may attract wolves due to scents or when searching for food although less frequently than wolverine (McNay 2002). Wolves generally avoid areas of human activity (Thurber et al. 1994). Moreover, similar projects in Nunavut and Northwest Territories have not reported problem or food-conditioned wolves. Mortality of nuisance wolves as a result of attraction to the Project-site and infrastructure is not anticipated after mitigation.

#### 8.5.2.7 *Exposure to Contaminants*

Exposure to contaminants for wolverine and wolves due to the Project was evaluated in the country foods effects assessment (Volume 8, Chapter 5) and in the Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in wolverine and wolves or its respective food chain components and surroundings (e.g., water, fish, caribou, etc.) were predicted to be below a value of one. A hazard quotient less than one indicates that an increase in contaminants in these media relative to baseline conditions is unlikely. Thus, a residual effect due to exposure to contaminants in wolverine and wolves is not anticipated and is not considered further in the assessment.

#### 8.5.2.8 *Reduction in Reproductive Productivity*

Reproductive productivity is usually quantified as the number of surviving young produced per year per female. With the obvious exception of mortality, all of the preceding effects may result in declines in reproductive productivity of individuals. Habitat loss and degradation, disturbance, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. Individuals in poor body condition often fail to produce young, or produce young that are more susceptible to mortality. Indeed, the body condition of parturient females is thought to be the main determinant of the health and survival of their young.

Population growth is determined by three key life history parameters: adult survival; birth rate (the ratio of total live births to total adult population); the survival rate of young. Because the reproductive success of adults and the survival of juveniles are influenced by their physiological condition, Project-related effects that result in lower body condition may result in population decline. Juveniles which are often preferred prey may also experience lower survival if displaced to poor quality habitats that offer little refuge from predators.

Evaluation of Reduction in Reproductive Productivity

*Wolverine*

Wolverines have low population densities and reproductive rates, making them susceptible to disturbances. Increased stress or decreased feeding could result in decreased reproductive success of wolverines. Further, residual effects of attraction and direct mortality as a result of attraction to the

Project are anticipated for a small number of individuals. In addition, an increase in energy requirement may occur for wolverine with territories in range of the disturbance due to blasting, thus reducing reproductive potential for these wolverines. Therefore, there is some potential for a reduction in reproductive productivity in wolverine due to the Project.

*Grey Wolf*

Reproductive success in wolves is strongly related to prey availability (Fuller 1989; Frame 2005) and prey availability in the central Arctic is a function of caribou migration patterns (Frame 2005). Scarce prey will also influence reproductive success, so again, the state of the caribou are vital to the success of wolves. Developments that alter the distribution or timing of caribou migration may have profound effects on reproductive productivity of wolves (Walton et al. 2001).

Given that the majority of pup mortality occurs within the first six months of life (Harrington, Mech, and Fritts 1983), females and pups are especially vulnerable to the effects of disturbance around their den sites. Disturbances that affect den site selection and activity around the den will affect reproductive success of the pack.

Overall, the magnitude of the synergistic effects of potential impacts from Project development will likely have a minimal effect on wolf reproductive productivity. Grey wolf productivity is tied closely with caribou migration and the location of den sites. This distances wolves travel between den sites and caribou post-calving ranges are great thus additional stressors on den sites may affect reproductive productivity. However, no active wolf dens were located within the Project area since 2007, the closest being 1.6 km. No residual effects are predicted.

### 8.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including wolverine and grey wolf. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on wolverine is anticipated resulting from habitat loss, disturbance due to noise, attraction, and reduced reproductive productivity. A residual effect of the Project on grey wolf is anticipated resulting from habitat loss, and disturbance due to noise. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to wolverine and grey wolf. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

#### 8.5.3.1 *Mitigation for Habitat Loss*

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to wolverine and grey wolves may include the following:

- Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as identified denning habitat (Volume 10, Chapter 20);
- infrastructure designed to minimize the Project footprint to reduce habitat loss for wolverine and furbearers (Project Description; Volume 2, Chapter 2);

- consideration of the location of the stockpiles and windbreaks to minimize dust fall, and reduce habitat degradation for wolverine and furbearers (Volume 10, Chapter 17);
- infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located, thereby minimizing the Project footprint to reduce habitat loss for wolverine and furbearers (Project Description; Volume 2, Chapter 2); and
- winter road access corridors proposed (no all-weather roads for re-supply routes or between the Goose and George Properties), to minimize direct habitat loss, habitat degradation due to dust deposition for wolverine and grey wolf (Volume 2, Chapter 2).

#### 8.5.3.2 *Mitigation for Disturbance due to Noise*

The primary mitigation and management strategies to minimize the effects of disturbance due to noise to wildlife are addressed in the Noise and Vibration Assessment (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance due to noise to wolverine and furbearers may include:

- winter roads designed to avoid known wolverine and grey wolf dens within 1 km of the proposed alignment to ensure that works and activities do not disturb wolverine and grey wolf during denning (Volume 10, Chapter 20);
- pre-construction ground clearing conducted outside of denning periods for wolverine and furbearers, where possible, to reduce disturbance to wolverine and furbearers (Volume 10, Chapter 20);
- underground mining used, where possible, to reduce noise emitted by the Project for excavating and hauling waste rock, and minimize the effects of noise disturbance to wolverine and grey wolf (Volume 2, Chapter 2);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to wolverine and grey wolf (Volume 10, Chapter 18);
- vehicles restricted to site roads, winter roads and quarry footprints during construction and operations to avoid unnecessary disturbance to wolverine and grey wolf habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

#### 8.5.3.3 *Mitigation for Disruption to Movement*

The following mitigation measures and best management practices may be applied to minimize the possible effects of disruption to movement to wolverine and furbearers:

- winter access roads only, when wolves are not as abundant, so access roads will not cause disruption of movement for grey wolves (Volume 2, Chapter 2); and

- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce the disruption of movement to winter occurring wildlife such as wolverine (Volume 2, Chapter 2).

#### 8.5.3.4 *Mitigation for Direct Mortality and Injury*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to wolverine and furbearers may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);
- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to wolverine and furbearers (Volume 10, Chapter 20);
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education Program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

#### 8.5.3.5 *Mitigation for Indirect Mortality*

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to wolverine and furbearers may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project employees and contractors while on site (Volume 10, Chapter 23).

#### 8.5.3.6 *Mitigation for Attraction*

The primary mitigation and management strategies to minimize effects of attraction to the Project to wolverine and furbearers and other wildlife are described in the Landfill and Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10 Chapter 11) and the Employee Education Program, described in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to wolverine and furbearers:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- wildlife-proof receptacles used for all waste and wildlife attractants, where possible, to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);

- a waste and wildlife attractant management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- the use of wildlife-attracting dust suppressants avoided, where possible (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20); and
- a protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers (Volume 10, Chapter 20).

#### 8.5.3.7 *Mitigation for Exposure to Contaminants*

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to mitigation for air quality (Volume 10, Chapter 17) and freshwater quality mitigation measures in the Aquatic Effects Management Plan (Volume 10, Chapter 19). Mitigation measures intended to control fugitive dust or air pollution will also serve to control the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and wildlife RSA and thus, will help to minimize the effect of exposure of contaminants to wolverine and furbearers.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including wolverine and furbearers from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- the use of wildlife-attracting dust suppressants avoided wherever possible (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20);
- wildlife exclusion measures implemented if wildlife are frequently accessing or attempting to access waste storage areas (Volume 10, Chapter 20); and

- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

### 8.5.4 Characterization of Residual Effects

Residual adverse environmental effects are those environmental effects predicted to remain after the application of mitigation. Wherever possible, the rating for each residual adverse environmental effect integrates the cumulative environmental effects of all activities taking place during a particular Project phase. It is therefore the cumulative environmental effect of all Project activities occurring with a Project phase that could result in an adverse environmental effect on wolverine and grey wolf.

#### 8.5.4.1 *Habitat Loss*

Wolverine

The total area of habitat loss due to the Goose, George and MLA PDAs is equivalent to 10,237 ha. An additional 8,444 ha of area may be lost and/or degraded due to the Winter Road PDA, of which 3,404 ha falls outside the wildlife RSA. Within the PDAs (within the wildlife RSA), 5,944 ha of high-quality habitat will be altered. The assessment assumed the entire area of the PDAs is lost. However, the actual Project footprint within the PDA will be much smaller than the PDA itself (infrastructure footprint accounts for 10 to 15% of the PDA), and the Project footprint has been designed to be minimal as possible. Therefore, the total area of habitat loss will be lower than the area evaluated in the assessment.

The direction of the effect is negative, as habitat will be lost. The alteration of habitat due to Project development represents a relatively small percentage of the available high-quality habitats for wolverine in the wildlife RSA. In total, the Project will alter between 0.8% and 1.1% of the available suitable denning habitat for wolverine in the wildlife RSA. Thus, the magnitude of this effect is rated as low, using the quantitative thresholds for magnitude of effect in Table 8.5-2. The extent of the effect is at the Project footprint scale, as habitat loss is generally limited to PDAs. The effect of habitat loss on wolverine habitat will have a long-term duration (beyond the life of the Project). However, the frequency of effect is sporadic, as habitat will be lost as the pits, camps, and other infrastructure are constructed, a small amount of high-quality habitat along the winter road alignments may be degraded due to compaction, but is anticipated to recover. The effect of habitat loss is irreversible, as some area will not be reclaimed during Reclamation/Closure (e.g., pits, waste-rock storage) and thus will be permanently lost. The probability of the effect occurring is likely, and the confidence in the significance rating is high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose, George, MLA, and Winter Road PDAs will not be developed.

Overall, the residual effect of habitat loss for wolverine is assessed as Not Significant.

Grey Wolf

The total area of habitat loss due to the Goose, George and MLA PDAs is equivalent to 10,237 ha. An additional 8,444 ha of area may be lost and/or degraded due to the Winter Road PDA, of which 3,404 ha falls outside the wildlife RSA. Within the PDAs (within the wildlife RSA), 67 ha of high-quality habitat will be altered. The assessment assumed the entire area of the PDAs is lost. However, the

actual Project footprint within the PDA will be much smaller than the PDA itself (infrastructure footprint accounts for 10 to 15% of the PDA), and the Project footprint has been designed to be minimal as possible. Therefore, the total area of habitat loss will be lower than the area evaluated in the assessment.

The direction of the effect is negative, as habitat will be lost. The alteration of habitat due to Project development represents a relatively small percentage of the available high-quality habitats for grey wolf in the wildlife RSA. In total, the Project will alter less than 1% of the available high-quality habitat. Thus, the magnitude of this effect is rated as low, using the quantitative thresholds for magnitude of effect in Table 8.5-2. The extent of the effect is at the Project footprint scale, as habitat loss is generally limited to PDAs. The effect of habitat loss on grey wolf will have a long term duration, as habitat will be lost beyond the life of the Project. However, the frequency of effect is sporadic, as the majority of habitat loss or degradation will occur during construction of the pits, camps and other Project infrastructure. A small amount of high-quality habitat along the winter road alignments may be degraded due to compaction, but is expected to recover during the growing season. The effect of habitat loss is irreversible, as some area will not be reclaimed during Reclamation/Closure (e.g., pits, waste-rock storage) and thus will be permanently lost. The probability of the effect occurring is likely, and the confidence in the significance rating is high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose, George, MLA, and Winter Road PDAs will not be developed.

Overall, the residual effect of habitat loss for grey wolf is assessed as Not Significant.

#### 8.5.4.2 *Disturbance due to Noise*

Wolverine

After considering the effects of habitat loss, the total area functionally lost due to blasting (≥ 120 dB) is 35 ha (or < 0.1% of the wildlife RSA). This area accounts for approximately 20 ha of high-quality habitat for wolverine (< 0.1% of the available high-quality habitat after accounting for habitat loss). An additional 982 to 27,140 ha ranging between 554 and 8,602 ha of high-quality habitat (0.1 to 1.6% of available high-quality habitat after accounting for habitat loss due to Project infrastructure and that functionally will be lost due to blasting) will be disturbed due to blasting (> 108 dB), general Project noise (> 45 dBA) or aircraft noise (> 80 dBA). However, disturbance due to blasting and aircraft noise will be intermittent, and 2,093 ha (due to general Project noise) will be continuously disturbed. Based on home range sizes of 126 $km^2$ for female and 400 $km^2$ for male wolverines, this corresponds to 16% of the home range of a female wolverine, or 5% of the home range of a male wolverine. Following the quantitative thresholds for magnitude listed in Table 8.5-1, the magnitude of the effect is considered low.

The extent of the effect of disturbance due to noise is local (i.e., extends beyond the footprint but for the most part is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for noise due to blasting activities and aircraft noise, thus sporadic overall, and the duration is considered medium as the effect of disturbance due to noise is expected to subside at Reclamation/Closure. The effect is considered to be reversible as wolverines are anticipated to relocate to areas that were disturbed by noise once the effect subsides. The probability of the effect occurring is likely, and confidence is high, as wolverines are known to be sensitive to blasting activities related to mining.

Overall, the residual effect of disturbance due to noise on wolverine is assessed as Not Significant.

Grey Wolf

After considering the effects of habitat loss, the total area functionally lost due to blasting (≥ 120 dB) is 35 ha (or < 0.1% of the wildlife RSA). No high-quality habitat for grey wolves falls in the area affected by blasting noise outside of the PDAs. An additional 982 to 27,140 ha ranging between 26 and 146 ha of high-quality habitat (0.1 to 0.3% of available grey wolf high-quality habitat after accounting for habitat loss due to Project infrastructure) will be disturbed due to general Project noise (> 45 dBA) or aircraft noise (> 80 dBA). However, disturbance due to aircraft noise will be intermittent, and 26 ha of high-quality habitat (0.1% of high-quality habitat available in the wildlife RSA) due to general Project noise will be continuously disturbed. Following the quantitative thresholds for magnitude listed in Table 8.5-1, the magnitude of the effect is considered low.

The extent of the effect of disturbance due to noise is local (i.e., extends beyond the footprint but for the most part is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for noise due to blasting activities and aircraft noise, thus sporadic overall, and the duration is considered medium as the effect of disturbance due to noise is expected to subside at Reclamation/Closure. The effect is considered to be reversible as grey wolves are anticipated to relocate to areas that have been disturbed by noise once the effect subsides. The probability of the effect occurring is likely, and confidence is high, as grey wolves are known to be sensitive to noise from activities related to mining.

Overall, the residual effect of disturbance due to noise on grey wolves is assessed as Not Significant.

#### 8.5.4.3 *Attraction*

Wolverine

With mitigation measures, the magnitude of the effect of attractants on wolverine is rated as low, following the guidance on determining qualitative magnitude in Table 8.5-1. The geographic extent is footprint, as the effect is anticipated to remain within the PDAs. This effect is anticipated to be a negative effect as wolverines that become habituated to Project-related attractants may have to be destroyed if they become nuisance animals. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used, but not after Reclamation/Closure. The frequency of wolverines being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is high, and confidence is medium, as wolverines are known to be attracted to mining camps.

Overall, the residual effect of attractants on wolverine is concluded to be Not Significant.

#### 8.5.4.4 *Reduction in Reproductive Productivity*

Wolverine

The combination of residual effects of the Project can negatively affect the reproductive success of females due to elevated stress or decreased feeding time, or may reduce survival of individuals, including females and young, thereby lowering the overall health of the local population. Therefore, a residual effect is expected with a negative direction.

Reduction in reproduction for wolverine is expected to be of low magnitude. Mitigation for Project effects will greatly lessen the potential for reduced productivity, through Project design that limits noise disturbance and management practices that reduces incidences that may result in mortality of injury of individuals. Therefore, only a few individuals within the wolverine population inhabiting areas surrounding the Project may experience lowered productivity in relation to Project development and associated activities. While the effect may only be experienced by a small proportion of local

wolverine population, the extent of the effect is regional, as the home ranges of wolverine extend beyond the boundaries of the Project footprint and wildlife LSA.

The effect will be of medium term duration, as the reproduction of individual wolverine would only occur when the Project is active and will subside at Reclamation/Closure. The frequency of the effect is anticipated to be sporadic as the likelihood of reduction in reproductive productivity are limited to events such as mortality which may cause declines in the wolverine population, or on factors such as limited resources or disturbance events which may limit the success of reproduction, births and rearing of young. Reduction in productivity is expected to be a reversible effect for wolverine, though it may take several years following the closure of the Project for wolverine to return to their baseline reproductive potential.

Overall, the effect of reduction of reproductive productivity for wolverine is assessed as Not Significant.

### 8.5.5 Significance of Residual Effects

Wolverine

The effects assessment for wolverine identified four effects as residual after mitigation as follows:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- attraction, rated Not Significant; and
- reduction in reproductive productivity, due to a combination of the previous effects, rated Not Significant.

Overall, the effect of the Project on wolverine is expected to be **Not Significant**.

Grey Wolf

The effects assessment for grey wolf identified four effects as residual after mitigation as follows:

- habitat loss, rated Not Significant; and
- disturbance due to noise, rated Not Significant.

Overall, the effect of the Project on grey wolves is expected to be **Not Significant**.

The criteria used in the determination of the significance of each residual effect is detailed in Section 8.5.4 and summarized in Tables 8.5-11 and 8.5-12.

## 8.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

### 8.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. Following the methodology outlined in Volume 9, Chapter 1, a cumulative effects assessment is conducted as there are residual effects for the VEC wolverine and grey wolf. The following residual effects are included in the potential cumulative effects assessment for wolverine: habitat loss, disturbance due to noise, attraction, reduction in reproductive productivity. The following residual effects are included in the potential cumulative effects assessment for wolves: habitat loss and disturbance due to noise.

**Table 8.5-11. Summary of Residual Effects on Wolverine and Overall Significance Rating**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (footprint, local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not Significant (N), Significant (S), Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | Medium | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local-regional | Reversible | Likely | High | N |
| Attraction | Negative | Low | Medium | Sporadic | Footprint | Reversible | Moderate | Medium | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

**Table 8.5-12. Summary of Residual Effects on Grey Wolf and Overall Significance Rating**

| Description of Residual Effects | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (footprint, local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not Significant (N), Significant (S), Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | Medium | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Likely | High | N |

The cumulative effect assessment (CEA) generally follows the methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be attributed to the Project compared to other projects and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 8.5.1.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 8.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary wolverine and grey wolf.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 8.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for wolverine and grey wolf and not the wildlife RSA.

#### 8.6.1.1 *Spatial Boundaries for the Cumulative Effects Assessment*

Wolverine

The spatial boundary for the cumulative effects assessment (CEA) for wolverine is the wildlife RSA boundary (35 km diameter) surrounding the Project and 35 km diameter boundary around all proposed winter roads including the Tibbett to Contwoyto Winter Road Connector (Figure 8.6-1).

This distance encompasses the distance movements typically travelled by wolverines, which could interact with the Back River Project. Data from the wolverine DNA study (Rescan 2013b) show that cumulative straight line distance movements ranges from 24 to 43 km for females and 12 to 36 km for males between multiple DNA posts. The longest straight line distance between two posts visited by an individual during the entire survey was 22 km. The wildlife RSA was selected to represent the CEA spatial boundary for wolverine as its buffer was set at 35 km around Project infrastructures. Therefore, this distance is used to represent the longest distance that wolverine that inhabit areas in the vicinity

of the project may travel and thus may interact with other developmental projects. The total area for CEA boundary is 2,479,635 ha.

Grey Wolf

The spatial boundary for the CEA for grey wolf represents the summer range of the Bathurst and Ahiak caribou herds due to the interrelationship between grey wolves and their main prey, caribou. The total area for the CEA boundary is 19,114,304 ha.

#### 8.6.1.2 *Temporal Boundaries for Cumulative Effects Assessment*

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

### 8.6.2 Potential Interactions of Residual Effects with Other Projects

Wolverine

Four residual Project-related effects were identified during the wolverine effects assessment: habitat loss; disturbance due to noise; attractants; and reduction in reproductive productivity. Several additional projects or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the range of wolverine that interact with the Back River Project.

A total of 3 projects in addition to the Back River Project have been identified within the CEA boundary for wolverine (Figure 8.6-1), including one existing project (the Tibbett to Contwoyto Winter Road project), and two future foreseeable projects (BIPR and Hackett River projects). Potential interactions of these projects are described in Table 8.6-1.

Grey Wolf

Two residual Project-related effects were identified during the grey wolf effects assessment: habitat loss, and disturbance due to noise. Several additional Projects or anthropogenic activities may contribute cumulatively to these effects if they occur within the range of grey wolves that interact with the Back River Project.

A total of 14 projects in addition to the Back River Project have been identified within the CEA boundary for grey wolves (Figure 8.6-2), including five past projects (Roberts Bay and Ida Bay, Lupin Mine, Jericho Mine, Salmita Mine, and Tundra Mine projects), four existing projects (Doris North, Diavik, EKATI, Contwoyto Lake Winter Road projects), and five future foreseeable developments (Hope Bay Belt, BIPR, Hackett River, Izok Corridor, Courageous Lake projects). Potential interactions of these projects are listed in Table 8.6-2.

#### 8.6.2.1 *Habitat Loss*

The residual effect of habitat loss associated with the development of the Back River Project was rated as Not Significant, with a low magnitude in the effects assessment for both wolverine and grey wolves. Habitat lost due to Back River Project infrastructure and infrastructure from other projects in the wolverine CEA boundary and the grey wolf CEA boundary is discussed in this section.

Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible and the range of wolverines and grey wolves overlaps additional projects which may contribute to habitat loss. While habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 8.5.4.1), additional habitat loss within the range wolverines and grey wolves may contribute to a nibbling effect whereby the total amount of habitat lost to all potential and current projects is additive to the point where a significant loss in habitat can occur.

PROJECT # 0194096-0040 GIS # BAC-05-001b November 12 2013

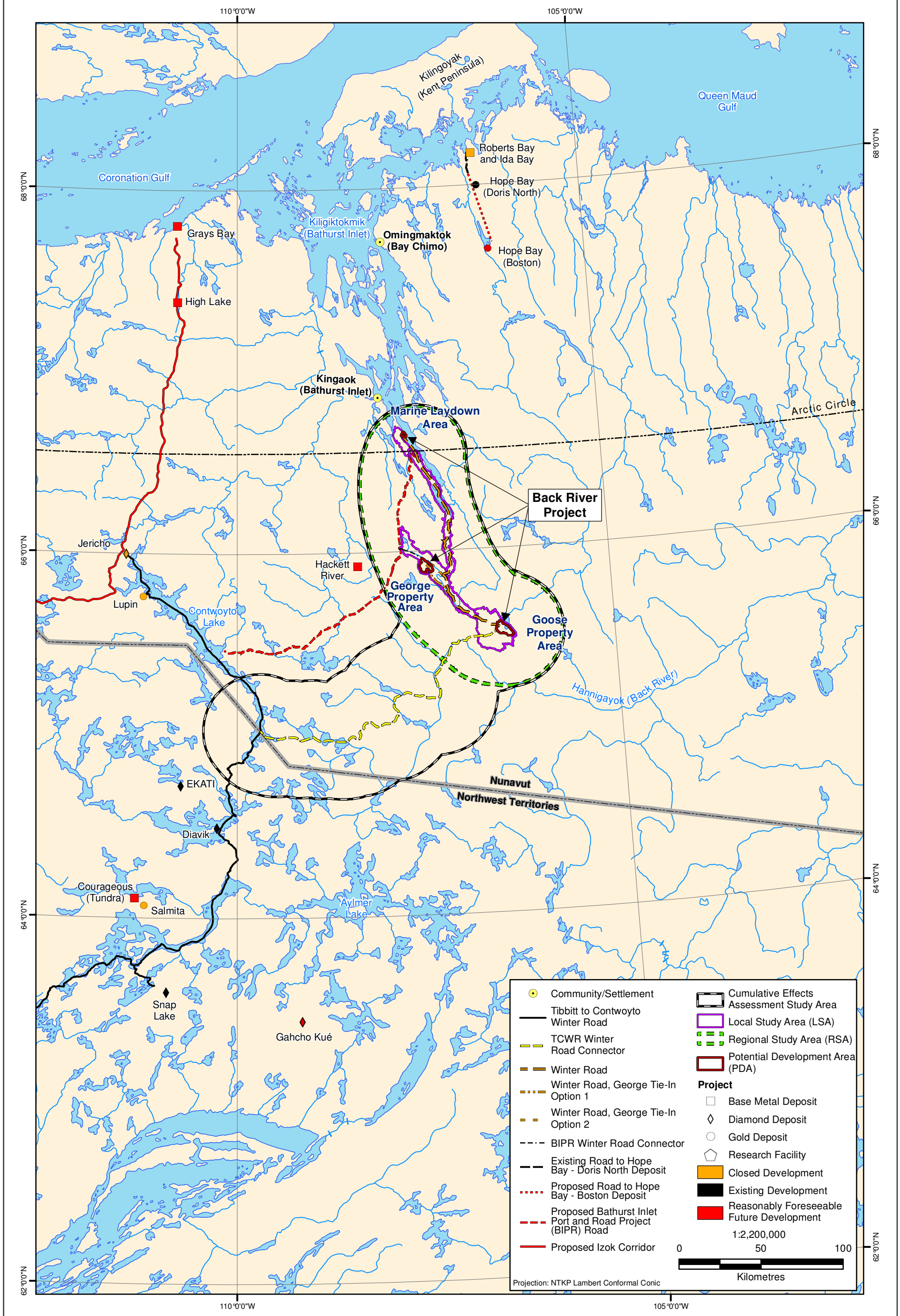


Figure 8.6-1

Sabina GOLD & SILVER CORP.

## Spatial Boundary for Wolverine Cumulative Effects Assessment

Figure 8.6-1

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-05-001f November 12 2013

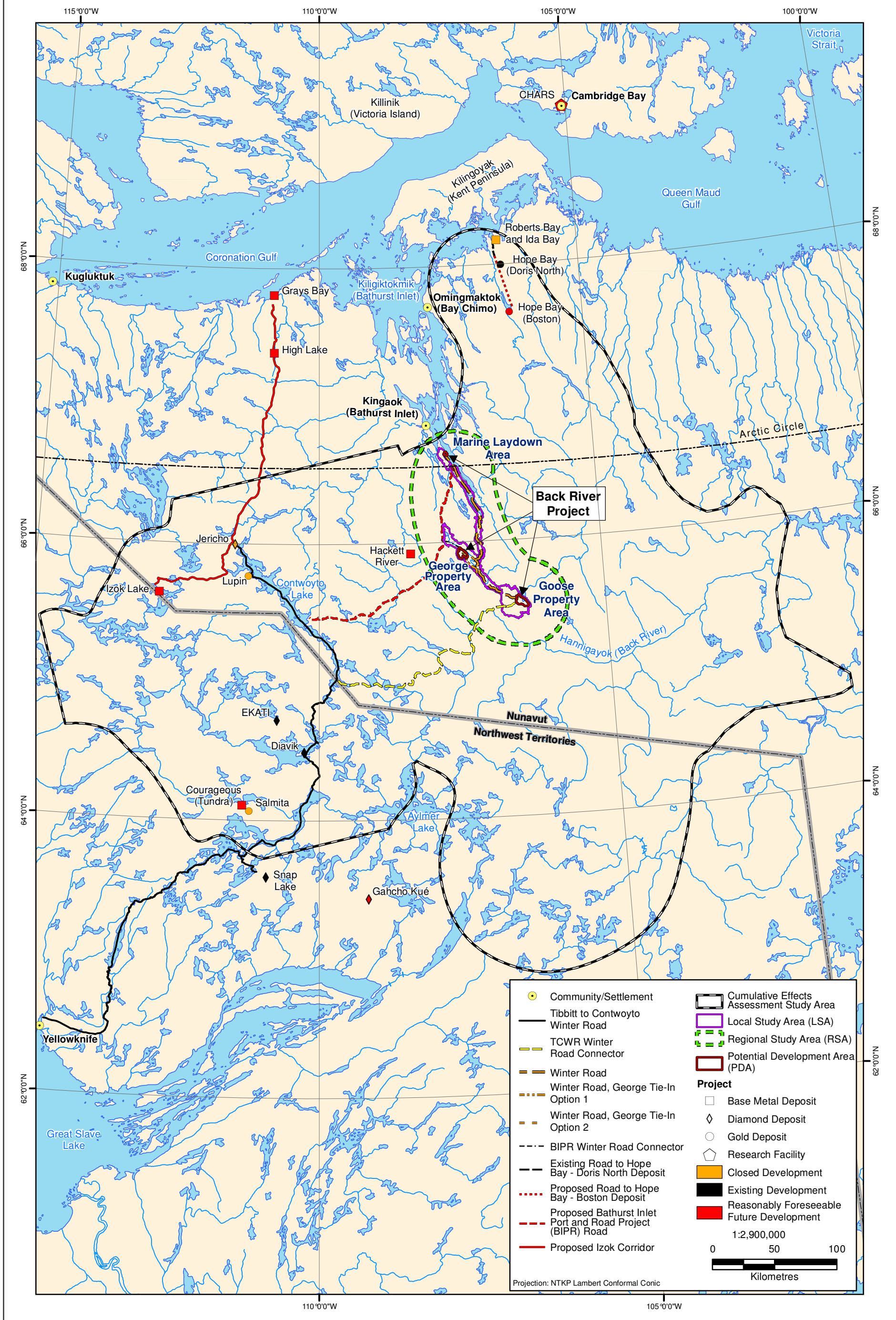


Figure 8.6-2

Sabina GOLD & SILVER CORP.

## Spatial Boundary for Grey Wolf Cumulative Effects Assessment

Figure 8.6-2

Rescan an ERM company

**Table 8.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Wolverines in the Cumulative Effects Assessment Boundary**

| Residual Effects from Back River Project | Magnitude of Residual Effect Rating from Back River Project | Other Project or Activity | | | Type of Potential Cumulative Effect |
|---|---|---|---|---|---|
| | | Past | Existing | Reasonably Foreseeable Future | |
| Habitat Loss | Low | N/A | TCWR[1] | BIPR[2], Hackett River | Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities |
| Disturbance due to Noise | Low | N/A | TCWR[1] | BIPR[2], Hackett River | Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance |
| Attractants | Low | N/A | TCWR[1] | BIPR[2], Hackett River | Additive attraction to foods and wastes resulting in attraction and negative human-wildlife interactions and destruction of nuisance animals |
| Reduction in Reproductive Productivity | Low | N/A | TCWR[1] | BIPR[2], Hackett River | Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects |

[1] *The Tibbitt to Contwoyto Lake Winter Road was included as a source of habitat loss and disturbance for wolverine during the winter.*
[2] *BIPR = Bathurst Inlet Port and Road Project*

**Table 8.6-2. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Grey Wolves in the Cumulative Effects Assessment Boundary**

| Residual Effect from Back River Project | Magnitude of Residual Effect Rating from Back River Project | Other Project or Activity | | | Type of Potential Cumulative Effect |
|---|---|---|---|---|---|
| | | Past | Existing | Reasonably Foreseeable Future | |
| Habitat Loss | Low | Roberts Bay and Ida Bay, Lupin, Jericho, Salmita, Tundra | Doris North, Diavik, EKATI | Hope Bay Belt, BIPR[1], Hackett River, Izok Corridor, Courageous Lake | Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities |
| Disturbance due to Noise | Low | N/A | Doris North, Diavik, EKATI, | Hope Bay Belt, BIPR[1], Hackett River, Izok Corridor, Courageous Lake | Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance |

[1]*BIPR = Bathurst Inlet Port and Road Project*

Potential cumulative effects from all past, existing and future foreseeable proposed projects in each CEA boundary were assessed (Tables 8.6-1 and 8.6-2). A background on the potential effects of disturbance due to noise to wolverines and grey wolves is presented in Section 8.5.2.2.

Calculation of Cumulative Habitat Loss

The amount of habitat removed due to projects was estimated from the generalized footprints of all projects and road corridors in the CEA assessment boundaries for wolverine and grey wolves. For all additional projects (other than the Back River Project), habitat within 100 m of removed habitat (due to Project infrastructure) was considered to be degraded habitat because 100 m is the distance within which most effects of large dust particles extend from roads and other developments (Walker and Everett 1987; Rescan 2012, Appendix V5-5D). This 100 m buffer of degraded habitat was not calculated for the Back River Project because it was assumed that the effects of habitat degradation due to dust were accounted for within the PDAs for each of the development areas (Goose Property Area, George Property Area, and the MLA).

The areas within the project footprints plus 100 m buffer was calculated and added to the area of habitat lost due to the Back River Project and compared to the total area of the CEA assessment boundaries for wolverine and grey wolves. This calculates the total amount of area lost within the CEA boundary. In order to put the amount of habitat lost in the perspective of habitat use by individual wolverines and grey wolves, the habitat loss due to all Projects in the CEA assessment boundaries for wolverine and grey wolves are compared to home range sizes for male and female wolverines or grey wolves. This is an overestimate of the amount of habitat loss within an individual's home range but will enable a calculation of the maximum number of home ranges that could be potentially lost due to the cumulative effect of habitat loss within the CEA boundaries for wolverine and grey wolves.

Evaluation of Cumulative Habitat Loss

*Wolverine*

Within the CEA boundary for wolverine, the cumulative effects assessment identified 19,176 ha of removed habitat, and 2,512 ha of degraded habitat. These areas account for a total of 21,653 ha after accounting for overlap between projects (approximately 0.9% of the total area in the CEA boundary; Table 8.6-3). The Back River Project alone will contribute 18,681 ha of the total area of habitat loss within the CEA boundary for wolverine which is equivalent to less than 0.7% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10 to 15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

The total area of habitat loss due to all projects in the CEA boundary for wolverine (21,582 ha), is equivalent to 0.5 home ranges of a male wolverine and 1.7 home ranges of a female wolverine. Assuming that approximately 50% of this area consists of high-quality habitat for wolverines, a total of 10,791 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the CEA boundary for wolverines are developed.

The amount of wolverine habitat that will be lost as a result of Project development represents a small portion of the total amount of habitat available in the CEA boundary (Table 8.6-3) and that of the home range of male and female wolverines. The carrying capacity of the habitat for wolverine at the landscape level is therefore unlikely to be affected due to the cumulative habitat loss of all Projects in the CEA boundary. It is concluded that the potential cumulative effect of habitat loss, while small, will result in a residual effect to wolverine.

**Table 8.6-3. Cumulative Habitat Loss in the Wolverine CEA Area**

| Project | Habitat Lost due to Project Infrastructure (ha) | Habitat Degraded due to Dust (ha) | Total Habitat Lost or Degraded (ha) | Total Habitat Lost without Winter Roads (ha) |
|---|---|---|---|---|
| Back River Project[1] | 18,681 | n/a | 18,681 | 10,237 |
| *Past Developments* | | | | |
| n/a | | | | |
| *Existing Operating Developments* | | | | |
| Tibbett to Contwoyto Winter Road | 125 | n/a | 125 | 0 |
| *Reasonably Foreseeable Future Developments* | | | | |
| BIPR | 330 | 2,292 | 2,622 | 2,622 |
| Hackett River | 40 | 231 | 271 | 271 |
| Total Area | 19,176 | 2,523 | 21,669 | 13,130 |
| Total Accounting for Area of Overlap | 19,176 | 2,512 | 21,653 | 13,130 |

[1] *Habitat Removed due to the Back River Project includes all winter roads including the TCWR Winter Road Connector and the BIPR Winter Road Connector.*

*Grey Wolf*

Within the CEA boundary for grey wolf, the cumulative effects assessment identified 32,044 ha of removed habitat, and 14,991 ha of degraded habitat. These areas account for a total of 46,601 ha after accounting for overlap between projects (totalling approximately 0.2% of the total area in the CEA boundary; Table 8.6-4). The Back River Project alone will contribute 10,237 ha of the total area of habitat loss within the CEA boundary for grey wolves which is equivalent to less than 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10 to 15% of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects. The total loss and degradation of wolf habitat (46,601 ha), is equivalent to 23% of an average male grey wolf summer home range or 42% of the average summer home ranges of a female grey wolf.

Assuming that approximately 50% of this area consists of high-quality habitat for grey wolves, a total of 23,300 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the CEA boundary for wolves are developed.

The amount of grey wolf habitat that will be lost as a result of Project development represents a small portion of the total amount of habitat available in the CEA boundary (Table 8.6-4) and that of the average summer home ranges of grey wolves. The carrying capacity of the habitat for grey wolf at the landscape level is therefore unlikely to be affected due to the cumulative habitat loss of all Projects in the CEA boundary. It is concluded that the potential cumulative effect of habitat loss, while small, will result in a residual effect to grey wolf.

### 8.6.2.2 *Disturbance due to Noise*

The residual effect of disturbance due to noise from auditory stimuli associated with the Back River Project was rated as Not Significant, with a low magnitude in the effects assessment for both wolverine and grey wolves. Habitat lost or disturbed due to Project-related noise resulting from activities at the Back River Project and other projects in the wolverine CEA boundary and the grey wolf CEA boundary is discussed in this section.

**Table 8.6-4. Cumulative Habitat Loss in the Grey Wolf CEA Boundary**

| Project | Habitat Lost due to Project Infrastructure (ha) | Habitat Degraded due to Dust (ha) | Total Habitat Lost or Degraded[1] (ha) | Total Habitat Lost without Winter Roads (ha) |
|---|---|---|---|---|
| Back River Project[2] | 18,681 | n/a | 18,681 | 10,237 |
| *Past Developments* | | | | |
| Roberts Bay and Ida Bay | 3 | n/a | 3 | 3 |
| Jericho Mine | 242 | n/a | 242 | 242 |
| Lupin Mine | 795 | n/a | 795 | 795 |
| Salmita | 10 | n/a | 10 | 10 |
| Tundra | 96 | n/a | 96 | 96 |
| *Existing Operating Developments* | | | | |
| Doris North | 279 | 533 | 812 | 812 |
| Ekati Mine | 3,222 | 2,057 | 5,279 | 5,274 |
| Diavik Mine | 80 | 32 | 112 | 112 |
| Contwoyto Lake Winter Road | 495 | n/a | 495 | 0 |
| *Reasonably Foreseeable Future Developments* | | | | |
| Hope Bay Belt | 2,995 | 1,064 | 4,059 | 4,059 |
| BIPR[3] | 499 | 4,113 | 4,613 | 4,613 |
| Hackett River | 1,454 | 2,057 | 3,511 | 2,511 |
| Gaucho Kue | 48 | | | |
| Izok Corridor Project[4] | 941 | 4,857 | 4,857 | 4,766 |
| Courageous | 2,204 | 842 | 3,046 | 3,046 |
| Total | 32,044 | 15,002 | 46,611 | 36,576 |
| Total Accounting for Area of Overlap | 32,044 | 14,991 | 46,601 | 36,561 |

[1] *Habitat Loss includes total area lost and does not take into account habitat suitability within the area.*
[2] *Habitat Removed due to the Back River Project includes the Goose Property, George Property and MLA PDAs.*
[3] *Bathurst Inlet Port and Road Project*
[4] *Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.*

Potential cumulative effects from all existing and future foreseeable proposed projects in each CEA boundary were assessed. Closed projects were excluded from the analysis, as areas that were disturbed by noise from these developments are anticipated to be recovered to baseline conditions. A background on the potential effects of disturbance due to noise to wolverines and grey wolves is presented in Section 8.5.2.2.

Calculation of Cumulative Disturbance due to Noise

To evaluate the potential cumulative effects of disturbance due to noise on wolverine and wolves, the area of habitat in which wolverines and wolves may be affected by disturbance due to noise within their respective CEA boundary areas was calculated and used as a key indicator of this potential effect. Noise modelling for the Back River Project has indicated that disturbance due to blasting noise will attenuate to below threshold values within 4 km from the source of blasting at quarries (Volume 4, Chapter 2). Thus, a 4 km buffer was applied to all projects to calculate the area lost due to blasting noise.

Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB

(Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km while that during construction would be similar to blasting at mine sites and would attenuate below threshold values at 4 km. Noise modelling on the winter roads for the Back River Project indicated that noise would attenuate to 200 m from vehicle traffic and activities on these roads (Volume 4, Chapter 2). Thus, a distance of 1.5 km or 4 km was used to measure habitat loss around all-weather roads during construction and operations, respectively for both wolverine and wolves and a buffer of 200 m around winter roads was used for wolverine. The winter road buffer was not used for grey wolves, as wolves are found only in very small density above tree line during the winter.

The total area of indirect habitat loss due to all projects was compared to the total area of the CEA boundary for wolverines and grey wolves and to the average home range size of a male and female wolverine or grey wolf territories.

Evaluation of Cumulative Disturbance due to Noise

*Wolverine*

The CEA boundary for wolverine is approximately 2,479,635 ha. During the operation phase of the Back River Project disturbance due to noise was calculated based on a worst case scenario whereby the disturbed habitat at the Back River Project for year three at the Goose Property Area and year seven at the George Property Area are combined to calculate the maximum possible disturbance due to noise for wolverines. The area of habitat altered due to disturbance due to noise from the Back River Project alone would cover 53,817 ha, or 2.2% of the CEA boundary for wolverines (Figure 8.6-3).

The area of habitat loss for the cumulative effects of noise due to all existing and proposed projects in the CEA boundary for wolverines, assuming a worst case scenario whereby construction of all-weather roads due to all additional projects would occur at the same time, would result in 136,992 ha of disturbed habitat, or 5.5% of the CEA boundary. During the operational phase, assuming all proposed projects are operational, the effect of all projects combined would result in 101,213 ha of disturbed habitat (4% of the CEA boundary). Estimated areas of noise disturbance for each project are reported in Table 8.6-5.

**Table 8.6-5. Area of Habitat Disturbance by Noise in the Wolverine CEA Boundary**

| Project | Areas of Wolverine Habitat Disturbed (ha) | | | | | |
|---|---|---|---|---|---|---|
| | Winter Roads (200 m) | All-weather Roads Construction (4 km) | All-weather Roads Operation (1.5 km) | Mine (4 km) | Total during Construction | Total during Operation |
| Back River Project | 16,891 | | | 53,817 | 53,817 | 53,817 |
| *Existing Developments* | | | | | | |
| Tibbett to Contwoyto Winter Road | 3,325 | | | | | |
| *Reasonably Foreseeable Future Developments* | | | | | | |
| BIPR | | 67,153 | 31,307 | 8,027 | 75,180 | 39,334 |
| Hackett River | | 85 | 152 | 7,910 | 7,995 | 8,062 |
| *Totals* | | | | | | |
| Total Area | 20,216 | 67,238 | 31,459 | 69,754 | 136,992 | 101,213 |
| Total Area Accounting for Overlap | 20,125 | 67,238 | 31,459 | 69,754 | 136,992 | 101,122 |
| % CEA Boundary | 0.8 | 2.7 | 1.3 | 2.8 | 5.5 | 4.0 |

The cumulative effect of disturbance due to noise from all projects assuming a worst-case scenario (during construction of all future-foreseeable projects at the same time) results in the equivalent of 3.4 male wolverine home ranges or approximately 10.9 female wolverine home ranges. Despite mitigation measures, a residual effect is anticipated for disturbance due to noise to wolverines.

*Grey Wolf*

The CEA boundary for grey wolves is approximately 19,114,304 ha. During the operation phase of the Back River Project disturbance due to noise was calculated based on a worst case scenario whereby the disturbed habitat at the Back River Project for year three at the Goose Property Area and year seven at the George Property Area are combined to calculate the maximum possible disturbance due to noise for grey wolves. The area of habitat altered due to disturbance due to noise from the Back River Project alone would cover 53,817 ha, or 0.3% of the CEA boundary for grey wolves (Figure 8.6-4).

The area of habitat loss for the cumulative effects of noise due to all existing and proposed projects in the CEA boundary for grey wolves, assuming a worst case scenario whereby construction of all-weather roads due to all additional projects would occur at the same time, would result in 537,027 ha of disturbed habitat, or 2.8% of the CEA boundary. During the operational phase, assuming all proposed projects are operational, the effect of all projects combined would result in 360,782 ha of disturbed habitat (1.9% of the CEA boundary). Estimated areas of noise disturbance for each project are reported in Table 8.6-6.

The cumulative effect of disturbance due to noise from all projects assuming a worst-case scenario (during construction of all future-foreseeable projects at the same time) results in the equivalent of 2.7 male grey wolf summer home ranges or approximately 4.8 female grey wolf home ranges. Despite mitigation measures, a residual effect is anticipated for disturbance due to noise to grey wolves.

**Table 8.6-6. Area of Habitat Disturbance by Noise in the Grey Wolf CEA Boundary**

| Project | All-weather Roads Construction (4 km) | All-weather Roads Operation (1.5 km) | Mine (4 km) | Total during Construction | Total during Operation |
|---|---|---|---|---|---|
| Back River Project | | | 53,817 | 53,817 | 53,817 |
| Existing Developments | | | | | |
| EKATI Mine | | 8,408 | 30,985 | 39,393 | 39,393 |
| Diavik Mine | | | 11,713 | 11,713 | 11,713 |
| Doris North | | 6,460 | 17,152 | 23,612 | 23,612 |
| Reasonably Foreseeable Future Developments | | | | | |
| Izok Lake | 123,328 | 52,920 | 16,606 | 139,934 | 69,526 |
| BIPR* | 157,337 | 68,776 | 13,710 | 171,047 | 82,486 |
| Hackett River | 8,748 | 6,693 | 23,653 | 32,401 | 30,346 |
| Hope Bay (phase 2) | 29,114 | 13,893 | 12,384 | 41,498 | 26,277 |
| Courageous Lake | | | 23,042 | 23,612 | 23,612 |
| Totals | | | | | |
| Total Area | 318,527 | 157,150 | 203,062 | 537,027 | 360,782 |
| Total Area Accounting for Overlap | 318,527 | 157,150 | 203,062 | 537,027 | 360,782 |

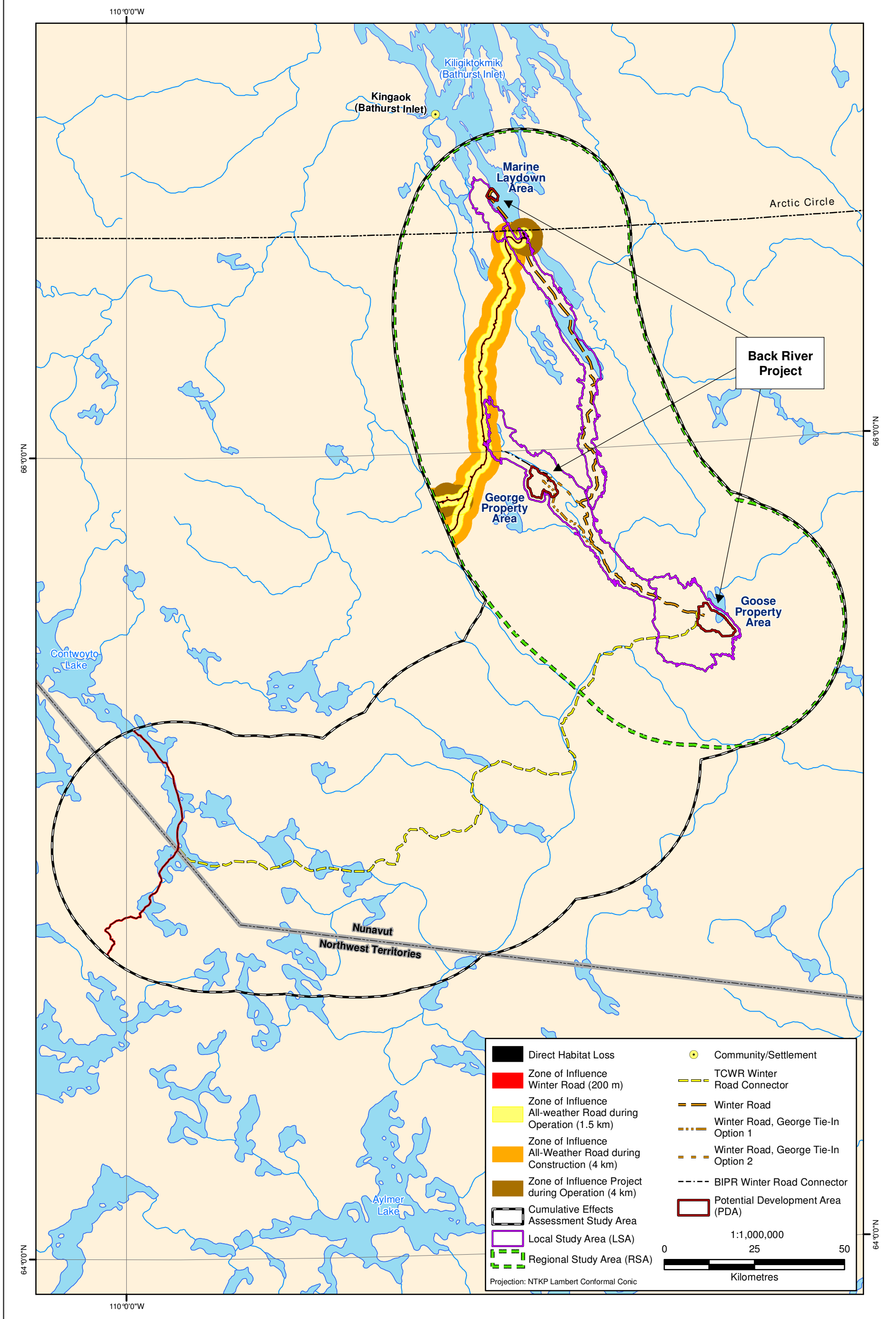


Figure 8.6-3

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# Habitat Lost or Altered due to All Project Footprints and Noise in the Wolverine Cumulative Effects Assessment Boundary

Figure 8.6-3

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-245f November 12 2013

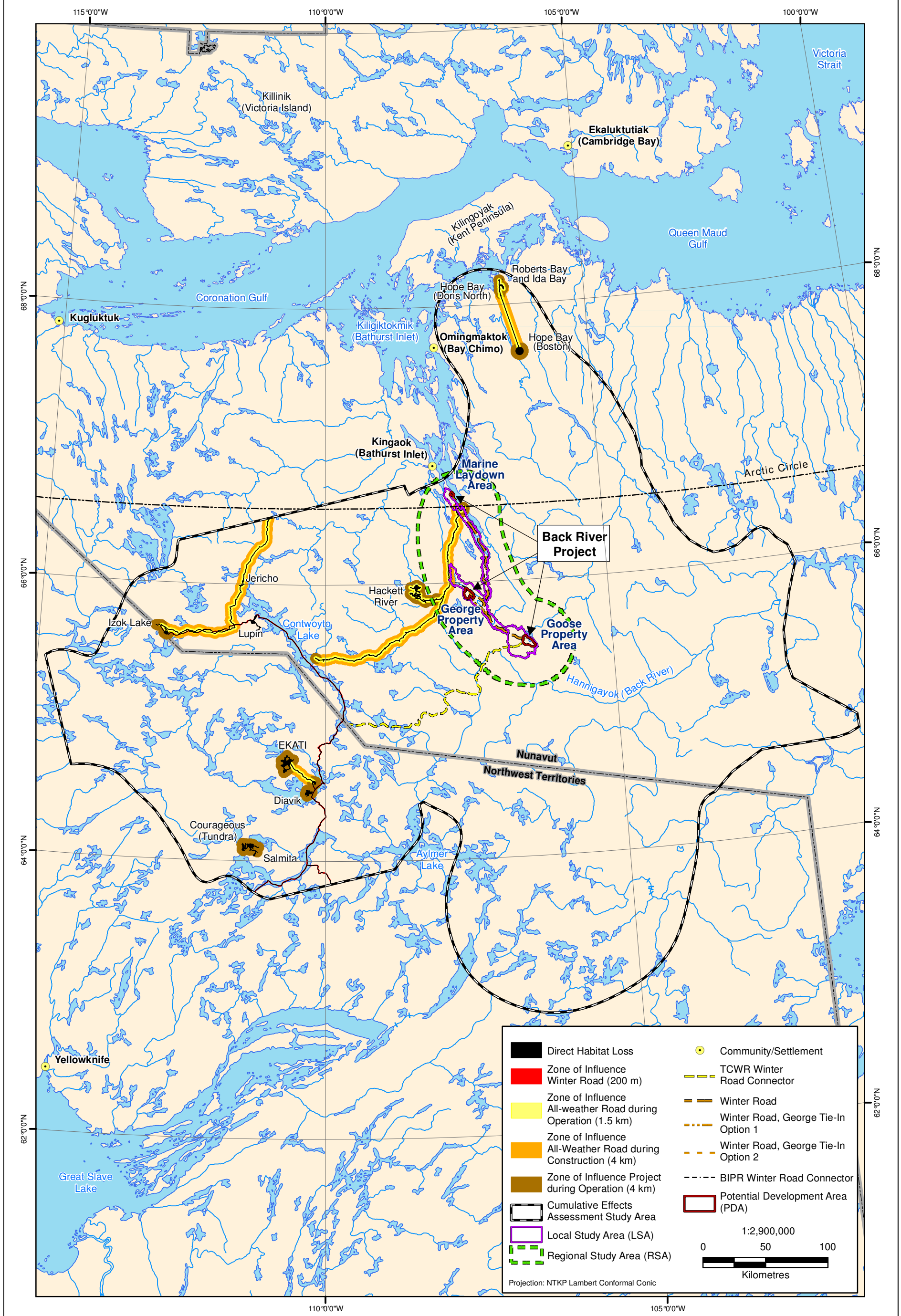


Figure 8.6-4

Sabina GOLD & SILVER CORP.

## Habitat Lost or Altered due to All Project Footprints and Noise in the Grey Wolf Cumulative Effects Assessment Boundary

Figure 8.6-4

Rescan an ERM company

#### 8.6.2.3 *Attraction*

Wolverines are often attracted to a human settlement due to curiosity and/or attraction (Section 8.5.2.6). Additional camps associated with the construction and operation that occur in the area assessed for cumulative impacts on wolverine will increase the probability of attraction of wolverines. The more areas where wolverines are attracted to scents of foods and wastes, or where they will potentially receive a reward, the greater the chance of producing nuisance animals. A crucial consideration for cumulative effects on attraction of wolverines is that one poorly managed camp has the potential to attract and create habituated wolverines that can then move into many other areas of human use; thus the probability of creating and interacting with nuisance animals increases exponentially with the number of new developments in an area.

Evaluation of Attraction

Best management practices for reducing the attractiveness of camps and infrastructure are expected to be implemented at all project sites. However, existing mines and camps in Northwest Territories and Nunavut report problem wildlife at a low level despite implementing these best management practices. Therefore a residual effect is predicted for the cumulative assessment of attractants for wolverine.

#### 8.6.2.4 *Reduction in Reproductive Productivity*

Wolverines have low population densities and reproductive rates, making their populations particularly susceptible to alterations in reproductive productivity. Increased road traffic, extensions of the road haul season, and the proposed projects could have consequences for the greater population within the CEA. Changes to dispersal and feeding behaviours may also increase stress levels, decrease physical condition, and thus decrease reproductive success of wolverines. The residual cumulative effects on wolverine due to all Projects in the CEA include habitat loss, disturbance due to noise, and attraction. This effect may have higher consequences on the reduction of reproductive productivity on wolverines relative to the residual effects of habitat loss, disturbance due to noise, and attraction anticipated from the Back River Project. Reduction in reproductive productivity is expected to be small and very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

### 8.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for wolverines will be similar to those applied for the Back River Project. For a list of these mitigation and management measures see Section 8.5.3 and Volume 10.

### 8.6.4 Characterization of Cumulative Residual Effects

After the application of mitigation and management measures, there are four residual effects predicted in the wolverine cumulative effects assessment area: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity and two residual effect on grey wolf: habitat loss, and disturbance due to noise.

#### 8.6.4.1 *Habitat Loss*

Wolverine

The overall loss or degradation of area due to all projects in the wolverine CEA boundary is 21,653 ha (approximately 0.9% of the CEA boundary) which is equivalent to 0.5 home ranges of a male wolverine and 1.7 home ranges of a female wolverine assuming all habitat lost falls within one wolverine's home

range. As this amount of habitat loss is minimal relative to the amount of habitat in the CEA boundary the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local as it is expected to occur near the project footprints, the frequency is sporadic, as habitat loss would occur during construction of project infrastructure for each Project, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas may be reclaimed to baseline condition. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss were converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for wolverines is concluded to be Not Significant.

Grey Wolf

The overall loss or degradation of area due to all projects in the grey wolf CEA boundary is 46,6601 ha (approximately 0.2% of the total area in the CEA boundary for grey wolves) and equivalent to 0.3 average summer home ranges of a grey wolf, assuming all habitat lost falls within one wolf's home range. As this amount of habitat loss is minimal relative to the amount of habitat in the CEA boundary the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local as habitat loss is anticipated to occur near the project footprints, the frequency is sporadic, as habitat loss would occur during construction of project infrastructure for each of the projects and habitat degradation due to dusting would occur when blasting activities occur, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss were converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for grey wolf is concluded to be Not Significant.

#### 8.6.4.2 *Disturbance due to Noise*

Wolverine

The total additional area of habitat disturbed by noise created by all projects within the CEA boundary is 136,992 ha during the worst case scenario assuming all future foreseeable projects are constructed at the same time. This area is equivalent to 5.5% of the CEA boundary for wolverine. The maximum area of disturbance due to noise is equivalent to 3.4 male wolverine home ranges or approximately 10.9 female wolverine home ranges. These areas represent a small amount of habitat disturbed relative to that available in the CEA boundary for wolverine. Thus, the magnitude of the effect of disturbance due to noise to wolverine is considered low.

The extent of the effect of disturbance due to noise is local as the majority of noise would be contained near the infrastructure for most projects, but may extend slightly beyond, the frequency is expected to be continuous for general Project noise and sporadic for noise during blasting activities and aircraft noise, but overall sporadic covering the majority of the disturbed areas, and the duration is considered medium as the effect of disturbance due to noise is expected to subside at Reclamation/Closure of the projects. The effect is considered to be reversible as wolverines are anticipated to relocate to areas disturbed by noise once the effect subsides. The probability of the effect occurring is likely. The confidence in the effect of disturbance due to noise is high. However, the confidence in the actual proportion of the area that will be affected is considered medium, as it is anticipated that a much small proportion of the area will be disturbed due to noise. The cumulative residual effect of disturbance due to noise on wolverines is concluded to be Not Significant.

Grey Wolf

The total area of habitat disturbed by noise created by all projects within the CEA boundary for grey wolves is 537,027 during the worst case scenario. This area of disturbance due to noise in the CEA boundary for grey wolves is equivalent to 2.8% of the CEA boundary for grey wolves. This maximum area of disturbance due to noise is equivalent to 2.7 male grey wolf summer home ranges or approximately 4.8 female grey wolf summer home ranges. These areas represent a small amount of habitat disturbed relative to that available in the CEA boundary for grey wolves. Thus, the magnitude of the effect of disturbance due to noise to grey wolf is considered low.

The extent of the effect of disturbance due to noise is local as the majority of noise would be contained near the infrastructure for most projects, but may extend slightly beyond, the frequency is expected to be continuous for general Project noise and sporadic for noise during blasting activities and aircraft noise, but overall sporadic covering the majority of the disturbed areas, and the duration is considered medium as the effect of disturbance due to noise is expected to subside at Reclamation/Closure of the projects. The effect is considered to be reversible as wolves are anticipated to relocate to areas disturbed by noise once the effect subsides. The probability of the effect occurring is likely. The confidence in the effect of disturbance due to noise is high. However, the confidence in the actual proportion of the area that will be affected is considered medium, as it is anticipated that a much small proportion of the area will be disturbed due to noise. The cumulative residual effect of disturbance due to noise on grey wolves is concluded to be Not Significant.

#### 8.6.4.3 *Attractants*

Wolverine

With mitigation measures applied and assumed similar among projects, the magnitude of the effect of attractants on wolverine is determined from the definitions of qualitative effects (Table 8.5-1) is rated as low. The geographic extent is local as the effect will occur near the footprints of the projects in the CEA boundary for wolverine. The effect of attraction is anticipated to result in a negative effect as wolverines that become habituated to Project-related attractants may have to be destroyed if they become nuisance animals. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used. The frequency of wolverines being attracted to infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is high, and confidence is medium, as wolverines are known to be attracted to mining camps. The cumulative residual effect of attractants on wolverines is concluded to be Not Significant.

#### 8.6.4.4 *Reduction in Reproductive Productivity*

Wolverine

The potential for a reduction in reproductive productivity in wolverines depends on the magnitude of all other effects (disturbances) they experience. Disturbance leading to displacement of wolverines with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young due to wolverine becoming nuisance animals as a results of being attracted to projects, would likely lead to the greatest effects on wolverines populations in the region.

The residual effects of the Project on wolverines include habitat loss, disturbance due to noise, and attraction. These effects combined can result in a reduction in reproductive productivity in wolverines. The highest magnitude of any of the residual effects on wolverines after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on wolverines is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of wolverines in the regional area. The duration of the effect is expected to be medium term as reduction to reproductive productivity would be anticipated to recover once the projects in the CEA boundary for wolverine close. The frequency of the effect is anticipated to be sporadic. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the various mines are closed. The effect is anticipated to be regional as wolverines have large home ranges and may come into contact with many of the projects in the CEA boundary. The confidence in the effect rating is medium as it is unknown how the effects of the Project on reproduction of wolverines may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the cumulative residual effect of reduction of reproductive productivity is concluded to be Not Significant.

### 8.6.5 Significance of Cumulative Residual Effects

Wolverine

The cumulative effects assessment for wolverine identified four effects as residual after mitigation as follows and in Table 8.6-7:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- attraction, rated Not Significant; and
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Overall, the residual cumulative effect of wolverines is **Not Significant.**

Grey Wolf

The cumulative effects assessment for grey wolves identified two effects as residual after mitigation as follows and in Table 8.6-8:

- habitat loss, rated Not Significant; and
- disturbance due to noise, rated Not Significant.

Overall, the residual cumulative effect of grey wolves is **Not Significant.**

**Table 8.6-7. Summary of Cumulative Residual Effects to Wolverine and their Significance**

| Cumulative Residual Effects | Evaluation Criteria | | | Likelihood of Occurrence of Cumulative Residual Effects | | | Significance of Cumulative Residual Effects | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not Significant (N), Significant (S), Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Local | Irreversible | Likely | High | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | N |
| Attraction | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | N |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Regional | Reversible | Unlikely | Medium | N |

**Table 8.6-8. Summary of Cumulative Residual Effects to Grey Wolf and their Significance**

| Cumulative Residual Effects | Evaluation Criteria | | | Likelihood of Occurrence of Cumulative Residual Effects | | | Significance of Cumulative Residual Effects | | |
|---|---|---|---|---|---|---|---|---|---|
| | Direction (positive, neutral, negative) | Magnitude (negligible, low, moderate, high) | Duration (short, medium, long) | Frequency (once, sporadic, continuous) | Geographic Extent (local, regional, beyond regional) | Reversibility (reversible, reversible with effort, irreversible) | Probability (unlikely, moderate, likely) | Confidence (low, medium, high) | Not Significant (N), Significant (S), Positive (P) |
| Habitat Loss | Negative | Low | Long | Sporadic | Local | Irreversible | Likely | High | N |
| Disturbance due to Noise | Negative | Low | Medium | Sporadic | Local | Reversible | Likely | High | N |

## 8.7 TRANSBOUNDARY EFFECTS

Residual effects of the Project on wolverine are predicted to occur in both the Project effects assessment and the cumulative effects assessment. However, wolverine inhabiting areas surrounding the project would rarely travel into the Northwest Territories. The transboundary effects that cross jurisdictional boundaries are predicted to be accounted for in the cumulative effects assessment for wolverine — all of which are rated as Not Significant. Thus, the overall transboundary effect is anticipated to be Not Significant.

For grey wolf, the CEA boundary is designed to encompass the summer range of grey wolves that follow the Ahiak and Bathurst herds and includes habitat within the Northwest Territories; the transboundary effects that cross jurisdictional boundaries are accounted for in the cumulative effects assessment for grey wolf – all of which were rated as Not Significant. Thus the overall transboundary effect on grey wolf is anticipated to be Not Significant.

## 8.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC wolverine and grey wolf. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including wolverine and grey wolf. Mitigation measures specific to wolverine and grey wolf are listed in Section 8.5.3 and summarized in Table 8.8-1 in Section 8.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including wolverine and grey wolf. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2 — the Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1 — the Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7 — the Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

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

- Risk Management and Emergency Response Plan: Chapter 3;
- Fuel Management Plan: Chapter 4;
- Spill Contingency Plans: Chapter 5;
- Oil Pollution Emergency Plan: Chapter 6;
- Site Water Monitoring and Management Plan: Chapter 7;
- Ore Storage Management Plan: Chapter 8;
- Mine Waste Rock and Tailings Management Plan: Chapter 9;

- Landfill and Waste Management Plan: Chapter 10;
- Hazardous Materials Management Plan: Chapter 12;
- Explosive Management Plan: Chapter 13;
- Road Management Plan: Chapter 14;
- Shipping Management Plan: Chapter 15;
- Borrow Pits and Quarry Management Plan: Chapter 16;
- Fish Offsetting Plan: Chapter 21;
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22;
- Socio-economic Monitoring Plan: Chapter 23; and
- Mine Closure and Reclamation Plan: Chapter 29.

### 8.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of wolverine and grey wolf dens. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of the PDAs after the redesign of Project elements. Table 8.8-1 in Section 8.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on wolverines and grey wolves.

### 8.8.2 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes eight separate plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to wolverine and grey wolf are listed in Section 8.5.3, and listed in Table 8.8-1 in Section 8.8.5.

### 8.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or

- if results from the Wildlife Monitoring Program, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

### 8.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

### 8.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 8.8-1 includes all planned mitigation and adaptive management measures that may be applicable to mitigate the effects of the Project on wolverine and grey wolf.

**Table 8.8-1. Summary of Mitigation and Management Measures Applicable to Wolverine and Furbearers (Grey Wolf)**

| Mitigation Category | Mitigation Measures |
|---|---|
| 1. Mitigation by Project Design | 1. Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas.<br>2. Infrastructure designed to minimize the Project footprint.<br>3. Consideration of the location of the stockpiles and windbreaks to minimize dust fall.<br>4. Infrastructure, waste rock storage areas, and the TIA at the Goose and George Properties confined to the local watersheds where the deposits are located.<br>5. Winter road access corridors proposed (no all-weather roads for re-supply routes or between the Goose and George Properties).<br>6. Winter roads designed to avoid known wolverine and furbearer dens within 1 km of the proposed alignment.<br>7. Underground mining used, where possible, to reduce noise emitted by the Project for excavating and hauling waste rock.<br>8. Infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities.<br>9. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination.<br>10. Buildings designed and maintained to exclude wildlife.<br>11. WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA. |
| 2. Best Management Practices | 1. Pre-construction ground clearing will be conducted outside of sensitive periods for wildlife, where possible.<br>2. Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats.<br>3. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed. |

*(continued)*

**Table 8.8-1. Summary of Mitigation and Management Measures Applicable to Wolverine and Furbearers (Grey Wolf) (continued)**

| Mitigation Category | Mitigation Measures |
|---|---|
| 2. Best Management Practices *(cont'd)* | 4. Vehicles restricted to site roads, winter roads and quarry footprints during construction and operations and not permitted on winter road corridors outside of the frozen ground period between December and April.<br>5. Truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits.<br>6. Wildlife given the right-of-way on all roads at all times.<br>7. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance.<br>8. A policy prohibiting hunting by Project employees and contractors while on site.<br>9. Berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury.<br>10. A waste and wildlife attractant management protocol will be developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants.<br>11. Wildlife-proof receptacles used for all waste and wildlife attractants, where possible.<br>12. The use of wildlife-attracting dust suppressants avoided, where possible.<br>13. A policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced.<br>14. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.<br>15. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers.<br>16. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife.<br>17. Participation by all contractors and employees working on the Project in the Employee Wildlife Education Program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation. |
| 3. Adaptive Management | 1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:<br>• if negative wildlife interactions become a concern, or<br>• if results from the WMMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.<br>2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies. |

*(continued)*

**Table 8.8-1. Summary of Mitigation and Management Measures Applicable to Wolverine and Furbearers (Grey Wolf) (completed)**

| Mitigation Category | Mitigation Measures |
|---|---|
| 4. Monitoring | |
| | Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This plan may include:<br>1. Footprint monitoring to monitor habitat loss.<br>2. Noise monitoring to monitor disturbance to wildlife.<br>3. Human activity monitoring of Project site roads and winter roads.<br>4. Waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes.<br>5. Fence and skirting monitoring to ensure that fences are operational and effective at excluding wildlife without causing them harm.<br>6. Wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions.<br>7. Incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible.<br>Focal-species monitoring program to monitor Project-related effects on wolverine and furbearers including:<br>1. A monitoring program for wolverine and furbearer dens including wolves and foxes.<br>2. Incidental reporting of wildlife to record wolverine and furbearer activity in the wildlife RSA. |

## 8.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

Facility-specific monitoring is designed to:

- Monitor wildlife interactions with Project Infrastructure;
- Monitor mitigation actions and their efficacy; and
- Identify opportunities for adaptive management.

Focal-species monitoring is designed to:

- evaluate impact predictions in the effects assessment;
- continuously reduce uncertainty of Project effects on wildlife; and
- collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to wolverine and grey wolf are summarized in the following sections.

### 8.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife, as discussed in the DEIS. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented.

Facilities that will be monitored for wildlife effects include:

- project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property and George Property;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20):

- footprint monitoring;
- noise monitoring;
- human activity monitoring;
- pit and quarry wall nest monitoring;
- waste management monitoring;
- skirting/fencing monitoring;
- wildlife-vehicle interactions monitoring;
- on-ice monitoring at the MLA; and
- incidental wildlife monitoring.

The objective of the waste management monitoring is to reduce the effects of attraction to wolverine and other wildlife. Waste disposal facilities will be monitored frequently to ensure that wastes are being properly disposed of. Waste facilities will be inspected for signs of wildlife activity (e.g., chew marks on waste, wildlife mediated waste dispersion, wildlife scat or tracks). Any incidents where wildlife have been observed to interact directly with wastes, or observations of habituated wildlife (particularly bears and wolverine) will be reported to Project Environment Team and the Department of Environment, Nunavut. Problem wildlife will be evaluated by Environment Team and corrective measures implemented in consultation with the Nunavut Department of Environment.

### 8.9.2 Focal-species Monitoring

The focal-species monitoring program is proposed to include monitoring wolverine and furbearers by remote motion-triggered cameras. Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013d, Appendix V5-5C). Wolverines and furbearers along with other wildlife are often recorded by these cameras. The use of remote cameras for annual monitoring of caribou is currently proposed for the WEMP (Section 8.3.1.3).

Incidental observations of wolverines and furbearers detected by remote camera along with incidental observations during other wildlife monitoring surveys will continue to be recorded.

The four objectives of this monitoring program are to:

1. Monitor the Project site to examine how wolverine and furbearers interact with Project facilities (e.g., on roads, pits).
2. Monitor the Project site at areas with and without mitigation structures or activities to evaluate the efficacy of mitigation activities (e.g., in areas with dust vs. without).
3. Monitor areas identified as important for wolverines and wolves from land user knowledge (e.g., eskers) and at points with high number of wolverine identified during baseline surveys (e.g., the habitat along the shoreline of Bathurst Inlet near the MLA).
4. Record the times at which wolverine use the wildlife RSA during the year.

Methods for data management and analysis will follow those for caribou (Volume 10, Chapter 20; Section 8.3.1 of WMMP Plan).

## 8.10 IMPACT STATEMENT

A review of the Project activities identified eight potential effects that may occur due to the Construction and Operational phases of the Project for furbearers (wolverine and grey wolf). These eight potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct and indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other proposed effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of wolverine and furbearers (grey wolves) was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on furbearers resulted in the evaluation of four potential effects as likely having residual effects for wolverine after mitigation: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity, and two potential effects likely having residual effects for grey wolf after mitigation: habitat loss and disturbance due to noise. Each of these effects are rated with a low magnitude and are rated as Not Significant, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20).

The residual effect which could have the largest effect on the population is attributed to reduction in reproduction, which may occur due to a number of other potential or residual effects interacting with one another. However, the overall likelihood of a reduction in reproductively in wolverine is low because of the high availability of habitat of varying quality outside of the influence of the Project. It is not expected that wolverine will be displaced into lower quality habitats as a result of the Project. Displacement could lead to lower productivity due to stress or reduced foraging success, particularly during sensitive periods such as denning.

A cumulative effects assessment was conducted because residual Project effects were predicted and other projects occur within the movement area defined for wolverine and grey wolf that interact with the Project. For wolverine, four potential cumulative effects were evaluated for the cumulative effects assessment: habitat loss, disturbance due to noise, attraction and reproductive productivity. For the grey wolf, two potential cumulative effects were evaluated: habitat loss and disturbance due to noise. Key indicators were calculated for potential effects where data were available and residual cumulative effects were predicted for all potential effects. Each residual cumulative effect was rated by using threshold values and determined to have a low magnitude effect on the wolverine and grey wolf populations within their respective cumulative effects assessment areas.

It is anticipated that all projects within the CEA boundary will likely have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on wolverines in the CEA boundary. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on grey wolves in the CEA boundary.

The overall effect of the Project on the VEC furbearers is rated as **Not Significant**.

# 9. Migratory Birds (Upland Birds and Waterfowl)

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# 9. Migratory Birds (Upland Birds and Waterbirds)

## 9.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 9.1.1 Introduction

With the exception of a few species, the majority of bird species that breed in the Arctic migrate long distances between their summer range on the tundra, and their winter ranges at southern latitudes. For the purposes of this assessment, migratory birds are divided into three groups — waterbirds, upland birds, and seabirds. Potential effects on waterbirds and upland birds within the terrestrial wildlife Regional Study Area (RSA) of the Back River Project (the Project) are addressed in this chapter. Waterbirds are defined as birds that primarily forage within waterbodies. The Arctic waterbird community is comprised of geese and the tundra swan, several species of dabbling and diving ducks, gulls and the Arctic tern, four species of loons, and the sandhill crane. Some waterbird species such as greater scaup also use marine habitats during some portion of the breeding season. Potential interactions between the Project and waterbirds that use coastal habitats within the wildlife marine RSA are addressed in Volume 7, Chapter 6 (Seabirds/Seaducks). Upland birds are defined as birds that primarily forage and nest in upland areas (i.e., not waterbirds). The Arctic upland bird community is comprised of songbirds, shorebirds, ptarmigan, and jaegers.

Baseline studies confirmed that at least 25 waterbird species and 27 upland bird species occur within the wildlife Regional Study Area (RSA) during migration and breeding. Of these species, 17 waterbird and 24 upland bird species were identified as species that regularly occur within the wildlife RSA during the breeding season or during migration (Rescan 2012b, Appendix V5-5D; Rescan 2013c, Appendix V5-5C; Rescan 2014).

Willow and rock ptarmigan are the only upland birds that overwinter on the tundra. Some raptors overwinter on the tundra as well, which are discussed in Volume 5, Chapter 10. Ptarmigan are year-round residents on the tundra, although some ptarmigan migrate relatively short distances depending on weather conditions (e.g. Holder and Montgomerie 1993; S. J. Hannon, P. K. Eason, and K. Martin 1998). Ptarmigan are included in this assessment of Project effects on migratory birds because ptarmigan and their eggs are an important food source to Inuit communities (KIA 2012a).

### 9.1.2 Population Trends and Conservation

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994), which prohibits killing migratory birds and their eggs, taking their nests, and also prohibits the deposition of harmful substances in waters or areas frequented by migratory birds. In addition, migratory birds and ptarmigan in Nunavut are protected under the Nunavut *Wildlife Act* (2003), which prohibits destruction of bird nests when these are being used by birds, and prohibits disturbance to a "substantial number" of birds, such as to flocks of waterbirds during spring and fall staging.

With the exception of the red knot, no species of migratory bird occurring in the wildlife RSA is legally listed as a species of conservation concern under the federal *Species at Risk Act* (SARA; 2002). The red knot subspecies *rufa* is listed on Schedule 1 of SARA as "Endangered." It was not recorded during baseline surveys, possibly because it migrates in low numbers making it difficult to detect.

Because of the difficulty in conducting standardized surveys over the vast area of the Arctic, regional estimates of population trends are not available for most species of migratory birds that breed in the

Arctic (NABCI 2012). However, population trends have been estimated for some populations from counts of birds during their migration and on wintering grounds; the magnitude of trends are less certain. Regulatory organizations that track and assign conservation status based on population trend and other criteria include the North American Waterbird Conservation Plan (Kushlan et al. 2002), the North American Waterfowl Management Plan (North American Waterfowl Management Plan (NAWMP) 2004), Partners in Flight Upland bird Conservation Plan (Berlanga et al. 2010), and the Canadian Shorebird Conservation Plan (Donaldson et al. 2004).

The conservation status of migratory birds in Nunavut has been assigned by the Canadian Endangered Species Conservation Council (CESCC). Species designated as "Sensitive" by CESCC rankings are species that may require special attention to prevent population declines (CESCC 2010). CESCC rankings for species in Nunavut are administered by the Government of Nunavut, Department of Environment, and are currently in draft form until future review by the Nunavut Wildlife Management Board. These designations were used in this report to identify migratory bird species of conservation concern that occur within the wildlife RSA.

#### *9.1.2.1 Waterbirds*

Five waterbird species that occur in the wildlife RSA show declining population trends: lesser scaup, northern pintail, long-tailed duck, red-throated loon, and the Arctic tern (Kushlan et al. 2002; NAWMP 2004; Conant, Roetker, and Groves 2006). In addition, the yellow-billed loon has been identified as a species of concern because it is rare, and there are insufficient data to estimate population trends (S. Earnst et al. 2005). The following three waterbird species are listed as 'Sensitive' under the CESCC designations for Nunavut: Arctic tern, glaucous gull, and long-tailed duck (CESCC 2010).

Arctic populations of geese and the tundra swan have generally remained stable or have increased in abundance (CWS 2011). Populations of Canada geese have increased an average of 7% per year since 1998 on the mainland of the Northwest Territories (USF WS 2006).

#### *9.1.2.2 Upland Birds*

Ten upland bird species that regularly occur in the wildlife RSA are listed as "Sensitive" under the CESCC designations for Nunavut: American golden plover, least sandpiper, red-necked phalarope, red phalarope, semipalmated sandpiper, American pipit, American tree sparrow, Harris's sparrow, hoary redpoll, and white-crowned sparrow. Of the 11 shorebird species that regularly occur within the wildlife RSA, data suggest a declining global population for all species except the semipalmated plover and stilt sandpiper (Morrison et al. 2006). Of the 15 songbird species that regularly breed in the wildlife RSA, data show large scale population decline for two of these species: Harris's sparrow and horned lark (Berlanga et al. 2010) The breeding range of the Harris's sparrow is small and restricted entirely to Canada.

At local scales, populations of upland birds naturally fluctuate due to food availability, weather, and predation rates. For example, redpolls declined by 90% in 2009 near Daring Lake due to low production of birch seeds in 2008; the population recovered by 2010 (Obst 2011). Heavy snow cover late into the season can result in poor breeding (Latour, Machtans, and Beyersbergen 2005). Upland birds and their eggs and young are prey for raptors, especially the gyrfalcon and peregrine falcon, and for mammals, especially red and Arctic foxes (White et al. 2002; Samelius et al. 2007; Barichello and Mossop 2011). A recent study has found correlations in bird abundance among species preyed upon by foxes (McKinnon et al. 2013). In years of low lemming abundance, a preferred prey of Arctic fox, predation on geese nests and nearby artificial shorebird nests was high. These results suggest that local upland bird population size may be linked to lemming abundance, mediated by the predation behaviour of mutual predators, especially red and Arctic foxes (McKinnon et al. 2013).

### 9.1.3 Distribution and Migration Patterns

Migratory birds arrive on the Arctic tundra from their winter ranges in the south from early to late May, and depart again in the fall, usually in late August and throughout September. Migration occurs through a series of relatively rapid movements between staging areas, where birds spend days to several weeks foraging to "refuel" (Mallory et al. 2006).

#### *9.1.3.1 Waterbirds*

Some waterbird species such as long-tailed ducks, yellow-billed loons, Canada and greater white-fronted geese nest on inland waterbodies and wetlands across the Arctic tundra, while other species such as the red-throated loon are found at highest densities along coastlines (Derksen, Rothe, and Eldridge 1981; Conkin and Alisauskas 2013). Most Arctic streams, ponds, and lakes, including those within the Project area, are relatively nutrient poor (Rescan 2012a); wetlands tend to be more productive and nutrient rich (Rescan 2012c). Thus, waterbirds tend to be patchily distributed across the Arctic tundra, according to the productivity of waterbodies and the patchy distribution of wetlands (Conkin and Alisauskas 2013). Both scientific and Inuit Traditional Knowledge report that Arctic waterbirds nest at higher densities in large wetlands (KIA 2012a; Conkin and Alisauskas 2013).

Waterbirds can spend up to 50% of the year migrating between wintering and breeding areas, and up to 95% of migration at staging areas; thus staging areas are considered key habitats necessary to sustain populations (Petrie and Wilcox 2003). Species such as the long-tailed duck and red-breasted merganser, all of the loon species, and the glaucous gull stage at coastal sites on the ocean that become ice-free early in the spring (Dickson and Gilchrist 2002). These sites were important waterbird hunting areas for Inuit (KIA 2012a). Both scientific and Inuit Traditional Knowledge show that inland waterbodies that become ice-free relatively early are important staging areas for waterbirds. Such areas include shallow lakes and rivers with fast-flowing water (KIA 2012a).

Spring arrival to Arctic breeding grounds is earlier (early to mid-May) for the larger-bodied waterbirds, an observation that is consistent with Inuit TK of the Kitikmeot region (KIA 2012a). The smaller-bodied waterbirds, like loons and ducks arrive later, in late May to early June. Breeding occurs soon after the birds arrive on the tundra and brooding of young occurs from late June to mid-September.

Most waterbird species moult their breeding plumage during or just after breeding. The timing of moulting varies across species, gender, and reproductive status. Typically, waterbirds that are not engaged in the care of eggs or young — males of uniparental species, non-breeders, and failed breeders — congregate to moult during the incubation stage and onward (S. R. Johnson and Richardson 1982). Dabbling ducks gather in local wetlands near nesting sites, but geese, swans, seaducks and scaup usually migrate to traditional moulting areas, sometimes up to hundreds of kilometers from breeding sites (Derksen, Rothe, and Eldridge 1981; Reed et al. 2003; Larned, Stehn, and Platte 2012). Scaups use shallow, non-turbid, wind and wave sheltered coastal areas with abundant forage, such as lagoons and bays (Dickson and Gilchrist 2002; Fischer and Larned 2004). Birds are flightless for several weeks while moulting their flight feathers; though flightless, birds are capable of swimming more than 15 km between coastal moulting sites (Flint et al. 2004). Birds typically congregate at fall staging sites prior to southward migration, though these are typically smaller congregations than those that occur during spring migration (Dickson and Gilchrist 2002).

#### *9.1.3.2 Upland Birds*

With the exception of ptarmigan, upland birds breeding within the Kitikmeot region are migratory and winter in areas extending from the treeline to the southern tip of South America. The Arctic tern migrates to the Antarctic. The willow and rock ptarmigan make only short local migrations depending

on weather conditions, but are otherwise resident species that over-winter on the tundra (S. J. Hannon, P. K. Eason, and K. Martin 1998; Montgomerie and Holder 2008; KIA 2012a).

Upland bird species begin to arrive on the Arctic tundra to breed in late May, coincident with the emergence of insects. The exceptions to this timing include the seed-eating horned lark and hoary redpoll which arrive in early and mid-May. Most females initiate clutches in early June, which they incubate for about 10 days. Parents feed nestlings for a period for 10 to 15 days, thus fledging usually occurs by late July. Parents tend to fledglings for about two weeks, and migration occurs shortly thereafter. By mid-September most upland birds have migrated south; by October all migratory birds except ptarmigan have left the tundra (Obst 2011).

During the breeding season from May to October, the upland bird community is broadly distributed across the Arctic such that almost every hectare of tundra supports at least one individual.

### 9.1.4 Habitat Use and Diet

#### *9.1.4.1 Waterbirds*

The Arctic provides breeding habitat for one-third of the world's waterbird population, including two-thirds of all geese (Zöckler 1998). The habitat preferences of waterbirds during the breeding season correspond to their diets. For example, the common loon and yellow-billed loon feed almost entirely on fish, and thus select large, deep lakes for nesting, probably because these tend not to freeze to the bottom, ensuring the over-winter survival of fish (S. L. Earnst, Platte, and Bond 2006). Dabbling ducks, such as the northern pintail and green-winged teal, forage on aquatic seeds, plants, and invertebrates, and thus are found in shallow wetlands where this forage is abundant (Austin and Miller 1995; Robertson and Savard 2002). Geese and the tundra swans graze on both terrestrial and aquatic plants and geese feed on berries later in the season (Cadieux, Gauthier, and Hughes 2005), which explains their frequent detections using upland heath tundra during moulting and staging (Rescan 2013c, Appendix V5-5C). Inuit in the Kitikmeot region have also reported that Canada geese feed on berries (KIA 2012a).

Waterbirds typically nest in habitat that provides protection from predators, and thus often nest within approximately 100 m of water, and on small mid-water islands since these offer protection from terrestrial predators (Sovada, Anthony, and Batt 2001). Inuit TK of the Kitikmeot region includes observations of waterbirds nesting on mid-stream islands and on cliffs (KIA 2012a). Geese nest in flooded wetlands adjacent to large water bodies, which provide escape from terrestrial predators (Bart and Earnst 1991; Stickney et al. 2002). Some waterbird species, especially geese, nest on cliffs near nesting raptors where they receive protection from mutual nest predators (Bety et al. 2001). Because they are unable to walk on land, loon nests are always in emergent vegetation within 1 to 2 m of water. Individuals of many species of waterbirds exhibit fidelity to their nest sites and territories from year-to-year (Anderson, Rhymer, and Rohwer 1992).

#### *9.1.4.2 Upland Birds*

The upland bird community in most Arctic regions is dominated by songbirds, which occur up to six times more abundantly than shorebirds (Andres 2006). The Lapland longspur consistently has been found to be the most common upland bird, occurring up to three times more commonly than other upland bird species (V. H. Johnson, Gratto-Trevor, and Pepper 2000; Latour, Machtans, and Beyersbergen 2005; Andres 2006; Rescan 2013c, Appendix V5-5C). The Lapland longspur is unique among Arctic upland birds in its relatively ubiquitous use of a wide variety of habitats across the tundra. Consistent among studies conducted across the Arctic, habitat associations of the majority of

upland bird species are highly influenced by preferences for vegetation communities, which in turn are structured by the moisture regime (Brown et al. 2007; Ashenhurst and Hannon 2008).

The majority of species show preference for either moist to wet or dry vegetation communities for nesting. Upland bird species associated with moist to wet vegetation communities include the Savannah sparrow, the majority of shorebird species, and the willow ptarmigan. Species associated with dry upland heath and rocky tundra include the American pipit, Harris's sparrow, horned lark, American golden plover, and rock ptarmigan (Latour, Machtans, and Beyersbergen 2005; Brown et al. 2007; Liebezeit, White, and Zack 2011). Rock ptarmigan generally avoid shrubs during breeding, preferring dry heath tundra, whereas willow ptarmigan tend to select sites in moist areas with dense shrubs (Wilson and Martin 2008).

Across the Arctic, upland birds are more abundant and diverse in lowlands, which are usually dominated by moist to wet sedge meadows (V. H. Johnson, Gratto-Trevor, and Pepper 2000; Latour, Machtans, and Beyersbergen 2005; Liebezeit, White, and Zack 2011). Most shorebird species prefer moist to wet lowland sites (Brown et al. 2007; Liebezeit, White, and Zack 2011), but some do not — the American golden plover has been found at higher abundance in dry upland areas (Latour, Machtans, and Beyersbergen 2005; Rescan 2013c, Appendix V5-5C). Some species like the red phalarope and red-necked phalarope are generally confined to wetlands (Latour, Machtans, and Beyersbergen 2005; Brown et al. 2007; Ashenhurst and Hannon 2008), but most species do not confine their use of habitats to only wet or only dry areas. For example, though the American golden plover prefers to nest in dry upland areas, it forages at least some of the time in nearby wetlands (O. W. Johnson and Connors 2010). Thus, though lowlands typically support more upland birds, the upland bird community uses a mosaic of habitat types across the full moisture regime from dry to wet.

In addition to the moisture regime, the height of tundra vegetation provides another major gradient across which upland birds show preference. A third upland bird community can be distinguished where shrubs are tall enough to provide vertical habitat, which is primarily within riparian corridors (Rescan 2007). Tall riparian shrubs occur relatively rarely across the tundra, but provide habitat for a diverse bird community. Breeding habitat for two species, the yellow warbler and grey-cheeked thrush, appears to be restricted to riparian corridors across the Arctic (Wolfden Resources Inc. 2006). The wildlife LSA contains just 440 ha (0.33% of the wildlife LSA) of tall riparian shrubs, all of which occur in the marine-influenced areas at Bathurst Inlet (Volume 5, Chapter 4).

Almost all species of upland birds, even those that forage primarily on vegetation, feed on invertebrates during some stage of the nesting cycle (Tulp and Schekkerman 2008). For example, ptarmigan feed mostly on buds, leaves, and twigs of ericaceous shrubs, but protein-rich insects are important for clutch formation in egg-laying females and for the growth of young (S. J. Hannon, P. K. Eason, and K. M. Martin 1998). Invertebrates are a critical food resource for upland birds, and thus the timing of arrival and of egg-hatching is synchronized with the emergence of insects in spring. The breeding productivity of Arctic birds has been found to be negatively impacted by climate change, which has caused variability in the timing of insect emergence (Both et al. 2010).

### 9.1.5 Baseline Data for Migratory Birds

To generate baseline data on migratory birds, waterbirds were surveyed from helicopter, and both waterbirds and upland birds were surveyed from the ground. Incidental observations were also collected to confirm the presence of species within the wildlife RSA that were not detected during surveys.

Specific sources of baseline terrestrial wildlife information used in this section include the following reports:

- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012b; Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013c; Appendix V5-5C); and
- *Back River Project*: *2013 Wildlife Baseline Report* (Rescan 2014).

Results from the 2013 wildlife baseline program will be available in 2014.

Other sources of supplementary wildlife data used in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012b);
- *Field Report — Back River Project: Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008);
- *Bathurst Inlet Port and Road Project*: *Wildlife Baseline Studies, 2001-2002* (Rescan 2002);
- *Bathurst Inlet Port and Road Project*: *Wildlife Songbird and Shorebird Baseline Study, 2007* (Rescan 2007);
- *Bathurst Inlet Port and Road Project*: *Upland Breeding Birds Baseline Study, 2012* (Rescan 2012d); and
- *Hackett River Project: Wildlife Baseline Report 2008* (Rescan 2008).

### *9.1.5.1 Waterbirds*

Methods for Baseline Data Collection

Aerial and ground surveys for waterbirds were conducted in 2011 to 2013. To provide pre-development data while controlling for natural variability in bird distribution, waterbirds were surveyed within a focus survey block centred on each of the PDAs and the MLA, and in an adjacent reference survey block. In 2011, a focus and reference survey block was surveyed around the Goose Property PDA in the southern portion of the wildlife RSA (Figure 9.1-1a and b). In 2012, focus and reference survey blocks were surveyed around the George and Goose Property PDAs. In 2013, aerial surveys for waterbirds were conducted within focus and reference survey blocks near the MLA during the spring, summer, and fall periods (Figure 9.1-2). Aerial surveys followed established protocols created by the Canadian Wildlife Service (CWS) and the United States Fish and Wildlife Service (CWS and USFWS 1987). Across the three years, at least one survey was conducted during the spring migration, pre-incubation, early brooding, and fall migration stages. Ground surveys for nests were conducted in 2011 within 100 m of the shoreline at Bathurst Inlet. Migratory bird species that regularly occur within the wildlife RSA were identified from species' range maps, and the timing and frequency of detections during baseline surveys (Table 9.1-1).

Results of Baseline Data Collection

During baseline studies, 13 of the 17 waterbird species that regularly occur within the wildlife RSA were observed throughout the breeding season during aerial surveys: Canada and greater white-fronted geese, pacific, red-throated, and yellow-billed loon, greater scaup, long-tailed duck, red-breasted merganser, northern pintail, Arctic tern, glaucous and herring gull, and sandhill crane (Tables 9.1-1 and 9.1-2). In addition to the tundra swan and green-winged teal which were observed infrequently, and brant and snow geese which were observed during migration only, these 17 species comprise the typical waterbird community of the Kitikmeot region. Eight additional species were observed infrequently and mostly incidentally—the gadwall, northern shoveler, mallard, lesser scaup, and common loon during breeding, and the white-winged scoter, surf scoter, and black scoter during migration (Table 9.1-1).

PROJECT # 0194096-0040 GIS # BAC-23-263a November 29 2013

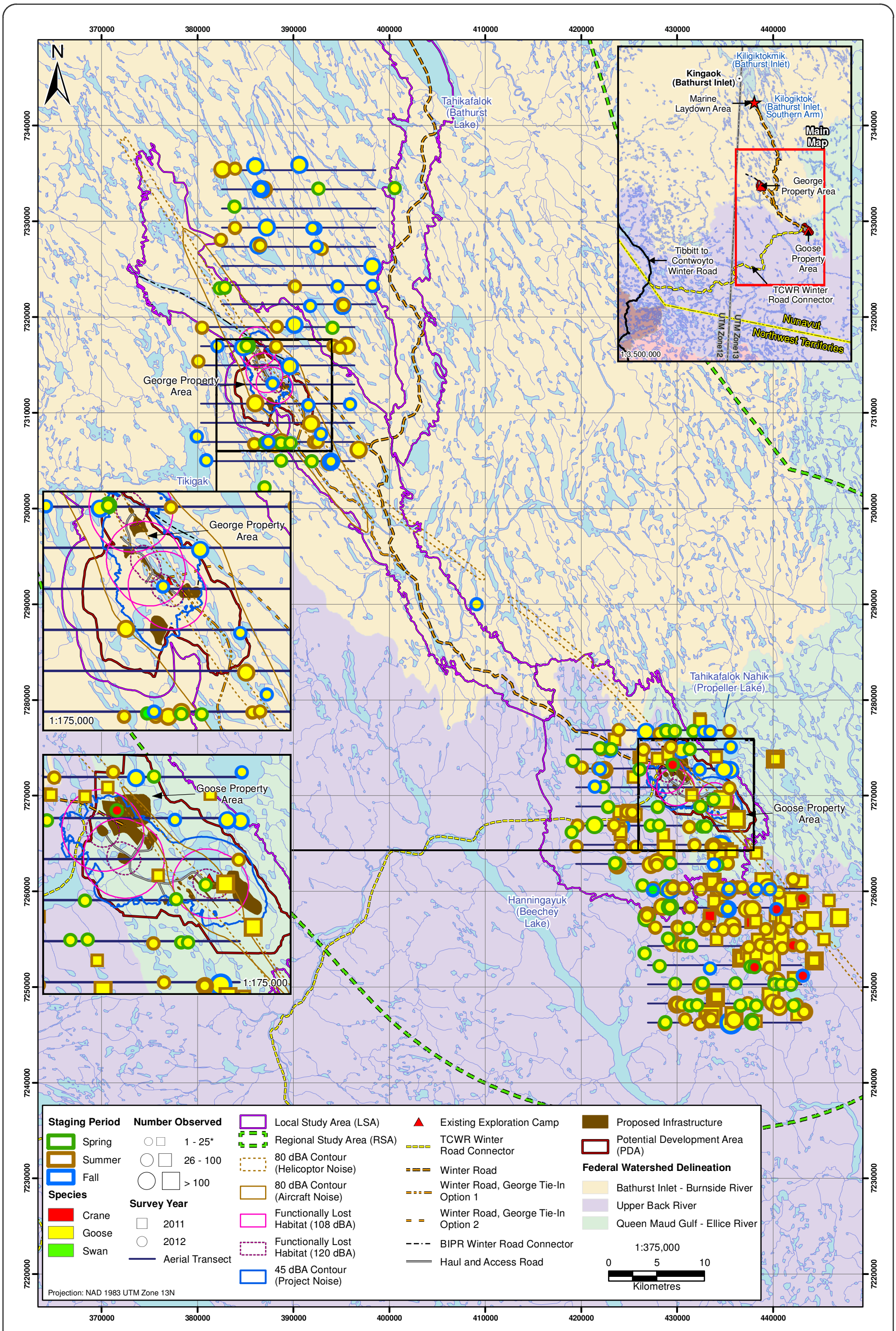


Figure 9.1-1a

Sabina GOLD & SILVER CORP.

# Geese, Cranes, and Swans Observed Near the George and Goose Property Areas during Aerial Surveys in 2011 and 2012

Figure 9.1-1a

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-263b December 18 2013

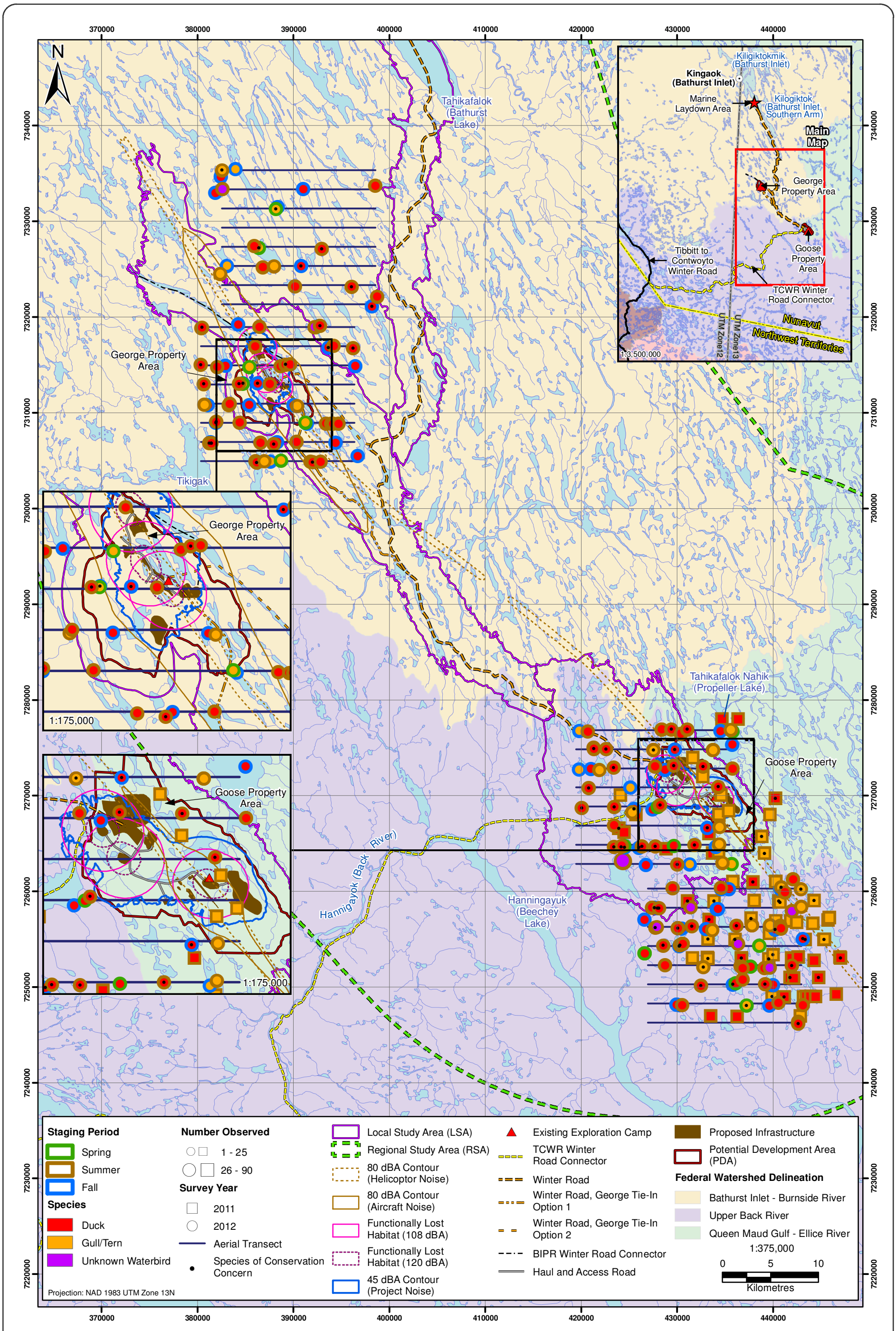


Figure 9.1-1b

Sabina GOLD & SILVER CORP.

# Ducks, Gulls, and Terns Observed Near the George and Goose Property Areas during Aerial Surveys in 2011 and 2012

Figure 9.1-1b

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-252 December 18 2013

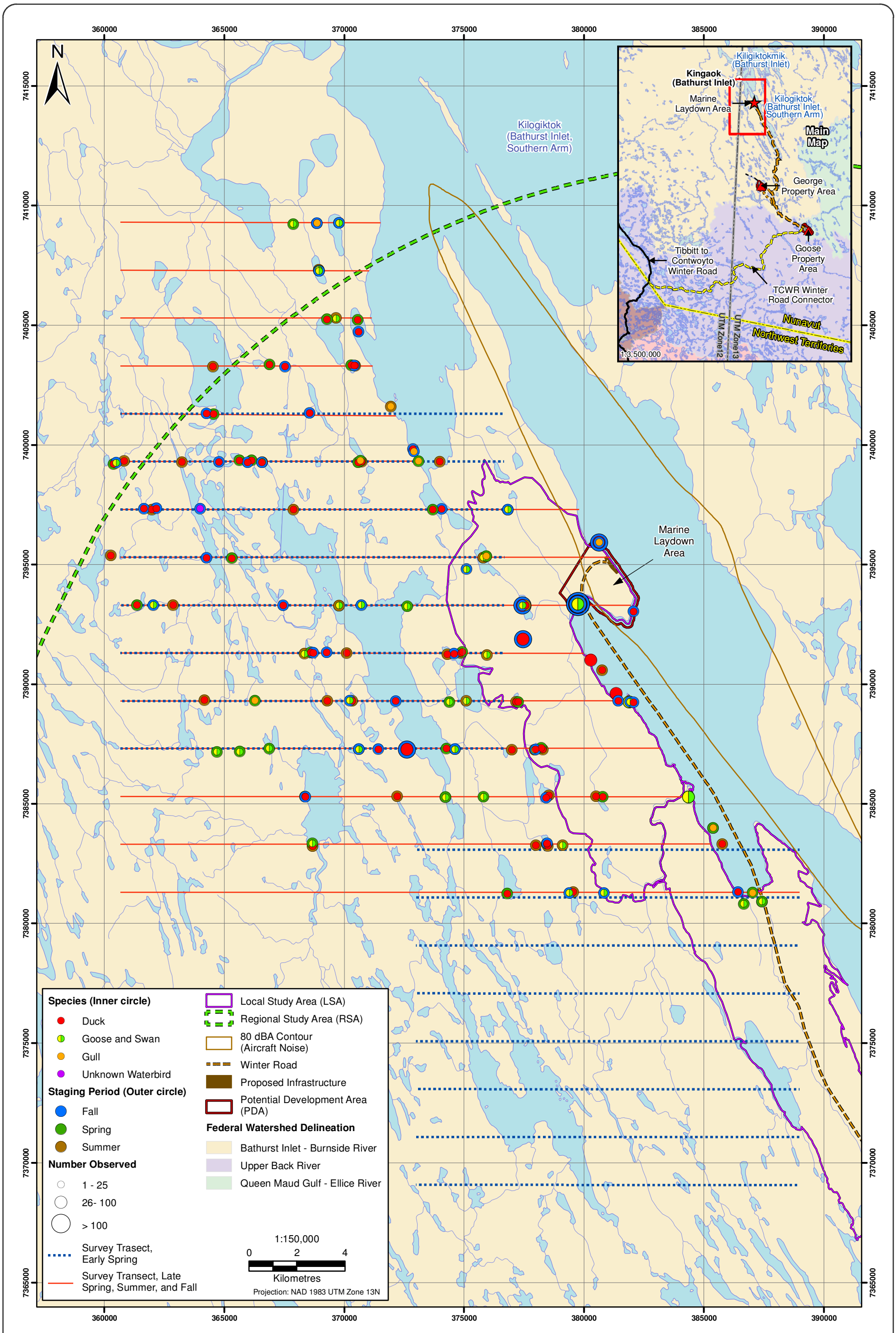


Figure 9.1-2

Sabina GOLD & SILVER CORP.

# Waterbirds Observed near the Marine Laydown Area during Aerial Surveys in 2013

Figure 9.1-2

Rescan an ERM company

**Table 9.1-1. Regularity and Timing of Occurrence of Migratory Bird Species in the Wildlife RSA**

| Common Name | Scientific Name | Group | Sub-group | Regularity of Occurrence | Detected during Baseline Studies | Timing of Occurrence | Conservation Status | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Terr. Rank | COSEWIC | SARA | Global Rank | IUCN Red List |
| American Golden-Plover | *Pluvialis dominica* | Upland Bird | Shorebird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Semipalmated Plover | *Charadrius semipalmatus* | Upland Bird | Shorebird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Least Sandpiper | *Calidris minutilla* | Upland Bird | Shorebird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Semipalmated Sandpiper | *Calidris pusilla* | Upland Bird | Shorebird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Red-necked Phalarope | *Phalaropus lobatus* | Upland Bird | Shorebird | Regular | Y | Breeding | Sensitive | | | G4G5 | Least Concern |
| Wilson's snipe | *Gallinago delicata* | Upland Bird | Shorebird | Regular | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Pectoral Sandpiper | *Calidris melanotos* | Upland Bird | Shorebird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Stilt Sandpiper | *Calidris himantopus* | Upland Bird | Shorebird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Long-tailed Jaeger | *Stercorarius longicaudus* | Upland Bird | Jaeger | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Parasitic Jaeger | *Stercorarius parasiticus* | Upland Bird | Jaeger | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| White-rumped Sandpiper | *Calidris fuscicollis* | Upland Bird | Shorebird | Regular | N | Migrant | Secure | | | G5 | Least Concern |
| Buff-breasted Sandpiper | *Tryngites subruficollis* | Upland Bird | Shorebird | Regular | N | Migrant | Sensitive | | | G4 | Near threatened |
| Red Phalarope | *Phalaropus fulicaria* | Upland Bird | Shorebird | Regular | N | Migrant | Sensitive | | | G5 | Least Concern |
| Baird's Sandpiper | *Calidris bairdii* | Upland Bird | Shorebird | Rare | Y | Breeding | Secure | | | G5 | Least Concern |
| Lesser Yellowlegs | *Tringa flavipes* | Upland Bird | Shorebird | Rare | N | Breeding | Undetermined | | | G5 | Least Concern |
| Ruddy Turnstone | *Arenaria interpres* | Upland Bird | Shorebird | Rare | N | Migrant | Sensitive | | | G5 | Least Concern |
| Red Knot | *Calidris canutus* | Upland Bird | Shorebird | Rare | N | Migrant | At Risk | EN/SC | | G4 | Least Concern |
| Sanderling | *Calidris alba* | Upland Bird | Shorebird | Rare | N | Migrant | Sensitive | | | G5 | Least Concern |
| Pomarine Jaeger | *Stercorarius pomarinus* | Upland Bird | Jaeger | Rare | N | Migrant | Secure | | | G5 | Least Concern |
| Horned Lark | *Eremophila alpestris* | Upland Bird | Songbird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Gray-cheeked Thrush | *Catharus minimus* | Upland Bird | Songbird | Regular | Y | Breeding | Undetermined | | | G5 | Least Concern |
| American Pipit | *Anthus rubescens* | Upland Bird | Songbird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| American Tree Sparrow | *Spizella arborea* | Upland Bird | Songbird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Savannah Sparrow | *Passerculus sandwichensis* | Upland Bird | Songbird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| White-crowned Sparrow | *Zonotrichia leucophrys* | Upland Bird | Songbird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Harris's Sparrow | *Zonotrichia querula* | Upland Bird | Songbird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Lapland Longspur | *Calcarius lapponicus* | Upland Bird | Songbird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Snow Bunting* | *Plectrophenax nivalis* | Upland Bird | Songbird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Common Redpoll | *Carduelis flammea* | Upland Bird | Songbird | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Hoary Redpoll | *Carduelis hornemanni* | Upland Bird | Songbird | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Yellow Warbler | *Setophaga petechia* | Upland Bird | Songbird | Regular | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Willow Ptarmigan | *Lagopus lagopus* | Upland Bird | Game Bird | Regular | Y | Resident | Secure | | | G5 | Least Concern |
| Rock Ptarmigan | *Lagopus muta* | Upland Bird | Game Bird | Regular | Y | Resident | Secure | | | G5 | Least Concern |
| Smith's Longspur | *Calcarius pictus* | Upland Bird | Songbird | Rare | N | Breeding | Secure | | | G5 | Least Concern |
| American Robin* | *Turdus migratorius* | Upland Bird | Songbird | Rare | Y | Breeding | Secure | | | G5 | Least Concern |
| Cliff Swallow* | *Petrochelidon phyrrhonota* | Upland Bird | Songbird | Rare | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Yellow-billed Loon | *Gavia adamsii* | Waterbird | Loon | Regular | Y | Breeding | Secure | NAR | | G4 | Least Concern |
| Pacific Loon | *Gavia pacifica* | Waterbird | Loon | Regular | Y | Breeding | Secure | | | G5 | Least Concern |

*(continued)*

**Table 9.1-1. Regularity and Timing of Occurrence of Migratory Bird Species in the Wildlife RSA (completed)**

| Common Name | Scientific Name | Group | Sub-group | Regularity of Occurrence | Detected during Baseline Studies | Timing of Occurrence | Conservation Status | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Terr. Rank | COSEWIC | SARA | Global Rank | IUCN Red List |
| Red-throated Loon | *Gavia stellata* | Waterbird | Loon | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Greater White-fronted Goose | *Anser albifrons* | Waterbird | Geese and Swans | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Canada Goose | *Branta canadensis* | Waterbird | Geese and Swans | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Tundra Swan | *Cygnus columbianus* | Waterbird | Geese and Swans | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Northern Pintail | *Anas acuta* | Waterbird | Dabbling Duck | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Green-winged Teal | *Anas crecca* | Waterbird | Dabbling Duck | Regular | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Greater Scaup | *Aythya marila* | Waterbird | Diving Duck | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Long-tailed duck | *Clangula hyemalis* | Waterbird | Sea Duck | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Red-breasted Merganser | *Mergus serrator* | Waterbird | Sea Duck | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Sandhill Crane | *Grus canadensis* | Waterbird | Crane | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Herring Gull | *Larus argentatus* | Waterbird | Gulls and Terns | Regular | Y | Breeding | Secure | | | G5 | Least Concern |
| Glaucous Gull | *Larus hyperboreus* | Waterbird | Gulls and Terns | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Arctic Tern | *Sterna paradisaea* | Waterbird | Gulls and Terns | Regular | Y | Breeding | Sensitive | | | G5 | Least Concern |
| Brant* | *Branta bernicla* | Waterbird | Geese and Swans | Regular | Y | Migrant | Secure | | | G5 | Least Concern |
| Snow Goose | *Chen caerulescens* | Waterbird | Geese and Swans | Regular | Y | Migrant | Secure | | | G5 | Least Concern |
| Lesser Scaup* | *Aythya affinis* | Waterbird | Diving Duck | Rare | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Northern Shoveler* | *Anas clypeata* | Waterbird | Dabbling Duck | Rare | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Common Loon* | *Gavia immer* | Waterbird | Loon | Rare | Y | Breeding | Secure | NAR | | G5 | Least Concern |
| Mallard* | *Anas platyrhynchos* | Waterbird | Dabbling Duck | Rare | Y | Breeding | Undetermined | | | G5 | Least Concern |
| Gadwall | *Anas strepera* | Waterbird | Dabbling Duck | Rare | Y | Breeding | Accidental | | | G5 | Least Concern |
| White-winged Scoter* | *Melanitta fusca* | Waterbird | Sea Duck | Rare | Y | Migrant | Undetermined | | | G5 | Least Concern |
| Surf Scoter* | *Melanitta perspicillata* | Waterbird | Sea Duck | Rare | Y | Migrant | Undetermined | | | G5 | Least Concern |
| Black (American) Scoter | *Melanitta americana* | Waterbird | Sea Duck | Rare | Y | Migrant | Undetermined | | | G5 | Least Concern |

** Observed incidentally during baseline studies*

**Table 9.1-2. Total Number of Waterbirds Observed in the Wildlife RSA during Baseline Aerial Surveys (2011-2013)**

| | | Total Number of Individuals Observed (number of young observed in parentheses) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Near George and Goose Property PDAs | | | | | | Near MLA | | | |
| | | 2011 | | 2012 | | | | 2013 | | | |
| | Species | Early Brood | Fall Staging | Spring Staging | Pre-incubation | Early Brood | Fall Staging | Spring Staging | Pre-incubation | Early Brood | Fall Staging |
| Swans and Geese | Canada Goose | 650 | 1,125 (5) | 170 | 837 | 1,726 (24) | 1,855 | 57 | 128 | 37 | 84 |
| | Greater White-fronted Goose | 12 | 5 | 197 | 7 | 5 | | 78 | | | |
| | Snow Goose | | | 203 | | 1 | | 70 | | | 20 |
| | Tundra Swan | | | 2 | | | 2 | 2 | 7 | 14 | 25 (2) |
| | Sandhill Cranes | 1 | 1 | 1 | 1 | 1 | 2 | | | | |
| | Unknown Goose | | | 15 | | | | 20 | | 6 | 16 |
| Gulls | Arctic Tern | 21 | 14 | | 6 | 3 | | | | | |
| | Glaucous Gull | | | 9 | | | | 1 | 18 | | 3 |
| | Herring Gull | 16 | 8 | 12 | 16 | 3 | 18 | 3 | | | |
| | Unknown Gull | | 9 | | | 4 | | | | 1 | |
| Ducks and Loons | American Green-winged Teal | | | | | | | 3 | | | |
| | Black Scoter | | | | | 14 | | | | | |
| | Gadwall | 3 | | 2 | | | | | | | |
| | Greater Scaup | 10 | | | 19 | 8 | 50 | 14 | 37 | 53 | 531 |
| | Long-tailed Duck | 20 | | | 60 | 8 | 75 | 8 | 29 | 13 (4) | 16 |
| | Northern Pintail | 4 | 2 (8) | 6 | 8 | | 20 | 245 | 7 | 8 (4) | 42 (6) |
| | Pacific Loon | | 22 | | | 4 (1) | 8 | | 1 | 5 | |
| | Red-breasted Merganser | 16 | 3 | 2 | 14 | 2 | 64 | | 22 | 29 | 90 |
| | Red-throated Loon | 1 | | | | 7 | 1 | | 2 | 8 | 9 |
| | Yellow-billed Loon | | | | 2 | 4 | | | | | |
| | Unknown Duck | | 17 | 3 | 3 | 90 | 19 | | | 97 (6) | 24 |
| | Unknown Loon | | | | | | 5 | | | 4 | 1 |
| | Unknown Waterbird | | | | | 61 (4) | | | | | 8 |
| Total | | 753 | 1,205 (13) | 612 | 972 | 1,941 (29) | 2,117 | 502 | 251 | 279 (14) | 877 |

Canada geese were the most commonly observed species across all surveys, accounting for 80% to 90% of all detections. Spring surveys conducted in the wildlife RSA revealed that large flocks of geese migrate through the wildlife RSA, especially in the area of the Goose Property, which contains several large wetlands (Figure 9.1-1a). Observations of large numbers of Canada geese observed in flocks during the summer surveys (Table 9.1-2) were likely of moulting non-breeders and failed breeders, indicating that the Project area is used as a moulting site, to which failed breeders likely migrate from other areas (Section 9.1.4.1).

Counts of waterbirds in 2012 were consistently lower in the George Property Area relative to the Goose Property Area (Figure 9.1-1a and b). Counts were particularly low in the control transect block to the north of the George Property, indicating this rocky upland area consisting of shallow meltwater ponds and few wetlands provides poor habitat for waterbirds. The presence of Canada geese there during fall migration may have been because the geese were foraging on upland berries and forbs (Section 9.1.3.1).

A main objective of aerial surveys for waterbirds was to locate waterbird nesting colonies (e.g., Arctic tern) and key staging and moulting sites, identified as waterbodies that are frequently used by large numbers of waterbirds during the migration and moulting periods. Aerial surveys crossed each of the principal waterbodies in the PDAs and surrounding survey blocks. No nesting colonies of waterbirds were observed. No waterbodies were identified as key staging and moulting sites within the three PDAs. A key staging site was identified at a small shallow lake just outside the northwest border of the George Property PDA where large flocks of geese were consistently observed during both spring and fall staging surveys (Figure 9.1-1a). Large flocks of ducks were observed there incidentally. Waterbirds were well distributed on waterbodies in the survey blocks near the Goose Property in both 2011 and 2012.

Most waterbirds counted during aerial surveys conducted in 2013 near the MLA were ducks breeding and staging on inland ponds and lakes during summer and fall migration (Figure 9.1-2). During spring staging, no waterbirds were observed in the southern transect lines, likely because there was very little open water at that time (Figure 9.1-2).

No nests were found during ground surveys for nests conducted in 2011 within 100 m of the shoreline in the wildlife marine RSA. There were few observations of young during 2011-2013 aerial surveys in mid-July in the early brooding season. It is likely that young were detected infrequently because the surveys were conducted too early in the season, before most young had hatched and grown to a size large enough to be readily detected from the air.

The Arctic tern, glaucous gull, and long-tailed duck are listed as “Sensitive” by CESCC rankings as species that may require special attention to prevent population declines (CESCC 2010). All three species were detected either during aerial surveys or incidentally within the wildlife LSA; the glaucous gull and long-tailed duck were detected within the George and Goose Property PDAs.

### *9.1.5.2 Upland Birds*

Methods for Baseline Data Collection

Baseline studies for upland birds were conducted in the wildlife LSA and RSA around Goose and George Properties, and at Bathurst Inlet (Figure 9.1-3). Upland birds were surveyed within 12 hectare plots (300 × 400 m) in June of 2011 (n = 30 plots; Rescan 2012b; Appendix V5-5D), 2012 (n = 54; Rescan 2013c; Appendix V5-5C), and 2013 (n = 8; Rescan 2014) using the rapid survey technique of the Program for Regional and International Shorebird Monitoring (PRISM; CWS 2010).

PROJECT # 0194096-0040 GIS # BAC-23-210 November 08 2013

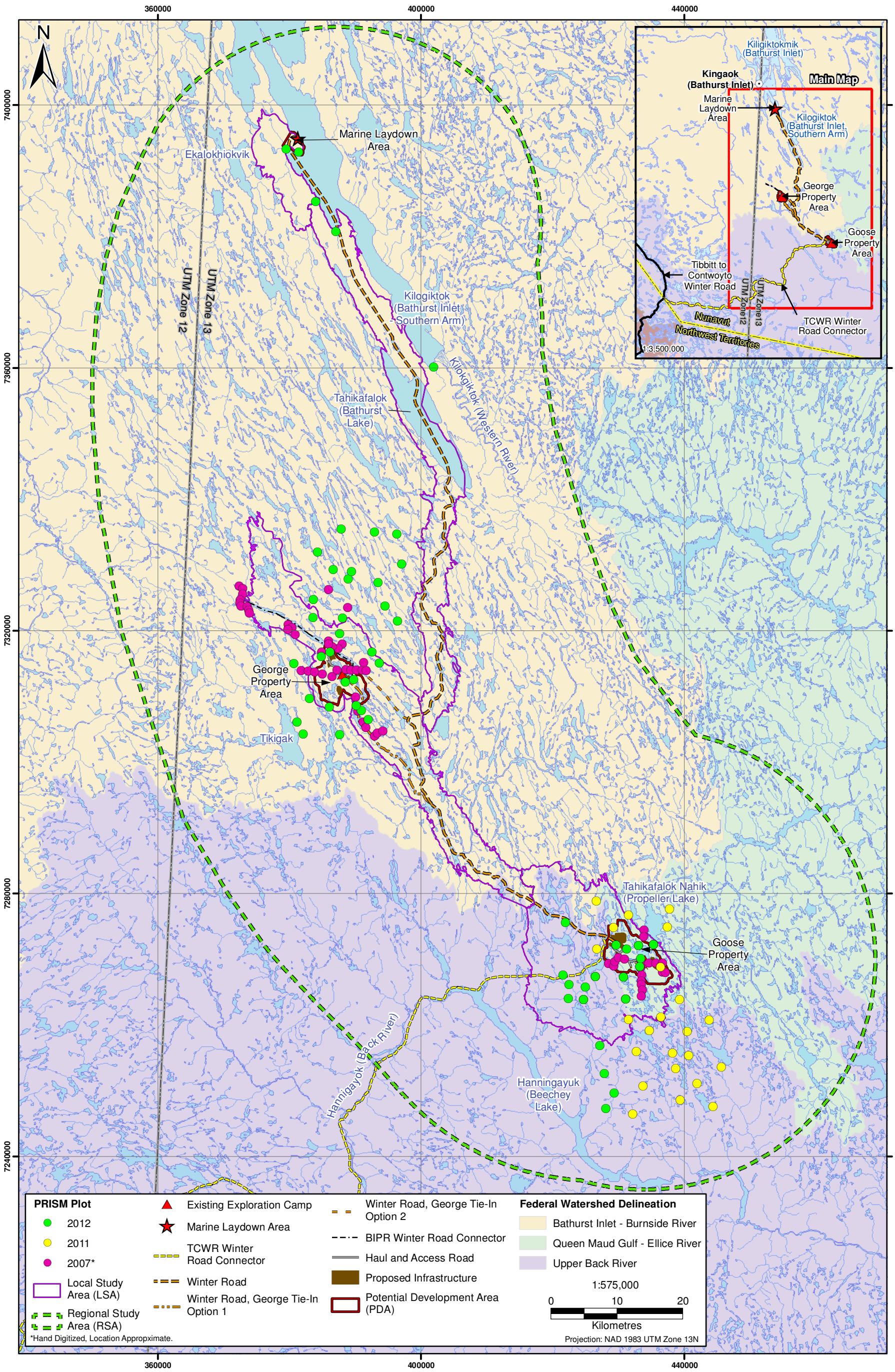


Figure 9.1-3

Sabina GOLD & SILVER CORP.

## Location of PRISM Plots to Survey Upland Birds within the Regional Study Area

Figure 9.1-3

Rescan an ERM company

In 2007, upland birds were surveyed within slightly larger PRISM plots (400 × 400 m) and along 400 to 800 m line transects (Gartner Lee Limited 2007). Plots were located within reference sites and near proposed infrastructure to provide pre-development baseline data on the relative abundance and distribution of the upland bird community (Figure 9.1-3).

In 2013, upland birds were also surveyed within 60 circular point counts within a 100 m radius conducted within a 5 km area surrounding the proposed MLA, and in an ecologically similar reference site located approximately 20 km north of the MLA (Rescan 2014).

*Deriving Density Estimates for Breeding Pairs*

Density estimates for upland birds (pairs/km$^2$) were derived from territory counts made within 12 ha PRISM plots. While walking each plot, observers used counts of singing males (one territory per singing male), close associations of male and female birds, nests, and other observations to estimate the number of territories within each plot. Because of the large influence of the moisture regime on the composition of upland bird communities in the Arctic (Section 9.1.3.2), baseline studies in 2012 were designed to derive density estimates of upland birds in moist to wet and dry vegetation communities (Rescan 2013c; Appendix V5-5C). Lowland plots were placed so that each plot contained at least 30% wetland and 50% moist habitat. Upland plots contained at least 30% dry boulder-bedrock and heath lichen, with at least 50% additional cover by dry sparsely vegetated tundra.

The number of territories estimated per plot is an underestimate of the true number present, because observers almost never detect all birds present. For example, using the PRISM survey method, Brown et al. (2007) estimated that the detection rate for shorebirds was 77% ± 5%. The detection rate for songbirds is higher than for shorebirds, because male songbirds frequently vocalize during the egg and nestling stages of breeding. Based on expert opinion, a detection rate of 85% was used to correct territory counts to derive density estimates (pairs/km$^2$) of upland bird species detected per habitat type.

Results of Baseline Data Collection

Upland bird species that regularly occur within the wildlife RSA were identified from species' range maps, and the timing and frequency of detections during baseline surveys (Table 9.1-1). In total, 27 upland bird species were detected during baseline studies — 24 species that regularly occur in the wildlife RSA and 3 species that rarely occur. Three additional species identified as regularly-occurring within the wildlife RSA were not detected, likely because these are regular migrants and probably do not breed in the wildlife RSA.

**Table 9.1-3. Density Estimates (Uncorrected for Detectability) of Upland Birds in PRISM Plots**

| | Habitat | Uncorrected Density (Pairs per km$^2$) | Standard Error |
|---|---|---|---|
| All Upland Birds | Moist-Wet | 113 | 8.3 |
| | Dry | 80 | 5.8 |
| Songbirds | Moist-Wet | 98 | 7.6 |
| | Dry | 74 | 5.7 |
| Shorebirds | Moist-Wet | 13 | 1.5 |
| | Dry | 5 | 1.2 |
| Ptarmigan | Moist-Wet | 1 | 2.1 |
| | Dry | 1 | 0.6 |

*(continued)*

**Table 9.1-3. Density Estimates (Uncorrected for Detectability) of Upland Birds in PRISM Plots (completed)**

| | Habitat | Uncorrected Density (Pairs per km$^2$) | Standard Error |
|---|---|---|---|
| ***Common Species**** | | | |
| Lapland Longspur | Moist-Wet | 42 | 4.1 |
| | Dry | 40 | 5.1 |
| Savannah Sparrow | Moist-Wet | 36 | 3.7 |
| | Dry | 9.4 | 2.3 |
| Redpoll spp. | Moist-Wet | 11 | 2.3 |
| | Dry | 8.3 | 2.2 |
| American Tree Sparrow | Moist-Wet | 5.5 | 1.8 |
| | Dry | 2.5 | 1.3 |
| Semipalmated Sandpiper | Moist-Wet | 4.6 | 1.0 |
| | Dry | 1.8 | 0.8 |
| Horned Lark | Moist-Wet | 2.3 | 0.8 |
| | Dry | 11 | 2.2 |
| American Golden Plover | Moist-Wet | 2.0 | 0.7 |
| | Dry | 2.2 | 0.8 |

** Detected across more than 20% of survey plots*

Songbirds were the most commonly detected of the upland bird groups, accounting for 88% of all detections. The upland bird community in the wildlife RSA is dominated by a few common songbird species — the Lapland longspur (54% of all detections), common and hoary redpoll, savannah sparrow, and horned lark. These observations are consistent with those of other studies in the Arctic (Section 9.1.3.2).

Comparison of species richness and abundance between dry upland (e.g., rocky heath) and moist to wet lowland (e.g., sedge meadow) habitats revealed that although lowland habitat supported a richer and more abundant bird community, especially for shorebirds, the horned lark was rarely found in lowland habitats (Table 9.1-3; Rescan 2013c; Appendix V5-5C). Differences across the moisture gradient in the upland bird community measured in baseline studies reflect those found in other studies across the Arctic (Section 9.1.4.2).

Patterns in the regional distribution of the upland bird community were revealed from baseline studies (Figure 9.1-4). Species richness of upland bird species was relatively lower within the mostly dry rocky uplands north of the George Property, and higher within the wetland-dominated area to the southwest of the Goose Property and in the marine-influence habitat along the coast of Bathurst Inlet. A similar pattern was found for the waterbird community, which suggest that the area north of the George Property in general provides relatively poor habitat for most migratory birds (Section 9.1.5.3).

Ten upland bird species that regularly occur in the wildlife RSA are listed as “Sensitive” under the CESCC designations for Nunavut: American golden plover, least sandpiper, red-necked phalarope, red phalarope, semipalmated sandpiper, American pipit, American tree sparrow, Harris’s sparrow, hoary redpoll, and white-crowned sparrow. All of these species were observed with the PDAs, with the exception of the red phalarope, a regular migrant that was not observed during baseline studies (Table 9.1-1).

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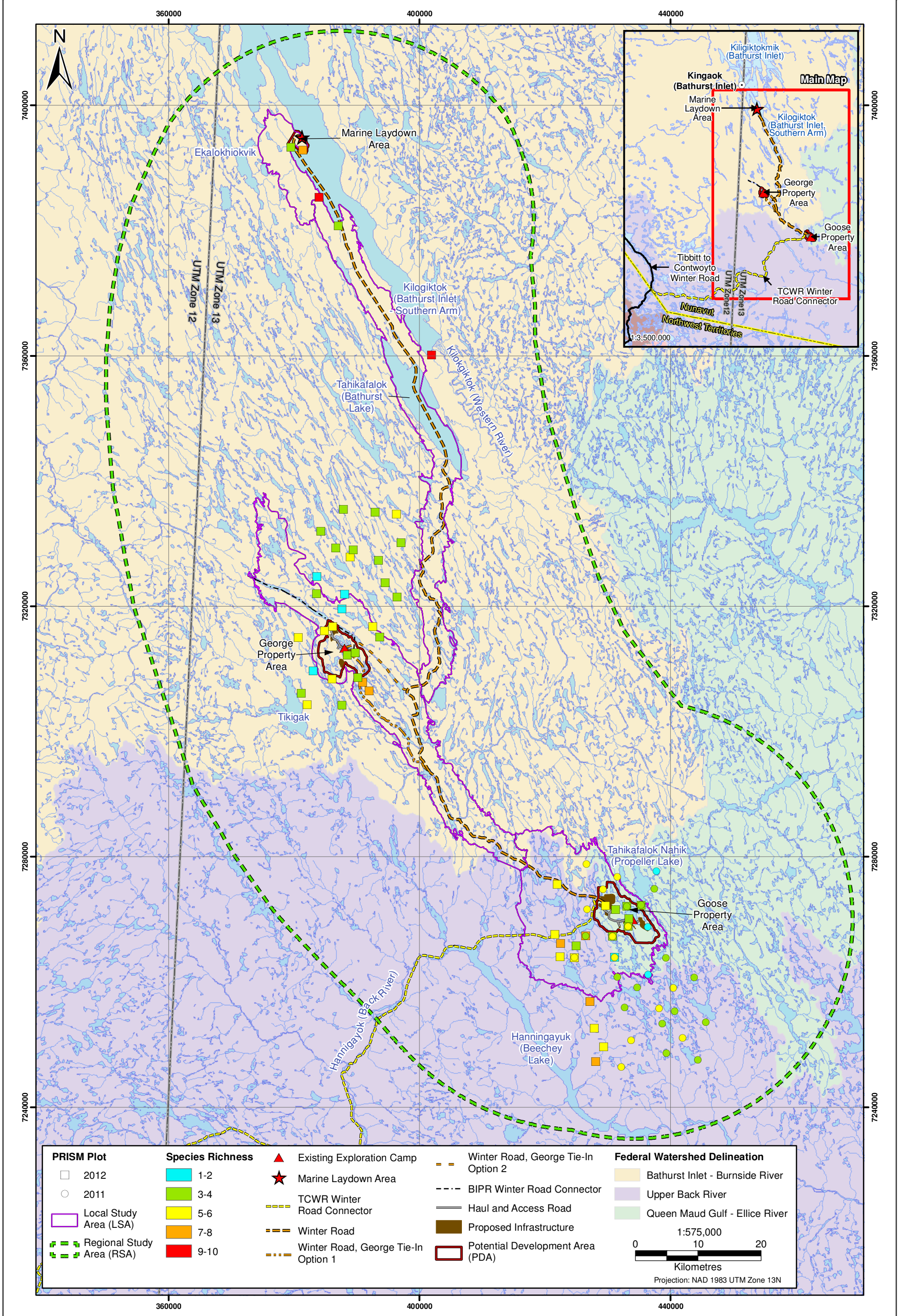


Figure 9.1-4

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## Species Richness of Upland Birds in PRISM Plots, 2011 and 2012

Figure 9.1-4

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*Deriving Density Estimates for Breeding Pairs*

Estimates of the number of upland bird territories within PRISM plots (Table 9.1-3) were corrected using an estimated 85% detection rate, which resulted in a density estimate of 133 ± 9.8 upland bird pairs per km$^2$ in moist to wet lowland habitat, and 94 ± 6.8 upland bird pairs in dry upland habitat (Rescan 2013c; Appendix V5-5C).

Density estimates based on accurate counts of nests usually provide more accurate estimates of population density than density estimates based on counts of adult birds. The corrected density estimates based on counts of adults made during baseline studies within the wildlife RSA are comparable to density estimates derived from a study in which researchers used extensive effort to find nests within survey plots at Prudhoe Bay, Alaska (Liebezeit, White, and Zack 2011; Table 9.1-4). Density estimates derived by Liebezeit et al. (2011) represent underestimates of the density of upland birds because all songbird species were excluded from the estimate except the Lapland longspur. Because the Lapland longspur usually dominates the Arctic songbird community, this estimate is likely approximately 20-30% below the true density. Thus, it was concluded that the corrected density estimates derived from baseline studies are likely to be reliable estimates.

**Table 9.1-4. Density Estimates Derived from Counts of Upland Bird Pairs and Nests in Moist to Wet and Dry Habitats**

| Study | All Upland Bird Species | | | Shorebirds | | | Songbirds (pairs/km$^2$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | All Habitats | Moist to Wet | Dry | All Habitats | Moist to Wet | Dry | All Habitats | Moist to Wet | Dry |
| ***Counts of Birds (pairs/km$^2$)*** | | | | | | | | | |
| Back River 2012 Baseline | | 113 (8.3)[1] | 80 (5.8) | | 13 (1.5) | 5 (1.2) | | 98 (7.6) | 74 (5.7) |
| Back River 2007 Baseline[2] | | | | 25 | | | 92 | | |
| Johnson et al. 2000 | | | | | 27 (13) | 11 (10) | | 39 (24) | 33 (14) |
| ***Counts of Nests (nests/km$^2$)*** | | | | | | | | | |
| Liebezeit et al. 2011[3] | | 126 (19.5) | 77 (8.9) | | 70 (16) | 38 (7.5) | | | |

[1] *Numbers in brackets are the standard error of the mean number of pairs across PRISM plots.*
[2] *Gartner Lee Ltd. (2008).*
[3] *Density estimate does not include songbird species other than Lapland longspur and therefore represents an underestimate of the density of upland bird species.*

## 9.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The report Inuit *Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report, commissioned by Kitikmeot Inuit Association (KIA 2012a) was reviewed for information on the ecology of migratory birds (KIA 2012a). Inuit TK includes detailed knowledge on the timing of bird migration, habitat use, and the spatial distribution of waterbirds (KIA 2012). The life histories of individual species are described, particularly of waterbirds which were an important food source for Inuit, especially in coastal areas (KIA 2012a). Inuit TK includes observations of the earlier migration of the snow bunting and of large-bodied birds, such as the tundra swan and geese, and identification of ravens and ptarmigan as non-migratory, resident birds. Examples of detailed observations of bird habitat use include frequent foraging on berries by geese, nesting of waterbirds on mid-stream islands and of geese and some ducks on cliffs, and observations of higher

densities of nesting waterbirds in large wetlands. Inuit TK also includes the identification of regularly-used staging sites by waterbirds as areas that become ice-free earlier than other areas, such as fast-flowing rivers. Only one staging site was identified within the wildlife RSA, an area at the outflow of Beechey Lake. This area was not surveyed for waterbirds as it was deemed too far from potential sources of Project-related effects (Figure 9.1-1). The following reports were reviewed for TK specific information related to migratory birds:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012a);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VEC selection, assessment boundaries, and recommendations for mitigation and adaptive management.

### 9.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

### 9.2.2 Incorporation of TK for VEC and VSEC Selection

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

### 9.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013b). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

### 9.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of Inuit values into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

### 9.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

## 9.3 VALUED COMPONENTS

### 9.3.1 Potential Valued Components and Scoping

The scoping process for determining VECs is outlined in the General Assessment Methodology Chapter (Volume 9, Chapter 1), and included the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

As part of the scoping process, the following aspects were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members.

### 9.3.2 Valued Components included in Assessment

Migratory birds were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Migratory birds were selected as a VEC based on Sabina-led public consultation, the TK report (Rescan 2013a), consultation with regulatory agencies, and regulatory considerations, particularly their protected status under the *Migratory Birds Convention Act (1994)*.

Migratory birds were and continue to be an important food source for Inuit. Ptarmigan were a widely-used food source to Inuit, both within coastal areas and on the inland tundra. Hunting and egg-collecting for waterbirds primarily occurred in coastal areas. Spring staging waterbirds, especially eider ducks and loons, were hunted along coastal areas where the birds foraged in early-opening ice before migrating to nesting areas. In the summer, adult waterbirds were hunted during the flightless period when they moulted their feathers. Inuit travelled to coastal areas to collect the eggs of waterbirds, probably mostly of eiders, along the coast and on small coastal islands. Sandhill cranes were hunted early in the spring when their fat reserves were high. Migratory birds were also important to Inuit because their movements in spring and fall were used to mark the passage of seasons (Rescan 2013a).

The following migratory bird species that regularly occur in the wildlife RSA are listed as “Sensitive” under the CESCC designations for Nunavut: waterbirds — Arctic tern, glaucous gull, and long-tailed duck; upland birds — American golden plover, least sandpiper, red-necked phalarope, red phalarope, semipalmated sandpiper, American pipit, American tree sparrow, Harris’s sparrow, hoary redpoll, and white-crowned sparrow (CESCC 2010).

The red knot is the only species listed on Schedule 1 of SARA of all the non-predatory species of migratory birds that may occur within the wildlife RSA (Table 9.1-1). The red knot was not detected during baseline surveys as it probably migrates in low numbers through the wildlife RSA.

Migratory birds are effective indicators of overall ecosystem function and health (Niemi and McDonald 2004). Birds often respond rapidly to environmental change and are thus sensitive indicators of habitat degradation and other disturbances (Koch, Derver, and Martin 2011).

## 9.4 SPATIAL AND TEMPORAL BOUNDARIES

### 9.4.1 Spatial Boundaries

Project-related effects on migratory birds were evaluated within two study areas: a local study area (LSA) and a larger regional study area (RSA; Figure 9.4-1).

#### *9.4.1.1 Local Study Area*

The boundaries of the Local Study Area (LSA) for migratory birds were set to encompass the following:

- the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, George, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property, George Property, and MLA. The wildlife LSA covers an area of approximately 134,369 ha (Figure 9.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

#### *9.4.1.2 Regional Study Area*

The RSA for migratory birds encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three Project areas. The wildlife RSA covers an area of approximately 1,262,005 ha (Figure 9.4-1). The wildlife RSA extends slightly more than 35 km from proposed infrastructure on the eastern side to encompass the Western River.

### 9.4.2 Temporal Boundaries

The Project has an approximate planned life of 24 years (not including the Post-closure, Temporary Closure, or Care and Maintenance phases). The temporal boundaries used for the migratory birds effects assessment align with the time periods of the phases of the Project as presented in Table 9.4-1.

With the exception of the willow and rock ptarmigan, all migratory bird species migrate in spring and fall, and occur in the wildlife RSA during the non-winter seasons only. The two ptarmigan species over-winter in the Arctic, and thus may interact with the Project throughout the year.

**Table 9.4-1. Temporal Boundaries — Project Phase Durations**

| Activities | Duration |
|---|---|
| Site Preparation | 2 years |
| Construction phase | 2 years |
| Operational phase | 10 years |
| Reclamation and Closure phase | 10 years |
| Post-closure phase | 5 years |
| *Other Potential Phases* | |
| Temporary Closure | Less than 2 years |
| Care and Maintenance phase | 2 to 10 years |

## 9.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

The potential effects of the Project on migratory birds within the wildlife RSA are assessed in this Section of the DEIS. Academic and monitoring studies have shown that under certain circumstances migratory birds may be susceptible to development-related disturbances, which may result in displacement of migratory birds from preferred habitat, higher rates of nest predation, and possible declines in their breeding productivity and population abundance. For this reason, potential effects of the Project on migratory birds were considered. In the following assessment of the effect of the Project on migratory birds, qualitative and quantitative information was used to characterize the potential residual effects, and predict residual effects that may remain following mitigation and management strategies.

### 9.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on migratory birds as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

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

The potential effects of the Project on migratory birds is evaluated for the construction, operations, decommissioning, and post-closure periods as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, effects are evaluated for the phase associated with the worst-case scenario; lower effects are anticipated during all other Project phases.

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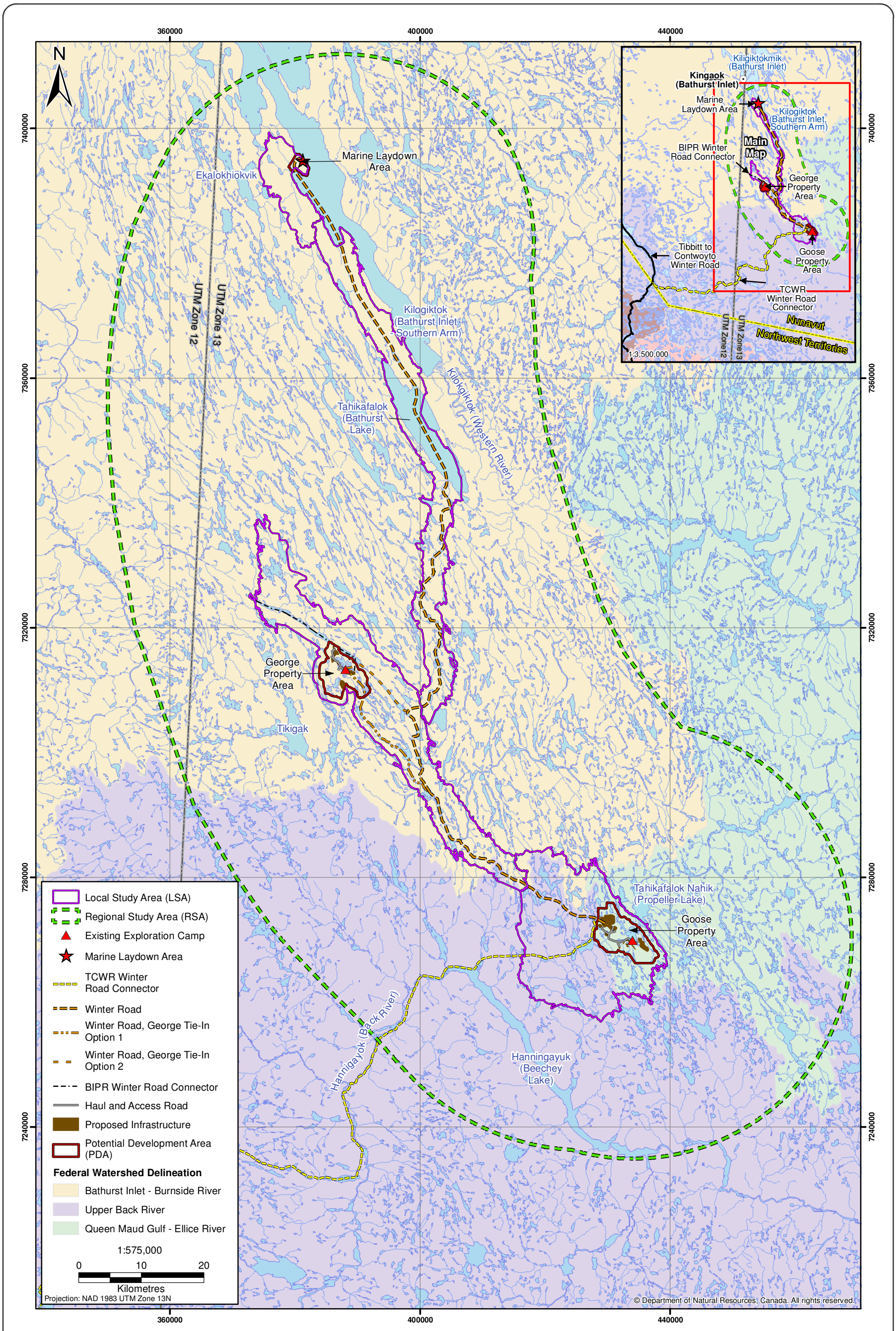


Figure 9.4-1

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# Local Study Area and Regional Study Area for Migratory Birds

Figure 9.4-1

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### *9.5.1.1 Indicators used to Characterize Potential Residual Effects*

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 9.5-1). For each potential effect, indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger an assessment of residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of "yes" or "no" where triggering of residual effects assessment occurred if the indicator value was "yes".

**Table 9.5-1. Criteria and Indicators used to Characterize Potential Effects on Migratory Birds**

| Potential Effect | Criteria | Indicator |
|---|---|---|
| Habitat Loss | Change in Population Health | Amount (ha) of habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA and expressed as a ratio of area lost to the area of the wildlife RSA |
| Disturbance due to Noise | Change in Population Health | Amount (ha) of habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA and expressed as a ratio of area lost to the area of the wildlife RSA |
| Disruption to Movement | Change in Population Health | Presence of tall structures with lights |
| Direct Mortality and Injury | Change in Population Health | Collisions of migratory birds with vehicles occurs at other locations |
| Indirect Mortality | Change in Population Health | Indirect mortality due to nest predation occurs at other locations |
| Attraction | Change in Population Health | Attraction occurs at similar Projects in Nunavut and Northwest Territories |
| Exposure to Contaminants | Change in Population Health | Predicted Hazard Quotients for metals in environmental media and wildlife |
| Reduction in Reproductive Productivity | Change in Population Health | Literature suggests combined residual effects on migratory birds |

### *9.5.1.2 Magnitude Ratings for Residual Effects*

Magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. Residual effects were designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects is provided in Table 9.5-2.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in population health via alterations in habitat availability and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for migratory birds, which provide benchmark measures, as well as estimates of the natural variability.

**Table 9.5-2. Definitions of the Magnitude Ratings for Population Health Criterion**

| Magnitude Rating | Magnitude Descriptor of Criteria (Population Health) |
|---|---|
| Negligible | No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%. |
| Low | Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%. |
| Moderate | Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%. |
| High | Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%. |

*Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects, the effect on the sub-population and thus the magnitude of the effect was assessed using professional judgment and literature review.*

Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

#### *9.5.1.3 Overall Significance Ratings for Residual Effects*

To assess the significance of residual effects, eight descriptors for evaluating residual biophysical effects were used and defined in Volume 9, Chapter 1: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. To assess residual effects, quantitative data were used as a default approach. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 9.5-2) and reversibility were used as the primary descriptors; the extent, duration, and frequency of the effect as secondary descriptors.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as Positive, Significant, or Not Significant (Table 9.5-3). For example, a residual effect receives a rating of 'Not Significant' if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

Finally, the degree of uncertainty in the rating was provided as a qualifier.

**Table 9.5-3. Definitions of Significance Ratings for Residual Effects on Migratory Birds**

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

### 9.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions between the VEC migratory birds and the Project is provided in Volume 9, Chapter 1. Migratory birds may potentially interact with most Project activities during all Project phases. Interactions will vary across species depending on migratory guild. As resident species, the rock and willow ptarmigan occur in the wildlife RSA during winter, and thus may interact with traffic on the winter roads, whereas all other migratory bird species will interact with the Project during April to October only. Potential effects on wildlife from the Project have been scoped based on NIRB guidelines. Interactions of migratory birds with Project components were evaluated to determine which of the following potential effects may occur (Table 9.5-4):

- direct habitat loss;
- disturbance (e.g., displacement, behavioural effects leading to negative energetic balance, physiological stress);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality due to increased access and associated increase in hunting;
- attraction;
- exposure to contaminants; and
- reduction in reproductive productivity due to all potential effects of the Project combined.

Each potential effect is described below, and then evaluated as to whether or not it will occur. Potential effects that will likely occur are then evaluated as to whether or not these are predicted to result in a residual effect after mitigation actions are implemented.

#### *9.5.2.1 Habitat Loss*

The potential for habitat loss to affect migratory birds is evaluated in this section. Migratory bird habitat will be removed and replaced by Project infrastructure. The potential for habitat near infrastructure to be degraded due to dust generated from industrial developments was assessed in Country Foods chapter (Volume 8, Chapter 5) and Environmental Risk Assessment (Volume 8, Chapter 6). This analysis did not predict any residual effects due to dust on vegetation and therefore on migratory bird habitat.

**Table 9.5-4. Interactions of Migratory Birds with Project Components that May Result in Effects on Migratory Birds**

| Potential Development Area<br>Project Component | Habitat Loss[1] | Disturbance | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity |
|---|---|---|---|---|---|---|---|---|
| ***Goose Property Area*** | | | | | | | | |
| Open Pits (Main (Goose, Umwelt, and Llama) | x | x | | x | x | x | | x |
| Haul and access roads | x | x | | x | x | x | | x |
| Winter roads | | x | | x | x | | | x |
| Stockpiles | x | x | | x | x | x | x | x |
| Waste rock storage areas | x | x | | x | x | x | x | x |
| Explosives storage areas | x | x | | x | x | x | x | x |
| Tailings Impoundment Area | x | x | | x | x | x | x | x |
| Quarries | x | x | | x | x | x | | x |
| Landfill | x | x | | x | x | x | x | x |
| Camp / Plant site | x | x | | x | x | x | | x |
| Airstrip | x | x | | x | x | x | | x |
| Other infrastructure (diversion channels, water intakes) | x | x | | x | x | x | | x |
| ***George Property Area*** | | | | | | | | |
| Open Pits (LCP North, Locale 1,and Locale 2) | x | x | | x | x | x | | x |
| Haul and access roads | x | x | | x | x | x | | x |
| Winter roads | | x | | x | x | | | x |
| Stockpiles | x | x | | x | x | x | x | x |
| Waste rock storage areas | x | x | | x | x | x | x | x |
| Explosives storage areas | x | x | | x | x | x | x | x |
| Landfill | x | x | | x | x | x | x | x |
| Camp | x | x | | x | x | x | | x |
| Other infrastructure (water intake) | x | x | | x | x | x | | x |
| ***Marine Laydown Area*** | | | | | | | | |
| Camp | x | x | | X | X | X | | x |
| Barge landing location | x | x | | X | X | X | | x |
| Haul and access roads | x | x | | X | X | X | | x |
| Winter roads | | x | | x | x | | | x |
| Other infrastructure (interception ditch) | x | x | | x | x | x | | x |

[1] *It was assumed that the entire PDA was lost for the effects assessment. All Project infrastructure lies within the PDA.*

The location of infrastructure will be planned to avoid wildlife sensitive areas, and the layout of infrastructure will be designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. However, some habitat loss is unavoidable.

To enable flexibility in siting of Project infrastructure, three Project Development Areas (Goose Property, George Property, and the MLA) were delineated, which contain all proposed Project infrastructure in the entire Project footprint for each area (Section 9.4.1). It was assumed that habitat loss for migratory birds will occur within the total area of each PDA. This represents an overestimate of habitat loss as only about 10% of the entire area within each PDA will be developed.

The only Project activity not contained within the PDA is the winter roads. Habitat loss within these areas is not expected for migratory birds because no migratory species are present in the wildlife RSA during winter. Ice roads are not anticipated to result in loss of habitat for ptarmigan, which are not migratory, because most of the proposed road route crosses waterbodies where ptarmigan do not occur. Ice roads are not permanent infrastructure, and thus are not anticipated to result in habitat degradation for migratory birds during the snow-free season.

Habitat of migratory birds may also be indirectly lost if migratory birds avoid the Project area outside of the PDAs due to disturbance, which is discussed in Section 9.5.2.2.

Calculation of Habitat Loss

Assessment of the effect of habitat loss for migratory birds was based on:

1. a calculation of the total area lost to development, calculated as the sum of the PDA areas, and expressed as a proportion of the wildlife LSA and RSA; and
2. a calculation of the area of suitable habitat contained within the PDA areas, and expressed as a proportion of the area of suitable habitat for migratory birds within the wildlife LSA and RSA.

*Calculating Total Area Lost*

The total expected area of habitat lost or degraded by the mine footprint was calculated by summing the areas of loss due to the entire Goose, George, and MLA PDAs and comparing this area to the total area of the wildlife LSA and RSA. The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary. The actual area developed, and subject to habitat loss, will be much smaller, as determined by the final design infrastructure and placement.

*Calculating Area of Suitable Waterbird Habitat Lost*

Suitable habitat for waterbirds was considered to be all mapped waterbodies and wetlands. The effect of loss of suitable habitat was quantitatively assessed as the amount of suitable habitat expected to be lost within the PDAs, relative to the amount of suitable habitat mapped within the wildlife LSA and RSA.

*Calculating Area of Suitable Upland Bird Habitat Lost*

Suitable habitat for upland birds was considered to be dry and moist to wet vegetation communities. To quantitatively assess the effects of habitat loss for upland birds, the amount of suitable habitat lost within the PDAs was calculated relative to the portion available within the wildlife LSA and RSA. Areas of these vegetation types were calculated separately because the bird community is different across this moisture gradient (Section 9.1.4 and 9.1.5.2).

Evaluation of Habitat Loss

*Total Area of Loss*

The total area of loss as represented by the Goose, George and MLA PDAs is 10,237 ha, which represents 7.5% of the wildlife LSA and 0.8% of the wildlife RSA (Table 9.5-5). The magnitude of habitat loss is rated low (Table 9.5-2).

**Table 9.5-5. Area of Habitat Loss within the Project Development Areas**

| Project Development Area (PDA) | Area Lost (ha) | Proportion of LSA (%)[1] | Proportion of RSA (%)[1] |
|---|---|---|---|
| George Property Area | 4,226 | 3.1 | 0.3 |
| Goose Property Area | 5,358 | 4.0 | 0.4 |
| Marine Laydown Area | 653 | 0.4 | <0.1 |
| Total Lost | 10,237 | 7.5 | 0.8 |

[1] *LSA = 134,369 ha, RSA = 1,262,005 ha*

*Loss of Suitable Waterbird Habitat*

Waterbodies (e.g., lakes) comprise 18.2 % of the wildlife LSA and 12.9% of the wildlife RSA; wetlands comprise 10.5% of the wildlife LSA and 23.9% of the wildlife RSA (Table 9.5-6 and Table 9.5-7; Rescan 2013c; Appendix V5-5C). In total, 28.7% of the wildlife LSA and 36.8% of the wildlife RSA represent potential habitat for waterbirds. This amount is an over-estimate of habitat available to waterbirds, since some waterbodies are likely to be low quality habitat for waterbirds (Section 9.1.5).

**Table 9.5-6. Surface Area of Waterbodies and Wetlands in the Wildlife LSA**

| Waterbody Type | Area of LSA[1] (ha) | % of Total LSA |
|---|---|---|
| Lake | 17,962 | 13.4 |
| Pond | 6,174 | 4.6 |
| River | 290 | 0.2 |
| Saltwater | 1071 | 0.0 |
| Total Waterbodies | 24,533 | 18.2 |
| Wetlands | 14,066 | 10.5 |
| Total Waterbodies and Wetland | 38,599 | 28.7 |

[1] *LSA extends across 107 ha of marine water in Bathurst Inlet adjacent to the MLA*

**Table 9.5-7. Surface Area of Waterbodies in the Wildlife RSA Based on WKSS Landcover Classification**

| Ecological Land Classification Unit | Area of RSA (ha) | % of Total RSA |
|---|---|---|
| Deep Water | 102,226 | 8.1 |
| Water | 61,065 | 4.8 |
| Total Waterbodies | 163,291 | 12.9 |
| Total Wetlands[1] | 301,208 | 23.9 |
| Total Waterbodies and Wetland | 464,499 | 36.8 |

[1] *Includes shallow water*

Based on mapping of waterbodies and wetlands, 14.9% and 1.3% of waterbird habitat available in the wildlife LSA and RSA respectively will be lost within the three PDAs, which is rated as low magnitude

(Table 9.5-8; Table 9.5-2). No nesting colonies or key staging sites were observed within the PDAs (Section 9.1.5.3), thus neither of these types of habitat will be lost to Project development.

**Table 9.5-8. Suitable Habitat Lost for Waterbirds in the Wildlife LSA and RSA due to the Project PDAs**

| Habitat Type | Suitable Habitat Lost to PDAs (ha) | Suitable Habitat in the LSA (ha) | Percent of Suitable Habitat in LSA Lost (ha) | Suitable Habitat in the RSA (ha) | Percent of Suitable Habitat in RSA Lost (ha) |
|---|---|---|---|---|---|
| Waterbodies | 1, 416 | 24,533 | 5.8% | 163,291 | 0.87% |
| Wetlands | 1, 288 | 14,066 | 9.1% | 301,208 | 0.43% |
| Total | 2,704 | 38,599 | 14.9% | 464,499 | 1.3% |

*Loss of Suitable Upland Bird Habitat*

Moist to wet vegetation communities cover 55.7% of the wildlife LSA, dry upland vegetation covers 26.6%, and waterbodies cover 21.4% (Table 9.5-9). The wildlife RSA is comprised of 40.1% moist to wet vegetation communities, 38.5% dry vegetation, and 21.1% waterbodies (Table 9.5-10). Less than 1.2% of upland bird habitat in the wildlife LSA and RSA will be lost within the three PDAs (Table 9.5-11).

**Table 9.5-9. Landcover of Dry and Moist to Wet Vegetation Communities in the Wildlife LSA**

| Moisture Regime | Vegetation Cover | Area (ha) | % LSA |
|---|---|---|---|
| Dry | Bedrock-Lichen | 6,704 | 5 |
| | Bedrock Outcrop | 3,382 | 2.5 |
| | Sparse Tundra and Esker | 25,010 | 18.6 |
| | Dry Total | 35,096 | 26.1 |
| Moist to Wet | Mesic Dwarf Shrub | 45,920 | 34.2 |
| | Shrubby | 12,976 | 9.7 |
| | Riparian | 1,885 | 1.4 |
| | Wetland | 14,067 | 10.4 |
| | Moist to Wet Total | 74,848 | 55.7 |
| Total | | 109,944 | 81.8[1] |

[1] *The remainder of the wildlife LSA is covered by waterbodies.*

**Table 9.5-10. Landcover of Dry and Moist to Wet Vegetation Communities in the Wildlife RSA**

| Moisture Regime | Vegetation Cover | Area (ha) | % RSA |
|---|---|---|---|
| Dry | Bedrock-Heath-Boulder | 456,551 | |
| | Sparse Tundra and Esker | 29,841 | |
| | Dry Total | 486,392 | 38.5 |
| Moist to Wet | Mesic Dwarf Shrub | 283,599 | |
| | Shrubby | 16,046 | |
| | Riparian | 6,616 | |
| | Wetland[1] | 199,302 | |
| | Moist to Wet Total | 505,563 | 40.1 |
| Total | | 991,955 | 78.6[2] |

[1] *Vegetated wetlands excluding areas covered by shallow water.*
[2] *The remainder of the wildlife RSA is covered by waterbodies.*

**Table 9.5-11. Suitable Habitat Lost for Upland Birds in the Wildlife LSA and RSA due to the Project PDAs**

| Habitat Type | Suitable Habitat Lost to PDAs (ha) | Suitable Habitat in the LSA (ha) | Percent of Suitable Habitat in LSA Lost | Suitable Habitat in the RSA (ha) | Percent of Suitable Habitat in RSA Lost |
|---|---|---|---|---|---|
| Dry Upland | 2,484 | 35,096 | 7.1% | 486,392 | 0.5% |
| Moist to Wet Lowland | 6,163 | 74,848 | 8.2% | 505,563 | 1.2% |
| Total | 8,647 | 109,944 | 7.9% | 991,955 | 0.9% |

Using density estimates derived from baseline surveys (Section 9.1.5.6), at least 132,478 ± 7,709 upland bird pairs are expected to be present within the wildlife LSA during the breeding season. This population estimate is comprised of an estimated 99,484 ± 7,330 upland bird pairs in lowland moist to wet areas (748 $km^2$ of moist to wet habitat × 133 ± 9.8 upland bird pairs per $km^2$) and 32,994 ± 2,387 upland bird pairs in dry upland areas (351 $km^2$ of dry upland habitat × 94 ± 6.8 upland bird pairs per $km^2$) within the wildlife LSA.

At least 1,197,095 upland bird pairs are expected to be present with the wildlife RSA during the breeding season. This population estimate is comprised of an estimated 739,879 ± 54,517 pairs in lowland moist to wet areas (5,563 $km^2$ of moist to wet habitat × 133 ± 9.8 upland bird pairs per $km^2$) and 457,216 ± 33,075 pairs in dry upland areas (4,864 $km^2$ of dry upland habitat × 94 ± 6.8 upland bird pairs per $km^2$) within the wildlife RSA.

The estimated population size of upland birds within the three PDAs is 2,335 ± 169 breeding pairs of upland birds in dry habitat, and 8,192 ± 604 breeding pairs in moist to lowland habitat. Combined, an estimated 10,527 ± 627 breeding pairs of upland birds are expected to breed within the area of the three PDAs, which is 8.0% of the estimated 131,214 ± 7,709 breeding pairs within the 134,369 ha of the wildlife LSA, and 0.9% of the estimated 1,129,607 breeding pairs within the 1,262,005 ha of the wildlife RSA. It is anticipated that approximately 10% of the PDAs will be developed, and thus an estimated 1,053 pairs of breeding upland birds will be displaced as a result of habitat loss due to Project development, which is 0.09% of the population breeding in the wildlife RSA.

Whenever possible, reclamation activities will be undertaken to restore habitat for migratory birds upon Project closure. Mitigation is expected to lower but not completely eliminate the effect of habitat loss to migratory birds, and thus a residual effect is predicted to occur.

#### *9.5.2.2 Disturbance due to Noise*

Noise and human and vehicle movements generated from developments can cause disturbance to migratory birds. Disturbance can result in behavioural changes, and changes in spatial distribution through avoidance of preferred habitats when these become disturbed (Bayne, Habib, and Boutin 2008). The intensity of behavioural responses is related to the degree to which birds perceive disturbances as a threat (Frid and Dill 2002).

Disturbance of migratory birds will occur throughout the life of the Project. Some disturbances like blasting and aircraft flights will occur intermittently, while other disturbances like the presence of humans and the movement of vehicles will occur relatively regularly. Potential disturbance to migratory birds due to the Project could result from the following activities:

- blasting (noise and ground vibrations from mining and construction activities);

- general Project noise (e.g., camp noise, vehicle traffic, human presence); and
- noise generated from aircraft traffic.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the Umwelt open pit while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the Construction and Operational phases. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned, while at the MLA, while it is active, a maximum of six flights per week are planned.

Bird densities have been found to decrease within 1 km of infrastructure, such as roads, seismic lines, and oil fields (Benitez-Lopez, Alkemade, and Verweij 2010). Studies have found lower density of territorial males, reduced total annual output of males, and reduced overall population size near roads (Clark and Karr 1979; Van Der Zande et al. 1984; Foppen and Reijnen 1994; R. Reijnen and R Foppen 1994; M. J. S. M. Reijnen 1995; M. J. S. M. Reijnen, Veenbaas, and Foppen 1995; R. Reijnen, Foppen, and Meeuwsen 1996). Effects have been observed to extend as far as 1.8 km from a busy highway and as much as 600 m from a rural road (R. Reijnen, Foppen, and Meeuwsen 1996). Studies on birds in grasslands reported that the abundance and diversity of birds began to drop when noise levels reached 47 ± 3.5 dBA near roads (R. Reijnen and R. Foppen 1994; R. Reijnen, Foppen, and Meeuwsen 1996). Noise from traffic was correlated to bird densities close to roads (M. J. S. M. Reijnen, Veenbaas, and Foppen 1995). However, these earlier studies were not designed to test for the independent effects of mortality due to vehicle strikes, and thus mortality and noise levels were confounded. More recent work shows bird densities are low near roads due to mortality; little support was found for an effect of noise on bird abundance (Summers, Cunnington, and Fahrig 2011).

Noise appears to affect bird populations in other ways. Noise can negatively affect individuals even when it is not experienced as threatening. Anthropogenic noise can mask songbird vocalizations, which they use to establish and maintain territories for breeding and communicate with young (Habib, Bayne, and Boutin 2007). In some cases, there may be few behavioural indicators of disturbance — birds may choose to nest close to human activities — yet experience physiological stress (Blickley et al. 2012). A potential concern regarding disturbance to breeding birds is that it can result in energetic imbalances that can ultimately result in reproductive failure. For example, disturbance can cause reduced rates of food provisioning to young (Verhulst, Oosterbeek, and Ens 2001), which may lead to poor body condition of young and thus higher rates of mortality.

Quantification of Disturbance to Migratory Birds

Disturbances from multiple stressors (e.g., noise, visual, vibration) to migratory birds were quantitatively assessed by considering the spatial overlap between breeding migratory birds and Project infrastructure and activities. In addition, the effects of noise disturbance to migratory birds were quantitatively assessed based on noise modeling of the area over which noise emissions from the Project are estimated to occur (Volume 4, Chapter 2). Disturbance is described for the Project phase anticipated to result in the "worst-case" effects; all other Project phases are expected to result in less disturbance.

*Flight Initiation Distance*

The zone of influence for disturbance effects from multiple sources including visual disturbances and vibrations generated from the Project on migratory birds is assumed to be 300 m. Flight Initiation Distance (FID) is defined as the distance between birds and a disturbance when birds flush in response to an approaching disturbance (Ruddock and Whitfield 2007). Data on FIDs recorded for breeding

waterbirds have been used to delimit the boundaries of spatial buffers to restrict human activities around nest sites and staging areas (Whitfield, Ruddock, and Bullman 2008). These studies show that most FIDs recorded for waterbirds are within 300 m from the disturbance source (Rodgers Jr. and Schwikert 2002; Ruddock and Whitfield 2007; Whitfield, Ruddock, and Bullman 2008). Studies have shown that the strongest effects of Arctic developments on upland birds are limited to within 300 m from footprints and activities (Male and Nol 2005; Smith et al. 2005).

Disturbance effects of the Project were quantitatively assessed based on numbers of migratory birds expected to occur within 300 m of proposed Project infrastructure. For waterbirds, this was estimated as the number of flocks of waterbirds expected to use this area during the staging season, when disturbances are expected to result in greater effects. For upland birds, this was estimated as 35% of the upland birds estimated to use the three PDAs (Section 9.5.2.1), based on an estimated area covered by proposed infrastructure and buffered by 300 m, which is an area approximately 35% of the PDAs.

*Noise Contour Modeling to Evaluate Indirect Habitat Loss*

To assess indirect habitat loss due to sensory disturbance, the area outside of the PDAs anticipated to be affected by noise was calculated. The effects due to noise beyond the existing PDA boundaries are expected to be small, because the loss of habitat within the PDAs, where most of the effect of disturbance will likely occur, was already considered in the habitat loss assessment (Section 9.5.2.1).

Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2; Rescan 2013b) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case (year three of the Operational phase at the Goose Property Area and year seven of the Operational phase at the George Property Area). The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature at which wildlife have shown behavioural effects from the noise.

Threshold noise values were determined from the literature, above which wildlife are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as “functional habitat loss” and “disturbed habitat” for migratory birds. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 9.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling; Section 9.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise “pressure” caused by brief noises, such as from blasting at quarries and noise due to aircraft. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat (“functional habitat loss”; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond

behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for wildlife resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (Lpeak) or higher for instantaneous noise effects on migratory birds during construction and operation. Blasting noise models were conducted during peak noise levels for each of the PDAs: year three at the Goose PDA and year seven at the George PDA.

General Project-related noise levels or continuous noise levels are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). A flight impact zone was delineated based on noise modeling results showing the area over which aircraft noise attenuates to 80 dBA or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001).

To assess indirect habitat loss due to sensory disturbance for migratory birds, the total area of suitable habitat outside of the three PDAs (Section 9.5.2.1), but within noise level contours was calculated. The following noise contours were used: 120 dB for functionally-lost habitat from instantaneous blasting noise, resulting in abandonment of habitat, 108 dB for disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response, 45 dBA for general Project noise, and 80 dBA for disturbed habitat from instantaneous aircraft noise.

*Noise Modelling to Evaluate Disturbance to Waterbirds Breeding near Infrastructure*

The effects of noise disturbance on waterbirds were also evaluated by determining whether noise thresholds are predicted to be exceeded at sites close to proposed infrastructure where waterbirds were observed during the spring or fall migration periods during baseline studies (Dragon Lake within the George Property PDA and Propellor Lake within the Goose Property PDA (Volume 4, Chapter 2; Rescan 2013b).

Evaluations of Disturbance to Migratory Birds

*Flight Initiation Distance* — Less than five flocks of waterbirds (Canada goose and greater white-geese) have been observed during the staging season within the 300 m zone of influence for disturbance. The estimated number of upland bird pairs exposed to disturbance effects within this zone of influence is 3,652 breeding pairs (35% of 10,434 breeding pairs, Section 9.5.2.1), which is 2.8% of the estimated population size within the wildlife LSA.Noise Contour Modelling to Evaluate Indirect Habitat Loss

*Blasting Noise* — Less than 0.1% of the wildlife RSA (Table 9.5-12) beyond the PDAs will be functionally lost (35 ha) and disturbed (982 ha) due to blasting noise (Table 9.5-12). These areas overlap less than 0.01% of suitable habitat available for migratory birds beyond the PDAs in the wildlife RSA (Tables 9.5-13 and 9.5-14).

**Table 9.5-12. Total Additional Area Functionally Lost or Disturbed due to Project Noise**

| Project Area | Total Area Lost to Project PDAs | | | Additional Area Functionally Lost due to Blasting (120 dBA) | | | Additional Area Disturbed due to Blasting (108 dBA) | | | Additional Area Disturbed due to General Project Noise (45 dBA) | | | Additional Area Disturbed due to Aircraft Noise (80 dBA) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA* | % RSA |
| George Property Area | 4,226 | 3.1 | 0.3 | 17 | <0.1 | <0.1 | 699 | 0.5 | <0.1 | 359 | 0.3 | <0.1 | 11,278 | 8.4 | 0.9 |
| Goose Property Area | 5,358 | 4 | 0.4 | 18 | <0.1 | <0.1 | 283 | 0.2 | <0.1 | 262 | 0.2 | <0.1 | 3,495 | 2.6 | 0.3 |
| MLA | 653 | 0.4 | <0.1 | - | - | - | - | - | - | - | - | - | 12,367 | 9.2 | 1 |
| Total | 10,237 | 7.5 | 0.8 | 35 | <0.1 | <0.1 | 982 | 0.7 | <0.1 | 621 | 0.5 | <0.1 | 27,140 | 17.1 | 2.2 |

**Table 9.5-13. Suitable Habitat for Waterbirds Disturbed and/or Abandoned outside of the Project PDAs due to Noise**

| Study Area | Amount of Suitable Habitat | Suitable Habitat Lost or Altered due to the Project PDA | | Additional Area of Suitable Habitat Functionally Lost due to Blasting (120 dBA) | | Additional Area of Suitable Habitat Disturbed due to Blasting (108 dBA) | | Additional Area of Suitable Habitat Disturbed due to General Project noise (45 dBA) | | Additional Area of Suitable Habitat Disturbed due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Area without Winter Roads | % Lost or Altered | Area (ha) | % Lost | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered |
| LSA | 38,599 | 2,704 | 7.0 | 12 | 0.0 | 261 | 0.7 | 83 | 0.2 | 777 | 2.0 |
| RSA | 464,499 | 2,704 | 0.6 | 12 | 0.0 | 261 | 0.0 | 83 | 0.0 | 1,103 | 0.2 |

**Table 9.5-14. Suitable Habitat for Upland Birds Disturbed and/or Abandoned outside of the Project PDAs due to Noise**

| Study Area | Amount of Suitable Habitat Area (ha) | Suitable Habitat Lost or Altered due to the Project PDA | | Additional Area of Suitable Habitat Functionally Lost due to Blasting (120 dBA) | | Additional Area of Suitable Habitat Disturbed due to Blasting (108 dBA) | | Additional Area of Suitable Habitat Disturbed due to General Project noise (45 dBA) | | Additional Area of Suitable Habitat Disturbed due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Area without Winter Roads | % Lost or Altered | Area (ha) | % Lost | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered |
| Upland | | | | | | | | | | | |
| LSA | 35,096 | 2,484 | 7.1 | 14 | 0.0 | 378 | 1.1 | 243 | 0.7 | 3,149 | 2.9 |
| RSA | 486,392 | 2,484 | 0.5 | 14 | 0.0 | 378 | 0.0 | 243 | 0.0 | 5,561 | 0.1 |
| Lowland | | | | | | | | | | | |
| LSA | 74,848 | 6,163 | 8.2 | 20 | 0.0 | 572 | 0.8 | 310 | 0.4 | 4,342 | 3.1 |
| RSA | 505,563 | 6,163 | 1.2 | 20 | 0.0 | 572 | 0.0 | 310 | 0.0 | 6,967 | 0.4 |
| Total | | | | | | | | | | | |
| LSA | 109,944 | 8,647 | 7.9 | 34 | 0.0 | 950 | 0.9 | 553 | 0.5 | 7,491 | 3.0 |
| RSA | 991,955 | 8,647 | 0.9 | 34 | 0.0 | 950 | 0.0 | 553 | 0.0 | 12,527 | 0.2 |

*General Project Noise* — The total amount of area affected by elevated noise levels outside of the three PDAs is 5,598 ha or 0.04% of wildlife RSA (Table 9.5-12), of which 83 ha is mapped as suitable habitat for waterbirds (Table 9.5-13), and 553 ha is mapped as suitable habitat for upland birds (Table 9.5-14). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise* — The total amount of area affected by aircraft noise (80 dBA) outside of the three PDAs represents 2.2% of the wildlife RSA (27,140 ha; Table 9.5-12). In total, 1,103 ha (0.2%) of suitable waterbird habitat and 12,527 ha (0.2%) of suitable habitat for upland birds is mapped within the area disturbed by aircraft noise (Tables 9.5-13 and 9.5-14). Relative to the Goose Property PDA, sensory disturbance due to aircraft noise will be greater near the George Property PDA and the MLA where the noisier Dash 7 aircraft are anticipated to be used.

The combined effect of noise disturbance from blasting, general Project noise, and aircraft is anticipated to have a residual effect on migratory birds. The largest area over which noise will occur is within the flight impact zones, which overlap 1,103 ha of suitable waterbird habitat and 12,527 ha of suitable upland bird habitat outside the PDAs (Tables 9.5-13 and 9.5-14). The majority of the area assessed as being above noise guidelines for wildlife is within the Goose and George Property PDAs, which are assessed as lost habitat in Section 9.5.2.1.

*Noise Modelling to Evaluate Disturbance to Waterbirds Staging near Infrastructure*

The effects of noise disturbance on migratory birds were also evaluated by determining whether noise thresholds are predicted to be exceeded at two lakes where waterbirds were observed during spring and fall migration (Dragon Lake within the George Property PDA and Propellor Lake within the Goose Property PDA). No exceedances of the 45 dB night time disturbance threshold, or disturbance thresholds due to aviation and blasting noise were predicted at these two staging sites (Volume 4, Chapter 2; Rescan 2013c).

*Summary of Evaluations of Disturbance to Migratory Birds*

The effects of noise are predicted to be confined to the PDAs for nesting upland birds and waterbirds, which have already been evaluated as lost in the habitat lost section. Since only approximately 10% of the PDAs will be developed, it is likely that less than five flocks of waterbirds and approximately 3.1% of the population of upland bird. pairs in the wildlife LSA may experience visual disturbances especially from aircraft, and vibration disturbances from blasting within the PDAs. However, for this assessment, these effects are not considered as residual effects because the areas disturbed are already considered as lost.

Migratory birds may experience disturbances from noise primarily within the flight impact zones that extend outside the PDAs. These areas correspond to less than 0.2% of the suitable habitat available in the wildlife RSA, which is rated as low magnitude (Table 9.5-2). Mitigation is expected to lower but not completely eliminate the effect of disturbance to migratory birds, and thus a residual effect of disturbance on migratory birds is predicted to occur.

### *9.5.2.3 Disruption of Movement*

Lights on tall structures are known to attract migratory birds during their nocturnal migration, especially songbirds. Birds can become exhausted while circling lights, and can collide with lit structures resulting in mortality events (Longcore et al. 2013). Tall structures with lights will not be constructed for the Project. Thus, the Project is not expected to effect the movements of migratory birds.

### *9.5.2.4 Direct Mortality and Injury*

Mortality and injury of migratory birds are evaluated due to strikes with ground vehicles and aircraft, and as a result of nest destruction from vegetation clearing during Project construction and operations. To ensure that nests of migratory birds are not destroyed, ground clearing will be conducted outside of the sensitive nesting periods for migratory birds. If construction cannot be scheduled outside of the nesting period, a qualified on-site monitor may conduct pre-clearing surveys for migratory birds and their nests. Thus, mortality and injury of migratory birds is not expected to occur as a result ground clearing. Despite mitigation measures, some interactions of migratory birds with Project vehicles may be unavoidable, and thus the effects are evaluated in this section.

Waterbirds

Worldwide, strikes with aircraft cause significant mortality to waterbirds, and strikes of aircraft with waterbirds comprised the majority of bird-aircraft strikes reported by the US Air Force (Bird Strike Committee USA 2000 in Erickson, Johnson, and Young Jr 2005). However, strikes with aircraft occur most often at high altitudes at night when birds are migrating (Dolbeer 2006). Strikes at lower elevations (< 150 m) more often occur with geese foraging along airstrips (DeVault et al. 2011). Because most waterbird species migrate at night, and at high altitudes, collisions of migrating waterbirds with aircraft servicing the Project are unlikely. Large concentrations of waterbirds were observed during baseline studies at only one site within the flight impact zone of the airstrips at either the George or Goose Properties (Figure 9.1-1a). This site was identified as a key staging site, and is a small shallow lake just outside the George Property PDA (Figure 9.1-1a). Given mitigation measures to restrict flights over concentrations of migratory birds, no residual effect on waterbirds is predicted of direct mortality and injury resulting from interactions of waterbirds with aircraft servicing the project.

Upland Birds

Upland birds may be exposed to risk of mortality due to strikes with vehicles along Project roads. Strikes with ground vehicles account for the mortality of over a billion birds per year worldwide, mostly of small birds like passerines and other upland birds (Erritzoe, Mazgajski, and Rejt 2003; Erickson, Johnson, and Young Jr 2005). Mortality rates of birds due to vehicle strikes increase with traffic volume and speed (Erritzoe, Mazgajski, and Rejt 2003).

Strikes of upland birds with Project ground vehicles are expected to occur very rarely. During three years of wildlife monitoring at the Hope Bay Mine (2010 to 2012), only four bird mortalities (three songbirds and one ptarmigan) were recorded, likely as a result of vehicle strikes (Rescan 2011b, 2011a, 2013d). Less than 30 km of all-weather roads will be constructed for the Project, traffic volumes will be relatively low and speeds limited to 60 km/h. No migratory birds except ptarmigan will be present in the wildlife RSA during winter. Ptarmigan may be susceptible to mortality risk due to traffic on the winter roads, but road and traffic mitigation actions are expected to eliminate this effect. Thus, no residual effect of Project traffic on migratory birds is expected.

With the application of mitigation plans, no residual effect of direct mortality and injury is predicted for migratory birds.

### *9.5.2.5 Indirect Mortality*

Wildlife mortality may indirectly result from the Project if hunting is facilitated by easier access to game species along the proposed road. Increased hunter access to the wildlife RSA due to the Project would be only possible when the winter road is active during the winter months, when only ptarmigan are present in the wildlife RSA. Socio-economic studies conducted in the Kitikmeot Region report that

an increase in human immigration and hunting is unlikely in the Project area (Volume 8, Chapter 3). Road access will be restricted to Project employees, who will not be permitted to hunt. Thus, hunting of ptarmigan is unlikely, and therefore, indirect mortality of migratory birds due increased hunter access is not anticipated to occur.

Indirect mortality can also occur through increased rates of nest predation. Research has shown that the abundance of some nest predators of migratory birds—the Arctic and red fox, gulls, and the common raven—may be enhanced near industrial projects. Infrastructures and human wastes provide supplemental food, as well as structures for nesting and denning (reviewed in Liebezeit et al. 2009). Developments can also serve as a refuge to foxes from wolves, which prey upon and compete with foxes.

Previous research has not found population-level effects of Arctic developments on waterbird reproduction (Truett, Miller, and Kertell 1997), however, researchers have not tested for localized effects of augmented predator populations and the resultant effect on predation rates. Higher predation rates on songbird nests were found close to infrastructures in Prudhoe Bay, Alaska (Liebezeit et al. 2009). Despite low detection rates of foxes in bird surveys (gulls and jaegers comprised 80% of detections of nest predators) at Prudhoe Bay Alaska, most nests were predated by Arctic foxes (Liebezeit and Zack 2008).

Mitigation to reduce the possibility for indirect mortality will include proper waste management, and measures to exclude nesting and denning of bird and mammalian nest predators from Project infrastructure.

Quantification of Indirect Mortality Effects on Migratory Birds

Between 2002 and 2005, research within the oil fields of Prudhoe Bay Alaska found relatively high predation rates on songbird nests within 300 m of infrastructure, despite the introduction of waste management standards. No effects on nest predation of shorebirds and waterbirds were found, but this may have been due to low sample sizes (Liebezeit et al. 2009). Based on this research, nest predation rates close to Project infrastructure were used to evaluate effects of indirect mortality. Estimates for nest predation rates for songbirds were used to evaluate nest predation rates for shorebirds and waterbirds, due to the absence of reliable estimates for these two species groups.

Evaluation of Indirect Mortality Effects on Migratory Birds

Based on the findings of Liebezeit et al. (2009), it is expected that the probability of predation of migratory bird nests may increase to 68% within 300 m of Project infrastructure, relative to a background rate of 17% at least 6 km away. Because indirect mortality effects are anticipated to be limited to the three PDAs, and the residual effect of the loss of these areas has already been assessed in Section 9.5.2.1, no residual effect of indirect mortality is predicted for migratory birds with the PDAs.

#### *9.5.2.6 Attraction*

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. Attractants may include physical structures that provide habitat, or artificial waterbodies that tend to be warmer than surrounding natural ponds and lakes.

Waterbirds

Migrating waterbirds use bodies of water that open relatively early in the Arctic (Section 9.1.2.1), and thus waterbirds may be attracted to the tailings impoundment area (TIA). Numerous studies have documented the use by waterbirds of artificial waterbodies associated with mines, such as sewage and tailings ponds (Read 1999 and citations therein). In some cases, mortality of waterbirds has occurred as a result of exposure to contaminants in waterbodies (Ryan and Shanks 1996; Read 1999; Donato et al. 2007).

There will be no sewage ponds generated for the Project; instead water from the Sewage Treatment Plant will be discharged to the land during Project construction, and to the TIA during operation. If water quality in Project ponds (including the TIA) does not meet water quality guidelines for wildlife, appropriate management will be conducted to exclude birds from these areas (e.g., air cannons). The effectiveness of deterrent systems will be monitored and adaptively managed if they are not successful. No residual effects of contaminants on waterbirds are anticipated due to the Project (Section 9.5.2.7). With the application of mitigation measures, no residual effect of attraction to waterbodies associated with the Project is anticipated for waterbirds.

Upland Birds

The densities of some species of upland birds have been found to be higher near Arctic infrastructure and within urban areas relative to undisturbed sites (e.g., horned larks, semipalmated plover, white-crowned sparrows; Staniforth 2002; Male and Nol 2005; Smith et al. 2005). This result has been found for species that generally prefer open or gravelled habitats. This finding suggests that a small portion of the upland bird community may be attracted to the areas close to the Project footprints for establishment of breeding territories. It is likely that attracted birds will use Project infrastructure as habitat (e.g., elevated sites for perching and singing). Due to the possibility for higher nest predation rates close to infrastructure (Section 9.5.2.5), lower breeding productivity may result for breeding pairs attracted to Project infrastructure for territory establishment. This effect is evaluated in Section 9.5.2.8.

It is anticipated that a small number of birds that are attracted to Project infrastructure may experience mortality and injury. Over three years of monitoring at the Hope Bay mine, only four mortalities were reported of upland birds that had become trapped in infrastructure (Rescan 2011a, 2011b, 2013d). This effect will be minimized by mitigation measures to limit access to infrastructure by birds and to remove nesting material prior to egg-laying. With the application of mitigation activities, no residual effect on upland birds is predicted to occur as a result of their attraction to Project infrastructure and activities.

### *9.5.2.7 Exposure to Contaminants*

Exposure to contaminants in migratory birds due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6). This assessment resulted in contaminant hazard quotients for migratory birds predicted to be below a value of one, indicating that contaminants in migratory birds and their food chain components are not likely to increase above baseline conditions. Thus, a residual effect due to exposure to contaminants in migratory birds is not anticipated and is not considered further in the assessment.

### *9.5.2.8 Reduction in Reproductive Productivity*

Reproductive productivity is quantified as the number of surviving young produced per year per female. The combined effects of habitat loss, disturbance, and indirect mortality may result in declines in the breeding productivity of migratory birds. Migratory birds will most likely be affected by the Project through disturbances that result in habitat avoidance, and higher nest predation rates due to the attraction of foxes and other predators to the Project area. Each effect individually or synergistically could result in lower reproductive productivity.

Because disturbance and indirect mortality effects are anticipated to be limited to the three PDAs, and the residual effect of the loss of these areas has already been assessed in Section 9.5.2.1, no residual effect of reduced reproductive productivity is predicted for migratory birds with the PDAs.

### 9.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Management Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including migratory birds. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment, and are included in Volume 10.

A residual effect of the Project on migratory birds is anticipated resulting from habitat loss and disturbance. The following sections describe the mitigation and management measures that will be conducted to minimize or eliminate potential Project-related effects to migratory birds. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

#### *9.5.3.1 Mitigation for Habitat Loss*

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to migratory birds may include the following:

- Project infrastructure designed to avoid, where possible, the locations of identified waterbird staging areas (Volume 10, Chapter 20);
- the preferred Tailings Impoundment Area (TIA) located to avoid sensitive areas used by migratory birds such as staging and breeding areas (Volume 2, Chapter 2); and
- winter road access corridors only (no all-weather roads for re-supply routes or between the Goose and George Properties), to minimize effects of habitat lost to all migratory bird species, except ptarmigan which over-winter in the wildlife RSA (Volume 2, Chapter 2).

#### *9.5.3.2 Mitigation for Disturbance*

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance to migratory birds may include:

- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

#### *9.5.3.3 Mitigation for Mortality and Injury*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to migratory birds may include:

- pre-construction ground clearing conducted outside of sensitive nesting periods for migratory birds. If construction cannot be scheduled outside of sensitive nesting periods, a qualified on-site monitor may conduct pre-clearing surveys for migratory birds and nests (Volume 10, Chapter 20);

- all-weather roads restricted to PDAs, thereby minimizing the potential for vehicle strikes (Volume 2, Chapter 2); and
- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to migratory birds (Volume 10, Chapter 20).

#### *9.5.3.4 Mitigation for Indirect Mortality*

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to migratory birds may include:

- buildings designed and maintained to exclude wildlife from entering for nesting and denning (Volume 10, Chapter 20);
- a waste and wildlife attractant management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20).

#### *9.5.3.5 Mitigation for Attraction*

The primary mitigation and management strategies to minimize effects of wildlife attraction to the Project are described in the Landfill and Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10, Chapter 11), the Borrow Pits and quarry Management Plan (Volume 10, Chapter 16), and the Waste Management Plan detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to migratory birds:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- No sewage ponds created (Volume 2, Chapter 2);
- a waste and wildlife attractant management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- the use of wildlife-attracting dust suppressants avoided, where possible (Volume 10, Chapter 20);
- construction of tall structures that have the characteristics that can attract and cause mortality for migratory birds (i.e., tall, guyed towers with aircraft warning flashing lights) avoided (Volume 10, Chapter 20);
- lighting directed into facilities and toward the ground whenever possible (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20); and
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20).

#### *9.5.3.6 Mitigation for Exposure to Contaminants*

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to control the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to migratory birds.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- the use of wildlife-attracting dust suppressants avoided, wherever possible (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

### 9.5.4 Characterization of Residual Effects

Residual effects are those effects predicted to remain after the application of mitigation and management. The Project is not expected to result in a residual effect on migratory birds due to disruption of movement, direct and indirect mortality, or attraction. Two potential effects were predicted to have residual effects after mitigation: habitat loss and disturbance. These effects are assessed for their significance in the sections following.

#### *9.5.4.1 Habitat Loss*

Waterbirds

The effect on waterbirds of habitat loss as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because only 1.3% of waterbodies and

wetlands available in the wildlife RSA will be affected. Though habitat loss is likely and irreversible, it will be mitigated through closure planning, and this effect will be ameliorated by the relatively large amounts of habitat available in the wildlife RSA. The effect of direct habitat loss on waterbirds will occur sporadically over the long term, but will be limited to the Project footprint. Thus, the residual effect of direct habitat loss is expected to be Not Significant. Confidence is this assessment is high, because relatively few waterbirds and no key staging sites were observed within the PDAs during baseline studies, relatively few waterbirds are expected to experience habitat loss due to Project development.

Upland birds

The effect of habitat loss on upland birds, as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because only 1.7% of habitat available in the wildlife RSA will be affected. Though habitat loss will be irreversible, it will be mitigated through closure planning, and this effect will be ameliorated by the relatively large amounts of habitat available in the wildlife RSA. The effect of direct habitat loss on upland birds will occur sporadically over the long term, but will be limited to the Project footprint. Thus, the residual effect of direct habitat loss is expected to be Not Significant. Confidence is this assessment is high, because direct habitat loss is expected to occur within approximately 10% of the PDAs, causing displacement of an estimated 1,053 breeding pairs of the 10,527 ± 627 pairs within the three PDAs, which represents 0.9% of the estimated population size within the wildlife RSA.

#### *9.5.4.2 Disturbance*

Waterbirds

The effect on waterbirds of disturbance as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because with the exception of noise primarily from aircraft, disturbance effects are expected to be limited to the local areas near the three PDAs, which were assessed as lost habitat. The largest effect of disturbance outside the PDAs is predicted to be due to aircraft noise, which is predicted to affect less than 0.2% of suitable habitat within the wildlife RSA. Disturbance effects will be mitigated with flight altitude rules and flight paths to avoid large concentrations of waterbirds. Disturbance outside the PDAs is likely to occur sporadically over the medium term within the local extent of the Project. Disturbance effects will likely be reversible upon Project closure. Thus, the residual effect of disturbance is expected to be Not Significant. Confidence is this assessment is high, because baselines studies showed only one key staging site within disturbed areas outside the PDAs, and studies elsewhere found no measurable effects on the movements or distribution of waterbirds due to disturbances from industrial developments and activities (Truett, Miller, and Kertell 1997; S. R. Johnson 1998).

Upland Birds

The effect on upland birds of disturbance as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because with the exception of noise primarily from aircraft, disturbance effects are expected to be limited to the local areas near the three PDAs, which were assessed as lost habitat. The largest effect of disturbance outside the PDAs is predicted to be due to aircraft noise, which is predicted to affect less than 0.2% of suitable habitat within the wildlife RSA. Disturbance effects will be mitigated with flight altitude rules and flight paths. Disturbance outside the PDAs is likely to occur sporadically over the medium term within the local extent of the Project. Disturbance effects will likely be reversible upon Project closure. Thus, the residual effect of disturbance is expected to be Not Significant. Confidence is this assessment is high, because studies elsewhere have found few effects of Artic developments on upland birds outside of a 300 m zone of influence, which is encompassed within the three PDAs which were assessed as lost habitat (Male and Nol 2005; Smith et al. 2005).

### 9.5.5 Significance of Residual Effects

Considering the Project and the distribution of migratory birds within the wildlife RSA, the assessment of residual effects resulted in a Not Significant rating for the two residual Project effects (Tables 9.5-15 and 9.5-16):

- Direct Habitat Loss, rated Not Significant;
- Disturbance, rated Not Significant.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Volume 10, Chapter 20), the combined significance of residual effects for migratory birds is predicted to be **Not Significant** (Tables 9.5-15 and 9.5-16).

## 9.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

### 9.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. The cumulative effect assessment (CEA) general methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's potential incremental contribution to the potential cumulative effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Table 9.5-2). Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 9.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 9.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary and not the wildlife RSA.

**Table 9.5-15. Summary of Residual Effects Assessment for Waterbirds Resulting in Overall Significance Rating**

| | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| **Description of Residual Effects** | **Direction** *(positive, neutral, negative)* | **Magnitude** *(negligible, low, moderate, high)* | **Duration** *(short, medium, long)* | **Frequency** *(once, sporadic, continuous)* | **Geographic Extent** *(footprint, local, regional, beyond regional)* | **Reversibility** *(reversible, reversible with effort, irreversible)* | **Probability** *(unlikely, moderate, likely)* | **Confidence** *(low, medium, high)* | **(Not significant (N); Significant (S); Positive (P))** |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | High | **N** |
| Disturbance | Negative | Low | Medium | Sporadic | Local | Reversible | Likely | High | **N** |

**Table 9.5-16. Summary of Residual Effects Assessment for Upland Birds Resulting in Overall Significance Rating**

| | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| **Description of Residual Effects** | **Direction** *(positive, neutral, negative)* | **Magnitude** *(negligible, low, moderate, high)* | **Duration** *(short, medium, long)* | **Frequency** *(once, sporadic, continuous)* | **Geographic Extent** *(footprint, local, regional, beyond regional)* | **Reversibility** *(reversible, reversible with effort, irreversible)* | **Probability** *(unlikely, moderate, likely)* | **Confidence** *(low, medium, high)* | **Not significant (N); Significant (S); Positive (P)** |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | High | **N** |
| Disturbance | Negative | Low | Medium | Sporadic | Local | Reversible | Likely | High | **N** |

#### *9.6.1.1 Spatial Boundary*

The CEA boundary is different for each VEC species for which a CEA assessment was conducted because it was based on knowledge of each species' movement patterns and home range size.

#### *9.6.1.2 Temporal Boundary*

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

### 9.6.2 Potential Interactions of Residual Effects with Other Projects

Residual effects of the Project on migratory birds are predicted for habitat loss and disturbance (Section 9.5.2, Tables 9.5-15 and 9.5-16). Most residual Project effects on waterbirds and upland birds are expected to result from habitat loss.

To determine the potential for cumulative effects on migratory birds, it was determined whether migratory birds expected to interact with the Project are likely to regularly interact with nearby past, existing and future projects during spring, summer, and fall when they occur on the tundra. The zone of influence of the Project on migratory birds was assumed to be limited to within the three PDAs (Section 9.5.2).

The only past, present, or future project in the wildlife RSA is the Proposed Bathurst Inlet Port and Road project, a proposed all-weather road 75 km from the Goose Property, with a port site approximately 15 km from the MLA (Volume 9, Table 3.4-1), more than 13 km outside the zone of influence of the Project.

Thus, no cumulative effects of the Project on migratory birds are expected to occur, because it is expected that migratory birds interacting with the Project will not regularly interact with other nearby projects.

## 9.7 TRANSBOUNDARY EFFECTS

All Project residual effects were confined to the wildlife LSA, and there were no residual cumulative effects. The wildlife LSA lies completely within Nunavut, therefore no transboundary effects are expected.

## 9.8 MITIGATION AND ADAPTIVE MANAGEMENT

Mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC migratory birds. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) contains the wildlife mitigation and management plans that will be in place to reduce or eliminate potential effects to wildlife including migratory birds. Mitigation measures specific to migratory birds are listed in Section 9.5.3 and summarized in Section 9.8.5, Table 9.8-1.

In addition, mitigation and management plans will be in place to minimize potential effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including migratory birds. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2 — the Noise Abatement Plan can be found in Volume 10, Chapter 18;

- Air Quality: Volume 4, Chapter 1 — the Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7 — the Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

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

- Risk Management and Emergency Response Plan: Chapter 3;
- Fuel Management Plan: Chapter 4;
- Spill Contingency Plans: Chapter 5;
- Oil Pollution Emergency Plan: Chapter 6;
- Site Water Monitoring and Management Plan: Chapter 7;
- Ore Storage Management Plan: Chapter 8;
- Mine Waste Rock and Tailings Management Plan: Chapter 9;
- Landfill and Waste Management Plan: Chapter 10;
- Hazardous Materials Management Plan: Chapter 12;
- Explosive Management Plan: Chapter 13;
- Road Management Plan: Chapter 14;
- Shipping Management Plan: Chapter 15;
- Borrow Pits and Quarry Management Plan: Chapter 16;
- Fish Offsetting Plan: Chapter 21;
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22;
- Socio-economic Monitoring Plan: Chapter 23; and
- Mine Closure and Reclamation Plan: Chapter 29.

### 9.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of water bird staging sites. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of the PDAs after the redesign of Project elements. Table 9.8-1 in Section 9.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on migratory birds.

### 9.8.2 Best Management Practices

The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes eight separate plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to

minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to migratory birds are listed in Section 9.5.3, and in Table 9.8-1 in Section 9.8.5.

### 9.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and available. The Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

### 9.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring — facility-specific monitoring and focal species monitoring.

### 9.8.5 Summary Table of General Wildlife Mitigation and Adaptive Management Measures

Table 9.8-1 includes all planed mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on migratory birds.

**Table 9.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife — including Migratory Birds**

| Mitigation Category | Mitigation Measures |
|---|---|
| **1. Mitigation by Project Design** | |
| | 1. Project infrastructure designed to avoid, where possible, the locations of identified waterbird staging areas. |
| | 2. Infrastructure designed to minimize the Project footprint. |
| | 3. Winter road access corridors only (no all-weather roads for re-supply routes or between the Goose and George Properties). |

*(continued)*

**Table 9.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife — including Migratory Birds (continued)**

| Mitigation Category | Mitigation Measures |
|---|---|
| **1. Mitigation by Project Design *(cont'd)*** | |
| | 4. All-weather roads restricted to PDAs.<br>5. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination.<br>6. The preferred Tailings Impoundment Area (TIA) located to avoid sensitive areas used by migratory birds such as staging and breeding areas (Volume 2, Chapter 2).<br>7. No sewage ponds created.<br>8. Construction of tall structures that have the characteristics that can attract and cause mortality for migratory birds (i.e., tall, guyed towers with aircraft warning flashing lights) avoided.<br>9. Buildings designed and maintained to exclude wildlife.<br>10. WAD cyanide destruction inside the mill. |
| **2. Best Management Practices** | |
| | 1. Pre-construction ground clearing may be conducted outside of sensitive periods for migratory birds.<br>2. Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats.<br>3. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible.<br>4. Vehicles restricted to site roads, winter roads and quarry footprints during Construction and Operations.<br>5. Truck speed limits developed, signage installed to alert drivers of speed limits, and speed limits enforced.<br>6. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic. Road use restricted only to persons required for Project construction, operations and maintenance.<br>7. A waste and wildlife attractant management protocol developed.<br>8. The use of wildlife-attracting dust suppressants avoided, where possible.<br>9. Lighting directed into facilities and toward the ground, whenever possible.<br>10. A policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation, and enforced.<br>11. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.<br>12. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers.<br>13. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to the health of migratory birds.<br>14. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures. |

*(continued)*

**Table 9.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife — including Migratory Birds (completed)**

| Mitigation Category | Mitigation Measures |
|---|---|
| **3. Adaptive Management** | 1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:<br>• if negative wildlife interactions become a concern, or<br>• if results from the Wildlife Mitigation & Monitoring Program, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.<br>2. The Wildlife Effects Monitoring Plan (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies. |
| **4. Monitoring** | Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This plan will include:<br>1. footprint monitoring to monitor habitat loss;<br>2. noise monitoring to monitor disturbance to wildlife;<br>3. human activity monitoring of Project site roads and winter roads;<br>4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes;<br>5. fence and skirting monitoring to ensure that fences are operational and effective at excluding wildlife without causing them harm;<br>6. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and<br>7. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible.<br>Focal-species monitoring program to monitor Project-related effects on migratory birds within a zone of influence of the PDAs, in comparison reference areas.<br>1. Aerial and/or ground surveys for migratory birds to document Project-related changes in the distribution of migratory birds in the wildlife RSA. |

## 9.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:

- evaluate impact predictions in the effects assessment;
- continuously reduce uncertainty of Project effects on wildlife; and
- collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to migratory birds are summarized in the following sections.

### 9.9.1 Wildlife Mitigation and Monitoring Plan

#### *9.9.1.1 Facility-specific Monitoring*

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife effects include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area and George Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human activity monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

The objective of pre-clearing surveys for nests is to identify active nests of migratory birds that may be at risk of disturbance from vegetation clearing. Site clearing is planned for outside of bird sensitive periods; pre-clearing surveys may be conducted if some clearing is scheduled during bird nesting periods. If bird nesting activity is identified in areas slated for clearing, pre-clearing surveys will be used to:

- document birds nesting in areas slated for clearing;
- document locations and habitat where active nesting is occurring; and
- identify opportunities for protecting established nests.

Nest surveys will may be conducted within 14 days in areas scheduled to be cleared for construction using standard observation techniques by a qualified person. Surveys maywill be repeated if clearing activities do not occur within 14 days of the original survey. Reports of active nests will be provided to the appropriate regulators on a case-by-case basis to advise on the management response, if necessary. Findings will be summarized, along with any adaptive management initiatives resulting from nest findings; these will be included in the WEMP report.

#### *9.9.1.2 Focal-species Monitoring of the WEMP*

As a component of the WEMP, migratory birds will be monitored on a yearly basis during Project construction and every two years during operations (Volume 10, Chapter 20). Staging areas for waterbirds will be monitored from the air to identify important areas and to determine whether the Project is resulting in changes in the distribution of staging waterbirds. From the ground, the breeding productivity of the waterbird population within a zone of influence of the Project will be monitored and compared to breeding productivity within reference sites.

The relative abundance and species composition of the upland bird community may be monitored using a combination of PRISM and point count surveys. Surveys will be conducted within a zone of influence of the Project, and within reference areas. Baseline data will be integrated into the analyses to derive statistical tests for Project effects on the migratory bird community.

## 9.10 IMPACT STATEMENT

A review of the Project activities identified eight potential effects that may occur due to the construction and operation of the Project. These eight potential effects are: loss of habitat, disturbance, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of migratory birds was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on migratory birds resulted in the evaluation of two potential effects as likely having residual effects after mitigation: habitat loss and disturbance. Each of these effects are rated with a low magnitude and are rated as Not Significant, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Volume 10, Chapter 20).

Disruption of movement is not anticipated to result from the interactions of migratory birds with the Project. Direct mortality and injury, attraction to infrastructure, and exposure to contaminants are not anticipated to result in a residual effect upon implementation of mitigation measures. Based on empirical research in the western Arctic (Liebezeit et al. 2009), the effect of indirect mortality via nest predation due to the attraction of nest predators to Project infrastructure is expected to be limited to within approximately 300 m of Project infrastructure. In addition to the majority of disturbances, the effects of indirect mortality are expected to be contained within the PDAs. Thus, the synergistic effects of disturbance and indirect mortality resulting in reduced reproductive productivity are also expected to be confined to the PDAs. Because the PDAs were assessed as lost, indirect mortality and reduced reproductive productivity are not anticipated to result in a residual effect on migratory birds.

Relative to disturbance effects, the effect of habitat loss is expected to result in the largest residual effect on the migratory bird community within the wildlife RSA. This magnitude of this effect is rated low for waterbirds and upland birds. Disturbance effects are primarily expected to occur to staging waterbirds during the migration period as a result of aircraft servicing the George and Goose Property Areas. Mitigation measures which will include restrictions of flight altitudes to above 650 m over large concentrations of migratory birds will minimize this effect. However, it is expected that weather and other factors may require lower altitude flights, which may cause disturbance to waterbirds. Ongoing monitoring as part of the WEMP will determine the magnitude of disturbance effects, and whether further mitigation measures are needed. Overall, Project effects on migratory birds are rated as **Not Significant**.

It is expected that migratory birds interacting with the Project will not regularly interact with the only other project in the wildlife RSA (a reasonably foreseeable future project—BIPR), and thus cumulative effects of the Project on migratory birds are not expected to occur.

# 10. Raptors

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# 10. Raptors

## 10.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

### 10.1.1 Introduction

Arctic raptors can be divided into two guilds based on migration and nesting patterns. The gyrfalcon, snowy owl, and common raven are Arctic residents that overwinter in the Arctic. All other species migrate south in the fall and return in the spring to breed. Arctic-breeding raptors nest either on steep faces of rock outcrops, or on the ground. Bald eagles (*Haliaeetus leucocephalus*), which have been observed in the wildlife Regional Study Area (RSA), nest in both types of habitat at more southerly latitudes, but so far there have been no confirmed records of bald eagles breeding on the tundra.

Baseline studies have confirmed that four species of cliff-nesting raptors regularly breed in the wildlife RSA: peregrine falcon (*Falco peregrinus tundrius*), gyrfalcon (*Falco rusticolus*), rough-legged hawk (*Buteo lagopus*), and golden eagle (Aquila chrysaetos; Rescan 2012a, Appendix V5-5D; 2013e, Appendix V5-5C; 2014). Common ravens (*Corvus corvax*) which are considered to be 'functional raptors' also breed in the wildlife RSA (Rescan 2012a, Appendix V5-5D; 2013e, Appendix V5-5C; 2014) and are thus included in this assessment. Common ravens use similar food and breeding resources as cliff-nesting raptors, and construct stick nests that are used by raptor species for nesting (Poole and Bromley 1988; Poole 2011).

Three ground-nesting raptor species were observed in the wildlife RSA: snowy owl (*Bubo scandiacus*), short-eared owl (*Asio flammeus*), and northern harrier (Circus cyaneus; Rescan 2012a, Appendix V5-5D; 2013e, Appendix V5-5C; 2014). One short-eared owl nest was found within the wildlife RSA; breeding within the wildlife RSA was not confirmed for the other two ground-nesting species. Ground-nesting species were detected infrequently during baseline studies, likely because these species occur rarely within the wildlife RSA. Snowy and short-eared owls naturally occur at low densities, while northern harriers within the wildlife RSA represent individuals at the extreme northern limit of the species' range (Parmelee 1992; Wiggins, Holt, and Leasure 2006; Smith et al. 2011).

### 10.1.2 Population Trends and Conservation

Raptors are protected under the *Nunavut Wildlife Act* (2003) and the *Canada Wildlife Act* (1985; on National Wildlife Refuges and Migratory Bird Sanctuaries). Though most raptors are long distance migrants, raptors are not protected under the *Canadian Migratory Bird Convention Act* (1994).

Four cliff-nesting species and one ground-nesting species are of conservation concern. Golden eagle, gyrfalcon, and rough-legged hawk are listed as "Sensitive" in Nunavut by the Canadian Endangered Species Conservation Council (CESCC). Peregrine falcon, *tundrius* subspecies, while listed as Secure in Nunavut by the CESCC (2010), is federally listed on Schedule 1 as a population of Special Concern under *SARA* (Government of Canada 2013). The ground-nesting short-eared owl is also listed as Sensitive in Nunavut and is listed on Schedule 1 as a species of Special Concern under *SARA* (CESCC 2010; Government of Canada 2013).

As top predators in the food chain, raptors can bio-accumulate environmental toxins (Newton 1995). Hatching failure of eggs with thin shells caused population crashes in some raptor species globally, which led to worldwide banning of DDT organochlorine pesticides (Newton 1995). Species such as the peregrine falcon *tundrius* subspecies declined dramatically in the 1970s as a result of bio-accumulation of toxins like DDT (Hickey and Anderson 1968). The estimated 1,500 to 2,000 pairs currently occurring

in the Canadian Arctic is similar to pre-collapse numbers, indicating that the subspecies has recovered (COSEWIC 2007). However, the population is relatively small, making *tundrius* peregrine falcons vulnerable to natural and human disturbances.

Golden eagle populations are relatively stable in Canada and Alaska but declining elsewhere, whereas bald eagle populations appear to be increasing in the Arctic (Buehler 2000; Kochert and Steenhof 2002).

There is no evidence that the abundance of North American populations of gyrfalcons and rough-legged hawks have changed over the long term (Bechard and Swem 2002; Booms, Cade, and Clum 2008). However, local populations of both species are known to fluctuate in response to weather, and to prey availability, particularly where these species specialize on prey that show strong cyclical trends in abundance (Gunn 2003; Barichello and Mossop 2011). Gyrfalcon reproductive productivity and population abundance is strongly tied to 3-4 year cycles in abundance of ptarmigan, which form the majority of their prey early in the breeding season (Barichello and Mossop 2011; Nielsen 2011). Similarly, the reproductive performance of rough-legged hawks at Bathurst Inlet was positively correlated with the abundance of lemmings (Poole and Bromley 1988), which typically have a population cycle of high to low abundance every three to four years (Krebs 1964).

Similar to the rough-legged hawk, Arctic populations of ground-nesting raptors are known to fluctuate cyclically in response to the abundance of lemmings and other small mammals (Parmelee 1992; Wiggins, Holt, and Leasure 2006). In addition to cyclical fluctuations, the short-eared owl has shown a widespread declining trend in North America since the 1970s (COSEWIC 2008). Canadian populations of the short-eared owl appear to have decreased by 43% from 1966 to 1989 (GNWT ENR 2012), and by 23% over the past decade (COSEWIC 2008). The snowy owl was designated as Not at Risk by COSEWIC in 1995 because this species is widespread and there is no evidence of population declines. Approximately 30,000 pairs of snowy owls occurred in Canada in the early 1900s (Kirk, Hussell, and Dunn 1995); current population trends for the wildlife RSA are unavailable.

### 10.1.3 Distribution and Migration Patterns

During the breeding season, cliff-nesting raptors are distributed throughout the Arctic in areas where steep cliffs provide suitable habitat for breeding. The cliffs along Bathurst Inlet may be an area of high quality raptor habitat, indicated by a high density of peregrine falcon nests (data from the Northwest Territories and Nunavut Raptor Data Base (COSEWIC 2007). Inuit Traditional Knowledge (TK) has identified two areas along the eastern shore of Bathurst Inlet where cliff-nesting raptors are known to breed (KIA 2012); one of these areas is within the wildlife RSA.

Of the four cliff-nesting raptor species that regularly breed in the Project area, three species (golden eagle, peregrine falcon, and rough-legged hawk) are long-distance migrants and leave the Arctic to over-winter at more southern latitudes. These species typically arrive in May, and initiate egg-laying soon thereafter and then leave in October (Poole and Bromley 1988). The golden eagle and rough-legged hawk have a holarctic distribution, and are found in North America and Eurasia (Bechard and Swem 2002; Kochert et al. 2002), while the peregrine falcon is widely distributed across the globe from the Arctic to the tropics (White et al. 2002).

The gyrfalcon and common raven migrate short or long distances, but both species spend the winter in the Arctic. Some gyrfalcon populations make short movements between breeding cliffs and wintering areas, while some populations migrate thousands of kilometers over the Arctic ocean to ensure access to abundant prey during winter (Burnham and Newton 2011). Because they spend the winter in the Arctic, gyrfalcons and common ravens initiate breeding earlier than the other raptor species, usually

beginning in April, though clutch initiation has been observed as early as late March (Poole and Bromley 1988; Barichello and Mossop 2011).

Like migratory cliff-nesting raptors, the ground-nesting short-eared owl and northern harrier typically arrive on the tundra from southern latitudes in May, and leave before late October. The short-eared owl is found throughout the Eastern and Western hemispheres (Wiggins, Holt, and Leasure 2006), and the northern harrier is widely distributed in North and Central America and the Caribbean (Smith et al. 2011).

Snowy owls are both migratory and resident species – some individuals migrate south for the winter, and some over-winter in the Arctic, especially in years when prey are abundant (Therrien, Gauthier, and Bety 2011). Inuit TK includes observations of snowy owls and common ravens occurring in the Project region in winter (KIA 2012). Recent satellite tracking has revealed that over-wintering snowy owls migrate across the sea ice to access prey, such as seabirds using open water areas (Therrien, Gauthier, and Bety 2011). Snowy owls are distributed around the world throughout the northern hemisphere (Parmelee 1992).

In winter, gyrfalcons and snowy owls migrate to open water areas during winter to access marine resources, and therefore are expected to occur in low densities in the wildlife RSA in winter (Burnham and Newton 2011; Therrien, Gauthier, and Bety 2011).

### 10.1.4 Habitat Use and Diet

According to scientific research and Inuit Traditional Knowledge, cliff-nesting raptors in the Arctic select sites on cliffs and rocky outcrops for nesting, which occurs from April through August (Poole and Bromley 1988; KIA 2012). To provide protection from mammalian predators, nests are usually located on steep ledges at heights that make the ledges inaccessible from the bottom or top of the cliff. Cliffs also provide protection from the weather – the majority of raptors across all cliff-nesting species select south-facing cliffs within the wildlife RSA, probably because these are warmer (Poole and Bromley 1988; Rescan 2013e, Appendix V5-5C). Overhang is an important habitat characteristic for gyrfalcons and common ravens, because they initiate breeding early in the year, when weather can limit breeding productivity (Poole and Bromley 1988; Cade and Bird 2011). The availability of high quality cliff sites is likely an important determinant of breeding success, indicated by occupancy of the same cliff sites by breeding raptors for millennia (Sinclair et al. 2003; Burnham, Burnham, and Newton 2009).

Peregrine falcons and gyrfalcons do not construct nests, but instead make ‘scrapes’ of exposed soil on cliff ledges, or lay eggs in stick nests constructed by other species, frequently those of common ravens (Burnham, Burnham, and Newton 2009). Rough-legged hawk pairs usually build a new nest each year on exposed cliff ledges with little overhang (Poole and Bromley 1988), whereas golden eagles add to existing nests each year, such that their nests are usually distinguishable as a thick platform of sticks (Kochert et al. 2002).

Cliff-nesting raptors in the Arctic can be divided roughly into diet specialists and generalists, dependent on both the availability of prey and the selectivity of raptors for certain prey. The diet of rough-legged hawks is comprised almost entirely of lemmings and voles in years when these are abundant, whereas rough-legged hawks consume a wider range of prey when small mammals are scarce (Bechard and Swem 2002). Similarly, due to the timing of prey availability, the diet of gyrfalcons is comprised almost entirely of ptarmigan during winter and early spring; ptarmigan and Arctic hare comprise the majority of their diet during brood-rearing (Barichello and Mossop 2011). Peregrine falcons actively select birds as prey, primarily birds small enough for them to capture in flight, which on the tundra are mostly passerines, shorebirds, and ptarmigan (White et al. 2002). Golden eagles consume primarily ground squirrels, Arctic hare, and ptarmigan but are considered to be prey generalists relative to other raptor species in the Arctic (Poole and Bromley 1988; Mcintyre and

Schmidt 2012). Common ravens, golden eagles, and bald eagles on the tundra will also feed on carcasses of animals killed by mammalian carnivores (Sellers et al. 2003).

Raptors can make long distance movements from nests to search for food during the breeding season (e.g., up to approximately 50 km), but more typically forage within about 12 km from nest sites (Table 10.1-1). Thus, in addition to suitably tall and steep cliffs that provide protection from weather and exposure to the sun, raptors also select nest sites within habitats that provide abundant prey. For example, peregrine falcons more often hunt from a perch location, and need good 'look-outs' over areas such as wetlands with abundant small birds (White et al. 2002).

**Table 10.1-1. Average Home Range Size of Cliff-nesting Raptor Species**

| Species | Breeding Home Range (ha) | Maximum Breeding Home Range Radius (km) | Average Foraging Distance during Breeding (km) | Maximum Ranging Distance during Breeding (km) | Source |
|---|---|---|---|---|---|
| Golden Eagle | 900 to 13,000 | < 11 | Few data | 51 | Kochert et al. 2002 |
| Rough-legged Hawk | Few data | Few data | Few data | Few data | |
| Gyrfalcon | 14,000 to 120,000 | < 11 | Few data | 35 | Booms et al. 2008 |
| Peregrine Falcon | 35,000 to 150,000 | < 12 | 5 (3 to 8) | 43 | White et al. 2002 |

In the Arctic, ground-nesting raptors during the breeding season are associated with wetland habitat, where their small mammal prey is more abundant. Observations of ground-nesting raptors associated with wetland habitats is a component of Inuit Traditional Knowledge for the Project region (KIA 2012). Snowy owls choose dense, hummocky, dwarf shrub meadows for nesting (Parmelee 1992). Short-eared owls frequently choose a nesting site adjacent to wetlands where they forage for small mammals (Wiggins, Holt, and Leasure 2006; COSEWIC 2008). The northern harrier nests near grassy wetlands (Smith et al. 2011).

### 10.1.5 Baseline Data for Raptors

Aerial surveys by helicopter were conducted in the wildlife RSA to locate raptor nests on cliffs. In addition, habitat suitability modeling was conducted for cliff-nesting and ground-nesting raptors to estimate and map the availability of suitable nesting habitat in the wildlife RSA.

Densities of ground-nesting raptor species are expected to be very low within the wildlife RSA (Section 10.1.1). Data on ground-nesting raptor species was collected while walking line transects within 12 ha plots surveyed for upland birds (Volume 5, Chapter 9), and incidentally during baseline surveys for all wildlife VECs.

Specific sources of baseline terrestrial wildlife information used in this section include the following reports:

- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012a, Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013e, Appendix V5-5C);
- *Back River Project*: *2013 Wildlife Habitat Suitability Baseline Report* (Rescan 2013a, Appendix V5-5A); and
- *Back River Project*: *2013 Wildlife Baseline Report* (Rescan 2014).

The results of the 2013 wildlife baseline program will be available in 2014.

Other sources of supplementary wildlife data used in this section include:

- *Bathurst Inlet Port and Road Project*: *Wildlife baseline studies, 2001-2002* (Rescan 2002);
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008);
- *Hackett River Project: Wildlife Baseline Report 2008* (Rescan 2008); and
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012).

### *10.1.5.1 Methods for Baseline Data*

Raptor Nest Surveys and Incidental Observations

Baseline surveys were conducted in 2002 (Rescan 2002), 2007 (Gartner Lee Limited 2007), 2008 (Rescan 2008) , 2011 (Rescan 2012a, Appendix V5-5D) , 2012 (Rescan 2013e, Appendix V5-5C), and 2013 (Rescan 2014) to estimate the relative abundance, distribution, and breeding performance of cliff-nesting raptor species within the wildlife RSA (Figure 10.1-1). A survey in July 2002 was conducted in the northern portion of the wildlife RSA along the proposed BIPR road (within a 3 km buffer of the BIPR road alignment; Figure 10.1-1). Surveys conducted in 2007 covered the majority of the wildlife RSA with the exception of the cliffs along the Western River and tributaries, and the eastern side of Bathurst Inlet. In 2008, one survey was conducted in early June in the northern portion of the wildlife RSA (along the northern portion of the BIPR road and port site). Surveys in 2011 were concentrated (within a 30 km buffer) around the Goose Property, and in 2012 within a 30 km buffer around both the George and Goose Properties. Surveys conducted in 2013 were focused in the northern portion of the wildlife RSA near the proposed MLA, near the Goose Property Area and in a reference area along the Western River drainage (Figure 10.1-1).

During each survey, nest sites identified during previous surveys within the survey area were re-visited, and data were collected at any new nest sites found. Two aerial surveys were conducted each year: 1) a spring occupancy survey to determine whether historical and newly-found nest sites were occupied by breeding raptors; and 2) a summer productivity survey to determine the reproductive performance of raptors, measured as the proportion of occupied nests at which breeding pairs produced young, and the mean brood size among nests at which accurate counts of young could be made.

A database was compiled containing all nest locations collected from previous surveys conducted in the study area since 2002. A unique ID was assigned to each individual nest site, defined as a cliff site where one adult or a pair was observed displaying territorial behaviour during the breeding season. Nest sites typically contain more than one nest. The database contains the data collected at each nest visit, during both occupancy and productivity surveys, across baseline studies for the Project and for other projects.

A nesting territory is a confined locality within the home range of a breeding pair containing one or more nests where no more than one pair is known to have bred at one time (Steenhof and Newton 2007). Without several years of monitoring data, is difficult to identify distinct nest sites (i.e., on different cliffs) belonging to the same territory. Without banded individuals, nests sites belonging to the same territory are identified based on the occupancy history of nest sites, such that only one breeding pair of a particular species can use a territory in a given year (e.g., (Nielsen 2011). Applying this method, clusters of nests belonging to the same species found across multiple baseline survey years were mapped as distinct nest sites. If an adjacent nest site was unoccupied in one year, but occupied by another pair of the same species in a subsequent survey year, then these two adjacent nest sites were then labelled as two distinct nesting territories. Thus, the database of nest sites

probably represents the majority of breeding territories found within the surveyed areas of the wildlife RSA, though some portion of nest sites likely belong to the same breeding territories.

Observations of ground-nesting raptors generally occurred during upland bird surveys conducted in the wildlife RSA using the Program for Regional and International Shorebird Monitoring (PRISM) methodology (CWS 2010), and incidentally during other baseline studies conducted in the wildlife RSA between 2007 and 2013 (Gartner Lee Ltd. 2008; Rescan 2012a, Appendix V5-5D; 2013e, Appendix V5-5C; 2014). All ground-nesting raptor species observed on the ground or while flying were recorded.

Habitat Suitability Modeling

To estimate the availability of suitable habitat for cliff-nesting raptors, habitat suitability mapping was conducted for the spring nesting season using two methods (Rescan 2013a, Appendix V5-5A). Suitable nesting habitat was defined as areas within a one kilometre radius from raptor nests. A one-kilometer radius around active nests was assumed to be large enough to encompass most alternate nests sites within the territory of a breeding pair. Thus, a one kilometer radius around active nests was assumed to represent core nesting habitat for raptors within the wildlife RSA. All other areas were designated as unsuitable habitat. Secondly, suitable habitat was considered to be south-facing rock faces taller than 10 m and within 1 km of water; all other areas were considered to be unsuitable (Rescan 2013a, Appendix V5-5A). To calculate the total amount of suitable habitat, areas mapped as suitable using these two methods were summed, and areas of overlap were excluded.

To estimate the availability of suitable habitat for ground-nesting species, the short-eared owl was selected as the representative species because it is a species of conservation concern (Rescan 2013a, Appendix V5-5A). Habitat suitability modeling was conducted for the spring nesting season. The summer (brood rearing) season was not modeled as it was assumed that the majority of the terrestrial portion of the wildlife LSA and wildlife RSA would be suitable for hunting. Suitable habitat for ground-nesting raptors was considered to be areas with high cover of low to tall shrubs and no surface water. All other areas were considered unsuitable nesting habitat for ground-nesting raptors (Rescan 2013a, Appendix V5-5A).

### *10.1.5.2 Results of Baseline Data Collection*

Baseline Raptor Nest Surveys and Incidental Observations

The distribution of raptor nest sites found during baseline surveys is highly correlated with the location of cliffs, mapped within the wildlife RSA from slope classification based on Digital Elevation Modeling (Figure 10.1-1). Cliffs within the wildlife RSA are found primarily along large rivers and their tributaries, such as the Western River in the eastern half of the wildlife RSA, where approximately half of the nest sites were found (Figure 10.1-1). Within the wildlife LSA, land slope rarely exceeds 15%, and thus relatively few nest sites were found in the wildlife LSA (Rescan 2013c, Appendix V5-3A). Most of the nest sites observed during baseline surveys were found on cliffs that faced south or south-west (Rescan 2013e, Appendix V5-5C). With the exception of one common raven and one short-eared owl nest, no raptor nests were found within the southeast portion of the wildlife RSA during baseline studies, where very few cliffs are found (Figure 10.1-1).

The largest cliffs within the wildlife RSA, reaching up to 610 m, are found along the eastern shoreline of Bathurst Inlet and were identified as important cliff-nesting habitat by Inuit Traditional Knowledge (TK; KIA 2012). A second area for raptor habitat was identified by Inuit TK near the outflow of Beechey Lake (KIA 2012). These areas were not surveyed because they are more than 1.5 km from any potential sources of Project-related effects, and thus raptors nesting there are not expected to regularly interact with the Project.

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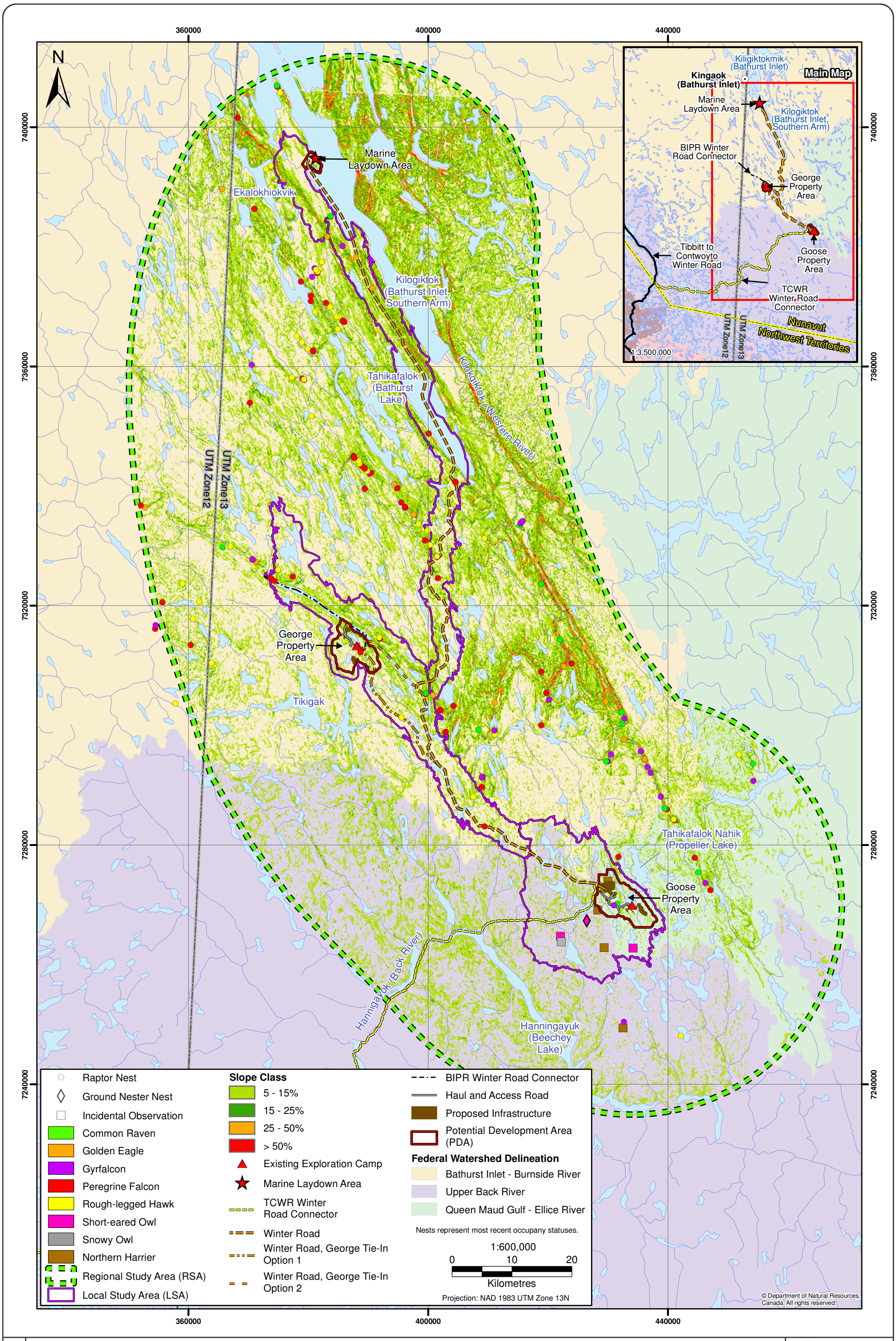


Figure 10.1-1

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# Nest Site Locations of Raptors and Incidental Observation of Ground-nesting Raptors in the Regional Study Area, 2002 to 2013

Figure 10.1-1

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A total of eight raptor species as well as the common raven were observed either during aerial raptor nest surveys or incidentally during other field surveys (Table 10.1-2). Of the eight raptor species, breeding was confirmed for peregrine falcon, gyrfalcon, rough-legged hawk, golden eagle, short-eared owl, and common raven (Table 10.1-3). The peregrine falcon was the most frequently observed raptor within the wildlife RSA (Table 10.1-2), and based on the relative frequency with which it occupied nest sites, the peregrine falcon was likely the most abundant cliff-nesting raptor species in the wildlife RSA (Table 10.1-3).

**Table 10.1-2. Total Number of Raptors Observed in the Wildlife RSA during 2007, 2011, 2012, and 2013 Surveys**

| Raptor Species | Total Number of Raptors Observed in the RSA during 2007, 2011, 2012, and 2013 Surveys (incidental observations in heses) | | | |
|---|---|---|---|---|
| | 2007 | 2011 | 2012 | 2013 |
| Peregrine Falcon[1] | 6 (1) | 5 (1) | 25 (4) | 27 (4) |
| Gyrfalcon[1] | (1) | 12 (1) | 17 (4) | 20 (2) |
| Rough-legged Hawk[1] | (1) | 5 | 14 (5) | 27 (6) |
| Golden Eagle[1] | 6 (1) | 1 (3) | 7 (8) | 11 (5) |
| Bald Eagle | - | - | (7) | (12) |
| Common Raven | (6) | 2 | 4 (10) | 10 (2) |
| Northern Harrier | - | (2) | | (3) |
| Short-eared Owl[1] | (1) | 1 | (2) | (4) |
| Snowy Owl | - | | (1) | (1) |
| Unknown Falcon | - | 5 | - | 7 (5) |

[1] *Species of Conservation Concern*

**Table 10.1-3. Total Number of Occupied Nest Sites Detected in the Wildlife RSA during Baseline Surveys 2002 to 2013**

| Raptor Species | Total Number of Nests by Survey Year (number of nests with eggs or nestlings in parentheses) | | | | | |
|---|---|---|---|---|---|---|
| | 2002* | 2007 | 2008** | 2011[1] | 2012 | 2013 |
| Peregrine Falcon[2] | 9 (8) | 39 (28) | 11 (0) | 1 (0) | 14 (7) | 16 (11) |
| Gyrfalcon[2] | 2 (1) | 2 (2) | 5 (0) | 4 (0) | 11 (9) | 10 (6) |
| Rough-legged Hawk[2] | 8 (8) | 27 (24) | 2 (0) | 4 (0) | 11 (11) | 16 (10) |
| Golden Eagle[2] | 0 (0) | 9 (9) | 3 (1) | 1 (0) | 7 (7) | 7 (5) |
| Bald Eagle | - | - | | - | - | - |
| Common Raven | 1 (1) | 4 (3) | | - | 5 (5) | 9 (8) |
| Northern Harrier | - | - | | - | - | - |
| Short-eared Owl[2] | - | - | | 1[3] (unknown) | - | - |
| Unknown Falcon | - | - | | 2 (0) | - | - |
| Snowy Owl | - | - | | - | - | - |

[1] *Survey conducted within a 30 km radius around Goose Property only*
[2] *Species of Conservation Concern*
[3] *Nest found during upland bird survey*
** no occupancy survey was conducted so a high proportion of nests found had eggs or young (most adults who did not breed had likely moved away from nest site)*
*** no productivity survey so no confirmation of breeding (most nests found prior to egg laying or actual nest not found so no eggs confirmed in most cases)*

Across all baseline surveys, the location of a total of 147 raptor nest sites have been mapped in the areas surveyed within the wildlife RSA (Figure 10.1-1). In 2012, a year with relatively high survey coverage, 48 of 87 nest sites were occupied by raptors (Table 10.1-3), resulting in an estimated occupancy rate of 55% of available nest sites. Extrapolation of this estimated rate of occupancy results in an estimated 81 pairs of raptors that attempt to breed within approximately 80% of the wildlife RSA each year (excluding the eastern side of Bathurst Inlet). This number represents a rough estimate of the breeding population within the surveyed area, and is expected to vary from year to year, dependent primarily on food and weather conditions.

In contrast to cliff-nesting species, ground-nesting raptors only rarely re-nest in the same site, though up to 30% of pairs may be faithful to the general area of breeding home ranges (Parmelee 1992; Wiggins, Holt, and Leasure 2006; Smith et al. 2011). No short-eared owls were observed during 2012 at or within 2 km of the nest site found in 2011. Ground-nesting species were relatively infrequently observed (Figure 10.1-1).

Habitat Suitability Modeling

*Cliff-nesting Raptors*

By superimposing a 1 km radius buffer on all active raptor nests, an estimated 3.6% of the wildlife LSA and 3.6% of the wildlife RSA contains suitable habitat for cliff-nesting raptors (Table 10.1-4; Figure 10.1-2). Modeling of cliffs taller than 10 m and within 1 km of water resulted in smaller estimates of habitat amount, comprising 0.4% of the wildlife LSA and 2.6% of the wildlife RSA. In total, 4% of the wildlife LSA and 6.2% of the wildlife RSA is estimated to contain suitable habitat for cliff-nesting raptors. The remainder of the wildlife LSA and RSA (96% and 93.8%, respectively) was mapped as unsuitable habitat (Table 10.1-4; Figure 10.1-2).

**Table 10.1-4. Area and Proportion of Suitable and Not Suitable Habitat within the LSA and RSA for Cliff-nesting Raptors**

| Suitability Rating | Model Type | Amount of Habitat in the LSA[1] | | Amount of Habitat in the RSA[1] | |
|---|---|---|---|---|---|
| | | Area (ha) | % of LSA[2] | Area (ha)[3] | % of RSA[2] |
| Suitable | Active Nests with 1 km Radius Buffer | 4,790 | 3.6% | 45,674 | 3.6% |
| | Cliff-Nesting Habitat | 643 | 0.4% | 33,413 | 2.6% |
| Not Suitable | | 128,973 | 96% | 1,182,917 | 93.8% |

*[1] LSA = 134,370 ha, RSA = 1,262,005 ha. Approximately 4,852 ha of the wildlife RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,153 ha.*
*[2] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100% (e.g., 99% or 101%).*
*[3] Includes area of Local Study Area (LSA)*

*Ground Nesting Raptors - Short-eared Owl*

Approximately half of the wildlife LSA (51.9%) and one third (32.1%) of the wildlife RSA was mapped as suitable nesting habitat for ground-nesting raptors, based on the habitat requirements of the short-eared owl (Table 10.1-5; Figure 10.1-3). These results are based on the portion of both study areas that contain tall or dense shrubby areas.

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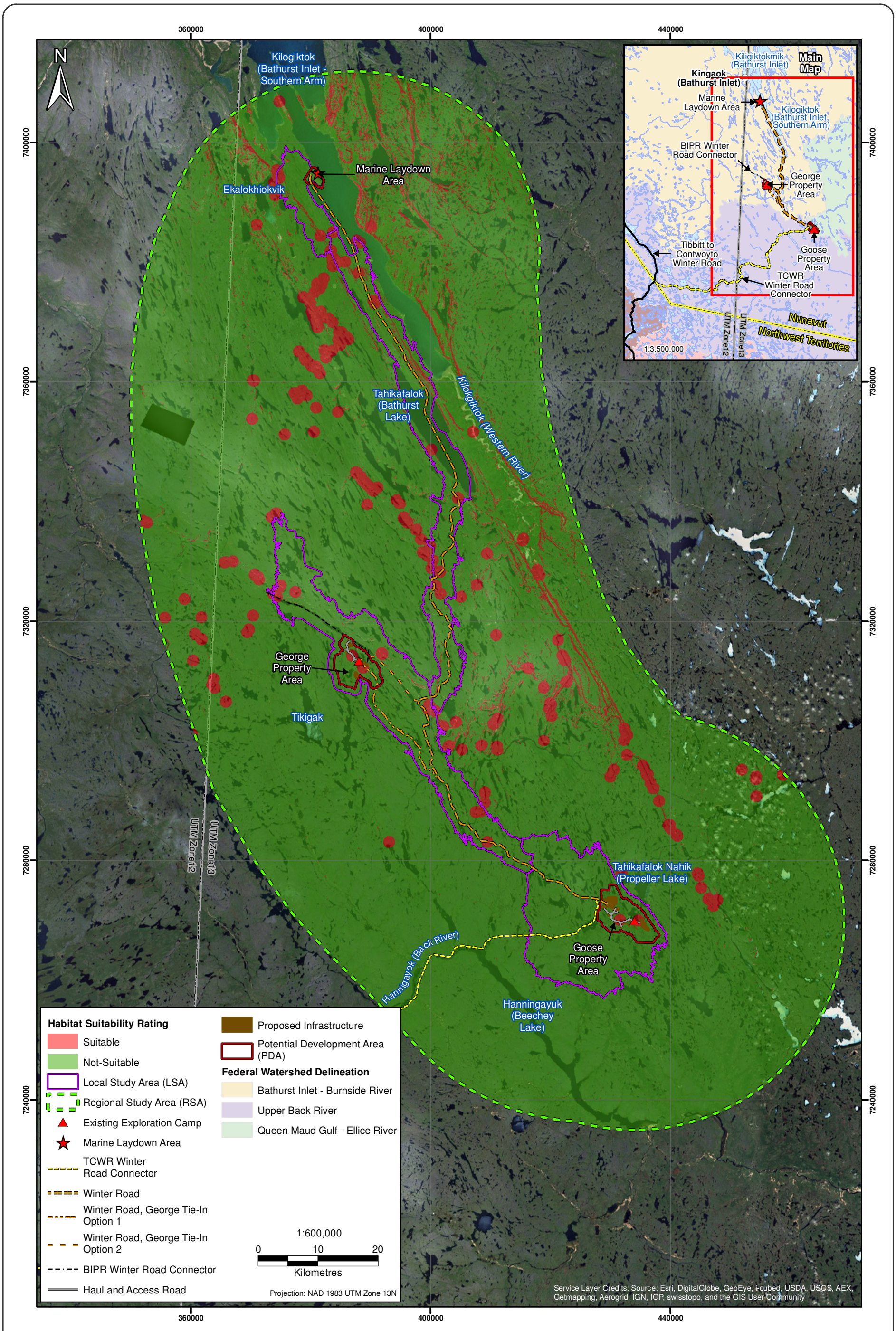


Figure 10.1-2

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# Cliff-nesting Raptors: Nesting Habitat in the Local Study Area and Regional Study Area

Figure 10.1-2

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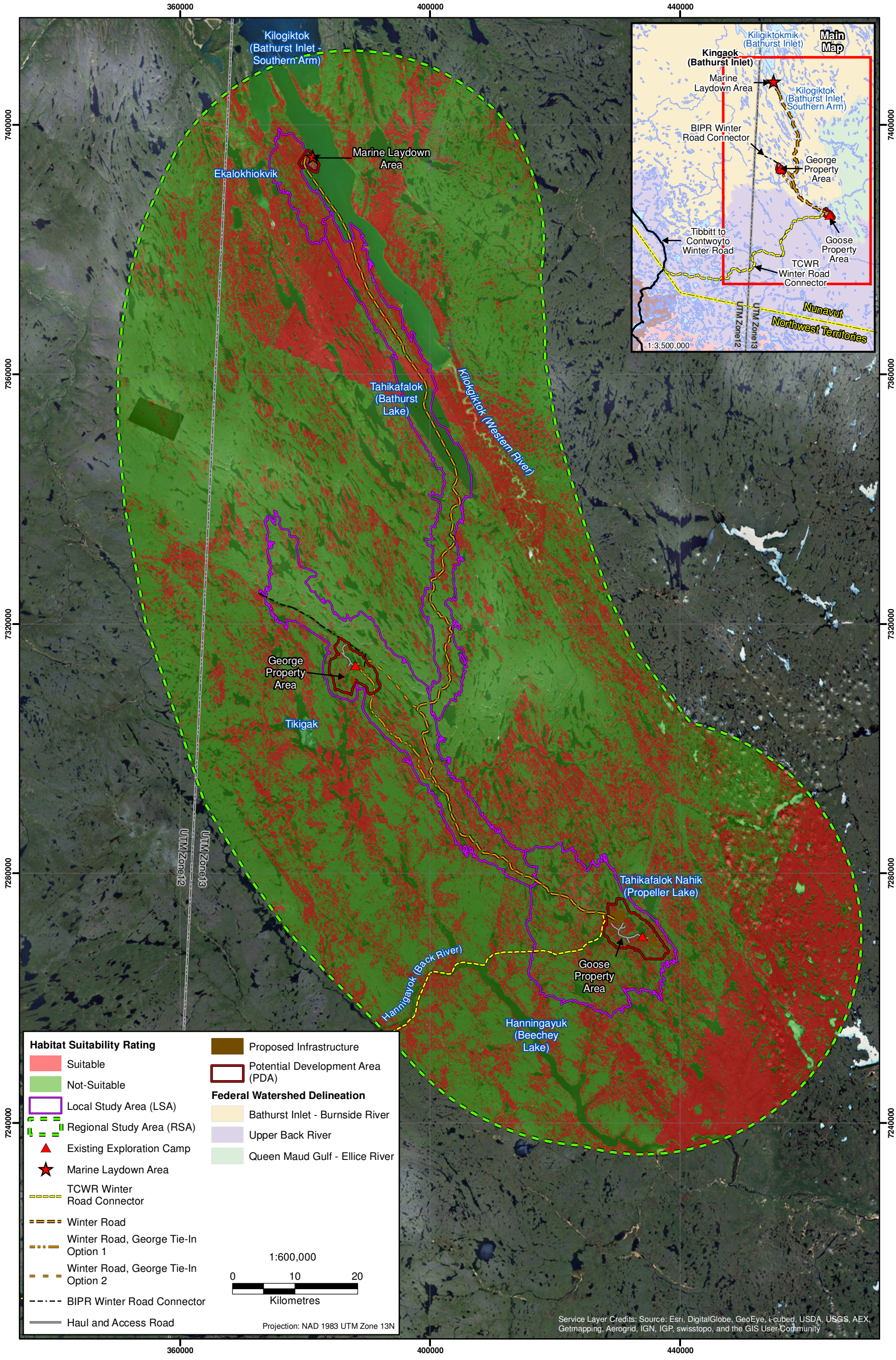


Figure 10.1-3

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# Short-eared Owl: Nesting Habitat in the Local Study Area and Regional Study Area

Figure 10.1-3

Rescan an ERM company

**Table 10.1-5. Area and Proportion of Suitable and Not Suitable Habitat within the LSA and RSA or Short-eared Owl**

| Suitability Rating | Amount of Habitat in the LSA[1] | | Amount of Habitat in the RSA[1] | |
|---|---|---|---|---|
| | Area (ha) | % of LSA[2] | Area (ha)[3] | % of RSA[2] |
| Suitable | 69,805 | 51.9% | 404,975 | 32.1% |
| Not Suitable | 64,565 | 48.1% | 852,178 | 67.5% |

*[1] LSA = 134,369.31 ha, RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the wildlife RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,152.58 ha.*
*[2] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100% (e.g., 99% or 101%).*
*[3] Includes area of Local Study Area (LSA)*

## 10.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The report Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012) was reviewed for information on the ecology of raptors (KIA 2012). Traditional Knowledge provides insight into the importance of cliffs to nesting raptors including eagles, falcons, and hawks, citing that raptor nests are located on high cliffs, and in fact, most cliffs will have nesting raptors(KIA 2012). Cliff nesting habitat identified by Inuit in the wildlife RSA includes areas west of Goose Property on the northern shores of Beechey Lake, near Kingaok, as well as on the eastern shores of Bathurst Inlet near Omingmaktok (KIA 2012). Inuit also recognize that ground-nesting raptors prefer areas around wetlands or non-cliff areas as they hunt mainly small rodents. This knowledge was used to prioritize areas to search for raptor nests during baseline studies.

The following reports were reviewed for TK specific information related to raptors:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VEC selection, assessment boundaries, and recommendations for mitigation and adaptive management.

### 10.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds were also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou.

This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, cliffs, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

### 10.2.2 Incorporation of TK for VEC and VSEC Selection

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

### 10.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013b). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

### 10.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

### 10.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), thoughts from Inuit people regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby

reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the DEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

## 10.3 VALUED COMPONENTS

### 10.3.1 Potential Valued Components and Scoping

The scoping process for determining VECs is outlined in the General Assessment Methodology Chapter (Volume 9, Chapter 1), and included the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

As part of the scoping process, the following aspects were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by NWA;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members.

### 10.3.2 Valued Components included in Assessment

Raptors were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Raptors were selected as a VEC based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations.

Of the nine raptor species occurring in the region, four cliff-nesting and one ground-nesting species are of conservation concern. The *tundrius* subspecies of the peregrine falcon that occurs in the wildlife RSA, while listed as Secure in Nunavut by the CESCC (2010), is federally listed on Schedule 1 as a population of Special Concern under the *Species at Risk Act* (CESCC 2010; Government of Canada 2013). The golden eagle, gyrfalcon, and rough-legged hawk are listed as Sensitive in Nunavut by the Canadian Endangered Species Conservation Council (CESCC). The short-eared owl is listed as Sensitive in Nunavut and is also listed on Schedule 1 of SARA as a species of Special Concern (Government of Canada 2013).

Raptors provide an important ecological role in Arctic ecosystems as top predators in the food chain. Raptors can serve as indicator species, because the breeding dynamics of raptors can influence the breeding of other bird species (e.g., geese), which nest in close proximity to raptors to seek protection from mutual nest predators, such as wolves and foxes (Bety et al. 2001). Fluctuations in breeding productivity of some Arctic-breeding raptor species appear strongly tied to changes in prey populations (e.g., rough-legged hawk and lemmings; Bechard and Swem 2002), and thus, declines in raptor productivity can indicate effects on predator-prey dynamics.

Breeding raptors can serve as indicators of the effects of human activities on ecosystem health - as top predators in the food chain they are sensitive to environmental conditions (Sergio et al. 2008). Raptors bio-accumulate environmental toxins, which in previous decades caused hatching failure of eggs and subsequent major population crashes in some species, resulting in the worldwide banning of DDT organochlorine pesticides (Newton 1995).

## 10.4 SPATIAL AND TEMPORAL BOUNDARIES

### 10.4.1 Spatial Boundaries

Project-related effects on raptors were evaluated within two study areas: a Local Study Area (LSA) and a larger Regional Study Area (RSA; Figure 10.4-1).

#### *10.4.1.1 Local Study Area*

The boundaries of the LSA for raptors were set to encompass the following:

- the Goose and George Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose and George Property Areas, respectively;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, George, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs associated with the Goose Property, George Property, and MLA. The wildlife LSA covers an area of approximately 134,369 ha (Figure 10.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

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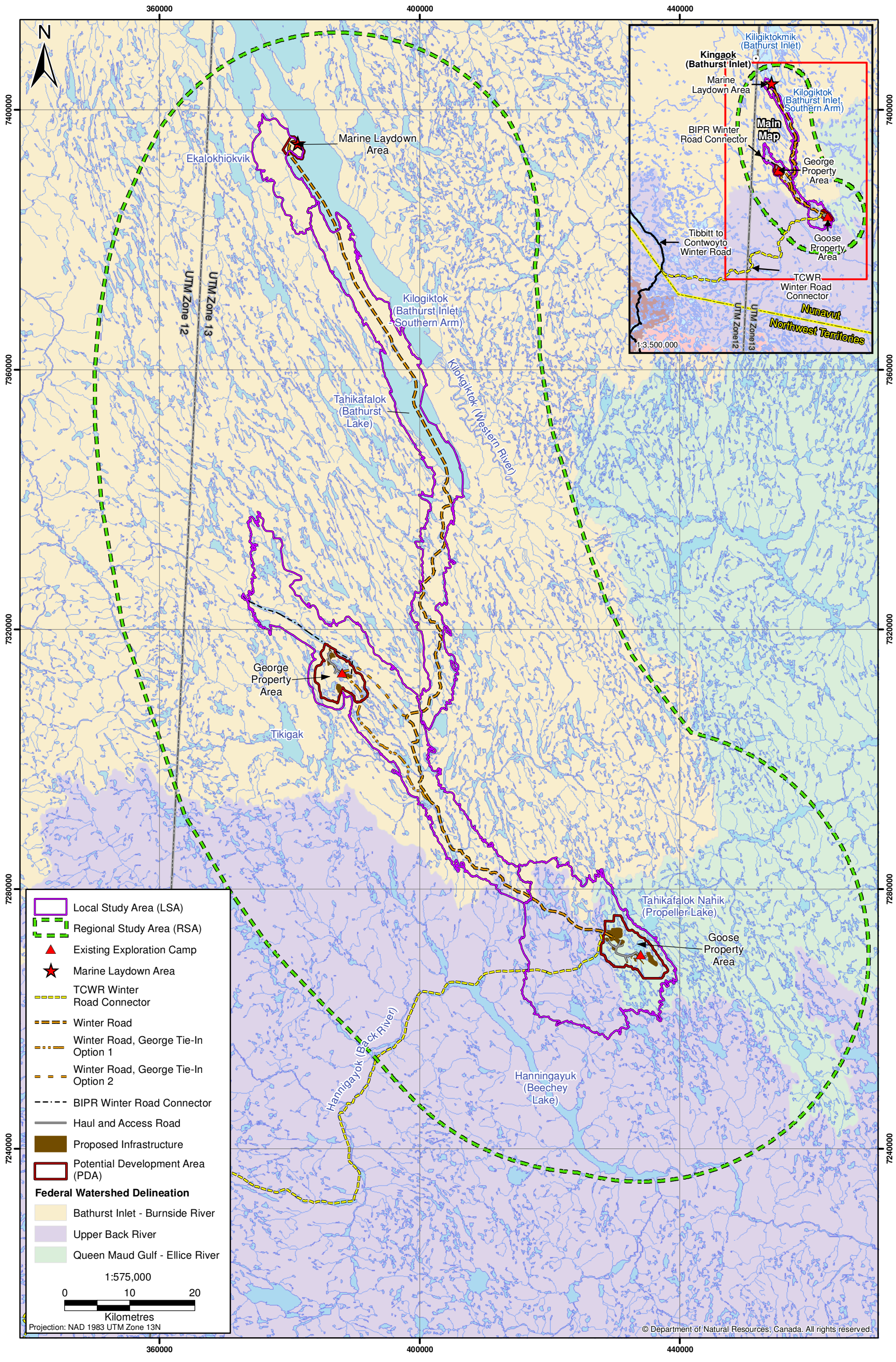


Figure 10.4-1

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# Local Study Area and Regional Study Area for Raptors

Figure 10.4-1

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#### *10.4.1.2 Regional Study Area*

The RSA for raptors encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three Project areas. The RSA covers an area of approximately 1,262,005 ha (Figure 10.4-1). The wildlife RSA extends slightly more than 35 km from proposed infrastructure on the eastern side to encompass the Western River.

### 10.4.2 Temporal Boundaries

The Project has an approximate planned life of 24 years (not including the Post-closure, Temporary Closure, or Care and Maintenance phases). The temporal boundaries used for the raptor effects assessment follow the time periods of the phases of the Project as presented in Table 10.4-1.

**Table 10.4-1. Temporal Boundaries – Project Phase Durations**

| Activities | Duration |
|---|---|
| Site Preparation | 2 years |
| Construction Phase | 2 years |
| Operational Phase | 10 years |
| Reclamation and Closure Phase | 10 years |
| Post-closure Phase | 5 years |
| *Other Potential Phases* | |
| Temporary Closure | Less than 2 years |
| Care and Maintenance phase | 2 to 10 years |

The majority of raptor species migrate in spring and fall, occurring in the wildlife RSA during the non-winter seasons only. The gyrfalcon, snowy owl, and common raven over-winter in the Arctic and thus may interact with the Project throughout the year.

## 10.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

The potential effects of the Back River Project (the Project) on raptors within the wildlife Regional Study Area (RSA) are assessed in this Section of the DEIS. Academic and monitoring studies have shown that under certain circumstances raptors may be susceptible to development-related disturbances, which may result in displacement of raptors from preferred habitat, and possible declines in their breeding productivity and population abundance (Steidl and Anthony 2000; Whittington and Allen 2008). For this reason, potential effects of the Project on raptors were considered. In the following assessment of the effect of the Project on raptors, qualitative and quantitative information was used to characterize the potential residual effects, and predict residual effects that may remain following mitigation and management strategies.

### 10.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on raptors as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. identification of potential interactions between the Project and raptors;
2. characterization of the potential effects that could result from these interactions;
3. identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;

4. characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. determination of the significance of residual effects using eight attributes to rate the residual effects on raptors including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on raptors is evaluated for the construction, operations, decommissioning, and post-closure periods as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, effects are evaluated for the phase associated with the worst-case scenario, which for raptors is anticipated to be during blasting at open pits throughout Project operations. Lower effects are anticipated during all other Project phases.

#### *10.5.1.1 Indicators Used to Characterize Potential Residual Effects*

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 10.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger an assessment of potential residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of 'yes' or 'no' where triggering of residual effects assessment occurred if the indicator value was "yes."

**Table 10.5-1. Criteria and Indicators Used to Characterize Potential Effects on Raptors**

| Potential Effect | Criteria | Indicator |
|---|---|---|
| Habitat Loss | Change in Population Health | Amount (ha) of high-quality habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA |
| Disturbance due to Noise | Change in Population Health | Amount (ha) of high-quality habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA |
| Disruption to Movement | Change in Population Health | Presence of tall structures |
| Direct Mortality and Injury | Change in Population Health | Collisions of raptors with vehicles occurs in other locations |
| Indirect Mortality | Change in Population Health | Predicted increase in human access to wildlife RSA |
| Attraction | Change in Population Health | Attraction occurs at similar projects in Nunavut and Northwest Territories |
| Exposure to Contaminants | Change in Population Health | Predicted Hazard Quotients for metals in environmental media and wildlife |
| Reduction in Reproductive Productivity | Change in Population Health | Literature suggests combined residual effects on raptors |

#### *10.5.1.2 Magnitude Ratings for Residual Effects*

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects is provided in Table 10.5-2.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

**Table 10.5-2. Definitions of the Magnitude Ratings for Population Health Criterion**

| Magnitude Rating | Magnitude Descriptor of Criteria (Population Health) |
|---|---|
| Negligible | No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%. |
| Low | Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%. |
| Moderate | Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%. |
| High | Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%. |

*Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects, the effect on the sub-population and thus the magnitude of the effect was assessed using professional judgment and literature review.*

Population health can be measured using various criteria, either indirectly using measures of change in population health via alterations in habitat availability and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for raptors, which provide benchmark measures, as well as estimates of the natural variability.

Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

### *10.5.1.3 Overall Significance Ratings for Residual Effects*

To assess the significance of residual effects, eight descriptors for evaluating residual biophysical effects were used and defined in Volume 9, Chapter 1: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. To assess residual effects, quantitative data were used as a default approach. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 10.5-2) and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 10.5-3). For example, a residual effect receives a rating of ‘not significant’ if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1).

Finally, the degree of uncertainty in the rating was provided as a qualifier.

**Table 10.5-3. Definitions of Significance Ratings for Residual Effects on Raptors**

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

### 10.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions between the VEC raptors and the Project is provided in Volume 9, Chapter 1. Raptors may interact with most Project activities during all Project phases. Interactions will vary across species depending on migratory guild. As resident species, the gyrfalcon, common raven, and snowy owl occur in the wildlife RSA during winter, and thus may interact with traffic on the winter roads, whereas all other raptor species are migratory and do not occur in the wildlife RSA during winter.

Interactions will also depend on the distance between infrastructure and the nest sites and home ranges of individual raptors. Raptors nesting close to infrastructure (e.g., within the 1.5 km zone of influence for disturbance based on Flight Initiation Distance, Section 10.5.2.2) may be susceptible to disturbance, injury, and mortality, especially from blasting and aircraft. Removal of rock from quarries with steep cliff faces may remove good raptor habitat, but may also create sites for raptor nesting (e.g., Moore et al. 1997). Raptors have also been observed colonizing walls of open pit mines for nesting (Rescan 2012b).

Based on the maximum values for average home range sizes of Arctic-breeding raptors reported in the literature, raptors that nest up to approximately 12 km away from infrastructure may also interact with the Project (Table 10.1-1). Raptors on foraging forays to feed incubating females or young sometimes make long distance movements up to 50 km from nests. However, these movements are expected to be relatively infrequent.

Potential effects on wildlife from the Project have been scoped based on NIRB guidelines. Interactions of raptors with Project components were evaluated to determine which of the following potential effects may occur (Table 10.5-4):

- direct habitat loss;
- disturbance (e.g., displacement, behavioural effects leading to negative energetic balance, physiological stress);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality due to increased access and associated increase in hunting;
- attraction;
- exposure to contaminants; and
- reduction in reproductive productivity due to all potential effects of the Project combined.

**Table 10.5-4. Interaction of Raptors with Project Components that May Result in Effects on Raptors**

| Potential Development Area Project Component | Habitat Loss[1] | Disturbance | Disruption to Movement | Direct Mortality and Injury | Indirect Mortality | Attraction | Exposure to Contaminants | Reduction in Reproductive Productivity[2] |
|---|---|---|---|---|---|---|---|---|
| *Goose Property Area* | | | | | | | | |
| Open Pits (Main, Umwelt, and Llama) | x | x | | x | | x | | x |
| Haul and access roads | x | x | | x | | x | | x |
| Winter Roads | | x | | x | | | | x |
| Stockpiles | x | x | | x | | | x | x |
| Waste rock storage areas | x | x | | x | | | x | x |
| Explosives storage areas | x | x | | x | | | x | x |
| Tailings Impoundment Area | x | x | | x | | | x | x |
| Quarries | x | x | | x | | x | | x |
| Landfill | x | x | | x | | | x | x |
| Camp / Plant site | x | x | | x | | | | x |
| Airstrip | x | x | | x | | | | x |
| Other infrastructure (diversion channels, water intakes) | x | x | | x | | | | x |
| *George Property Area* | | | | | | | | |
| Open Pits (LCP North, Locale 1,and Locale 2) | x | x | | x | | x | | x |
| Haul and access roads | x | x | | x | | x | | x |
| Winter roads | | x | | x | | | | x |
| Stockpiles | x | x | | x | | | x | x |
| Waste rock storage areas | x | x | | x | | | x | x |
| Explosives storage areas | x | x | | x | | | x | x |
| Landfill | x | x | | x | | | x | x |
| Camp | x | x | | x | | | | x |
| Other infrastructure | x | x | | x | | | | x |
| *Marine Laydown Area* | | | | | | | | |
| Camp | x | x | | X | | | | x |
| Barge landing location | x | x | | X | | | | x |
| Haul and access roads | x | x | | X | | | | x |
| Winter roads | | x | | x | | | | x |
| Other infrastructure (diversion ditch) | x | x | | x | | | | x |

[1] *It was assumed that the entire PDA was lost for the effects assessment. All Project infrastructure lies within the PDA.*
[2] *Reduction in reproductive productivity is considered to be a synergistic effect resulting from all other potential effects.*

Each potential effect is described below, and then evaluated as to whether or not it will occur. Potential effects that will likely occur are then evaluated as to whether or not these are predicted to result in a residual effect after mitigation actions are implemented.

#### *10.5.2.1 Habitat Loss*

The potential for habitat loss to affect raptors is evaluated in this section. Raptor habitat will be removed and replaced by Project infrastructure. The potential for habitat near infrastructure to be degraded due to dust generated from industrial developments was assessed in the Country Foods chapter (Volume 8, Chapter 5) and Environmental Risk Assessment (Volume 8, Chapter 6). This analysis did not predict any residual effects due to dust on vegetation and therefore on raptor habitat.

The location of infrastructure will be planned to avoid wildlife sensitive areas, and the layout of infrastructure will be designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. However, some habitat loss and degradation is unavoidable.

To enable flexibility in siting of Project infrastructure, three Project Development Areas (Goose Property, George Property, and the MLA) were delineated, which contain all proposed Project infrastructure in the entire Project footprint for each area (Section 10.4.1). It was assumed that habitat loss for raptors will occur within the total area of each PDA. This represents an overestimate of habitat loss as only about 10% of the entire area within each PDA will be developed.

The only Project activity not contained within the PDA is the winter roads. Habitat loss within these areas is not expected for raptors because construction of ice roads will not result in loss of any cliff habitat. The gyrfalcon, common raven, and snowy owl are the only raptors present in the wildlife RSA during winter, but these are expected to occur at very low densities (Section 10.1.3). Ice roads are not permanent infrastructure, and thus are not anticipated to result in habitat degradation for ground-nesting raptors during the snow-free season.

Raptor habitat may also be indirectly lost if raptor species avoid the Project area outside of the PDAs due to disturbance, which is discussed in Section 10.5.2.2.

<u>Calculation of Habitat Loss</u>

Assessment of the effect of habitat loss for raptors was based on:

1. Total area - a calculation of the expected total area of habitat lost to development, calculated as the sum of the PDA areas, and expressed as a proportion of the wildlife LSA and RSA; and
2. Suitable habitat - a calculation of the area of suitable habitat contained within the PDA areas, and expressed as a proportion of the area of suitable habitat for raptors within the wildlife LSA and RSA.

*Total Area of Loss*

The total expected area of habitat lost or degraded by the mine footprint was calculated by summing the areas of loss due to the entire Goose, George, and MLA PDAs and comparing this area to the total area of the wildlife LSA and RSA. The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary. The actual area developed, and subject to habitat loss, will be much smaller, as determined by the final design infrastructure and placement.

*Area of Suitable Habitat Loss*

Raptor habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A). The effect of loss of suitable habitat was quantitatively assessed as the amount of

suitable raptor habitat expected to be lost within the PDAs, relative to the amount of suitable habitat mapped within the wildlife LSA and RSA. A two class rating system (suitable versus not suitable) was used to map raptor habitat (Rescan 2013a, Appendix V5-5A).

Evaluation of Habitat Loss for Raptors

*Total Area of Loss*

The total area of loss as represented by the Goose, George and MLA PDAs is 10,237 ha, which represents 7.6% of the wildlife LSA and 0.8% of the wildlife RSA (Table 10.5-5). The magnitude of habitat loss is rated low (Table 10.5-2).

**Table 10.5-5. Area of Habitat Loss within the Project Development Areas**

| Project Development Area | Area Lost (ha) | Proportion of LSA (%)[1] | Proportion of RSA (%)[1] |
|---|---|---|---|
| George Property Area | 4,226 | 3.1 | 0.3 |
| Goose Property Area | 5,358 | 4.0 | 0.4 |
| Marine Laydown Area | 653 | 0.5 | <0.1 |
| **Total Lost** | **10,237** | **7.6** | **0.8** |

[1] *LSA = 134,369 ha, RSA = 1,262,005 ha*

*Loss of Suitable Habitat*

Of the 5,433 ha of suitable habitat mapped within the wildlife LSA (4,790 ha mapped around active raptor nests, and 643 ha of cliffs, Table 10.1-4), an estimated 2,003 ha will be lost and degraded within the three PDAs, which represents 36.9% of the suitable habitat within the wildlife LSA, and 2.5% of suitable habitat mapped within the wildlife RSA, which is rated as low magnitude (Table 10.5.6; Table 10.5-2).

**Table 10.5-6. Suitable Habitat Lost for Cliff-nesting Raptors in the LSA and RSA due to the Project PDAs**

| Suitable Habitat Lost to PDAs (ha) | Suitable Habitat in the LSA (ha) | Percent of Suitable Habitat in LSA Lost (ha) | Suitable Habitat in the RSA (ha) | Percent of Suitable Habitat in RSA Lost (ha) |
|---|---|---|---|---|
| 2,003 ha | 5,433 | 36.9 % | 79, 087 ha | 2.5 % |

Based on habitat suitability modeling for the short-eared owl (Table 10.1-5), 3,445 ha of suitable habitat for ground-nesting raptors will be removed within the three PDAs (Table 10.5-7). This represents 4.9% of the wildlife LSA and 0.8% of the wildlife RSA, which is rated as of low magnitude (Table 10.5-7, Section 10.5.1.1).

**Table 10.5-7. Short-eared Owl Suitable Habitat Lost in the Wildlife LSA and RSA due to the Project PDAs**

| Suitable Habitat Lost to PDAs (ha) | Suitable Habitat in the LSA (ha) | Percent of Suitable Habitat in LSA Lost (ha) | Suitable Habitat in the RSA (ha) | Percent of Suitable Habitat in RSA Lost (ha) |
|---|---|---|---|---|
| 3,445 ha | 69,805 ha | 4.9% | 404,975 ha | 0.8 % |

Based on a maximum breeding home range radius of 12 km (Table 10.1-1), the largest amount of habitat loss for raptors (3,445 ha) represents 7.7% of one raptor home range. Wherever possible, reclamation activities will be undertaken to restore habitat upon Project closure. Mitigation is expected to lower but not completely eliminate the effect of habitat loss to raptors, and thus a residual effect is predicted to occur.

#### *10.5.2.2 Disturbance due to Noise*

Developments can result in disturbance to raptors through noise, especially from blasting and aircraft, the movement of vehicles, and the close proximity of humans to nest sites. Disturbance can result in behavioural changes, and changes in spatial distribution through avoidance of preferred habitats when these become disturbed (Martínez-Abraín et al. 2010). In some cases, there may be few behavioural indicators of disturbance even though disturbance may affect reproduction. For example, habituated raptors may choose to nest close to human activities yet experience enough physiological stress that contributes to reproductive failure (Strasser and Heath 2013). A concern regarding disturbance to breeding raptors is that it can result in energetic imbalances to eggs or chicks, particularly due to decreased nest attendance by adults (Martínez-Abraín et al. 2010), which can ultimately result in reproductive failure.

Disturbance of raptors will occur throughout the life of the Project. Some disturbances like blasting and aircraft flights will occur intermittently, while other disturbances like the presence of humans and the movement of ground vehicles will occur relatively regularly. Potential disturbance to raptors due to the Project could result from the following activities:

- blasting (noise and ground vibrations from mining and construction activities);
- general project noise (e.g., camp noise, vehicle traffic, human presence); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the Umwelt open pit while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the Construction and Operational phases. At the Goose and George Properties, a maximum of three flights per day and one helicopter flight per day are planned, while at the MLA, while it is active, a maximum of six flights per week are planned.

Raptors typically display behaviours that signal they are disturbed by human activities near their nests. The intensity of responses to disturbance varies across species (Holmes et al. 1993). For example, rough-legged hawks frequently flush from nests during aerial research surveys (Rescan 2014), but golden eagles rarely do (Kochert and Steenhof 2002). Thus, findings of behavioural effects of disturbance to one species (e.g., few effects of helicopter disturbance to nesting golden eagles; Kochert and Steenhof 2002; Grubb et al. 2010) may not be applicable to other species (e.g., high response of bald eagles to disturbance from helicopters; Stalmaster and Kaiser 1997). In addition, a lack of a behavioural response to a disturbance event does not necessarily indicate a species is relatively undisturbed. For example, golden eagles are considered to be among the raptors with the lowest tolerance to human disturbance (Whittington and Allen 2008) and rarely flush from nests in response to helicopters, likely because they rarely exhibit nest defense behaviours (Pagel, Whittington, and Allen 2010).

The intensity of behavioural responses is related to the degree to which raptors perceive disturbances as a threat (Frid and Dill 2002). Because behavioural responses vary across species, the magnitude of any subsequent negative effects is also expected to show considerable variation across species. Extreme signs of disturbance include nest abandonment, sudden flight of startled adults resulting in mortality of eggs and chicks knocked from nests, or premature fledging of juvenile birds. More moderate responses include increased vigilance and nest defense behaviour, which in most species frequently involves initiation of flight by incubating or brooding adults (reviewed in Whittington and Allen 2008; Pagel, Whittington, and Allen 2010). Extreme behaviors have primarily been observed in response to frequent and very close proximity of humans, such as humans walking or camping within 100 m of nest sites

(Steidl and Anthony 2000; Martínez-Abraín et al. 2010; Pagel, Whittington, and Allen 2010). In general, approach of nest sites by humans on foot is probably the most disturbing component of well-managed developments to nesting raptors. For example, raptor species including the rough-legged hawk and golden eagle were observed to flush from nests 100% of the time in response to approaching humans, but less than 40% of the time in response to vehicles (Holmes et al. 1993).

Studies have shown relatively minor effects of noise and vibration from blasting on the behaviour of nesting raptors; effects on reproduction have not been studied as frequently. For example, though peregrine falcons in Ireland showed high selection rates of active and inactive quarries as nesting habitat, effects of blasting on subsequent reproductive output were not measured at the active quarries (Moore et al. 1997). In general, most research suggests that some raptor species are able to habituate to blasting (e.g., successful nesting within 500 m of firing ranges; Lehman et al. 1999; Schueck, Marzluff, and Steenhof 2001; e.g., use of active military ranges).

Raptors successfully fledge young each year from nests sites on the walls of all the open pits at the Ekati diamond mine in the Northwest Territories, including those with active blasting and hauling operations (e.g., Rescan 2012b, 2013f). In Idaho, prairie falcons changed their behaviour after blast events 68% of the time when blasts were on average 130 m away, but only 16% of the time when blasts were 560 m to 1 km away (Holthuijzen et al. 1990). Similarly, perched prairie falcons flew after blasts 58% versus 7% of the time for close blasts versus more distance blasts, respectively. Incubating and brooding falcons left their eggs or young for brief flights 39% and 13% of the time, respectively, but when blasts were greater than 560 m away, responses were minor and infrequent (< 10% of the time).

Despite behavioural responses to blast events, effects on reproduction were low – three of four pairs exposed to nearby blasting (< 130 m) successfully fledged young (Holthuijzen et al. 1990). Blasting may have affected territory occupancy in the subsequent year, but sample sizes were too low to make inferences – one of four exposed territories was re-occupied, versus two of three un-exposed territories. Similar to observations of raptor responses to simulated sonic booms and military jet overflights (Ellis, Ellis, and Mindell 1991), incubating or brooding adults did not dislodge eggs or young when flushed from nests in response to blasts (Holthuijzen et al. 1990). These results indicate that blasts 1 km away may influence raptors, but the effects are likely to be minor.

Quantification of Disturbance to Raptors

Disturbances from multiple stressors (e.g., noise, visual, vibration) to raptors were quantitatively assessed by considering the spatial overlap between breeding raptors and Project infrastructure and activities. In addition, the effects of noise disturbance to raptors were quantitatively assessed based on noise modeling of the area over which noise emissions from the Project are estimated to occur (Volume 4, Chapter 2). Disturbance is described for the Project phase anticipated to result in the 'worst-case' effects; all other Project phases are expected to result in less disturbance.

*Flight Initiation Distance and Home Range Size*

Studies investigating the levels and types of activities which result in disturbance to breeding raptors have used flight initiation distances as a measure of the intensity by which raptors experience threat from disturbance (see references in Martínez-Abraín et al. 2010). The flight initiation distance is defined as the distance between a disturbance and an individual bird when it is flushed from a perched position (Holmes et al. 1993). Data on flight initiation distances (FIDs) recorded for incubating or brooding raptors have been used to delineate the boundaries of spatial buffers to restrict human activities around nest sites (e.g., Keeley and Bechard 2011). It is important to note that raptors may be disturbed by activities occurring beyond this distance, and display nest defence behaviours such as vocalization, but FIDs are thought to represent the minimum distance raptors require to feel relatively safe while at the nest site.

Recommendations for the size of spatial buffers more often have been derived using expert opinion, rather than empirical data on FIDs (Richardson and Miller 1997). Depending on raptor species and type of disturbance, recommendations based on expert opinion and FIDs vary from 200 m to 1,600 m (Richardson and Miller 1997; Whittington and Allen 2008; AANDC (Aboriginal Affairs and Northern Development Canada) 2011; Keeley and Bechard 2011). These recommendations closely match the finding through meta-analysis of 25 datasets that raptors place nests 200 m to 1,400 m away from roads (Martínez-Abraín et al. 2010). Thus, 1.5 km is likely a robust estimate of the distance from activities at which raptors may experience threat from disturbances that is severe enough to initiate flight as a form of nest defense.

Disturbance effects of the Project were quantitatively assessed based on numbers of raptors expected to nest within the zone of influence for disturbance. For disturbance at the nest site, 1.5 km was used as the radius of the zone of disturbance effects, which are most likely due to aircraft and blasting. The zone of influence of disturbance to raptors while foraging on their home ranges was assumed to be 12 km, which is the largest radius of the average home range size reported in the literature (Table 10.1-1). Based on a 12 km radius home range, raptors nesting within 12 km of the Project would be anticipated to encounter Project infrastructure and activities during foraging forays from the nest to feed nestlings, or during the post-fledging period when fledglings are learning to hunt for prey.

*Noise Contour Modeling to Evaluate Indirect Habitat Loss*

To assess indirect habitat loss due to sensory disturbance, the area outside of the PDAs anticipated to be affected by noise was calculated. The effects due to noise beyond the existing PDA boundaries are expected to be small, because the loss of habitat within the PDAs, where most of the effect of disturbance will likely occur, was already considered in the habitat loss assessment (Section 10.5.2.1).

Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2; Rescan 2013d) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case (year three of the Operational phase at the Goose Property Area and year seven of the Operational phase at the George Property Area). The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature at which wildlife have shown behavioural effects from the noise.

Threshold noise values were determined from the literature, above which wildlife are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as “functional habitat loss” and “disturbed habitat” for raptors. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 10.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling; Section 10.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries and noise due to aircraft. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak); and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for wildlife resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (Lpeak) or higher for instantaneous noise effects on raptors during operations. Blasting noise models were conducted during peak noise levels for each of the PDAs: year three at the Goose PDA and year seven at the George PDA.

General Project-related noise levels or continuous noise levels are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). A flight impact zone was delineated based on noise modeling results showing the area over which aircraft noise attenuates to 80 dBA or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001).

To assess indirect habitat loss due to sensory disturbance for raptors, the total area of suitable raptor habitat (Rescan 2013a, Appendix V5-5A) outside of the three PDAs (Section 10.5.2.1), but within noise level contours was calculated. The following noise contours were used: 120 dB for functionally-lost habitat from instantaneous blasting noise, resulting in abandonment of habitat, 108 dB for disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response, 45 dBA for general Project noise, and 80 dBA for disturbed habitat from instantaneous aircraft noise.

*Noise Modeling to Evaluate Disturbance to Raptors Breeding Near Infrastructure*

The effects of noise disturbance on raptors were also evaluated by determining whether noise thresholds are predicted to be exceeded at nest sites where raptors attempted to breed during baseline surveys within the PDA (Rescan 2013d; Table 10.5-8). Raptors at three nest sites within 3 km of proposed infrastructure were used as receptors for this evaluation – a peregrine falcon nest 875 m from the proposed airstrip at George Property, and a gyrfalcon nest site 440 m from haul and access roads at the Goose property, both of which were within the PDA. A rough-legged hawk nest 2,800 m from the proposed landfill at George Property just outside the PDA served as a third noise receptor.

**Table 10.5-8. Raptor Nests within 1.5 km and 12 km of Proposed Infrastructure**

| Project Area | Nearest Component | Distance to Nearest Component (m) | Distance to Airstrip (m) | Distance to Quarry (m) | Inside PDA | 2002 | 2007 | 2008 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| George Property | Waste Rock Storage Area | 214 | 875 | | Yes | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Peregrine Falcon with Young (2 chicks 2 weeks old) | Not surveyed |
| George Property | Landfill | 2,800 | | | No | Not surveyed | Inactive | Not surveyed | Not surveyed | Common Raven Nest with Eggs (Failed) and Rough-legged Hawk with Young | Rough-legged Hawk Adults and Peregrine Falcon Adults |
| Goose Property | Haul and Access Road | 440 | 1400 | 888 | Yes | Not surveyed | Peregrine Falcon with Eggs (Failed) | Not surveyed | Gyrfalcon with Young | Gyrfalcon Adults (no eggs at occupancy, no young) | Common Raven Adults (no eggs at occupancy, no young) and Gyrfalcon Adults (no eggs at occupancy, no young) |
| Goose Property | Tailings Impoundment Area Embankment | 4,200 | | | No | Not surveyed | Peregrine Falcon Adults | Not surveyed | Inactive | Inactive | Inactive |
| MLA | Diversion Ditch | 6,600 | | | No | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Rough-legged Hawk Adults |
| MLA | Diversion Ditch | 7,500 | | | No | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Rough-legged Hawk with 4 Young |
| MLA | Diversion Ditch | 7,800 | | | No | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Not surveyed | Rough-legged Hawk with 4 Young |
| MLA | Diversion Ditch | 9,800 | | | No | Common Raven with Young | Peregrine Falcon with Eggs (Failed) | Not surveyed | Not surveyed | Not surveyed | Peregrine Falcon with 4 Young |
| MLA | Diversion Ditch | 9,800 | | | No | Inactive | Common Raven Adult | Not surveyed | Not surveyed | Not surveyed | Inactive |

Evaluation of Disturbance to Raptors

*Flight Initiation Distance and Home Range Size*

Two pairs of raptors nested within 1.5 km of proposed infrastructure (within the PDA) during baseline studies, and thus two pairs are expected to be affected by disturbance due to the Project while at their nest sites (Table 10.5-8). An additional seven raptor nest sites were occupied in at least one year since 2002 within 12 km of proposed infrastructure, which is 4.8% (7 of 147 nest sites) of the number mapped within the wildlife RSA (Table 10.5-8). Thus seven breeding pairs of raptors are expected to be affected by disturbance while foraging on their home ranges. Overall, raptors that nest at 6.1% (9 of 147 nest sites) of the total number of nest sites mapped in surveyed areas are expected to be exposed to disturbance at regular intervals from the Project during the breeding season. To minimize disturbance to nesting raptors, as much as possible based on environmental and safety conditions, aircraft will fly at a minimum altitude of 300 m over active raptor nests, and scheduling of construction and blasting schedules during construction will consider raptors breeding within 1.5 km.

*Noise Contour Modeling to Evaluate Indirect Habitat Loss*

*Blasting Noise*: Less than 0.1% of the wildlife RSA (Table 10.5-9) beyond the PDAs will be functionally lost (35 ha) and disturbed (982 ha) due to blasting noise (Table 10.5-9, Figures 10.5-1 and 10.5-2). These areas overlap less than 0.1% of suitable habitat available for raptors beyond the PDAs in the wildlife RSA (Tables 10.5-10 and 10.5-11).

*General Project Noise*: The total amount of area affected by elevated noise levels outside of the three PDAs is 5,598 ha or 0.04% of wildlife RSA (Table 10.5-9), of which 366 ha is mapped as suitable habitat for cliff-nesting raptors (Table 10.5-10), and 1,493 ha is mapped as suitable habitat for short-eared owls (Table 10.5-11). The majority of sensory disturbance will be associated with the development and operation of the TIA, processing plant, roads and camps.

*Aircraft Noise*: The total amount of area affected by aircraft noise (80 dBA) outside of the three PDAs represents 2.2% of the wildlife RSA (27,140 ha, Table 10.5-9). In total, 1,355 ha (1.7%) of suitable cliff-nesting raptor habitat and 4,996 ha (1.2%) of suitable habitat for short-eared owls is mapped within the area disturbed by aircraft noise (Tables 10.5-10 and 10.5-11). Sensory disturbance due to aircraft noise will be greater near the George PDA and the MLA when these areas are active relative to the Goose PDA as Twin Otter aircraft, which are noisier than Dash 7 aircraft are anticipated to be used in these areas.

The combined effect of noise disturbance from blasting, general Project noise, and aircraft is anticipated to have a residual effect on raptors outside the PDAs. The largest area over which noise will occur is within the flight impact zones, which overlap 1,355 ha of suitable cliff-nesting raptor habitat and 4,996 ha of suitable nesting habitat for short-eared owls. These areas correspond to less than 2% of the suitable habitat available in the wildlife RSA, which is rated as of low magnitude (Table 10.5-2), and 3% of a 12 km radius breeding home range. The majority of the area assessed as being above noise guidelines for wildlife is within the Goose and George PDAs, which are assessed as lost habitat in Section 10.5.2.1.

*Noise Modeling to Evaluate Disturbance to Raptors Breeding Near Infrastructure*

Based on the results of noise modeling, raptors breeding at a peregrine falcon nest site located 875 m from the proposed airstrip at the George Property are predicted to experience an exceedance of 21 dBA of aviation noise levels above the disturbance threshold of 80 dBA (Rescan 2013d; Table 10.5-8). Raptors nesting at a gyrfalcon nest site 440 m from proposed haul and access roads at the Goose Property are predicted to experience an exceedance of 12 dBA of noise above the night time disturbance threshold of 45 dBA. Noise from blasting is not predicted to exceed the threshold for disturbance at 108 dB for either of these two receptors. Noise disturbance from any source is not predicted to exceed threshold levels for raptors breeding at a rough-legged hawk nest site 2,800 m from the proposed landfill at the George Property.

**Table 10.5-9. Total Additional Area Functionally Lost or Disturbed due to Project Noise**

| Project Area | Total Area Lost to Project PDAs | | | Additional Area Functionally Lost due to Blasting (120 dBA) | | | Additional Area Disturbed due to Blasting (108 dBA) | | | Additional Area Disturbed due to General Project Noise (45 dBA) | | | Additional Area Disturbed due to Aircraft Noise (80 dBA) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA | % RSA | Area (ha) | % LSA* | % RSA |
| George Property Area | 4,226 | 3.1 | 0.3 | 17 | <0.1 | <0.1 | 699 | 0.5 | <0.1 | 359 | 0.3 | <0.1 | 11,278 | 8.4 | 0.9 |
| Goose Property Area | 5,358 | 4 | 0.4 | 18 | <0.1 | <0.1 | 283 | 0.2 | <0.1 | 262 | 0.2 | <0.1 | 3,495 | 2.6 | 0.3 |
| MLA | 653 | 0.4 | <0.1 | - | - | - | - | - | - | - | - | - | 12,367 | 9.2 | 1 |
| **Total** | **10,237** | **7.5** | **0.8** | **35** | **<0.1** | **<0.1** | **982** | **0.7** | **<0.1** | **621** | **0.5** | **<0.1** | **27,140** | **17.1** | **2.2** |

**Table 10.5-10. Suitable Habitat for Cliff-nesting Raptors Disturbed and/or Abandoned outside of the Project PDAs due to Noise**

| Study Area | Amount of Suitable Habitat | Suitable Habitat Lost or Altered due to the Project PDA | | Additional Area of Suitable Habitat Functionally Lost due to Blasting (120 dB) | | Additional Area of Suitable Habitat Disturbed due to Blasting (108 dB) | | Additional Area of Suitable Habitat Disturbed due to General Project noise (45 dBA) | | Additional Area of Suitable Habitat Disturbed due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Area without Winter Roads | % Lost or Altered | Area (ha) | % Lost | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered |
| LSA | 5,433 | 1,296 | 23.8 | 0 | 0.0 | 2.2 | < 0.1 | 351 | 0 | 49 | 0.9 |
| RSA | 79,087 | 1,296 | 1.6 | 0 | 0.0 | 2.2 | < 0.1 | 366 | 0 | 1,355 | 1.7 |

**Table 10.5-11. Suitable Habitat for Short-eared Owls Disturbed and/or Abandoned outside of the Project PDAs due to Noise**

| Study Area | Amount of Suitable Habitat | Suitable Habitat Lost or Altered due to the Project PDA | | Additional Area of Suitable Habitat Functionally Lost due to Blasting (120 dB) | | Additional Area of Suitable Habitat Disturbed due to Blasting (108 dB) | | Additional Area of Suitable Habitat Disturbed due to General Project noise (45 dBA) | | Additional Area of Suitable Habitat Disturbed due to Aircraft Noise (80 dBA) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Area (ha) | Area without Winter Roads | % Lost or Altered | Area (ha) | % Lost | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered | Area (ha) | % Lost or Altered |
| LSA | 41,589 | 3,445 | 8.3 | 12 | 0.0 | 130 | 0.3 | 1,240 | 0.0 | 2,211 | 5.3 |
| RSA | 404,975 | 3,445 | 0.9 | 12 | 0.0 | 54 | 0.0 | 1,493 | 0.0 | 4,996 | 1.2 |

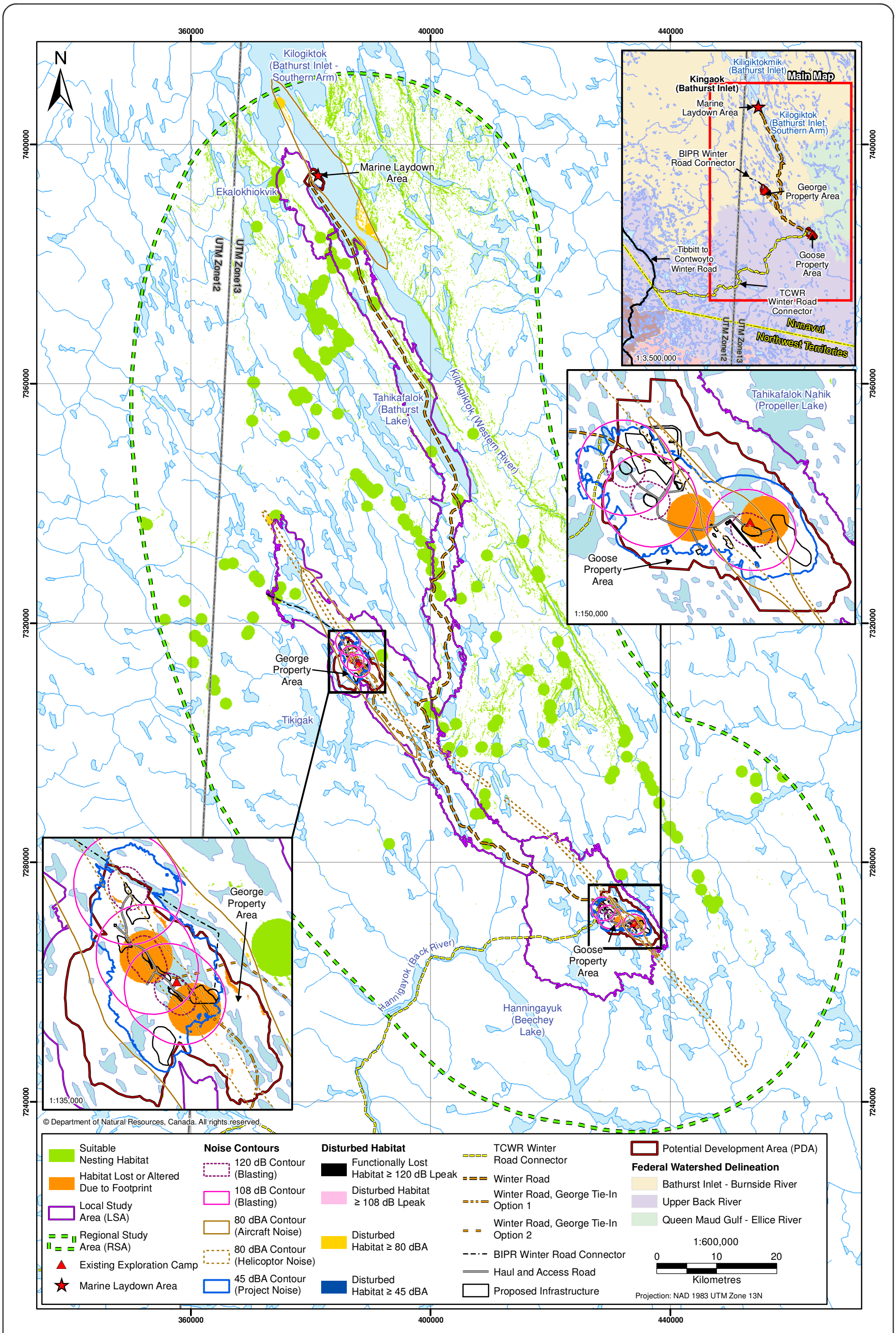


Figure 10.5-1

Sabina GOLD & SILVER CORP.

## Suitable Nesting Habitat Lost, Altered or Disturbed due to the Project for Cliff-nesting Raptors

Figure 10.5-1

Rescan an ERM company

PROJECT # 0194096-0040 GIS # BAC-23-241a December 18 2013

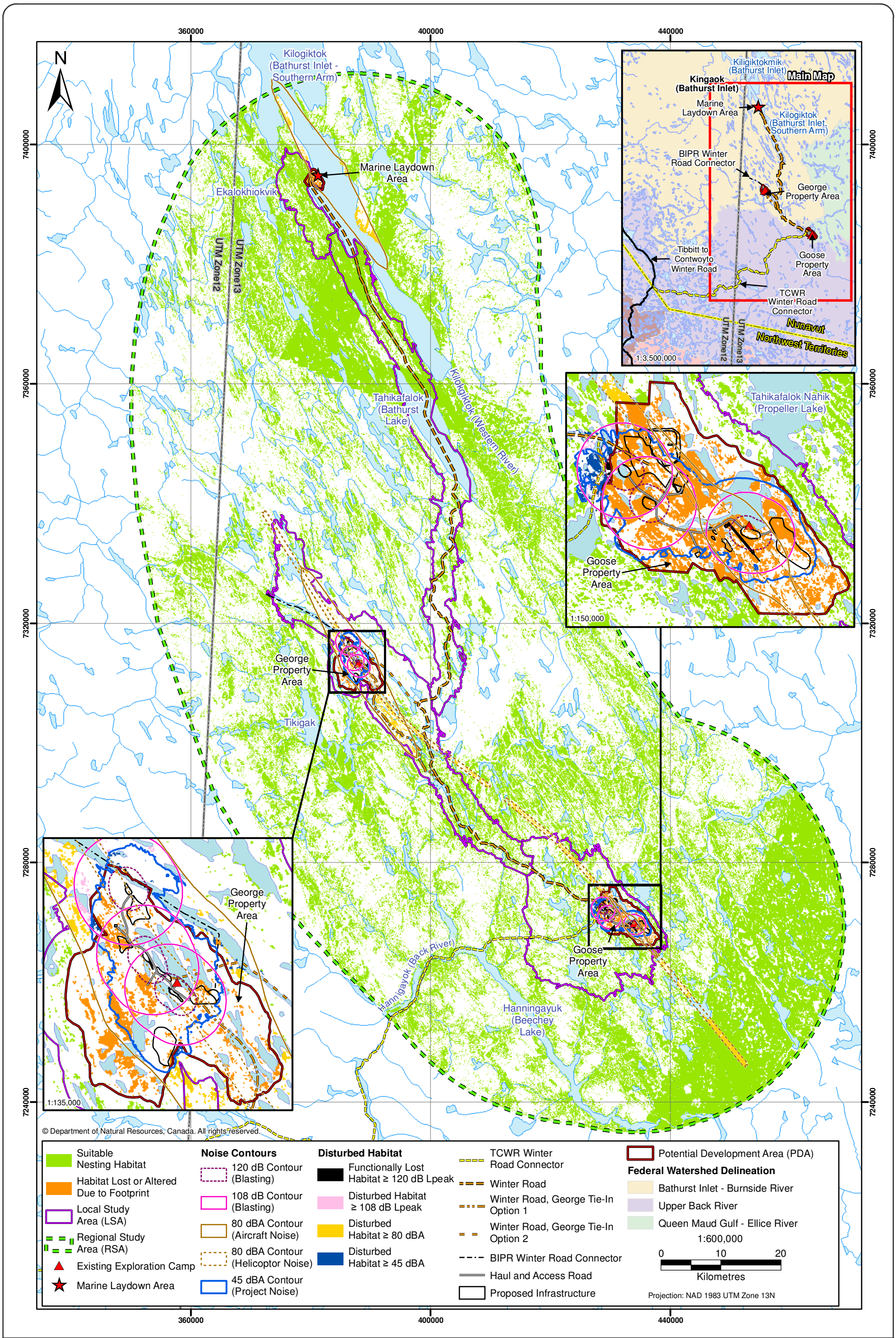


Figure 10.5-2

Sabina GOLD & SILVER CORP.

# Short-eared Owl Suitable Nesting Habitat Lost, Altered or Disturbed due to the Project

Figure 10.5-2

Rescan an ERM company

*Summary of Evaluations of Disturbance to Raptors*

Two raptor nest sites occur within the PDAs. Since the entire PDAs will not be developed, it is likely that these two nest sites will not be lost. Raptors nesting at these sites are predicted to experience minor exceedances of noise thresholds, and may experience visual disturbances especially from aircraft, and vibration disturbances from blasting. The residual effect of the loss of these two nest sites has already been assessed in Section 10.5.2.1, thus no residual effect of disturbance is predicted for raptors nesting with the PDAs. An additional seven raptor nest sites occur within a 12 km radius of the PDAs. Raptors nesting at these sites may encounter Project disturbances while foraging from nest sites, or during the fledgling period.

Mitigation is expected to lower but not completely eliminate the effect of disturbance to raptors. Thus, a residual effect of disturbance on raptors is predicted for raptors nesting outside of the PDAs within a 12 km radius.

### *10.5.2.3 Disruption to Movement*

Developments can impede the movements of raptors due to mortality from collisions with tall structures such as communication towers and wind turbines (Erickson, Johnson, and Young Jr 2005). No tall structures will be constructed for the Project and thus interactions of raptors with the Project are not expected to result in any effects on the movements of raptors on their home ranges. Raptors migrate during the daylight hours, and due to the high altitudes at which migratory raptors fly, it is unlikely that migrating raptors will interact with the Project. Thus, no effects of the Project are expected on the home range or migratory movements of raptor species and this effect is rated as not residual.

### *10.5.2.4 Direct Mortality and Injury*

Mortality and injury of raptors can result from their interactions with developments as a result of collisions with vehicles and blasted rock, and as a result of nest destruction during vegetation clearing. To lower the risk of mortality and injury by minimizing the potential for interactions between raptors and the Project, nests constructed by raptors on infrastructure will be removed prior to egg-laying to dissuade raptors from nesting on infrastructure during all Project phases. To ensure that nests of ground-nesting raptors are not destroyed, ground clearing will be conducted outside of the sensitive nesting periods for ground-nesting raptors. If construction cannot be scheduled outside of the nesting period, a qualified on-site monitor will conduct pre-clearing surveys for nests of ground-nesting raptors. Thus, mortality and injury of raptors is not expected to occur as a result of ground clearing. Despite mitigation measures, some interactions of raptors with Project vehicles and blast zones may be unavoidable, and thus the effects are evaluated in this section.

The Project may result in mortality and injury of raptors that collide with vehicles during all Phases of the Project. Mortality and injury of raptors may result from strikes with vehicles along haul and access roads, and with aircraft. Raptor collisions with ground vehicles servicing the Project are expected to occur very rarely, since the majority of roads will be operational only in winter, when no raptor species except the gyrfalcon, common raven, and snowy owl are present in the wildlife RSA. These raptor species are expected to occur in very low densities in the wildlife RSA in winter (Section 10.1.3).

Injury and mortality of raptors may also occur due to collisions with rock blasted from quarries and pit walls. No published accounts of raptor mortality or injury due to blasting at quarries and pits were found in the literature. However, this effect may be under-reported given the high degree of spatial overlap of suitable quarry sites with suitable nest sites on rock outcrops, and the relatively low detectability of some raptors during aerial surveys (e.g., one out of every five nest sites are undetected; Booms et al. 2011).

Mitigation measures for ground and air traffic will decrease the likelihood for raptor mortality and injury (Section 10.5.3). In urban areas where traffic is concentrated, collisions with air and ground vehicles result in significant annual mortality and injury to raptors (Blackwell and Wright 2006; Hager 2009). Raptor collisions with aircraft occur more frequently at lower altitudes (< 150 m above ground level; e.g., red-tailed hawks, Blackwell and Wright 2006), which implies that birds were hunting and thus distracted when struck. The reduction of perching and food resources in proximity to active areas has been found to reduce the likelihood of aircraft strikes (Blackwell and Wright 2006). Thus, when weather and safety conditions permit, pilots of aircraft will avoid active raptor nests, and maintain a minimum elevation of 300 m within 1.5 km of active raptor nests. Infrastructure near the airstrips will be monitored to ensure no raptors are nesting or perching nearby. If raptors are observed foraging near airstrips, mitigation to minimize risk of collision with aircraft will include covering any sites used for perching with bird spikes.

Quantification of Mortality and Injury of Raptors

Mortality and injury of raptors was quantitatively assessed based on the number of raptors and the relative frequency with which they are expected to occur within the zone of influence for mortality and injury. Rock from blasting sites can fall 100 to 200 meters from quarry sites. Based on recommendations of the Canadian Wildlife Service, a flight impact zone was delineated within 3 km along each side and 5.4 km from the ends of the proposed airstrips.

Evaluation of Mortality and Injury of Raptors

During all survey years (2007-2013), peregrine falcons, gyrfalcons, and common raven occupied a nest site 888 m from a proposed quarry within the Goose Property PDA (Table 10.5-8). Should the nest site be used in future years, adults and fledglings of this nest site may be exposed to blasted rock from this quarry. Two additional raptor nest sites are within the flight impact zone of the airstrips at the George and Goose Properties. Thus, it is expected that three breeding pairs of raptors and their fledglings will be regularly exposed to the risk of injury or mortality from collisions with aircraft. Mitigation is anticipated to lower but not completely eliminate the effect of mortality and injury on raptors, thus a residual effect is predicted to occur.

#### *10.5.2.5 Indirect Mortality*

Wildlife mortality may indirectly result from the Project if hunting is facilitated by easier access to game species along the proposed winter roads. However, raptor species are rarely hunted. Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the Project area (Volume 8; Chapter 3). Road access will be restricted to Project employees, who will not be permitted to hunt. Thus, hunting of raptors is unlikely, and therefore, indirect mortality of raptors due to the Project is not anticipated to occur.

#### *10.5.2.6 Attraction*

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. Attractants may include physical structures that provide habitat, or a high density of raptor prey species attracted to and thus concentrated at waste sites.

Raptors are primarily attracted to developments in the following ways:

- attraction to prey species that are attracted to domestic food waste;
- attraction to carrion at road kill sites; and
- attraction to pit walls and rock faces at quarry sites for nesting.

Once mitigation measures for proper domestic waste storage and incineration have been implemented, raptors are not expected to be attracted to waste sites.

The rough-legged hawk, golden eagle, and bald eagle eat carrion, and thus may be attracted to roadsides with a relatively high density of road kill, which may increase the potential for collisions of these raptors with vehicles (Whittington and Allen 2008). This potential effect will be reduced by the use of winter haul roads only, and the removal of any road kill from access and haul roads. Thus, no residual effect on raptors of attraction to Project roadsides is predicted to occur.

The walls of the open pits and rock faces created at quarries may provide attractive nesting habitat for cliff-nesting raptor species. At the Ekati Diamond Mine, at least one raptor pair successfully produces fledglings on the rock faces of open pits each year (Rescan 2012b, 2013f). Frequent observations of raptors nesting on cliff-faces of active quarries reveals high selection rates of quarries by raptors – 30% of surveyed quarries in Ireland were occupied by peregrine falcons, with no signs of avoidance of active quarries (49% of active quarries were occupied compared to 50% of inactive quarries; Moore et al. 1997).

The pits will become progressively deeper through operation, and thus the open pit walls may begin to resemble steep-sided cliffs with attractive nesting ledges for cliff-nesting raptors. The use of open pits and quarries by nesting raptors (and common ravens) has the potential to affect operation, as the *Nunavut Wildlife Act* prevents the destruction of nests occupied by a bird or its eggs. In addition, the common raven will likely be attracted to any tall vertical Project infrastructure for nesting.

Mitigation measures to decrease attraction by nesting raptors to the walls of open pits and quarries may include deterrence of nesting on pit and quarry walls by clearing of nest material, and covering potential nesting areas with netting prior to egg legging. Despite similar mitigation measures used at Ekati diamond mine, breeding pairs have continued to colonize the walls of active pits for nesting.

Calculation of Attraction Effects for Raptors

The significance of this residual effect was quantitatively assessed based on the number of raptor pairs expected to colonize pit and quarry walls for nesting. Results of wildlife monitoring at Ekati were summarized to derive an estimated number of raptor pairs expected to be attracted to the Project as nesting habitat. Open pits for the Project are expected to be smaller than those at Ekati, thus, estimates of the number of raptor pairs expected to colonize Project pit and quarry walls are considered to be a maximum.

Evaluation of Attraction Effects for Raptors

Monitoring of raptor nesting within the open pits at the Ekati mine shows that up to three breeding pairs will attempt to nest in one open pit in any given year (e.g., Rescan 2012b, 2013f). Open pits at the Ekati mine are more than three times larger than those planned for the Project. Thus, up to three breeding pairs may attempt to breed in the three pits, one pair per pit. The size of the largest proposed quarry relative to the open pits suggests that no more than one breeding pair is expected to be attracted to the quarry walls. Due to the likelihood that pairs will be attracted to pit walls for nesting, a residual effect of attraction is expected for the Project.

#### *10.5.2.7 Exposure to Contaminants*

Exposure to contaminants in raptors due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6). This assessment resulted in contaminant hazard quotients for raptors predicted to be below a value of one, indicating that contaminants in raptors and their food chain components are not likely to increase above baseline conditions. Thus, a residual effect due to exposure to contaminants in raptors is not anticipated and is not considered further in the assessment.

#### *10.5.2.8 Reduction in Reproductive Productivity*

Reproductive productivity is quantified as the number of surviving young produced per year per female. With the exception of mortality, all of the preceding effects may result in declines in reproductive productivity of raptors. Raptors most likely will be affected by the Project through disturbance from blasting and aircraft, injury from strikes with aircraft or blasted rock, and attraction to active pits and quarries to build nests resulting in subsequent disturbance or injury. Each effect individually or synergistically could result in lower reproductive productivity. Research suggests effects on reproduction are most likely to occur through abandonment of nests in extreme cases, but more commonly through increased vigilance and nest defense behaviours, leading to decreased nest attendance and provisioning of food and warmth to young (Steidl and Anthony 2000; Martínez-Abraín et al. 2010; Pagel, Whittington, and Allen 2010). These effects may in turn impose a negative effect on the energetic balance of adults and young, which may result in poorer body condition. Adults in poorer body condition produce fewer young; while young in poor body condition are more susceptible to mortality.

Population growth is determined by three key life history parameters: adult survival; birth rate (the ratio of total live births to total adult population); and the survival rate of young. Because the reproductive success of adults and the survival of juveniles are influenced by their physiological condition, Project-related effects that result in lower body condition may result in population decline. A residual effect of reduced breeding productivity is predicted to occur for raptors, as a result of the synergistic interactions of the other residual effects, which may result in localized population decline.

The effects of climate change on raptors are poorly understood, but one key concern is that climate change may have a large effect on breeding productivity. Observations captured using cameras at nests have revealed the possibility for large and detrimental impacts of climate change on reproductive productivity (Arctic Raptor Project 2010). Researchers have observed reproductive failure at the egg and chick stage for peregrine falcons in Nunavut due to unusually heavy rain events – a female was unable to incubate eggs at a flooded nest site, and at another nest, the rain-soaked nestlings died during a rain storm, probably due to hypothermia (Arctic Raptor Project 2010).

As top predators in a harsh environment, Arctic-breeding raptors are specialist species and thus may have relatively little inherent flexibility to adapt to the rapid environmental change induced by climate warming. Alternatively, as specialist species, raptors may respond to environmental change with a high degree of sensitivity. Initial research has indicated that in general, raptor species are delaying fall migration later than other birds, and this effect is greatest in Arctic breeders (van Buskirk 2012). Of 15 raptor species studied to determine shifts in migration timing, the golden eagle, rough-legged hawk, and bald eagle showed the largest shifts to a later fall migration. Due to their more northerly distribution relative to the other species, this effect may indicate that the magnitude of climate-related effects on Arctic-breeding raptors may be larger relative to species with more southerly distributions (van Buskirk 2012).

Climate change may interact with residual effects of the Project to produce effects that are novel, or of larger magnitude, causing larger effects to the population health of raptors than predicted. Monitoring of raptor population health throughout the life of the Project will be designed to distinguish Project-related effects from those occurring due to climate change (e.g., by ongoing monitoring in reference areas in addition to areas within the zone of influence of the Project).

With the exception of mortality, all of the preceding effects may result in energetic stress to raptors, which may negatively impact nest attendance rates, and food provisioning to chicks, and thus may lower body condition subsequently causing reproductive failure.

Quantification of Reduction in Reproductive Productivity

The rating is based on the combined maximum effect expected from all preceding effects combined. The significance of this residual effect was quantitatively assessed based on the number of raptor pairs expected to colonize pit and quarry walls for nesting (four pairs), in addition to the number of pairs expected to nest within the 12 km radius zone of influence of the Project (six pairs).

Evaluation of Reduction in Reproductive Productivity

It is estimated that up to ten breeding pairs of raptors may be exposed to effects from habitat loss, disturbance, attraction, and injury. This number of raptor pairs represents approximately no more than 12% (10 of 81 pairs, Section 10.1.5.2) of the number of raptors pairs estimated to breed within the wildlife RSA on an annual basis. Mitigation will reduce synergistic effects of multiple stressors on raptors, such that only a small portion of pairs exposed to stressors are expected to experience declines in reproductive productivity. Due to the possibility for negative effects on the breeding productivity of a limited number of raptor pairs, a residual effect of reduction in reproductive productivity is anticipated for the Project.

### 10.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Management Plan (Volume 10 Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including raptors. In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on raptors is anticipated resulting from habitat loss, disturbance due to noise, mortality and injury, attraction, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to raptors. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this residual effect.

#### *10.5.3.1 Mitigation for Habitat Loss*

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to raptors may include the following:

- Project infrastructure designed to avoid, where possible, the locations of identified cliff nests (Volume 10, Chapter 20).

#### *10.5.3.2 Mitigation for Disturbance*

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife specific measures to minimize the effect of disturbance to raptors may include:

- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20);
- minimum flight elevations established within 1.5 km of known active raptor nests, provided safety and weather conditions allow (Volume 10, Chapter 20);

- work activities halted within a buffered distance of any newly identified active raptor nests located within 1.5 km of the proposed alignment. Department of Environment, Nunavut contacted for further instruction (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining minimum prescribed altitudes when possible wherever wildlife species are observed.

#### *10.5.3.3 Mitigation for Mortality and Injury*

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Additional wildlife specific measures to minimize the effect of mortality and injury to raptors may include:

- perch sites covered to prevent perching if raptors are observed perching and foraging near airstrips (Volume 10, Chapter 20); and
- pre-construction ground clearing conducted outside of sensitive nesting periods for ground-nesting raptors (northern harrier and snowy and short-eared owls). A qualified on-site monitor may conduct pre-clearing surveys for ground nesting raptor species if construction cannot be scheduled outside of sensitive nesting periods (Volume 10, Chapter 20).

#### *10.5.3.4 Mitigation for Indirect Mortality*

The primary mitigation and management strategies to minimize effects of indirect mortality to wildlife are described in the Socio-economics chapter (Volume 8, Chapter 3) the Socio-economic Monitoring Plan (Volume 10, Chapter 23). The following mitigation measures may apply to raptors:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting from and within a buffered area along all infrastructure developed and enforced to prevent an increase in mortality to raptors (Volume 10, Chapter 23).

#### *10.5.3.5 Mitigation for Attraction*

The primary mitigation and management strategies to minimize effects of attraction to the Project to raptors and other wildlife are described in the Landfill and Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10 Chapter 11), and the Borrow Pits and quarry Management Plan (Volume 10, Chapter 16). The following mitigation measures may be applied:

- winter road access corridors only, to minimize potential for roadkill, and thus, attraction to road surfaces by carrion-eating raptors (e.g., golden eagle; see Project Description: Volume 2, Chapter 2);
- ledges on pit walls that attract perching by raptors covered with appropriate material to prevent further use by raptors (Volume 10, Chapter 20); and
- roadkill regularly removed along all-weather roads (Volume 10, Chapter 20).

#### *10.5.3.6 Mitigation for Exposure to Contaminants*

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to control

the quality and quantity of fugitive dust or atmospheric deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to raptors.

Mitigation and management measures to minimize the potential for effects to wildlife from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20) may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- the use of wildlife-attracting dust suppressants avoided wherever possible (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20);
- wildlife exclusion measures implemented if wildlife are frequently accessing or attempting to access waste storage areas (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10 Chapter 20).

The wildlife mitigation and management strategies (Wildlife Mitigation and Monitoring Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

### 10.5.4 Characterization of Residual Effects

Residual effects are those effects predicted to remain after the application of mitigation and management. Five potential effects were predicted to have residual effects after mitigation: direct habitat loss, disturbance, direct mortality, attraction and reduction in reproductive productivity. These effects are assessed for their significance in the section following.

#### *10.5.4.1 Direct Habitat Loss*

The effect on raptors of habitat loss and degradation as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because less than 3% of cliff nesting habitat and less than 1% of ground nesting habitat available in the wildlife RSA will be affected. Though habitat loss will be irreversible, this effect will be ameliorated by the expected creation of raptor nesting habitat on pit and quarry walls. The effect of direct habitat loss will occur sporadically over the long term, but will be limited to the Project footprint. Habitat loss is likely to occur, given that the home ranges of an estimated six breeding pairs overlap the PDAs. The effect will not be mitigated, but will be ameliorated by relatively large amounts of unaffected habitat available

to raptors in the wildlife RSA. Thus, the residual effect of direct habitat loss is expected to be Not Significant. Confidence is this assessment is high, because baseline surveys were thorough and thus there is a high degree of confidence that breeding home ranges of only a small proportion (< 10%) of the breeding population in the wildlife RSA overlap with the Project footprint.

#### *10.5.4.2 Disturbance*

Arctic cliff-nesting raptor species show a high degree of fidelity to nest sites such that the same rock faces are used by raptors over decades, centuries, and even millennia (Burnham, Burnham, and Newton 2009). These 'traditional' nest sites probably represent the majority of the available cliff-nesting habitat within a given area. Typically, each year some proportion of traditional nest sites are not used by raptors, and different species may occupy a nest site from one year to the next (Poole and Bromley 1988). Nest sites with high re-use rates probably represent the better nest sites. Though some nest sites are vacant each year, 'good' nest sites are likely limited (Newton 1979). Though there are usually unoccupied nest sites every year, these sites may not provide the resources necessary for pairs to reproduce successfully. Thus, high quality nest sites that are lost due to development may be irreplaceable, despite the availability of nearby unoccupied nest sites.

The effect on raptors of disturbance as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because only two pairs of raptors are expected to experience disturbances regularly, which represent less than 3% of the expected size of the breeding population in the wildlife RSA (of more than 81 breeding pairs annually, Section 10.1.5.2). Further, noise effects are predicted to extend over less than 2% of the suitable habitat available for raptors within the wildlife RSA. An additional seven pairs are expected to breed within 12 km of Project activities, but are expected to experience disturbance only while on foraging forays. One raptor nest site is located 214 m from the proposed Waste Rock Storage Area at the George Property Area, and within 900 m of the airstrip. A second raptor nest site is within 888 m of a quarry at the Goose property and 440 m of the haul and access road. Noise modeling predicts exceedances of noise disturbance thresholds of up to 21 dBA at these nest sites. Indirect loss of raptor nest habitat may occur if these nest sites are abandoned due to disturbance. The contribution of these nest sites as suitable habitat may not be replaceable by nearby unoccupied sites. However, elsewhere raptors showed few behavioural responses to blasting beyond 550 m (Holthuijzen et al. 1990); thus, nest abandonment is not expected to occur. If it does occur, which is expected to be the largest effect of disturbance on raptors by the Project, the effect on the local population size of raptors is predicted to be of low magnitude.

Disturbance effects will be mitigated with flight altitude rules, deterrence of nesting by raptors on pit and quarry walls, and scheduling of construction and blasting. Disturbance effects will be local, and limited to the breeding ranges of raptors experiencing disturbance, which is likely to be within approximately 12 km of Project activities. For the three pairs expected to breed within 1.5 km of the PDAs, disturbance effects are expected to be continuous for general Project noise, and sporadic for blasting and aircraft noise, with overall Project disturbance rated as sporadic and occurring over the medium term for all other raptors in the area. Disturbance effects are likely to occur, with likelihood of occurrence greater for the expected six raptor pairs that may interact with Project activities on their home range, but reversible upon Project closure. Thus, the residual effect of disturbance is expected to be Not Significant. Confidence is this assessment is high, because raptors have been found to habituate to disturbances, and because there is a high degree of confidence that only a small proportion of the breeding population in the wildlife RSA will interact with the Project.

### *10.5.4.3 Direct Mortality and Injury*

The effect of mortality and injury on raptors due to blasted rock and strikes with ground and air vehicles will be direct and negative. The magnitude of the effect is rated as low, because it is expected that only three breeding pairs of raptors and their fledglings (< 5% of the minimum population size of breeding raptor pairs in the wildlife RSA) will be regularly exposed to the risk of injury or mortality from blasted quarry rock or collisions with aircraft. The risk of mortality and injury may be mitigated by deterring raptors from nesting on pit and quarry walls, flight altitude rules, and scheduling of construction. Mortality and injury effects will be local and limited to the breeding ranges of affected raptors, which is likely to be within approximately 12 km of Project activities. Mortality and injury effects are expected to be sporadic over the medium term, reversible, and of moderate likelihood of occurrence, with likelihood of occurrence greater for the three raptor pairs expected to nest within 1.5 km of Project activities. Thus, the residual effect of direct mortality and injury is expected to be Not Significant. Confidence is this assessment is high, due to the very low likelihood of collisions of raptors with Project-related infrastructures.

### *10.5.4.4 Attraction*

The effect of attraction to pit and quarry walls for nesting by breeding raptors will be direct and negative, for raptors that subsequently experience stress, injury, or reduced productivity. The magnitude of the effect is rated as low, because though a maximum of four breeding pairs of raptors may be attracted to pit and quarry walls in one year, it is expected that a high proportion of these pairs will reproduce successfully. At Ekati mine, raptors have successfully reproduced at all pits, including those with active blasting and hauling (Rescan 2012b). Raptors will be deterred from nesting on pit and quarry walls. For those that successfully colonize walls and initiate egg-laying, further mitigation measures will be undertaken to ensure these raptors are not physically injured. Attraction effects are likely to occur sporadically within the Project footprint over the medium term, because the adverse effects of attraction will only occur during the life of the Project and adaptive mitigation and management is anticipated to minimize the effect of attraction. These effects will be reversible with effort, comprised of remediation activities upon closure to ensure the stability of pit and quarry walls. Thus, the residual effect of attraction is expected to be Not Significant. Confidence is this assessment is high, because raptors have been observed reproducing successfully within industrial blast zones.

### *10.5.4.5 Reduction in Reproductive Productivity*

The effect of reduction of reproductive productivity of raptors will be direct and negative. The magnitude of the effect is rated as negligible, because only a small portion of the pairs that may be exposed to Project-related stressors are expected to experience declines in reproductive productivity. Two nesting sites may be abandoned due to disturbance, and though those pairs may find nesting habitat nearby, it may be of poor enough quality to limit their reproduction. Effects on reproductive productivity of the remaining 80% of the breeding population (eight of ten pairs) in the wildlife RSA that may be exposed to stressors is expected to be infrequent and of low magnitude. The largest effect of the Project will likely be attraction to pit and quarry walls. The net effect of the Project on reproductive productivity may be positive based on observations of raptors successfully producing young from nest sites on pit walls at Ekati. Thus negative effects on reproductive productivity are rated as unlikely, but should these occur, the effects are expected to occur locally and continuously over the medium term, but will be reversible upon Project closure. Thus, the residual effect of attraction is expected to be Not Significant. Confidence is this assessment is high, because raptors have been observed reproducing successfully in close proximity to industrial infrastructures and activities elsewhere in the Arctic and throughout North America.

### 10.5.5 Significance of Residual Effects

Considering the Project and the distribution of breeding raptors within the wildlife RSA, the assessment of residual effects resulted in a Not Significant rating for all five residual Project effects (Table 10.5-12):

- habitat Loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- direct mortality and injury, rated Not Significant;
- attraction, rated Not Significant; and
- reduction in Reproductive Productivity, rated Not Significant.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Volume 10; Chapter 20), the combined significance of residual effects for raptors is predicted to be **Not Significant** (Table 10.5-12).

## 10.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

### 10.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities.

The cumulative effect assessment (CEA) general methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other projects and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's potential incremental contribution to the potential cumulative effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators and ratings used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Table 10.5-2).

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 10.5.1.3).

**Table 10.5-12. Summary of Residual Effects Assessment for Raptors Resulting in Overall Significance Rating**

| | Significance Criteria | | | Likelihood of Occurrence | | | Overall Significance Rating | | |
|---|---|---|---|---|---|---|---|---|---|
| **Description of Residual Effects** | **Direction** *(positive, neutral, negative)* | **Magnitude** *(negligible, low, moderate, high)* | **Duration** *(short, medium, long)* | **Frequency** *(once, sporadic, continuous)* | **Geographic Extent (footprint, local, regional, beyond regional)** | **Reversibility** *(reversible, reversible with effort, irreversible)* | **Probability** *(unlikely, moderate, likely)* | **Confidence** *(low, medium, high)* | **(Not significant (N); Significant (S); Positive (P))** |
| Habitat Loss | Negative | Low | Long | Sporadic | Footprint | Irreversible | Likely | High | **N** |
| Disturbance | Negative | Low | Medium | Sporadic | Local | Reversible | Likely | High | **N** |
| Direct Mortality and Injury | Negative | Low | Medium | Sporadic | Local | Reversible | Moderate | High | **N** |
| Attraction | Negative | Low | Medium | Sporadic | Footprint | Reversible with effort | Likely | High | **N** |
| Reduction in Reproductive Productivity | Negative | Low | Medium | Sporadic | Local | Reversible | Unlikely | High | **N** |

#### *10.6.1.1 Spatial Boundary*

The spatial boundary used for the raptor potential cumulative effects assessment was a circle extending 12 km from all Project PDAs; each circle is contained within the boundaries of the wildlife RSA. Twelve km is the maximum width of a home range for reported for raptor species occurring in Nunavut (Section 10.5.2.2) and was used to determine if a raptor home range may overlay projects adjacent to the Project and be subject to potential cumulative effects.

#### *10.6.1.2 Temporal Boundary*

The temporal boundary used for the potential cumulative effects assessment was past, present, and reasonably foreseeable projects. A list of potential projects is included in the general assessment methodology (Volume 9; Chapter 1).

### 10.6.2 Potential Interactions of Residual Effects with Other Projects

Residual effects of the Project on raptors are predicted for habitat loss, disturbance, direct mortality and injury, attraction, and reduction in reproductive productivity (Section 10.5, Table 10.5-12). Based on observations of raptors colonizing the walls of open mine pits and quarries elsewhere, most residual Project effects are expected to result from attraction of raptors to Project quarry and open pit walls during Project construction and operation. Given observations of successful reproduction of raptors within industrial blasting zones and at nest sites on pit walls at Ekati mine, the magnitude of this effect on the local raptor population is expected to be low, and no declines in raptor population abundance are expected.

To determine the potential for cumulative effects on raptors, it was determined whether raptors expected to interact with the Project are likely to regularly interact with nearby past, existing and future projects. The zone of influence of the Project on raptors is estimated to be 12 km in radius, corresponding to the maximum expected home range radius of breeding raptors (Section 10.1.4, Table 10.1-1).

The nearest project is the Proposed Bathurst Inlet Port and Road project, a proposed all-weather road 75 km from the Goose Property, with a port site approximately 15 km from the MLA (Volume 9, Table 1.3-1), just outside the zone of influence of the Project.

Thus, no cumulative effects of the Project on raptors are expected to occur, because it is expected that raptors interacting with the Project will not regularly interact with other nearby projects.

## 10.7 TRANSBOUNDARY EFFECTS

All Project residual effects were confined to the wildlife LSA, and there were no residual cumulative effects. The wildlife LSA lies completely within Nunavut; therefore, no transboundary effects are expected.

## 10.8 MITIGATION AND ADAPTIVE MANAGEMENT

Many mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC raptors. The Wildlife Mitigation and Management Plan (Volume 10, Chapter 20) contains the management plans that will be in place to reduce or eliminate potential effects to wildlife including raptors. Mitigation measures specific to raptors are listed in Section 10.5.3, and summarized in Table 10.8-1 in Section 10.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including raptors. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11;
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

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

- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock and Tailings Management Plan: Chapter 9.
- Landfill and Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosive Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21
- Metal Leaching and Acid Rock Drainage Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

### 10.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of raptor nest sites. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, and the DEIS evaluates the potential for effects given the locations of the PDAs after the redesign of Project elements. Table 10.8-1 in Section 10.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on all wildlife species including raptors.

### 10.8.2 Best Management Practices

The Wildlife Mitigation and Management Plan (Volume 10, Chapter 20) includes eight separate plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to raptors are listed in Section 10.5.3, and listed in Table 10.8-1 in Section 10.8.5.

### 10.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the Wildlife Mitigation and Monitoring Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

### 10.8.4 Monitoring

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal-species monitoring.

### 10.8.5 Summary Table of General Wildlife Mitigation and Adaptive Management Measures

Table 10.8-1 includes all planed mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on raptors.

**Table 10.8-1. Summary of Mitigation and Management Measures Applicable to Raptors**

| Mitigation Category | Mitigation Measures |
|---|---|
| 1. Mitigation by Project Design | |
| | 1. Project infrastructure designed to avoid, where possible, the locations of identified cliff nests. |
| | 2. Winter road access corridors only (no all-weather roads for re-supply routes or between the Goose and George Properties). |
| | 3. Buildings designed and maintained to exclude wildlife. |
| | 4. WAD cyanide destruction inside the mill. |

*(continued)*

**Table 10.8-1. Summary of Mitigation and Management Measures Applicable to Raptors (continued)**

| Mitigation Category | Mitigation Measures |
|---|---|
| 2. Best Management Practices | 1. Pre-construction ground clearing conducted outside of sensitive periods for ground-nesting raptors, where possible.<br>2. Pre-determined flight paths to provide horizontal and vertical buffer distances between flight paths and sensitive raptor habitats, where possible.<br>3. Minimum flight elevations established within 1.5 km of known active raptor nests, provided safety and weather conditions allow.<br>4. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining minimum prescribed altitudes when possible wherever wildlife species are observed.<br>5. Work activities halted within a buffered distance of any newly identified active raptor nests located within 1.5 km of proposed infrastructure. Department of Environment, Nunavut contacted for further instruction.<br>6. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance.<br>7. Roadkill regularly removed along all-weather roads.<br>8. The use of wildlife-attracting dust suppressants avoided, wherever possible.<br>9. Perch sites covered to prevent perching if raptors are observed perching and foraging near airstrips.<br>10. Ledges on pit walls that attract perching by raptors covered with appropriate material to prevent further use by raptors.<br>11. A policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees.<br>12. A no-littering policy developed, and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.<br>13. A policy prohibiting hunting by Project employees and contractors while on site.<br>14. Wildlife exclusion measures implemented if raptors are frequently accessing or attempting to access waste storage areas.<br>15. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to health of raptors.<br>16. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures. |
| 3. Adaptive Management | 1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included:<br>• if negative wildlife interactions become a concern, or<br>• if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.<br>2. The Wildlife Mitigation & Monitoring Plan (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies. |
| 4. Monitoring | Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on raptors. This plan may include:<br>1. footprint monitoring to monitor habitat loss;<br>2. noise monitoring to monitor disturbance to wildlife; |

*(continued)*

**Table 10.8-1. Summary of Mitigation and Management Measures Applicable to Raptors (completed)**

| Mitigation Category | Mitigation Measures |
|---|---|
| 4. Monitoring *(cont'd)* | 3. human activity monitoring of Project site roads and winter roads;<br>4. nest avoidance monitoring to identify active bird nests at risk of disturbance from vegetation clearing;<br>5. pit and quarry monitoring to identify raptors at active nests that may be at risk of disturbance from blasting activities;<br>6. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes;<br>7. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and<br>8. incidental raptor reporting to record general raptor activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible.<br>Focal-species monitoring program to evaluate predictions in the effects assessment on raptors. This plan may include:<br>1. monitoring raptor nests in the wildlife RSA for occupancy and productivity; and<br>2. incidental reporting of raptors when observed during other wildlife and environmental monitoring programs. |

## 10.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20). Strategies specific to raptors are summarized in the following sections.

### 10.9.1 Wildlife Mitigation and Monitoring Plan

#### *10.9.1.1 Facility-specific Monitoring*

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife effects include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area, and George Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20):

- Footprint monitoring;
- Noise Monitoring;
- Human activity monitoring;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA; and
- Incidental Wildlife Monitoring.

#### *10.9.1.2 Focal-species Monitoring of the WEMP*

The proposed focal-species monitoring program will include monitoring of raptors within the wildlife RSA (Volume 10, Chapter 20). The WEMP outlines proposed monitoring for raptors every year during construction, and every three years in during operations. Raptor breeding sites in the wildlife RSA will be monitored to determine distribution, occupancy, and productivity at historic and new nest sites in the wildlife RSA. The survey methods will follow previously established protocols used during baseline surveys. Analyses will be conducted to determine trends over time in the distribution, occupancy rate, and productivity rate of raptors in relation to mine infrastructure. Nests within 1.5 km of Project infrastructure will be a priority for monitoring in addition to nests in an undisturbed reference area within the Western River drainage within the wildlife RSA (Figure 10.1-1).

## 10.10 IMPACT STATEMENT

A review of the Project activities identified eight potential effects that may occur due to the construction and operation of the Project.. These eight potential effects are: loss of habitat, disturbance, disruption of movement, direct and indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater

concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of raptors was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on raptors resulted in the identification of five potential effects as likely having residual effects after mitigation: habitat loss, disturbance, direct mortality and injury, attraction and reduced reproductive productivity. Each of these residual effects were rated with a low magnitude and are rated as **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Volume 10; Chapter 20).

Relative to other residual effects, the effect of attraction on raptors is expected to result in the largest residual effect on the raptor population within the wildlife RSA. It is estimated that fewer than four breeding pairs will be attracted to pit and quarry walls for nesting, thereby exposing raptors to high levels of disturbance and the risk of mortality and injury. While the most currently available mitigation measures are proposed for the Project, effects of attraction on raptors have been recorded at other existing projects with similar mitigation measures. However, given observations of successful reproduction of raptors within industrial blasting zones and at nest sites on pit walls at the EKATI mine (e.g., Rescan 2013f), the magnitude of this effect on the local raptor population is expected to be low. Ongoing monitoring will measure this effect to determine whether further mitigation measures are needed. Overall, Project effects on raptors are rated as **Not Significant**. It is expected that raptors interacting with the Project will not regularly interact with the only other project in the wildlife RSA (a reasonably foreseeable future project – BIPR), and thus no cumulative effects of the Project on raptors are expected to occur.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Acronyms and Abbreviations section.


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