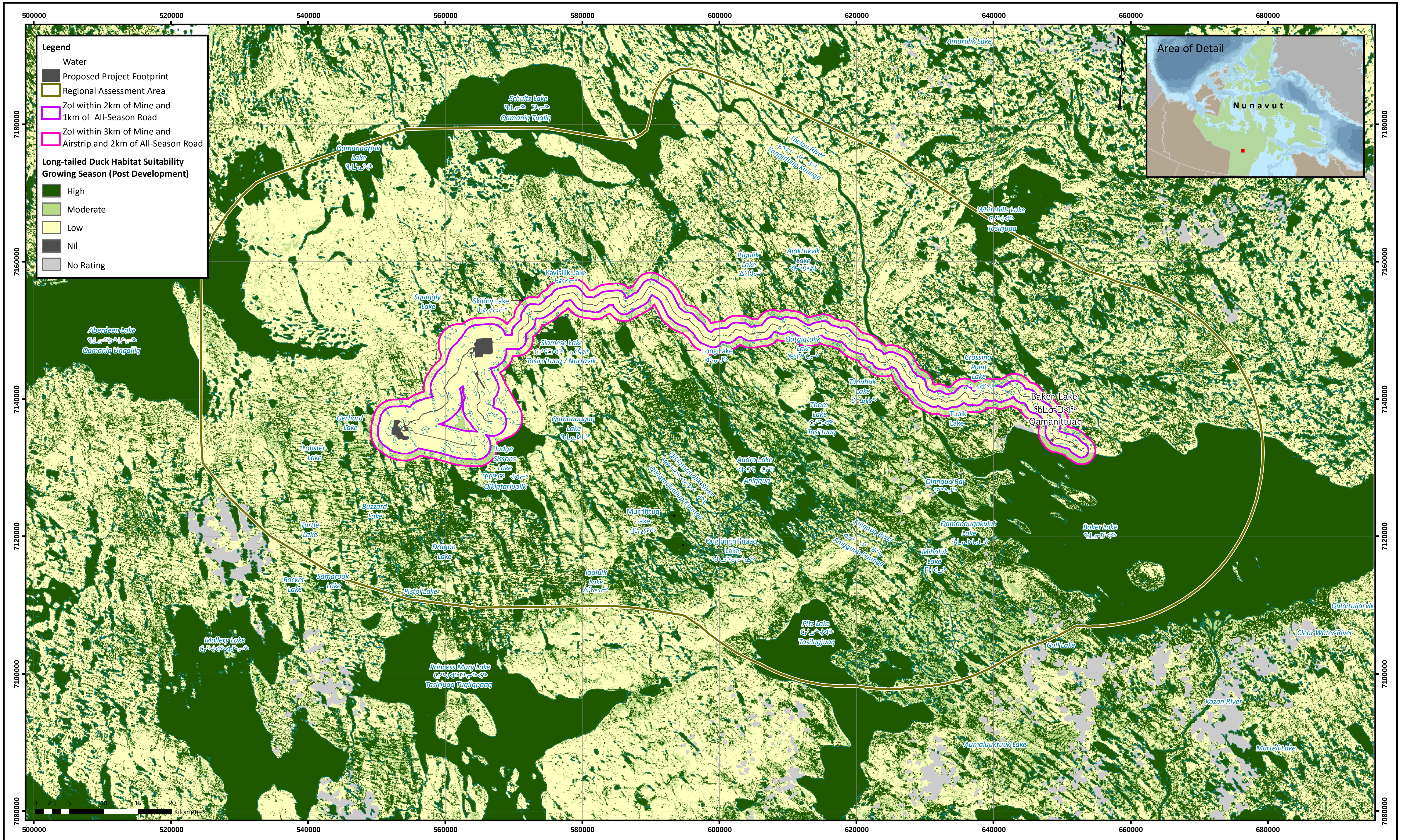
Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 07/07/2014 Scale: 1:500,000
File: 16.2-1_Habitat_Suitability_Growing_PD_Lapland.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 16.2-1
POST-DEVELOPMENT LAPLAND LONGSPUR HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



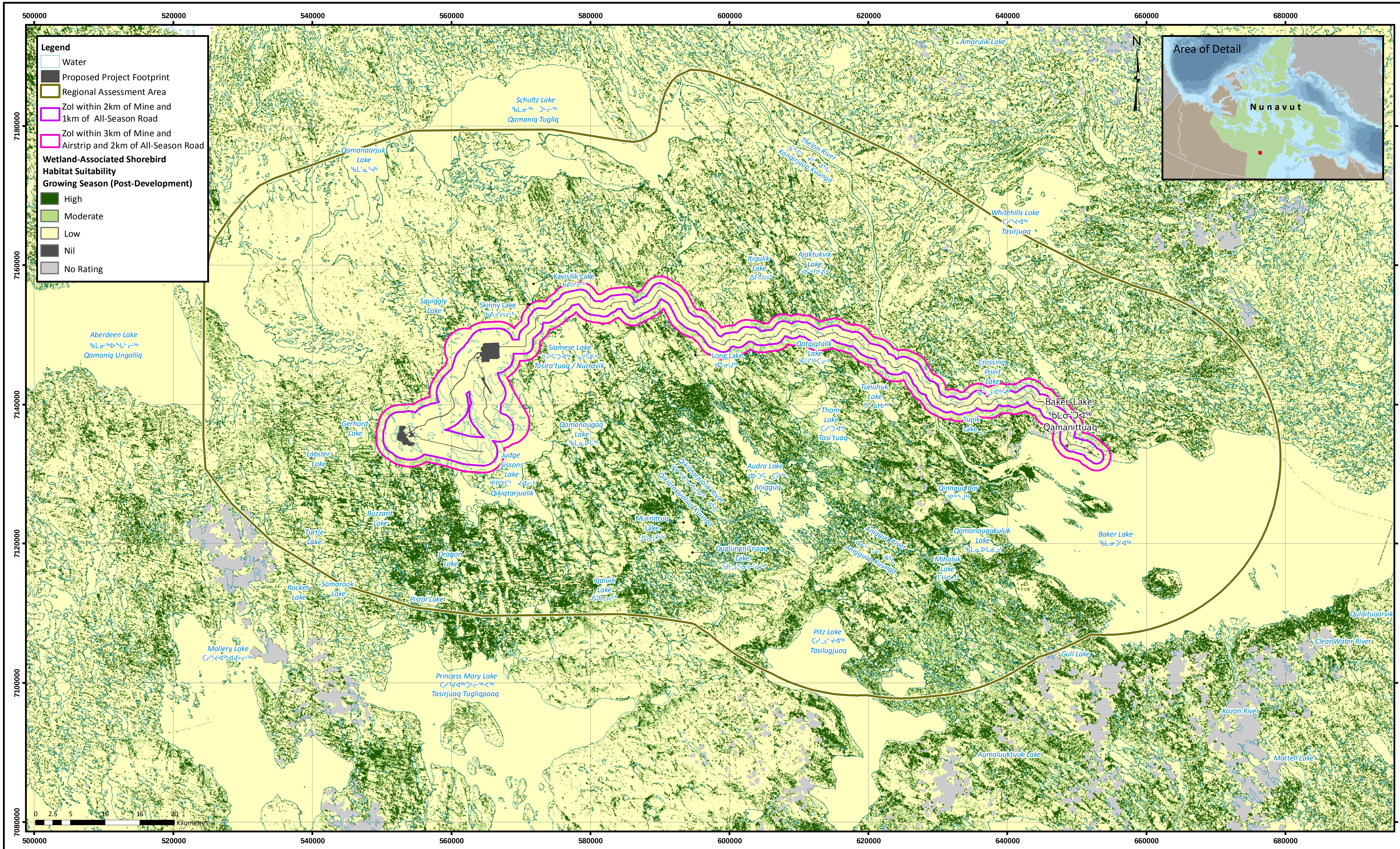
Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 07/07/2014 Scale: 1:500,000
File: 16.2-2_Habitat_Suitability_Growing_PD_LongTailedDuck.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 16.2-2
POST-DEVELOPMENT LONG-TAILED DUCK HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



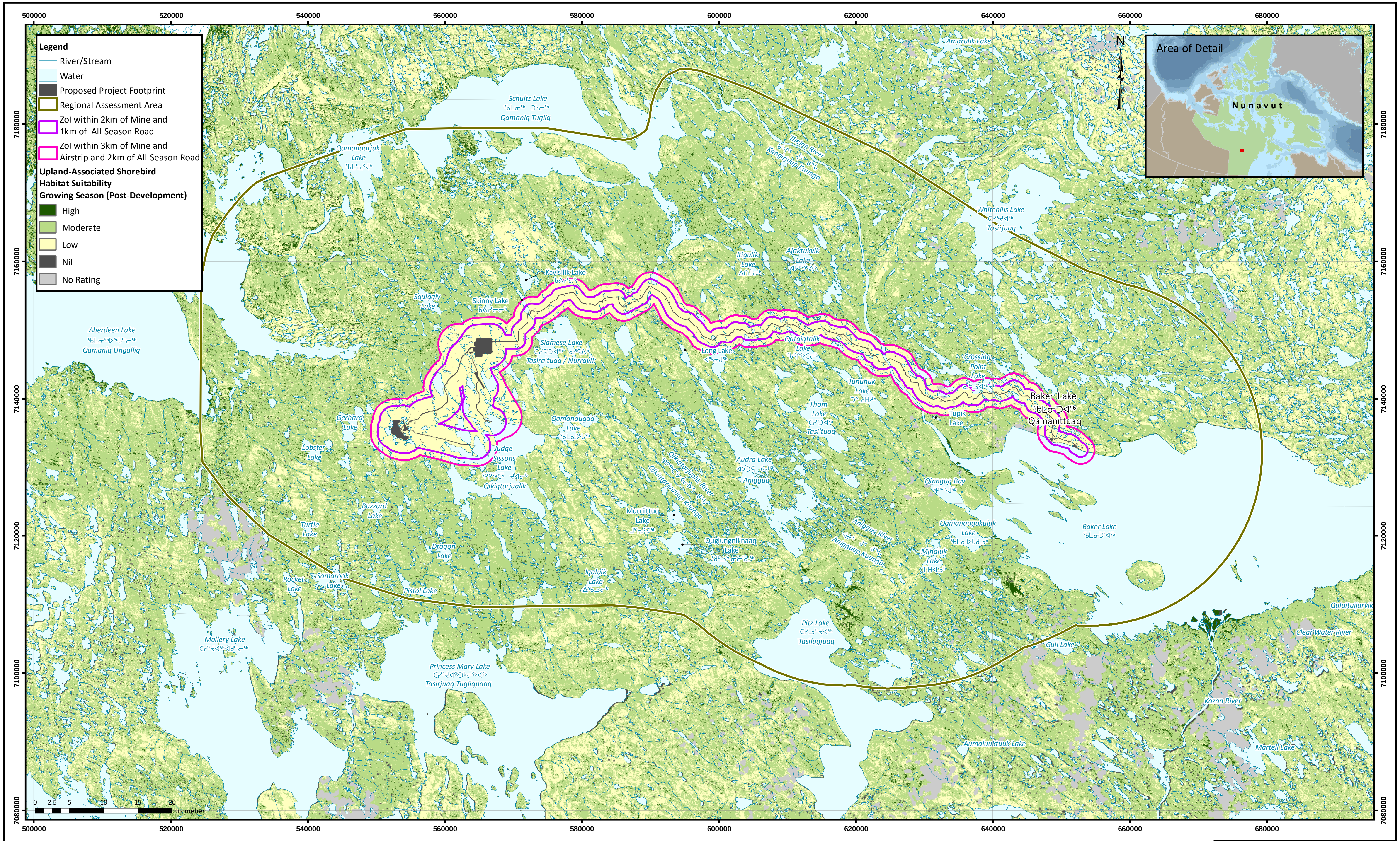
Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 07/07/2014 Scale: 1:500,000
File: 16.2-3_Habitat_Suitability_Growing_PD_Wtlnd_Shorebirds_ASR.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 16.2-3
POST-DEVELOPMENT WETLAND-ASSOCIATED SHOREBIRD HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 07/07/2014 Scale: 1:500,000
File: 16.2-4_Habitat_Suitability_Growing_PD_Uplnd_Shorebird_ASR.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 16.2-4
POST-DEVELOPMENT UPLAND-ASSOCIATED SHOREBIRD HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

16.2.1.6 Determination of Significance for Change in Bird Habitat Availability

Lapland Longspur and Long-tailed Duck — The effect of the Project on habitat within the RAA will be not significant. Predicted loss of available habitat for Lapland longspur and long-tailed duck due to the Project is less than 5% of the habitat units. The magnitude of adverse effects of the Project on habitat availability is rated as low during all Project phases and for both road options. The Project is expected to result in a detectable loss of habitat within the LAA. The loss of habitat will be not significant as all migratory birds in the RAA will continue to have abundant suitable habitat available for foraging. The effect will occur regularly during each growing season for the life of the Project. All effects are expected to be confined within the LAA. The loss of habitat is reversible once operations cease and the disturbed areas are reclaimed. The confidence in the prediction is rated as moderate because there is some uncertainty in the exact size of the ZOI. Given recent findings at the Ekati Mine, the assessed effects of the Kiggavik Project on migratory birds is likely an over-estimate.

Shorebirds — The effect of the Project on shorebird habitat within the RAA will be not significant. Predicted loss of available habitat for shorebirds due to the Project is less than 5% of the habitat units. The magnitude of adverse effects of the Project on shorebird habitat availability is rated as low during all Project phases. The Project is expected to result in a detectable loss of habitat within the LAA, which will be not significant as all shorebirds in the RAA will continue to have abundant suitable habitat available for nesting and foraging. The effect will occur regularly during each growing season for the life of the Project with all effects expected to be confined within the LAA. The loss of habitat is reversible once operations cease and the disturbed areas are reclaimed. Given recent findings at the Ekati Mine, the assessed effects of the Kiggavik Project on breeding shorebirds is likely an overestimate.

16.2.1.7 Summary of Project Residual Effects for Change in Bird Habitat Availability

Table 16.2-9 summarizes the residual environmental effects for change in habitat availability for migratory birds.

16.2.1.8 Compliance and Environmental Monitoring for Change in Bird Habitat Availability

The extent of the Project footprint will be monitored on an annual basis to confirm habitat loss predictions.

Table 16.2-9 Summary of Project Residual Environmental Effects for Change in Bird Habitat Availability

Project Phase	Mitigation / Compensation Measures	Direction	Residual Environmental Effects Characteristics: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
Change in Breeding Bird Habitat — All-Season Road Option												
Construction	progressive reclamation; Project footprint; dust suppression	N	L	L	MT	R	R	U	N	NA	M	None required
Operation												
Final Closure	None required	N	L	L	MT	R	R	U	N	NA	M	
Change in Breeding Bird Habitat —Winter Road Option												
Construction	progressive reclamation; Project footprint; dust suppression; winter road;	N	L	L	MT	R	R	U	N	NA	M	None required
Operation												
Final Closure	None required	N	L	L	MT	R	R	U	N	NA	M	

KEY

Direction:

P Positive

N Negative

Magnitude:

N Negligible: No anticipated effect on wildlife species.

L Low: Detectable change to high quality habitat that does not cause a behavioural change in birds, or observable effect on wildlife species but not likely to affect the species' sustainability in the LAA.

M Moderate: Detectable change in the amount of high quality habitat that could result in a behavioural response of birds, or observable effect on wildlife species but not likely to affect the species' sustainability in the RAA.

H High: A detectable change in high quality habitat across the seasonal range that results in a behavioural change of a population of birds, or measurable effect on wildlife species that will likely affect the species' sustainability in the RAA.

Geographic Extent:

L Local: Effect confined to the LAA

R Regional - Effect extends beyond the LAA but within the RAA

T Territorial: Effect extends beyond the RAA but within Nunavut

N National: Effect extends beyond Nunavut but within Canada

Duration:

ST Short term: Less than one year

MT Medium term: More than one year, but not beyond the end of Project decommissioning

LT Long term: Beyond the life of the Project

Frequency:

O Once: Effect occurs once

S Sporadically: Effect occurs occasionally but not consistently throughout the life of the Project

R Regularly: Effect occurs at regular intervals throughout the life of the Project

C Continuous: Effect occurs continuously throughout the Project

Reversibility:

R Reversible: Will likely recover to baseline conditions after or before the end of Project decommissioning

I Irreversible: Unlikely to recover to baseline conditions after the end of Project decommissioning

Environmental Context:

U Undisturbed: Area relatively or not adversely affected by human activity

D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:

S Significant

N Not significant

Prediction Confidence:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation

L Low level of confidence

M Moderate level of confidence

H High level of confidence

Likelihood of Significant Effects:

Based on professional judgment

L Low probability of occurrence

M Medium probability of occurrence

H High probability of occurrence

Other Projects, Activities and Actions:

Human disturbance associated with Meadowbank Mine, various exploration operations, and various regional communities.

16.2.2 Assessment of Change in Bird Health

Emissions from the Project have the potential to expose migratory birds (represented by Lapland longspur, long-tailed duck and shore birds) to COPC. The potential for these emissions to cause adverse effects to migratory birds was evaluated.

16.2.2.1 Analytical Methods for Change in Bird Health

Emissions from the Project can affect COPC concentrations in environmental components (e.g., water, soil, aquatic vegetation, insects) which have the potential to interact with migratory birds. The COPC included in the assessment were uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc.

The Lapland longspur is a common songbird that forages on seeds and insects. Long-tailed ducks forage on molluscs and crustaceans at the bottom of lakes (benthic invertebrates) as well as fish. Shorebirds, represented in this assessment by the semipalmated sandpiper (*Calidris pusilla*), forage on sandy beaches and mudflats and feed almost exclusively on small invertebrates. To estimate potential COPC exposure to these birds, the predicted COPC concentration in forage items needs to be considered. Detailed air quality modelling (discussed in Tier 2, Volume 4) and water quality modelling (discussed in Tier 2, Volume 5) are used as inputs to the environmental pathways assessment (Tier 3, Appendix 8A). The concentrations in environmental components are predicted by using transfer factors that relate the concentration in different components (e.g., water-to-benthic invertebrates). The transfer factors are based on site-specific information where possible, augmented by literature data. The Ecological and Human Health Risk Assessment report (i.e., Tier 3, Appendix 8A) provides a detailed discussion on the selection of transfer factors and how they are applied.

COPC intake by migratory birds is estimated using the predicted concentrations and assumptions about how much forage the birds consume. The amount of time that wildlife spend in the area is also an important factor. Although migratory birds are expected to be in the area fo 4 months (i.e., the snow-free period) in their established territories during the breeding season, migratory birds were assumed to spend 100% of the year in the area for the exposure assessment. The estimated intakes were compared to benchmarks that are protective of avian species. For estimating radionuclide dose, the concentration within the individual of each radionuclide was estimated from the calculated intake through the use of a transfer factor. Dose coefficients were used to estimate the dose from each radionuclide based on the concentration. Radiation effects on biota depend not only on the absorbed dose, but also on the relative biological effectiveness (RBE) of the particular radiation (i.e., alpha, beta or gamma radiation). Recent recommendations have focused on an RBE of 10 for alpha radiation; this value was used in the assessment for consistency with recommendations outlined in the N288.6 standard (CSA 2012). The total dose, which is based on the baseline plus Project emissions for the sum of the uranium-series radionuclides, is compared to a benchmark that is protective of avian species (2.7 mGy/d).

The bounding scenario carried through the ecological assessment was based on separate discharges from the Kiggavik WTP and Sissons WTP, an extended operating period (25 years) followed by a 22-year period of consolidation where water treatment would be required. The assessment accounted for the uncertainty and variability in the emissions and the behaviour in the environment. The details are provided in the Ecological and Human Health Risk Assessment report (Tier 3, Appendix 8A).

16.2.2.2 Baseline Conditions for Change in Bird Health

Under baseline conditions, Lapland longspur, long-tailed ducks, and shorebirds are exposed to naturally occurring COPC concentrations. COPC concentrations in forage items (e.g., fish, insects) measured during baseline studies were incorporated in the pathways assessment. In addition, measured baseline information from sparrows was used to validate the modelling for Lapland longspur.

16.2.2.3 Effect Mechanism and Linkages for Change in Bird Health

Changes in the health of migratory birds can occur if they are exposed to COPC at levels that are associated with an effect. As it is important that migratory bird populations are maintained, the potential for COPC to affect the growth and reproduction of migratory birds is examined. The assessment of changes in health of migratory birds depends on the estimated changes in COPC concentrations of environmental components such as vegetation, fish and soil, which are derived from the atmospheric and the aquatic environment assessments.

The Project-environment interactions and effects described in the Atmospheric Environment report (i.e., Tier 2, Volume 4) and Aquatic Environment report (i.e., Tier 2, Volume 5) form the basis for the effects mechanisms and linkages. The Project air quality effects relate to emissions of dust containing COPC from open pit and underground mining and supporting activities, milling and vehicle traffic on unpaved roads. The Project water quality effects relate to emissions of COPC from WTPs at the Kiggavik and Sissons sites. Complete details about the COPC sources and all assumptions used in the assessments were provided in the atmospheric and aquatic environment assessments.

16.2.2.4 Mitigation Measures and Project Design for Change in Bird Health

Design aspects, operational measures and other mitigation measures have been incorporated into the current Project plans which will minimize Project-associated emissions and/or the potential effect of Project-related emissions. These have been discussed in the Atmospheric Environment report (i.e., Tier 2, Volume 4) and the Aquatic Environment report (i.e., Tier 2, Volume 5) in more detail.

The Atmospheric Environment report (i.e., Tier 2, Volume 4) provides a detailed list of the mitigation measures applied to reduce the changes to ambient air quality. Mitigation measures that are incorporated to reduce emissions of dust containing COPC include:

- minimizing or reducing vehicle speed on unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons haul road and enforcement of speed limits, where possible
- applying water or another approved dust suppressant to the surfaces of unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons haul road, when possible
- maintaining all unpaved road surfaces via grading or other maintenance practices to minimize the amount of silt (i.e., fine particles) present in the roadbed material
- installing appropriate air pollution controls on the exhaust stacks of the mill complex and acid plant (e.g., wet scrubbers, dust collectors) and
- releasing tailings to the TMFs as a slurry below a water surface to avoid tailings dust emissions

The Kiggavik WTP and Sissons WTP have been designed so that the effluent will meet all appropriate regulations such as the Metal Mining Effluent Regulations (MMER) as well as site-specific discharge limits. Environmental considerations were paramount in the selection of the appropriate technology for the WTP. Further detail on the design of the WTP can be found in the Project Description (Tier 2 Volume 2).

Contamination Risk to Waterfowl and Waterbirds

Given the abundance of natural waterbodies and watercourses in the Project area that provide good quality habitat, the sedimentation ponds adjacent to the ore pad and Type 3 mine rock pad and water cover on the Tailings Management Facility (TMF) are not anticipated to be attractive for use by waterfowl and waterbirds, based on the following design and mitigation measures:

- The sedimentation ponds adjacent to the ore pad and Type 3 mine rock pad will be double lined, with a liner system extending from the pad into the pond (Tier 3, Volume 2, Project Description and Assessment Basis, Technical Appendix 2D, Section 5.2), thereby preventing the establishment of vegetation within and immediately adjacent to the ponded water;

- These ponds will be periodically cleaned out (Tier 3, Volume 2, Project Description and Assessment Basis, Technical Appendix 2D, Section 5.2), with water removed from the ponds for treatment at one of the water treatment plants; and,
- Sediment that accumulates in the ponds will be periodically removed (Tier 3, Volume 2, Project Description and Assessment Basis, Technical Appendix 2D, Section 5.2).

No specific plans are proposed to mitigate waterfowl and waterbirds from accessing ponds containing site run-off. The use of these ponds by waterfowl and waterbirds is predicted to be low, due to the lack of forage opportunities (e.g., aquatic vegetation, benthic invertebrates, etc.) in the ponds, and the lack of vegetation within and surrounding the ponds that is available for nesting and foraging.

Decommissioning of the three pits at the Kiggavik site (i.e., Main Zone, Centre Zone, and East Zone) used as TMFs will be a progressive closure and reclamation program as tailings deposition and consolidation occur. The conceptual decommissioning plan for the Centre Zone and East Zone TMFs consists of backfilling first with mine rock from the Type 1 / Type 2 mine rock pile followed by a compacted till cover from the overburden pile (Tier 3, Technical Appendix 5J, Section 3.9.1; Tier 3, Technical Appendix 2R, Section 4.3.1).

Decommissioning of the Main Zone TMF is anticipated to be backfilled similar to East Zone and Centre Zone TMFs. Additional resources discovered over the life of the Project would allow the Main Zone TMF to be filled with tailings; however, if additional resources are not found over the life of the Project, whereby the Main Zone TMF would only be partially filled with tailings, the conceptual decommissioning plan consists of first backfilling the tailings mass with Type 3 mine rock followed by Type 1 / Type 2 mine rock and installing a compacted till cover. An alternative option was to only partially backfill the Main Zone TMF with mine rock with a compacted till cover, and then allowing a pond to develop (Tier 3, Technical Appendix 2R, Section 4.3.3).

Lessons learned from previous TMF decommissioning projects will be incorporated in the decision-making pertaining to Main Zone TMF decommissioning. The pond option, if considered based on the Main Zone TMF not being filled with tailings, would be investigated further with additional modeling to determine the risk of pond water contamination and risk to waterfowl prior to a decision pertaining to Main Zone TMF decommissioning.

16.2.2.5 Residual Effects for Change in Bird Health

In this study, adverse effects from exposure to COPC were characterized by a simple screening index. This index was calculated by dividing the predicted exposure by the toxicity reference value for each ecological receptor as follows:

$$Screening\ Index = \frac{Exposure}{Toxicity\ Reference\ Value}$$

For the wildlife species, the US EPA risk-based ecological soil screening levels (Eco-SSLs) (US EPA 2010) were used as the primary data source for the derivation of toxicity reference values used to determine the potential for an effect. For this assessment, the lowest observable adverse effect levels (LOAELs) based on growth and reproduction were selected, as these endpoints are considered to be the most relevant for the maintenance and persistence of wildlife populations. For COPC without Eco-SSL data (in this case uranium), literature studies were reviewed and values from long-term (chronic) exposure studies were selected. The Eco-SSL database provides information for a number of different species that could be used as a surrogate for other species with similar diets. For example, for nickel the value for a mallard duck is used as the surrogate for the long-tailed duck. If none of the test species were similar to the ecological receptors selected in this assessment, then the lowest value was selected as the conservative default benchmark for the ecological receptor. The Ecological and Human Health Risk Assessment report (i.e., Tier 3, Appendix 8A) provides the final selected values along with additional detail on the derivation and rationale for the value.

Screening index values are not estimates of the probability of ecological effect. Rather, the index values are correlated with the potential of an effect, e.g., higher index values imply a greater potential of an effect. The estimated exposure of the Lapland longspur, the long-tailed duck, and the semipalmated sandpiper includes both the natural baseline levels as well as the effect of the Project emissions. Therefore, a screening index value less than 1.0 indicates that the estimated total exposure is less than the threshold level that is associated with a potential adverse effect. The screening index values for the migratory birds are shown in Table 16.2-10.

Emissions from the Project are not anticipated to result in a discernible change in exposure to COPC for these migratory birds. In addition, the results show that it is not expected that the exposure to Lapland longspur, long-tailed duck, or semipalmated sandpiper will exceed exposure levels associated with adverse effects. The baseline exposure for Lapland longspur for zinc is equal to the LOAEL value; however, this is due to baseline conditions and not related to the Project.

Table 16.2-10 Screening Index Values for Migratory Birds

COPC	Screening Index (SI)					
	Lapland Longspur		Long-tailed Duck		Semipalmated Sandpiper	
	Baseline	Present at Judge Sissons Lake near Discharge Location	Baseline	Present at Judge Sissons Lake near Discharge Location	Baseline	Present at Judge Sissons Lake near Discharge Location
Arsenic	0.130	0.154	0.104	0.140	0.339	0.443
Cadmium	0.023	0.038	<0.001	0.019	0.008	0.068
Cobalt	0.024	0.026	0.001	0.001	0.050	0.062
Copper	0.134	0.134	0.202	0.202	0.244	0.244
Lead	0.029	0.029	0.009	0.010	0.045	0.046
Molybdenum	0.013	0.047	0.003	0.047	0.011	0.152
Nickel	0.196	0.198	0.050	0.052	0.183	0.190
Selenium	0.095	0.110	0.038	0.049	0.211	0.278
Uranium	-	-	-	-	-	-
Zinc	**1.008**	**1.008**	0.268	0.268	0.905	0.906
Radioactivity	<0.01	<0.01	0.01	0.01	0.02	0.02

NOTES:

SI values for non-radiological COPC are based on the maximum mean exposure compared to a LOAEL (lowest observed adverse effects level)

SI values of radiological effects include the contribution from U-238, Th-230, Ra-226, Pb-210 and Po-210, using an RBE of 10 and compared to a benchmark of 2.7 mGy/d

Details of calculation as well as additional results provided in Tier 3, Appendix 8A

16.2.2.6 Determination of Significance for Change in Bird Health

As the level of exposure for Lapland longspur, long-tailed duck and semipalmated sandpiper are not expected to change from baseline or the exposure will remain below exposure levels associated with adverse effects, no residual or significant effects are expected on the health of migratory birds.

16.2.2.7 Compliance and Environmental Monitoring for Change in Bird Health

No specific monitoring requirements are recommended based on the assessment for change in health of migratory birds. The monitoring of other environmental components (e.g., water, insects) will provide valuable information for confirming the results of the assessment.

16.3 Cumulative Effects Analysis for Migratory Birds

The effects of other projects and activities have acted cumulatively on the migratory birds and habitat within the RAA during the Base Case and Project Case. The existing conditions described in the Base Case are a result of the effects of past and current projects on wildlife and habitat. The assessment of the Project Case describes the cumulative effects of the Project in combination with the Base Case. This section addresses how environmental effects associated with reasonably foreseeable future projects will interact with the Project Case.

Project construction and operation activities will contribute to loss of available habitat. These effects have the potential to act cumulatively during the migratory bird breeding season. The development of the mine, port access, and All-Season road access has the potential to increase similar development activity-related disturbances and resulting effects on migratory birds and habitat.

16.3.1 Screening for Cumulative Effects on Birds

Project effects on habitat availability have the potential to act cumulatively with effects from other projects. Residual effects habitat loss/reduced suitability are expected because habitat will be lost beyond the life of the Project to the footprint of the Project and mitigations will only be able to partially mitigate effects of the Project. These effects will be similar to others associated with current and future regional terrestrial development activities that could interact with the Project, and will overlap in time and space. The cumulative effect of a change in habitat availability is assessed.

There are no predicted environmental effects caused by the Project on migratory birds; therefore, they were not considered in the cumulative effects assessment.

16.3.2 Assessment of the Cumulative Effects: Change in Bird Habitat Availability

The Project is not anticipated to result in significant adverse effects on migratory bird habitat within the RAA. Although the residual effects of the Project on changes in habitat availability are not significant, the effects could act cumulatively with similar effects from other human activity in the Kivalliq region that affects migratory bird habitat. The cumulative effect of the habitat loss could reduce the overall availability of habitat for migratory birds in the region to a point that population level effects occur.

16.3.2.1 Effect Mechanisms and Linkages for Cumulative Change in Bird Habitat Availability

The cumulative direct loss of migratory bird habitat will reduce the amount of available habitat regionally, but this effect will not result in measurable or detectable changes in the region. Indirect loss of migratory bird habitat from human disturbance that results in avoidance of use of otherwise suitable habitat may be the largest source of habitat loss. While human disturbance causes a loss of habitat, the effect is temporary as it occurs only while there is human activity.

Current human disturbance within the Kivalliq region that reduces the availability of migratory bird habitat habitat includes:

- Meadowbank Mine — The footprint of the mine and mine access road has reduced the availability of migratory bird habitat during the growing season. Activity at the mine site and transportation to the mine from Baker Lake has indirectly reduced the availability of migratory bird habitat in the area. The Meadowbank Mine is expected to operate until 2018.
- Mineral Exploration Operations — There are numerous mineral deposits being explored in the region. Each of these operations has some amount of human activity (e.g., drilling, surveying). Exploration activities mostly take place during the summer and the footprint of the camps, drill pads and other disturbances is relatively small.
- Local Communities — The footprint of Arviat, Whale Cove, Rankin Inlet, Chesterfield Inlet and Baker Lake reduces the availability of habitat of migratory bird habitat. Sensory disturbance from vehicles, generators, aircraft traffic and other human activities in these communities indirectly reduce the availability of migratory bird habitat.

The Kiggavik Project will add to the overall loss of migratory bird habitat. While there are a number of mineral exploration operations in the region, few exploration projects turn into active mines.

16.3.2.2 Mitigation Measures for Cumulative Change in Bird Habitat Availability

Mitigation measures for cumulative changes in habitat availability are the same as those presented for the Project Case in Section 16.2.1.4. No further actions are necessary to mitigate cumulative effects.

16.3.2.3 Residual Cumulative Change in Bird Habitat Availability

The magnitude of effects of the Project on migratory bird habitat is expected to be negligible. Few projects are expected to overlap temporally with the Kiggavik Project within the Kivalliq region.

16.3.2.4 *Determination of Significance for Cumulative Change in Bird Habitat Availability*

Currently, there are few human activities in the region that affect migratory birds. The Meadowbank mine and regional communities are currently the greatest sources of habitat loss for migratory birds. The addition of the Kiggavik Project to these disturbances is not expected to measurably reduce the amount of migratory bird habitat. Mineral exploration is currently not causing significant loss of habitat. Although there is the potential for future mine development in the region, given the history of such development the likelihood of multiple future mines existing at the same time as the Kiggavik Project is low. The cumulative change to habitat availability for migratory birds as a result of the Kiggavik Project is therefore assessed as not significant.

There is high confidence in the prediction of a low magnitude cumulative effect on migratory birds and habitat. Lapland longspur, long-tailed duck and shorebirds habitat requirements are generally well understood. There is abundant breeding and foraging habitat for birds in the Kivalliq region. There were no breeding concentrations or critical habitat components identified within the Kivalliq region that experience cumulative effects associated with the Project. There are few land uses planned in the region that will overlap temporally and spatially with the Kiggavik Project RAA.

16.3.2.5 *Compliance and Environmental Monitoring for Cumulative Change in Bird Habitat Availability*

Compliance and environmental monitoring for cumulative changes in habitat availability are the same as those presented for the Project Case in Section 16.2.1.8.

16.3.3 Summary of Residual Cumulative Effects on Migratory Birds

Table 16.3-1 summarizes the cumulative environmental effects of the Project on migratory birds.

Table 16.3-1 Summary of Residual Cumulative Environmental Effects on Migratory Birds

Cumulative Environmental Effect	Case	Other Projects, Activities and Actions	Mitigation and Compensation Measures	Residual Cumulative Environmental Effects Characteristics: Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Prediction Confidence	Likelihood	Proposed Follow-up and Monitoring Programs
Changes in Habitat Availability	Cumulative Effect with Project (Future Case)	Meadowbank Mine, various exploration operations, and various regional communities	Dust management; Minimize Project footprint; Progressive reclamation	N	N	L	LT	C	R	D	N	H	N/A	None
	Project Contribution to Cumulative Effect	NA	NA	N	N	L	LT	C	R	D	N	H	N/A	NA

KEY

Direction:

P Positive

N Negative

Magnitude:

N Negligible: No anticipated effect on wildlife species.

L Low: Detectable change to high quality habitat that does not cause a behavioural change in birds, or observable effect on wildlife species but not likely to affect the species' sustainability in the LAA.

M Moderate: Detectable change in the amount of high quality habitat that could result in a behavioural response of birds, or observable effect on wildlife species but not likely to affect the species' sustainability in the RAA.

H High: A detectable change in high quality habitat across the seasonal range that results in a behavioural change of a population of birds, or measurable effect on wildlife species that will likely affect the species' sustainability in the RAA.

Geographic Extent:

S Site-specific

L Local: Effect confined to the LAA

R Regional - Effect extends beyond the LAA but within the RAA

T Territorial: Effect extends beyond the RAA but within Nunavut

N National: Effect extends beyond Nunavut but within Canada

Duration:

ST Short term: Less than one year

MT Medium term: More than one year, but not beyond the end of Project decommissioning

LT Long term: Beyond the life of the Project

Frequency:

O Once: Effect occurs once

S Sporadically: Effect occurs occasionally but not consistently throughout the life of the Project

R Regularly: Effect occurs at regular intervals throughout the life of the Project

C Continuous: Effect occurs continuously throughout the Project

Reversibility:

R Reversible: Will likely recover to baseline conditions after or before the end of Project decommissioning

I Irreversible: Unlikely to recover to baseline conditions after the end of Project decommissioning

Environmental Context:

U Undisturbed: Area relatively or not adversely affected by human activity

D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:

S Significant

N Not significant

Prediction Confidence:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation

L Low level of confidence

M Moderate level of confidence

H High level of confidence

Likelihood of Significant Effects:

Based on professional judgment

L Low probability of occurrence

M Medium probability of occurrence

H High probability of occurrence

Other Projects, Activities and Actions:

Human disturbance associated with Meadowbank Mine, various exploration operations, and various regional communities.

16.4 Summary of Residual Effects on Migratory Birds and Habitat

16.4.1 Project Effects

The Project is expected to result in no significant effects to migratory birds. All effects on migratory birds caused by the Project are rated as low in magnitude, and the effects are anticipated to occur within the LAA. The effects are reversible when the Project enters the closure stage and habitat reclamation is implemented. The confidence in the prediction of significance is moderate.

AREVA acknowledges the importance of avoiding disturbance of migratory birds during the breeding season, and the regulations pertaining to migratory birds in the *Migratory Birds Convention Act, 1994* and the Migratory Bird Regulations (C.R.C., c. 1035). As such, AREVA will endeavour to schedule land clearing activities outside of the migratory bird breeding season. However, in the event that land clearing must occur within the season, AREVA will ensure that nesting birds are not disturbed by conducting Active Migratory Bird Nest Surveys and establish no disturbance buffers until nesting is completed (described in detail in Appendix 6D — Wildlife Migitation and Monitoring Plan).

Interaction of waterbrids with waste water and potential effects will be limited. Water management for the Kiggavik Project is described in Tier 2, Volume 2 — Project Description and Assessment Basis, Section 9.1. Non-contact water (i.e., water that does not contact site activities, e.g., water in the freshwater diversion structures) will be diverted away from site activities to the surrounding natural drainage systems. Contact water (e.g., water from snowmelt, precipitation, or surface runoff water that may have been physically or chemically affected by site activities) will be intercepted, contained, analyzed and treated when required. All water released to the environment will meet the discharge quality criteria; furthermore discharge quality objectives were selected to minimize potential environmental effects associated with the release of treated effluent.

Waterfowl interactions with water control structures within the Kiggavik Project footprint (i.e., waste rock drainage ponds, the purpose-built water storage facility, the treated effluent monitoring ponds) is anticipated to be negligible as these will not provide waterfowl habitat, and the water control structures are located within the Project footprint where operational activities will be a deterrent to waterfowl use. Temporary use of these structures will not present population level risks.

The tailings management plan uses mined out pits for tailings disposal and does not include any aboveground tailings storage. For the majority of the lifespan of an in-pit tailings management facility (TMF), the water elevation within the TMF will be managed well below the brow of the pit. This configuration (i.e., steep rock walls surrounding TMF water surface) combined with the lack of habitat within these facilities are strong deterrents to waterfowl use, and reflect an application of mitigation by design.

Additionally, there will be continuous site presence throughout the operational life of the Project. Observation will determine whether any additional mitigation is required to deter waterbird use of contact water.

16.4.2 Cumulative Effects on Birds

The contribution of the Project to cumulative effects on migratory birds and habitat are assessed as not significant. The Project is expected to have negligible measurable effects on migratory birds and their nesting and foraging habitats in the Kivalliq region. The confidence in this prediction is high.

16.4.3 Effects of Climate Change on Project and Cumulative Effects on Migratory Birds

Determining the effects of climate change on migratory birds is complicated due to the breadth of habitats and human interactions that migratory birds experience across their annual range. Winter ranges of migratory birds often extend from southern North America to southern South America. The expanse of the wintering range introduces an entirely different suite of climate-related effects that are beyond the scope of this assessment. Effects of climate change on migratory birds that seasonally occur within the RAA would likely be related to increased environmental stochasticity resulting in local weather conditions above or below normal condition (e.g., extreme frost or snow events in spring or summer). Indirectly, temporal deviations in environmental conditions (e.g., late snowmelt) could result in increased mortality due to a lack of available forage. An example of this is Lapland longspur diet that consists of the previous season's berries and catkins when they first arrive in the early spring, and arthropods during the summer. Climate change may alter the tundra vegetation from low-lying shrubs (e.g., berries) to taller deciduous shrubs, benefiting arthropod production, resulting in abundant summer forage, but decreasing the production of berries and catkins that are needed when the birds first arrive in the spring (Polar Field Services 2011). These mechanisms are expected to occur independently, and are not expected to act in combination with any other Project effects. Although bird habitat will be lost due to the Project footprint, it is expected that climate change will not act cumulatively with Project effects. AREVA has high confidence that the contribution of the Project to cumulative effects on migratory birds and habitat is not significant. The Project effects will not substantially interact with or exacerbate potential climatic changes within the lifespan of the Project.

16.5 Transboundary Effects on Birds

Project effects on migratory birds will be not detectable or measurable as a transboundary effect.

16.6 Summary of Mitigation Measures for Migratory Birds

The winter road is a Project design feature that reduction of potential effects on migratory birds. Minimizing the Project footprint will reduce the overall loss of available habitat. AREVA will mitigate potential adverse effects on migratory birds through:

- minimizing Project activities outside of the footprint
- progressively reclaiming disturbed areas
- providing dust suppression along mine site roads during dry summer periods.

Project facilities will be designed to minimize the potential for predatory or scavenging animals' use of the facilities for shelter or a source of food. The guidance provided in Environment Canada's "Preventing Wildlife Attraction to Northern Industrial Sites" (Environment Canada 2007) outlines the design of Project facilities and infrastructure to discourage attraction of or nesting by predatory birds. That document also provides specific examples of how other northern mines have designed infrastructure to support responsible waste management (e.g. the kitchen at the Ekati mine connected to the incinerator room). Other mines have incorporated wildlife-specific waste management actions into mitigation plans (e.g. Snap Lake, Diavik). Those actions included employing a wildlife interaction expert to conduct regular audits on Project facilities, inspecting waste sites or containers to evaluate the effectiveness of waste management plans, or monitoring for and clearing of litter on Project-related roads.

AREVA acknowledges the potential for an increase in the number of predators as a result of human activity in the area. To minimize the potential for increasing densities of bird nest predators (e.g., foxes, wolverines, ravens), AREVA will:

- Implement strict waste management procedures as outlined in the Waste Management Plan (Tier 3, Volume 2, Project Description and Assessment Basis, Appendix 2S);
- Buildings will be designed to avoid/eliminate denning, roosting and nesting sites. For example: bird spikes will be installed on horizontal surfaces near heat sources,
- Limit the number of sheltered surfaces on buildings where nests could be established.
- Conduct regular monitoring of Project facilities and waste disposal sites to ensure that predator control measures are effective. If Project facilities are found to be used by predators, then the environmental manager will contact consulting biologists to identify adaptive management options that will displace the predators and deter them from using the site in subsequent years.

16.7 Summary of Compliance and Environmental Monitoring for Migratory Birds

The details of monitoring that may be realted to potential Project effects on migratory birds are provided in the Wildife Mitigation and Monitoring Plan (Appendix 6D). There are no effects-monitoring program suggested for migratory birds per se. There will be pre-construction active migratory bird nest sureys if clearing needs to occur during the nesting season, and regular on-site inspections to determine if deterrence of nest predators is effective. AREVA is willing to contribute to Environment Canada's continued efforts to monitoring shorebird abundance through the PRISM technique described in the Wildife Baseline report (Appendix 6C).

17 Effects Assessment for Species at Risk

17.1 Scope of the Assessment for Species at Risk

The species at risk (SAR) effects assessment focuses on the indicators Short-eared owl, grizzly bear, and wolverine. Peregrine falcon, the only other wildlife species at risk known to occur within the RAA is the key indicator for the effects assessment on raptors (Section 15).

17.1.1 Project-SAR Interactions and Effects

Key issues of concern for species at risk include Project-related effects on habitat availability and health for short-eared owls, and health for grizzly bear and wolverine. Key Project components related to these potential effects include site clearing (habitat loss), mine operation (reduced habitat effectiveness), road construction (habitat loss), operation (reduced habitat effectiveness), and milling (noise and dust and influence on habitat effectiveness and dust effects on forage and ultimately health).

The primary limiting factor affecting short-eared owl is habitat loss and alteration (COSEWIC 2008). Austen et al. (1994) suggested the decline in short-eared owls is mostly related to habitat loss and degradation on its wintering grounds, with continuing habitat loss and degradation on its breeding grounds in southern Canada. Secondary to habitat loss is increased nest depredation by species such as snowy owls, peregrine falcon and great horned owls (Clark 1975). Nest depredation has been increasing as a result of habitat fragmentation (Johnson and Temple 1986; COSEWIC 2008). Declines in prey abundance (as a result of changes in habitat), collisions with vehicles, utility lines and barbed wire fences, and to a lesser degree effects due to pesticide and contaminants are also factors in the decline of short-eared owl (COSEWIC 2008).

Grizzly bear mortality was identified as the primary threat to grizzly bear populations in North America (Ross, 2002). Wolverine populations in Canada are threatened by a combination of factors that are thought to be causing a decline of wolverines across their ranges, and no primary population limiting issue has been identified. Threats to the wolverine population are habitat loss, direct mortality, loss of primary food sources (e.g., caribou) and food providers (e.g., wolves), and disturbance at denning sites (COSEWIC 2003).

A potential Project effect to both grizzly bear and wolverine (and other scavengers such as gulls) is attraction to garbage. This was not assessed for this Project because garbage and waste management will follow best management practices and attraction is unlikely.

Some of the key Project activities that could affect species at risk are outlined in Table 17.1-1.

Table 17.1-1 Project-Environment Interactions and Effects on Species at Risk

		Environmental Effects		
		Short-eared owl		Grizzly Bear and Wolverine
Project Component	Project Activities	Change in Habitat	Change in Health	Change in Health
Construction				
On-Land Construction	Site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing	2		
Supporting Activities	Transport fuel and construction materials	2		
	Air transport of personnel and supplies	2		
	Explosives storage and use	2	2	2
Operation				
Mining	Mining ore (blasting, loading, hauling)	2	2	2
Milling	Crushing and grinding		2	2
Final Closure				
On-land Decommissioning	Revegetation	2		
NOTES: Only Project interactions ranked as 2 in Table 5.5-1 are carried forward to this table.				

17.1.2 Residual Environmental Effects Criteria for Species at Risk

Residual effects on species at risk were characterized quantitatively and qualitatively using the following six attributes: direction, magnitude, geographic extent, frequency, duration and reversibility. Table 17.1-2 provides definitions for these attributes.

Table 17.1-2 Residual Environmental Effects Criteria for Species at Risk

Attribute	Description	Rating	Definition
Direction	The ultimate long-term trend of the environmental effect	Positive	Increased habitat availability (nesting and foraging) or improvements to health relative to baseline conditions
		Neutral	No change in habitat availability or health
		Adverse	Reduced habitat availability or health
Magnitude	Amount of change in a measurable parameter relative to baseline conditions; for health, defined by potential for exposure compared to a toxicity benchmark	Negligible	No anticipated effect on species at risk
		Low	Observable effect on species at risk, but not likely to affect the species' sustainability in the LAA
		Moderate	Observable effect on species at risk, but not likely to affect the species' sustainability in the RAA
		High	Measurable effect on species at risk that will likely affect the species' sustainability in the RAA
Geographic Extent	The geographic area within which an environmental effect occurs	Local	Effect confined to the LAA
		Regional	Effect extends beyond the LAA but within the RAA
		Territorial	Effect extends beyond the RAA but within Nunavut
		National	Effect extends beyond Nunavut but within Canada
Frequency	Number of times that an effect may occur over the life of the Project	Once	Effect occurs once
		Sporadically	Effect occurs occasionally but not consistently throughout the life of the Project
		Regularly	Effect occurs at regular intervals throughout the life of the Project
		Continuous	Effect occurs continuously throughout the Project
Duration	Length of time over which the effect is measurable	Short term	Less than one year
		Medium term	More than one year, but not beyond the end of Project decommissioning
		Long term	Beyond the life of the Project
Reversibility	Likelihood that a measurable parameter for a VEC will recover from an environmental effect to baseline conditions	Reversible	Will likely recover to baseline conditions after or before the end of Project decommissioning
		Irreversible	Unlikely to recover to baseline conditions after the end of Project decommissioning

17.1.3 Standards or Thresholds for Determining Significance

Habitat — There is no known existing standard or threshold for determining a significant loss of habitat for short-eared owl. Based on professional opinion, experience from other northern Project, knowledge of short-eared owl ecology in arctic Canada, the relatively low number of occurrences of the species in the region, Project effects on habitat availability are considered significant if greater than 10% of habitat units in the RAA are affected.

Health — There are no generic guidelines for Nunavut or Canada that are applicable to assess the effect of changes in biota based on their exposure to COPC. For this assessment, the estimated exposure to COPC by wildlife and birds is compared to values that are set to be protective of health and if the exposure is lower than this value then no adverse effects are expected. The estimated dose received by the biota from exposure to radioactivity, considering both baseline and Project emissions, is compared to a level that is protective of mammals and birds.

17.1.4 Technical Limitations of the Assessment for Species at Risk

Project effects on short-eared owls, grizzly bears and wolverine are likely limited. The animals are infrequently observed in the region, so are expected to have few encounters with the Project. Each species shows high annual variability in their use of specific habitat features for reproduction or hibernation, further reducing the likelihood of effects because animals are not restricted to specific locations. Quantifying effects on these species, and then monitoring potential effects is very difficult because of limited data availability, variability in occurrence, lack of site fidelity for reproduction or hibernation, and low sample size upon which to validate results.

Short-eared owls were rarely documented during baseline studies within the RAA; 23 observations and 2 nests were found during 1979–1980 and 2007–2010. Short-eared owls do not reuse nest sites among years, though they may nest in similar locations because of the habitat. The unknown variation in short-eared owl distribution and abundance, and their lack of nest site fidelity makes confidence in predictions moderate, and methods of follow-up monitoring to determine Project-related effects weak.

Grizzly bear and wolverine abundance in the RAA is thought to be relatively low, though both are wide ranging so individuals may occupy habitat throughout the RAA. Grizzly bears and wolverine were consistently but infrequently observed during baseline studies within the RAA. There were 31 grizzly bear observations during 1979–1980, 1991–1992 and 2007–2010, and 23 wolverine observations during 2007–2010. Both animals are solitary throughout most life stages and season, and occur at lower densities compared to many other terrestrial animals. Furthermore, it is uncommon for of these species to reuse den sites among years, though they may den in similar locations because of the habitat characteristics. The low numbers of grizzly bear and wolverine, and their lack of site fidelity to den sites makes confidence in predictions moderate, and methods of follow-up monitoring to determine Project-related effects weak.

17.2 Effects Assessment for Species At Risk

17.2.1 Assessment of Change in Shoret-eared Owl Habitat Availability

The Kiggavik Project will result in a loss of and reduced effectiveness of short-eared owl habitat. Habitat availability can be affected by human developments through two pathways:

1. direct habitat loss from Project's footprint; and
2. reduced habitat effectiveness from human activity associated with the Project that causes a functional loss of habitat

17.2.1.1 Analytical Methods for Change in SAR Habitat Availability

Habitat availability for short-eared owl was assessed using the baseline ELC units were classified as High, Medium, Low or Nil based on the vegetative characteristics of the ELC units and the species' life requisites during the growing (breeding) season. Ratings were based on knowledge of short-eared owl habitat gained during a literature review and field biologist observations.

To assess the overall loss of short-eared owl habitat availability within the RAA a habitat unit index was developed. The index is based on assigning a ranked value to each habitat class (e.g., high=3, moderate=2, low=1, nil=0), and summing the available habitat, measured in hectares, weighted by the value of each class. The difference in the weighted sum of available habitat for the baseline conditions, and the predicted direct and indirect loss of habitat indicate the expected loss of short-eared owl habitat.

The Project's footprint was quantified as a complete loss of habitat (i.e., rating "nil") and reduced habitat effectiveness within a ZOI for habitats proximate to mine facilities. Direct habitat loss is assessed by identifying ELC units that will become unavailable due to construction of the Project footprint. All ELC units within the Project footprint become "nil" quality once the Project is constructed. The winter road options will remove habitat in winter, but the habitat will be available again each summer when the road is decommissioned. Habitat effectiveness is addressed quantitatively by reducing habitat units by one or two categories, depending on their proximity to mine infrastructure within the ZOI. Details are provided below.

17.2.1.2 Baseline Conditions for Change in SAR Habitat Availability

Short-eared owls were observed during the baseline surveys consisting of 23 different sitings (Tier 3, Appendix 6C). One nesting pair was suspected, though a nest site was not confirmed.

Short-eared owl populations can fluctuate yearly due to variation in cyclic small mammal populations, such as voles and lemmings, making local occurrence unpredictable (Clark 1975; Dechant et al. 2001). Short-eared owl nest site selection is typically associated with cyclic prey populations (Holt and Leasure 1993; Poulin et al. 2001). In Nunavut, higher concentrations of short-eared owl occur during years of lemming outbreaks (COSEWIC 2008).

Short-eared owls prefer open habitats such as arctic tundra (Johnsgard 1998), grasslands (Clark 1975), peat bogs (Mikkola 1983), fresh and saltwater marshes (Holt and Leasure, 1993), old pasture/croplands (Houston 1997), and shrub-steppe (Lehman et al. 1998). In the arctic, preferred nesting sites include tundra containing small willows (e.g., in Churchill region; Jehl 2004); generally in areas larger than 100 ha (Dechant et al. 2001). Nests are thought to be initiated in early June in northern ecosystems (Jehl 2004). ELC units that contain grasses, shrubs and willows are used by short-eared owls as nesting and feeding habitat (Clark 1975; Jehl 2004). ELC units that contain willow components are Graminoid/Shrub Tundra, Shrub Tundra and Shrub/Heath Tundra. Based on this information, ELC units were rated as high, medium, low or nil in the RAA (Table 17.2-1).

Table 17.2-1 Summary of Relative Value of Ecological Land Classification Units to Short-eared Owls

ELC Unit	Growing season rank	Reasoning
Water	nil	Short-eared owls do not nest or are known to use open water habitats
Sand	L	Vegetation generally absent to sparse for supporting nesting short-eared owl; limited foraging opportunities
Gravel	L	Vegetation generally absent to sparse for supporting nesting short-eared owl; limited foraging opportunities
Rock Association	L	Pockets of vegetation are sparsely distributed and of variable suitability for supporting and concealing a nest. Rock Associations are good prey species habitat (lemmings and voles) for short-eared owls.
Wet Graminoid	M	Small hummocks and rises within this habitat type provide moderate quality nesting habitat for short-eared owl. Habitat also of moderate to high quality for prey species (lemmings and voles).
Graminoid Tundra	H	High quality nesting and foraging habitat for short-eared owl; prey species abundant in this habitat
Graminoid/ Shrub Tundra	H	High quality nesting and foraging habitat for short-eared owl; prey species abundant in this habitat

Table 17.2-1 Summary of Relative Value of Ecological Land Classification Units to Short-eared Owls

ELC Unit	Growing season rank	Reasoning
Shrub Tundra	H	High quality nesting and foraging habitat for short-eared owl; prey species abundant in this habitat
Shrub/Heath Tundra	H	High quality nesting and foraging habitat for short-eared owl; prey species abundant in this habitat
Heath Tundra	M	Moderate quality nesting and foraging habitat for short-eared owls; prey species abundant in this habitat
Heath Upland	M	Vegetative cover generally well-represented, but vertical structure suitable for nesting short-eared occurs in small pockets. Habitat contains prey for short-eared owl
Lichen Tundra	L	Vegetation inadequate as short-eared owl nesting habitat, and moderately suitable for supporting prey (voles)
Heath Upland/Rock Complex	L	Vegetation inadequate as short-eared owl nesting habitat, and moderately suitable for supporting prey (voles)
NOTE: H = High; M = Moderate; L = Low		

17.2.1.3 Effect Mechanism and Linkages for Change in SAR Habitat Availability

The primary threat to short-eared owls across their North American range is loss of prairie habitat in southern Canada and USA (COSEWIC 2008). The Project has the potential to affect short-eared owl habitat by removing probable or actual nesting and foraging sites. Areas such as large grasslands and wetlands that support high densities of prey species (e.g., lemmings) are key to reducing Project effects on short-eared owl (Dechant et al. 2001).

Short-eared owls are known to avoid areas of disturbance. The use of habitat may be affected by proximity to disturbance, such as buildings and roads. For example, Combs-Bettie (1993) found that the average distance of nests to buildings was approximately 789 m, with a minimum distance of 250 m. There is no other known literature on the influence of development on short-eared owl nesting and there was no IQ collected on the potential influence of development on short-eared owl nesting. For the purposes of this assessment, all habitats within 250 m of Project facilities (mine, roads, buildings, ports) were reduced to low quality. All habitats from 250 m to 1 km from the edge of the Project footprint are reduced by one habitat category to a minimum of low (Table 17.2-2). Habitat beyond 1 km remains as baseline conditions.

Table 17.2-2 Summary of the Zone of Influence used to calculate reduced habitat effectiveness for Short-eared Owl

Project infrastructure	ZOI (Radius from Edge of Footprint)	Habitat Reduction	Justification
Mine	0 – 0.25 km	2 class reduction to a minimum of Low	Combs-Bettie (1993)
	0.25 – 1 km	1 class reduction to a minimum of Low	Combs-Bettie (1993)
All-Season Road	0 – 0.25 km	2 class reduction to a minimum of Low	Combs-Bettie (1993)
	0.25 – 1 km	1 class reduction to a minimum of Low	Combs-Bettie (1993)
Winter Road	n/a	No change	Owls are not present in the RAA during winter road operation

17.2.1.4 Mitigation Measures and Project Design for Change in SAR Habitat Availability

Mitigation measures that will be implemented to minimize effects on habitat availability for short-eared owls include the following:

- Project activities will be maintained within the boundaries of the Project footprint to the extent possible.
- If possible, construction activities involving site clearing will be scheduled to occur outside of the breeding and nesting period for migratory birds (May 15 to August 15; Environment Canada 2014).
- Prior to clearing activities during the breeding bird season, all areas within the construction area will be searched for short-eared owl nests. Active nests will be identified and a 400 m no-disturbance buffer will be applied until the chicks have fledged.
- All on-site observations of short-eared owl will be investigated to determine presence of nests sites. Active nests within 750 m will be monitored. A 400 m no-disturbance buffer around the nest will be established until chicks have fledged.
- Decommissioning of the Project will include dismantling and demolition of all site facilities, clean up and reclamation of disturbed areas, closure of the TMFs, and reclamation of mine rock stockpiles to promote vegetative growth, which will provide small mammal (prey) habitat and potential nesting habitat (see Tier 3, Appendix 2R, Preliminary Decommissioning Plan).

These mitigation measures are readily implemented by on-site environmental staff. Refer to the Wildlife Mitigation and Monitoring Plan for additional mitigation measures and monitoring information (Tier 3, Appendix 6D, Wildlife Mitigation and Monitorin Plan).

17.2.1.5 Residual Effects for Change in SAR Habitat Availability

Mine and All-Season Road

Of the two Project options, the All-Season Road will have the greatest effect on potential short-eared owl habitat because of the larger footprint and temporal overlap with owls during the breeding season. The road's footprint results in long-term habitat loss. The operation of the road during the breeding season could result in sensory disturbance (e.g., avoidance of areas with traffic noise) or habitat effects (e.g., dust effects on small mammal forage, reducing small mammal abundance in areas of high dust settlement). Within the RAA, the Project will result in a loss of 3.6% of available high quality habitat and 2.6% of available moderate quality habitat. This equates to an overall loss of 1.9% habitat units within the RAA. The baseline versus operation scenario of habitat in the RAA is presented in Table 17.2-3 and Figure 17.2-1.

Table 17.2-3 Mine and All-Season Road Baseline and Operational Habitat Quality for Short-eared Owls

Habitat rating		Baseline ELC	Direct loss[2]	Indirect effect[3]	RAA effect
Class	SI[1]	ha	ha	ha	%
High	3	303,660	-663	-10,346	-3.6
Moderate	2	344,073	-958	-7,948	-2.6
Low	1	81,306	-136	18,294	22.3
Nil	0	251,106	-24	0	0.7
No Rating		2,583	0	0	0.0
Total area		982,728	1,780	36,588	
Habitat units[4]		1,680,432	-4,039	-28,640	**-1.9**

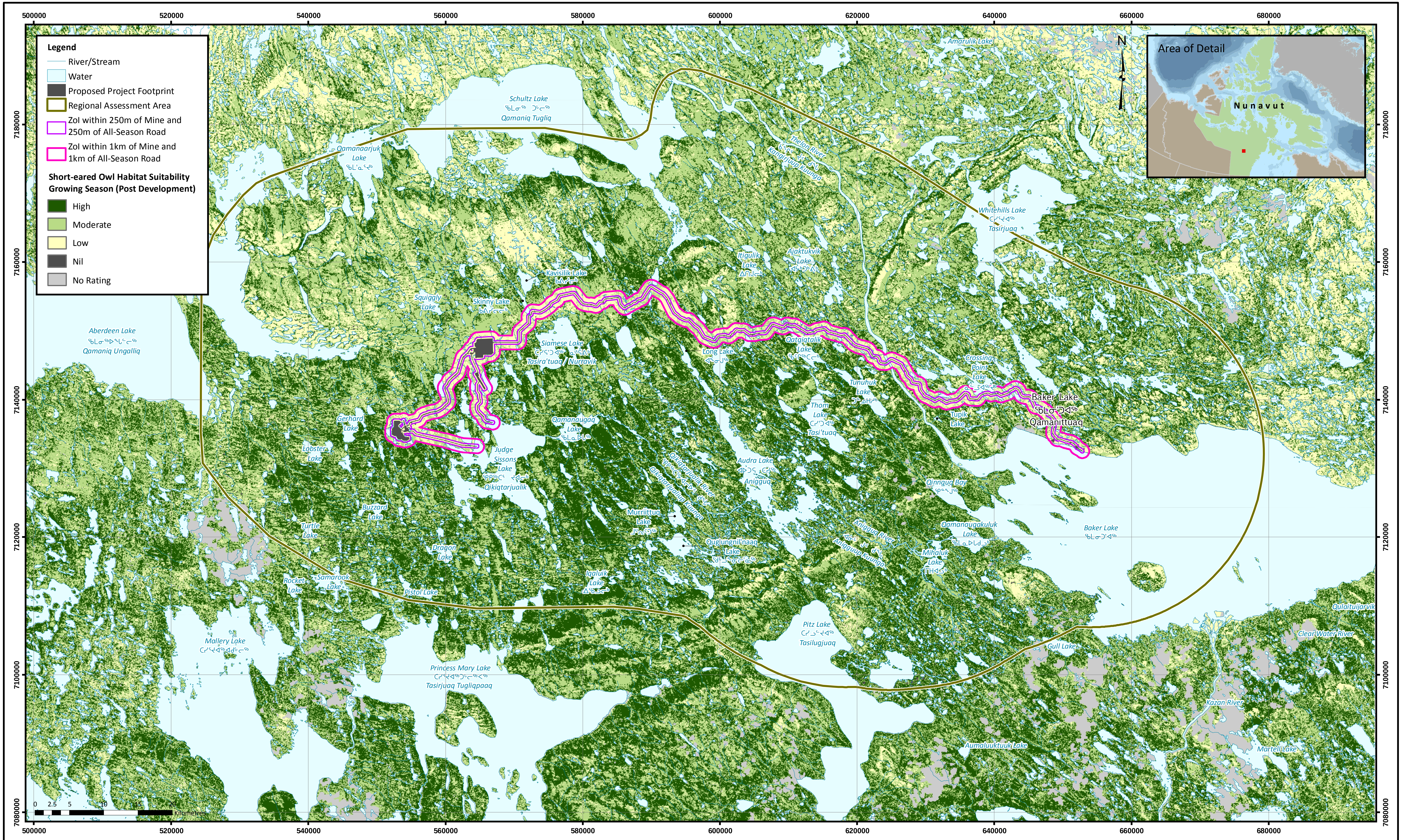
NOTES:

[1] SI = Suitability Index (used for weighted sum calculation of Habitat Units)

[2] Direct loss is the change in habitat availability due to the footprint of the project.

[3] Indirect effect is the change in habitat availability due to the zone of influence (ZOI) of the project.

[4] Habitat units are the weighted sum of all available habitat (sum [ha * SI]).



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 07/07/2014 Scale: 1:500,000
File: 17.2-1_Habitat_Suitability_Growing_PD_Short-eared_Owl.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 17.2-1
POST-DEVELOPMENT SHORT-EARED OWL HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project
AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

Mine and Winter Road

Residual effects are limited to the mine portion of the Project. The winter road option does not temporally overlap with short-eared owl presence within the region. All Project effects will be due to direct loss of habitat to the mine footprint and indirect loss of habitat within the ZOI because of disturbance associated with Project activities. After mitigation, the Project is anticipated to reduce the availability of high and moderate quality habitat by 1.3% and 1.0%, respectively, within the RAA (Table 17.2-4). This equates to an overall reduction of 0.7% of the habitat units within the RAA.

Table 17.2-4 Mine and Winter Road Baseline and Operational Habitat Quality for Short-eared Owls

Habitat rating		Baseline ELC	Direct loss[2]	Indirect effect[3]	RAA effect
Class	SI1	ha	ha	ha	%
High	3	303,661	-548	-3,282	-1.26%
Moderate	2	344,075	-792	-2,476	-0.95%
Low	1	81,308	-16	5,758	7.06%
Nil	0	251,110	-22	0	NA
No Rating		2,583	0	0	0.00%
Total area		982,737	-1,378	-11,516	
Habitat units4		1,680,441	-3,244	-9,040	-0.73%

NOTES:

Values in this table were not updated from the DEIS. The reduced Project footprint is 1,102; consequently, the predicted effect errs on the side of precaution for predicting Project effects on short-eared owl habitat availability.

[1] SI = Suitability Index (used for weighted sum calculation of Habitat Units)

[2] Direct loss is the change in habitat availability due to the footprint of the project.

[3] Indirect effect is the change in habitat availability due to the zone of influence (ZOI) of the project.

[4] Habitat units are the weighted sum of all available habitat (sum [ha * SI]).

17.2.1.6 Determination of Significance for Change in SAR Habitat Availability

The Project will result in the long-term loss of some nesting and foraging habitat for Short-eared owls. The change in habitat will be measureable, but will be limited to the Project footprint (complete loss) and within the ZOI (Table 17.2-5). Reduced habitat effectiveness is reversible once operations cease. Overall, Project effects on Short-eared owl nesting and foraging habitat is predicted to be not significant. The confidence in this prediction is rated as moderate as short-eared owls are known to respond adversely to habitat loss and alteration, and the Project will result in a loss of foraging and nesting habitat. While the exact extent of the ZOI is uncertain due to indirect habitat loss caused by the Project, the ZOI is considered to be a conservative estimate.

17.2.1.7 Summary of Project Residual Environmental Effects for Habitat Availability of Short-eared Owl

Table 17.2-5 summarizes the Project residual effects for habitat availability for short-eared owl.

17.2.1.8 Compliance and Environmental Monitoring for Change in SAR Habitat Availability

The extent of the Project footprint will be assessed on an annual basis to confirm habitat loss predictions.

Table 17.2-5 Summary of Project Residual Environmental Effects for Short-eared Owl Habitat Availability

Project Phase	Mitigation / Compensation Measures	Direction	Residual Environmental Effects Characteristics: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
Change in Short-eared owl Habitat Availability –Mine + All-Season Road												
Construction	Pre-clearing nest searches; no-disturbance buffers; reclamation	N	M	L	LT	S	I	U	N	N/A	M	No disturbance buffers around SAR breeding sites through to completion of breeding.
Operation		N	M	L	MT	R	R	U	N	N/A	M	
Final Closure		N	M	L	MT	O	I	U	N	N/A	M	
Change in Short-eared owl Habitat Availability – Mine + Winter Road Options												
Construction	Pre-clearing nest searches; no-disturbance buffers; reclamation	N	M	L	LT	S	I	U	N	N/A	M	No disturbance buffers around SAR breeding sites through to completion of breeding.
Operation		N	M	L	MT	R	R	U	N	N/A	M	
Final Closure		N	M	L	MT	O	I	U	N	N/A	M	

KEY

Direction:
- P Positive
- N Negative

Magnitude:
- N Negligible: No anticipated effect on wildlife species.
- L Low: Observable effect on wildlife species but not likely to affect the species' sustainability in the LAA.
- M Moderate: Observable effect on wildlife species but not likely to affect the species' sustainability in the RAA.
- H High: Measurable effect on wildlife species that will likely affect the species' sustainability in the RAA.

Geographic Extent:
- S Site-specific
- L Local: Effect confined to the LAA
- R Regional - Effect extends beyond the LAA but within the RAA
- T Territorial: Effect extends beyond the RAA but within Nunavut
- N National: Effect extends beyond Nunavut but within Canada

Duration:
- ST Short term: Less than one year
- MT Medium term: More than one year, but not beyond the end of Project decommissioning
- LT Long term: Beyond the life of the Project

Frequency:
- O Once: Effect occurs once
- S Sporadically: Effect occurs occasionally but not consistently throughout the life of the Project
- R Regularly: Effect occurs at regular intervals throughout the life of the Project
- C Continuous: Effect occurs continuously throughout the Project

Reversibility:
- R Reversible: Will likely recover to baseline conditions after or before the end of Project decommissioning
- I Irreversible: Unlikely to recover to baseline conditions after the end of Project decommissioning

Environmental Context:
- U Undisturbed: Area relatively or not adversely affected by human activity
- D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:
- S Significant
- N Not significant

Prediction Confidence:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence

Likelihood of Significant Effects:

Based on professional judgment
- L Low probability of occurrence
- M Medium probability of occurrence
- H High probability of occurrence

Other Projects, Activities and Actions:

Human disturbance associated with Meadowbank Mine, various exploration operations, and various regional communities.

17.2.2 Assessment of Change in Species at Risk Health

Emissions from the Project have the potential to expose species at risk (i.e., short-eared owl, grizzly bear, and wolverine) to COPC. The potential for emissions to cause adverse effects to species at risk was evaluated.

In the Ecological and Human Health Risk Assessment report (Tier 3, Appendix 8A), the peregrine falcon was selected to represent all types of birds of prey (including short-eared owl). The short-eared owl's diet comprises of a larger fraction of small mammals compared to the peregrine falcon but this diet variation is expected to be captured within the uncertainty included in the Ecological Risk Assessment. The assessment of peregrine falcon health is used for the evaluation of short-eared owls.

17.2.2.1 Analytical Methods for Change in SAR Health

Emissions from the Project can the influence COPC concentrations in environmental components (e.g., water, soil, fish), which in turn could potentially influence COPC concentrations in short-eared owls (modeled as peregrine falcons), grizzly bears, and wolverines that consume these environmental components. The COPC included in this assessment were uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc.

Peregrine falcons (representing short-eared owls in the model) prey almost exclusively on birds but will also eat small mammals such as rodents and squirrels. Grizzly bears forage on mammals and in some areas migrating salmon, but also rely heavily on vegetation (specifically berries) for food. Wolverine is an opportunistic carnivore and will consume carrion from large mammal kills by other carnivores as well as hunting for birds and small to medium-sized mammals. To estimate animal exposure, the predicted COPC concentrations in all environmental components that could potentially be consumed were included in the analysis. Detailed air quality modelling (see Tier 2, Volume 4, Atmospheric Environment) and water quality modelling (see Tier 2, Volume 5, Aquatic Environment) are used as inputs to the environmental pathways assessment. The concentrations in environmental components are predicted by using transfer factors that relate the concentration in different components (e.g., soil-to-plant). Transfer factors are based on site-specific information where possible, augmented by literature data. COPC intake in birds and small mammals is calculated by multiplying a separate transfer factor to obtain COPC concentration in these animals. These concentrations are used for representing the prey. The pathways assessment is discussed in further detail in the Ecological and Human Health Risk Assessment report (i.e., Tier 3, Appendix 8A).

COPC intake in falcons (representing short-eared owls in the model), grizzly bears, and wolverines is estimated based on predicted COPC concentrations in prey, as well as using assumptions regarding how much prey is consumed. The amount of time both the prey items and the carnivores spend within the exposure area is also an important factor. For peregrine falcon, it is assumed that individuals would be present for four months within the LAA and RAAs. Grizzly bear and wolverine were assumed to spend half of their time in the LAA. In addition, the wolverine was assumed to reside entirely within the RAA. The estimated intakes were compared to benchmarks considered safe for avians and mammals. For estimating radionuclide dose, the concentration within the animal of each radionuclide is estimated from the calculated intake through the use of a transfer factor. Dose coefficients are used to estimate the dose from each radionuclide based on the concentration. Radiation effects on biota depend not only on the absorbed dose, but also on the relative biological effectiveness (RBE) of the particular radiation (i.e., alpha, beta or gamma radiation). Recent recommendations have focused on an RBE of 10 for alpha radiation; this value was used in the assessment for consistency with the recommendation of the N288.6 standard (CSA 2012). The total dose, which is based on the baseline plus Project emissions for the sum of the uranium-series radionuclides, is compared to a benchmark that is protective of avians and mammals (2.7 mGy/d).

The bounding scenario carried through the ecological assessment was based on separate discharges from the Kiggavik and Sissons water treatment plants (WTP), an extended operating period (25 years) followed by a 22-year period of consolidation where water treatment would be required. The assessment accounted for the uncertainty and variability in the emissions and the behaviour in the environment. The details are provided in the Ecological and Human Health Risk Assessment report (Tier 3, Appendix 8A).

17.2.2.2 Baseline Conditions for Change in SAR Health

Under baseline conditions, falcons (representing short-eared owls in the model), grizzly bear, and wolverine are exposed to naturally occurring COPC concentrations in the environment. Concentrations of COPC in food items (e.g., fish, berries, small mammals such as voles and lemmings, and small birds such as sparrow) were measured and this baseline information was used to make sure the current conditions were reflected in the pathways assessment.

17.2.2.3 Effect Mechanisms and Linkages for Change in SAR Health

Changes in the health of species at risk can occur if they are exposed to COPC at levels that are associated with an effect. As it is important to maintain these populations, the potential for a COPC to affect the growth and reproduction of the biota is examined. The assessment of changes in health of the biota depends on the estimated changes in concentrations of environmental components such as vegetation and soil which are derived from the atmospheric and aquatic environment assessments.

The Project-environment interactions and effects described in the Atmospheric Environment (Tier 2, Volume 4) and the Aquatic Environment (Tier 2, Volume 5) reports form the basis for the effects mechanisms and linkages. The Project air quality effects relate to emissions of dust containing

COPC from open pit and underground mining and supporting activities, milling and vehicle traffic on unpaved roads. The Project water quality effects relate to emissions of COPC from WTPs at the Kiggavik and Sissons sites. Complete details about the COPC sources and all assumptions used in the assessments were provided in the atmospheric and aquatic environment assessments.

17.2.2.4 Mitigation Measures and Project Design for Change in SAR Health

Design aspects, operational measures and other mitigation measures have been incorporated into the current Project plans which will minimize Project-associated emissions and/or the potential effect of Project-related emissions.

The Atmospheric Environment report (i.e., Tier 2, Volume 4) provides a detailed list of the mitigation measures applied to reduce the changes to ambient air quality. Mitigation measures that have been incorporated to reduce emissions of dust containing COPC include:

- Minimizing or reducing vehicle speed on unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons access road and enforce speed limits, where possible
- Applying water or another approved dust suppressant to the surfaces of unpaved mine site roads (including pit ramps) and the Kiggavik-Sissons haulroad, when possible
- Maintaining all unpaved road surfaces via grading or other maintenance practices to minimize the amount of silt (i.e., fine particles) present in the roadbed material
- Installing appropriate air pollution controls on the exhaust stacks of the mill complex and acid plant (e.g., wet scrubbers, dust collectors) and
- Releasing tailings to the TMFs as a slurry below a water surface to avoid tailings dust emissions

The Kiggavik and Sissons WTPs have been designed so that the effluent will meet all appropriate regulations such as the Metal Mining Effluent Regulations (MMER) as well as site-specific discharge limits. Environmental considerations were paramount in the selection of the appropriate technology for the WTP. Details on the design of the WTPs are in the Project Description report (Tier 2, Volume 2).

17.2.2.5 Residual Effects for Change in SAR Health

In this study, adverse effects from exposure to COPC were characterized by a simple screening index. This index was calculated by dividing the predicted exposure by the toxicity reference value for each ecological receptor as follows:

$$Screening\ Index = \frac{Exposure}{Toxicity\ Reference\ Value}$$

For the wildlife species, the US EPA risk-based ecological soil screening levels (Eco-SSLs) (US EPA 2010) were used as the primary data source for the derivation of toxicity reference values used to determine the potential for an effect. For the assessment of species at risk, the no observable adverse effect levels (NOAELs) based on growth and reproduction were selected, for protection of individual organisms of a species at risk. A lowest observable adverse effect level (LOAEL) was used in the absence of an appropriate NOAEL value. For COPC without Eco-SSL data (in this case uranium), literature studies were reviewed and values from long-term (chronic) exposure studies were selected. The Eco-SSL database provides information for a number of different species that could be used as a surrogate for other species with similar diets. For example, for arsenic the value for a dog is used as the surrogate for the bear and wolverine. If none of the test species were similar to the ecological receptors selected in this assessment, then the lowest value was selected as the conservative default benchmark for the ecological receptor. The Ecological and Human Health Risk Assessment report (Tier 3, Appendix 8A) provides the final selected values along with additional detail on the derivation and rationale for the value.

Screening index values are not estimates of the probability of ecological effect. Rather, the index values are correlated with the potential of an effect; for example, higher index values imply a greater potential of an effect. The estimated exposure of peregrine falcon (representing short-eared owl in the model), grizzly bear, and wolverine includes both the natural baseline levels as well as the effect of the Project emissions. Therefore, a screening index value less than 1.0 indicates that the estimated total exposure is less than the threshold that is associated with a potential adverse effect. The screening index values for grizzly bear and wolverine are shown in Table 17.2-6.

In the Ecological and Human Health Risk Assessment report (Tier 3, Appendix 8A), the peregrine falcon was selected to represent all types of raptors (including short-eared owl). The short-eared owl's diet comprise comprises of a larger fraction of small mammals compared to the peregrine falcon but this diet variation is expected to be captured within the uncertainty included in the Ecological Risk Assessment. As discussed in Section 15.4.1, there are no residual effects with respect to peregrine falcon health due to emissions created by the Project. The analysis presented in Section 15.4.1 was based on consideration of the LOAEL toxicity benchmarks. Table 17.2-7 presents results for the peregrine falcon with consideration of the NOAEL toxicity benchmark to assess the potential for effects on the short-eared owl, which is a species at risk.

Table 17.2-6 Screening Index Values for Species at Risk – Grizzly Bear and Wolverine

COPC	Screening Index (SI)				
	Grizzly bear		Wolverine		
	Baseline	Present in Local Assessment Area	Baseline	Present in Local Assessment Area	Present in Regional Assessment Area
Arsenic	0.012	0.012	0.003	0.003	0.003
Cadmium	0.028	0.028	0.005	0.008	0.006
Cobalt	0.008	0.008	0.002	0.002	0.002
Copper	0.060	0.061	0.064	0.064	0.064
Lead[a]	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum[a]	0.017	0.017	0.006	0.006	0.006
Nickel	0.002	0.002	<0.001	<0.001	<0.001
Selenium[a]	0.063	0.063	0.027	0.028	0.028
Uranium	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc[a]	0.222	0.222	0.149	0.149	0.149
Radioactivity	<0.01	<0.01	<0.01	<0.01	<0.01

NOTES:

a - SI values for non-radiological COPC are based on the maximum mean exposure compared to a NOAEL, with the exception of the COPC indicated.

SI values of radiological effects include the contribution from U-238, Th-230, Ra-226, Pb-210 and Po-210, using an RBE of 10 and compared to a benchmark of 2.7 mGy/d

Details of calculation as well as additional results provided in Tier 3, Appendix 8A

Table 17.2-7 Screening Index Values for Species at Risk — Peregrine Falcon (Representing Short-Eared Owl)

COPC	Screening Index (SI)		
	Baseline	Falcon Present in the LAA	Falcon Present in the RAA
Arsenic[a]	0.004	0.004	0.004
Cadmium	0.003	0.004	0.004
Cobalt	0.006	0.006	0.006
Copper	0.075	0.075	0.075

Table 17.2-7 Screening Index Values for Species at Risk — Peregrine Falcon (Representing Short-Eared Owl)

COPC	Screening Index (SI)		
	Baseline	Falcon Present in the LAA	Falcon Present in the RAA
Lead	0.005	0.005	0.005
Molybdenum[a]	0.001	0.003	0.003
Nickel	0.003	0.003	0.003
Selenium	0.763	0.783	0.783
Uranium	<0.001	<0.001	<0.001
Zinc[a]	0.093	0.093	0.093
Radioactivity	0.01	0.01	0.01

NOTES: The peregrine falcon represents the short-eared owl in the assessment

a - SI values for non-radiological COPC are based on the maximum mean exposure compared to a NOAEL, with the exception ofthe COPC indicated.

SI values of radiological effects include the contribution from U-238, Th-230, Ra-226, Pb-210 and Po-210, using an RBE of 10 and compared to a benchmark of 2.7 mGy/d

Details of calculation as well as additional results provided in Tier 3, Appendix 8A

Emissions from the Project are not anticipated to result in a discernible change in exposure to COPC concentrations for these species compared with baseline exposures, with the exception of a slight increase in selenium for the falcon (representing the short-eared owl for the assessment). In addition, the results show that peregrine falcon, grizzly bear, and wolverine exposure to COPC concentrations will not exceed exposure levels associated with adverse effects. As there are no residual effects with respect to peregrine falcon health due to emissions created by the Project, it is anticipated that there are no residual effects on the health of short-eared owls either.

17.2.2.6 Determination of Significance for Change in SAR Health

Short-eared owl, grizzly bear, and wolverine health are not expected to change significantly from baseline values of exposure, and the exposure will remain below levels associated with adverse effects. Therefore, no residual effects are expected on the health of these species.

17.2.2.7 Compliance and Environmental Monitoring for Change in SAR Health

No specific monitoring requirements are recommended based on the assessment for change in health of species at risk. The monitoring of other environmental components (e.g., water, fish, berries) will provide valuable information for confirming the results of the assessment.

17.3 Cumulative Effects Analysis for Species at Risk

17.3.1 Screening for Cumulative Environmental Effects — SAR

Project effects on habitat availability have the potential to act cumulatively with effects from other projects. Residual effects on reduced habitat availability are expected as the Project Footprint will cause a habitat loss that will extend beyond the life of the Project. Mitigation measures to reduce Project effects on habitat availability will likely only partially mitigate these effects. Project effects will likely be similar to effects from current and future development activities that could interact with the Project, and will overlap in time and space. The cumulative effect of a change in habitat availability for short-eared owls was assessed.

Short-eared owl, grizzly bear, and wolverine health are not expected to change significantly from baseline values of exposure, and the exposure will remain below levels associated with adverse effects. No residual Project effects are expected on the health of short-eared owl, grizzly bear, and wolverine. Project effects on short-eared owl, grizzly and wolverine will be managed through mitigation. There will be no effect so there is minimal opportunity to interact cumulatively with other past, present or future projects and activities. Therefore, the Project's effect on health of these species is not considered in this cumulative effects assessment.

17.3.2 Assessment of the Cumulative Effects: Change in SAR Habitat Availability

As noted in the baseline section, COSEWIC (2008) and Austen et al. (1994) identified the loss of prairie breeding habitat as a threat to short-eared owls. Short-eared owls are irruptive breeders and nesting success appears to be in part a response to local small mammal populations. Additionally, short-eared owls are near the northern extent of their range in the Project Area. It is unlikely that habitat for nesting is a limiting feature in mainland Nunavut. Therefore, the Project is not expected to result in a measurable or reasonably expected cumulative effect on short-eared owl habitat in arctic Canada.

17.3.2.1 Effects Mechanisms and Linkages for Cumulative Change in SAR Habitat Availability

The cumulative direct loss of short-eared owl habitat will reduce the amount of available habitat regionally, but this effect will not result in measurable or detectable changes in the region. Indirect loss of short-eared owl habitat from human disturbance that results in avoidance is the largest source of habitat loss. While human disturbance causes a loss of habitat, the effect is temporary as it occurs only while there is human activity. For the Kiggavik Project to cause a significant additional functional loss of habitat in the region other human disturbances need to overlap temporally.

Current human disturbance within the Kivalliq region that could reduce the availability of nesting habitat for short-eared owl include:

- **Meadowbank Mine** — The footprint of the mine and mine access road has reduced the availability of short-eared owl habitat during the growing season. Activity at the mine site and transportation to the mine from Baker Lake has indirectly reduced the availability of short-eared owl habitat in the area. The Meadowbank Mine is expected to operate until 2019.
- **Mineral Exploration** — There are numerous mineral deposits being explored in the region. Each of these operations has some amount of human activity (e.g., drilling, surveying). Exploration activities mostly take place during the summer and the footprint of the camps, drill pads and other disturbances is relatively small.
- **Local Communities** — The footprint of Arviat, Whale Cove, Rankin Inlet, Chesterfield Inlet and Baker Lake reduces the availability of habitat of short-eared owl habitat. Sensory disturbance from vehicles, generators, aircraft traffic and other human activities in these communities indirectly reduce the availability of short-eared owl breeding habitat.

The Kiggavik Project will add to the overall loss of short-eared owl habitat. While there are a number of mineral exploration operations in the region, few exploration projects may turn into active mines. Therefore, it is likely that the Kiggavik Project will overlap temporally with only a few operating mines or other industrial developments in mainland Kivalliq region during the life of the Project.

17.3.2.2 Mitigation Measures for Cumulative Change in SAR Habitat Availability

Mitigation measures for cumulative changes in habitat availability are the same as those presented for the Project Case in Section 17.2.1.4. No further mitigations are necessary to mitigate cumulative effects of the Project on short-eared owls.

17.3.2.3 Residual Cumulative Change in SAR Habitat Availability

The magnitude of effects of the Project on short-eared owl habitat is expected to be negligible. Few projects are expected to overlap temporally with the Kiggavik Project within the Kivalliq region.

17.3.2.4 Determination of Significance for Cumulative Change in SAR Habitat Availability

Currently, there are few human activities in the region that affect short-eared owls. The Meadowbank mine and regional communities are currently the greatest sources of habitat loss for short-eared owls. The addition of the Kiggavik Project to these disturbances is not expected to measurably reduce the amount of available short-eared owl habitat. Mineral exploration is currently not causing significant loss of habitat. Although there is the potential for future mine development in the region, given the history of such development the likelihood of multiple future mines existing at the same time as the Kiggavik Project is low. The cumulative change to habitat availability for short-eared owls as a result of the Kiggavik Project is therefore assessed as not significant.

The predicted magnitude of Project effects species at risk is rated as low because there are few land uses planned in the region that will overlap temporally and spatially with the Kiggavik Project. Confidence in this prediction is high because effects of the Project on the short-eared owl will be limited to the ZOI and will not cause changes to the population at the regional scale.

17.3.2.5 Compliance and Environmental Monitoring for Cumulative Change in SAR Habitat Availability

Compliance and environmental monitoring for cumulative changes in habitat availability are the same as those presented for the Project Case in Section 17.2.1.8.

17.3.3 Summary of Residual Cumulative Environmental Effects on Species at Risk

Table 17.3-1 summarizes the cumulative environmental effects of the Project on species at risk.

Table 17.3-1 Summary of Residual Cumulative Environmental Effects on Species at Risk — Short-eared Owl Habitat Availability

Cumulative Environmental Effect	Case	Other Projects, Activities and Actions	Mitigation and Compensation Measures	Residual Cumulative Environmental Effects Characteristics							Significance	Prediction Confidence	Likelihood	Proposed Follow-up and Monitoring Programs
				Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context				
Changes in Habitat Availability	Cumulative Effect with Project (Future Case)	Meadowbank Mine, various exploration operations, and various regional communities	Dust management; Minimize Project footprint; Progressive reclamation	N	N	L	LT	C	R	D	N	H	N/A	None
	Project Contribution to Cumulative Effect	NA	NA	N	N	L	LT	C	R	D	N	H	N/A	NA

KEY

Direction:
P Positive
N Negative

Magnitude:
N Negligible: No anticipated effect on wildlife species.
L Low: Observable effect on wildlife species but not likely to affect the species' sustainability in the LAA.
M Moderate: Observable effect on wildlife species but not likely to affect the species' sustainability in the RAA.
H High: Measurable effect on wildlife species that will likely affect the species' sustainability in the RAA.

Geographic Extent:
S Site-specific
L Local: Effect confined to the LAA
R Regional - Effect extends beyond the LAA but within the RAA
T Territorial: Effect extends beyond the RAA but within Nunavut
N National: Effect extends beyond Nunavut but within Canada

Duration:
ST Short term: Less than one year
MT Medium term: More than one year, but not beyond the end of Project decommissioning
LT Long term: Beyond the life of the Project

Frequency:
O Once: Effect occurs once
S Sporadically: Effect occurs occasionally but not consistently throughout the life of the Project
R Regularly: Effect occurs at regular intervals throughout the life of the Project
C Continuous: Effect occurs continuously throughout the Project

Reversibility:
R Reversible: Will likely recover to baseline conditions after or before the end of Project decommissioning
I Irreversible: Unlikely to recover to baseline conditions after the end of Project decommissioning

Environmental Context:
U Undisturbed: Area relatively or not adversely affected by human activity
D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:
S Significant
N Not significant

Prediction Confidence:
Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
L Low level of confidence
M Moderate level of confidence
H High level of confidence

Likelihood of Significant Effects:
Based on professional judgment
L Low probability of occurrence
M Medium probability of occurrence
H High probability of occurrence

Other Projects, Activities and Actions:
Human disturbance associated with Meadowbank Mine, various exploration operations, and various regional communities.

17.4 Summary of Residual Effects on Species at Risk

17.4.1 Project Effects

The residual Project effects on short-eared owl habitat availability are assessed as not significant. Reduced habitat availability caused by the Project is expected to be confined within the mine site and All-Season Road LAA. The winter road option will not temporally overlap with short-eared owl presence in the region.

The Project effects on short-eared owl, grizzly bear, and wolverine health are assessed as not significant. The Project is expected to not significantly increase exposure to COPC relative to baseline values, and the exposure will remain below levels associated with adverse effects to health. No residual effects on short-eared owl, grizzly bear, and wolverine health are anticipated because of exposure the COPCs.

17.4.2 Cumulative Effects

The cumulative change to habitat availability for short-eared owls as a result of the Kiggavik Project is assessed as not significant. The habitat lost to the Project footprint represents a small portion of the breeding habitat in the species range. The habitat loss summarised in the caribou effects cumulative effects assessment can be used as an indicator as the maximum amount of habitat that would be lost to shoret-eared owl. That analyses shows at most a loss of 0.4% of habitat within a >1.5 million square kilometre area of habitat that could contain breeding short-eared owls. The cumulative addition of the Project represents <0.001% of the habitat in that area. The cumulative effect of the Project on short-eared owl habitat is not significant.

17.4.3 Effects of Climate Change on Project and Cumulative Effects on Species at Risk and Habitat

Climate change occurs continuously at a global scale and will likely have long-term effects on wildlife and habitats. Climate change could exacerbate effects on Species at Risk, especially if they are already subject to current environmental pressures. Effects of climate change on Project and cumulative effects on Species at Risk are expected to occur independently and are not expected to act in combination with any other Project-specific effects.

17.5 Transboundary Effects

There are no transboundary effects of the limited habitat loss for short-eared owls. Habitat loss is limited to the footprint of the Project and the operational ZOI (i.e., up to 1 km from Project facilities and activities).

17.6 Summary of Mitigation Measures for Species at Risk

All sightings of Species at Risk will be communicated to the on-site environmental manager as a priority for possible environmental management actions. Where sightings may indicate potential nesting or denning, a site investigation of the reported observation will be conducted to determine if operations may interact negatively with the site. Mitigation for species at risk breeding or denning sites that may interact with the Project will be dealt with as indicated in the mitigation measures sections.

17.7 Summary of Compliance and Environmental Monitoring for Species at Risk

Occurrence of species at risk in the area is expected to be rare and infrequent. Short-eared owl monitoring during construction will include pre-disturbance active nest monitoring programs where a 400 m no-disturbance buffer will be placed around the nest until fledgling is complete. Monitoring during operation will include on-site observations of nesting by short-eared owl. Grizzly bear and wolverine sightings will be noted and investigations will be conducted if their sightings are associated with waste management problems. Problem wildlife will be reported to regional Conservation Officers, and camp waste management will be adjusted as necessary to eliminate attracting problem wildlife.

18 Summary of Project Residual Effects on the Terrestrial Environment

18.1 Context — Terrestrial Environment Assessment

The social and ecological context is based on AREVA's understanding of Inuit land use and values through literature review and more importantly, as shared with AREVA by residents of the Kivalliq region. The intent of this attribute for the environmental assessment is to describe the broad social and ecological landscape within which Project effects and cumulative effects may occur. The social and ecological context provides an integrated perspective of past and current Inuit use and values and ecological information (IQ, community information and western science) for terrestrial environments. Context provides the foundation for mitigation and monitoring environmental effects, not just for maintenance of ecological integrity, but also for continued land use and access.

Information on AREVA's approach to collecting and interpreting information on social and ecological context is provided in Appendix 1F, including the methods used to develop maps representing what is known about the relative amounts of land use activity by Inuit in the Baker Lake region. That information was based on IQ, other recent information from interviews, community meetings, and documented historical information (e.g., Riewe, 1992).

It is important to note that while the land-use maps depict areas of moderate to high use, other areas are still used and will continue to be used by the Inuit, but perhaps less intensively or only when environmental conditions are suitable (e.g., shifts in animal distributions, changes in weather). The maps therefore show areas that may typically be used more commonly for harvesting and other uses, but are not meant to imply that harvesting or other uses do not occur in other parts of the Kivalliq region. As many residents of the Kivalliq region have said in many ways, all of the land and water is used and valued.

Within the Kivalliq region, the major industrial activities are currently associated with the operation and supply of the Meadowbank mine. Mining exploration and, in some cases, advanced exploration, also occur throughout the region. The primary centres for human settlement are Baker Lake, Chesterfield Inlet and Rankin Inlet. As a result, much of the Kivalliq region is subject to very low levels of industrial and associated human activity.

Based on IQ, information from homeland visits and published information, harvesting and other land use activities are largely concentrated along the Thelon River, including Qamanaarjuk lakes, as well as in the general vicinity of Audra Lake and west of the Meadowbank road. The Baker Lake Harvest study also shows that hunting densities and activity are high within a 30-35 km radius around Baker Lake (Technical Appendix 1F Figure 4.2-1).

18.1.1 Social Context

Inuit land use throughout the Kivalliq region has evolved over the past 60 years. Traditionally, the Baker Lake Inuit lived a nomadic lifestyle following caribou migration routes and established camps at preferred hunting locations. The most notable changes occurred with the relocation of Inuit to coastal communities and the inland community of Baker Lake during the 1950s, and the establishment of residential schools (Tier 3, Volume 9, Technical Appendix 9A Socio-economic Baseline). As resettlement occurred, Inuit less frequently occupied traditional sites year round and many began to use camps closer to communities on a seasonal basis. The homeland visit initiative and knowledge of archaeologically important areas show generally consistent land use intensity areas as presented in Riewe (1992), with the areas east and north of the Kiggavik Project having high levels of historic land use intensity and harvest densities. Although harvesting patterns and intensities have changed, Inuit continue to use the land without bounds throughout the Kivalliq region to harvest a range of species throughout the year.

Information on Inuit land use was compiled by AREVA to develop maps of the relative importance of the Baker Lake local area, using the methodology described in Appendix 1F. Two different relative importance maps were developed:

- Land use based only on IQ interviews with all aspects weighted equally (Technical Appendix 1F Figure 4.4-1); and
- Land use based on IQ interviews and other community information (e.g., the Baker Lake Harvest Study and NWMB Harvest Study, Inuit harvest areas form the KIA, Identified Hunting and Fishing Areas, Camping, Human Travel and Spiritual Significance) with all aspects weighted equally (Technical Appendix 1F Figure 4.4-2).

Inuit primarily harvest around the lakes and river systems of the Baker Lake region, which include cultural and spiritual sites located near traditional hunting and camping locations that were largely associated with the caribou migration routes. These migrations routes were also identified as wolf and caribou hunting areas during IQ interviews. As identified through archaeological surveys, homeland visits, and IQ interviews, Inuit have traditionally congregated throughout the lakes of the Thelon River watershed extending from Beverly Lake, to Aberdeen Lake, and Schultz Lake into the Thelon River. They used small lakes for camping areas and travel routes. Meat caches were located near harvest areas for use in the winter near Qamanaarjuk Lake, Schultz Lake, and Audra Lake. Land use activities were common near the Kazan and Thelon Rivers which are valued travel routes.

Harvest patterns around Baker Lake have changed through time with the relocation to Baker Lake and with improved accessibility from the Meadowbank access road. Although some hunters continue to hunt in their traditional hunting grounds, a number prefer easier access near their home in Baker Lake, near cabins and along established travel paths. As indicated during the hunter harvest study, less than 1% of the harvest remains in the Kiggavik area west of the Thelon River. Currently Baker

Lake residents travel regularly along the eastern bank of the Thelon River and near the Meadowbank access road for easier harvest access around Whitehills Lake. They also travel to Audra Lake and Long Lake for seasonal harvest activities, and regularly fish in Baker Lake, primarily near Haqliq Island and south of the outlet of the Thelon River. Harvest activities are also common on the southern shore of Baker Lake near the outlet of the Kazan River.

Based on the relative importance maps for Inuit land use in the Baker Lake region, both IQ and other information suggest that the proposed Kiggavik mine site is in an area that is less intensively used than the areas east and north of the proposed project site. The greatest intensity of land uses occurs to the north and east of the proposed Kiggavik mine site. The highest intensity of land use is along the Aberdeen, Qamanaarjuk and Shultz lakes watershed, and along the Thelon River between Baker Lake and Schultz Lake. Audra (Anigguq) Lake and Whitehills (Tasirjuaq) Lake also support a number of different land uses, as does the corridor.

The proposed winter road does cross through Audra Lake, which supports a moderate to high intensity of land uses. The winter road will only operate from November through to May. As a result, if the Kiggavik mine only uses the winter road option, project activities associated with the winter road will interact with harvesting activities primarily associated with winter caribou and muskox hunts, hunting and trapping of furbearers, winter fishing, and other winter harvesting activities. The greatest area of overlap will be in the vicinity of Audra Lake and Judge Sissons Lake. As the winter road will not be used during the remainder of the year, there will be no direct overlap with harvesting activities or travel along the winter road during the open water season.

If the all-season road option is used, road activities will overlap with more commonly used harvest areas in the vicinity of the Thelon River, south of Itigulik and Ajaktukvik lakes and north of Qatgiqtalik Lake. As the all-season road will be used year-round, road activities will overlap with both winter and summer activities and use. The western half of the all-season road is located in areas with lower levels of use than areas to the northwest, north and northeast.

The all-season access road between the mine sites and Judge Sissons Lake also overlap with areas of moderate land use activity. Since the road will be used year-round it could affect harvesting during both winter and summer.

Inuit have expressed concerns about road activities and effects on harvesting activities and general use. As noted in this volume of the EIS, environmental protection measures will be implemented along all sections of the winter road and the all-season road (if developed), as well as the vicinity of the mine site and dock.

AREVA will work with residents of Baker Lake in the design and implementation of related monitoring initiatives or programs that might be implemented in areas of high harvest densities and harvesting activity to compliment any environmental effects based monitoring programs. For example, monitoring activities could be focused in areas with or times of higher harvesting activity. This would help ensure that mitigation and environmental protection measures are effective, and effects on Inuit use and environmental sustainability are minimized.

18.1.2 Ecological Context

The caribou and muskox herds that occupy the region are the vital component of the ecology of the area. The caribou herds travel large distances during seasonal migrations between their traditional calving grounds and winter ranges. There are few land animals world-wide that continue to exhibit this behaviour. The caribou herds are an important source of food for predatory anmials in the area; consequently, they likely support the wolves, grizzly bears, and wolverine populations. The calving grounds are the most defined habitats for caribou, but information indicates that they are not as static as biologists originally thought. Outside of the calving ground, caribou move relatively freely across a landscape that is relatively homogeneous from a caribou's perspective. The Project is located well north of the Qamanirjuaq caribou herd calving grounds and east of the Beverly caribou herd calving grounds. Three are no known site-specific areas of importance to the muskox of the region.

The Project site appears to be outside of key habitats and caribou migratory routes. There are some water crossings near the footprint that may be important to caribou in some years, but likely not in all years. To minimize potential effects on caribou and muskox, the Project will manage activities to allow animals' free movement through Project infrastructure where there is no harm to the animals and human safety is not put at risk.

Wolves, grizzly bear and wolverine are the top terrestrial predators in the ecosystem. They are likely to be found in the Project area occasionally and in low numbers (e.g., individuals) through the life of the project, and all species may den within the Project area. Mitigation for disturbances to the top predators is achieved by minimizing their attraction to the site (e.g., proper waste management practices) and following strict response protocol when they are observed on site.

Cliff-nesting raptors have likely long-established nest sites within the vicinity of the road. Those nests sites may have been continuously or intermittently occupied and productive for hundreds of years when food and weather conditions are favourable to breeding and productivity. There are no nests within the Project footprint, and disturbance to occupied nests can be managed by AREVA by planning disturbance activities near those nests outside of the nesting season.

Migratory birds and shorebirds nest in the Project area and some likely in suitable habitats within the Project footprint. Many bird populations are declining for a number of reasons that may include winter season habitat loss. The Project site provides abundant summer breeding and chick rearing habitat. AREVA can mitigate disturbance to migratory birds by conducting pre-disturbance bird nest surveys and avoiding nesting birds, avoiding active nest sites during operation, and ensuring that Project infrastructure does not provide cover to nest predators, thus improving possibility of nest productivity near Project infrastructure.

18.2 Terrain, Soils and Vegetation

18.2.1 Terrain

18.2.1.1 Permafrost Conditions and Terrain Stability

Project residual effects on permafrost conditions and terrain stability will be confined within the Project footprint and are predicted to be not significant. The total disturbed area will encompass about 803 ha, which represents 2.2% of the Mine LAA. This will be caused by vegetation clearing, organic soil and frozen overburden stripping (645 ha or 1.8% of the Mine LAA) and burial (158 ha or 0.4% of the Mine LAA). The residual effects are predicted to be low in magnitude, site specific, long term, continuous over the life of the Project, and reversible. The confidence in this prediction is rated as high. With the implementation of mitigation measures, the residual effects on changes to permafrost conditions and terrain stability are anticipated to be negligible.

18.2.1.2 Landforms

Project residual effects on common depositional landforms are predicted to be not significant. The estimated surface areas covered by alluvial, glaciomarine, bedrock and morainal (glacial till) landforms that will be disturbed by the Project encompass 0.06%, 0.001%, 0.19% and 1.99% of the total area of Mine LAA, respectively, which represent about 2.2% of the Mine LAA in total. The residual effects of changes in landforms are predicted to be low in magnitude, site specific, long term, will likely occur once, and irreversible. The confidence in this prediction is rated as high. With the implementation of mitigation measures during design and construction phases of the Project, the residual effects on changes to landforms are anticipated to be negligible.

18.2.2 Soils

18.2.2.1 Soil Quality

The effect of the Project on soil quality is assessed as not significant. Changes in COPC concentrations were predicted to be below the CCME (2009) soil quality guidelines. About 81 ha of soil located outside of the Project footprint have the potential to be exposed to PAI greater than the threshold value, which represents approximately 0.2 % of the Mine LAA. The residual effects caused by soil admixing, compaction and erosion are anticipated to be negligible with the implementation of effective mitigation measures. The confidence in this prediction is rated as high.

18.2.2.2 Soil Quantity

The effect of the Project on soil quantity is assessed as not significant. Depending on the Project development option selected, changes in soil quantity are predicted to occur within an area of between 953 ha and 1,212 ha, both of which represent less than 1% of the combined LAAs. Of this total, about 645 ha will be disturbed by topsoil stripping and an additional 208 ha to 567 ha will be disturbed from soil burial. The confidence in this prediction is rated as high.

18.2.3 Vegetation

Project residual effects on vegetation is discussed in relation to vegetation abundance and community diversity, and vegetation quality.

18.2.3.1 Vegetation Abundance and Community Diversity

Project residual effects on vegetation abundance and community diversity are predicted to be not significant. Depending on the Project development option selected, the total disturbed area will range between 1,449 ha and 1,708 ha of upland area, which represents between 1.1% and 1.4% of the combined LAAs, respectively. The confidence in this prediction is rated as high.

18.2.3.2 Vegetation Quality

Project residual effects on vegetation quality are predicted to be not significant. Changes in these analyte concentrations are not anticipated to exceed upper thresholds; therefore, no adverse effects on vegetation quality are expected to occur. PAI levels greater than the critical load threshold value are predicted to occur over 81 ha adjacent to the Kiggavik mine site, affecting approximately 0.2% of the Mine LAA. No residual effects from NO_2 and SO_2 concentrations on vegetation are anticipated to occur, as generated emissions are predicted to be below threshold values. Effects of dust deposition on vegetation are predicted to be located immediately adjacent to the Kiggavik and Sissons mine sites, spanning a combined area of about 36 ha. Dust deposition along the proposed access roads is anticipated to be negligible, with a predicted annual deposition of 0.1 g/m^2. The confidence in this prediction is rated as moderate.

18.3 Terrestrial Wildlife

Project residual effects on wildlife and habitat is discussed in relation to caribou and muskox, peregrine falcon (representing raptors), lapland longspur, long-tailed duck and shorebirds (representing migratory birds) and short-eared owl, grizzly bear and wolverine (representing Species at Risk).

18.3.1 Caribou and Muskox

The Project will likely have a not significant effect on caribou wildlife mortality risk. AREVA is able to mitigate potential sources of direct and some indirect mortality. Managing public access to and vehicle speed along the roadways are the primary mitigations needed to reduce the potential for Project-related mortality. The change in ungulate mortality will be negligible because no caribou or muskox mortality is expected along the roadways. The confidence in this prediction is rated as moderate because the responsibility for mitigation is not entirely in control of AREVA. Management actions from wildlife management authorities and the local and regional wildlife organizations may be required in the form of harvest monitoring and harvest management.

The Project will likely have a not significant effect on tcaribou and muskox habitat availability. There will be a long-term loss of some habitat within the Project footprint and a reversible reduction of habitat effectiveness within the Project Zone of Influence (ZOI). The change in available habitat will be measurable, but will be not significant at the scale of the ranges of wildlife species indicators that could interact with the Project. The confidence in this prediction is rated as moderate because of the potential for improved habitat mapping and both science and IQ not having a complete understanding of disturbance effects on habitat, and ultimately what those disturbances mean at the population level.

The Project will likely have a not significant effect on caribou movement. Few caribou are expected to interact with the Project during the migratory seasons, but there could be more localized movements within the area. Although there are some water crossings near Project infrastructure, disturbances near those crossings can be reduced if caribou behaviour is substantially affected. The confidence in this prediction is rated as moderate. The effects on movement were based on a strong IQ knowledge about caribou movement through the project area, but specific encounter and residency rates are based on a limited sample of collared female caribou. Also, given the variability of momements observed from all information sources, caribou could occur, or not, within the Project area in either low or high density at any time of year. AREAVA has mitigation options available that will be used to minimize disturbances to caribou when they are in the Project area.

The Project will likely result in a not significant effect on caribou and muskox health from exposure to COPC. The confidence in this prediction is rated as high.

When Project effects are combined (i.e, disturbances to mortality, habitat, movement and health are considered), overall, the Project will have little effect on caribou energetics, and no measurable effect on population projections through to 2040. The number of Qamanirjuaq caribou is predicted to increase through that time period with or without the presence of the Project. The confidence in this prediction is moderate because all data used in the modelling were not specific to the caribou herd, because of possible errors in assumptions, and because predictive population models are subject to errors that may be due to changing environmental features that may be beyond the capability of the model to address.

The Project removes a very small amount of habitat (0.001%) from within the combined ranges. Within individual ranges, the loss ranges from 0.004% to 0.007%. The loss is so small within each herd's range as to be not significant. Total cumulative loss due to all disturbances within the cumulative effects assessment area amounts to, at most, 0.4%, and is considered not significant. The maximum loss of muskox habitat, using an assessment process that errs on the side of precaution, is ~3% of MX/21. These numbers likely represent an over-estimate of loss of habitat to footprints. Mitigating cumulative loss of habitat, should it increase to be of concern, requires management beyond the capabilities or responsibilities of AREVA. Mitigationg cumulative loss of habitat, and cumulative effects in general lies in collaboration with government, management partners, and the land use planning process.

18.3.2 Wolf

The Project will permanently affect some potential wolf-denning habitat in the footprint of the Project, but that loss of habitat is likely to be not-significnat. There are no known active dens in the Project footprint. Wolves may choose to den near Project infrastructure in the future, and AREVA can mitigate disturbances at those dens when they are occupied.

18.3.3 Raptors

The Project will likely result in a not significant effect on raptor habitat availability. There will be a long-term loss of some raptor habitat within the Project footprint and a reversible loss of habitat effectiveness within the Project ZOI. The change in available habitat will be measurable, but will only be detectable within the LAA. The confidence in this prediction is rated as moderate.

The Project will result in a not significant effect on raptor nest productivity. Nest sites are only known to occur near the All-Season Road. Activity along the winter road will not interact with nesting raptors. The greatest potential effect to raptor nest productivity will occur during the construction phase of the Project because of intensive human activity along the all-season road, but few nests occur in proximity to the road. Consequently, the magnitude of the effect is rated as moderate during construction, low during operation, and negligible after mine operation ends. The confidence in this prediction is rated as moderate during construction (assuming the birds will respond to proposed mitigation), and high during operation and final closure.

The Project will result in a not significant effect on raptor health from exposure to COPC. The confidence in this prediction is rated as high.

18.3.4 Migratory Birds

The Project will result in a not significant effect on migratory bird habitat availability. There will be a long-term loss of some migratory bird habitat within the Project footprint and a reversible loss of habitat effectiveness within the Project ZOI. The change in available habitat will be measurable, but will only be detectable within the LAA. The confidence in this prediction is rated as moderate.

The Project will result in a not significant effect on migratory bird health from exposure to COPC. The confidence in this prediction is rated as high.

18.3.5 Species at Risk

The Project will result in the long-term loss of some nesting and foraging habitat for short-eared owls. The change in habitat will be measureable, but will be limited to the footprint (complete loss) and within the LAA. Reduced habitat effectiveness is reversible once operations cease. Overall, Project effects on short-eared owl nesting and foraging habitat will be not significant. The confidence in this prediction is rated as moderate.

The Project will result in a not significant effect on grizzly bear and wolverine health from exposure to COPC. The confidence in this prediction is rated as high.

18.4 Combined Effects on the Terrestrial Environment

Overall effect of the Project on the terrestrial environment is assessed as not significant. Residual Project effects on permafrost conditions, terrain stability and landforms are predicted to be negligible and not significant. Residual effects on soil quality and quantity are assessed as negligible to low and not significant. Residual effects on vegetation abundance and community diversity and vegetation quality are rated as negligible to low and not significant. Residual effects on caribou, muskox and wolf are predicted to be negligible to low and not significant. Residual effects to raptors migratory birds, and shorebirds are anticipated to be low to moderate during construction, low during operation and negligible post operation. These effects are restricted to the Project footprint and ZOI and are assessed as not significant. The residual effects of the Project on species at risk is assessed low to negligible and not significant.

19 Summary of Mitigation Measures for the Terrestrial Environment

19.1 Terrain, Soils and Vegetation

19.1.1 Terrain

Effective mitigation strategies for effects on terrain will identify terrain types that may be susceptible to either terrain instability or thaw settlement or are considered to be important and sensitive landforms. By identifying specific locations of such terrain areas, effective mitigation measures can be tailored to address site-specific conditions.

Detailed mitigation measures will vary depending on local conditions and Project activities. Best construction and Project management practices with due consideration of the projected rate of climate warming coupled with recent engineering advances, especially in permafrost engineering, will be implemented to address any issues with changes in permafrost conditions, and terrain stability. Issues related to the surface disturbance to any challenging landforms will be best addressed by proper citing of Project facilities and associated infrastructure.

Design mitigation measures will include minimizing Project disturbance footprint and a number of drainage areas affected by the Project components and activities, and avoiding surface disturbance in high ground-ice areas and susceptible terrain and landforms to reduce potential for deepening thaw depth and associated thaw settlement and terrain stability. Discipline-specific mitigation will include the consideration of Project activities such as construction in permafrost sensitive areas during the winter (where feasible), controlled vehicular traffic along roads, planning of proper culvert location and construction and maintenance of roads susceptible to excessive groundwater seepage.

Additional mitigation measures that will reduce or eliminate potential Project effects on terrain include:

- sustain safe construction and operation practices within and adjacent to the Project footprint
- use coarser materials for road construction to minimize frost effects.
- manage drainage around infrastructure to reduce deep pools of water at the surface
- insulate infrastructure, where feasible
- avoid or minimize susceptible terrain associated with high ground-ice content and fine- to medium-textured materials on sloping topography within the mine infrastructure area and along major road alignments

- avoid uncommon landforms like eskers, wetlands and shoreline areas during the design phase of Project
- minimize cut width or disturbance through eskers, wetlands and shoreline areas
- reduce the use of glaciofluvial landforms during mine infrastructure construction

Supplementary engineering field investigations prior to construction of mine infrastructure will provide information that will aid in refining terrain mitigation measures. Additional site-specific field investigations will be conducted to assess specific poorly drained areas and drainage condition, local variations in permafrost conditions (ground-ice content), terrain slope, and ground temperature prior to construction of mine infrastructure and roads.

19.1.2 Soils

19.1.2.1 Soil Quality

Air emissions that could cause soil acidification as well as changes in COPC concentrations within soils will occur throughout the duration of the Project. These effects will be minimized because emissions from all industrial machinery and equipment, including the diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce emissions associated with diesel fuel combustion. In addition, scrubbers will be installed on any mill stacks that emit particulates and contaminants (e.g., acid plant exhaust stack) to remove these items from the air stream before discharge.

Soil admixing will likely occur to varying degrees during topsoil stripping, as topsoil depth varies across the Project development area. To reduce soil admixing, AREVA environmental personnel will be on-site to work with construction crews during the stripping process to help identify areas where the topsoil layer has been adequately stripped to prevent further stripping at these locations. Stripped topsoil will be kept separate from subsoils stored at the overburden pile location to prevent soil admixing, as well as loss of the growth medium layer that will be used for reclamation purposes. Stripped topsoils will also be well-segregated from the ore piles and the Type 3 mine rock stockpiles to prevent soil contamination. Efforts will be made during the storage process to place frozen or wet soils removed during site preparation within drier soil materials of the same nature (i.e., topsoil, subsoil) to prevent potential migration and subsequent admixing with other soil or waste rock piles. The stripped topsoil and subsoil materials stored in the overburden pile location will be scanned in order for any radiation contaminated soil to be removed and not used in reclamation.

Soils exposed during construction are susceptible to erosion from surface drainage and wind events. Soil erosion from surface drainage can occur as a result of: 1) natural surface drainage from the surrounding area travelling over the Project footprint; and 2) surface drainage from within the Project footprint caused by rain events. Freshwater diversion channels will be constructed to divert surface drainage around the Project footprint, thereby reducing the potential for on-site erosion. Riprap armouring overlying a geotextile will be placed on the channel bottom and side slopes of the diversion channels to mitigate potential erosion of the channel (see Tier III, Appendix 2E). Other erosion control structures (e.g., sediment breakers, wattles) may also be placed within the diversion channels following initial excavation to reduce the amount of soil erosion by flowing water until vegetation has established or a geotextile liner is placed within the channel. Culverts will be installed where the proposed all-season road crosses natural drainage patterns to facilitate water movement, and in a manner that will prevent scouring of the tundra environment at the culvert outflow location.

Site containment will involve sloping the site pads towards the runoff ponds. However, during construction and prior to site containment, disturbed soils may be susceptible to erosion from surface drainage within the Project footprint caused by precipitation events and snowmelt. If the disturbed areas are deemed to be susceptible to erosion prior to development of site containment, temporary erosion control structures (e.g., silt fences) will be placed on the downslope side of the Project footprint to capture and filter sediment-laden runoff.

Erosion of soils stored in the overburden pile will be monitored throughout the duration of the Project. If climatic events (e.g., precipitation, wind) cause excessive soil erosion from the overburden piles, AREVA will apply mitigation (e.g., the application of a soil tackifier) to the overburden piles to prevent further erosion.

Soil compaction will occur through the duration of the Project due to the movement of vehicles on roads and site pads, as well as placement of infrastructure (e.g., mine plant, accommodations complex). During final closure, areas ready for reclamation will be scarified to loosen compacted soils, allowing for increased success rates of seed germination and sprouting of propagules within the areas being reclaimed. Vehicle travel along the winter roads will likely not cause soil compaction as travel will be occurring during frozen ground conditions. However, rutting may occur in localized spots where the integrity of the winter road may be compromised. Efforts to identify and avoid vehicle travel on soft spots along the winter road will be employed. Rig matting may also be used to prevent rutting and other disturbances to soils where the winter road's integrity is compromised.

Dust will be created during mining and movement of materials to either the ore piles or waste rock piles. During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds. Dust suppression will involve spraying water from a tanker truck affixed with either a spray nozzle or spray bar onto dust-prone mine site areas. If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focussing on additional dust suppression techniques will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines. Speed limits around the mine site and along all roads will be strictly adhered to, to reduce airborne dust from vehicular and other equipment traffic.

19.1.2.2 Soil Quantity

Best management practices will occur during construction of the Project. Construction activities will likely be postponed during large precipitation events to prevent excessive disturbance to vegetation and soils due to wet working conditions.

During topsoil stripping, efforts will be made to reduce the movement of stripped topsoil when transferring to the overburden pile. For example, topsoil stripped at the far end of the construction area will likely be hauled to the overburden pile using carrying equipment (e.g., buggy scrapers, dump truck) rather than pushing the stripped topsoil to the overburden pile using a bulldozer or grader. This will help prevent soil loss from movement of disturbed soils over the work area.

Preventing soil loss caused by soil movement during the construction phase is important for conserving enough of the growth medium layer for future reclamation purposes. Prior to commencing construction activities, a construction plan for topsoil stripping will be developed based on the topography and terrain features at the proposed mine sites and dock facility. This plan will help determine where stripping will occur, the direction of travel when stripping, taking into consideration terrain features and topography to prevent loss of stripped topsoil as well as where stripped topsoils will be placed. If possible, stripped topsoils will be pushed towards the proposed overburden pile location. Temporary overburden piles may be required in areas where terrain features or topography prevent pushing stripped materials to the overburden pile without causing substantial loss of stripped materials. In these instances, stripped materials will be transported from the temporary overburden piles in either a buggy scraper or dump truck to the final overburden pile location.

Soil burial during development of the roads and airstrip will be confined to the boundaries established from the detailed design for these components. Soil erosion during construction activities has the potential to occur where topsoil stripping or other disturbances to soils have occurred. Mitigation measures for soil erosion are presented in this section above regarding soil quality.

19.1.3 Vegetation

19.1.3.1 Vegetation Quantity

Pre-construction surveys will be completed of the surveyed Project footprint boundaries for listed species to confirm their absence from the area to be disturbed. If any listed species are observed, a number of mitigation measures may be employed. For any listed species observed along the proposed access roads, efforts will be made to re-route the access to avoid disturbing the listed species. If listed species are observed within the proposed mine sites or dock facility, AREVA will consult with the GN regarding transplanting the listed species to another suitable location.

Best management practices will occur during construction of the Project. Construction activities will likely be postponed during large precipitation events to prevent excessive disturbance to vegetation and soils due to wet working conditions.

Site clearing and vegetation burial will occur within the confines of the Project footprint to reduce the potential for additional vegetation loss and prevent unnecessary disturbance to vegetation adjacent to the Project development area. The work area boundaries will be clearly identified by markers placed along the perimeter during construction to reduce vegetation damage and disturbance.

During topsoil stripping and stockpiling, the vegetation seedbank will also be preserved. Preservation of this seedbank will provide seeds and propagules during soil replacement, facilitating natural regeneration of native vegetation to reclaimed areas.

The proposed routing of the winter roads makes use of waterbodies (e.g., lakes) and watercourses (e.g., streams) as much as possible. Rugged microtopography will be avoided, where practical, along the proposed winter access road to reduce the amount of granular material required for creating a level travel surface that would cause vegetation burial. Rig matting may also be used in areas where the use of granular material is not practical to prevent damage to the underlying vegetation along the winter road.

To prevent the introduction of invasive and/or non-native vegetation to the Project area, all equipment and machinery will be cleaned of foreign particles (e.g., soil, thatch) prior to initial transport to the Project (i.e., prior to loading onto the barge, or shipping by air). All equipment and machinery will be further inspected for foreign particles upon arriving at either the dock facility or while being off-loaded at the airstrip. Any foreign particles found on equipment and machinery will be removed, collected, and incinerated to prevent propagule establishment and proliferation.

Progressive reclamation will occur throughout the Project on decommissioned areas to return disturbed areas to a natural state. Adaptive management strategies based on the most recent research and literature pertaining to reclamation of disturbed areas in arctic environments will be implemented and monitored for succession and to assess whether further reclamation efforts are necessary.

19.1.3.2 Vegetation Quality

Air emissions that could adversely affect vegetation quality will occur throughout the duration of the Project. To reduce the effects of air emissions on vegetation, all industrial machinery and equipment and diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce SO_2 fumigation. The acid plant will be the largest producing unit of SO_2 associated with the Project. As such, a scrubber will be installed on the exhaust stack to remove particulates, acid mist and excess SO_2.

Dust will be created throughout the duration of the Project due to Project activities such as blasting, hauling of ore and waste rock materials from the mine pits, as well as vehicular traffic along the access roads, During the detailed design of the roads, efforts will be made to use non-calcareous materials from quarry sites to minimize dust-prone aggregate from being used during road construction. During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds. Dust suppression will involve spraying water from a tanker truck affixed with either a spray nozzle or spray bar onto dust-prone mine site areas. If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focussing on additional dust suppression techniques will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines. Speed limits around the mine site and along all roads will be strictly adhered to, to reduce airborne dust from vehicular and other equipment traffic.

19.2 Terrestrial Wildlife

Mitigation for wildlife is detailed the Wildife Mitigation and Monitoring Plan (WMMP, Tier 3, Volume 6, Appendix 6D). The WMMP describes mitigation and monitoring that AREVA will implement to reduce or eliminate disturbance effects on terrestrial wildlife and habitat. The WMMP provides guidance to protect and limit disturbances wildlife from Project activities. The WMMP lists all of the wildlife-related mitigation actions that will be taken by AREVA. This section only summarizes the key points.

AREVA is committed to working with the Baker Lake HTO, government organizations, regulators and stakeholders to ensure that wildlife populations remain healthy and can successfully coexist with the Project through the construction, operation, final closure and post-closure phases. The WMMP is the primary management tool to achieve this. AREVA will provide the necessary resources (human, financial and materials) to implement and maintain the WMMP. AREVA has the capacity and authority to implement Project effects-related mitigation and monitoring actions and plans. Although AREVA will not make decisions regarding wildlife management (e.g., harvest management) they will support regional wildlife management initiatives if those broader management objectives would help to reduce direct or indirect Project effects.

The WMMP is a working document. Revisions will keep the mitigation strategies and actions focused on key potential effects to ensure that AREVA and stakeholder resources are effectively applied to managing Project effects on terrestrial wildlife and wildlife habitat. The remainder of this section summarizes much of the detail on mitigation that is found in the WMMP (Tier 3, Volume 6, Appendix 6D).

Mitigation of potential increased mortality risk will involve AREVA and other parties such as the Baker Lake Hunter and Trapper Organization (BLHTO), the Kivalliq Inuit Association (KIA) and the Government of Nunavut (GN) for harvest management and population assessment. AREVA is confident in the implementation of measures such as road closures, private access, or limits to seasonal use if the winter road option is selected. Several effective mitigation options that AREVA can implement independently are described in Section 13.3.3.4 (Mitigation Measures for Cumulative Change in Caribou Mortality), policy, agreements with the BLHTO/KIA that they will abide by road traffic restrictions, and other potential agreements that are described in the section about Mitigation by AREVA and others.

Wildlife harvest is regulated by the GN. The GN's Caribou Strategy Framework identifies a number of actions oriented towards working with industry, HTOs and other management partners to support harvest management (described in Section 13.3.3.4 — Mitigation by Other Organizations and Agencies). The management of potential over harvest of caribou is beyond the control of the Project and ultimately is the responsibility of the GN and its wildlife co-management partners.

There are a number of mitigation tools available to AREVA, resource users (e.g., HTO, KIA), and the GN that should be effective at mitigating potential caribou harvest. An all-season access road from Baker Lake to a mine site is not expected to be a trigger of concern for potential overharvest of Qamanirjuaq or other caribou presuming that the authorities react to any future management needs.

The Kiggavik Project will mitigate potential adverse effects on wildlife habitat through Project design and mitigation action. Project design includes keeping the footprint as small as possible, limiting activities outside of the footprint, and eliminating dust dispersal from the tailings management facility through subaqueous deposition of tailings. Mitigation actions include managing road activity in the presence of wildlife. Other mitigation options can include dust suppressional along mine site roads during dry periods to reduce effects on habitat, and progressively reclaiming disturbed area. The details of these options are provided in the WMMP (Appendix 6D).

The Project will mitigate effects on wildlife movement through design and mitigation actions. Design elements will include adjusting the all-season road embankment slopes to accommodate caribou movement in identified areas where the embankment is high, and minimizing the use of fencing and, where required, minimizing the lengths of fencing unless required for safety. Actions will include snow management that avoids long continuous cuts or piles of snow that could restrict movement across the winter access road and mine roads, avoiding construction activities within 10 km of designated water crossings during 15 May to 1 September, in accordance with the DIAND Caribou Protection Measures, and implementing temporary road shutdowns if large numbers of caribou are observed migrating through the area. Design aspects, operational measures and other mitigation measures were incorporated into the Project plans that will minimize Project-associated emissions and/or the potential effect of Project-related emissions on habitat. Those were discussed in the Atmospheric Environment report (i.e., Tier II, Volume 4) and the Aquatic Environment report (i.e., Tier II, Volume 5) in more detail.

AREVA will minimize disturbance to nesting raptors by restricting blasting activities (for road construction) within 3 km of a known nest site to outside of the territory occupancy and nesting season (about mid-May through to end of August) when nest sites are occupied. During operation, land-based activities off the road within a 3 km radius of active nest sites during the nesting season will be restricted, and areas will be noted as no fly zones where possible. These mitigations will likely require that AREVA develp nest-site specific management plans for when construction is occurring within 3 km of a known nest site. Measures to mitigate the effects of the Project on the health of raptors will be as described in Section 15.

Mitigation measures that will be implemented to minimize effects on ground nesting birds (including the Key indicators Lapland longspur, long-tailed duck, shorebirds, and short-eared owl) will be based on surveys prior to construction, and established no-disturbance buffers as identified in the WMMP (Appendix 6D). If possible, construction activities involving site clearing will be scheduled to occur outside of the breeding and nesting period for migratory birds (i.e., May to July). All on-site observations of short-eared owl, or other species at risk, will be investigated to determine presence of nest sites.

Measures to mitigate the effects of the Project on the health of grizzly bears and wolverine will be as described for terrestrial wildlife in Section 17.

20 Summary of Monitoring for the Terrestrial Environment

20.1 Terrain, Soils and Vegetation

20.1.1 Terrain

While the implementation of mitigation strategies is critical to reducing any effects on terrain, it is equally important to complete regular and routine monitoring to ensure that effects are minimized and to identify where new mitigation measures may be required. Monitoring will begin upon construction and will continue through the duration of the Project.

A key consideration in design of the monitoring programs is that the environment is expected to change independent of the Project as a result of climate change. For the most part, visual monitoring will suffice as it will be important to visually observe any changes (e.g., accelerated solifluction, groundwater seepage, erosion, etc.). In some cases, especially on steeper slopes, slope monitoring devices will be used for the duration of the Project. Similarly, thermistors will be installed at key sites to determine and monitor the rate of change in ground temperature. Special devices will also be installed to record maximum thaw penetration and maximum ground-surface movement at thaw depth monitoring sites. While such devices are not required extensively throughout the Project footprint, a number of permanent monitoring plots will be established at the outset of the Project to monitor any effects of climate change and hence the overall change in the natural landscape. Laboratory analysis of soil samples will be conducted, which will help to determine geotechnical parameters such as total moisture content, frozen bulk density and ground-ice content. These parameters will be used to calculate thaw strains, which are used to determine the thaw settlement resulting from the simulated increase in thaw depth at the each sampling site.

20.1.2 Soils

20.1.2.1 Soil Quality

Soil quality will be monitored throughout the duration of the Project. Air emissions and dust deposition monitoring will be a component of soil quality monitoring. Chemical analyses of soil samples from permanent sample plots located within the Mine LAA (i.e., exposure plots) and within the RAA (i.e., reference plots) will occur, and comparisons will be made to air emission and dust deposition results, as well as to the baseline values and CCME guidelines. The overburden piles will be routinely checked for erosion, and mitigation measures will be implemented if issues are identified. The winter road will be monitored during use for structural integrity to avoid rutting and/or damage to the underlying soils, and mitigation will be applied to areas of concern. The All-Season Road will also be monitored for structural integrity and the effectiveness of dust suppression techniques, as well as the effectiveness of culverts for allowing surface drainage while preventing soil scouring.

20.1.2.2 Soil Quantity

Soil quantity will be monitored primarily during the construction phase of the Project, as well as when any earthwork involving the removal or placement of topsoil is required. An environmental monitor will likely be on-site during the construction phase to assist AREVA personnel and contractors with mitigation strategies to reduce the effects of the Project on soil quantity, such as topsoil stripping, soil storage, and soil erosion on disturbed areas. Dust deposition monitoring will occur throughout the duration of the Project to identify and mitigate potential effects.

20.1.3 Vegetation

20.1.3.1 Vegetation Quantity

An environmental monitor will be on-site during all phases of the Project to work with AREVA personnel and contractors to meet and comply with environmental regulations associated with vegetation.

Throughout the duration of the Project, monitoring for invasive species will be conducted. Any invasive species identified adjacent to the Project footprint will be documented. If invasive species are identified as noxious weeds, or other vegetation species that are suspected of competing with native vegetation, efforts will be made to remove these occurrences to prevent a spread or proliferation of these invasive species.

Measurements of dust deposition from snow survey stations and dust gauges placed around the Project Footprint and along the proposed access roads will be taken prior to construction activities. Permanent sampling plots to monitoring vegetation abundance and community diversity will also be established around the Project Footprint and adjacent to the proposed access roads prior to their construction. These permanent sampling plots will be routinely surveyed and assessed to measure potential changes in vegetation abundance and community diversity. Results from dust deposition monitoring and the vegetation community monitoring will inform on the effectiveness of mitigation, and whether further actions are required.

20.1.3.2 Vegetation Quality

Vegetation monitoring will occur throughout the duration of the Project, along with air emissions and dust deposition to evaluate their effects on vegetation quality. Vegetation quality monitoring will involve collection of vegetation samples from permanent sample plots located within the predicted exposure areas as determined by the isopleths for PAI and TSP within Mine LAA (i.e., exposure plots), as well as reference plots located within the Project RAA. Chemical analyses of the vegetation samples will be completed and comparisons will be made between the reference and exposure site values, as well as to the baseline values and CCME guidelines.

An Air Quality Monitoring and Mitigation Plan (Tier 3, Appendix 4C) will be undertaken to determine the amount of dust generated by the Project and its dispersal. The monitoring program will help determine if any effects are occurring on vegetation and to inform continual improvement opportunities and adaptive management strategies, where necessary (Tier 3, Appendix 2T Environmental Mangement Plan).

20.2 Terrestrial Wildlife

Monitoring of Project effects must be relevant to the possible effects which the Project will have on terrestrial wildlife and habitat. As outlined in Tier 3, Appendix 2T, Environmental Management Plan, the monitoring framework provides the means to evaluate the accuracy of environmental assessment impact predictions, inform continual improvement opportunities and identify when adaptive management measures need to be applied to the Project. The objectives of the Kiggavik Project monitoring framework are to:

- Develop a comprehensive and integrated terrestrial wildlife monitoring program, incorporating an ecosystem-based approach for monitoring and management of Project related terrestrial wildlife effects.
- Integrate IQ knowledge into the development and implementation in the terrestrial wildlife monitoring programs.
- support the meaningful participation of regulators, Inuit organizations, and local stakeholders in the terrestrial wildlife and habitat monitoring program.
- Align the monitoring plan with regional monitoring objectives and methods to facilitate data compatibility and comparability with regional monitoring information.
- Coordinate aspects of the terrestrial wildlife monitoring program.
- Report in an effective and timely manner on the monitoring program and its results in ways that are meaningful to both regulators and stakeholders.

The wildlife and wildlife habitat monitoring framework's objectives are guided by the following principles:

- Monitor and verify potential effects related to the Project.
- Monitor and evaluate the effectiveness of mitigation measures.
- Identify unanticipated effects.
- Monitor effects where predictions were based on limited information.

- Provide an early warning of undesirable change.
- Identify continual improvement opportunities and, where necessary, the need for adaptive management measures.

Following those principles, AREVA is proposing to independently monitor and annually update status on the Project footprint area, maintain logs if incidental wildlife observations, raptor occupancy and productivity, Height-of-Land surveys, caribou track surveys, and den site occupancy and productivity within the Project area.

AREVA will contribute to regional-level monitoring/survey programs, incluiding continued support of the GN-led collaring program, the industry-led hunter harvest surveys, project-related mortality (with follow-up investigations and corrective actions), support GN-led herd delimitation and population estimate survey (determine regional herd population trends), etc. AREVA is also willing to support agency-led monitoring initiatives that help to better inform Project-related effects or mitigation efficacy. This could include some type of caribou harvest or health monitoring, shorebird monitoring, or other inventory or research initiatives.

Table 20.2-1 identifies the key considerations for each monitoring plan component considered in the wildlife monitoring programme. The table outlines the monitoring approach taken for a number of Valued Ecosystem Components (VECs) as identified by the NIRB. Monitoring is focused on measureable parameters of Key Indicators. Each monitoring component has a goal, objective, and identified thresholds for adaptive management actions. Additional items identify the scope of the monitoring work (spatial and temporal scale), agency partners, and a cross-reference to [future] Project Conditions [if the Project is approved and a NIRB Project Certificate is issued].

Table 20.2-1 Monitoring Framework: Overview and Definitions

VEC	Valued Component (e.g., Terrestrial Wildlife) — identified by NIRB, addressed in Kiggavik Project FEIS
Key Indicator	The species or relevant feature selected to represent the VEC (e.g., caribou)
Monitoring Category	One of three categories — Baseline Research, Surveillance, Monitoring
Design	e.g., Before-After Control-Impact (BACI), opportunistic
Measurable Parameter	A quantifiable feature used to assess potential effects on an indicator (e.g., movement)
Key Project Interactions	Identification of key project features that result in residual effects on the Indicator and Measurable Parameter (e.g., all weather access road as a filter to caribou (Indicator) movement (Measureable Parameter)).
Goal	Statement of the expected residual effect of the Project (e.g., the Project will have a not significant effect on caribou movement because of Project infrastructure and activities).
Objective	Evaluate a potential response specific to the mine and operations (e.g., evaluate movement patterns of caribou as they approach or cross the all-weather road).

Table 20.2-1 Monitoring Framework: Overview and Definitions

Threshold	Early warning indicator (note: usually about an order of magnitude lower than the significance criteria used in the FEIS)
Scope of Monitoring Work	Brief overview of key components of a monitoring program including note of temporal and spatial scale, frequency, duration.
Agency/Partner Participation	Identification of regulatory agencies and local partners in the monitoring programs (e.g., Baker Lake HTO).
Mitigation Measures	A list of measures used to reduce Project-related effects (e.g., Project design elements, adjustments to operations)
Project Terms and Conditions	Indicates the Project Terms and Conditions that will be addressed [pending project approval and award of certificate] by this monitoring plan component

There are three categories of study related to monitoring and follow-up of Project-related effects:

1. **Baseline Research** — includes background studies intended to establish need for, or parameters of, an Environmental Effects Monitoring program. Research studies could address issues such as natural variability of a measurable parameter or monitoring target, or examine the nature, extent, or duration of a potential Project–VEC interaction.
2. **Surveillance** — programs to produce information about the pattern of occurrence of key indicators.
3. **Monitoring** — programs to address and quantify cause and effect linkages between Project activities and components of the receiving environment.

Wildlife species selected for monitoring focuses on the key indicator species (FEIS Tier 2, Volume 6 Terrestrial Environment, Section 11.6 Valued Environmental Components, Indicators and Measurable Parameters), with a primary focus on caribou. Monitoring efforts will focus on a variety of spatial and temporal scales, depending on the focal species and the possible effect being monitored. Most local monitoring efforts will focus studies at the scale of the Project footprint (e.g., wildlife mortality monitoring), while others will focus on larger scales to adequately quantify and/or qualify effects (e.g., changes or alteration in wildlife movement).

No specific monitoring requirements are recommended based on the assessment for change in health of caribou and muskox, raptors, migratory birds, or species at risk. The monitoring of other environmental components (e.g. water, vegetation — specifically lichen) will provide valuable information for confirming the results of the assessment.

21 References

ACIA (Arctic Climate impact Assessment) 2005. Arctic Climate Impact Assessment. Cambridge University Press.

Adamczewski, J. Z., C. C. Gates, B. M. Soutar, and R. J. Hudson. 1988. Limiting effects of snow on seasonal habitat use and diets of caribou (*Rangifer tarandus groenlandicus*) on Coats Island, Northwest Territories, Canada. *Canadian Journal of Zoology* 66:1986–1996.

Agnico-Eagle Mines Limited (Meadowbank Division). 2013. Meadowbank Gold Project 2013 Annual Report.

Agnico-Eagle Mines Limited (Meadowbank Division). 2012. Meadowbank Gold Project 2012 Annual Report.

Agnico-Eagle Mines Limited (Meadowbank Division). 2010. Meadowbank Gold Project 2010 Annual Report.

Agnico-Eagle Mines Limited (Meadowbank Division). 2008. Meadowbank Gold Project 2008 Annual Report.

Agnico Eagle Mines. 2013. Meadowbank | Agnico Eagle Mines. [Online.] Available at http://www.agnicoeagle.com/en/Operations/Our-Operations/Meadowbank/Pages/default.aspx.

Alberta Peregrine Falcon Recovery Team. 2005. Alberta Peregrine Falcon Recovery Plan 2004-2010. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Recovery Plan No. 3. Edmonton, AB. 16 pp.

ARE (Arviat Elders). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Susan Ross. March 31, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment E.

ARHT (Arviat Hunters and Trappers Organization). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Susan Ross. March 30, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment E.

AR NIRB (Arviat - Nunavut Impact Review Board). May 2010. From "Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB's Review of AREVA Resources Canada Inc's Kiggavik Project (NIRB File No. 09MN003)"; in Appendix 3A: Public Engagement Documentation, Part 11.

ARVJ (Arviat Hunters and Elders). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with five HTO members and two Elders. February 18, 2011; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment E.

Austen, M.J., M.D. Cadman and R.D. James. 1994. Ontario Birds at Risk: Status and Conservation Needs. Federation of Ontario Naturalists and Long Point Bird Observatory, Ontario. 165 pp.

Bednarz, J. C. 1984. The effect of mining and blasting on breeding prairie falcon (*Falco mexicanus*) occupancy in the Caballo Mountians, New Mexico. Raptor Research 18:16-19.

Bergerud, A.T., R.D. Jakimchuk and D. R. Carruthers. 1984. The buffalo of the north: caribou (*Rangifer tarandus*) and human developments. *Arctic* 37:7–22.

Beverly and Qamanirjuaq Caribou Management Board (BQCMB). 1999. *Protecting Beverly and Qamanirjuaq caribou and caribou range. Part 1, Background information*. Page 19. Beverly and Qamanirjuaq Caribou Management Board, Ottawa, Ontario, Canada. Retrieved from www.arctic–caribou.com.

BHP Billiton Canada Inc. 2012. Ekati Diamond Mine 2012 Environmental Impact Report. Prepared by BHP Billiton Canada Inc. Yellowknife, NT. 529 pp.

BHP Billiton Canada Inc. 2012. Ekati Diamond Mine: 2012 Wildlife Effects Monitoring Program (WEMP). Prepared by BHP Billiton Canada Inc., Yellowknife, NWT. 529 pp.

BL CLC (Baker Lake Community Liaison Committee). November 2008. Meeting Notes. November 28, 2008; in Appendix 3A: Public Engagement Documentation, Part 1.

BL CLC (Baker Lake Community Liaison Committee). October 2012. Meeting Notes. October 17, 2012; in Appendix 3A: Public Engagement Documentation, Part 1.

BLE (Baker Lake Elders). 2009. Excerpt from socio-economic focus group conducted by Susan Ross, Mitchell Goodjohn, and Hattie Mannik. March 5, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BLE (Baker Lake Elders). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with ten Elders. February 17, 2011; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL EL (Baker Lake Elders Society (Qalautimiut)). March 2009. Meeting Notes. March 4, 2009; in Appendix 3A; Public Engagement Documentation, Part 2.

BL EL (Baker Lake Elders Society (Qilautimiut)). October 2012. Notes from workshop on Significance. Oct 30, 2012; in Appendix 3A: Public Engagement Documentation, Part 2.

BL EL (Baker Lake Elders Society (Qilautimiut) September 2013. Notes from a Workshop with Baker Lake Elders (Qilautimiut) Group on the meaning of IQ. September 5, 2013; in Appendix 3A: Public Engagement Documentation, Part 2.

BL 01 (Baker Lake Interview 01). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 02 (Baker Lake Interview 2). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 04 (Baker Lake Interview 04). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 05 (Baker Lake Interview 05). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 06 (Baker Lake Interview 6). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 07 (Baker Lake Interview). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 10 (Baker Lake Interview 10). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL 17 (Baker Lake Interview 17). 2008. Summary of individual Elder IQ interview conducted by Hattie Mannik in Baker Lake, 2008; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BLH (Baker Lake Hunters). 2009. Excerpt from socio-economic focus group conducted by Susan Ross and Mitchell Goodjohn. March 4, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BLHT (Baker Lake Hunters and Trappers). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with eight representatives of the Baker Lake Hunters and Trappers Organisation. February 16, 2011; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment B.

BL HTO (Baker Lake Hunters and Trappers Organization). March 2009. Meeting Notes. March 4, 2009; in Appendix 3A: Public Engagement Documentation, Part 2.

BL HTO (Baker Lake Hunters and Trappers Organization). February 2013. Notes from a meeting to discuss Information Requests. February 21, 2013; in Appendix 3A: Public Engagement Documentation, Part 2.

BL OH (Baker Lake Open House). October 2012. From "Kivalliq Community Information Sessions 2012 Report." May 2013; in Appendix 3A: Public Engagement Documentation, Part 6.

BL NIRB (Baker Lake - Nunavut Impact Review Board). April 2010. From "Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB's Review of AREVA Resources Canada Inc's Kiggavik Project (NIRB File No. 09MN003)"; in Appendix 3A: Public Engagement Documentation, Part 11.

BQCMB. 2006. *24th Annual Report 2005–2006*. Available at: http://www.arctic-caribou.com/publications_reports.html

BQCMB. 2008. *26th Annual Report 2007–008*. 55 pp. Available at: http://www.arctic-caribou.com/publications_reports.html

Boulanger, J., K.G. Poole, A. Gunn, and J. Wierzchowski. (2012). Estimating the zone of influence of industrial developments on wildlife: a migratory caribou *Rangifer tarandus groenlandicus* and diamond mine case study. Wildlife Biology 18: 164-179.

Boulet, M., S. Couturier, S. D. Côté, R. D. Otto and L. Bernatchez. 2007. Integrative use of spatial, genetic, and demographic analyses for investigating genetic connectivity between migratory, montane, and sedentary caribou herds. *Molecular Ecology* 16: 4223–4240.

Bradley, M., Franke, A., Court, G., Johnstone, R., Duncan, T., and Setterington, M. 2005. Climate Change - What could it mean for Arctic-nesting Peregrine Falcons? Poster presentation ArcticNet Scientific Meeting. Banff, AB.

Bradshaw, C. J. A., S. Boutin and D. M. Hebert. 1998. Energetic implications of disturbance caused by petroleum exploration to woodland caribou. *Canadian Journal of Zoology* 76:1319–1324.

Cameron, R. D., D. J. Reed, J.R. Dau and W. T. Smith. 1992. Redistribution of calving caribou in response to oil-field development on the Arctic slope of Alaska. *Arctic* 45:338–342.

Cameron, R. D., W. T. Smith, R. G. White and B. Griffith. 2005. Central Arctic Caribou and petroleum development: Distributional, nutritional, and reproductive implications. *Arctic* 58:1-9.

Campbell, Mitch. 2010. Regional Caribou Biologist, Department of Environment, Government of Nunavut. Phone conversation with Martin Gebauer on August 20, 2010.

Campbell, M., J. Nishi and J. Boulanger. 2010. A calving ground photo survey of the Qamanirjuaq migratory barren-ground caribou (*Rangifer tarandus groenlandicus*) population — June 2008. Government of Nunavut Technical Report Series 2010 – No. 1-10.

Campbell, M. W., J.G. Shaw, C.A. Blyth. 2012. Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective. Government of Nunavut, Department of Environment. Technical Report Series #1-2012. 274 pp.Canadian Endangered Species Conservation Council (CESCC). 2010. Wild Species 2010: The General Status of Species in Canada. Wild Species | Species Search Tool. [Online.] Available at http://www.wildspecies.ca/ResultSimple.cfm?lang=e&PageIndex=1&orderBy=ReportYear.

Canadian Standards Association (CSA) 2012. Environmental risk assessments at Class I nuclear facilities and uranium mines and mills. N288.6-12.

CCME (Canadian Council of Ministers of the Environment). 2009. Soil quality guidelines for the protection of environmental and human health. Available at: http://st-ts.ccme.ca/. Accessed October 3, 2011.

CI01 (Chesterfied Inlet interview 01). 2009. Summary of IQ interview conducted by Mitchell Goodjohn with a family of three hunters. May 6, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment C.

CI03 (Chesterfield Inlet Interview 03). 2009. Summary of IQ interview conducted by Mitchell Goodjohn with two Elders. May 6, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment C

CI06 (Chesterfield Inlet Interview 06). 2009. Summary of IQ interview conducted by Mitchell Goodjohn with individual Elder. May 7, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment C.

CI KIA (Chesterfield Inlet – Kivalliq Inuit Association). April 2007. From "Uranium Community Tour, Kivalliq Region, April 10-14th, 2007 Questions/Comments and/or Concerns"; in Appendix 3A: Public Engagement Documentation, Part 12.

Clark, R. J. 1975. A field study of the Short-eared Owl, *Asio flammeus* (Pontoppidan) in North America. Wildlife Monographs 47:1–67.

Combs-Beattie, K. 1993. Ecology, habitat use patterns and management needs of Short-eared Owls and Northern Harriers on Nantucket Island, Massachusetts. M.Sc. thesis. University of Massachusetts Amherst, Department of Forestry and Wildlife Management. Amherst, MA.

CHE (Coral Harbour Elders). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn. May 14, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment H.

CH NIRB (Coral Harbour - Nunavut Impact Review Board). May 2010. From "Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB's Review of AREVA Resources Canada Inc's Kiggavik Project (NIRB File No. 09MN003)"; in Appendix 3A: Public Engagement Documentation, Part 11.

CH OH (Coral Harbour Open House). November 2010. From "Part 5 – Kivalliq Community Information Sessions (Round 2, 2010)" December 2011; in Appendix 3A: Public Engagement Documentation, Part 5.

CIHT (Chesterfield Inlet Hunters and Trappers Organisation). 2011. Summary of IQ focus group conducted by Barry McCallum with eight HTO members. June 3, 2011; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment C.

Cornelissen et al. 2001. Cornelissen, J. H. C., T. V. Callaghan, J. M. Alatalo, A. Michelsen, E. Graglia, A. E. Hartley, D. S. Hik, S. E. Hobbie, M. C. Press, C. H. Robinson, G. H. R. Henry, G. R. Shaver, G. K. Phoenix, D. Gwynn Jones, S. Jonasson, F. S. Chapin III, U. Molau, C. Neill, J. A. Lee, J. M. Melillo, B. Sveinbjörnsson and R. Aerts. 2001. Global change and arctic ecosystems: is lichen decline a function of increases in vascular plant biomass? *Journal of Ecology* 89: 984–994.

COSEWIC 2003. COSEWIC assessment and update status report on the wolverine Gulo gulo in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 41 pp.

COSEWIC. 2008. COSEWIC assessment and update status report on the Short-eared owl Asio flammeus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 24pp. (www.sararegistry.gc.ca/status/status_e.cfm)

Court, G.S., Gates, C.C., and Boag, D.A. 1988a. Natural history of the peregrine falcon in the Keewatin District of the Northwest Territories. Arctic 41:17–30.

Cronin, M. A., W. B. Ballard, J. Truett and R. Pollard. 1994. *Mitigation of the effects of oil field development and transportation corridors on caribou.* Final report by LGL Alaska Research Associates to the Alaska Caribou Steering Committee (Alaska Oil and Gas Association, U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, and North Slope Borough), Anchorage, Alaska.

Cumberland Resources Ltd. 2005. Meadowbank Gold Project: Terrestrial Ecosystem Impact Assessment. Submitted to Nunavut Impact Review Board, October 2005.

De Beers Canada Inc. 2010a. Gahcho Kué Project Environmental Impact Statement, Section 13: Cumulative Effects. Prepared by Golder Associates Ltd., Submitted to Mackenzie Valley Environmental Impact Review Board.

De Beers Canada Inc. 2010b. Gahcho Kué Project Environmental Impact Statement, Section 7: Key Line of Inquiry Caribou. Prepared by Golder Associates Ltd., Submitted to Mackenzie Valley Environmental Impact Review Board, December 2010.

Dechant, J. A., M. L. Sondreal, D. H. Johnson, L. D. Igl, C. M. Goldade, M. P. Nenneman, and B. R. Euliss. 2001. Effects of management practices on grassland birds: Short-eared owl. Northern Prairie Wildlife Research Center, Jamestown, ND. 10 pp.

Ellis, D. H., C. H. Ellis, et al. 1991. Raptor responses to low-level jet aircraft and sonic booms. Environmental Pollution 74: 53–83.

Environment Canada. 2007. Preventing wildife attraction to northern industrial sites. Canadian Wildlife Service. 30 pp.

Environment Canada. 2011. Scientific assessment to inform the identification of critical habitat for woodland caribou (*Rangifer tarandus caribou*), boreal population, in Canada. Canadian Wildlife Service, Ottawa.

Environment Canada. 2012. Recovery strategy for the woodland caribou (*Rangifer tarandus caribou*), boreal population in Canada. Environment Canada, Ottawa.

Environmental Canada. 2014. General Nesting Periods of Migratory Birds in Canada. Available at: http://www.ec.gc.ca/paom-itmb/default.asp?lang=En&n=4F39A78F-1#_tab01. Accessed 4 June 2014.

Farmer, A., R.T. Holmes and F.A. Pitelka. 2013. Pectoral Sandpiper (*Calidris melanotos*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/348.

Fischer, C. A. and L. B. Keith. 1974. Population responses of central Alberta ruffed grouse to hunting. *Journal of Wildlife Management* 38: 585–600.

Frame, P.F., H.D. Cluff, and D.S. Hik. 2007. Response of wolves to experimental disturbance at homesites. Journal of Wildlife Management 71: 316–320.

Franke, A., Setterington, M. A., Court, G.S., Birkholz, D. 2010. Long-term Trends of Persistent Organochlorine Pollutants, Occupancy and Reproductive Success in Peregrine Falcons (*Falco peregrinus tundrius*) Breeding near Rankin Inlet, Nunavut, Canada. Arctic. 63 (4) 442–450.

Fuller, T. K. 1990. Dynamics of a Declining White-Tailed Deer Population in North-Central Minnesota. *Wildlife Monographs* 110: 3–37.

Golder Associates Ltd. 2011. Effects of Development on Barren-ground Caribou: Insight from IQ and an Ecological Model. Submitted to Kugluktuk Hunters and Trappers Organization. August 19, 2011. 84 pp.

Golder Associates Ltd. 2014. Final Environmental Impact Statement (FEIS) — Meliadine Gold Project, Nunavut: Volume 6.0 Terrestrial Environment and Impact Assessment. Prepared for Agnico Eagle Mines, Submitted to Nunavut Impact Review Board.

Government of Nunavut (GN). 2002. Environmental guideline for dust suppression. Available at: http://env.gov.nu.ca/node/82#Guideline Documents. Accessed: October 3, 2011.

Government of Nunavut Department of Environment. 2005. Recommendaitons on total allowable harvest (TAH) rates for terrestrial willdife populations in Nunavut. Prepared by Wildlife Research Section. Available at http://www.nwmb.com/en/public-hearings-a-meetings/public-hearings-1/2006/sep-25-28-2006-special-meeting-no-12a-a-12b/193-29-tah-report-eng/file

Government of Nunavut. 2005. Consolidation of Wildlife Act (Current to: November 6, 2012).

Government of Nunavut. 2009. Pinasuaqtavut 2004-2009: our commitment to building Nunavut's future: working to improve the health, prosperity, and self-reliance of Nunavummiut, ISBN 9781553250678, 1553250672

Government of Nunavut Department of Environment. 2007. Statutory report on wildlife to the Nunavut Legislative Assembly, Section 176 of the Wildlife Act, 2007. Final Wildlife Report No. 17, Government of Nunavut, Department of Environment, Iqaluit.

Government of Nunavut Department of Environment. 2010. Working together for caribou: Draft Nunavut caribou strategy framework. March 2010..

Government of Nunavut Department of Environment. 2013. Statutory report on wildlife to the Nunavut Legislative Assembly, Section 176 of the Wildlife Act, August 2013. Government of Nunavut, Department of Environment, Iqaluit.

Gratson, M.W. and C L. Whitman. 2000. Road closures and density and success of elk hunters in Idaho. *Wildlife Society Bulletin:* 302–310.

Gundersen, H., Andreassen, H.P., and T. Storass. 1998. Spatial and temporal correlates to Norwegian moose-train collisions. Alces 34(2): 385–394.

Gunn, A. 1984. Aspects of the management of Muskox in the Northwest Territories. In: D.R. Klein, R.G. White, and S. Keller (eds.). 1984. *Proceedings of the First International Muskox Symposium.* Institute of Arctic Biology, Biol. Pap. Univ. Alaska Special Report No. 4. p. 33–40.

Gunn, A. and M. Sutherland. 1997. *Muskox diet and sex-age composition in the Central Arctic coastal mainland (Queen Maud Gulf area), 1988–1991.* NWT Department of Resources, Wildlife and Economic Development, Manuscript Report No. 95. Yellowknife, NT.

Gunn, A. 1995. Responses of Arctic ungulates to climate change. Pages 89–94 In *Peterson, D.L. and D.R. Johnson. Human ecology and climate change: people and resources in the Far North.* Taylor & Francis Group, Washington, DC, USA.

Gunn, A., C.J. Johnson, J.S. Nishi, C.J. Daniel, D.E. Russell, M. Carlson and J.Z. Adamczewski. 2011. Understanding the cumulative effects of human activities on barren-ground caribou. Pages 107–128 In P.R. Krausman and L.K. Harris, editors. *Cumulative Effects in Wildlife Management: Impact Mitigation*. CRC Press, Boca Raton, FL, USA.

Halfwerk, W., L. J. M. Holleman, C. K. Lessells, and H. Slabbekoorn. 2011. Negative impact of traffic noise on avian reproductive success. Journal of Applied Ecology 48:210–219.

Hanson, W. C. 1981. Caribou (*Rangifer tarandus*) encounters with pipelines in northern Alaska. *Canadian Field-Naturalist* 95:57–62.

Hicklin, P. and C.L. Gratto-Trevor. 2010. Semipalmated Sandpiper (*Calidris pusilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/006.

Hinkes, M. T., G. H. Collins, L. J. Van Daele, S. D. Kovach, A. R. Aderman, J. D. Woolington and R. J. Seavoy. 2005. Influence of population growth on caribou herd identity, calving ground fidelity, and behavior. *Journal of Wildlife Management* 69:1147–1162.

Holt. D. W. and S. M. Leasure. 1993. Short-eared Owl (*Asio flammeus*). In: Poole, A. and F. Gill, Editors. *The Birds of North America*, No. 62, The Academy of Natural Sciences, Philadelphia, PA; The American Ornithologists` Union, Washington, D.C., 22pp.

Holthuijzen, A. M., Eastland, W. G., Ansell, A. R., Kochert, M. N., Williams, R. D., and Young, L. S. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18: 270–281.

Houston, C. S. 1997. Banding of Asio owls in south-central Saskatchewan. In: Duncan, J. R., D. H. Johnson, and T. H. Nicholls, Editors. *Biology and conservation of owls in northern hemisphere: second international symposium, USDA Forest Service General Technical Report NC-190.* St. Paul, MN.

Hussell, D.J. and R. Montgomerie. 2002. Lapland longspur (*Calcarius lapponicus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/656

IDS (Interdisciplinary Systems Ltd.). 1978. *Effects of exploration and development in the Baker Lake area. Volume 1 — Study Report.* Prepared for Department of Indian and Northern Affairs Canada, Ottawa Ontario. February 1978. 309 pp.

Jehl, J. R. 2004. *Birdlife of the Churchill Region: status, history, biology*. Trafford Publishing. Victoria, B.C.

Johnsgard, P. A. 1988. *North American owls: biology and natural history*. Smithsonian Institution, Washington, D.C. 295 pp.

Johnson, O.W. and P.G. Connors. 2010. American Golden-Plover (*Pluvialis dominica*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/201.

Johnson, R. G. and S. A. Temple. 1986. Assessing habitat quality for birds nesting in fragmented tallgrass prairies. Pages 245-249 In: Verner, J., M. L. Morrison, and C. J. Ralph, Editors. *Wildlife 2000: modelling habitat relationships of terrestrial vertebrates*. University of Wisconsin Press, Madison, WI.

Joint Secretariat. 2003. Inuvialuit Harvest Study Data and Methods Report 1988–1997. NWT Fisheries and Joint Fisheries Committee.

Joly, K., C. Nellemann and I. Vistnes. 2006. A reevaluation of caribou distribution near an oilfield road on Alaska's North Slope. Wildlife Society Bulletin 34:866–869.

JT Consulting. 2011. Preliminary Report on the Inuit Qaujimajatuganit Regarding Areva's "Road Options." Prepared for the Baker Lake Hunters and Trappers Organization by JT Consulting, Baker Lake, Nunavut.

Klein, D. R. 1971. Reaction of reindeer to obstructions and disturbances. *Science* 173:393–398.

Klein, D. R., H. V. Goldman, B. Forbes, and G. Kofinas. 2000. Arctic grazing systems. *Polar Research* 19:91–98.

Klima, J. and J.R. Jehl, Jr. 2012. Stilt Sandpiper (*Calidris himantopus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/341.

Kuyt, E. 1972. Food habits and ecology of wolves on barren-ground caribou range in the Northwest Territories. Report Series Number 21, Canadian Wildlife Service, Ottawa, Ont.

Lehman, R. N., L. B. Carpenter, K. Steenhof, and M. N. Kochert. 1998. Assessing relative abundance and reproductive success of shrub steppe raptors. *Journal of Field Ornithology* 69: 244–256.

Mahoney, S. P. and J. A. Schaefer. 2002. Hydroelectric development and the disruption of migration in caribou. Biological Conservation 107:147–153.

Male, S. K. and Nol, E. 2005. Impacts of roads associated with the Ekati Diamond Mine™, Northwest Territories, Canada, on reproductive success and breeding habitat of Lapland longspurs. Canadian Journal of Zoology 83: 1286–1296.

Mayor, S. J., J. A. Schaefer, D. C. Schneider and S. P. Mahoney. 2009. The spatial structure of habitat selection: A caribou's-eye-view. *Acta Oecologica-International Journal of Ecology* 35:253–260.

McLaren, M. A. and J. E. Green. 1985. The reactions of muskoxen to snowmobile harassment. *Arctic* 38:188–193.

Mikkola, H. 1983. *Owls of Europe*. Buteo Books, Vermillion, SD. 397 pp.

Miller, F. L. 1985. Some physical characteristics of caribou spring migration crossing sites on the Dempster Highway, Yukon Territory. Pages 15–21 in Caribou and human activity : proceedings of the 1st North American Caribou Workshop, Whitehorse, Yukon, 28-29 September 1983 (A. M. Martell and D. E. Russell, Eds.). Canadian Wildlfie Service, Ottawa.

Millsap, B. A., P. L. Kennedy, M. A. Byrd, G. S. Court, J. H. Enderson and R. N. Rosenfield. 1998. Review of the proposal to de-list the American peregrine falcon. Wildlife Society Bulletin 26:522–538.

Moskoff, W. and R.Montgomerie. 2002. Baird's Sandpiper (*Calidris bairdii*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/661.

Mountain Province Diamonds. 2012. Gahcho Kué Project History | Mountain Province Diamonds. [Online.] Available at http://www.mountainprovince.com/project/project-history/.

Mueller, H. 1999. Wilson's Snipe (*Gallinago delicata*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/417.

Nagy, J. A., D. L. Johnson, N. C. Larter, M. W. Campbell, A. D. Derocher, A. Kelly, M. Dumond, D. Allaire, and B. Croft. 2011. Subpopulation structure of caribou (*Rangifer tarandus* L.) in arctic and subarctic Canada. *Ecological Applications* 21:2334–2348.

Nebel, S. and J.M. Cooper. 2008. Least Sandpiper (*Calidris minutilla*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/115.

Nellemann, C. and P.E. Reynolds, 1997. Predicting late winter distribution of Muskox using an index of terrain ruggedness. *Arctic and Alpine Research* 29:334–338.

Nettleship, D.N. 2000. Ruddy Turnstone (*Arenaria interpres*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/537.

Nunavut (Nunavut Department of Justice). 2008. Consolidation of Wildlife Act, SNu 2003, c 26, <http://canlii.ca/t/51x1n> retrieved on 2014-07-04

Nunavut Impact Review Board. 2011. Guidelines for the Preparation of an Environmental Impact Statement for AREVA Resources Canada Inc.'s Kiggavik Project (NIRB File No. 09MN003). Cambridge Bay, Nunavut.

Nunavut Impact Review Board. 2013. Preliminary Hearing Conference Decision concerning the Kiggavik Project (NIRB File No. 09MN003). Nunavut Impact Review Board, Cambridge Bay, Nunavut.

Nunavut Tunngavik Inc. 2005. *Contaminants in Nunavut: Inuit Capacity-Building Workshop-Summary Report February 15-17, 2005.* Prepared by Nunavut Tunngavik Inc. Iqaluit, NU May 2005.

NLUIS (Northern Land Use Information Series). 1980. 1:250,000 Map Sheets 66A (Schultz Lake) and 66B (Aberdeen Lake). Indian and Northern Affairs and Department of Environment. Ottawa.

Nol, E. and M.S. Blanken. 1999. Semipalmated Plover (*Charadrius semipalmatus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/444.

Nunavut Planning Commission. 2000. Keewatin Regional Land Use Plan.

Ontario Ministry of Natural Resources [OMNR] 1987. Peregrine Falcon habitat management guidelines. MNR # 51611. ISBN 0-7794-2367-4. http://www.ontla.on.ca/library/repository/mon/6000/10299750.pdf

Parmelee, D.F. 1992. White-rumped Sandpiper (*Calidris fuscicollis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/029.

Paulson, D.R. 1995. Black-bellied Plover (*Pluvialis squatarola*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/186.

Polar Field Services 2011. Field notes: plants, bugs, and migratory songbirds. Available at: http://www.polarfield.com/blog/tag/lapland-longspur/

Postovit, H. R. and B. C. Postovit. 1987. Impacts and mitigation techniques. Pages 183–213 in B. A. Giron Pendleton, B. A. Millsap, K. W. Kline, and D. M. Bird, eds. Raptor management techniques manual. National Wildlife Federation., Washington, D.C.

Postupulsky, S. 1974. Raptor reproductive success: some problems with methods, criteria, and terminology. In: Hamerstrom, F.E., Harrell, B.E., and Olendorff, R.R., eds. Management of Raptors. Vermillion, South Dakota: Raptor Research Foundation, Raptor Research Report .No. 2. 21–31.

Poulin, R. G., T. I. Wellicome, and L. D. Todd. 2001. Synchronous and delayed numerical responses of a predatory bird community to a vole outbreak on the Canadian prairies. *Journal of Raptor Research* 35: 288–295.

Priest, H., and P. J. Usher. 2004. Nunavut Wildlife Harvest Study - 2004. Nunavut Wildlife Management Board.

RBJ (Repulse Bay Hunters and Elders). 2011. Summary of community review meeting conducted by Mitchell Goodjohn with five representatives of the Repulse Bay HTO and six Elders; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G.

RI KWB (Rankin Inlet- Kivalliq Wildlife Board). May 2009. Notes from questions asked about the AREVA Presentation, May 13, 2009; in Appendix 3A: Public Engagement Documentation, Part 2.

RI KWB (Rankin Inlet- Kivalliq Wildlife Board). October 2009. Notes from questions asked about the AREVA Presentation, October 29, 2009; in Appendix 3A: Public Engagement Documentation, Part 2.

RI OH (Rankin Inlet Open House). November 2013. From "Kivalliq Community Information Sessions 2013 Report." May 2013 ; in Appendix 3A: Public Engagement Documentation, Part 2.

RIW (Rankin Inlet Women). 2009. Excerpt from socio-economic focus group conducted by Susan Ross and Linda Havers. April 3, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment D.

RIYA (Rankin Inlet Young Adults). 2009. Excerpt from socio-economic focus group conducted by Susan Ross and Linda Havers. April 2, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment D.

Reijnen, R., R. Foppen, and H. Meeuwsen. 1996. The effects of traffic on the density of breeding birds in Dutch agricultural grasslands. *Biological Conservation* 75:255–260

Reimers, E., S. Eftestol, and J. E. Colman. 2003. Behavior responses of wild reindeer towards direct provocation by a snowmobile or skier. *Journal of Wildlife Management* 67:747–754.

Reimers, E., and J. E. Colman. 2006. Reindeer and caribou (*Rangifer tarandus*) response towards human activities. *Rangifer* 26:55–71.

RBE (Repulse Bay Elders). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn. May 11, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G

RBHT (Repulse Bay Hunters and Trappers Organization). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Mitchell Goodjohn. May 11, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment G.

RB NIRB (Repulse Bay - Nunavut Impact Review Board). April 2010. From "Public Scoping Meetings Summary Report, April 25-May 10, 2010, for the NIRB's Review of AREVA Resources Canada Inc's Kiggavik Project (NIRB File No. 09MN003)"; in Appendix 3A: Public Engagement Documentation, Part 11.

Rescan. 2013. The Back River Project Draft Environmental Impact Statement: Volume 5 Terrestrial Environment. Prepared for Sabina Silver and Gold, Submitted to Nunavut Impact Review Board.

Richardson, C. T. and Miller, C. K. 1997. Recommendations for protecting raptors from human disturbance: a review. Wildlife Society Bulletin 25: 634–638.

Riewe, R.. 1992. Nunavut Atlas. Canadian Circumpolar Institute and Tungavik Federation of Nunavut, Edmonton, Alberta.

Ritchie, R. J. 1987. Response of adult Peregrine Falcons to experimental and other disturbances along the trans-Alaska pipeline system, Sagavanirktok River, Alaska, 1985, 1986. Anchorage, Alaska. Alaska Biological Research for Alyeska Pipeline Service Company. 91p.

Robertson, G.J. and J-P.L. Savard. 2002. Long-tailed duck (*Clangula hyemalis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology. Available at:: http://bna.birds.cornell.edu/bna/species/651

Ross. P.I. 2002. Update COSEWIC status report on the grizzly bear Ursus arctos in Canada, in *COSEWIC assessment and update status report on the Grizzly Bear Ursus arctos in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 91 pp.

Rubega, M.A., D. Schamel and D.M. Tracy. 2000. Red-necked Phalarope (*Phalaropus lobatus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/538.

Russell, D. 2012. Appendix 6H: Energy-protein modeling of North Baffin caribou in relation to the Mary River mine project. In: Mary River Project Final Environmental Effect Statement, Volume 6 – Terrestrial Environment. 41pp. Baffinland Iron Mines Corporation, Toronto. ftp://ftp.nirb.ca

Russell, D. 2014. Energy-protein modeling of North Baffin Island caribou in relation to the Mary River Project: a reassessment from Russell (2012). Prepared for EDI Environmental Dynamics Inc., Whitehorse YT and Baffinland Iron Mines Corporation, Oakville Ontario

Russell, D.E.,R.G. White, R.G., and C.J. Daniel 2005. Energetics of the Porcupine Caribou herd: A computer Simulation Model. Tech. Rept. Ser. No. 431. Canadian Wildlife Service, Ottawa, Ontario. 64pp.

Speller, S.D., R.E. Harris, J. Pangman, J. Boot., N.J. Dodd and L.S. McCarty. 1979. Environmental Studies Report – 1979. Urangesellschaft Canada Limited. December 1979. 230 pp.

Stankowich, T. 2008. Ungulate flight responses to human disturbance: A review and meta-analysis. *Biological Conservation* 141:2159–2173.

Statistics Canada. 2006. Community Profile — Baker Lake, NT. Available at: http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=6205023&Geo2=PR&Code2=62&Data=Count&SearchText=Baker%20Lake&SearchType=Begins&SearchPR=62&B1=All&Custom=. Accessed: November 2009.

Sturm, M. C. Racine, and K. Tape. 2001. Climate change: increasing shrub abundance in the Arctic. *Nature* 411: 546-547.

Swift, T. L., and S. J. Hannon. 2010. Critical thresholds associated with habitat loss: a review of the concepts, evidence, and applications. Biological Reviews 85:35–53.

Tagalik, Shirley. 2012. Inuit Qaujimajatuqangit: The role of Indigenous knowledge in supporting wellness in Inuit communities in Nunavut. National Collaborating Centre for Aboriginal Health. January 2012.

Unsworth, J. W., L. Kuck, M. D. Scott and E. O. Garton. 1993. Elk mortality in the Clearwater drainage of northcentral Idaho. *Journal of Wildlife Management* 57:495–502.

US EPA (United Stated Environmental Protection Agency) 2010. Ecological Soil Screening Levels. Information obtained from Interim Eco-SSL Documents available at: http://www.epa.gov/ecotox/ecossl/

van der Grift, E.A. 2001. The Impacts of Railroads on Wildlife. Produced for Wildlands CPR Road RIPorter Volume 6 Issue 6. Available at: http://www.wildlandscpr.org/node/221. Posted on Novemrber 10, 2001.

Vistnes, I. I., C. Nellemann, P. Jordhoy and O.-G. Stoen. 2008. Summer distribution of wild reindeer in relation to human activity and insect stress. *Polar Biology* 31:1307–1317.

Walker M.D., C.H. Wahren, R.D. Hollister, G.H.R. Henryd, L.E. Ahlquist, J.M. Alatalo, M.S. Bret-Harte, M.P. Calef, T.V. Callaghan, A.B. Carrolla, H.E. Epstein, I.S.Jónsdóttir, J.A. Klein, B.Magnússon, U. Molau,S.F. Oberbauer, S.P. Rewa, C.H. Robinson, G.R. Shaver, K.N. Suding, C.C. Thompson, A. Tolvanen, Ø. Totland, P.L. Turner, C.E. Tweedie, P.J. Webber and P.A. Wookey. 2006. *Plant community responses to experimental warming across the tundra biome.* Proceedings of the National Academy of Sciences 103: 1342-1346.

Warnock, N.D. and R.E. Gill. 1996. Dunlin (*Calidris alpina*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/203.

WCE (Whale Cove Elders). 2009. Excerpt from socio-economic focus group conducted by Linda Havers and Susan Ross. April 9, 2009; in Appendix 3B: Inuit Qaujimajatuqangit Documentation, Attachment F.

Wolfden Resources Inc. 2006. High Lake Project, Volume 6, Section 3: Wildlife and Wildlife Habitat. Submitted to Nunavut Impact Review Board November 2006.

White, C. M. and S. K. Sherrod. 1973. Advantages and disadvantages of the use of rotor-winged aircraft in raptor surveys. Raptor Research 7(3-4): 97–104.

White, C. M. and T. L. Thurow. 1985. Reproduction of Ferruginous Hawks *Buteo regalis* exposed to controlled disturbance. Condor 87(1):14–22.

White, R.G., D. Russell, C. Daniel. In press. Simulation of maintenance, growth and reproduction of caribou and reindeer as influenced by ecological aspects of nutrition, climate change and industrial development using an energy-protein model. Rangifer Special Issue xx pp

Willliams, R. D. and E. W. Colson. 1987. *Raptor associations with linear rights-of-way.* Pages 173–192 in B. A. Giron, C. E. Ruibal, D. L. Krahe, K. Steehnof, M. N. Kocjert, M. N. LeFranc, Jr. eds. Proc. western raptor management symposium and workshop. National Wildlife Federation, Washington, D.C.

Wolfe, S. A., B. Griffith, and C. A. Gray Wolfe. 2000. Response of reindeer and caribou to human activities. *Polar Research* 19:63–73.