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15. SUBJECTS OF NOTE

15.4 SPECIES AT RISK AND KEY BIRD SPECIES

15.4.1 Introduction

This section of the Developer's Assessment Report (DAR) for the Taltson Hydroelectric Expansion Project (Project) consists solely of the Subject of Note (SON): Species at Risk and Key Bird Species outlined in the Terms of Reference (TOR) issued on March 28, 2008 by the Mackenzie Valley Environmental Impact Review Board (MVEIRB, 2008a). This SON contains a comprehensive assessment of the effects of the Project on Species at Risk and Key Bird Species. Aspects of the SON may overlap slightly with the following biophysical Key Lines of Inquiry (KLOI) and SON:

- KLOI: Water Fluctuations in the Taltson River Watershed (Chapter 13);
- KLOI: Ecological Changes in Trudel Creek (Chapter 14); and
- SON: Access (Section 15.5).

The SON: Species at Risk and Key Bird Species contains the primary in-depth assessment of the Project effect on mammals, birds, amphibians, and plants that are identified as biologically vulnerable species. Individual species that are at risk are often part of a larger community of animals or plants. Bird species at risk that are a part of the key bird species communities would be assessed as part of those groups (i.e. passerines, waterfowl, and raptors). Bird species that do not fall into the above groups are addressed individually as required.

15.4.2 Species at Risk in the Northwest Territories

The Terms of Reference (MVEIRB 2008a) requires the inclusion of vulnerable species (hereafter referred to as Species at Risk) within the Project's regional study area (RSA). Species at Risk are defined as those listed in the following documents:

- any species listed in the *2006 to 2010 General Status Ranks of Wild Species in the Northwest Territories Report* (General Status Ranks in NWT, Working Group on General Status of NWT Species 2006);
- any species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2008); and
- any species listed in the *Species at Risk Act* (SARA 2008).

The General Status Ranks in NWT currently lists 202 species as At Risk, May be at Risk, or Sensitive that occur within the RSA in the Taiga Shield and Southern Arctic Ecozones (Table 15.4.1). Although the importance of protecting species at risk is recognized, this list was too large to be able to provide a reasonable level of detail for each species.

Table 15.4.1 — Species listed under the General Status Ranks for the Northwest Territories in the Southern Arctic and Taiga Shield Ecozones

Species Group	At Risk	May Be At Risk	Sensitive	Total
Amphibian			1	1
Bird	1	5	38	44
Butterfly			5	5
Fish			5	5
Plant		48	92	140
Terrestrial Mammal	1		6	7
Grand Total	**2**	**53**	**147**	**202**

Source: Working Group on General Status of NWT Species 2006

The MVEIRB has prepared draft guidelines for effects assessment to species at risk (MVEIRB 2008b). The guidelines were produced with substantial input from Environment Canada and the GNWT Department of Environment and Natural Resources. These guidelines (MVEIRB 2008b) recommended that species at risk include:

- species listed as At Risk in the General Status Ranks in NWT (Working Group on General Status of NWT Species 2006);
- species listed as Endangered, Extirpated, Threatened, or of Special Concern under COSEWIC (2008); or
- species listed as Endangered, Threatened, or of Special Concern under Schedule 1 of SARA (2008).

Although not required by the MVEIRB species at risk guidelines, species listed as May Be at Risk under the Northwest Territories General Status Ranks were also included in the assessment.

These guidelines provided a better indication of the species that are truly at risk of extirpation or extinction in the NWT, and which could be adequately addressed within an environmental assessment. As such, these criteria were adapted to those described in the TOR. Using these guidelines, the following sections outline the terrestrial, aquatic, and plant Species at Risk within the vicinity of the Project.

15.4.3 Valued Components and Assessment Endpoints

15.4.3.1 Valued Component Selection

An important aspect of the valued component (VC) selection process is that it reflects the values of concerned people, which were presented during the public screening sessions. During the issue scoping exercises, concerns were expressed about the potential effects that the Project could have on Species at Risk and key bird species (MVEIRB 2008c). This SON includes a detailed assessment of impacts on Species at Risk and key bird species that could potentially be affected by the Project. The selection process for Species at Risk and key bird species is described in the following sections.

15.4.3.1.1 Selection of Species at Risk

The determination of Species at Risk was completed according to the TOR (MVEIRB 2008a), the MVEIRB draft guidelines for assessing effects to species at risk (MVEIRB 2008b), and species listed as May Be at Risk under the Northwest Territories General Status Ranks (Working Group on General Status of NWT Species 2006, see Section 9.5.7 Vulnerable Species). The following species and species groupings were selected to represent Species at Risk.

15.4.3.1.1.1 Rare Vascular Plants

There are currently no COSEWIC-listed vascular plants, lichens or mosses in the Northwest Territories (NWT) (COSEWIC 2008) or plant species considered At Risk in the Taiga Shield or Southern Arctic ecozones of the NWT (Working Group on General Status of NWT Species 2006, Table 15.4.1). However, there are 48 plant species considered May be at Risk, either because of limited habitat or because of limited information. Of these 48 species, 43 species may potentially occur within RSA (defined as a 5 km buffer around the Project footprint); five species were excluded on the basis that they are found only in salt plains. Therefore, the VC for the assessment included the remaining 43 species of rare vascular plants that may occur within the RSA.

15.4.3.1.1.2 Terrestrial Mammals

Both grizzly bears and wolverine in the NWT are listed as Sensitive (Working Group on General Status of Northwest Territories Species 2006), and federally as a species of Special Concern by COSEWIC (2008). Neither is listed under the Species at Risk Act (SARA, 2008). Grizzly bear and wolverine are therefore VCs that would be assessed for effects from the Project.

Table 15.4.2 — Animal Species At Risk in the Project Regional Study Area

Common Name	Scientific Name	COSEWIC Status[1]	SARA Status[2]	GNWT Status[3]	Rationale
Grizzly bear	*Ursus arctos*	Special concern	—	Sensitive	Habitat fragmentation Sensitivity to human caused mortality
Wolverine	*Gulo gulo*	Special concern	—	Sensitive	Habitat fragmentation Increased harvester access
Whooping crane	*Grus americana*	Endangered	Schedule 1	At risk	Small population Restricted distribution.
Peregrine falcon	*Falco peregrinus anatum/tundrius*	Special concern	—	Sensitive	Small population
Short-eared owl	*Asio flammeus*	Special concern	Schedule 3	Sensitive	Small, declining population
Rusty blackbird	*Euphagus carolinus*	Special concern	—	May be at risk	Population declines

Common Name	Scientific Name	COSEWIC Status[1]	SARA Status[2]	GNWT Status[3]	Rationale
Olive-sided flycatcher	*Contopus cooperi*	Threatened	—	Sensitive	Long-term population declines
Common nighthawk	*Chordeiles minor*	Threatened	—	Secure	Long-term population declines
Northern leopard frog	*Rana pipiens*	Special concern	—	Sensitive	Limited distribution in NWT Contraction of range nationwide

1 = Committee on the Status of Endangered Wildlife in Canada 2008

2 = Species at Risk Act 2008

3 = Working Group on General Status of NWT Species 2006

Notes: "-" indicates species not listed; NWT = Northwest Territories; COSEWIC = Committee on the Status of Endangered Wildlife in Canada; SARA = Species at Risk Act; GNWT = Government of the Northwest Territories.

Grizzly bear and wolverine are both harvested in the Northwest Territories, but hunting of the barren-ground grizzly bears (the population found within the RSA) is not permitted. There remains a small harvest of barren-ground grizzly bears, mostly due to problem bears, but which also includes some illegal harvests (McLoughlin and Messier 2001). Between 1958 and 2000, a total of 265 barren-ground grizzly bears, or an average of approximately 6 bears per year, were harvested (McLoughlin and Messier 2001). There is a quota for barren-ground grizzly bears within Nunavut of 9 grizzly bears per year. Inuit may also hunt grizzly bear for subsistence (G. Atatahak, personal communication, 2008). During the hunting season of 2006-07, one grizzly bear hide was submitted to ENR from Yellowknife hunters, and none from Łutsel K'e (ITI 2008), suggesting this species does not have a significant level of traditional or non-traditional use. Other populations of grizzly bear exist in the NWT, such as the Mackenzie Mountains grizzly bear, and are harvested under a quota system (ENR 2008). However, only the barren-ground grizzly bear is found within the RSA, and within this document, grizzly bear refers to the barren-ground grizzly bear population only.

Wolverine are harvested by sport hunters as furbearers, although the overall contribution of this species to the economy is relatively small (i.e. less than $10,000 among the five South Slave communities and less than $5,000 to Yellowknife in 2006-07 (ENR 2008b). Only two wolverine were harvested by sport hunters in the North Slave region in 2008 (S. Acton, personal communication, November 3, 2008).

Wolverine populations in the boreal forest and tundra are likely genetically independent and can be considered separate populations (Wilson et al., 2000; Chappell et al. 2004). Gene flow between populations does occur because males and females do make periodic long-distance movements (Gardner et al. 1986; Mulders 2000). However, most of the gene flow in the NWT is accomplished by males, with females contributing minimal gene flow between populations (Chappell et al. 2004; Wilson et al. 2000). Based on these conclusions, the tundra population and boreal forest population are likely two separate populations of wolverines within the Project area.

15.4.3.1.1.3 *Birds*

Six bird species at risk were identified. Rather than assess these individually, they were assessed as part of the larger groups of passerines, waterfowl, and raptors. Individual species were mentioned and considered separately where appropriate.

15.4.3.1.1.4 *Species Not Included in this Subject of Note*

The northern leopard frog is listed as Sensitive in the NWT (Working Group on General Status of NWT Species 2006), and federally as a species of Special Concern by COSEWIC (2008). Therefore, northern leopard frog was selected for the assessment. Although the northern leopard frog has been identified as a Species at Risk, impacts are expected to be limited to aquatic effects. Transmission lines are not anticipated to have a substantive effect to amphibian populations (Harron, 2003), although the proposed changes to the hydrology regime does have potential to affect amphibians. Effects to the northern leopard frog are therefore assessed in Section 13 (KLOI: Water Fluctuations in the Taltson River Watershed) and Section 14 (KLOI: Ecological Changes in Trudel Creek).

The yellow rail is listed as May be at Risk in the NWT (Working Group on General Status of NWT Species 2006), and federally as a species of Special Concern by COSEWIC (2008). Though the theoretical range of the yellow rail overlaps with the RSA, yellow rail were not observed at the Taltson River during baseline surveys (see Section 9.5.3, Birds and Bird Habitat). Therefore, the yellow rail is not considered a Species at Risk for the assessment.

Although the wood bison is a Species at Risk, this species does not extend into the Taiga Shield ecozone or to the RSA (ENR, 2008), and none were observed during baseline studies. Therefore, the wood buffalo is not considered a Species at Risk for the assessment.

15.4.3.1.2 Selection of Key Bird Species

To define key bird species for this assessment, the bird species present within the RSA were identified, based on theoretical ranges and baseline studies (see Section 9.5.3, Birds and Bird Habitat). Passerines, waterfowl, and raptors were the major groupings, and were selected as the VCs to represent Key Bird Species. Passerines, specifically sparrows, warblers and finches, were selected as a VC because they include several Species at Risk (the rusty blackbird, olive-sided flycatcher, and common nighthawk), provide a suitable indicator of effects from disturbance (Simons et al. 1999), occupy small home ranges, and are present in large numbers throughout the geographic extent of the Project. Waterfowl were selected as a VC because they are particularly prone to collisions with transmission lines, may be affected by changes to the hydrology regime associated with the Project, and are a traditional food source. The whooping crane was assessed as part of the waterfowl VC, unless specifically noted otherwise. Raptors were selected as a VC because they include Species at Risk and because they perch and nest on transmission line towers.

15.4.3.2 Assessment Endpoints

Assessment endpoints represent the key properties of the VC that should be protected for use by future human generations. Assessment endpoints are general statements about what is being protected. Assessment endpoints for the selected VCs are described in the following section, and are summarized in Table 15.4.3.

15.4.3.2.1.1 Rare Vascular Plants

The Project is not expected to lead to the extirpation of a plant Species at Risk, as effects would be predominantly limited to direct effects that do not extend beyond the Project footprint. However, it is possible that isolated patches of plant Species at Risk may be lost due to the Project. Large-scale development may also cause changes to rare plant abundance. Therefore, the assessment endpoint selected was the persistence of rare vascular plant abundance and distribution.

15.4.3.2.1.2 Grizzly Bear and Wolverine

Although the harvesting of wolverine constitutes a small economic contribution, the persistence of wolverine harvesting was included as an assessment endpoint. Assessment endpoints for grizzly bear and wolverine included persistence of abundance and distribution of these two species.

15.4.3.2.1.3 Passerines, Waterfowl, and Raptors

The assessment endpoint for the passerine, waterfowl, and raptor VCs included persistence of abundance and distribution. Changes to abundance may result from direct mortality, reduced recruitment and, over the longer term, factors that affect the environment's carrying capacity. Changes to distribution may occur following sensory disturbance, such as construction noise and activity, and from behavioural changes in response to vegetation removal (e.g. passerine diversity is often observed to change across linear developments [Jalkotzy et al. 1997]). Continued opportunities for hunting and other human uses of birds was not included as an assessment endpoint because concerns regarding impacts of the Project on human use of birds was not raised during the public hearings (Rescan 2004, MVLWB 2007, MVEIRB 2008c), and there are no commonly-used waterfowl hunting grounds within the RSA.

With regards to bird Species at Risk, the rusty blackbird and olive-sided flycatcher were assessed as passerines. Although not a passerine, the common nighthawk is an upland bird and may be affected by development through the same pathways as a passerine, and was assessed as such. No waterfowl Species at Risk were identified for the Project assessment. Although whooping cranes are not waterfowl, they share similar habitat requirements (e.g. shallow, grassy ponds), and are likely to be affected by the same pathways that may affect waterfowl (e.g. changes to hydrology). Therefore, the whooping crane was assessed as part of the waterfowl VC, unless specifically noted otherwise. Peregrine falcons and short-eared owls were identified as Species at Risk for the Project assessment and are assessed as part of the raptor VC.

Table 15.4.3 — Valued Components and Assessment Endpoints for Subject of Note Species at Risk and Key Bird Species

Valued Component	Assessment Endpoints
Rare Plants	Persistence of abundance and distribution
Grizzly bear	Persistence of abundance and distribution
Wolverine	Persistence of abundance and distribution Persistence of harvesting opportunities
Passerine Waterfowl Raptors	Persistence of abundance and distribution

15.4.4 Spatial and Temporal Boundaries of the Assessment

The effects study area (i.e. spatial boundary of the assessment) for this SON was not specifically identified in the TOR (MVEIRB 2008a). To assess the potential effects of the Project on the VCs, it is necessary to define appropriate spatial boundaries. The spatial boundaries were delineated based on the predicted extent of the Project-related effects, as well as life history attributes of the VCs potentially interacting with the Project, and available landscape classification data.

- Local Study Area (LSA): This was defined as the entire Project footprint (or area to be disturbed), plus a 100 metre (m) buffer on either side. The LSA was selected to assess existing conditions, and the immediate direct and small-scale indirect effects of the Project on individual animals.
- Regional Study Area (RSA): This area was defined as the entire Project footprint, plus a 5 km buffer on either side (for a total area of 1,003,443 ha). The RSA was developed to assess the larger scale direct and indirect effects to the VCs.
- Cumulative Effects Study Area (CESA): This area was defined as the spatial boundary for baseline conditions and assessing Project-specific (incremental) and cumulative effects from other developments. Cumulative effects study areas were specific to each VC. As well, the CESA for wolverine was split between tundra and boreal populations along the treeline (Figure 15.4.1, Table 15.4.4).
- Slave Geological Province (SGP) Study Area: This study area was used for specific analyses, (i.e. to estimate the effects of habitat fragmentation and sensory disturbance on habitat quality for grizzly bear and tundra wolverine), to take advantage of existing data and analysis (i.e. that completed by Johnson et al. 2005). The SGP study area takes advantage of higher quality landscape classification data not presently available for the other study areas, and approximates the likely population boundaries of grizzly bear and tundra wolverine (Figure 15.4.2).

The Project footprint includes the location and geographic extent of the Project components. The location and extent of these components were determined by using the most recent engineering plans, where available; conservative estimates were used where no engineering plans were available. The transmission line right-of-way (ROW) was estimated to be 30 m wide, winter haul roads were estimated to be 15 m wide, temporary access trails were estimated to be 5 m wide, and each staging area was estimated at 5 ha. Where uncertainty existed in the geographic extent of the Project components, the maximum expected extent was used. For example, transmission line ROW clearing would likely range from 15 m to 30 m wide, and each staging area is expected to range between 2 and 5 ha.

Cumulative effects represent the sum of all natural and human-induced influences on the physical, biological, cultural, and economic properties of the socio-ecological system within a defined period of time and space. Where an effect to a VC was identified, overlapping effects from other developments and activities were also considered. Study areas for the assessment of cumulative effects were defined for each species using estimates of natal dispersal distances as buffer widths around the proposed Project footprint. Natal dispersal by immature animals is important for colonization and the maintenance of metapopulation connectivity (D'Eon et al. 2002). Natal dispersal distances are defined here as distances at which 90% of dispersing females successfully leave the natal range and establish a new home range. For passerines and waterfowl, allometric equations for juvenile dispersal distances were not used due to the very poor explanatory power of the models for herbivorous and omnivorous birds (adjusted r^2 of 0.02 for maximum dispersal distances; Sutherland et al. 2000). Instead, literature values for the estimated maximum natal dispersal distances for gray jay and Canada goose were used as surrogate distances for passerines and waterfowl, respectively.

The CESAs were also adjusted to account for the distribution of each species relative to the treeline. For example, as grizzly bear are a tundra species, the grizzly bear CESA was bound by the northern limit of the boreal forest. Wolverine are found north and south of the treeline. Research in the NWT suggests that two populations of wolverine exhibit genetic independence, suggesting that distinct populations exist (Wilson et al. 2000). Based on these conclusions, the tundra and boreal populations of wolverine are likely two separate populations. Therefore, separate CESAs were for each population were used in the assessment. For grizzly bear and wolverine (tundra and boreal) CESAs, Project components that were located on the opposite side of the treeline were not included in the assessment. Passerines, waterfowl and raptors are found in both boreal and tundra areas; therefore, the CESAs for these species included the entire Project footprint (boreal and tundra). The resulting CESAs are listed in Table 15.4.4 and illustrated in Figure 15.4.1.

Table 15.4.4 — Overview of Assessment Study Areas for the Selected Valued Components

Valued Component	Study Area	Extent of Study Area	Size of Study Area (ha)
Grizzly bear	RSA	Project footprint north of treeline plus 5 km buffer	424,520
	CESA	Project footprint north of treeline plus 158 km dispersal distance buffer	11,156,512
	SGP	Approximated by the Slave Geological Province	19,269,796
Tundra wolverine	RSA	Project footprint north of treeline plus 5 km buffer	424,520
	CESA	Project footprint north of treeline plus 176 km dispersal distance buffer	12,665,642

Valued Component	Study Area	Extent of Study Area	Size of Study Area (ha)
	SGP	Approximated by the Slave Geological Province	19,269,796
Boreal wolverine	RSA	Project footprint south of treeline plus 5 km buffer	578,923
	CESA	Project footprint south of treeline plus 176 km dispersal distance buffer	17,829,033
Passerine and Waterfowl	RSA	Entire Project footprint plus 5 km buffer	1,003,443 total 424,520 above treeline 578,923 below treeline
	CESA	Entire Project footprint plus 11 km dispersal distance buffer[a]	1,900,857 total 852,395 above treeline 1,048,462 below treeline
Raptors	RSA	Entire Project footprint plus 5 km buffer	1,003,443
	CESA	Entire Project footprint plus 167 km dispersal distance buffer[b]	28,552,573

RSA = Regional Study Area

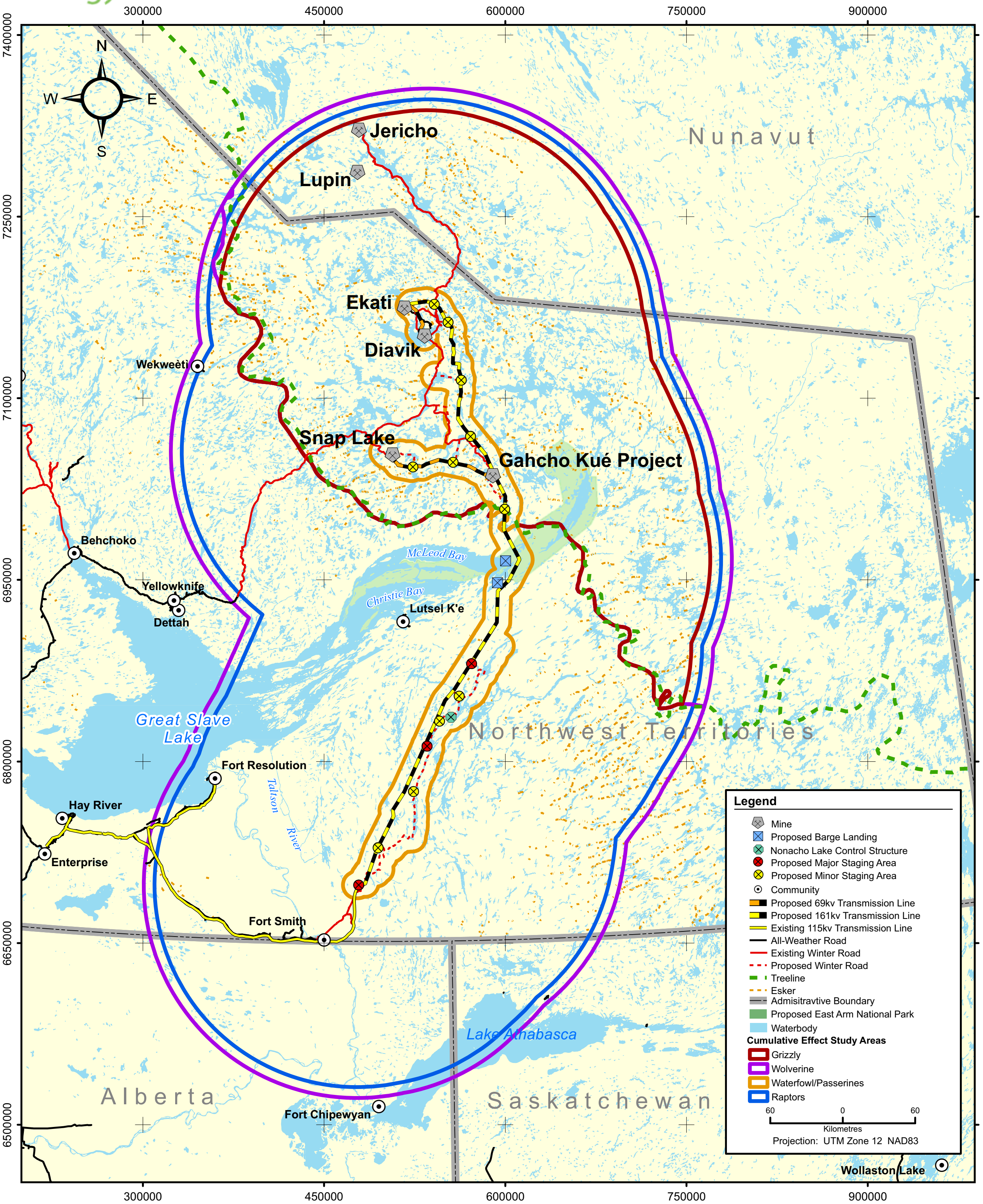
CESA = Cumulative Effects Study Area (see Figure 15.4.1)

SGP = Slave Geological Province Study Area (see Figure 15.4.2)

[a] Due to the weak predictive power of allometric equations for herbivorous/omnivorous birds, observations of maximum dispersal distances were taken from the literature. Dispersal distances for Canada goose represents waterfowl, and that of gray jay represents passerines.

[b] Natal dispersal distance of raptors is represented by that of the peregrine falcon, as predicted by the allometric equation and associated 'corrected' negative exponential functions of Sutherland et al. (2000).

With regard to temporal boundaries, the expected length of time that Project-related stressors would influence VCs during the construction phase is three years. Currently, the Project is expected to be in operation for 20 years to service the existing and proposed diamond mines. However, the infrastructure would have a lifespan of at least 40 years, and it is the intent of Dezé Energy Corporation (Dezé) to solicit new customers to extend the Project beyond 20 years. Subsequently, the expected length of time that Project-related stressors would influence VCs during the operation phase is assumed to be 40 years. Although Dezé intends to operate the Project longer than 40 years if customers can be found, increasing the duration of the Project's operation phase would increase the uncertainty in the effects predictions. For example, it is currently not known how much of the transmission line would be in operation after 40 years. Therefore, 40 years was defined as the longest reasonable duration of the operation phase for predicting and assessing effects from the Project.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Grizzly Bear, Wolverine, Raptors, Passerines and Waterfowl Cumulative Effects Study Areas	Figure 15.4.1

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TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Slave Geological Province Study Area**	**Figure 15.4.2**

Golder Associates Ltd./YK_136

15.4.5 Pathway Analysis

Pathway analysis identifies and screens the issues and linkages between Project components or activities and the potential effects on the selected VCs. A pathway analysis was completed to identify invalid, minor, and valid Project-related pathways.

The first part of the analysis provides a list of potential and relevant pathways, without considering if they can possibly occur. This step is followed by a summary of mitigation practices and mitigation design features that remove the pathway or limit the effects on the VC. Knowledge of the ecological system and mitigation are then applied to the pathways to determine which pathways are invalid, minor, or valid. Each potential pathway is evaluated to determine if it could lead to a change in the environment that could directly and indirectly affect the assessment endpoints defined for each VC.

15.4.5.1 MITIGATION

Mitigation refers to the practices taken to reduce or avoid environmental effects. Any effects remaining after mitigation are referred to as residual effects. Within this DAR, mitigation has been divided into two categories:

- Mitigation practices – refer to any activity, strategy, or practice (e.g. management plans, best management practices) used to reduce or avoid a negative effect.
- Mitigation design features – refer to designs that are incorporated into the Project to avoid or reduce a negative effect.

Mitigation practices and design features incorporated into the Project to remove or limit effects from Project pathways on the VCs are listed in Table 15.4.5.

Table 15.4.5 — Mitigation for Effects to Species at Risk and Key Bird Species

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Project footprint leading to disturbance of rare vascular plants Project footprint leading to habitat loss (changes in habitat quantity) and habitat fragmentation	Construction Operations	Wherever topography would allow, the line would span over lowland areas Selective clearing and retention of shrub vegetation at a height of up to 3 m in select areas (i.e. where terrain is too difficult for machinery to access within East Arm National Park) Adjustments to tower locations would be made during construction to avoid sensitive areas (e.g. wetlands and marshes with high soil contents) Routing and tower locations would be selected to have minimal site disturbances, such as locating poles on high elevation rock outcrops and spanning lowlands, locating the line in previously burned areas, and avoiding wetlands and riparian zones Clearing for camps and laydown areas would be limited to only those areas necessary to support the construction activities Substations would be placed within existing mine footprint boundaries Smaller crew camps would be located at existing causes to reduce infrastructure needs Helicopter construction methods should limit effects to vegetation between towers Access roads would only be used for three construction seasons (years) Use of proven best management practices for road construction The new winter road corridor would maximize the use of lake and wetland complexes Where portage clearing would be required, the corridor would be single lane width The following Environmental Management Plans would be implemented : - Vegetation Management Environmental Management Plan (EMP), - Human Wildlife Conflict Management

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Hazardous substance spills leading to degraded vegetation ecosystems Hazardous substance spills leading to negative changes to health or mortality of individual animals	Construction	Construction machinery and vehicles would be properly maintained so that harmful chemicals are not introduced into riparian sites and waterways during construction Refuelling of machinery and vehicles would be completed away from any watercourse Spill containment supplies would be available in designated areas where fuel and chemicals are stored Fuel storage tanks would be designed and constructed according to the American Petroleum Institute (API) 650 standard and placed within a lined and dyked containment area to contain any potential spills Aviation fuel for helicopters would be stored in sealed drums inside a lined berm area at the helipad All petroleum products would be stored in approved containers and in areas with secondary containment Separate areas would be established for the handling and temporary storage of hazardous wastes Spill Contingency EMP Waste Management EMP
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Sensory disturbance leading to changes in habitat quality	Construction Operations	Substations would be within existing mine footprint Blasting activities would only occur during the construction phase and do not involve substantial re-handling of material, which tends to decrease the fines content and thus the available particulate matter to become airborne Best management practices would be employed to limit equipment exhaust emissions (e.g. shutting off ignitions during extended periods of down-time) All employees would undergo environmental awareness training Winter access roads would be private roads, and access would be limited to vehicles involved in Project construction Winter access roads will not be maintained following construction Transmission line winter roads would be accessible only from the Twin Gorges to Nonacho Lake winter road Speed limits for the Project winter access roads would be established and enforced Human-Wildlife Conflict Management EMP would be implemented Electromagnetic noise from the transmission line would likely be inaudible Construction would mainly occur in winter, reducing dust and disturbance to migratory and hibernating species

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Dust deposition leading to loss of vegetation and changes to microsite conditions	Construction	Use of winter roads would reduce road dust Surface blasting would be limited to the Twin Gorges facilities, Nonacho Lake control structure, and where necessary on the winter roads
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landings Substations Transmission line	Destruction of migratory bird nests	Construction	Clearing of vegetation would take place outside of the migratory bird season (May 15 through July 31)
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landings Substations	Attraction to camps leading to problem wildlife and injury or mortality to individual animals	Construction	All food waste would be disposed of according to the Materials and Waste Management EMP Contractor would supply incinerators that meet or exceed the most current guidelines and standards Human-Wildlife Conflict Reduction EMP would be developed and followed All employees would undergo environmental awareness training

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities	Effects of changes in hydrology regime Effects of changes in hydrology regime changes to rare plants Changes in ice conditions (i.e. timing of freeze-up and break-up) leading to mortality or altered movement and behaviour	Operations	Project would be compliant with existing water licence Peak freshet flows would be lower, reducing effects to river banks and vegetation Power facility would have redundancies built-in to reduce the likelihood of interruption of flows to the Taltson River A by-pass spillway with 30 m^3/sec would be included to maintain flows in the Taltson River in event of a generation shut-down Plans for controlled and emergency shutdowns would be developed to reduce the effects of ramping (i.e. Large changes in flow volume over short periods of time) Materials from the canal and gateworks structure excavation would be used to raise the existing dam to decrease leakage through the structure Sufficient material would be placed in front of the sluice area such that the continued degradation of the timber structures in the existing structure would not affect the dam performance The spill of substantial volumes of excess water over the South Valley Spillway would likely no longer occur on a regular basis as the new regulating structure at Nonacho Lake would provide increased flow releases into the upper Taltson River, and the new generation plant would use more flow from the Forebay The Nonacho Lake control structure is required to balance the uncontrolled and unpredictable flow variation in the Tazin River system, such that water is effectively made available for power generation without excess spill or extended low flow periods at Twin Gorges There are no tundra wolverine or grizzly bear within the Taltson River watershed Continuation of annual inspections on the water conveyance and generation systems, and periodic dam safety reviews Reduced flows in Trudel Creek are anticipated to decrease bank erosion and downstream sediment deposition in the Taltson River The following EMPs would be developed and implemented: — Operational Water Management EMP — Spill Contingency EMP
Winter access roads Temporary access trails	Increased access and recreational activity leading to vegetation disturbance	Construction Operations	Winter roads would not be maintained following construction The winter road would be blocked at the end of each hauling season Slash would be placed across the lower portages to discourage use Access along the winter roads by other users for non-Project purposes (i.e. Aboriginal land uses) would be discussed with land users and agencies in consideration of traveler safety along the road and in and around the work sites

Project Component	Pathway	Pathway Duration	Mitigation
Winter access roads Temporary access trails	Ice bridges leading to changes in shoreline habitat	Construction	Cut trees may be placed on steep slopes to reduce erosion potential Adhere to the Erosion and Sediment Control EMP Disturbance to riparian zones would be avoided where practical Stream crossing locations would consider bank stability and erosion potential Clearing of vegetation would take place outside of the migratory bird season (May 15 through July 31) Proven best practices would be used for winter road construction The use of frozen lakes and rivers for the winter road would be maximized Recreational use of construction vehicles would not be permitted Environmental sensitivity training for all staff would include a unit on erosion and sediment control
Winter access roads Temporary access trails	Vehicle collisions leading to injury or mortality	Construction	Human-wildlife Conflict Management EMP will be implemented Establishing and enforcing speed limits Providing wildlife with the right-of-way
Winter access roads Temporary access trails	Improved access leading to increased harvesting	Construction	Winter roads would not be maintained following construction The winter road would be blocked at the end of each hauling season Slash would be placed across the lower portages to discourage use Southern sector winter roads will be salted and public use would not be permitted
Winter access roads Temporary access trails	Winter road leading to introduction of invasive plant species	Construction	Effects are anticipated to be negligible, and no mitigation is proposed
Transmission line	Transmission tower perching leading to altered predation rates for raptors	Operations	No mitigation is suggested
Transmission line	Collisions with the transmission line leading to mortality	Operations	Use of bird flight diverters would be investigated in areas of high waterfowl density Ground wires (wires of a smaller diameter than the conductor wires, used to protect the conductor wires from lightening strikes) would only be used within 2 km of the mines There would be no access corridors created next to the transmission line (disturbance of birds causes flushing and distraction, leading to more collisions)

Project Component	Pathway	Pathway Duration	Mitigation
Transmission line	Electrocution leading to bird mortality	Operations	Industry standards to reduce electrocutions would be incorporated in tower design The minimum span between the lines would be approximately 2.8 m eliminating the threat of electrocutions

15.4.5.2 PATHWAY VALIDATION

The pathways presented in Table 15.4.5 and Table 15.4.6 were identified through reviewing concerns raised during the following:

- public information sessions in Fort Smith, Fort Resolution, and Hay River in March, 2004 (Rescan 2004);
- feedback received from the Aboriginal organizations, as well as territorial and federal government departments, during the land use permit application to the Mackenzie Valley Land and Water Board (MVLWB 2007); and
- public hearings hosted by the MVEIRB, and the MVEIRB TOR (MVEIRB 2008a).

Potential pathways leading to effects on the VCs include direct and indirect effects on individuals and their habitat (Table 15.4.6). These changes may ultimately affect the population size and distribution of the VCs. In the pathway validation, each potential pathway was screened to assess its validity for the Project, after mitigation practices and mitigation design features have been incorporated.

Each potential pathway is evaluated and characterized as follows:

- invalid – pathway does not exist, is removed by mitigation, or mitigation results in no detectable (measurable) change and residual effect relative to baseline or guideline values.
- minor – mitigation results in a minor change from the pathway, but has a negligible residual effect (e.g. the loss of a small amount of wildlife habitat, or a short-duration stressor such as blasting noise); or
- valid – a pathway that likely contributes to residual effects to a VC.

Pathway validity is determined using scientific knowledge, logic, and experience with similar developments. Invalid and minor pathways were not carried forward into the effects assessment. Valid pathways require a more detailed analysis to assess effects.

Table 15.4.6 — Pathways to Species at Risk and Key Bird Species

Project Component	Pathway	Pathway Duration	Valued Component	Pathway Validation
Winter access roads Temporary access trails	Increased access and recreational activity leading vegetation disturbance	Construction Operations	Rare vascular plants	Invalid
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Chemical spills leading to negative changes to health or mortality of individual animals	Construction Operations	Grizzly bear Wolverine Passerine Waterfowl Raptors	Invalid

Project Component	Pathway	Pathway Duration	Valued Component	Pathway Validation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landings Substations Transmission line	Destruction of migratory bird nests	Construction	Passerine Waterfowl Raptor	Invalid
Winter access roads Temporary access trails	Vehicle collisions leading to injury or mortality	Construction	Grizzly bear Wolverine	Invalid for grizzly bear Minor for wolverine
Winter access roads Temporary access trails	Changes in access leading to increased harvesting	Construction	Grizzly bear Wolverine Waterfowl	Invalid for grizzly bear Invalid for waterfowl Minor for wolverine
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities	Changes in ice conditions leading to mortality or altered movement and behaviour	Operations	Grizzly bear Wolverine	Invalid for grizzly bear Invalid for wolverine
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Hazardous substance spills leading to degraded vegetation ecosystems	Construction Operations	Rare vascular plants	Minor
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Dust deposition leading to loss of vegetation and changes to microsite conditions	Construction	Rare vascular plants	Minor
Winter access roads Temporary access trails	Winter road leading to introduction of invasive plant species	Construction	Rare vascular plants	Minor

Project Component	Pathway	Pathway Duration	Valued Component	Pathway Validation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landings Substations	Attraction to camps leading to problem wildlife and injury or mortality to individual animals	Construction	Grizzly bear Wolverine	Minor
Transmission line	Transmission tower perching leading to altered predation rates for raptors Electrocution leading to bird mortality	Operations	Passerine Waterfowl Raptor	Minor
Winter access roads Temporary access trails	Ice bridges leading to changes in shoreline habitat	Construction	Passerine Waterfowl Raptor	Minor
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Project footprint leading to vegetation loss	Construction Operations	Rare vascular plants	Valid
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Project footprint leading to habitat loss and fragmentation	Construction Operations	Grizzly bear Wolverine Passerines Waterfowl Raptors	Minor for waterfowl Minor for raptors Valid for passerine Valid for grizzly bear Valid for wolverine
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Staging areas Barge landing Substations Winter access roads Temporary access trails Transmission line	Sensory disturbance leading to changes in habitat quality	Construction Operations	Grizzly bear Wolverine Passerines Waterfowl Raptors	Valid

Project Component	Pathway	Pathway Duration	Valued Component	Pathway Validation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities	Effects from changes in hydrology regime	Operations	Passerines Waterfowl Raptors Rare vascular plants	Minor for passerines, raptors and rare plants Valid for waterfowl
Transmission line	Collisions with the transmission line leading to mortality	Operations	Passerine Waterfowl Raptor	Minor for passerines Minor for raptors Valid for waterfowl

15.4.5.2.1 Invalid Pathways

Pathways are invalid if the activity does not occur, the pathway does not lead to a VC, or there is no detectable effect. Invalid pathways are not assessed in the effects analysis. Pathways presented below were determined to be invalid for linking Project-related activities to effects to the VCs.

15.4.5.2.1.1 Increased Access and Recreational Activity Leading to Disturbance of Rare Vascular Plants

The use of winter roads would be limited to a two- to three-month period, and for a three-year construction period, after which time the roads are not expected to be maintained. Mitigation practices and design features have also been incorporated to reduce potential access. This includes restricting access to winter roads to Project vehicles during construction, blockading the entrance to winter roads at the end of each hauling season, and placing slash across the lower portions of the winter road when construction is completed. Recreational use of vehicles by Project staff would not be permitted. There may be a low level of recreational activity within the RSA by the general public through unauthorized use of the winter roads. However, any recreational activity is expected to be restricted to the winter, when disturbance to vegetation is less severe.

As human recreational activity in the RSA would be controlled, and any recreational activity which does occur likely would be restricted to the winter, the disturbance of rare plant communities should not be detectable relative to baseline conditions. Therefore, this pathway was determined to be invalid for rare vascular plants.

15.4.5.2.1.2 Hazardous Substance Spills Leading to Negative Changes to Health or Mortality of Individual Animals

Hazardous substance spills have not been reported as the cause of wildlife mortality at the Ekati Diamond Mine, Diavik Diamond Mine, Jericho Diamond Mine, or the Snap Lake Mine (BHPB 2007; Tahera 2007; DDMI 2008; De Beers 2008). Chemical spills are usually localized, and are quickly reported and managed. Mitigation practices identified in the Spill Contingency Plan and mitigation design features would be in place to prevent and limit the frequency and extent of chemical spills within the Project footprint, including along winter access roads (Table 15.4.5). The following mitigation practices and mitigation design features would be used to reduce the risk from hazardous substance spills:

- construction machinery and vehicles would be properly maintained so that harmful chemicals are not introduced into riparian areas and waterways during construction and maintenance;
- refuelling of machinery and vehicles would be performed away from any watercourse;
- spill containment supplies would be available in designated areas where fuel and chemicals are stored;
- fuel storage tanks would be designed and constructed according to the American Petroleum Institute (API) 650 standard and placed within a lined and dyked containment area to contain any potential fuel spills;
- aviation fuel for helicopters would be stored in sealed drums inside a lined berm area at the helipad;
- all petroleum products would be stored in approved containers and in areas with secondary containment;
- separate areas would be established for the handling and temporary storage of hazardous wastes;
- access to the Southern Sector winter roads would not be permitted for non-Project vehicles;
- the Preliminary Spill Contingency and Response Plan would be implemented and followed; and
- the Materials and Waste Management Plan would be implemented and followed.

The implementation of the Preliminary Spill Contingency and Response Plan and mitigation design features are anticipated to result in no detectable effect on wildlife health and mortality from spills throughout all phases of the Project. Therefore, this pathway was determined to be invalid for grizzly bear and wolverine.

15.4.5.2.1.3 Destruction of Migratory Bird Nests

Section 6(a) of the *Migratory Birds Regulations* states that migratory bird nests and eggs shall not be disturbed or destroyed. Environment Canada (2007c) states that the migratory bird nesting season extends from approximately May 15 to July 31 for NWT and Nunavut. Areas where vegetation disturbance is expected include the Twin Gorges to Nonacho Lake winter road, temporary access trails, staging areas, barge landing points, and the transmission line ROW and tower footings. All vegetation clearing would take place outside of the migratory bird nesting season, resulting in no temporal overlap with construction activities. Therefore, this pathway was determined to be invalid for passerines, waterfowl, and raptors.

15.4.5.2.1.4 Vehicle Collisions Leading to Injury or Mortality of Grizzly Bear

During the three-year construction period, spurs would be constructed from the Tibbitt to Contwoyto winter road in the Northern Sector, which is within the range of grizzly bear. The Tibbitt to Contwoyto winter road is active from January to early April (T-C Joint Venture 2008). However, grizzly bears are inactive during the winter, when they den and enter a dormant state, approximately from October to April (ENR 2008). As such, there is little or no temporal overlap between grizzly bears and winter roads within the Project footprint. Therefore, this pathway was determined to be invalid for grizzly bears.

15.4.5.2.1.5 Improved Access Leading to Increased Harvesting of Grizzly Bear and Waterfowl

Hunting of grizzly bears is not permitted within the RSA (ENR 2008). Typically, grizzly bear may only be killed to defend life and property. In addition, grizzly bears are inactive during the winter, when they den and enter a dormant state, approximately from October to April (ENR 2008), while the Tibbitt to Contwoyto winter road is active from January to early April (T-C Joint Venture 2008). As there is little or no temporal overlap between grizzly bears and winter roads, access to the SGP provided by the Project spur roads from the Tibbitt to Contwoyto winter road is not expected to result in increased harvesting of grizzly bears. Therefore, this pathway was determined to be invalid for grizzly bear.

Waterfowl are not present during the months of January to April when winter roads are expected to be active in the RSA during this time. Therefore, this pathway was determined to be invalid for waterfowl.

15.4.5.2.1.6 Change in Ice Conditions Leading to Mortality or Altered Movement and Behaviour of Grizzly Bear and Wolverine (boreal and tundra)

The Project is expected to cause minor changes to the ice conditions (specifically to freeze-up and break-up) of the Taltson River. There are no grizzly bears or tundra wolverine within the Taltson watershed. Therefore, this pathway was determined to be invalid for grizzly bears and tundra wolverine.

Because the majority of water that flows into Nonacho Lake is released downstream to Taltson Lake, the Taltson River would experience reduced summer flows and increased winter flows, which is required to generate a consistent power supply for the projected customers. In addition, changes in the flow regimes from the Project, especially for Trudel Creek, may contribute to the development of winter icing conditions. Hydrological modelling results indicate that changes in operations of the Nonacho Lake reservoir and Twin Gorges facilities would decrease the seasonal variation of the predicted flows downstream of the hydropower facility compared to baseline conditions. Although the average monthly water levels from January through May are higher than baseline conditions (as water within the reservoir is released during the low flow period) changes in the timing of freezing and break-up cycles are anticipated to be negligible. Therefore, the frequency of injury or mortality, as well as altered movement and behaviour from changes in the freezing and break-up, are anticipated to be within the range of natural variation. Consequently, any changes to freezing and break-up is not anticipated to affect boreal wolverine. Therefore, this pathway was determined to be invalid for boreal wolverine.

15.4.5.2.2 Minor Pathways

In some cases, both a source and a pathway exist, but the change caused by the Project is anticipated to be minor. Minor pathways are not assessed in the effects analysis. Pathways presented below were determined to be minor.

15.4.5.2.2.1 *Collisions with the Transmission Line Leading to Mortality of Passerines and Raptors*

Mid-air collisions with transmission lines and towers by birds may cause injury or mortality. The frequency of these strikes is difficult to monitor because it happens quickly and carcasses are often rapidly removed by scavengers (Prince et al., 1986; Bevanger, 1995). Although it does occur, transmission line strikes have not been identified as a major cause of mortality for most species of raptors or passerines (APLIC 1994). Species generally affected by transmission strikes include hawks, owls, waterfowl, cranes, herons, and grouse (Malcom, 1982; Brown and Drewien, 1995; Lehman et al., 2007). Janss (2000) classified avian mortality by morphology, and found that weight, wing length, total length, and tail length could be used to accurately predict species with a high risk of collision. Birds with a high wing loading (i.e. poor manoeuvrability), heavy weights, and short wings and tails were more frequently victims of collision. Behavioural differences between species likely plays a role, with species that flock, fly frequently, and fly at low altitudes being more susceptible to transmission line collision (Janss, 2000; APLIC, 1994).

Olendorff and Lehman (1986; cited in Harron, 2003) found that only 26 raptor collisions with transmission lines had been reported in 21 years. Olendorff (1986; cited in Harron, 2003) described raptor collisions with transmission lines as a low-level and inconsequential mortality factor of raptor populations. Lee (1978) observed that most collisions with transmission lines at a wetland near Portland Oregon involved waterfowl species, while Hobbs and Ledger (1986) found susceptibility of waterfowl to collisions with conductors and ground wires. The available information suggests waterfowl are the most susceptible of the three bird VCs to transmission line collisions, and few concerns are raised regarding the effects to passerines and raptors. Therefore, this pathway was determined to be valid for waterfowl (see Section 15.4.6.4), but was determined to be minor for passerines and raptors.

15.4.5.2.2.2 *Improved Access Leading to Increased Harvesting for Wolverine*

Of the VCs assessed in this chapter, wolverine are the only species harvested in winter, when Project winter roads may lead to improved access. In determining the degree of disturbance that occurs in the vicinity of the travel corridor, ecosystem and land cover changes are often not the most important factor (Jalkotzy et al. 1997). Human activities, particularly harvesting, often can be the primary source of disturbance for wildlife (Jalkotzy et al. 1997). The Twin Gorges to Nonacho Lake winter road would be constructed and operational during the winter between 2009 and 2011. The old winter road alignment from Fort Smith to Twin Gorges would be refurbished and brought back into operation during this same time. Currently, there does not exist an easily accessible snowmobile route from Fort Smith to Nonacho Lake, but this may change following the construction of the Twin Gorges to Nonacho Lake road. However, to mitigate environmental effects, the Fort Smith to Twin Gorges and the Twin Gorges to Nonacho Lake winter roads would be blocked at the end of each hauling season and would not be maintained following the construction phase of the Project. Further, public access to these roads would not be permitted. Gates would be installed across the entrance to each road and should limit access to public vehicles during and following the hauling season. However, snowmobile access may still be possible. At the end of construction, slash would be placed across the lower portages to discourage use by vehicles and snowmobiles.

Although no data are available regarding wolverine densities, it is likely that wolverine densities are higher within the Taiga Plains Ecozone (in which Fort Smith is located) than the Taiga Shield Ecozone (which would be made more accessible with the proposed winter roads). This is due to the higher productivity and vegetation cover in the Taiga Plains Ecozone. Therefore, there may be little benefit to using the proposed winter roads for harvesting wolverine. The number of wolverine harvested due to Project winter roads from Fort Smith is expected to result in a negligible change to the persistence of wolverine populations. Therefore, this pathway was determined to be minor for boreal and tundra wolverine.

15.4.5.2.2.3 Project Footprint Leading to Habitat Loss and Fragmentation for Waterfowl and Raptors

Habitat loss due to the Project footprint may affect the quantity of habitat available to VCs. Waterfowl depend upon lakes and wetlands for forage and predator avoidance, while upland habitat is used for nesting and foraging. For geese, nest site selection is correlated with upland and wetland sites as these areas provide elevation (allowing earlier nest initiation) and vegetation for forage (Williams and Marshall 1937). The availability of specific habitat attributes, including grazing areas for adults and broods, partly determines habitat selection in Canada geese (Williams and Sooter 1940; Williams and Nelson 1943). Both ground nesting and cavity nesting ducks use terrestrial habitat for breeding (Bellrose 1976; Bellrose 1979). As clearing of vegetation would take place outside of the migratory bird season (May 15 through July 31), effects to waterfowl nesting are anticipated to be negligible. Using estimates of waterfowl densities, and the Project footprint, effects to waterfowl from habitat loss due to the Project footprint were estimated.

Two aerial surveys for waterfowl were completed in June 2008 to capture early and late arriving waterfowl in the transmission line boreal regions (see Section 9.5.3 Birds and Bird Habitat for details on methods). Waterfowl densities within 1 km of the Project were estimated at 0.033 birds/ha, irrespective of land cover. These results are similar to the 0.035 birds/ha for the Taiga Shield in 2008 reported by the USFWS (2008). Based on these densities and an estimated Project footprint below the treeline of 1,522 ha, an estimated 50 to 60 waterfowl may be within the Project footprint south of the treeline (assuming a transmission line ROW of 30 m). It was anticipated that most of the waterfowl habitat would remain available, as the Project footprint is not anticipated to cause direct effects to water. For example, 44% of the Project footprint over water would be winter roads on ice, and 54% would be due to transmission lines over water. The presence of transmission lines over water are not anticipated to cause habitat loss for waterfowl. Much greater concern has been expressed with the issue of waterfowl collisions with transmission lines (i.e. APLIC 2006), suggesting that waterfowl use habitat near transmission lines.

Waterfowl densities are lower on the tundra than in the boreal forest, and the effect to waterfowl is anticipated to be less in the tundra environment. Waterfowl densities above the treeline were obtained from data collected at the Jericho Diamond Mine in Nunavut, which estimated a maximum waterfowl density of 0.008/ha (the highest density observed during four surveys over two years, Golder 2008c). Baseline water bird surveys completed at Diavik calculated a density of 0.58 birds per kilometre of shoreline (Penner & Associates 1998), while baseline surveys of lakes surrounding the Snap Lake Mine during June recorded an average density of 2.2 and 2.4 individuals per kilometre of shoreline (N=18 lakes) in 1999 and 2000, respectively (De Beers 2002). As there would be less land cover disturbance due to the Project above the treeline (area is 1,201 ha, and vegetation does not need to be cleared for the ROW or winter roads), waterfowl disturbance and displacement is anticipated to be substantially lower than in the boreal regions.

Whooping crane densities for the RSA were not available, but are anticipated to be very low, as only seven were observed during baseline studies in 2008. Whooping cranes have been confirmed at the Taltson River (two groups observed, totalling seven individuals in June 2008). The loss of habitat to whooping crane is anticipated to be negligible, because critical habitat defined for whooping crane is not found in the Taiga Shield Ecozone, but limited to areas in and near Wood Buffalo National Park (Olson and Olson 2003).

Effects to waterfowl and whooping crane from habitat loss were considered to be of negligible effect, and local in geographic extent. Therefore, the pathway was considered to be minor.

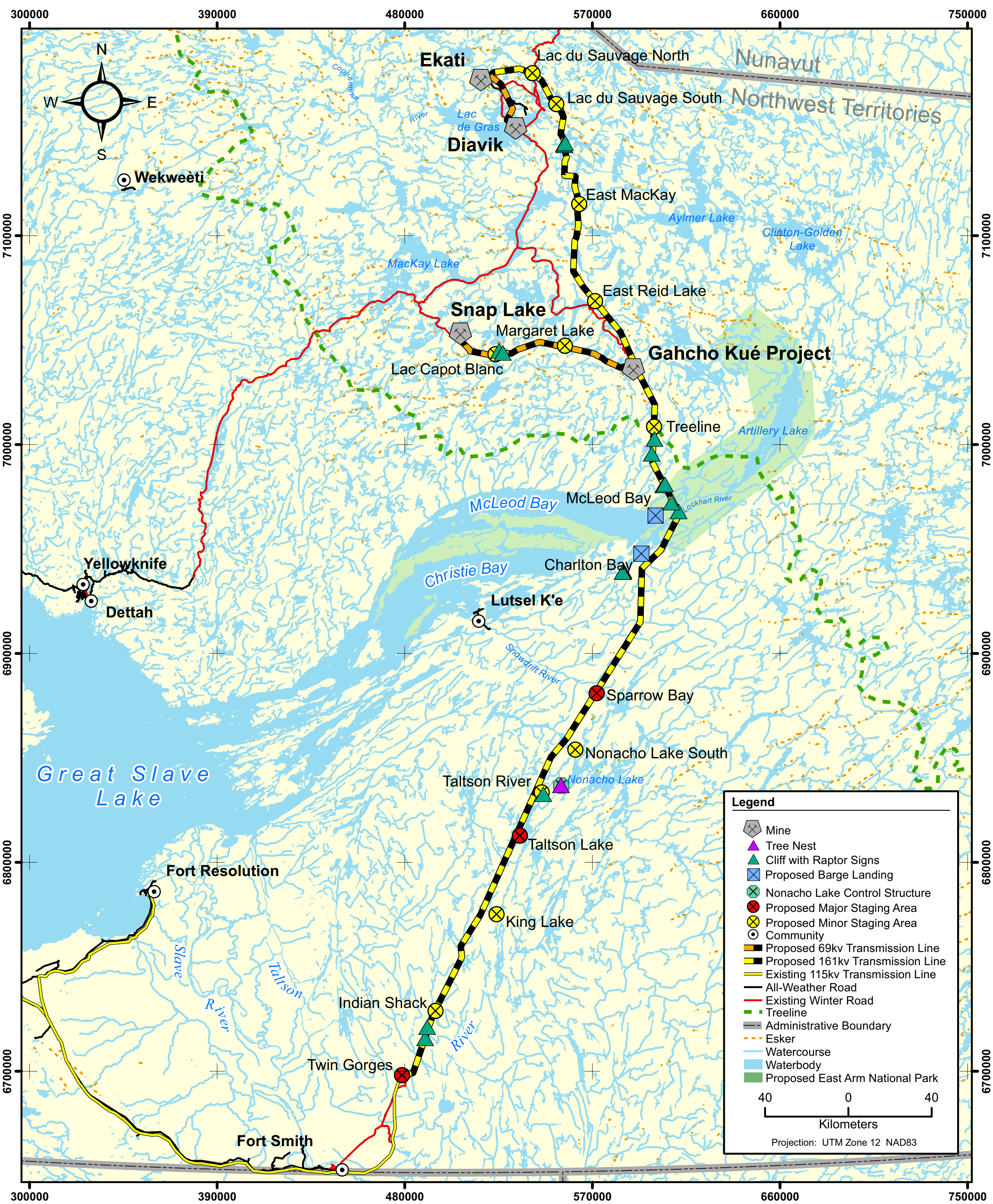
ENR has recommended that effects to nest sites of either peregrine falcon or short-eared owl identified within 1.5 km of activity between April 15 and September 15 may require mitigation (ENR 2008). During baseline studies, a total of 50 cliffs within approximately 1.5 km of the transmission line route were investigated. Of these, 15 had signs of historic nesting such as whitewash or stick nests (see Section 9.5.3 Birds and Bird Habitat). These historic nests were found to be largely concentrated in specific areas, such as within the proposed East Arm National Park, southeast of Snap Lake, and near the Indian Shack staging area (Figure 15.4.3). One tree nest was also observed, near the Nonacho Lake Control Structure. Raptors were not observed at any of the nest sites found, although the timing of the survey (August) was not optimal to detect raptor activity.

To avoid any disturbance of nesting raptors, the Environmental Monitors would identify areas where construction activity may pass within 1.5 km of a known nest site of any raptor species during the nesting season. Surveys would be completed to ascertain which nests are occupied. If a known nest is found to be occupied, or a new nest is found, construction managers would be requested to identify strategies to avoid the nest. ENR would be contacted for further advice if avoidance of the 1.5 km buffer around an active nest during the construction season is not easily achievable.

Considering the small number of raptor nests within 1.5 km of the ROW, the low nest densities within the ROW, and the large home range size of raptors, direct habitat loss from the Project is anticipated to be negligible. Also, as discussed in Section 15.4.5.2.2.8, presence of towers along the transmission line ROW may benefit raptor populations. Therefore, the pathway was considered minor for raptors.

In addition to direct loss of habitat, the Project may also result in fragmentation of the existing landscape, potentially changing quality of habitats. Habitat fragmentation is the progressive subdivision of habitat blocks into fragments. Although fragmentation always accompanies habitat loss, it is a different phenomenon (McGarigal and Cushman 2002). Habitat fragmentation effects are of lesser a magnitude than direct habitat loss (Andrén 1999, Fahrig 1997, 2003). Only 11% of the existing land cover within the RSA consists of closed forest. The abundance of open and sparse forest and tundra environments in the RSA indicates that clearing for the transmission line ROW would have a negligible effect on habitat due to fragmentation. Therefore, the habitat fragmentation pathway was considered minor for passerine, waterfowl and raptors.

Effects to passerines from changes to habitat quantity and fragmentation are considered to be valid and are assessed in Section 15.4.8.1.



TALTSON HYDROELECTRIC EXPANSION PROJECT	Developer's Assessment Report 2009	Raptor Nest Observations, 2006 and 2008	Figure 15.4.3

15.4.5.2.2.4 *Chemical Spills Leading to Degraded Vegetation Ecosystems Affecting Rare Vascular Plants*

Chemical spills are usually localized, and are quickly reported and managed. It is anticipated that chemical spills may occur during Project construction but are likely to be minimal during Project operations. Mitigation practices identified in the Preliminary Spill Contingency and Response Plan (Chapter 7) would be in place to limit the frequency and extent of chemical spills that result from any Project activities. The following are examples of mitigation design features and practices that would be used to reduce the risk from chemical spills:

- all hazardous and toxic materials would be transported, stored, used and disposed of according to the Materials and Waste Management Plan;
- relevant guidelines and laws (e.g. *Transportation of Dangerous Goods Act*) would be adhered to;
- spill containment supplies would be provided in designated areas;
- a trained spill response team consisting of on-site personnel would be present at all times; and
- spills would be immediately isolated and cleaned up.

The implementation of the Preliminary Spill Contingency and Response Plan (Chapter 7) and proposed mitigation practices are anticipated to result in a negligible effect on vegetation from spills throughout all phases of the Project. Further, environmental monitors would be present during the construction phase to monitor and manage spills. Therefore, this pathway was determined to be minor for vascular plants.

15.4.5.2.2.5 *Dust Deposition Leading to Loss of Vegetation and Changes to Microsite Conditions Affecting Rare Vascular Plants*

During the construction phase of the Project, there is potential for dust deposition from blasting activities, equipment operation, aircraft, and vehicles. Accumulation of fugitive dust (i.e. total suspended particulate [TSP] deposition) produced from the Project may result in a direct loss of vegetation within the RSA.

Blasting activities are expected to occur during construction at the Twin Gorges facilities, the Nonacho Lake control structure, and at the southern end of the winter road. In-stream blasting may occur at the South Valley Spillway. Minor surface blasting may be required on the Twin Gorges to Nonacho Lake winter road to level exposed rock, but the preference would be to divert the winter road around such obstructions. All blasting is expected to be completed within 17 months, between 2010 and 2011. The total area affected by blasting at the facilities is expected to be within the Project footprint, plus a 500 m buffer. The most deleterious effects of blasting dust are generally confined to the immediate area adjacent to the dust source, such as roads (Everett 1980; Walker and Everett 1987). Auerbach et al. (1997) stated that although the species composition may change, and the aboveground biomass is lowered, due to dust deposition, the ground cover is still maintained.

All hauling would be done in winter, with the exception of the existing all-season road between the Twin Gorges facilities and airstrip, which covers a distance of approximately 5 km. In general, dust emissions from the winter access road are minimal, and if extended over the whole year, should result in a negligible effect on annual depositions. Other sources of dust include staging areas, where limited summer activities may occur during the construction phase (up to three years).

Direct effects from dust deposition from construction activities and the winter access road are predicted to be largely confined to within the Project footprint, with a negligible effect on adjacent habitat. Therefore, this pathway was determined to be minor for rare vascular plants.

15.4.5.2.2.6 Winter Road Leading to Introduction of Invasive Plant Species Affecting Rare Vascular Plants

The potential introduction of invasive plant species (i.e. plant species whose often rapid establishment and spreading can adversely affect ecosystems, habitats and other plant species [Haber 1997]) is often associated with developments. The successful establishment of invasive plants into an area depends on the availability of suitable habitat, means of access, and a dispersal mechanism.

The ground disturbance associated with construction activities can create the type of habitat favoured by invasive plant species. The Twin Gorges Facilities represents the largest single area of plant disturbance. Transportation corridors to and from construction areas provide a means of access, as well as additional habitat in the form of disturbed road edges. Vehicles and machinery can serve as dispersal mechanisms for seeds that can get lodged in tires, the undercarriage, or surface of the vehicle.

Invasive plant seeds could be brought into the area from dirty vehicles and machinery operating on the winter road and on the transmission line. The potential to introduce invasive plants is low to negligible due to the exclusive use of these roads during the winter. If any invasive plant seeds are introduced to the area, the harsh local environment is expected to prevent establishment (Cooper et al. 2004). Once construction is complete, vehicular and air traffic would be minimal as roads would be closed and the number of people requiring access during operations is limited. Therefore, this pathway was determined to be minor for rare vascular plants.

15.4.5.2.2.7 Attraction to Camps Leading to Problem Wildlife and Injury or Mortality to Individual Grizzly Bear and Wolverine

Waste food from the Project camps may act as an attractant to wildlife. Wildlife in camps present a hazard to both camp staff and to wildlife. Wildlife that have found food in camps then become problem wildlife as they associate camps with food. This is particularly problematic for grizzly bears and wolverines as individuals often end up being destroyed.

Strategies to manage attractants at the camps are outlined in the Materials and Waste Management Plan. The following mitigation design features and practices have been established to limit the numbers of grizzly bears and wolverine attracted to the Project:

- education and reinforcement of proper waste management practices provided to all workers and visitors to the site,
- food waste and non-food waste would be separated at source,
- the Human-Wildlife Conflict Management Plan would be adhered to,

- construction phase environmental monitors would inspect all camps and manage wildlife issues as they arise,
- food waste and non-toxic combustible waste would be burned in oil-fired incinerators daily,
- educating people on the risks associated with feeding wildlife and careless disposal of food garbage, and
- ongoing monitoring of the efficiency of the waste management program would be conducted by the environmental monitors, and improved as required through adaptive management.

The Ekati Diamond Mine, Diavik Diamond Mine, and Snap Lake Mine have reported attractants in the landfill despite waste management. This suggests that attractants may still be available within the Project footprint despite the proposed mitigation. However, the implementation of mitigation practices and design features are expected to limit the numbers of grizzly bear and wolverine attracted to the Project footprint. As well, construction of the Project would be limited to three years and all new camps would be removed after that time.

Table 15.4.7 summarizes incidents for grizzly bear and wolverine that have occurred at the Diavik Diamond Mine, Ekati Diamond Mine, and Snap Lake Mine since 1996 (BHPB 2001, 2002, 2004, 2007, DDMI 1998, 2004, 2007, and De Beers 2006, 2007, 2008). Incidents include all occasions when there was an interaction between the mine and the carnivore, and some action was required (e.g. deterrent, re-location, or report of damage). An incident does not include mortality. The cause of wildlife mortality is clear for cases where problem wildlife are deliberately destroyed. However, in other cases, such as when an animal is found dead within the mine property with no physical injury, the cause of death (natural or mine-related) may not be known.

Table 15.4.7 — Wolverine and Grizzly Bear Incidents at Ekati, Diavik, and Snap Lake: 1996 to 2007

Mine	Year	Phase	Species	Incidents[1]	Destroyed[2]	Found dead[3]
Diavik	1996 to 1999	Exploration	Wolverine	1	1	—
	2000	Construction	—	—	—	—
	2001	Construction	Grizzly bear	3	—	—
	2001	Construction	Wolverine	2	—	1
	2002	Construction	—	—	—	—
	2003	Production	Grizzly bear	1	—	—
	2004	Production	Grizzly bear	20	1	—
	2005	Production	Grizzly bear	43	—	—
	2005	Production	Wolverine	5	—	—
	2006	Production	Grizzly bear	21	—	—
	2006	Production	Wolverine	2	—	—

Mine	Year	Phase	Species	Incidents[1]	Destroyed[2]	Found dead[3]
	2007	Production	Grizzly bear	20	—	—
	2007	Production	Wolverine	1	—	—
Ekati	1998 to 2001	Construction Production	Wolverine	3	2	—
	2000	Production	Grizzly bear	—	1	—
	2001	Production	Wolverine	7	2	—
	2003	Production	Grizzly bear	5	—	—
	2004	Production	Grizzly bear	3	—	—
	2004	Production	Wolverine	3	—	—
	2005	Production	Grizzly bear	18	2	—
	2005	Production	Wolverine	23	1	1
	2006	Production	Grizzly bear	15	—	—
Snap Lake	1999 to 2003	Exploration	No incidents	—	—	—
	2005	Construction	Grizzly bear	1	—	—
	2006	Construction	Wolverine	2	—	—

Notes: - = not applicable.

[1] Each occasion where animals are deterred, relocated, or a damage report was filed. General observations and mortalities are not included. The number of different individuals involved may not be unknown.

[2] Animal intentionally destroyed by mine or government personnel.

[3] Animal found dead, mortality can not be linked to mine activities.

When grizzly bear kill rates from all of the mines in the SGP are considered, a kill rate of 0.18 grizzly bears per mine per year can be expected. In comparison, an annual harvest rate of approximately 10 grizzly bears per year due to humans (e.g. sport, commercial and subsistence) occurs within Nunavut. There have been seven wolverine mortalities due to mining activities in the SGP since 1998, and two wolverine were found dead of unknown causes (one at Diavik Diamond Mine and one at Ekati Diamond Mine). To date, there has been one wolverine mortality for every 2.4 years of mining (or mine construction), assuming that all nine mortalities were mine-related.

The Project is expected to result in a negligible change to the persistence of grizzly bear and wolverine populations for the following reasons:

- rates of grizzly bear and wolverine mortalities at the existing diamond mines have been low;
- no new camps are required north of the treeline in the RSA of grizzly bear and tundra wolverine (existing mine facilities would be used); and
- camps required south of the treeline in the boreal wolverine RSA would be seasonal, temporary, and much smaller than diamond mine camps.

Therefore, this pathway was determined to be minor for grizzly bear and wolverine (boreal and tundra).

15.4.5.2.2.8 *Transmission Tower Perching Leading to Altered Predation Rates for Raptors*

The transmission line ROW may improve hunting success rates for raptors, which can benefit from the perching structures offered by the transmission towers and lines. These structures provide and enhance foraging opportunity by affording views of the immediate hunting habitat (LGL Limited 2005). The use of transmission towers and lines for hunting perches and nest sites has been documented (see review in Jalkotzy et al. 1997), but does not always lead to improved hunting success (Smith 1985; LGL Limited 2005; Lihu et al. 2007).

Studies have found that not all raptor species would use perches when available (Widen 1994; Wolff et al. 1988; Sheffield et al. 2000). In two related studies, Wolff et al. (1999) and Sheffield et al. (2001) documented the use of perching structures by northern harriers and American kestrels. The results indicated that American kestrels used artificial perches to aid foraging while northern harriers did not. Neither study was able to detect any change in prey populations (i.e. voles) as a result of the perches and more frequent visitation by American kestrels, despite the 11-fold increase in visitation reported by Wolff et al. (1998). Some minor effects were detected, such as changes to juvenile recruitment, and in male home range size and activity levels. Both studies found that vegetation characteristics beneath the perch influenced visitation by raptors and vole populations. Amar et al. (2008) found that high densities of harriers may reduce the abundance of key prey species, potentially leading to lower harrier breeding densities in subsequent years.

Any incremental decrease in prey species as a result of increased hunting success should be weighed against the corresponding increase in raptor numbers. There have been active recovery efforts for peregrine falcon, including approximately 1,500 anatum peregrine falcons bred in captivity and released in Canada to support wild populations (COSEWIC 2007). Therefore, an increase in raptor populations is a desirable endpoint. The overall effect of the transmission tower on raptors may benefit raptor populations. Ultimately, raptor populations would be driven by fluctuations in prey abundance. Local extirpation of songbirds resulting from increased raptor hunting near the transmission line towers is unlikely given the mobility of songbirds. Therefore, this pathway was determined to be minor for raptors.

15.4.5.2.2.9 *Electrocution Leading to Bird Mortality*

Thousands of raptors are killed annually by electrocution on transmission towers, and this topic has been extensively studied and reviewed (see review in Lehman et al. 2007). Birds are most commonly electrocuted when they come in contact with two adjacent conductors (i.e. phase-to-phase electrocution). The Avian Powerline Interaction Committee (APLIC 2006) provides a summary of issues and solutions to avoid electrocutions. In general, electrocutions can occur on structures with the following (APLIC 2006):

- phase conductors separated by less than the wrist-to-wrist, head-to-foot, or flesh-to-flesh distance of a bird; or

- distance between grounded hardware (e.g. grounded wires and metal towers) and any energized phase conductor that is less than the flesh-to-flesh distance of a bird.

Because bird feathers do not conduct electricity well, contact must be made with fleshy parts, such as the skin, feet or bill. A 1.5 m spacing is sufficient to accommodate a bald eagle (APLIC 2006).

Electrocutions are usually associated with municipal distribution lines, which have complicated wiring and shorter distances between phases, rather than transmission lines (Harron, 2003). Industry standards for transmission line construction have been developed (APLIC 2006), and would be considered in the tower design. Although avian-safe construction reduces electrocution risk, electrocutions can never be completely eliminated. Because wet feathers may conduct electricity, larger birds may be electrocuted when their wings span conductors or grounded hardware.

The transmission towers would either be pole or lattice, the latter concept being very similar to the towers currently in use between Fort Smith and Pine Point. The precise tower design to be used would be determined by the contractor. However, based on the 69 kV transmission structure described in Section 6.4.6, transmission lines would be a minimum of 2.8 m apart, and greater on the 161 kV line (see Figure 6.4.8 and 6.4.9, Section 6). None of the bird species likely to encounter the line are large enough to span two conductors. For example, whooping crane, bald eagle, and golden eagle have a wingspan of up to 2.21, 2.29 and 2.34 m, respectively (National Geographic Society 1983). Phase-to-ground distances for the proposed transmission towers would be small enough that larger birds may span the distance between the conductor and the tower, but the orientation of the lines (either hanging below or suspended below an insulator) reduces the likelihood of phase-to-ground contact. Tower design would adhere to the Standards for Overhead Systems (CSA-C22.3, CSA 2006).

Studies in the NWT have indicated that nests may shorten the distance between conductor lines during wet weather (Poole 1985). The layout of the proposed metal lattice towers make nests most likely to be built below the conductors, reducing this risk. As such, electrocution of birds is expected to be infrequent, and a minor cause of bird mortalities. Therefore, this pathway was determined to be minor.

15.4.5.2.2.10 Ice Bridges Leading to Changes in Shoreline Habitat

Department of Fisheries and Oceans Operational Statement for Ice Bridges and Snow Fills (DFO 2007a) would be followed. Mitigation practices suggested by DFO (2007a), and further mitigation proposed by Dezé, include the following:

- avoiding steep slopes,
- placing cut trees on steep slopes to reduce erosion potential,
- adhering to the Erosion and Sediment Control Plan,
- avoiding disturbance to riparian zones, where practical,
- considering bank stability and erosion potential of stream crossing locations,
- clearing of vegetation would take place outside of the migratory bird season (May 15 through July 31),

- using proven best practices for winter road construction,
- maximizing the use of frozen lakes and rivers for the winter road,
- not allowing recreational use of construction vehicles, and
- training for all staff on environmental sensitivity including erosion and sediment control.

Table 15.4.8 summarizes the anticipated number of watercourse and water body crossings, for both the winter roads and temporary access trails. Winter road crossings would be wide (15 m) and used by haul trucks, while crossings by temporary access trails would be narrow (5 to 8 m wide), and traffic would consist of track vehicles and pickup trucks. Overall, the disturbance to riparian habitat within the RSA due to the Project winter roads is anticipated to be minimal. Therefore, this pathway was determined to be minor.

Table 15.4.8 — Anticipated Number of Water Course and Water body Crossings

Feature	Region	Watercourse Crossings[2]	Water body Crossings[3]
Winter road	Boreal	46	89
	Tundra[1]	11	55
Temporary access trails	Boreal	5	7
	Tundra	1	0
Transmission line [b]	Boreal	111	193
	Tundra	133	239

Notes:
[1] Includes spurs from the Tibbitt to Contwoyto winter road, but not the Tibbitt to Contwoyto winter road.
[2] Transmission line includes temporary access trails, except within the East Arm National Park
[3] Some watercourses and water bodies may be crossed twice.

15.4.5.2.2.11 Effects from Changes in Hydrology Regime

Effects to Taltson River hydrology would occur, from Nonacho Lake downstream. The change may be characterized as an initial change in water levels during the transition to the operations phase, followed by a regular, managed cycle of water level changes with reduced seasonal variation in water levels during the operational phase. Mitigation is incorporated in the hydrology regime, in that effects to fish and wildlife were considered during the design stage. During operation, Taltson River water levels would be within historic means, and in compliance with the existing water licence. The Project is expected to cause changes to the Taltson River hydrology, from Nonacho Lake downstream to Great Slave Lake. Hydrological modeling was completed to predict changes in the operations of the Nonacho Dam and the Twin Gorges facility following the proposed Project. The annual baseline variation in the predicted monthly average water levels within each of the Zone locations was compared to the modelling results for two scenarios; 36 and 56 megawatt (MW) hydropower facilities.

The timing of the water releases from Nonacho Lake would be managed to produce sufficient water flows for the planned expansion power production. Hydrological modelling results indicate that the proposed changes would decrease the seasonal variation of the predicted flows downstream of the hydropower facility compared to baseline. In addition, mitigation practices and designs have been included to limit potential bank erosion, which reduces the potential for localized changes to riparian habitat (Table 15.4.5).

The range of water levels anticipated to occur during the bird nesting season (June to August) was less than 20 cm above baseline levels. A number of pathways relevant to birds was investigated in detail in Section 13.10 (KLOI Water Fluctuations in the Taltson River Watershed), including;

- direct mortality and reduced reproductive success due to higher water levels,
- reduced reproductive success due to lower water levels,
- riparian habitat loss/modification leading to change in population abundance,
- changes to diet/submerged aquatic plant community,
- riparian habitat loss/modification, and
- change in diet/bioaccumulation of mercury in fish.

The pathway validation of effects to passerines, waterfowl, and raptors is presented in Section 13.10. Of the various scenarios (including both the 36 MW and 56 MW options), only the pathway of changes to diet/submerged aquatic plant community to waterfowl was found to be valid, and only in Nonacho Lake, Zone 1, 2 and 3. All other pathways were considered to be invalid or minor. Full justification is presented in Section 13.10.

The anticipated changes to vegetation may be viewed as a migration of the aquatic vegetation towards the centre of the river, following a drop in mean water levels. The localized effects to riparian habitat would be within the range of baseline conditions as species in this habitat class are more tolerant of flooding, water levels would remain within historic ranges, and the overall productivity of the river is not anticipated to change. Wetland modelling (Section 13.7) indicates that changes to wetlands and riparian vegetation may occur if water levels fall 20 cm or more below baseline levels. Under the 36 MW upgrade, this may occur in Nonacho Lake, Zones 1, 2 and 3. Under the 56 MW scenario, Nonacho Lake and Zones 2 and 3 may be influenced. However, the overall species composition and productivity of the shoreline is not anticipated to change.

It is possible that there are rare plant species among the wetlands that may be affected by these changes. Based on documented habitat preferences, the vascular plant species that may be found along river and lake margins in the Taiga Shield include the following 11 species. It has not been confirmed which of any of the species is actually present in the Taltson River watershed:

- bristly crowfoot
- Horenmann willow herb
- northern clustered sedge
- northern mudwort

- pinnate tansy-mustard
- purslane speedwell
- Richardson alumroot
- several vein sweetflag
- small-flower bitter cress
- spinulose wood fern
- water pigmy-weed

The areas most likely to see changes to wetland extent include Zone 1, Nonacho Lake in the 36 MW scenario and Zone 2 and Nonacho Lake in the 56 MW scenario. It is likely that the altered wetlands would re-establish because large water level fluctuations are not expected. However, considering that these changes would affect only the shoreline of the Taltson River, that the zones to be affected constitute only a small area of the wetland habitat in the RSA, and that the overall effects to wetland extent were considered not substantial (Section 13.7), the distribution of rare plants is not anticipated to be affected by changes in hydrology, and the pathway was considered minor.

15.4.5.2.2.12 Vehicle Collisions Leading to Injury or Mortality of Wolverine

Access to the Project would be through the re-commissioned Fort Smith to Twin Gorges winter road, and the proposed Twin Gorges to Nonacho Lake winter road. In addition, narrow temporary access trails and spur roads connecting the Northern Sector substations to the Tibbitt to Contwoyto winter road are also proposed as part of the Project. These winter roads would be used only during the three-year construction period, and would only be active during the winter season.

Mortality of animals from collision with vehicles has been a concern for most winter road and mining developments in the NWT, but such mortalities have not frequently occurred. No wildlife vehicle collisions were reported on the Tibbitt to Contwoyto winter road between 2000 and 2007 (E. Madsen 2008 pers. comm.). One wolverine was killed along the Tibbitt to Contwoyto winter road in 1996 (EBA 2001).

The following mitigation design features and practices, summarized from the Human Wildlife Conflict Management Plan, are expected to limit the risk from vehicle collisions with individual wolverine:

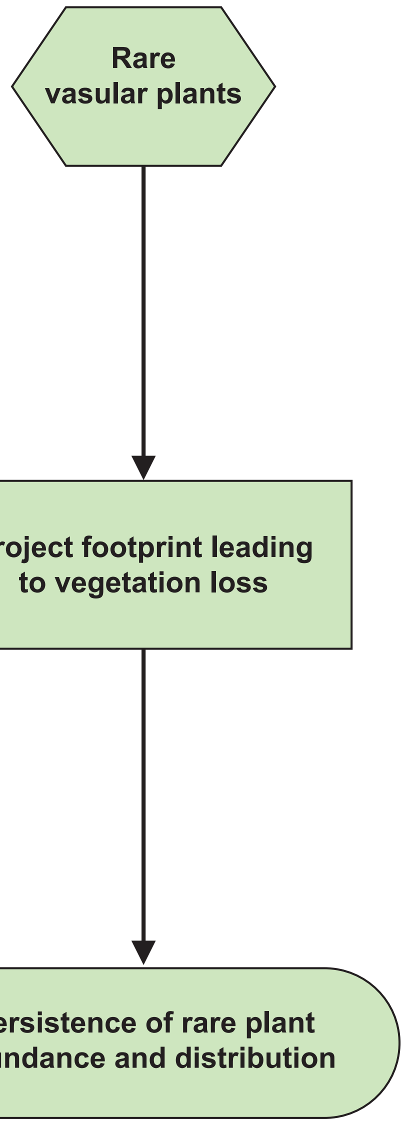
- access roads would be private roads and access would be limited to Project vehicles only,
- transmission line winter roads would be accessible only from the Twin Gorges to Nonacho Lake winter road,
- speed limits for the Project winter access roads would be established and enforced,
- all Project staff would undergo wildlife sensitivity training, which would include a discussion of collision hazards,
- the presence of wildlife on the winter roads would be communicated between drivers, and
- environmental monitors would monitor wildlife-vehicle collisions and implement mitigation actions where necessary.

Traffic volumes along these winter access roads are expected to range from 100 to 150 truckloads within the Southern Sector (i.e. from Fort Smith) and 60 to 80 truckloads in the Northern Sector (i.e. on the Tibbitt to Contwoyto winter road from Yellowknife) during Project construction, but the Project would lead to a long-term reduction of traffic on the Tibbitt to Contwoyto winter road. Use of winter roads would be limited to the winter months when the road is operational. In addition, the winter road would be operational only for the three-year construction period, after which time the road would not be maintained. Therefore, this pathway was determined to be minor for wolverine.

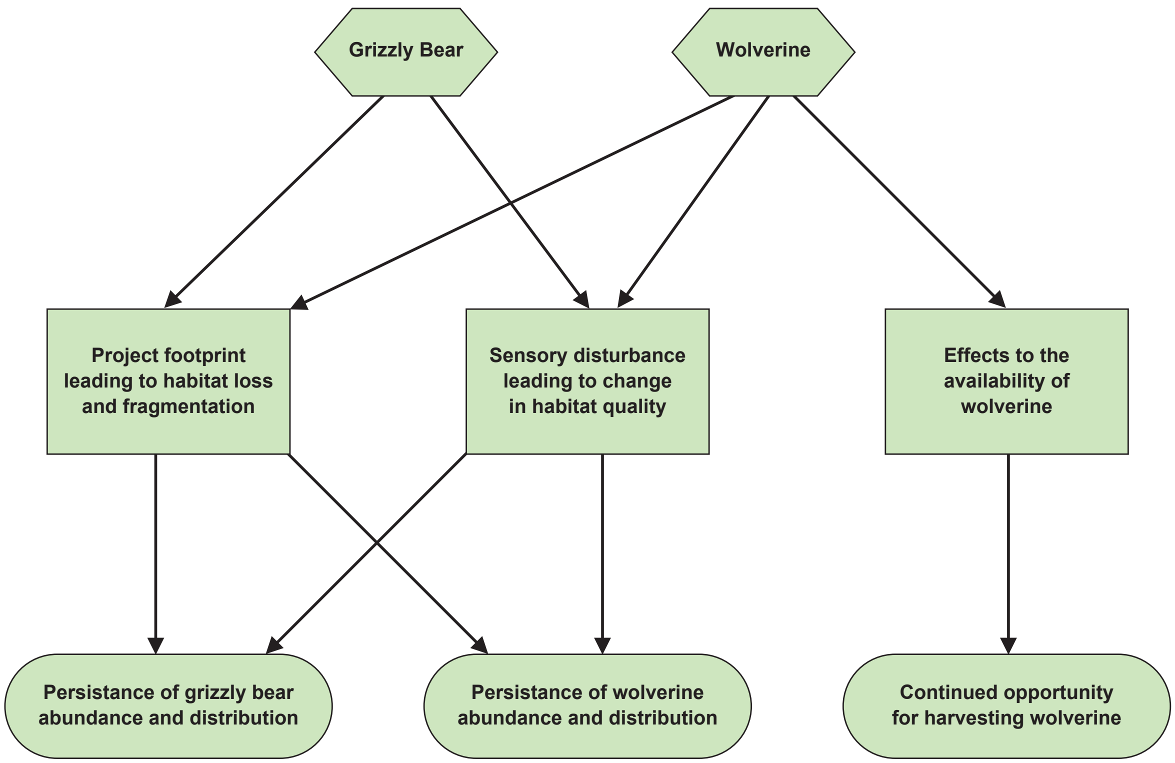
15.4.5.2.3 Valid Pathways

All valid pathways are carried forward and assessed in the effects analysis. The following pathways were determined to be valid for linking Project-related components and activities to effects on the VCs Figure 15.4.4 to Figure 15.4.6:

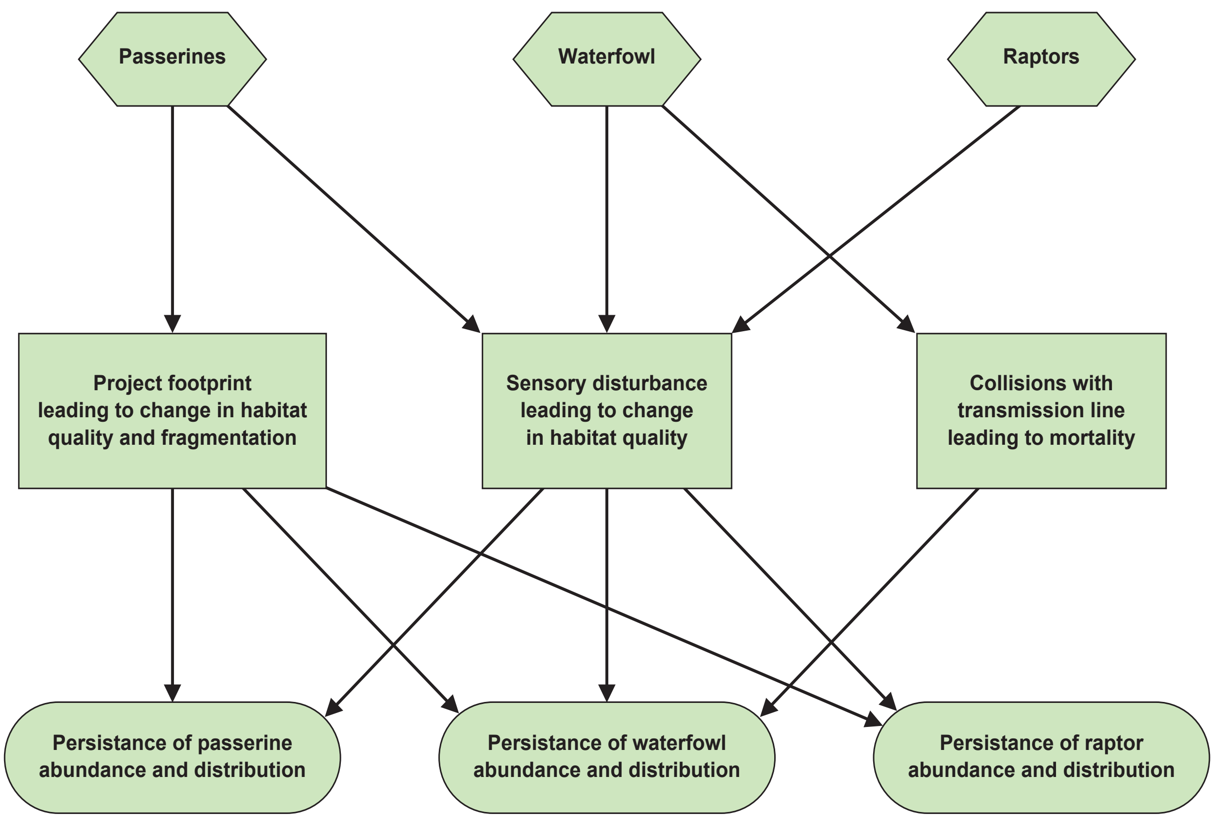
- Project footprint leading to vegetation loss affecting rare vascular plants.
- Project footprint leading to habitat loss and fragmentation for grizzly bear, wolverine, and passerines.
- Sensory disturbance leading to changes in habitat quality for grizzly bear, wolverine, passerines, waterfowl, and raptors.
- Changes in hydrology regime leading to changes in riparian habitat quantity and quality for waterfowl.
- Collision with the transmission line leading to mortality of waterfowl.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Pathway of Project Effects to Rare Vascular Plants	Figure 15.4.4



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Pathway of Project Effects to Grizzly Bear and Wolverine	Figure 15.4.5



Pathway of Project Effects to Passerines, Waterfowl and Raptors

Figure 15.4.6

15.4.6 Effects to Rare Vascular Plants

15.4.6.1 PROJECT FOOTPRINT LEADING TO VEGETATION LOSS

The Project footprint would lead to long-term and, in some areas, permanent loss of vegetation. To estimate effects to rare plants, land cover classes within the RSA were assessed for their potential to contain rare plants. This information was compared to the anticipated disturbance of land cover classes due to the Project.

15.4.6.1.1 Methods

The rare vascular plant species were organized according to known habitat preferences into the land cover classes in which they may occur. This information was used to determine rare plant potential ratings for each land cover class based on the prevalence of listed species within each class, and the relative availability of each land cover class within the RSA (Figure 15.4.7). The land cover classification used was the Earth Observation for Sustainable Development (EOSD) classification. These classes represent broad land cover classes, and describe the landscape at a larger scale than the available habitat information for each rare vascular plant species. As such, many rare plant species were classified as occurring within several EOSD classes, and occasionally may be found outside of these classes. Regardless, the EOSD was considered a suitable classification for a large-scale assessment, and has the advantage of extending across the entire Project RSA.

Professional judgment and natural breaks between scores were used to rate each land cover class with a high, moderate or low rare plant potential. Any identified effects to EOSD classes and vegetation would apply to rare plants as well; however, the severity of the effect to rare plants may be perceived as being greater due to both their low numbers and restricted distribution across the landscape.

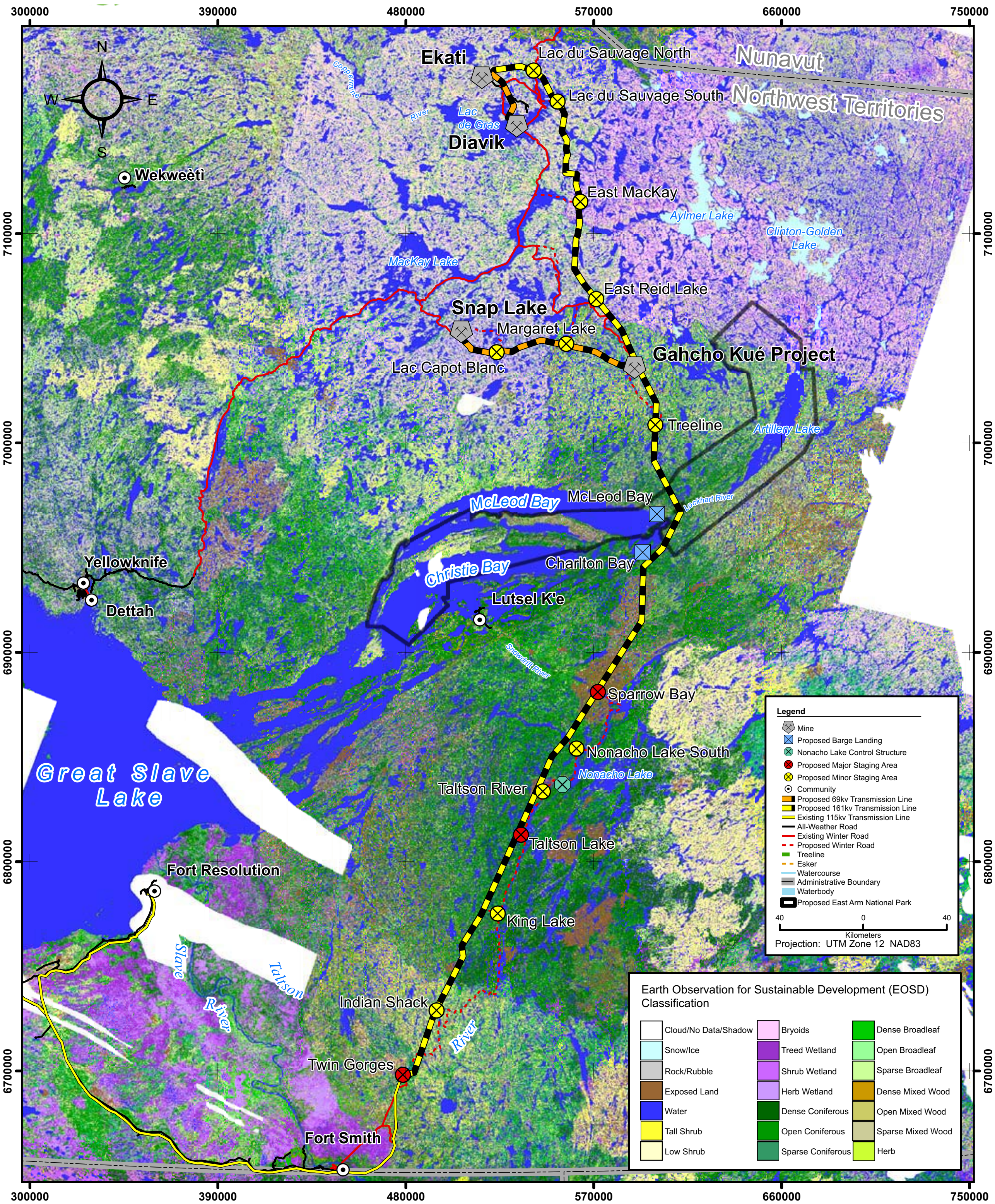
The incremental effects associated with habitat loss from the Project footprint, including the winter access roads, were estimated using geographical information system (GIS) software. Landscape mapping data was obtained from Natural Resources Canada (NRCan). This data is commonly known as Earth Observation for Sustainable Development of Forests (EOSD; Figure 15.4.7) and is primarily obtained from satellite imagery, such as Landsat-7 Enhanced Thematic Mapper. Using GIS software, the image was converted to a grid for analysis. The EOSD data was clipped to extract all landscape information within 5 km of all Project components (i.e. RSA) and the landscape classes and total areas within this buffer were described.

To complete the landscape disturbance analysis, GIS shapefiles were created to estimate the layout and extent of all components of the Project (i.e. the transmission line, winter roads, staging areas, barge landing sites, and improvements to the facilities at Twin Gorges and Nonacho Lake). The location and geographic extent of these components were determined using the most recent engineering plans, where available. Conservative estimates were used where no engineering plans were available. For example, the transmission line ROW was estimated to be 30 m wide, winter haul roads were estimated to be 15 m wide, temporary access trails were estimated to be 5 m wide, and each staging area was estimated at 5 ha. Where uncertainty existed in the geographic extent of the Project components, the maximum expected extent was used. For example, transmission line ROW clearing would likely range from 15 m to 30 m wide, and each staging area is expected to range between 2 and 5 ha. These Project components were overlaid on the EOSD landscape classification and the resulting landscape disturbance for each Project component by landscape class was estimated.

15.4.6.1.2 Results

Table 15.4.9 provides the listed plant species potentially occurring within the EOSD land cover class found within the RSA, as well as a description of each EOSD class. Table 15.4.9 provides a reasonable summary of the rare plants that may be found in each of the land cover classes, which are expected to be disturbed by the Project.

Dezé energy



TALTSON HYDROELECTRIC EXPANSION PROJECT	**Developer's Assessment Report 2009**	**Earth Observation for Sustainable Development Classification**	**Figure 15.4.7**

Table 15.4.9 — Rare Vascular Plant Species Potentially within the Land Cover Classes Occurring Within the Project Footprint

EOSD[1] Land Cover Class	Common Name	Habitat Information
Water (specifically shoreline) Lakes, reservoirs, rivers, streams, or salt water	Gmelin's orache	Gravelly beaches at river mouth
	Northern clustered sedge	Wet woodland bogs, marshes and sandy beaches
	Mackenzie sedge	Brackish marshes
	Few-seeded sedge	Wet, sandy lake shores
	Water pigmy-weed	Shallow ponds
	Dane's gentian	Sandy beaches and gravelly mud flats
	Sea milkwort	Saline sloughs
	Northern mudwort	Wet, muddy or sandy pond margins
	Water lobelia	Shallow, sandy shores of lakes and ponds
	Alternate-flower water milfoil	Shallow lakes and ponds
	Yellow owl's clover	Sandy riverbanks and lakeshores
	Muskeg lousewort	Bogs and marshes, fens
	Bristly crowfoot	Disturbed and marshy places
	Persistent-sepal yellow-cress	Low deltas
Rock/Rubble Bedrock, rubble, talus, blockfield, rubbley mine spoils, or lava beds	Bristly crowfoot	Disturbed and marshy places
	Persistent-sepal yellow-cress	Low deltas
	Small-flower bitter cress	Sandy, open places or rocky ledges
	Red pigweed	Salt plains and disturbed soils
	Slender rock-brake	Moist shale slopes
	Pinnate tansy-mustard	Sandy beaches and disturbed areas

EOSD[1] Land Cover Class	Common Name	Habitat Information
	Yellowstone whitlow-grass	Alpine tundra and rocky slopes
	Yukon fleabane	Calcareous, stony slopes
	Pygmy aster	Gravelly places
	Prairie-smoke	Dry prairie and grassland species - typical alvar species
	Western stickseed	Thickets, woods, clearings and banks
	Moss heather	Sheltered, rocky places in arctic /alpine areas
	Seaside plantain	Cliffs and sea-beaches or inland saline springs
	White mountain saxifrage	Rocky ledges
Exposed Land River sediments, exposed soils, pond or lake sediments, reservoir margins, beaches, landings, burned areas, road surfaces, mudflat sediments, cutbanks, moraines, gravel pits, tailings, railway surfaces, buildings and parking, or other non-vegetated surfaces	Purslane speedwell	Moist places of settled areas
	Bristly crowfoot	Disturbed and marshy places
	Persistent-sepal yellow-cress	Low deltas
	Small-flower bitter cress	Sandy, open places or rocky ledges
	Red pigweed	Salt plains and disturbed soils
	Pinnate tansy-mustard	Sandy beaches and disturbed areas
	Pygmy aster	Gravelly places
	Prairie-smoke	Dry prairie and grassland species - typical alvar species
	Western stickseed	Thickets, woods, clearings and banks
	Moss heather	Sheltered, rocky places in arctic /alpine areas
	Purslane speedwell	Moist places of settled areas
	Gmelin's orache	Gravelly beaches at river mouth
	Northern clustered sedge	Wet woodland bogs, marshes and sandy beaches
	Few-seeded sedge	Wet, sandy lake shores

EOSD[1] Land Cover Class	Common Name	Habitat Information
	Dane's gentian	Sandy beaches and gravely mud flats
	Northern mudwort	Wet, muddy or sandy pond margins
	Water lobelia	Shallow, sandy shores of lakes and ponds
	Yellow owl's clover	Sandy riverbanks and lakeshores
	Saltwater cress	Salt plains and sandy beaches
	Hairy rockcress (pilose braya)	Sandy seashores; found only on Bathurst Cape (unglaciated area in last Glaciation)
	Beach pea	Sheltered beaches and river banks
	Drummond bluebell	Sandy and gravelly ridges and sand banks
Bryoids Bryophytes (mosses, liverworts, and hornworts) and lichen (foliose or fruticose; not crustose); minimum of 20% ground cover or one-third of total vegetation must be a bryophyte or lichen	Oval-leaved willow	Sand beaches and terraces
	Moss heather	Sheltered, rocky places in arctic /alpine areas
	Yellowstone whitlow-grass	Alpine tundra and rocky slopes
	Swedish dwarf dogwood	Wet mossy areas
	Horenmann willow herb	Wet alpine tundra
	Wedgeleaf willow	Moist tundra
Shrub Tall At least 20% ground cover which is at least one-third shrub; average shrub height greater than or equal to 2 m	Western stickseed	Thickets, woods, clearings and banks
Shrub Low At least 20% ground cover which is at least one-third shrub; average shrub height less than 2 m	Western stickseed	Thickets, woods, clearings and banks
	Moss heather	Sheltered, rocky places in arctic /alpine areas
	Yellowstone whitlow-grass	Alpine tundra and rocky slopes
	Swedish dwarf dogwood	Wet mossy areas
	Horenmann willow herb	Wet alpine tundra
	Wedgeleaf willow	Moist tundra

EOSD[1] Land Cover Class	Common Name	Habitat Information
Wetland-Treed Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is coniferous, broadleaf, or mixed wood	Northern clustered sedge	Wet woodland bogs, marshes and sandy beaches
	Muskeg lousewort	Bogs and marshes, fens
	Several vein sweetflag	Wetlands
	Three-seed sedge	Bog
	White adder's mouth	Damp calcareous fens
Wetland-Shrub Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub	Northern clustered sedge	Wet woodland bogs, marshes and sandy beaches
	Muskeg lousewort	Bogs and marshes, fens
	Several vein sweetflag	Wetlands
	Three-seed sedge	Bog
	White adder's mouth	Damp calcareous fens
	Western stickseed	Thickets, woods, clearings and banks
	Horenmann willow herb	Wet alpine tundra
Wetland-Herb Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is herb	Northern clustered sedge	Wet woodland bogs, marshes and sandy beaches
	Muskeg lousewort	Bogs and marshes, fens
	Several vein sweetflag	Wetlands
	Three-seed sedge	Bog
	White adder's mouth	Damp calcareous fens
	Horenmann willow herb	Wet alpine tundra
	Swedish dwarf dogwood	Wet mossy areas
	Wedgeleaf willow	Moist tundra
	Bristly crowfoot	Disturbed and marshy places
	Purslane speedwell	Moist places of settled areas

EOSD[1] Land Cover Class	Common Name	Habitat Information
	Few-seeded sedge	Wet, sandy lake shores
	Northern mudwort	Wet, muddy or sandy pond margins
	Mackenzie sedge	Brackish marshes
	Alternate-flower water milfoil	Shallow lakes and ponds
Herb Vascular plant without woody stem (grasses, crops, forbs, gramminoids); minimum of 20% ground cover or one-third of total vegetation must be herb	Leafy thistle	Sedge and grass meadow
	Wedgeleaf willow	Moist tundra
	Leafy thistle	Sedge and grass meadow
	Yellowstone whitlow-grass	Alpine tundra and rocky slopes
	Persistent-sepal yellow-cress	Low deltas
	Prairie-smoke	Dry prairie and grassland spp. - typical alvar species
	Mingan's moonwort	Grassy meadows
	Richardson alumroot	Woodland meadows
Coniferous Dense Greater than 60% crown closure; coniferous trees are 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
	Velvetleaf blueberry	In dry or acid soil
Coniferous Open 26 to 60% crown closure; coniferous trees are 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
	Velvetleaf blueberry	In dry or acid soil
Coniferous Sparse 10 to 25% crown closure; coniferous trees are 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
	Velvetleaf blueberry	In dry or acid soil

EOSD[1] Land Cover Class	Common Name	Habitat Information
Broadleaf Dense Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
Broadleaf Open 26 to 60% crown closure; broadleaf trees are 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
Broadleaf Sparse 10 to 25% crown closure; broadleaf trees are 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
Mixedwood Dense Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
Mixedwood Open 26 to 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods
Mixedwood Sparse 10to 25% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area	Western stickseed	Thickets, woods, clearings and banks
	Spinulose wood fern	Rich woods

[1] EOSD = Earth Observation for Sustainable Development of Forests

Classification of relative potential for rare vascular plants for each land cover class within the Project footprint is shown in Table 15.4.10. The number of rare species potentially occurring within each land cover class, as well as the uniqueness of each land cover class within the Project footprint, was used to determine the relative potential (high, moderate and low) for rare vascular plants in each land cover class. An adjustment was made to the rating of the water class because it is represented by both high and low rare plant potential. Although the coverage of the water class includes lakes, this assessment refers specifically to lake margins, where emergent and semi-aquatic plants are primarily found.

Table 15.4.10 — Rare Plant Ratings for Land Cover Classes in the Regional Study Area

Rare Plant Potential	EOSD[1] Land Cover Class	Potential Number of Rare Plants	Proportion of Project footprint (%)
High	Exposed Land	22	9.41
	Rock/Rubble	15	3.38
	Wetland-Herb	15	2.87
	Water[2]	14	24.49
Moderate	Wetland-Shrub	7	1.14
	Herb	7	0.65
	Shrub Low	6	15.17
	Bryoids	5	7.29
	Wetland-Treed	5	2.65
Low	Coniferous Dense	3	4.71
	Coniferous Open	3	15.03
	Coniferous Sparse	3	7.80
	Broadleaf Dense	2	0.13
	Broadleaf Open	2	0.52
	Broadleaf Sparse	2	0.22
	Mixedwood Dense	2	0.52
	Mixedwood Open	2	2.32
	Mixedwood Sparse	2	0.12
	Shrub Tall	1	1.38
	Shadow	NA	0.21
	Snow/Ice	NA	0.01

[1] EOSD = Earth Observation for Sustainable Development of Forests; % = percent; NA = not applicable

[2] Water is a surrogate for shoreline habitat, which constitutes only a proportion of the total area of water.

Within the RSA, two sparsely vegetated land cover classes (i.e. exposed land and rock/rubble), one wetlands class (i.e. wetland-herb), and water (i.e. shoreline) were assigned high rare plant potential ratings (Table 15.4.10). Exposed land could support 22 rare plant species, while water (i.e. shoreline) could support 14 rare plant species. Twenty-five species are unique to habitats assigned high rare plant potential ratings. The habitats found within these land cover classes include natural land surfaces, such as bedrock, talus, blockfield, river sediment, beaches, and cutbanks. As the wetland-herb and water classes can be found adjacent to one another in the landscape, they share many of the same listed species (Table 15.4.10).

A moderate rare plant potential rating was assigned to the wetland-shrub, herb, shrub low, bryoids, and wetland-treed cover classes. This included habitat such as bogs, meadows, deltas and rocky areas. Of these, wetland-shrub and herb could each support seven rare plant species, while the wetland-treed land cover class could support five rare plant species. Two species are unique to habitats assigned moderate rare plant potential ratings. Low rare plant potential ratings were assigned to forested and tall shrub land cover classes, such as rich woods, thickets, and river banks. Two species are unique to habitats assigned low rare plant potential ratings. These land cover classes are expected to have a low number of listed species (one to three) within the Project footprint.

The Project footprint is estimated to be a total of 2,723.7 ha (Table 15.4.11). The majority of the land cover to be disturbed or within the transmission line ROW is water (approximately 25% of the total Project footprint). Excluding rock/rubble and exposed land, approximately 63% of the Project footprint is covered in terrestrial vegetation, of which low shrub and open conifer habitat are dominant. Natural recovery is expected in the terrestrial habitat on the winter road and barge landing areas after construction (12% [202 ha] of total disturbance), as the road would be closed and the barge landing areas removed. The transmission line ROW, however, would require ongoing vegetation management. The component with the greatest extent is the transmission line ROW, covering 76% of the total Project footprint. However, 49% of the ROW is north of the treeline, where clearing of vegetation would be limited to the tower foundations and staging areas. Approximately 6% of the Project footprint would be winter road above the treeline, where no vegetation clearing is required and the proposed mitigation would reduce effects to vegetation beneath the winter road.

Within the RSA, less than 0.5% of any single land cover class is expected to be disturbed by the Project footprint (Table 15.4.11). Excluding water, 426.5 ha (15.7%) of the Project footprint has a high rare plant potential. Water, which is used as an indicator of shoreline habitat, constitutes an area of 666.9 ha (24.5%). A further 732.55 ha of landscape disturbance (26.9% of the area to be disturbed) to land cover classes with a moderate ranking for rare plant habitat is also expected. This assumes a 30 m wide ROW for the entire transmission line route in all habitats (the transmission line ROW being the largest single Project component). Overall effects to rare plant habitat are anticipated to be low for the following reasons:

- less than 0.5% of any single land cover class with rare plant potential would be directly altered by the Project;
- the entire area of all water bodies within the Project footprint is included, whereas vascular plants would only occur on shorelines;

- in many areas, vegetation removal within the transmission line right-of-way would be selective (for vegetation greater than 3 m in height only) or not completed at all (in tundra areas and within the proposed East Arm National Park, for example);
- most of these plant species are low-lying plants; the exceptions to this include two willows (*Salix ovalifolia* and *Salix sphenophylla*) and the velvetleaf blueberry (*Vaccinium myrtilloides*), which are still unlikely to be cleared in areas where vegetation less than 3 m in height is preserved; and
- all of the land cover classes with a high potential for rare plants (water, wetland-herb, exposed land and rock/rubble) are low-lying communities which do not require vegetation clearing for the transmission line.

Table 15.4.11 — Landscape Disturbance in the Regional Study Area Associated with the Project Footprint

Rare Plant Potential	EOSD[1] Land cover class	Infra-structure[2]	Winter Access Roads	Trans-mission Line	Barge Landing & Laydown Areas	Total Project Disturbance[3]		Total Habitat in the RSA		Disturbance in the RSA by land cover class
		Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	Area (ha)	%	%
High	Water	0.74	361.17	297.12	8.90	666.92	24.49	266,192.66	26.53	0.25
High	Rock/Rubble	0.00	4.92	85.35	1.82	92.02	3.38	28,026.23	2.79	0.33
High	Exposed Land	15.23	21.80	206.94	13.21	256.37	9.41	87,485.56	8.72	0.29
High	Wetland-Herb	0.09	8.88	67.15	2.55	78.11	2.87	25,237.00	2.52	0.31
Moderate	Bryoids	0.00	13.48	180.13	5.78	198.56	7.29	67,229.82	6.70	0.30
Moderate	Shrub Low	10.74	22.06	368.89	13.91	413.31	15.17	125,061.87	12.46	0.33
Moderate	Wetland-Treed	0.31	17.05	50.00	5.49	72.11	2.65	23,874.05	2.38	0.30
Moderate	Wetland-Shrub	0.06	6.09	22.88	2.10	30.99	1.14	8,699.32	0.87	0.36
Moderate	Herb	1.69	2.57	13.33	0.28	17.58	0.65	5,461.97	0.54	0.32
Low	Shrub Tall	1.39	8.34	27.96	0.06	37.57	1.38	17,794.92	1.77	0.21
Low	Coniferous Dense	2.18	11.68	110.59	4.10	128.18	4.71	70,984.29	7.07	0.18
Low	Coniferous Open	2.81	28.08	368.84	10.22	409.26	15.03	162,421.08	16.19	0.25
Low	Coniferous Sparse	1.30	21.26	184.85	6.11	212.53	7.80	74,283.86	7.40	0.29
Low	Broadleaf Dense	0.55	0.58	2.44	0.00	3.49	0.13	1,887.84	0.19	0.18

Rare Plant Potential	EOSD[1] Land cover class	Infra-structure[2]	Winter Access Roads	Trans-mission Line	Barge Landing & Laydown Areas	Total Project Disturbance[3]		Total Habitat in the RSA		Disturbance in the RSA by land cover class
		Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	Area (ha)	%	%
Low	Broadleaf Open	0.00	1.16	12.87	0.38	14.23	0.52	3,765.98	0.38	0.28
Low	Broadleaf Sparse	0.00	0.22	5.66	0.00	5.88	0.22	1,300.22	0.13	0.45
Low	Mixedwood Dense	0.65	2.23	11.06	0.44	14.15	0.52	9,006.34	0.90	0.16
Low	Mixedwood Open	0.00	4.46	58.34	0.58	63.24	2.32	22,616.99	2.25	0.28
Low	Mixedwood Sparse	0.00	0.39	2.00	0.97	3.19	0.12	861.64	0.09	0.37
Low	Snow/Ice	0.00	0.10	0.20	0.00	0.30	0.01	201.10	0.02	0.15
Low	Shadow	0.13	0.60	2.14	3.01	5.73	0.21	1,048.88	0.10	0.55
Total		**37.87**	**537.13**	**2,078.74**	**79.91**	**2,723.72**	**100.00**	**1,003,442.72**	**100.00**	**0.27**

[1] EOSD = Earth Observation for Sustainable Development of Forests; RSA = Regional Study Area

[2] infrastructure includes the Twin Gorges facility, Nonacho Lake control structure and associated facilities, the South Valley Spillway, and substations.

[3] The Total Project Disturbance area was calculated with GIS software. There was spatial overlap among some Project components, which resulted in the sum of the Project components being slightly greater than the Total Project Disturbance.

15.4.7 Effects to Grizzly Bear and Wolverine

15.4.7.1 Project Footprint Leading to Habitat Loss and Fragmentation

Habitat loss refers to the destruction or alteration of land cover features that are necessary to the survival and reproduction of a species. To estimate these effects, habitat loss due to existing and historic development, and that anticipated due to the Project, were estimated and compared to a pristine environment.

15.4.7.1.1 Habitat Loss

15.4.7.1.1.1 Methods

Direct loss of habitat for grizzly bear and wolverine from the Project (incremental effects) and all existing and historic developments (cumulative effects) was estimated for the assessment. Existing development included the Gahcho Kué Project for the cumulative effects assessment.

The incremental effects associated with habitat loss from the Project footprint, including the winter access roads, were estimated using geographical information system (GIS) software. The landscape was divided into components north and south of the treeline to account for the distribution of grizzly bear and boreal versus tundra wolverine. Landscape mapping data was obtained from Natural Resources Canada (NRCan). This data is commonly known as Earth Observation for Sustainable Development of Forests (EOSD, Figure 15.4.7) and is primarily obtained from satellite imagery, such as Landsat-7 Enhanced Thematic Mapper. Using GIS software, the image was converted to a grid for analysis. The EOSD data was clipped to extract all landscape information within the RSA, and the landscape classes and total areas within each RSA were described.

GIS shapefiles were created to estimate the layout and extent of the Project components within the RSA (i.e. the transmission line, winter roads, staging areas, barge landing sites, and improvements to the facilities at Twin Gorges and Nonacho Lake). The location and geographic extent of these components were determined using the most recent engineering plans, where available; conservative estimates were used where no engineering plans were available. For example, the transmission line ROW was estimated to be 30 m wide, winter haul roads were estimated to be 15 m wide, temporary access trails were estimated to be 5 m wide, and each staging area was estimated at 5 ha. Where uncertainty existed in the geographic extent of the Project components, the maximum expected extent was used. For example, transmission line ROW clearing would likely range from 15 m to 30 m wide, and each staging area is expected to range between 2 and 5 ha. These Project components were overlaid on the EOSD landscape classification and the resulting landscape disturbance for each Project component by landscape class was estimated.

The cumulative effects associated with habitat loss from the Project and all existing and historic developments in the CESA for each VC were estimated. To create the development database, an understanding of existing and historic developments in each CESA was required. The extent of the existing and historic developments was estimated by the number, type, and location of developments within each CESA. The methods and sources used to create this database are provided in Section 19 (Cumulative Effects

Summary). Several assumptions were made concerning the temporal and spatial extent of effects from the development in the database.

The database contains no information on the size of the physical footprint of the development. For communities, as well as closed and operating mines, the footprint was digitized from Landsat 7 imagery from the Government of Canada (CanImage 2007, internet site). For all other developments, the physical area of the footprint was estimated using a number of assumptions. For example, footprints for roads were based on a 200 m wide corridor, which was related to the raster cell size of 200 x 200 m and the associated computational limitations of the large study area for wolverine and grizzly bear. A 1,000 m radius (314 ha) was used to estimate the area of the footprint for exploration sites, which likely overestimates the amount of habitat directly disturbed by exploration activities. Further details are available in Chapter 19 (Cumulative Effects Analysis).

Incremental effects were assessed within the RSA, while cumulative effects were assessed for each CESA (see Table 15.4.4). The RSA for grizzly bear and tundra wolverine included all Project components north of the treeline plus a 5 km buffer, for a total area of 424,520 ha. The RSA for boreal wolverine included all Project components south of the treeline plus a 5 km buffer, for a total area of 578,923 ha. The CESAs were defined using estimates of natal dispersal distances as buffer widths around the proposed Project footprint. The dispersal distance used for wolverine and grizzly bear was 176 km and 158 km from the Project footprint, respectively. This results in an area of 11,156,512 ha for grizzly bears, 12,665,642 ha for tundra wolverine, and 17,829,033 ha for boreal wolverine (i.e. south of the treeline, Table 15.4.4), as shown in Figure 15.4.1.

15.4.7.1.1.2 Results

The total Project footprint (incremental effect) is expected to be about 2,723.7 ha. Within the grizzly bear and tundra wolverine RSA (i.e. north of the treeline), there would be 1,201.4 ha of disturbance from the Project (Table 15.4.12) or 0.28% of the RSA would be disturbed. Of the area to be disturbed north of the treeline, 156.9 ha would be spur roads from the Tibbitt to Contwoyto winter road, which would only operate while grizzly bears are inactive. Most of this disturbance (84%) would be within the transmission line ROW, where minimal vegetation clearing is planned. Within the RSA, less than 0.5% of any habitat class would be disturbed.

Resource selection models (Johnson et al. 2004, 2005) indicate that grizzly bears show preference for riparian and low shrub areas. These are approximated by the Shrub Low and Wetland-Shrub classes within the EOSD classification, of which less than 0.4% would be disturbed within the RSA. Tundra wolverine show preference for rocky areas and sedge patches (equivalent to Rock/Rubble and Wetland-Herb), which also would have less than 0.4% of their total area in the RSA disturbed.

Table 15.4.12 — Landscape Disturbance North of the Treeline Resulting from the Project

EOSD[1] Land Cover Class	Proposed Winter Road Area (ha)	Transmission Line Area (ha)	Staging Areas Area (ha)	Total Area North of Treeline[2] (ha)	Proportion of Project Footprint North of Treeline[2] (%)
Water	102.69	145.10	4.79	251.89	20.97
Snow/Ice	0.09	0.20	0	0.29	0.02
Rock/Rubble	3.47	76.33	0.98	80.77	6.72
Exposed Land	3.17	29.19	1.63	33.78	2.81
Bryoids	13.48	180.13	5.78	198.56	16.53
Shrub Low	11.17	300.86	9.90	320.15	26.65
Wetland-Treed	0.97	15.18	0	16.15	1.34
Wetland-Shrub	1.17	19.77	0.88	21.68	1.80
Wetland-Herb	2.43	45.31	1.77	48.96	4.08
Herb	1.16	8.05	0.11	9.32	0.78
Coniferous Dense	1.21	7.09	0.19	8.46	0.70
Coniferous Open	5.59	57.66	1.30	64.39	5.36
Coniferous Sparse	6.15	90.78	2.45	98.90	8.23
Broadleaf Dense	0.09	0.54	0.0	0.64	0.05
Broadleaf Open	0.60	8.59	0.0	9.11	0.76
Broadleaf Sparse	0.17	3.83	0.0	4.00	0.33
Mixedwood Dense	0.09	0.73	0.0	0.82	0.07
Mixedwood Open	3.17	30.23	0.19	33.52	2.79
Mixedwood Sparse	0.00	0.0	0.0	0.00	<0.01
Total	**156.88**	**1019.57**	**29.97**	**1201.37**	

[1] EOSD = Earth Observation for Sustainable Development of Forests.

[2] The Total Project Disturbance area was calculated with GIS software. There was spatial overlap among some Project components, which resulted in the sum of the Project components being slightly greater than the Total Project Disturbance.

Within the boreal wolverine RSA (i.e. south of the treeline), there would be 1,522 ha of disturbance from the Project (Table 15.4.13) or 0.26% of the RSA would be disturbed. These estimates assume a transmission line ROW of 30 m width, although in practice this would vary from 15 to 30 m. Winter roads, barge landing and staging areas would be cleared for construction, but would not be permanent features on the landscape. Within the boreal regions, they would be allowed to regenerate after construction. The winter road portages constitute 6% of the terrestrial disturbance in the boreal region.

Table 15.4.13 — Landscape Disturbance South of the Treeline Resulting from the Project

EOSD[1] Land Cover Class	Infrastructure Area (ha)	Proposed Winter Road Area (ha)	Transmission Line Area (ha)	Barge Landing and Staging Areas (ha)	Total Area North of Treeline[2] (ha)	Proportion of Project Footprint South of Treeline[2] (%)
Shadow	0.13	0.60	2.14	3.01	5.73	0.38
Water	0.74	258.47	152.02	4.11	415.03	27.26
Snow/Ice	0.00	0.01	0	0.00	0.02	<0.01
Rock/Rubble	0	1.45	9.01	0.84	11.25	0.74
Exposed Land	15.23	18.62	177.74	11.58	222.59	14.62
Shrub Tall	1.39	8.34	27.96	0.06	37.57	2.47
Shrub Low	10.74	10.89	68.02	4.01	93.16	6.12
Wetland-Treed	0.31	16.08	34.83	5.49	55.97	3.68
Wetland-Shrub	0.06	4.92	3.11	1.22	9.31	0.61
Wetland-Herb	0.09	6.46	21.84	0.78	29.15	1.91
Herb	1.69	1.41	5.28	0.17	8.26	0.54
Coniferous Dense	2.18	10.48	103.50	3.92	119.72	7.86
Coniferous Open	2.81	22.49	311.18	8.91	344.87	22.65
Coniferous Sparse	1.30	15.11	94.07	3.67	113.64	7.46
Broadleaf Dense	0.55	0.49	1.90	0	2.85	0.19
Broadleaf Open	0	0.57	4.27	0.38	5.11	0.34
Broadleaf Sparse	0	0.06	1.83	0	1.89	0.12
Mixedwood Dense	0.65	2.14	10.33	0.44	13.33	0.88
Mixedwood Open	0	1.29	28.11	0.39	29.72	1.95
Mixedwood Sparse	0	0.39	2.00	0.97	3.18	0.21
Total	**37.87**	**380.26**	**1059.16**	**49.95**	**1522.34**	

[1] EOSD = Earth Observation for Sustainable Development of Forests.

[2] The Total Project Disturbance area was calculated with GIS software. There was spatial overlap among some Project components, which resulted in the sum of the Project components being slightly greater than the Total Project Disturbance.

The dominant land cover classes (i.e. greater than 5%) in the grizzly bear and tundra wolverine RSA are water, exposed land, rock/rubble, bryoids, low shrubs, dense conifer, open conifer, and sparse conifer. Although a number of different habitats would be disturbed, the disturbed area for each would be less than 0.5% of its current abundance within each RSA.

Mixedwood and conifer habitat are important to wolverine in the boreal forest (Wright and Ernst 2004). Within the boreal wolverine RSA, approximately 38% is conifer habitat and 3% is mixedwood habitat. Approximately 0.23% of mixedwood and conifer habitat in the RSA would be disturbed by the Project footprint.

Cumulative effects were assessed using historic and existing developments in the grizzly bear and wolverine CESAs. These developments are listed in Table 15.4.14. There are approximately 45,480 ha of presumed active developments (i.e. activities with a land use permit less than 5 years old) in the grizzly bear CESA, 47,530 ha in the tundra wolverine CESA, and 38,736 ha in the boreal wolverine CESA. This includes features such as outfitting lodges, existing and closed mines, existing and closed mineral exploration camps, and communities. Considering all developments (active and inactive), less than 0.7% of any of the three CESAs have been disturbed by development. The boreal wolverine CESA in particular has been influenced by very low levels of development; approximately 0.3% of the CESA would be disturbed by the Project, and all other existing and historic developments (Table 15.4.14). These estimates include the conservative assumptions of development footprints described above. For example, mineral exploration camps were assumed to have a footprint of 314 ha.

The predominant activity (by number of developments) in the grizzly bear and wolverine CESAs is mineral exploration (Table 15.4.14). There are currently an estimated 16,702 ha directly disturbed by 51 presumed active mineral exploration camps in the grizzly bear CESA, and 17,703 ha and 8,574 ha disturbed by 29 and 54 camps within the boreal and tundra wolverine CESAs, respectively. Other prominent features include the all-season roads in the boreal wolverine CESA (11,652 ha) and winter roads in the tundra wolverine CESA (20,922 ha). As grizzly bears are inactive in winter, they are not exposed to winter roads.

Table 15.4.14 — Historic and Existing Developments within the Grizzly Bear and Wolverine Cumulative Effects Study Area

Type of Development	Status	BOREAL WOLVERINE		TUNDRA WOLVERINE		GRIZZLY BEAR	
		Number	Footprint Area (ha)	Number	Footprint Area (ha)	Number	Footprint Area (ha)
All season road	Active	6	11,652	–	–	–	–
Communications	Active	–	–	1	13	1	13
Communications	Inactive	2	27	–	–	–	–
Community	Active	5	2,006	–	–	–	–
Community	Inactive	1	18	–	–	–	–

Type of Development	Status	BOREAL WOLVERINE		TUNDRA WOLVERINE		GRIZZLY BEAR	
		Number	Footprint Area (ha)	Number	Footprint Area (ha)	Number	Footprint Area (ha)
Fuel storage	Inactive	–	–	2	13	2	13
Gahcho Kué Project	Active	–	–	1	1,309	1	1,309
Gahcho Kué winter road	Active	–	–	1	2,399	1	2,399
Industrial	Active	1	13	–	–	–	–
Lodge	Active	–	–	10	133	9	120
Lodge	Inactive	1	13	7	93	7	93
Mine	Active	–	–	3	6,289	3	6,185
Mine	Inactive	1	44	3	178	3	178
Mineral exploration/camp	Active	29	8,574	54	17,703	51	16,702
Mineral exploration/camp	Inactive	38	10,747	97	28,201	94	26,988
Miscellaneous	Active	3	29	6	69	6	69
Miscellaneous	Inactive	12	104	12	131	12	131
Oil and gas	Active	3	38	–	–	–	–
Power	Active	2	666	–	–	–	–
Quarrying	Active	13	159	–	–	–	–
Quarrying	Inactive	16	177	1	13	1	13
Staging area	Active	1	4	–	–	–	–
Transmission line	Active	1	6,776	–	–	–	–
Winter road	Active	7	8,685	11	20,922	10	18,681
Woods operation	Active	10	133	–	–	–	–
Woods operation	Inactive	22	256	–	–	–	–
Taltson Project	Proposed	1	1,522	1	1,201	1	1,201.0
Total		**175**	**51,645**	**210**	**78,671**	**202**	**74,099**

Notes: ha = hectare; – = not applicable. Gahcho Kué was assume to be active and part of the existing environment for the purpose of the effects assessment

15.4.7.1.2 Habitat Fragmentation

In addition to direct habitat loss, the Project would also fragment the existing landscape, potentially altering the quality of habitat available. Habitat fragmentation is the progressive subdivision of habitat patches into smaller fragments. Although fragmentation always accompanies habitat loss, it is a different phenomenon (McGarigal and Cushman 2002). Habitat fragmentation effects are of a lesser magnitude than direct habitat loss (Andrén 1999, Fahrig 1997, 2003). Possible effects of habitat fragmentation include changes to predator-prey dynamics and the persistence of wildlife populations. With respect to the Project, habitat fragmentation is anticipated through localized site clearing such as at the Twin Gorge facilities and staging areas, and from linear disturbances, such as the transmission line ROW and portages for the winter road.

15.4.7.1.2.1 Methods

The analysis undertaken to estimate the effects of habitat fragmentation from the Project on grizzly bear and wolverine requires a detailed description of the habitats present in each study area. The EOSD landscape mapping data available for the CESAs, though used to estimate the effects of habitat loss (see Section 15.4.7.1.1), was too broad to assess changes in habitat quality. Suitable land cover data was available for the SGP (Figure 15.4.2). However, due to the limited extent of the dataset, the analysis was not completed for boreal wolverine. In this case, a qualitative assessment was completed instead.

The incremental and cumulative effects of habitat fragmentation on grizzly bear and tundra wolverine from the Project footprint and development database (described in Section 15.4.7.1.1) in the SGP study areas, were analyzed through changes in the area, composition, and spatial configuration of habitat classes on the landscape (i.e. landscape metrics). Landscape metrics for each habitat included total area, number of patches, mean area of patches, mean distance to the nearest similar patch, and coefficient of variation of mean distance to the nearest similar patch.

To estimate the effects of habitat fragmentation, grizzly bear and tundra wolverine habitat were classified using a remote sensing Land Cover of Canada data (1985 to 2000) provided by the Government of Canada in a GIS platform; land cover classes were developed similar to Johnson et al. (2004, 2005). The land cover dataset was modified from 1,000 m cell sizes to a 25 m resolution, and then joined with esker habitat in 1:50,000 scale national topographic database (NTDB) layers. The merged database was similar to the SGP dataset used in Johnson et al. (2004, 2005).

However, upon joining layers, the dataset was re-sampled to 200-m cell sizes using a nearest neighbour algorithm (versus 100 m in Johnson et al. [2004, 2005]) because of computational constraints with generating habitat rasters over the study area. Tests for accuracy suggested there were minimal differences in the overall areas per cover class between a 100 m resampled dataset, versus a 200 m resampled dataset (i.e. less than 0.1%). The Project footprint was also re-sampled to 200 m cell sizes (i.e. all features, including the transmission line ROW and the winter road were assumed to be 200 m wide). Therefore, results determined from the fragmentation analysis are conservative and result in an overestimation of disturbed area. In addition, the 200 m cell size facilitates consistency between the fragmentation calculations and wildlife habitat suitability modelling. Finally, the Land Cover of Canada data was reclassified into 12 classes that were similar to Johnson et al. (2004, 2005). Visual inspections of the distribution of cover data in the areas that overlapped the Slave Geological Province and Land Cover of Canada guided the reclassification process.

Land cover metrics were determined using the program FRAGSTATS (Version 3.0) within a GIS platform. The fragmentation analysis investigated the extent of land cover fragmentation by calculating statistical outputs based on the values of each raster cell. The change in land cover metrics from the development of the Project was determined for the Project footprint for the spring through autumn period (grizzly bear and tundra wolverine), and winter period (tundra wolverine only as grizzly bear hibernate during winter). Fragmentation analysis included the winter access road footprint for the winter period only.

Habitat fragmentation was measured at three discrete points in time:

- within a pristine environment (little to no development);
- within the existing (i.e. 2007) environment including the Gahcho Kué Project; and
- application of the Project to the existing (2007) landscape.

The period of time between pristine and existing environments is referred to as the baseline. The cumulative effect of the Project on the fragmentation of habitat was estimated by calculating the relative difference between the pristine and existing environments, and following the addition of the Project (application base). The following equations were used:

- baseline = (existing value – pristine value) / pristine value
- application = ([existing value + the Project] – [existing value]) / existing value)

This provides both direction and magnitude of the effect. For example, a high negative value for habitat area would indicate a substantial loss of that habitat class. Alternately, a negative value for mean distance to nearest neighbour indicates an increase in patch connectivity. Absolute differences in land cover metrics among cases are also provided (see Appendix 15.4A).

15.4.7.1.2.2 Results

Habitat fragmentation would be limited in Project boreal and tundra environments because:

- only 17% of the habitat through which the transmission line ROW would traverse south of the treeline is closed forest, which is more susceptible to fragmentation effects by winter road portages and the ROW than open areas such as water, open forest or unforested land;
- the calculations assume that the Project footprint was no less than 200 m wide (including the 30 m wide ROW); and
- no vegetation clearing is required on the tundra, with the exception of the transmission tower foundations and staging areas.

Analysis indicated that the relative change in measures of habitat fragmentation due to existing development and the proposed Project are low. For spring through autumn, total area per habitat class was reduced by less than or equal to 1.5% for esker, and 0.6% or less for all other habitat classes, from pristine through to existing conditions. With the addition of the Project, incremental decreases in area of habitat was less than or equal to a further 0.1% per habitat class (Table 15.4.15; see Appendix 15.4A for absolute values). The sum of these changes is the cumulative effect. The number of patches of each habitat class was reduced by 0.9% or less through to existing conditions. The incremental change in the number of habitat patches was 0.1% or less (i.e. negligible) per habitat class with the addition of the Project. The maximum decrease in numbers of patches of a habitat class due to the cumulative effects of the Project and other developments on the land cover in the SGP was 0.9% (Table 15.4.15). The number of patches increased by 0.1% for heath tundra and heath rock habitat classes.

Esker habitat is of particular importance for grizzly bears. The area of esker habitat has declined 1.5% since pristine land cover conditions. With the application of the Project, the change to esker habitat is not detectable. Similar trends were noted for the number of patches of esker habitat. Historic and existing developments have reduced the number of esker patches by 0.9%, and with the addition of the Project, there should be no detectable change in the number of esker patches in the SGP.

For tundra wolverine during the winter period, the largest decline in area of a habitat type was for esker, which declined 1.6% from pristine to existing conditions, but the incremental change was negligible (i.e. less than 0.1%) (Table 15.4.16). Rock association, a class selected by wolverine, has undergone a loss of 0.3% since pristine conditions, but the incremental changes are anticipated to be negligible. Application of the Project resulted in a 0.1% or less decrease in area among habitat classes. Similar trends were noted for number, size, and spatial distribution of similar habitat patches across the winter range of tundra wolverine population. The cumulative change (i.e. the sum of the baseline and application changes) in these metrics from the Project and other developments in the SGP is less than 1.5%. Data were not available to calculate fragmentation statistics for boreal wolverine. However, as the tundra wolverine has experienced higher levels of development relative to the boreal wolverine (0.6% of the CESA disturbed relative to 0.3% of the CESA for boreal wolverine), there is less potential for habitat fragmentation. Further, fragmentation effects have less effect than habitat loss (Fahrig, 1997: Andrén, 1999). Habitat fragmentation within the boreal wolverine range was thus considered to be minor. See Appendix 15.4A for absolute values of fragmentation statistics.

Table 15.4.15 — Proportional Landscape Changes (%) from Development in Spring through Autumn for Grizzly Bear and Tundra Wolverine, Slave Geological Province

Habitat Land Cover Class	Total Area (hectares)		Number of Patches		Total Edge (metres)		Mean Area of Patch (hectares)		Coefficient of Variation for Patch Area (%)		Mean Distance to Nearest Neighbour (metres)	
	Baseline	Application	Baseline	Application	Baseline	Application	Baseline	Application	Baseline	Application	Baseline	Application
Esker	-1.5	< -0.1	-0.9	< -0.1	-1.3	< -0.1	-0.6	< -0.1	-0.4	< -0.1	0.5	< -0.1
Lichen veneer	-0.3	-0.1	-0.4	< -0.1	-0.4	< -0.1	0.1	< -0.1	0.1	< -0.1	0.1	< -0.1
Rock association	-0.3	< -0.1	-0.3	< -0.1	-0.2	< -0.1	0.0	< -0.1	-0.1	< -0.1	< -0.1	< -0.1
Heath tundra	-0.4	-0.1	-0.2	0.1	-0.3	< -0.1	-0.2	-0.2	-1.1	-20.3	< -0.1	< -0.1
Heath rock	-0.4	< -0.1	-0.2	0.1	-0.4	< -0.1	-0.2	-0.1	-0.7	0.1	0.1	< -0.1
Sedge association	-0.4	< -0.1	-0.3	< -0.1	-0.4	< -0.1	-0.1	-0.1	0.2	-0.1	0.1	< -0.1
Riparian shrub	-0.3	< -0.1	-0.3	< -0.1	-0.3	< -0.1	0.0	< -0.1	0.1	< -0.1	0.1	< -0.1
Low shrub	-0.2	< -0.1	-0.3	< -0.1	-0.2	< -0.1	0.1	< -0.1	0.0	< -0.1	0.1	< -0.1
Forest	-0.6	< -0.1	-0.5	< -0.1	-0.5	< -0.1	-0.1	< -0.1	-0.1	< -0.1	0.1	< -0.1
Peat bog	-0.4	0.0	-0.3	0.0	-0.4	0.0	-0.1	0.0	-0.2	0.0	0.1	0.0
Young burn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Old burn	-0.5	0.0	-0.2	0.0	-0.4	0.0	-0.2	0.0	-0.1	0.0	0.0	0.0
Nonvegetated	-0.4	< -0.1	-0.1	0.1	-0.3	0.0	-0.3	-0.1	0.2	0.0	0.0	0.0

Notes:

Baseline = relative change from pristine to existing conditions in 2007.

Application = relative change to existing conditions resulting from the Taltson Project.

Note: Baseline and Application estimates were derived from input values of greater precision than are reported in Appendix 15.4A.

Table 15.4.16 — Proportional Landscape Changes (%) from Development in Winter for Tundra Wolverine, Slave Geological Province

Land Cover Class	Total Area (hectares)		Number of Patches		Total Edge (metres)		Mean Area of Patch (hectares)		Coefficient of Variation for Patch Area (%)		Mean Distance to Nearest Neighbour (metres)	
	Baseline	Application	Baseline	Application	Baseline	Application	Baseline	Application	Baseline	Application	Baseline	Application
Esker	-1.6	< -0.1	-0.9	< -0.1	-1.4	< -0.1	-0.7	< -0.1	-0.4	< -0.1	0.6	< -0.1
Lichen veneer	-0.3	-0.1	-0.5	< -0.1	-0.4	< -0.1	0.2	-0.1	0.1	0.1	0.1	< -0.1
Rock association	-0.3	< -0.1	-0.3	< -0.1	-0.3	< -0.1	0.0	< -0.1	-2.0	< -0.1	0.0	< -0.1
Heath tundra	-0.5	-0.1	0.0	0.1	-0.4	< -0.1	-0.5	-0.2	-21.9	-7.2	0.0	< -0.1
heath rock	-0.5	< -0.1	-0.2	0.1	-0.4	< -0.1	-0.3	-0.1	-1.1	0.1	0.1	< -0.1
Sedge association	-0.4	< -0.1	-0.3	< -0.1	-0.4	< -0.1	-0.2	-0.1	0.1	-0.1	0.1	< -0.1
Riparian shrub	-0.3	< -0.1	-0.4	< -0.1	-0.3	< -0.1	0.0	< -0.1	0.1	< -0.1	0.1	< -0.1
Low shrub	-0.2	< -0.1	-0.3	< -0.1	-0.3	< -0.1	0.1	< -0.1	0.0	< -0.1	0.2	< -0.1
Forest	-0.7	< -0.1	-0.4	< -0.1	-0.5	< -0.1	-0.2	< -0.1	0.0	< -0.1	0.2	< -0.1
Peat bog	-0.5	0.0	-0.3	0.0	-0.4	0.0	-0.2	0.0	-0.2	0.0	0.0	0.0
Young burn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Old burn	-0.6	0.0	-0.3	0.0	-0.5	0.0	-0.3	0.0	-0.1	0.0	0.0	0.0
Nonvegetated	-0.8	< -0.1	0.3	0.1	0.2	< -0.1	-1.1	-0.1	0.2	0.1	0.0	< -0.1

Notes:

Baseline = relative change from Pristine to existing conditions in 2007.

Application = relative change to existing conditions resulting from the Taltson Project. Note: Baseline and Application estimates were derived from input values of greater precision than are reported in Appendix 15.4A.

15.4.7.2 SENSORY DISTURBANCE LEADING TO CHANGES IN HABITAT QUALITY FOR GRIZZLY BEAR AND WOLVERINE

Development and the associated activity lead to changes in the surrounding distribution of grizzly bear and wolverine (Johnson et al., 2004, 2005), likely due to attraction and avoidance (see Section 9.5.7 Biological Environment for a summary of existing information). This can be viewed as a change in habitat quality surrounding the development due to sensory disturbance (i.e. smells, noise and human activity from the development). To estimate effects to grizzly bear and tundra wolverine habitat quality, three sources of information were used: information available from the literature, estimates of Project noise emissions, and resource selection functions (RSF).

15.4.7.2.1 Methods

The study area used for RSF analysis was the SGP (Figure 15.4.2). The EOSD landscape mapping data available for the CESAs, though beneficial for estimating the effects of habitat loss (see Section 15.4.7.1.1), was too broad to assess changes in habitat quality. The SGP was thus used to take advantage of existing data. The SGP also approximates the likely population boundaries of the grizzly bear and tundra wolverine. The RSF uses the Project footprint and development database (described in Section 15.4.7.1.1) and the remote sensing Land Cover of Canada dataset provided by the Government of Canada in a GIS platform (Johnson et al. 2004, 2005). The land cover dataset was modified from 1,000 m cell sizes to a 25 m resolution, and then joined with an esker layer (1:50,000 scale) from the National Topographic Data Base (NTDB). The merged database was similar to dataset used in Johnson et al. (2004, 2005). However, upon joining layers, the dataset was re-sampled to 200 m cell sizes using a nearest neighbour algorithm [versus 100 m in Johnson et al. (2004, 2005)] because of computational constraints with generating habitat rasters for the study area. Tests for accuracy suggested there were marginal differences in the overall areas per cover class between a 100 m resampled dataset, versus a 200 m resampled dataset (i.e. less than 0.1%). The Project footprint was also re-sampled to 200-m cell sizes (i.e. all features, including the transmission line ROW and the winter road were assumed to be 200 m wide). Finally, the Land Cover of Canada dataset was reclassified into 12 classes according to Johnson et al. (2004, 2005). Visual inspections of the distribution of cover data in the areas that overlapped the SGP and Land Cover of Canada guided the reclassification process.

Using the output from the reclassified dataset, patches of habitat per land cover class were identified such that each patch was a contiguous group of cells. Next, the proportional area of each patch, relative to that available for the related land cover class in a seasonal range was determined. Resource selection values were generated per cell based on the resulting raster layers and the application of RSF coefficients and formulas in Johnson et al. (2004, 2005) for grizzly bear and wolverine Table 15.4.17 and Table 15.4.18). Water bodies were calculated as nil (zero) during the habitat mapping process.

Table 15.4.17 — Resource Selection Model Coefficients for Grizzly Bear

Covariate	Spring Coefficient	Lower 95% CI	Upper 95% CI	Early Summer Coefficient	Lower 95% CI	Upper 95% CI
Sedge patch	0.585	0.142	1.029	1.381	0.994	1.768
Riparian shrub patch	1.527	0.458	2.595	2.085	1.003	3.167
Low shrub patch	1.388	0.849	1.928	1.994	1.484	2.504
Peat bog patch	n/a	n/a	n/a	n/a	n/a	n/a
Heath tundra patch	0.465	0.169	0.760	0.914	0.644	1.191
Heath rock patch	0.626	0.290	0.962	-0.001	-0.354	0.352
Rock patch	0.594	0.133	1.055	0.447	0.016	0.937
Forest patch	0.440	-1.811	2.692	n/a	n/a	n/a
Lichen patch	0.891	0.128	1.654	-0.542	-1.528	0.445
Esker patch	1.684	0.361	3.008	1.745	0.480	3.011
Unvegetated Patch	2.053	1.447	2.660	0.081	-0.690	0.851
Covariate	Late Summer Coefficient	Lower 95% CI	Upper 95% CI	Autumn Coefficient	Lower 95% CI	Upper 95% CI
Sedge patch	1.269	0.852	1.686	0.631	0.087	1.176
Riparian shrub patch	2.164	1.175	3.154	1.364	0.125	2.604
Low shrub patch	1.963	1.389	2.537	2.030	1.275	2.785
Peat bog patch	1.366	-0.840	3.571	-0.866	-3.533	1.801
Heath tundra patch	0.630	0.330	0.930	1.137	0.795	1.479
Heath rock patch	0.214	-0.159	0.586	0.126	-0.321	0.572
Rock patch	0.158	-0.369	0.686	-0.072	-0.773	0.629
Forest patch	-0.131	-2.061	1.799	-0.486	-1.900	0.929
Lichen patch	-0.694	-1.718	0.330	-0.223	-1.316	0.870
Esker patch	4.876	3.812	5.940	1.864	-0.071	3.800
Unvegetated Patch	0.999	0.246	1.752	0.594	-0.366	1.554

Source: Johnson et al. 2004, 2005

n/a = not available; CI = confidence interval

Table 15.4.18 — Resource Selection Model Coefficients for Tundra Wolverine

Covariate	Winter Coefficient	Lower 95% CI	Upper 95% CI	Summer Coefficient	Lower 95% CI	Upper 95% CI
Sedge patch	1.802	1.146	2.458	1.739	0.975	2.504
Riparian shrub patch	1.509	-1.173	4.192	-0.687	-4.341	2.966
Peat bog patch	n/a	n/a	n/a	-4.949	-13.307	3.408
Heath tundra patch	0.445	-0.121	1.011	0.615	-0.001	1.230
Heath rock patch	0.749	0.230	1.268	0.181	-0.485	0.847
Rock patch	2.735	1.520	3.950	-0.791	-2.557	0.975
Lichen patch	-0.355	-1.715	1.005	-1.484	-3.629	0.660
Esker patch	-1.541	-4.671	1.590	0.579	-2.600	3.758

Source: Johnson et al. 2004, 2005

n/a = not available; CI = confidence interval

Effects of assumed disturbance, which were based on hypothetical (not modelled), disturbance coefficients and zones of influence (ZOI) (Table 15.4.19), were applied to the RSF outputs generated from land cover datasets. Hypothetical disturbance coefficients provide a surrogate to modelled coefficients, and are consistent with previous efforts to estimate effects from development on habitat quality (Johnson et al. 2005). Disturbance coefficients (DC) reduce habitat quality within each defined ZOI. For example, a DC of 0.05 implies that habitat quality was reduced by 95% of the original value.

Effects of assumed disturbance were used to quantify changes in the relative availability of different quality habitats during pristine, 2007 existing conditions, and application of the Project. Values of disturbance coefficients and zones of influence were guided by the published literature (Johnson et al. 2005). Correlation among disturbance effects could not be statistically controlled, and therefore, the effects of multiple coefficients at the same location were not multiplied. The coefficient with the strongest effect was applied where zones of influence overlapped, which increased certainty that the predicted effect would not be underestimated.

For all closed mines and inactive land use permits, the physical footprint was carried through the entire effects analysis as it was assumed that direct disturbance to the land cover had not yet been reversed, providing a conservative approach. The size of the ZOI was similar for all permitted mines (i.e. 30 km) regardless of the level of activity or size of the Project footprint. In addition, the extent of the ZOI for exploration camps was set at 15 km for the duration of the permit period (i.e. 5 years) even though exploration typically does not occur throughout the year. This increases confidence that the assessment does not under-estimate ecological effects from development.

After habitat maps and modelling for each seasonal home range were completed, raster cells (ranging from 0 to 1) were divided into four categories (high, good, low, and poor) of approximate equal area (delineated by quartiles). However, the ArcGIS algorithm for this task was constrained by the large study areas (i.e. seasonal ranges), and distribution of cell values. Thus, category thresholds were manually determined by plotting a histogram of raster cell values, and running the equal area function on a lower range of data without outliers. Larger outlying values were grouped into the top category identified from the analysis on the lower (smaller) range of values. The RSF outputs based on only vegetation datasets were used as the pristine condition.

Table 15.4.19 — Disturbance Coefficients for Development Activities and Associated Zones of Influence for Grizzly Bear and Tundra Wolverine, Slave Geological Province

Development Activity	Feature Type	Footprint Extent (m)	Footprint (DC)	ZOI Range1[2] (km)	DC	ZOI Range 2 (km)	DC	ZOI Range 3 (km)	DC
Communications (e.g. microwave towers)	Point	200	0.00	0-5	0.90	n/a	n/a	n/a	n/a
Community	Polygon	Actual[2]	0.00	0-1	0.05	1-5	0.50	5-20	0.75
Fuel storage	Point	200	0.00	0-5	0.90	n/a	n/a	n/a	n/a
Lodge (outfitters, tourism	Point	200	0.00	0-5	0.10	n/a	n/a	n/a	n/a
Mine	Polygon	Actual[2]	0.00	0-1	0.05	1-5	0.50	5-30	0.75
Mineral exploration /camps	Point	1, 000	0.00	0-10	0.50	10-15	0.75	n/a	n/a
Miscellaneous (e.g. bridge)	Point	200	0.00	0-5	0.90	n/a	n/a	n/a	n/a
Quarry	Point	200	0.00	0-5	0.75	n/a	n/a	n/a	n/a
Winter road	Line	200	0.00	0-1	0.05	1-5	0.75	n/a	n/a

Note: NA = not applicable; DC = disturbance coefficient; ZOI = zone of influence; m = metres; km = kilometre.

Values were guided by published literature (Johnson et al. 2005).

[1] footprint delineated from remote sensing imagery.

[2] from edge of measured or hypothetical footprint.

Relative decreases in the area of high, good, low, and poor quality habitat were then calculated. Relative versus absolute net decreases were calculated per habitat quality category because of unequal bin sizes. As a conservative approach, changes in the amount of habitat quality classes were considered only for terrestrial habitat. The following equations were used to calculate the relative change in the amount of different quality habitats for the seasonal ranges in each development scenario:

- baseline = (existing value – pristine value) / pristine value,
- application = ([existing value + the Project] – [existing value]) / existing value).

The resulting value was then multiplied by 100 to give the percent change in habitat quality for each comparison, and provides both direction and magnitude of the effect. Effects on preferred habitats (i.e. good and high-quality habitats) were also evaluated through use of RSF maps of the population range per season for grizzly bear and tundra wolverine.

15.4.7.2.2 Results

15.4.7.2.2.1 Literature Review

Within the tundra sections of the Project, very little vegetation clearing would be required, and would be limited to the transmission tower footprints and staging areas. Grizzly bear and tundra wolverine would, therefore, be exposed to a transmission line crossing the tundra that is otherwise undisturbed. No information could be found within the scientific literature regarding the response of grizzly bear and wolverine to a transmission line in the absence of other disturbances (i.e. vegetation removal). Harron (2003) estimated that, while construction activity would cause a temporary displacement of black bears, they appear to be unaffected by physical structures like the towers and lines (as long as human intrusion is limited). Some studies regarding wildlife reactions to transmission lines have been completed for reindeer in Norway. Reimers et al. (2007) investigated the effects of a 66 kV power line transecting a range of wild reindeer in south-central Norway. Over a 31-year period, the authors concluded that the 66 kV power line transecting the reindeer habitat was not a barrier towards reindeer migration, that reindeer were not displaced by the transmission line, and that reindeer crossed underneath and grazed under and on both sides of the transmission line. In contrast, Vistnes et al. (2001) found the combination of two parallel power lines and a closed winter road in alpine areas of Norway greatly reduced wild reindeer migration across the infrastructure, a result supported by both telemetry studies and differences in lichen biomass (reflecting relative grazing intensity).

Grizzly bear and wolverine in the SGP have been observed to avoid developments. Using a variety of methods, it has been shown that mines within the SGP affect tundra wolverine and grizzly bear distribution (see Johnson et al. 2005; De Beers 2008; DDMI 2008; BHPB 2007). In some cases avoidance is detected, while in others, attraction is detected. For example, at the Snap Lake Mine, the probability of wolverine tracks between 2003 and 2007 was found to decrease with distance from the mine, while the zone of influence estimate indicates that wolverine track occurrence declines past 7.2 km from the mine (De Beers 2008). Johnson et al. (2005) estimated that grizzly bears avoid exploration camp activity by up to 23 km in late summer. Grizzly bear movements and behaviour should not be affected by winter road because the road would only be in use during the winter months, when bears are in hibernation.

15.4.7.2.2.2 Noise Emissions

Sound emitting from transmission lines may cause sensory disturbances to local wildlife (Ferris 1979; Forman and Deblinger 2000; Spellerberg 2002). Noise from Project activities would be of greatest magnitude during the construction phase. During operation, noise would be limited to activities at Twin Gorges facilities, such as snow removal, weekly flights, some humming from infrastructure, and noise from wind.

The primary source of noise, in terms of duration and geographic extent, would be from the transmission line construction (incorporating both the staging areas and helicopter activity). Table 15.4.20 lists the predicted noise levels at various distances from the activity (see Appendix 12C for a more complete analysis of construction-related noise). The two ground-based scenarios assumed that equipment noise sources were working continuously within a 500 m by 250 m area.

Table 15.4.20 — Construction Scenario Noise Predictions by Distance from Activity

Distance from Source to Nearest Receiver (m)	PREDICTED NOISE LEVEL L_d (dBA)1,[2]				
	Clearing and Preparation (Staging or ROW)	Staging Areas	Helicopter Work (hovering at 200 m)	Helicopter Work (fly-by at 200 m)	Blasting
250	51	49	59	50	75
500	46	46	55	47	71
1,000	41	42	47	41	64
2,000	34	35	39	34	55
3,000	30	30	33	29	49
4,000	26	25	28	25	45
5,000	22	22	25	21.2	41
10,000	6	6	9	6	25

[1] dBA = decibels; ROW = right-of-way

[2] L_d (daytime) noise levels, average noise level over a 10-hour work day.

Based on Table 15.4.20, noise from construction work along the ROW or at staging areas can be expected to be lower than the likely baseline level of 35 dBA (MGP 2004; ERBC 2007) at approximately 2 km from most construction activity. Helicopter activity involving hovering would propagate farther, reaching a noise level of 35 dBA at about 2.5 km. Blasting may attenuate to 35 dBA at about 7 km, but, this is a short-term or instantaneous event so disturbances up to this distance would not be sustained. However, the character of construction noise would differ from natural sounds.

During the three-year construction period, winter roads would be used. A total of 80 truck loads are required to move material in the Project's Northern Sector, and up to 150 truckloads are planned for the Southern Sector. Convoys of three trucks are assumed, with up to two convoys per day.

For the purpose of calculating the noise from the winter roads, the worst case scenario becomes a maximum of six highway-type transport trucks per hour. The sound power output of a typical highway truck is 99 dBA (FHWA 2006). Based on the same calculation methods used for the construction activity (ISO 1996), this indicates that the hourly noise level from the passage of six highway trucks would reach the upper end of ambient noise level (35 dBA) within approximately 500 m from the roadway. Noise levels would diminish to 25 dBA at approximately 1,500 m.

Overhead transmission lines may generate electric field noise that is audible, referred to as corona noise. Corona noise is generated by occasional discharges on insulators or in the air near the conductors. This noise is perceived as a hum or buzz, and becomes more pronounced in periods of high humidity. An audible corona noise level of 55 dBA at 15 m from the source is a design constraint used by other transmission line operators (BCTC, 2008). Based on distance attenuation only, this would diminish to 25 dBA at 50 m from the transmission line. Specific to the Project, audible noise levels generated by the lines during fair weather are predicted to be below 30 dBA. Noise levels may rise in humid conditions, but at no point should corona noise exceed 35 dBA (Teshmont 2008).

15.4.7.2.2.3 Resource Selection Functions

Resource selection functions provided an estimate of the change in habitat quality due to disturbance within the SGP. The scenarios considered were the pristine environment, the existing environment, and the application scenario (the existing environment with the Taltson and Gahcho Kué Projects). Results were generated for both grizzly bear and tundra wolverine.

For grizzly bear in spring, there was a 6.1% decrease in preferred habitats (high and good quality habitats combined) from pristine to existing (2007) conditions A further 0.1% decrease may occur due to the Project (i.e. a cumulative loss of 6.2%, (Table 15.4.21). For the early summer period, there was a 7.9% decline in preferred habitats from pristine to existing conditions. A further 0.1% decrease may occur due to the Project (Table 15.4.21).The largest decline in preferred habitats was for late summer. Historic and existing development was calculated to have reduced preferred grizzly bear habitat by 11% relative to pristine conditions (Table 15.4.21) and the incremental change in preferred habitats from the Project is 0.3%. There was a 7.8% decline in high and good quality habitats from pristine to existing conditions for the autumn season. With the addition of the Project, there was an incremental decline of preferred habitats by 0.2% in the autumn season.

The RSF modelling was also used to describe relative changes in the availability of habitat during the summer and winter period for wolverine in the SGP. For the summer period, the existing land cover had 11.0% less high and good-quality habitat than the pristine land cover. The incremental effect of the Project was a reduction of high and good-quality habitat by 0.2% (i.e. a cumulative loss of 11.2%). For the winter period, the historic and existing developments decreased high and good-quality habitat by 8.9% relative to a land cover with no development (Table 15.4.22). With the addition of the Project, there was an incremental decrease in preferred habitat by 0.2%. These estimates are based on the conservative assumption that the Project footprint, including the transmission line ROW, is at least 200 m wide.

Table 15.4.21 — Relative Changes in the Amount of Habitat within the Slave Geological Province for Grizzly Bear from Pristine through to Application of Project

Season / Habitat Category	Pristine (ha)[1]	Existing (ha, 2007)[2]	% Change from Pristine to Existing[3]	Application (ha)[4]	% Change from Existing to Application[3]
SPRING					
High	1,046,452	787,888	-1.7	779,168	-0.1
Good	2,364,048	1,680,092	-4.4	1,673,552	0.0
Low	2,212,564	1,592,468	-4.0	1,572,960	-0.1
Poor	9,980,724	11,543,340	10.0	11,578,108	0.2
Nil (water)	4,252,192	4,252,192	NA	4,252,192	NA
Total[5]	**15,603,788**	**15,603,788**	**NA**	**15,603,788**	**NA**
EARLY SUMMER					
High	2,204,768	1,649,388	-3.6	1,646,668	0.0
Good	2,552,952	1,883,076	-4.3	1,864,000	-0.1
Low	4,205,348	3,061,396	-7.3	3,039,388	-0.1
Poor	6,638,364	9,007,572	15.2	9,051,376	0.3
Nil(water)	4,251,236	4,251,236	NA	4,251,236	NA
Total[5]	**15,601,432**	**15,601,432**	**NA**	**15,601,432**	**NA**
LATE SUMMER					
High	2,574,016	1,776,180	-5.1	1,764,324	-0.1
Good	3,602,876	2,675,520	-5.9	2,647,772	-0.2
Low	8,887,176	6,477,120	-15.4	6,426,696	-0.3
Poor	539,720	4,674,968	26.5	4,764,996	0.6
Nil (water)	4,252,192	4,252,192	NA	4,252,192	NA
Total[5]	**15,603,788**	**15,603,788**	**NA**	**15,603,788**	**NA**
AUTUMN					
High	2,164,944	1,478,116	-4.4	1,463,808	-0.1
Good	2,166,144	1,635,832	-3.4	1,617,652	-0.1
Low	10,005,984	7,280,208	-17.5	7,223,092	-0.4
Poor	1,266,716	5,209,632	25.3	5,299,236	0.6
Nil (water)	4,252,192	4,252,192	NA	4,252,192	NA
Total[5]	**15,603,788**	**15,603,788**	**NA**	**15,603,788**	**NA**

Notes: ha = hectare; % = percent; NA = not applicable.

Due to unascribed GIS computational errors, the absolute value of changes to amount of habitat are not consistent across seasons.

[1] Pristine land covers (no development) were compared to maps modified by hypothetical disturbance coefficients and zones of influence (i.e. assumed disturbance).

[2] Existing includes Gahcho Kué.

[3] % change per habitat category was calculated as area lost or gained divided by total area of terrestrial habitat.

[4] Application includes Taltson.

[5] Total terrestrial habitat across categories.

Table 15.4.22 — Relative Changes in the Amount of Habitat for Wolverine within the Slave Geological Province from Pristine through to Application of the Project

Season / Habitat Category	Pristineha)[1]	Existing (ha, 2007)[2]	% Change from Pristine to Existing[3]	Application (ha)[4]	% Change from Existing to Application[3]
SUMMER					
High	3,006,804	2,108,344	-5.8	2,091,992	-0.1
Good	2,946,480	2,132,408	-5.2	2,109,868	-0.1
Low	9,264,076	6,764,268	-16.0	6,711,636	-0.3
Poor	386,428	4,598,768	27.0	4,690,292	0.6
Nil (water)	4,252,192	4,252,192	NA	4,252,192	NA
Total[5]	**15,603,788**	**15,603,788**	**NA**	**15,603,788**	**NA**
WINTER					
High	2,174,884	1,418,796	-4.8	1,404,396	-0.1
Good	2,152,172	1,519,876	-4.1	1,507,872	-0.1
Low	9,691,940	6,772,608	-18.7	6,727,136	-0.3
Poor	1,584,792	5,892,508	27.6	5,964,384	0.5
Nil (water)	4,252,192	4,252,192	NA	4,252,192	NA
Total[5]	**15,603,788**	**15,603,788**	**NA**	**15,603,788**	**NA**

Notes: ha = hectare; % = percent; NA = not applicable.

[1] Pristine land covers (no development) were compared to maps modified by hypothetical disturbance coefficients and zones of influence (i.e. assumed disturbance).

[2] Existing includes Gahcho Kué.

[3] % change per habitat category was calculated as area lost or gained divided by total area of terrestrial habitat.

[4] Application includes Taltson.

[5] Total terrestrial habitat across categories.

Graphic representation of changes to grizzly bear habitat suitability for each of the four seasons is provided in Appendix 15.4B, Grizzly Bear Habitat Suitability Maps. Graphic representation of changes to wolverine habitat suitability for each of the two seasons is provided in Appendix 15.4B, Wolverine Habitat Suitability Maps.

Effects to habitat quality are also relevant within the boreal environment. For example, May et al. (2006) found that boreal wolverine habitat selectivity was higher for wolverine in areas with low human development than in high areas of human development, suggesting that wolverine avoid areas with human infrastructure in forested habitats (May et al. 2006). As of yet, RSFs have not been developed for boreal wolverine, so a similar analysis could not be completed for activity south of the treeline. However, considering that:

- there is a slightly higher level of activity within the tundra wolverine CESA than in the boreal CESA (210 developments, of which 87 are active, in the tundra CESA versus 175 developments, of which 81 are active, in the boreal wolverine CESA, Table 15.4.14),
- development footprints were assumed to be larger than they actually are (e.g. the transmission line ROW was assumed to be 200 m wide, and mineral exploration camps were estimated to have a footprint of 314 ha);
- disturbance coefficients were over-estimated when there was uncertainty; and,
- sensory disturbance likely travels farther on the treeless tundra environment than in boreal environments;

the change in habitat quality has likely been over-estimated within the tundra environment, and effects within the boreal environment are likely less than that modelled within the tundra environment (i.e. the SGP).

15.4.8 Effects to Passerines, Waterfowl, and Raptors

15.4.8.1 Project Footprint Leading to Habitat Loss and Fragmentation for Passerines

The Project would require localized vegetation clearing, which would result in changes to and reduction of habitat for passerines. In addition to direct loss of habitat, the Project would also result in fragmentation of the existing landscape. Habitat fragmentation is the progressive subdivision of habitat blocks into fragments. Although fragmentation always accompanies habitat loss, it is a different phenomenon (McGarigal and Cushman 2002). Habitat fragmentation effects are of lesser a magnitude than direct habitat loss (Andren 1999, Fahrig 1997, 2003).

15.4.8.1.1.1 Habitat Loss Methods

Direct loss of habitat for passerines from the Project (incremental effects) and all existing and historic developments (cumulative effects) was estimated for the assessment. Existing development included the Project and the Gahcho Kué Project for the cumulative effects assessment.

The incremental effects associated with habitat loss from the Project footprint, including the winter access roads, were estimated using geographical information system (GIS) software. The estimated Project footprint was compared to land cover information, obtained from Natural Resources Canada (NRCan). This data is commonly known as Earth Observation for Sustainable Development of Forests (EOSD, Figure 15.4.7) and is primarily obtained from satellite imagery, such as Landsat-7 Enhanced Thematic Mapper. Using GIS software, the image was converted to a grid for analysis. The EOSD data was clipped to extract all landscape information within each VC's RSA, and the landscape classes and total areas within each RSA were described. Cumulative effects were assessed by estimating the habitat loss from all existing and historic developments within the CESA.

Methods used to create a shapefile of the Project footprint, and to create a database describing existing and historic development, are described in Section 15.4.7.1.1.1, as the methods were the same as those used to estimate habitat loss for grizzly bear and wolverine.

Incremental effects were assessed within the RSA, while cumulative effects were assessed within the CESA (see Table 15.4.4). The RSA for passerines included all Project components plus a 5 km buffer, for a total area of 1,003,443 ha. The CESAs were defined using estimates of natal dispersal distances as buffer widths around the proposed Project footprint. The dispersal distance used for passerines was 11 km. This results in an area of 1,900,857 ha for passerines (Table 15.4.4), as shown in Figure 15.4.1.

15.4.8.1.1.2 Habitat Loss Results

The effects of habitat loss on passerines have been well documented in the literature. Vegetation loss contributes to habitat degradation and reduced carrying capacity (Hansson et al 1995, Batary and Baldi 2004). However, it is anticipated that passerines would continue to nest and forage beneath the transmission lines, based on the results of two studies. Niemi and Hanowski (1984) found that changes to passerine densities below transmission lines were negligible. Milsom et al (2000) documented continued use of marshes below transmission lines, but with slightly reduced presence when compared to control areas. Possible reasons for this change proposed by Milsom et al. (2000) include effects to habitat due to transmission tower foundations, use of the transmission line and towers as perches by raptors, and interference with bird aerial displays.

Densities of passerines north of treeline were obtained from passerine monitoring conducted at the Ekati Diamond Mine since 1997 (BHPB 2007). These data provide an estimate of passerine density at 2.14 birds per hectare (birds/ha), excluding water (i.e. lakes, ponds, rivers). The density of passerines in boreal regions of Canada was estimated to be 4.60 birds/ha (presumably including water), based primarily on data from the Canadian Breeding Bird Census (BBC) (Blancher 2003). More specific to the Project region, baseline data collected by Fortune Minerals Ltd. suggests that passerine densities are slightly lower within the Taiga Shield. The Fortune Minerals NICO Project is located 40 km northwest of the community of Wha Ti, and, like much of the boreal sections of the Taltson Project, is located within the Taiga Shield High Boreal Ecoregion (see Section 9.1 - Location). Table 15.4.23 outlines the passerine densities in the major habitat classes, and overall passerine density, recorded at the NICO Project.

Table 15.4.23 — Passerine Density by Land Cover Class, Fortune Minerals' NICO Project

Land Cover Class	Density of passerines (birds/ha)
Bedrock open conifer	2.70
Mixedwood	3.91
Treed bog	4.15
Marsh/graminoid fen	4.84
Coniferous spruce	4.89
Treed fen	5.14
Deciduous aspen paper birch	5.24
Open bog	7.01
Shrubland	8.12
Total	**4.36**

Note: Results are preliminary, derived from Fortune Minerals Ltd. unpublished data.

Considering first the local, direct effects of the Project, the total habitat disturbance from the Project (incremental effect) is approximately 2,724 ha (Table 15.4.11), of which 1,201 ha is north of the treeline (949 ha when water is excluded; Table 15.4.12). Approximately 21% of the Project footprint would be over water, and 9% would be winter road over lakes, which is unlikely to disturb passerines.

North of the treeline, 85% of the area to be disturbed consists solely of the transmission line ROW, within which vegetation clearing would be limited to the transmission tower foundations, so the actual area to be disturbed would be substantially less. The area of vegetation disturbance would be limited to the staging areas (up to 5 ha each), the foundation for the transmission tower and guy wires (ranging from 1 to 7 m^2 per tower according to the substrate and the type of foundation required [Teshmont 2008]), and any damage to vegetation from the winter roads. Thus, the area of vegetation disturbance in the tundra environment is less than the Project footprint would suggest. As stated above, the density of passerines in the tundra environment is low, approximately 2.14 birds/ha (BHPB 2007).

South of the treeline, the Project is anticipated to cover a total of 1,522.34 ha (assuming a ROW of 30 m width). Not all of this area would be disturbed by the Project. Approximately 70% of the Project footprint is the ROW (assuming a 30 m ROW). Mechanical clearing of the ROW within boreal regions would range from 15 to 30 m wide, as required to maintain an adequate clearance between trees and the transmission line. In some designated areas (i.e. East Arm National Park, and surrounding the Indian Shack Staging Area), selective clearing of vegetation would occur to reduce effects and maintain shrub-level vegetation.

Much of the landscape in the boreal region supports relatively low passerine densities. The land cover classes of coniferous sparse and coniferous open together constitute approximately 30% of the area to be disturbed by the Project. These are roughly equivalent to the bedrock open conifer class from the Fortune Minerals' baseline data (Table 15.4.23), which found these habitats to have the lowest passerine density of all areas sampled (2.70 birds/ha). Approximately 15% of the Project footprint south of the treeline would be exposed land, which also supports low passerine densities (Table 15.4.13). Approximately 27% of the Project footprint would be over water, which does not support passerine nests.

Considering the vegetation available at the larger scale of the RSA, the Project would disturb less than 1% (or 0.28% of the RSA above the treeline, 0.26% below the treeline), assuming a 30 m wide ROW. The three dominant land cover classes are water, shrub low, and coniferous open, together constituting approximately 55% of the existing land cover (Table 15.4.11). The abundance of open land cover classes in the RSA indicate that clearing for the transmission line can be better described as a change in the ratio of existing habitat classes, rather than the introduction of a new habitat. South of the treeline, only 17% of the RSA is closed forest.

Very little of the passerine CESA would be disturbed by the cumulative effects of the Project and other developments. The CESA for passerines comprises 852,395 ha above treeline and 1,048,462 ha below treeline, based on the 11 km natal dispersal distance (Table 15.4.4). North of the treeline, historic and current land cover disturbances include mines, mineral exploration camps, winter roads and associated winter roads. These collectively amount to a total estimated disturbance of 18,657 ha including the Project, or 2.2% of the above-treeline CESA (Table 15.4.24). In the boreal regions, the total area that has been disturbed by existing or historic development within the passerine cumulative effects study areas is approximately 3,179 ha or 0.3% of the below-treeline CESA (Table 15.4.24).

Table 15.4.24 — Historic and Existing Developments in the Cumulative Effects Study Area for Passerines and Waterfowl in Tundra and Boreal Ecosystems

Activity	Number	Status	Area (ha)
TUNDRA			
Lodge	2	Active	15
Mine	3	Active	3,379
Gahcho Kué project	1	Active	1,309
Mineral exploration/camp	11	Active	3,521
Mineral exploration/camp	18	Inactive	4,457
Miscellaneous	2	Inactive	26
Taltson Project	1	Proposed	1,201
Winter road[1]	1	Active	2,992
Gahcho Kué winter road[1]	1	Active	1,757
Total	**40**		**18,657**
BOREAL			
Community	1	Inactive	19
Mineral exploration/camp	2	Active	667
Mineral exploration/camp	1	Inactive	253
Quarrying	1	Active	13
Taltson Project	1	Proposed	1,522
Transmission line	1	Active	225
Winter road[1]	1	Active	480
Total	**8**		**3,179**

[1] Winter roads would not be in operation during the breeding season.

Note: Gahcho Kué was assume to be active and part of the existing environment for the purpose of the effects assessment

15.4.8.1.2 Habitat Fragmentation

In addition to direct loss of habitat, the Project would also result in fragmentation of the existing landscape. Habitat fragmentation is the progressive subdivision of habitat blocks into fragments. Although fragmentation always accompanies habitat loss, it is a different phenomenon (McGarigal and Cushman 2002). Habitat fragmentation effects are of lesser magnitude than direct habitat loss (Andren 1999, Fahrig 1997, 2003). Only 17% of the boreal regions of the RSA consist of closed forest. The abundance of open and sparse forest in the RSA indicates that clearing for the transmission line can be better described as a change in the ratio of existing habitat classes, rather than the introduction of a new habitat.

Relatively narrow ROWs of less than 30 m in width appear to have limited impacts on the forest bird community (Harron, 2003), but bird movement may still be reduced. As the ROW width increases, a more open area is created which is better suited to the development of a shrubland bird community. Several forest bird species experience increased difficulty with respect to crossing the gap in the forest created by the ROW, particularly as its width increased beyond 30 m (Harron, 2003).

Some studies have found little to no effects of habitat fragmentation on birds (McGarigal and McComb 1995) while others have documented impacts to bird density and populations for specific species (Jalkotzy et al. 1997). Using simulation models, With and Crist (1995) found that the effect of habitat fragmentation on a species depends on its habitat requirements and dispersal ability. For example, a species with very specific habitat requirements and low dispersal ability is more likely to be impacted by habitat fragmentation. A species that disperses well (such as upland birds) would generally consider habitat patches to be connected even when covering only 35 to 40% of the landscape (With and Crist 1995). According to Fahrig (1997), the total amount of habitat remaining is more important for survival than the configuration of the remaining habitat (i.e. habitat loss is of greater concern than habitat fragmentation).

A complicating factor, but one that is likely to limit effects of habitat fragmentation to passerines, is the structure of the surrounding habitat (Jalkotzy et al. 1997). Closed forest may be more affected by clearing for winter roads and the transmission line ROW. Of the terrestrial vegetation that may be disturbed by the Project, only 22% is closed forest. The remaining landscape classes are either open or sparse forest, unvegetated, or shrubby. There currently exist communities of passerines that select open or shrubby habitats, such as white-throated sparrow, Harris' sparrow, yellow warbler and dark-eyed Junco.

Edge effects refer to those ecosystem changes that occur near the periphery of a habitat class, often in reference to clearing of forest habitat. It is believed that edge habitat generally supports a higher abundance of nest predators (Johnson and Temple 1990). For example, Kroodsma (1982) found that the edge effect did exist along a transmission line ROW and that bird densities increased along edges, due to an increase in species that prefer edge habitats, but also a decrease in species typically found in interior forest. Machtans (2006) found that songbird communities were not dramatically affected by 6 m wide seismic lines.

Ultimately, change to forest structure due to the Project is anticipated to have a negligible effect to passerine populations, given the patchy and open nature of the existing forest. Construction activity would be greatest during the winter, when most birds are not present, and roads would only be active in winter. Vegetation clearing above the treeline would be minimal, and neither the transmission line nor the clearings would create an impenetrable barrier to birds. Finally, vegetation loss is understood to be of greater importance to birds than fragmentation. Fragmentation effects were thus considered to be negligible and of local geographic extent.

15.4.8.2 Sensory Disturbance Leading to Changes in Habitat Quality for Passerines, Waterfowl and Raptors

15.4.8.2.1 Construction Schedule

No clearing of vegetation would take place during the migratory bird nesting season, May 15 to July 31 (EC 2007). However, there are several areas where there would be some overlap between nesting activity and Project construction (see the Project construction schedule, Section 6.9).

Between Gahcho Kué and Snap Lake, no construction activity is planned between April 15 and September 15, thus there would be little sensory disturbance to raptors, waterfowl or passerines. Between Gahcho Kué and Ekati and Diavik, the setting of transmission tower foundations and anchors is anticipated to extend from mid-February to late April, in 2010. As there are few raptor nests in this area, and the overlap between construction activity and the nesting season is short, effects would be negligible and construction may be scheduled to avoid known raptor nests.

Within the southern section (from Twin Gorges north to approximately the Snowdrift River), the erection of transmission towers and subsequent stringing would take place from mid-July to October 2011. This leaves some overlap between construction activity and nesting. Within the East Great Slave Lake section (from the Snowdrift River north, approaching the Treeline staging area), helicopter erection and stringing of the transmission towers and conductor is scheduled to take place from mid-July to late October.

The area of greatest overlap between construction activities and raptor nesting is within the East Great Slave Lake sector. Hand-clearing of the transmission line ROW within the proposed Park would begin in August 2010. This area has high densities of raptor nests (Figure 15.4.3), and would require more prolonged construction activities than other regions. This is partly due to constraints imposed by efforts to mitigate other effects. For example, hand-clearing would be used within the Park boundaries to reduce effects to aesthetics and vegetation within the Park. This, however, leads to a more prolonged construction period.

The construction activities described above would be mobile. Hand-clearing is anticipated to progress at a rate of 0.5 km per day. Approximately 6 km of transmission towers may be erected in one day by helicopter, while conductor stringing is anticipated to proceed at a rate of 2 km per day (Teshmont, 2008). Thus, construction activity would not remain within 1.5 km of a nesting raptor for long. Regardless, the potential remains for loss of eggs or delayed hatching if incubation is interrupted for this duration.

During operations, there would be little activity associated with the Project. Anticipated sources of sensory disturbance include the permanent camp at Twin Gorges, annual inspections of the transmission line by helicopter, and residual disturbance caused by the transmission line. Birds often perch or nest on transmission lines and towers, indicating they are not a source of disturbance. Sound emitting from transmission lines would be very low, and likely at or below background levels (Teshmont, 2008, full summary in Section 15.4.7.2.2). It is anticipated that birds would continue to use undisturbed habitat beneath the transmission lines; Niemi and Hanowski (1984) and Milsom et al. (2000) documented continued use of marshes below transmission lines.

15.4.8.2.2 Effects of Disturbance to Passerines, Waterfowl and Raptors

Construction activities would generate noise and activity that may affect the movement, behaviour or reproductive success of passerines, waterfowl, and raptors. As described in Section 15.4.7.2.2, noise created by the Project would likely attenuate to baseline levels within 2.5 km. Blasting noise may travel further, up to 7 km, but this is a short-term event and disturbance would not be sustained. However, the character of the noise may be different from natural sounds, and may be audible for greater distances. During the summer when passerines, waterfowl and raptors are present, blasting is only anticipated at the Nonacho Lake control structure and Twin Gorges sites. These bird groups would not be exposed to winter road noise.

Areas with continuous high levels of disturbance have been shown to displace waterfowl, but waterfowl would habituate to areas with continuous low levels of human activity (Hockin et al. 1992). Although noise and sensory disturbance can alter the movement and behaviour of wildlife, particularly hunted species (Bommer and Bruce 1996), the specific effects of sensory disturbance on many bird species are largely unknown. Some studies have found that noise and motion disturbances originating from man-made sources can negatively affect bird behaviour (Korschgen et al. 1985; Ward and Stein 1989; Dahlgren and Korschgen 1992). Disturbance impacts on birds may include displacement, nest abandonment, reduced nest success, or reduced foraging efficiency (Craven and Ellis 1982; Hockin et al. 1992; Korschgen and Dahlgren 1992; Thomas et al. 2002). Concerns have been raised regarding noises that startle or disturb nesting birds, and noises that mask mating calls.

Recent studies of passerines at the Ekati Diamond Mine (Smith et al. 2005) indicated that the density of passerines was not affected within 1 km of the mine footprint and species diversity was slightly higher in some of the plots near the mine. Concurrent studies of Lapland longspurs at the Ekati Diamond Mine indicated that nest success was unaffected within 300 m of major haul roads (Male 2005).

Disturbance to raptors while nesting can affect incubation success, and survival of the young. Peregrine falcons and short-eared owls were identified as the two species of greatest concern (ENR 2008). Therefore, if a nest site of either species is identified within 1.5 km of the Project, a distance of 1.5 km should be maintained between development activities and the nest site from April 15 to September 15 (ENR 2008). These dates are applicable for other species nesting in the Project region, with the exception of the great horned owl, which incubates from mid-February to late March in the Yukon (Houston et al. 1998).

The specific effects of Project-related sensory disturbance on many species of raptors are unclear. For example, at the Snap Lake Mine, variation in nest site occupancy and success was not strongly related to distance from the mine. Although weather and prey abundance were not highly correlated with nest success, these environmental variables had stronger associations with nest success than did distance from the mine

(De Beers 2008). However, spatial and temporal changes in raptor nest occupancy and success in the Lac de Gras region have been observed. Raptor nest success and occupancy increased with distance from the Diavik Diamond Mine, and nest success appeared to decline over time from construction through current operations (Golder 2005, 2008). However, the relationships were weak, and spring rainfall also contributed to the variation in nest success (Golder 2008).

Studies of prairie falcon responses to blasting activities found that falcons showed behavioural reactions to blasting in 54% of blasts (Holthuijzen et al. 1990). Incubating or brooding falcons flushed from their aeries in 22% of the blasts, but returned to their nests within an average of 3.4 minutes. The authors suggested that blasting associated with limited human activity does not need to be restricted at distances greater than 125 m from occupied prairie falcon nests, provided that peak noise levels do not exceed 140 dB at the aerie and no more than 3 blasts occur on a given day or 90 blasts during the nesting season.

There are indications that raptors are able to habituate to disturbance. There have been several attempts by peregrine falcons, gyrfalcons, rough-legged hawks and common ravens to nest within both active and abandoned open pits at the Ekati and Diavik diamond mines. Peregrine falcons made nesting attempts in open pits at Diavik Diamond Mine in 2005 and 2006 (DDMI 2007). Since 2004, there have been eight such occurrences among five open pits at the Ekati Diamond Mine, and all five Ekati pits had nesting birds in 2006 (BHPB 2007). In some cases, young have been detected in these nests (BHPB 2003, BHPB 2007). Nesting on pit walls has become so common at the Ekati Diamond Mine that a monitoring program has been implemented.

Raptors typically select the most remote and rugged terrain available for nesting, such as tree tops or cliff faces. Raptors often exhibit low nest densities, especially in habitats were prey may be limiting (Ontiveros et al. 2005). During baseline studies, a total of 50 cliffs within approximately 1.5 km of the transmission line route were investigated. Of these, 15 had signs of historic nesting such as whitewash or stick nests (see Section 9.5.3 Birds and Bird Habitat). Historic nests were found to be largely concentrated in specific areas, such as within the proposed East Arm National Park, southeast of Snap Lake, and near the Indian Shack staging area (Figure 15.4.3). One tree nest was also observed near the Nonacho Lake control structure. Raptors were not observed at any of the nest sites found, although the timing of the survey (August) was not optimal to detect raptor activity.

To assess cumulative effects, the number of developments within the passerine, waterfowl and falcon CESA were considered. Only active developments were considered, as it is the activity that would lead to sensory disturbance. Within the CESA for passerines and waterfowl (extending to 11 km from the Project), there are 24 currently existing or permitted developments, including the Gahcho Kué Project, that may be sources of sensory disturbance to birds (Table 15.4.24).The active projects are predominantly exploration camps (11) that are usually active seasonally and may not overlap with the summer breeding season. Other developments include three existing mines. Studies to date have not indicated that passerines are avoiding mines, nor is nesting success affected (Smith et al., 2005; Male, 2004). Within the larger raptor CESA (extending 167 km from the Project), 158 existing developments (including Gahcho Kué) were documented that may be sources of sensory disturbance (Table 15.4.25). Again, mineral exploration camps are the most numerous developments (78 active). Winter roads, quarries, lodges, woods operations and four mine sites are also present. As outlined above, there is some evidence to suggest that raptors avoid mine sites, although there have also been instances of raptors nesting within active open pits.

Table 15.4.25 — Existing Developments in the Cumulative Effects Study Area for Raptors

Activity	Number
All season road	4
Communications	1
Community	5
Industrial	1
Lodge	10
Mine	3
Gahcho Kué mine	1
Mineral exploration/camp	78
Miscellaneous	9
Oil and gas	3
Power	2
Quarrying	13
Staging area	1
Transmission line	1
Winter road	15
Gahcho Kué winter road	1
Woods operation	10
Total	**158**

Note: Gahcho Kué was assumed to be active and part of the existing environment for the purpose of the effects assessment

15.4.8.3 EFFECTS FROM CHANGES IN HYDROLOGY REGIME TO WATERFOWL

Effects to birds from changes to the hydrological regime within the Taltson River are assessed in detail in Section 13.10. Hydrological scenarios considered are the 36 MW and 56 MW plants, during both construction and operations, and in Nonacho Lake, Zone 1, 2, 3 and 4, for whooping crane, rusty blackbird, and waterfowl. The pathways investigated in Section 13.10 include:

- direct mortality from higher water levels leading to reduced population abundance,
- reduced reproductive success from higher water levels leading to reduced population abundance,
- reduced reproductive success from lower water levels leading to reduced population abundance
- sub-lethal effects (changes to diet/submerged aquatic plant community) leading to reduced population abundance,
- changes to diet/submerged aquatic plant community,
- riparian habitat loss/modification leading to change in population abundance, and
- lethal effects from bioaccumulation of methylmercury in fish.

Of these, only the pathway of changes to diet/submerged aquatic plant community to herbivorous waterfowl was found to be valid, and only in Nonacho Lake, Zone 1, 2 and 3. Pathway validation is provided in Section 13.10.6 - Taltson Watershed.

Changes to the hydrology regime would lead to both a change in the mean water level, the seasonality of maximum and minimum water levels, and the frequency of flooding events. Wetland modelling indicated that dabbling ducks and aquatic vegetation feeders may be affected wherever wetland modelling indicated a change to the amount of time of flooding would occur at the submergent vegetation boundary (Section 13.10), or in zones where wetland modelling was not possible but the incremental magnitude of alteration of wetland extent was either moderate or high. Under the 36 MW scenario, this pathway is valid for Nonacho Lake and Zone 1, 2 and 3. This pathway was considered invalid for Zone 4 where the magnitude of the alteration of wetland extent was classified as low. It is an invalid pathway for the other bird VCs as their diet does not primarily consist of aquatic vegetation (Section 13.10).

Under the 56 MW option, this pathway is valid for Nonacho Lake, Zones 2 and 3, where the change in the percentage of time the boundary of emergent/submergent vegetation that would be flooded was assessed as moderate in magnitude (Chapter 13.7).

Relative to other effects caused by the Project, effects to herbivorous waterfowl from changes in the hydrology regime would be geographically isolated. Effects would be limited to the shoreline of some zones of the Taltson River. Project components in other watersheds, or in tributaries to the Taltson River, are not anticipated to affect hydrology or waterfowl use of shorelines. Further, as there are no other Projects in the Taltson River watershed which may affect hydrology, cumulative effects are not anticipated. The effects would occur during operations phase only, as minimal changes to water levels are anticipated during constructions. During operations, it is anticipated that shoreline vegetation communities would adjust to the new water levels. Precise estimates of shoreline vegetation recovery are not available. Plant species can begin colonizing areas exposed by water drawdowns within years but may still not have stabilized after a decade or more (Odland & Moral, 2002; Shafroth, Friedman, Auble, Scott, & Braatne, 2002). This is, however, within the assessment period of 40 years.

15.4.8.4 COLLISIONS WITH THE TRANSMISSION LINE LEADING TO MORTALITY OF WATERFOWL

Collisions with transmission lines have been documented for most bird groups (including passerines, waterfowl, raptors, and cranes), and is a cause of additive mortality for these groups. However, the greater vulnerability of waterfowl and cranes to collisions with transmission lines compared with other birds has been noted in several studies. For example, Brown and Drewien (1995) found that waterfowl and cranes constituted 80% of 706 mortalities by power line collisions over a three-year period in the San Luis Valley in Colorado. Andersen-Harlid et al (1972) and Willard et al. (1977) concluded that large birds such as swans are particularly vulnerable to collisions with overhead wires. In a literature review of the effects to wildlife from transmission lines, Harron (2003) indicates that waterfowl are most susceptible to collisions. Transmission strikes have not been identified as a cause of mortality for most species of passerines and raptors (APLIC 1994). Thus, an analysis was completed of the possible effects of transmission line collisions by waterfowl.

Several studies have documented waterfowl collisions with transmission lines (Anderson 1978, Lee 1978, Beaulaurier 1981, Andersen-Harlid et al 1982, Malcolm 1982, URS Corporation 2005). An examination of non-hunting mortalities of North American waterfowl documented that 65% of deaths were attributed to wire collisions, while another 4% were due to contact with transmission line towers. Lee (1978) observed that most collisions with transmission lines at a wetland near Portland, Oregon, involved waterfowl species. Within waterfowl, dabbling ducks may be more prone to negative interactions with transmission lines than diving ducks, but the reason for this difference is unknown (Faanes 1987).

In addressing potential causes of transmission line collisions, several studies have made conclusions that include spatial, temporal, and behavioural factors. Willard et al. (1977) noted both species-specific morphology and weather conditions as contributing factors to collision potential. Studies (Stout and Cornwall 1976, NUS Corporation 1979, Hobbs and Ledger 1986, Brown and Drewien 1991, URS Corporation 2005) have suggested that transmission line collisions are a function of:

- awareness of the presence of transmission lines,
- wind and weather (specifically fog),
- time of day (collisions are more frequent during dawn and dusk),
- disturbances or distractions (e.g. mating),
- cable size (smaller gauge wires are responsible for increased collision frequency),
- the presence of municipal distribution lines (more numerous and arranged in grids) versus long-distance transmission lines (more likely to cross wetlands and lakes),
- the use of ground wire (used to protect the transmission lines from lightening strikes), which is smaller in diameter and causes a greater proportion of collisions than transmission wire (the Project would only use ground wire within 2 km of the mine sites),
- age (increased frequency of collision among juvenile birds),
- line location (lines below tree tops less hazardous than those above),

- morphology (birds with longer necks and legs collide more often than those with shorter appendages),
- wing loading (waterfowl are less manoeuvrable than passerines),
- the proximity of power lines to areas where birds congregate or along migration routes, and
- visibility of power lines to birds.

There is little description in the literature of collision rates (see APLIC 1994). Further, the difference between the collision rate and the resulting mortality rate has not been well investigated. It is assumed here that all collisions result in the mortality of the bird.

15.4.8.4.1 Methods

To determine effects to waterfowl from collisions with transmission lines, documented collision rates were compared with known waterfowl breeding densities to provide an estimate of the number of waterfowl that may collide annually with the Project transmission line. The effect to the boreal breeding population of waterfowl was assessed, as this group may cross the transmission line regularly over the breeding season and is at greatest risk of collision (in contrast to migrants, which may pass the transmission line en route to breeding grounds farther north).

Current boreal waterfowl breeding population estimates were obtained from baseline aerial surveys completed in June 2008 (Section 9.5.3 Birds and Bird Habitat). The average daily flight distance of common breeding waterfowl is 2 km (Mack 2003), indicating that waterfowl observed within 2 km of the transmission line are likely to encounter the transmission line regularly during the breeding season. Computer GIS software was used to calculate the total area of water bodies within 2 km of the transmission line ROW and south of the treeline, from the 1:50,000 scale National Topographic Database (NTDB). The estimated density of waterfowl from the aerial surveys completed in June 2008 (described in Section 9.5.3 Birds and Bird Habitat) was then extrapolated to the total area of water bodies within 2 km of the transmission line ROW to determine the breeding population of waterfowl present.

15.4.8.4.2 Results

A study completed in central Illinois over a two-year period observed that between 200 and 400 waterfowl were killed each fall (0.2% to 0.4% of maximum number of birds present) between September and December, due to collisions with high-voltage transmission lines (Anderson 1978). Blue-winged teals were found to be most vulnerable to collisions and mallards least vulnerable. A study in Saskatchewan monitored daily avian movements across a transmission line (Golder 1998). A total of 115,454 waterfowl were observed crossing over two transmission lines (230 kV and 14.4 kV). The combined number of waterfowl carcasses (22) recovered from beneath both transmission lines represented approximately 0.01% of the maximum number of waterfowl present in the region during the study period.

For the purposes of this assessment, a collision rate of 1.0% of the local breeding population (i.e. the maximum number of waterfowl present) per year was used to determine the number of waterfowl that may be killed annually due to the Project. This is higher than might be anticipated from either the Anderson (1978) study (which considered fall collisions only), and the Golder (1998) study when the collision rate per pass is adjusted for passes twice daily over the course of a breeding season.

The estimated waterfowl breeding density from the June 2008 aerial surveys was 0.0334 birds/ha regardless of land cover, or 0.24 waterfowl/ha of water body (Section 9.5.3 Birds and Bird Habitat). The total area of water bodies with 2 km of the transmission line south of the treeline was calculated to be 18,141.67 ha. Therefore, the estimated breeding waterfowl population with 2 km of the transmission line south of the treeline was 4,433 birds. Using the collision rate of 1.0% of the breeding population per year, and assuming 100% mortality, the estimated annual loss of waterfowl from the boreal breeding population due to the Project is approximately 44 waterfowl per year for the below-treeline sections of the transmission line. This effect would occur for the entire duration of Project operations, until the transmission line is removed, from the arrival of waterfowl in the spring until their departure in the fall. However, there is evidence to suggest that there are fewer collisions when local birds are aware of the presence transmission lines (Harron, 2003). The effect is anticipated to influence the local breeding population, which would have a higher encounter rate than birds migrating past the transmission line. The small percentage of the population to be affected indicates that the population is capable of recovery from this effect. As there is only one other transmission line within the RSA (that from Twin Gorges to Fort Smith), cumulative effects were anticipated to be negligible.

The aerial waterfowl surveys in June 2008 did not extend north of the treeline. Waterfowl densities are generally lower on the tundra than in the boreal forest and the effect to waterfowl is anticipated to be less in this environment. For example, two years of waterfowl studies at the Jericho Mine (within the SGP) estimated a maximum waterfowl density of 0.008 birds/ha, for all land cover classes (Golder 2008). Waterfowl collisions with the transmission line are likely to be correspondingly less in this environment. Transmission line lengths above and below the treeline are similar (312 km versus 353 km).

Collisions from waterfowl migrating past the Project to breeding grounds farther north are not included in this estimate. Although little is known of the location of these flyways within the Taltson region, the shoreline between the Slave River estuary, approximately 50 km east of the Taltson River outflow into Great Slave Lake, is considered prime staging and breeding waterfowl habitat, with over 74,000 birds recorded here in the spring of 1983. Birds included 23,520 lesser snow geese, 34,560 dark geese, and 5,300 tundra swans (IBA 2004). Although present in much larger numbers, migrants would likely pass the Project transmission line twice per year (i.e. spring and fall migrations), while local breeders may encounter the transmission line on a daily basis for the duration of the summer. Migrants also usually fly too high to be at risk of collision (APLIC 1994). Assuming risk of collision is primarily a function of the number of times a bird flies past the transmission line, the local breeding populations are clearly at greater risk.

Collisions with transmission lines and distribution lines are known to have accounted for the death or serious injury of at least 36 whooping crane since 1956 (Environment Canada 2007). Janss and Ferrer (2000) investigated collisions by common crane with transmission and distribution lines, and of the approximately 500 individual cranes observed crossing a 3.5 km section of transmission line, four collisions (0.8%) were documented. Collision rates per unit distance were not considered useful, as mortalities tended to occur in certain areas (e.g. 88% of collisions occurred within a section comprising only 37.5% of the study area, Janss and Ferrer 2000). However, as the Project is located north of the known whooping crane breeding grounds in Wood Buffalo National Park, exposure of whooping cranes to the Project is expected to be low.

15.4.9 Residual Effects Summary

15.4.9.1 Rare Vascular Plants

Exposed land, wetland-herb and rock/rubble are considered the most sensitive rare plant land cover classes, based on the high number of rare plants they are expected to contain and the scarcity of these land cover classes in the study area. Within the RSA, approximately 1.2% and 1.6% of land cover classes with high and moderate potential for species at risk within the study area, respectively, would be altered due to Project infrastructure during construction. Effects to rare plant habitat would be limited due to the following reasons:

- Within the RSA, less than 0.5% of any single land cover class with rare plant potential would be altered.
- The entire area of all water bodies within the Project footprint is included, whereas vascular plants would only occur on shorelines.
- In many areas, vegetation removal within the transmission line right-of-way would be selective (for vegetation greater than 3 m in height only) or not conducted at all (in tundra areas and within the proposed East Arm National Park, for example).
- Most of these plant species are low-lying plants,, the exceptions to this include two willows (*Salix ovalifolia* and *Salix sphenophylla*), and the velvetleaf blueberry (*Vaccinium myrtilloides*), which are still unlikely to be cleared in areas where vegetation less than 3 m in height is preserved.
- All of the land cover classes with a high potential for rare plants (water, wetland-herb, exposed land and rock/rubble) are low-lying communities which do not require vegetation clearing for the transmission line.

Natural recovery is expected in the terrestrial habitat on the winter road and barge landing areas after construction (12% of total disturbance), as the road would be closed and the barge landing areas removed. The transmission line ROW, however, would require ongoing vegetation management until Project closure.

15.4.9.2 GRIZZLY BEAR AND WOLVERINE

15.4.9.2.1 Barren-ground Grizzly Bear and Tundra Wolverine

Effects to grizzly bear and tundra wolverine from habitat loss are anticipated to be similar during the construction and operations phases of the Project, as effects from vegetation loss and land cover changes are long-lasting, particularly in arctic environments. The effect to grizzly bear extends to the population level by reducing the carrying capacity of the landscape they occupy. The direct effects would continue over the 40-year assessment period as the infrastructure would remain in place during this time; effects from vegetation loss have a lasting effect and forest may require decades to regenerate following disturbance.

Less than 0.3% of the RSA north of the treeline would be disturbed by the Project. Resource selection models (Johnson et al. 2005) indicate that grizzly bears show preference for riparian and low shrub areas. These are approximated by the Shrub Low and Wetland-Shrub classes within the EOSD classification, of which less than 0.4% would be disturbed within the RSA. Tundra wolverine show preference for rocky areas and sedge patches (equivalent to Rock/Rubble and Wetland-Herb), which also would have less than 0.4% of their total area in the RSA disturbed. Considering the cumulative habitat loss from the Project, Gahcho Kué and all other existing and historic developments, less than 0.7% of either the grizzly bear or tundra wolverine CESAs would be disturbed. The largest cumulative change in area of a habitat class from indirect and direct habitat change was for esker habitat (1.5%), which is important habitat for grizzly bears.

For spring through autumn, total area per habitat class was reduced by less than or equal to 1.5 % for esker, and 0.6% or less for all other habitat classes, from pristine through to existing conditions. With the addition of the Project, incremental decreases in area of habitat was less than or equal to 0.1% per habitat class. Similarly, other measures of habitat fragmentation showed a small change in habitat loss due to existing and historic developments, and often negligible incremental effects.

For grizzly bears the largest predicted decline in preferred habitat (i.e. the loss of good- and high-quality habitat combined, due to development) across seasons was during late summer. Existing (2007) land covers had 11% less area of preferred habitats than pristine land covers. There was 0.3 % incremental effect of the Project on area of preferred habitats for grizzly bear during the late summer season (i.e. a cumulative loss of 11.3%). The geographic extent of cumulative effects and incremental effects from changes in habitat quality, movement, and behaviour are beyond the RSA because the effect to grizzly bear extends to the population level. Sensory disturbance effects to grizzly bears are anticipated to be seasonal when individuals are not hibernating.

Wolverine fragmentation statistics indicate that the cumulative effect of the Project and other developments would also fragment habitats by reducing the number of patches within each habitat class by less than 1% in the summer (i.e. not considering the winter roads). Wolverines are active throughout the year; therefore, habitat fragmentation and changes in the availability of habitats from the winter access roads were also considered. For the winter period, the largest cumulative change in area of a habitat class was for esker (1.6%).

Due to sensory disturbance to wolverine in the vicinity of the Project and other developments, and the resulting changes to habitat quality, effects during construction are anticipated to be greater than during operations. During the construction phase, development of the Project is predicted to cause indirect changes to the amount of different quality habitats. The existing land cover had a decrease of 11.0% in preferred habitat (i.e. good- and high-quality habitat combined) from the undisturbed land cover in the summer. The magnitude of incremental effects from the Project was a reduction in area of preferred habitat by 0.2%, for a cumulative loss of 11.2%. These estimates are based on the conservative assumption that the Project footprint, including the transmission line ROW, is at least 200 m wide.

During the operations phase of the Project, the only human activity would be due to the permanent staff at the Twin Gorges site, and annual inspections completed by helicopter. As such, mechanisms such as noise, smells, dust, presence of attractants, and human activity are expected to be less during the operations phase. The transmission line, in particular, is expected to be negligible, causing only a visual impact and likely some noise and movement through wind action. Therefore, the incremental and cumulative effects of the Project to changes in the behaviour and distribution of grizzly bears and wolverine are expected to be lower during operation than construction (although operation is of a longer duration)

Related effects on traditional use (i.e. hunting and trapping) of wolverine were related to a decrease in hunting opportunities due to changes to wolverine survival and reproduction. Harvesting of wolverine along the Tibbitt to Contwoyto winter road has been limited; only three kills were reported between 2004 and 2006 (Ziemann 2007). Project effects to wolverine are such that noticeable effects to the abundance or distribution of wolverine to hunters and trappers are not anticipated. Boreal wolverine are harvested from the communities of Fort Smith, Fort Reliance, and Łutsel K'e. Records of fur sales indicate that these communities harvested at least 28 wolverine between 2005 and 2007 (ITI, 2007). The Project is not anticipated to affect this harvest. Although the creation of new winter roads may improve access for harvesting, these winter roads would not be open for public use, would not be maintained following construction, and would only improve snowmobile access for the regions beyond Twin Gorges (approximately 60 km from Fort Smith).

15.4.9.2.2 Boreal Wolverine

Boreal wolverine in the study area have been exposed to very low levels of development, approximately 0.3% of the CESA would be disturbed by the Project and all other existing and historic developments. These estimates include the conservative assumptions of development footprints (e.g. mineral exploration camps have a footprint of 314 ha). As the tundra wolverine has experienced higher levels of development relative to the boreal wolverine, there is less potential for habitat loss, fragmentation, and sensory disturbance. During operations, the main source of sensory disturbance to wolverine from the Project would be activity at the Twin Gorges site, and an annual inspection of the transmission line by helicopter. Where there was uncertainty, effects to boreal wolverine were assumed to be the same as those for tundra wolverine.

15.4.9.3 PASSERINES, WATERFOWL, AND RAPTORS

Three pathways to passerines, waterfowl and raptors were investigated. However, the validity of the pathways depended upon the group being assessed, as follows:

- Project footprint leading to habitat loss and fragmentation was considered valid for passerines;
- sensory disturbance leading to changes in habitat quality was considered valid for passerines, waterfowl, and raptors;
- effects from changes in hydrology regime was considered valid for waterfowl only; and
- collisions with the transmission line leading to mortality was considered valid for waterfowl only.

Each of these pathways would be summarized individually below.

At the local scale, the Project footprint would occupy 0.28% of the RSA above the treeline, and 0.26% below the treeline. The transmission line right-of-way above the treeline would not require any clearing, and below the treeline was assumed to be 30 m wide (although the actual width would range from 15 m to 30 m).

15.4.9.3.1 Habitat Loss and Fragmentation

The effects of habitat loss on passerines have been well documented in the literature. Vegetation loss contributes to habitat degradation and reduced carrying capacity (Hansson et al 1995, Batary and Baldi 2004). However, it is anticipated that passerines would continue to nest and forage beneath the transmission lines (the transmission line ROW constitutes approximately 76% of the Project footprint). Niemi and Hanowski (1984) found that changes to passerine densities below transmission lines were negligible. Milsom et al (2000) documented continued use of marshes below transmission lines, but with slightly reduced presence when compared to control areas.

North of the treeline, 85% of the area to be disturbed consists solely of the transmission line ROW, within which vegetation clearing would be limited to the transmission tower foundations, so the actual area to be disturbed would be substantially less. South of the treeline, much of the landscape in the boreal region supports relatively low passerine densities. The land cover classes of exposed land, coniferous sparse, and coniferous open together constitute approximately 45% of the area to be disturbed by the Project, which the available data shows to support low densities of passerines. Considering the vegetation available at the larger scale of the RSA, the Project would disturb less than 0.27% (or 0.28% of the RSA above the treeline, 1% below the treeline), assuming a 30 m wide ROW. Very little of the passerine CESA would be disturbed by the cumulative effects of the Project and other developments. The estimated cumulative loss of habitat in the passerines CESA is 2.2% and 0.3% within the tundra and boreal regions of the CESA, respectively.

Although fragmentation always accompanies habitat loss, it is a different phenomenon (McGarigal and Cushman 2002). Habitat fragmentation effects are of lesser magnitude than direct habitat loss (Andrén 1999, Fahrig 1997, 2003). A species that disperses well (such as upland birds) would generally consider habitat patches to be connected even when covering only 35 to 40% of the landscape (With and Crist 1995). Relatively narrow ROWs of less than 30 m in width appear to have limited impacts on the forest bird community (Harron, 2003), but bird movement may still be reduced. Several forest bird species experience increased difficulty with respect to crossing the gap in the forest created by the ROW, particularly as its width increased beyond 30 m (Harron, 2003). A complicating factor, but one that is likely to limit effects of habitat fragmentation to passerines, is the structure of the surrounding habitat (Jalkotzy et al. 1997). Of the terrestrial vegetation that may be disturbed by the Project, most is open or sparse forest, unvegetated, or shrub-dominated. These may be little affected by the transmission line ROW.

15.4.9.3.2 Sensory Disturbance

Construction activities would generate noise and activity that may affect the movement, behaviour or reproductive success of passerines, waterfowl, and raptors. Noise created by the Project would likely attenuate to baseline levels within 2.5 km. During construction of the Project, disturbance to bird populations would likely occur, with the concern being greatest during the breeding season (May 15 to October 15). Construction would be mostly completed in winter when most birds are not present. The construction phase would be limited to a three-year period, and many of the disturbances would be mobile and short-term in any one area (e.g. construction crews would move along the transmission line corridor). No vegetation clearing would occur during the nesting season (May 15 to July 31). During operations, there would be little activity associated with the Project, with the exception of the Twin Gorges site. It is anticipated that birds would continue to use undisturbed habitat beneath the transmission lines. Niemi and Hanowski (1984) and Milsom et al. (2000) documented continued use of marshes below transmission lines by birds.

Cumulative effects from sensory disturbance may also occur from other active developments within the CESA. There are 24 currently existing or permitted developments within the passerine and waterfowl CESA, and 158 in the much larger falcon CESA. The most common developments included mineral exploration camps, winter roads, quarries, lodges, woods operations, and four mine sites. Many of these developments are seasonal and do not overlap with the breeding season (including many lodges and mineral exploration camps, and all winter roads). Studies at existing mines have not provided clear evidence of effects. Although there is some evidence of effects to falcons nesting near the Ekati and Diavik mines, there are also records of falcons and hawks nesting within the open pits at these mines. Studies of songbirds adjacent to the Ekati Mine infrastructure and roads have not indicated any clear effects to passerine density, composition or reproductive success.

Disturbance to raptors while nesting can affect incubation success and survival of the young. Peregrine falcons and short-eared owls were identified as the two species of greatest concern (ENR 2008). Therefore, if a nest site of either species is identified within 1.5 km of the Project, a distance of 1.5 km should be maintained between development activities and the nest site, from April 15 to September 15 (ENR 2008). During baseline studies, 15 cliffs with signs of historic nesting were identified within 1.5 km of the transmission line. In cases where construction activity is scheduled to occur in the vicinity of these cliffs during the nesting season, monitoring would be undertaken to determine if the nest is occupied and mitigation would be implemented to avoid the site.

15.4.9.3.3 Effects from Hydrology Regime Changes

Lowered water levels would change the amount of time emergent and submergent vegetation communities would be flooded with water. Wetland modelling results indicated that for areas where the water levels would be greater than 20 cm below baseline conditions during the growing season, there may be a change to wetlands. The zones to be affected are slightly different under the 36 MW and 56 MW options, but Nonacho Lake, Zones 2 and 3 are anticipated to change under either scenario. This may affect submergent vegetation, an important food source for many waterfowl. Relative to other effects caused by the Project, effects to waterfowl from changes in the hydrology regime would be geographically isolated. Effects would be limited to the shoreline of some zones of the Taltson River. Project components in other watersheds or in tributaries to the Taltson River are not anticipated to affect hydrology or waterfowl use of shorelines. The effects would occur predominantly during construction, when the new hydrological regime would be phased in and effects to wetlands would occur. Following the start-up phase, it is anticipated that shoreline vegetation communities would adjust to the new water levels. Little is known of the recovery time for such changes in a northern environment. As there are no other Projects in the Taltson River watershed that may affect hydrology, cumulative effects are not anticipated.

15.4.9.3.4 Waterfowl Collisions with Transmission Lines

Collisions with transmission lines have been documented for most bird groups (including passerines, waterfowl, raptors, and cranes), and is a cause of additive mortality for these groups. Of these, waterfowl have been identified as the most susceptible to collisions. The estimated waterfowl breeding density and the average daily flight distance of common breeding waterfowl (2 km, [Mack, 2003]) was used to estimate the number of waterfowl that may encounter the transmission line daily.

Using a collision rate of 1.0% of the breeding population per year, and assuming 100% mortality, the estimated annual loss of waterfowl from the local boreal breeding population due to the Project is approximately 44 waterfowl per year, for the below-treeline sections of the transmission line. This effect would occur for the entire duration of Project operations until the transmission line is removed, from the arrival of waterfowl in the spring until their departure in the fall. However, there is evidence to suggest that there are fewer collisions when local birds are aware of the presence transmission lines (Harron, 2003). The effect is anticipated to influence the local breeding population, which would have a higher encounter rate than birds migrating past the transmission line. The small percentage of the population to be affected suggests that the population is likely capable of recovery from this effect. As there is only one other transmission line within the RSA (that from Twin Gorges to Fort Smith), cumulative effects were anticipated to be negligible. Waterfowl migrating past the Project to breeding grounds farther north were considered to be at substantially less risk of collision, as migrants may only pass the transmission line twice per year, and often at much greater altitudes.

Construction would be mostly completed during winter when few birds are present. The construction phase is limited to a three-year period, and many of the disturbances would be mobile and short-term in any one area (e.g. a construction team moving down the transmission line corridor). However, short-term effects to individuals are anticipated.

15.4.10 Residual Effects Classification

The purpose of the residual effects classification is to describe the residual effects from the Project on the VCs using a scale of common words, rather than numbers or units. The use of common words or criteria is a requirement in the TOR (MVEIRB 2008a). The following criteria were used to assess the residual effects from the Project:

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

15.4.10.1 METHODS

The effects analyses and residual effects summary presented both the incremental and cumulative changes from the Project on the VCs. Incremental effects represent the Project-specific changes relative to baseline values. Project-specific effects typically occur at the local scale (e.g. habitat loss due to the Project footprint) and regional scale (e.g. combined habitat loss and sensory disturbance from Project activities). Cumulative effects are the sum of all changes from pristine values through the application of the Project. In contrast to Project-specific (incremental) effects, the geographic extent of cumulative effects is determined by the distribution of the defined population. This is because the local and regional effects from the Project and other developments overlap with the distribution of plant and wildlife populations.

The final determination of significance would not be limited to the incremental effects of the Project, but also include the cumulative effects of existing and historical projects in addition to the Project. It is the goal of the cumulative effects assessment to estimate the contribution of these classes of effects, in addition to Project effects, to the amount of change in the VC relative to baseline conditions. Cumulative effects from the Project and other developments influence the entire range of the populations. In contrast, the geographic extent of incremental effects from the Project may have a local or regional influence on the range of the populations.

To provide transparency in the DAR, the definitions for these scales were ecologically or logically based on the VCs. Although professional judgement is inevitable in some cases, a strong effort was made to classify effects using scientific principles and supporting evidence. The criteria for classifying residual effects from the Project on VCs are provided in Table 15.4.26.

Table 15.4.26 — Definitions of Terms Used in the Residual Effects Classification

Direction	Magnitude	Geographic Extent	Duration	Reversibility[1]	Frequency	Likelihood
Neutral: no residual effect **Adverse:** a less favourable change relative to baseline values or conditions **Beneficial:** an improvement over baseline values or conditions	**Negligible:** no predicted detectable change from baseline values **Low:** effect is predicted to be within the range of baseline values **Moderate:** effect is predicted to be at or slightly exceeds the limits of baseline values **High:** effect is predicted to be beyond the upper or lower limit of baseline values so that there is likely a change of state from baseline conditions	**Local:** small-scale direct and indirect effect from the Project (e.g. footprint, physical hazards, and dust deposition) **Regional:** the predicted maximum spatial extent of combined direct and indirect effects from the Project that exceed local-scale effects (can include cumulative direct and indirect effects from the Project and other developments at the regional scale) **Beyond Regional:** cumulative local and regional effects from the Project and other developments extend beyond the regional scale	**Short-term:** effect is reversible at end of one year **Medium-term:** effect is reversible at end of the construction phase **Long-term:** effect is reversible after the assumed 40-year operation period	**Reversible:** effect would not result in a permanent change of state of the population compared to "similar" environments not influenced by the Project **Irreversible:** effect is not reversible (i.e. duration of impact is unknown or permanent)	**Isolated:** confined to a specific discrete period **Periodic:** occurs intermittently but repeatedly over the 40 year assessment period **Continuous:** occurs continually over the 40-year assessment period	**Unlikely:** effect is likely to occur less than once in 100 years **Possible:** effect is possible within a year, or at least one chance of occurring in the next 100 years **Likely:** effect is probable within a year, or at least one chance of occurring in the next 10 years **Highly Likely:** effect is very probable (100% chance) within a year

[1] "Similar" implies an environment of the same type, region, and time period.

The pathways for effects during the construction and operations phases of the Project can be different. For example, effects from pathways such as noise and effects from changes to the hydrology regime, are anticipated to have a greater magnitude during construction. In contrast, the pathway of bird collisions with the transmission line should predominantly occur during the operations phase. Subsequently, pathways that can be assigned to either construction or operations are classified for each Project phase.

15.4.10.2 RESULTS

15.4.10.2.1 Rare Vascular Plants

Within the RSA, less than 0.5% of the habitats with high or moderate rare plant potential would be affected. The magnitude of the effect is thus considered to be low. Effects are local in geographic extent, as the loss of vegetation and rare plant habitat is limited to that disturbed within the Project footprint. Disturbances to northern and arctic ecosystems are reversible, however, the length of time required for recovery is often long. Studies in the Arctic have shown that recovery can take from 20 to 75 years (Walker and Everett 1991, Forbes et al. 2001). The duration of effects to vegetation would vary, depending on the Project component causing the disturbance. The winter road portages and staging areas would be allowed to re-vegetate following construction. In other areas, there would be permanent change, such as at the Twin Gorges facilities expansion. Most of the vegetation disturbance is within the transmission line ROW, which constitutes 76% of the area to be disturbed (assuming it is 30 m wide). Within the ROW, there would be occasional clearing of trees to avoid contact with the conductors. Effects to rare plant species thus were considered to be irreversible, as recovery would be slow and may not begin until after operations (i.e. after the assessment period). Some areas, such as the facilities foundations, would be permanently affected. The frequency is periodic as vegetation is expected to be disturbed intermittently but repeatedly within the transmission line ROW during construction and operation. (Table 15.4.27)

Table 15.4.27 — Classification of Pathways Resulting in Residual Effects to Abundance and Distribution of Rare Plant Species

Pathway	Project Phase	Direc-tion	Magni-tude	Geogra-phic Extent	Dura-tion	Frequ-ency	Reversi-bility	Likeli-hood
Project footprint leading to vegetation loss	Construction and Operation	Negative	Low	Local	Irrevers-ible	Periodic	Irreversible	Highly likely

Effects to vegetation from the Project are local in geographic extent. With the exception of existing diamond mines, there are no existing overlapping developments within the Project footprint. The geographic overlap of the transmission line with the existing diamond mines could cause a cumulative effect, but the disturbance to vegetation above the treeline as a result of the Project is limited to the footprint of the transmission towers. Therefore, the contribution of this pathway to cumulative effects is negligible.

15.4.10.2.2 Grizzly Bear and Wolverine

15.4.10.2.2.1 Project footprint leading to habitat loss and fragmentation

The Project would contribute to habitat loss within the grizzly bear and wolverine range However, the cumulative direct habitat loss resulting from all existing and historic developments is estimated at approximately 0.5% of the grizzly bear CESA (including the Project), therefore, the magnitude from direct habitat loss is low incrementally (within the RSA) and cumulatively (within the CESA). Similarly, the cumulative direct habitat loss resulting from all existing and historic developments within the wolverine CESA is approximately 0.7% for the tundra wolverine, and approximately 0.3% for the boreal wolverine. Therefore, the magnitude from cumulative direct habitat loss is considered low for both populations. Habitat loss from the Project is a local effect, but because of the interaction with other developments (both existing and historical), the cumulative effect is beyond regional. Recovery of the landscape from disturbance is predicted to be irreversible within the temporal boundary of the assessment, as vegetation disturbance from some Project components may not begin until after the assessment period. Duration and reversibility are linked, and so an effect that is irreversible within the assessment period also has an irreversible (or indeterminate) duration. The frequency is periodic as vegetation is expected to be disturbed intermittently, but repeatedly during construction and operation of the Project (Table 15.4.28).

15.4.10.2.2.2 Sensory disturbance leading to changes in habitat quality

Effects to habitat quality from disturbance for grizzly bears and wolverine have been documented at existing diamond mines within the Slave Geological Province. Modelling indicated that the existing environment has up to 11% less preferred habitat than a pristine environment (depending on the season), for both wolverine and grizzly bear. There was up to 0.3% further loss of preferred habitat predicted as a result of the Project, which is an effect of low magnitude. The cumulative effect of changes to habitat quality is the sum of these, indicating a moderate cumulative effect. Sensory disturbance would be greatest during the construction phase, when there would be several seasonal camps, staging areas, winter roads and helicopter activity. During operations, Project-related activity would be limited to the permanent camp at Twin Gorges and minor helicopter activity each summer. Regardless, Project sensory disturbance was considered to be low during both the construction and operations phase (as the incremental loss of suitable habitat was only 0.3% or less), although construction phase effects are medium-term, and operations phase effects are long-term. Effects from disturbance have been observed to extend beyond the immediate footprint of existing developments, so the incremental effect from the Project is local to regional. Because of the interaction between the Project and other developments, the cumulative effect to habitat quality is beyond regional. The residual effects to habitat quality from the Project and other developments are anticipated to be irreversible for grizzly bear and wolverine populations, as they would reverse after the assumed 40-year operations period. The frequency of disturbance to wolverine is continuous during the life of the Project, and seasonal (periodic) for grizzly bears, which hibernate during winter (Table 15.4.28).

Table 15.4.28 — Classification of Pathways Resulting in Residual Effects to Abundance and Distribution of Grizzly Bears and Wolverine

Pathway	Project Phase	Direction	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	Reversibility	Frequency	Likelihood
			Incre-mental	Cumu-lative	Incre-mental	Cumu-lative				
Project footprint leading to habitat loss and fragmentation	Construction Operation	Negative	Low	Low	Local	Beyond regional	Irreversible	Irreversible	Periodic	Highly likely
Sensory disturbance leading to changes in habitat quality	Construction	Negative	Low	Moderate	Local regional	Beyond regional	Medium-term	Reversible	Periodic to continuous	Highly likely
	Operation	Negative	Low	Moderate	Local regional	Beyond regional	Long-term	Reversible	Periodic to continuous	Highly likely

15.4.10.2.2.3 Effects to Harvesting Opportunities

Effects to the availability of wolverine for harvesting are a function of wolverine abundance, distribution, and access. Given that the Project winter roads would restrict permit public access during construction, that the winter roads would not be maintained following construction, and that snowmobile access would only be improved for the areas beyond Twin Gorges (i.e. 60 km from Fort Smith), changes to wolverine harvesting due to improved access was considered to be a minor pathway. However, changes to the abundance and distribution of wolverine may still affect availability for hunters.

Wolverine abundance and distribution may be affected by the pathways of habitat loss and fragmentation, and from sensory disturbance (particularly during construction). As indicated in Table 15.4.29, the incremental and cumulative effects of the Project are anticipated to be low to moderate in magnitude, with the greatest effects occurring during the three-year construction phase. As wolverine harvesting from the affected communities is limited (see Section 9.5.7, Vulnerable Species), and there was little indication of wolverine harvesting within the RSA (see Section 9.6, Human Environment), the magnitude of effects to availability was considered to be low. However, the geographic extent of these cumulative effects is beyond regional (Table 15.4.29). The duration of effects is long-term to irreversible, as they would continue until closure after operation of the Project and there would be some of the permanent habitat loss. It is considered possible that there would be effects to harvesting opportunities.

Hunting of grizzly bear is not permitted within the Slave Geological Province (ENR 2008), with the exception of defending life and property. Therefore, effects from the Project and other developments are not expected to change the opportunity for harvesting grizzly bears.

Table 15.4.29 — Classification of Pathways Resulting in Residual Effects to Continued Harvesting Opportunities for Wolverine

Pathway	Project Phase	Direction	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	Reversibility	Frequency	Likelihood
			Incre-mental	Cum-ulative	Incre-mental	Cumu-lative				
Effects to abundance and distribution on the availability of wolverine	Construction Operation	Negative	Low	Low	Local	Beyond regional	Medium-term to irreversible	Reversible to irreversible	Periodic	Possible

15.4.10.2.3 Passerines, Waterfowl and Raptors

15.4.10.2.3.1 Project footprint leading to habitat loss and fragmentation

Habitat loss and fragmentation would ultimately reduce the number of birds that the landscape may support (Hansson et al 1995, Batary and Baldi 2004). This pathway was considered valid for passerines only. At the local scale, the Project footprint would occupy 0.3% of the RSA. North of the treeline, 85% of the area to be disturbed consists solely of the transmission line ROW, within which vegetation clearing would be limited to the transmission tower foundations, so the actual area to be disturbed would be substantially less. South of the treeline, effects are anticipated to be greater as the transmission line would require a ROW. The three dominant land cover classes are water, shrub low, and coniferous open, together constituting approximately 55% of the existing land cover within the RSA (Table 15.4.11). The abundance of open land cover classes in the RSA indicate that clearing for the transmission line can be better described as a change in the ratio of existing habitat classes, rather than the introduction of a new habitat. South of the treeline, only 17% of the RSA is closed forest. As very little of the RSA would be disturbed, disturbed habitat is expected to maintain some value to passerines, and as these effects are confined to the RSA, the effect is anticipated to be local in extent and of low magnitude. Further, these estimates are based on conservative assumptions, such as that all birds have been displaced from the entire area of all historic developments, considering that most historic disturbance is from temporary mineral exploration camps.

Very little of the passerine CESA would be disturbed by the cumulative effects of the Project and other developments. North of the treeline, historic and current land cover disturbances include mines, mineral exploration camps, winter roads, the proposed Gahcho Kué Project, and associated winter roads collectively, amounting to 2.2% of the above-treeline CESA.. In the boreal regions, approximately 0.3% of the below-treeline CESA has been disturbed. This represents an effect of low magnitude, as it is well below the 40% threshold value identified for habitat loss associated with declines in bird and mammal species (Andrén, 1994, 1999, Fahrig, 1997, With, 1997). The incremental effects of habitat loss are regional, local and restricted to the Project footprint. Cumulative habitat loss is beyond-regional in scale, as there may be interacting effects from adjacent projects (Table 15.4.30). The single largest source of vegetation loss would be the transmission line ROW, which constitutes 70% of the Project footprint south of the treeline. Forests require decades to recover from clearing, and the ROW would require regular clearing throughout the 40-year operations period, causing a periodic but irreversible effect within the duration of the assessment. Habitat loss effects would initiate during construction, but would carry through to operations. As such, construction and operations phase effects were anticipated to be similar.

Fragmentation may be caused by features such as the transmission line ROW and winter roads. Relatively narrow ROWs of less than 30 m in width appear to have limited impacts on the forest bird community (Harron, 2003), but bird movement may still be impaired. As the ROW width increases, a more open area is created which is better suited to the development of a shrubland bird community. Activity within the ROW confounds fragmentation, and would be of little consequence for the

Project as most construction activity would take place during the winter. A factor that is likely to limit effects of habitat fragmentation to passerines in the RSA is the structure of the surrounding habitat (Jalkotzy et al. 1997). Only 22% of the landscape is closed forest (i.e. most terrestrial habitat below the treeline is open, patchy forest), indicating that behavioural responses to features such as small patch size and habitat edges is already required.

15.4.10.2.3.2 Sensory disturbance leading to change in habitat quality

Construction activities would generate noise and activity that may affect the movement, behaviour or reproductive success of birds. Noise created by the Project would likely attenuate to baseline levels within 2.5 km, a local to regional scale effect. During construction of the Project, disturbance to bird populations would likely occur, with the concern being greatest during the breeding season (May 15 to October 15). Construction would be mostly completed during winter when few birds are present, the construction phase limited to a three-year period, and many of the disturbances would be mobile and short-term in any one area (e.g. a construction team moving down the transmission line corridor). All vegetation clearing would be completed predominantly during winter, which is outside of the breeding season. As such, the magnitude of sensory disturbance to birds in the RSA due to Project construction is anticipated to be low.

During operations, there would be little activity associated with the Project, with the exception of the Twin Gorges site. Noise from the transmission line would be negligible (Teshmont, 2008), and it is anticipated that birds would continue to use undisturbed habitat beneath the transmission lines. The magnitude of sensory disturbance effects in the RSA during operations is also anticipated to be low.

Effects are anticipated to be similar during construction and operation, but likely of a lower magnitude during operation (although the effect was classified as low in both scenarios). The main difference between construction and operation phases was the duration of the effects (medium-term for construction, and long-term for operation). Effects are, at worst, continuous over the assessment period (i.e. the summer breeding season). Sensory disturbance effects are anticipated to be quickly reversible following the cessation of activity, and are regional in scale (as most construction noise would be reduced to baseline levels within the RSA).

Cumulative effects from sensory disturbance may also occur from other active developments within the CESA. There are 24 existing or permitted developments within the passerine and waterfowl CESA, and 158 in the much larger falcon CESA, all of which have the potential to cause sensory disturbance to breeding passerines, waterfowl and raptors if they are active during the breeding season. Many of these developments are seasonal and do not overlap with the breeding season (including many lodges and mineral exploration camps, and all winter roads). Of the remaining developments, monitoring to date has not provided clear evidence of effects. For example, studies of passerines at Ekati have not indicated that passerines are avoiding mines, nor is nesting success affected (Smith et al., 2005, Male, 2004). Studies of raptors have been equivocal; raptor nest occupancy and success increased with distance from the Diavik Mine (Golder, 2008b), while raptors have successfully nested within active open pits at the adjacent Ekati Mine (BHPB, 2005).

15.4.10.2.3.3 Effects of hydrology regime change

Changes to hydrology regime of the Taltson River may affect the availability of forage for herbivorous waterfowl. Effects would be local and limited to the shoreline of some zones of the Taltson River. The effect would commence at the start of operation phase, when water levels are first adjusted. The effects are expected to be medium-term, as recovery of wetlands would occur during construction. Effects are anticipated to be moderate within Nonacho Lake and Zones 1,2, and 3 of the Taltson River. However, as Project components in other watersheds, or in tributaries to the Taltson River, are not anticipated to affect hydrology, and as effects are only anticipated to occur within specific zones of the Taltson watershed, the overall effect is anticipated to be low. Further, there are no other developments within the Taltson River that would affect hydrology, indicating that the cumulative effects would be negligible. The effect is continuous until vegetation recover, and reversible.

15.4.10.2.3.4 Collisions with the transmission line leading to mortality of waterfowl

Waterfowl collisions with transmission lines would occur each breeding season until the transmission lines are removed, a long-term effect that is continuous throughout the breeding season. Effects are anticipated to be mostly confined to the local breeding population within 2 km of the transmission lines (Mack, 2003), a local effect. Studies of transmission line collisions with waterfowl (such as Anderson, 1978, Golder 1998) indicate that less than 1% of the breeding population collides with a transmission line each year, indicating an effect of low magnitude that would be reversible (i.e. the effect would not lead to a change in state of the population). As there is only one other transmission line in the study area (that from Twin Gorge to Fort Smith), cumulative effects were considered negligible.

Table 15.4.30 — Classification of Pathways Resulting in Residual Effects to Abundance and Distribution of Birds

Pathway	VC	Project Phase	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	Reversibility	Frequency	Likelihood
			Incremental	Cumulative	Incremental	Cumulative				
Project footprint leading to habitat loss and fragmentation	Passerines	Construction Operation	Low	Low	Regional	Beyond regional	Irreversible	Reversible	Periodic	Highly likely
Sensory disturbance leading to change in habitat quality	Passerines Waterfowl Raptors	Construction	Low	Low	Local-regional	Beyond regional	Medium-term	Reversible	Continuous	Highly likely
		Operation	Low	Low	Local-regional	Beyond regional	Long-term	Reversible	Continuous	Highly likely
Effects of hydrology regime change	Waterfowl	Operation	Low	N/A	Local	N/A	Medium-term	Reversible	Continuous	Likely
Collisions with the transmission line leading to mortality of waterfowl	Waterfowl	Operation	Low	Negligible	Local	Local	Long-term	Reversible	Continuous	Highly likely

15.4.11 Determination of Significance

15.4.11.1 METHODS

The classification of residual effects on valid pathways for the VCs provides the foundation for determining significance from the Project on assessment endpoints. In the DAR, determining significance considers the entire set of pathways that influence a particular assessment endpoint. Significance is only determined for assessment endpoints, and not individual pathways. Assessment endpoints represent the ultimate ecological properties and services of the VCs that should be protected for use by future human generations. Magnitude, geographic extent, and duration (which includes reversibility) were the principal criteria used to predict significance. Other criteria such as frequency, likelihood, and ecological context, were used as modifiers (where applicable) in the determination of significance.

The relative contribution of each pathway is used to predict the significance of effects (e.g. magnitude of low to high). For example, a pathway with a high magnitude, large geographic extent, and long-term duration would be given more weight in determining significance, relative to pathways with smaller scale effects. The relative effect from each pathway is discussed; however, pathways that are predicted to have the greatest influence on changes to assessment endpoints are assumed to contribute the most to the determination of significance.

Similar to the residual effects classification, determination of significance was completed independently for assessment endpoints for construction and operation phases (where appropriate), and for combined Project phases. In summary, the following information was used in the determination of the significance of effects from the Project on the VCs:

- results from the residual effects classification of valid pathways;
- application of professional judgment and ecological principals, such as resilience, to predict the duration and associated reversibility of effects; and
- application of additional adaptive management and mitigation measures that may increase resilience, and decrease the significance of effects.

15.4.11.2 RESULTS

15.4.11.2.1 Rare Vascular Plants

Persistence of the abundance and distribution of rare plants was the assessment endpoint used to determine significance. The Project is not expected to cause changes to rare plant abundance and distribution, and the resulting effect to rare plants is expected to be long-term, but local and of a low magnitude. Therefore, the Project is not anticipated to result in significant adverse effects to the abundance and distribution of rare plant species. Cumulative effects are not anticipated to occur, based on the negligible degree of overlap between the Project and other developments on the landscape.

The Project should result in local-scale effects to individual plants. Effects to vegetation from the Project would be relatively low when compared to other activities such as forestry or agriculture, or natural events such as forest fires, and are not of a sufficient scale to cause extirpation. While developing the Project, all efforts would be made to limit disturbance to vegetation and preserve existing communities. Therefore, the current level of activity in the region and residual effects from the Project should not significantly influence the resilience or abundance of rare vascular plant populations.

15.4.11.2.2 Grizzly Bear and Wolverine

Effects to grizzly bears and wolverine from habitat disturbance at the individual level are expected, but it is unlikely that any would occur at the population level. Effects on habitat quantity due to the Project footprint would be irreversible within the temporal boundary of assessment. However, the actual area disturbed area is a very small proportion of the grizzly bear and wolverine ranges (less than 0.3% of the RSA north of the treeline), particularly considering that the Project would cause very little vegetation disturbance above the treeline.

The effect of the greatest magnitude for both grizzly bears and wolverine is the change in the amount of different quality habitats. Cumulative effects on the population size and distribution of grizzly bear and wolverine from changes in the amount of preferred habitat (i.e. good- and high-quality) ranged up to 11.3%, an effect of moderate magnitude. However, the incremental change from the Project is low (0.3% or less) for both grizzly bear and tundra wolverine. Effects of direct habitat loss indicated an effect of low magnitude. Boreal wolverine habitat quality could not be calculated quantitatively, however, there is less development activity in the CESA south of the treeline than north of the treeline (approximately 0.7% for the tundra wolverine, and approximately 0.3% for the boreal wolverine). The literature suggests that grizzly bear avoid areas of high human activity (Johnson et al., 2005) while wolverine may be attracted (De Beers, 2008), therefore, during construction it is anticipated that the distribution of these species may be affected during construction, but less so during operations when there would be less sensory disturbance. Much of the sensory disturbance that does occur would be mobile, dispersed, and during winter, when grizzly bears are hibernating. Therefore, the effects of the Project on the persistence of grizzly bear and wolverine abundance and distribution during both the construction and operations phases are considered not significant (Table 15.4.31).

Hunting of grizzly bear is not permitted within the Slave Geological Province, so effects to harvesting were considered invalid. Effects to wolverine abundance and distribution may affect traditional and non-traditional use of this species. Records of pelt sales indicate that the harvesting of wolverine is limited within the affected communities. As the Project is not likely to result in significant effect to the persistence of the abundance and distribution of wolverine in the Project footprint, effects to the availability of wolverine to hunters and trappers is also not anticipated to be significant (Table 15.4.31).

Table 15.4.31 — Determination of Significance for Grizzly Bear and Wolverine

Assessment Endpoints	Pathways	Project Phase	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	SIGNIFICANCE OF EFFECTS	
			Incremental	Cumulative	Incremental	Cumulative		Incremental	Cumulative
Persistence of grizzly bear abundance and distribution	Project footprint leading to changes in habitat quantity Sensory disturbance leading to changes in habitat quality	Construction Operation	Low	Low to moderate	Local to regional	Beyond regional	Long-term to irreversible	Not significant	Not significant
Persistence of wolverine abundance and distribution	Project footprint leading to changes in habitat quantity Sensory disturbance leading to changes in habitat quality	Construction Operation	Low	Low to moderate	Local to regional	Beyond regional	Long-term to irreversible	Not significant	Not significant
Continued opportunity for harvesting wolverine	Effects to abundance and distribution changes the availability of wolverine	Construction Operation	Low	Low	Local to regional	Beyond regional	Long-term	Not significant	Not significant

15.4.11.2.3 Passerines, Waterfowl and Raptors

The significance of effects to passerines, waterfowl and raptors to the assessment endpoint of persistence of abundance and distribution was assessed separately for each VC, as each is affected by different pathways.

The persistence and abundance of passerines may be affected by the pathways of habitat loss and fragmentation, and from sensory disturbance causing changes in habitat quality. Both would occur during construction and operation. Of these effects, habitat loss is predicted to have greater effects than habitat fragmentation (Andrén 1999, Fahrig 1997, 2003). Sensory disturbance to passerines would occur, particularly during construction. However, there would be limited construction activity during the passerine breeding season. Further, most disturbance would be relatively short-term as construction crews and helicopters work along the transmission line. Thus, effects of habitat loss was considered to be the most important factor affecting passerine abundance and distribution. The single greatest cause of habitat loss would be the transmission line ROW, which would constitute approximately 70% of the Project footprint south of the treeline. North of the treeline, vegetation clearing would not be required for the ROW. The magnitude of effects due to habitat loss and fragmentation were anticipated to be low, but irreversible (Table 15.4.32). Effects would be confined to the RSA, a regional effect. Effects from sensory disturbance are anticipated to be local to regional. Very little of the passerine CESA would be disturbed by the cumulative effects of the Project and other developments. The estimated cumulative loss of habitat in the passerines CESA is 2.2% and 0.3% within the tundra and boreal regions of the CESA, respectively. Thus, the magnitude of the cumulative effect is also low. Overall, the effect of habitat loss and fragmentation and from sensory disturbance to the persistence and abundance of passerines was anticipated to be not significant, incrementally and cumulatively.

With regards to the abundance and distribution of waterfowl, effects are anticipated to change between construction and operations. Changes to distribution may be affected by sensory disturbance, while changes to waterfowl abundance may occur due to effects from alteration in the hydrology regime change and collisions with the transmission line.

Sensory disturbance would occur during both the construction and operation phase. As outlined above, most construction activity would take place outside of the breeding season, suggesting an effect of low magnitude. There may continue to be some sensory disturbance to waterfowl during operations due to maintenance activity and the presence of the transmission line, but still the effect is anticipated to be low. Further, there is other development activity within the CESA, but it is predominantly mineral exploration and other small seasonal operations. The cumulative effect of sensory disturbance to waterfowl distribution was considered to be beyond regional and long-term, but of low magnitude. Overall, incremental and cumulative effects to waterfowl distribution due to sensory disturbance are considered not significant (Table 15.4.32).

Waterfowl abundance may be affected by collisions with the transmission lines, and effects related to the change in hydrology (i.e. changes to submerged vegetation, an important food source for waterfowl). Both of these effects are confined to the operations phase (Table 15.4.32). Of the two, collisions with the transmission lines is anticipated to have the greater effect, as it leads to direct mortality, occurs for the entire length of the transmission line (i.e. it is not confined to specific zones of the Taltson River), and is anticipated to continue until the transmission line is removed (whereas vegetation is anticipated to recover from the change in hydrology regime). Collision mortalities, while expected to occur, are not anticipated to be at a level that could threaten the viability of the population, particularly as collision rates may decline as waterfowl become familiar with the transmission line (Harron, 2003). The overall effect is anticipated to have a low effect, and a negligible cumulative effect (as there is only one other transmission line within the CESA). Similarly, there are no other developments within the Taltson River watershed that are anticipated to cause changes to the hydrology regime, and so cumulative effects from this pathway are also negligible. Effects from both pathways are confined to the RSA, leading to a local effect. As the effects are caused by Project operation, they are long-term. Overall, the effects of hydrology regime change and collisions with the transmission line are anticipated to be not significant in the incremental and cumulative cases.

For raptors, effects were considered to be largely similar during the construction and operations phases at the scale of the assessment. Effects considered included those from sensory disturbance, which is anticipated to affect distribution more than abundance. The specific effects of Project-related sensory disturbance on many species of raptors are unclear. For example, at the Snap Lake Mine, variation in nest site occupancy and success was not strongly related to distance from the mine. Although weather and prey abundance were not highly correlated with nest success, these environmental variables had stronger associations with nest success than did distance from the mine (De Beers 2008). However, spatial and temporal changes in raptor nest occupancy and success in the Lac de Gras region have been observed. Raptor nest success and occupancy increased with distance from the Diavik Diamond Mine, and nest success appeared to decline over time from construction through current operations (Golder 2005, 2008). However, the relationships were weak, and spring rainfall also contributed to the variation in nest success (Golder 2008). There are also indications that raptors are able to habituate to disturbance. There have been several attempts by peregrine falcons, gyrfalcons, rough-legged hawks and common ravens to nest within both active and abandoned open pits at the Ekati and Diavik diamond mines. Nesting on pit walls has become so common at the Ekati Diamond Mine that a monitoring program has been implemented.

ENR (2008) recommended that activity be restricted within 1.5 km of peregrine falcon and short-eared owl nests during the nesting season (April 15 to September 15). Baseline studies identified 15 cliffs with signs of historic nesting activity within 1.5 km of the transmission line. However, the construction schedule indicates that, in many cases, there would not be activity in the vicinity of the cliffs during the nesting season. In cases where overlap may occur, mitigation would be implemented to avoid or reduce sensory disturbance. Considering this avoidance of nesting raptors, and that sensory disturbance to raptors would be greatest during the nesting season, sensory disturbances due to construction activities are anticipated to cause a medium-term, low magnitude effect.

Noise modelling indicates that most Project noise would dissipate within 3 km of the Project, indicating a local-scale effect. Cumulatively, there exist other developments within the raptor CESA, some of which are active during the raptor breeding season. The existing diamond mines are likely the single greatest source of disturbance. Monitoring to date has provided some evidence that mining activity affects nesting raptors, but it remains unclear if this effect is due to the presence of mines, or other natural phenomenon (such as extreme weather events and changes in prey availability, Golder, 2008). Overall, the construction phase cumulative effect was considered to be low. Cumulative effects are beyond-regional in geographic extent, due to the likelihood of overlapping effects from adjacent developments. During operation, sensory disturbance to raptors is anticipated to be lower than during construction. There is little indication that transmission lines and towers are a source of sensory disturbance to raptors, as they are known to perch on these structures. Other sources of sensory disturbance during operation include the permanent camp at Twin Gorges, and annual inspections of the transmission line by helicopter. Operation phase effects are, however, long-term. Overall, the incremental and cumulative effects to raptors from sensory disturbance during the construction and operation phases were considered to be not significant (Table 15.4.32).

Table 15.4.32 — Determination of Significance for Passerines, Waterfowl, and Raptors

Valued Component Assessment Endpoints	Pathways	Project Phase	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	SIGNIFICANCE	
			Incremental	Cumulative	Incremental	Cumulative		Incremental	Cumulative
Persistence of abundance and distribution of passerines	Project footprint leading to habitat loss and fragmentation Sensory disturbance causing changes in habitat quality	Construction Operation	Low	Low	Local to regional	Beyond regional	Long-term to irreversible	Not significant	Not significant
Persistence of distribution of waterfowl	Sensory disturbance leading to change in habitat quality	Construction Operation	Low	Low	Local to regional	Beyond regional	Long-term	Not significant	Not significant
Persistence of abundance of waterfowl	Effects of hydrology regime change Collisions with the transmission line leading to mortality of waterfowl	End of Construction to Operation	Low	Negligible	Local	Local	Medium to long-term	Not significant	Not significant
Persistence of abundance and distribution of raptors	Sensory disturbance causing changes in habitat quality	Construction	Low	Low	Local to regional	Beyond regional	Medium-term	Not significant	Not significant
		Operation	Low	Low	Local to regional	Beyond regional	Long-term	Not significant	Not significant

15.4.12 Uncertainty

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

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

15.4.12.1 Rare Vascular Plants

The primary sources of uncertainty surrounding the identification of potential effects to rare vascular plant species are largely associated with the degree to which effects may occur (e.g. magnitude and duration). It is understood that development activities would disturb vegetation communities, however, long-term monitoring studies documenting the resilience of boreal and tundra ecosystems and the degree to which they recover are limited (e.g. Forbes 1992, Auerbach et al. 1997, Forbes et al. 2001). Further, the final area of the Project footprint is difficult to predict. For example, the transmission line ROW may require no clearing, or clearing of a corridor up to 30 m wide, depending on surrounding topography and vegetation. When faced with such uncertainty, the most conservative approach was chosen.

Reasonably foreseeable developments in the RSA, such as the proposed East Arm National Park, also contribute to uncertainty in assessment predictions. From a conservation perspective, the development of the proposed East Arm National Park would likely constitute a positive effect for plant species at risk and associated plant communities.

Elements that have been taken to reduce the uncertainty of predictions include incorporating available and applicable literature into the assessment of effects, relying on past experience (both in Arctic and other climates), using conservative assumptions and modelling inputs, and using best professional judgment. Additionally, follow-up monitoring would be implemented to test effects associated with the hydrology regime changes on vegetation communities and rare vascular plants. If effects are greater than predicted, then adaptive management and additional mitigation would be used to reduce effects on vegetation and plant species.

There are limitations to the methods used to estimate the presence of rare vascular plants and their distribution. The plants themselves do not adhere to any formal system, but grow where conditions suit their individual tolerances (Burt 1997). Habitat descriptions obtained from the NWT Species Monitoring Infobase (ENR 2007) sometimes describe specific microhabitats associated with listed species that are not necessarily tied to the broad land cover classes used for mapping. Because the land cover maps are derived from Landsat Thematic Mapper imagery, which has a 30 m by 30 m pixel size, the mapping classes may include a variety of microhabitats that are too small to be effectively differentiated from the landscape matrix by the imaging sensors.

15.4.12.2 GRIZZLY BEAR AND WOLVERINE

It is anticipated that the baseline data are sufficient for understanding current conditions and future changes not related to the Project, and that there is a moderate-to high level of understanding of Project-related effects on the ecosystem. During the past 10 to 12 years, monitoring studies at operating diamond mines, as well as government and university research programs, have provided good information on the response of grizzly bear and wolverine to development-related effects in arctic environments. Traditional knowledge studies and recommendations from Elders about how to mitigate effects from mines has also increased during this time. In general, research on wolverine has increased as radio-telemetry and genetic studies have become more viable options for research. This information increased the confidence in model inputs, grizzly bear and wolverine-Project interactions, and understanding the success of mitigation measures for limiting effects to grizzly bear and wolverine. Although grizzly bear and tundra wolverine have been monitored over the last 10 years over portions of the Project footprint, there is limited information on the population of wolverine in the boreal portion of the Project. Direct disturbance to habitats from development footprints represent minimal disturbance to habitat within grizzly bear and wolverine ranges, but there remains a moderate degree of uncertainty in the effectiveness of natural regeneration following Project construction.

Adding to the challenges of understanding complex systems is the difficulty of forecasting a future that may be outside the range of observable baseline environmental conditions, such as factors related to climate change (Walther et al. 2002). Potential future developments such as the proposed Bathurst Inlet Port and Road Project (BIPR) and the East Arm National Park, also generate uncertainty in effect predictions. The BIPR would provide access to the Arctic Ocean for remote mines. The port would be located on the west side of Bathurst Inlet, about 40 km south of the community of Bathurst Inlet, and the road would end near Contwoyto Lake (211 km in length). There is potential for this development, during both construction and operation, to affect grizzly bear and wolverine in their respective ranges.

Understanding and predicting the behaviour of populations within ecosystems requires the aggregation and simplification of available knowledge, retaining what is essential and disregarding what is not essential at the particular scale of interest. Ecological models (conceptual or quantitative) represent an attempt to create a simplified approximation of reality that can be used as a predictive tool. These models are essential for anticipating how grizzly bear and wolverine may respond to a changing landscape, and for predicting residual effects from the Project and other developments. However, the complexity of the dynamics of populations and the environment means that processes are not completely reducible to their components, and that predictions contain uncertainty (Boyce 1992, Walther et al. 2002, Wu and Marceau 2002).

Although quantitative and less biased than habitat models based on expert opinion, the resource selection function-based habitat maps used in this assessment have sources of uncertainty. These include the structure of the models, the accuracy and precision of underlying data layers, and biases associated with the chosen GIS algorithms (Burgman et al. 2005). Further, habitat maps provide a static view between carnivores and the environment, ignoring changes over time with ecological succession and natural disturbances such as climatic events. However, when considering the predictions on the effects of the Project on wolverine and grizzly bear habitat, sources of uncertainty were reduced by using multiple habitat mapping methods (Burgman et al. 2005). For example, the assessment included both fragmentation analyses and the use of habitat quality models, which together limit bias and imprecision in predictions. In addition, the following conservative assumptions were applied to the habitat models:

- the footprint (area of direct habitat disturbance) for all exploration sites was 1 km^2 (314 ha),
- a 15 km ZOI was applied to all active exploration permits for the entire five-year period, and over the entire year,
- a 30 km ZOI was applied to all active mine sites, regardless of the size of the footprint or the level of activity for each mine, and
- the maximum disturbance coefficients, which reduce habitat quality in the ZOIs, were applied in cases where ZOIs overlapped rather than using the average of two or more coefficients.

Therefore, throughout the grizzly bear and tundra wolverine assessment, conservative estimates were used in conceptual and quantitative models to increase confidence that effects were not underestimated. In addition, the spatial boundary (i.e. geographic extent) of the assessment was based on a large study area that would encompass a population or subpopulation that would be affected by the Project, and included all known historic and existing developments that may influence the population. Within the Project footprint, smaller-scale effects were also assessed including individual responses to estimated ZOI. All of these attributes provide confidence that the assessment has not underestimated the significance of the cumulative effects from the Project and other developments on grizzly bear and tundra wolverine.

The same certainty does not extend to boreal wolverine because the assessment was completed qualitatively. Data for wolverine in the boreal portion of the Project footprint are not well-studied, however, the most recent data and available peer-reviewed research on wolverine were used as the basis of the assessment. It is also assumed that boreal wolverine would respond to disturbance in similar manner to tundra wolverine.

15.4.12.3 PASSERINES, WATERFOWL, AND RAPTORS

It is anticipated that the baseline data is sufficient for understanding current conditions and future changes not related to the Project, and that there is a moderate- to high level of understanding of Project-related effects on the ecosystem. There is good information on the effects from human development on passerines and raptors in arctic and boreal habitats, but there is limited information available for waterfowl populations in tundra settings. Subsequently, there remains some uncertainty surrounding the degree to which some effects may occur (e.g. magnitude and duration).

The frequency and effect of bird collisions with the transmission line is also an area of uncertainty. The literature indicates that waterfowl are the most susceptible of the VCs investigated, likely due to their limited manoeuvrability, tendency to fly low from lake to lake, and flocking behaviour. However, there is a wide range in mortality rates and methods used in the calculation of the mortality rate. Further, many other factors must be considered, such as the number of conductor wires, presence or absence of ground wires, season, weather, and waterfowl species. Collisions do appear to occur in concentrated areas, and it is these sites where studies are focused. Resulting from this is a low level of certainty in the estimate of waterfowl collision mortalities. Regardless, most reports contend that this is unlikely to be a source of significant mortality.

Adding to the challenges of understanding complex systems is the difficulty of forecasting a future that may be outside the range of observable baseline environmental conditions, such as factors related to climate change (Walther et al. 2002). Migratory bird species are also under pressures on their wintering grounds. Potential future developments, such as the proposed East Arm National Park, also generate uncertainty in effect predictions. Overall, the proposed East Arm National Park would likely be beneficial to birds and associated species at risk from a conservation perspective.

15.4.12.4 REASONABLY FORESEEABLE PROJECTS

Cumulative effects assessment should include all other human activities that may substantially affect the VC, including past, present and reasonably foreseeable future projects (MVEIRB 2004). Like all predictions, this introduces further uncertainty (MVEIRB 2004). Reasonably foreseeable projects included in the cumulative effects assessment were projects or activities that:

- are currently undergoing regulatory review,
- are about to be submitted for review,
- have been officially announced by a proponent,
- are directly associated with the Project under review, and
- would be induced by the Project if the Project is approved.

The following proposed projects have been selected as a suite of major developments that may occur in the reasonably foreseeable future:

- the Gahcho Kué Project (was considered for the purposes of this DAR to be an existing project),
- a small scale diamond mine in the Lac de Gras region owned by Peregrine Diamonds Ltd. that would haul ore to Ekati for processing,
- the Tyhee NWT Corp Yellowknife Gold Project,
- the Bathurst Inlet Port and Road Project (BIPR), and
- the East Arm National Park.

None of the above projects are within the Taltson watershed, therefore, no cumulative effects to Taltson watershed hydrology, water quality or access are anticipated.

Further, as all developments (with the exception of the proposed East Arm National Park and the Yellowknife Gold Project) would be north of the treeline, no cumulative effects are anticipated to boreal wolverine, olive-sided flycatcher, common nighthawk, rusty blackbird, whooping crane, or northern leopard frog. As the proposed East Arm National Park would limit further development, effects from this Project are positive in nature to all the VCs and within its boundaries.

However, the reasonably foreseeable future projects listed above may lead to cumulative effects for the species found north of the treeline. A discussion of how these species may be affected by each project is provided below.

The Peregrine Diamonds Ltd.'s property is located in the Lac de Gras region, near the proposed transmission line ROW. A possible scenario for this project is the development of a small-scale underground mine and construction of an all-season haul road for the transportation of ore to the Ekati Diamond Mine site for processing. The viability of the Peregrine Diamonds property would improve with the presence of the Project transmission line. The proposed BIPR would provide access to the Arctic Ocean for projects located within the interior of the NWT and Nunavut. The proposed 211 km all-weather road, which would begin at a planned port facility south of the community of Bathurst Inlet, Nunavut, would connect with the existing ice road on Contwoyto Lake (BIPR 2008). These two projects could lead to cumulative habitat loss for grizzly bear, tundra wolverine, peregrine falcon, and short-eared owl. Monitoring at the existing diamond mines suggests that nesting success of peregrine falcons and gyrfalcons may improve with distance from the mine (De Beers 2008, Golder 2008), and a new mine on the landscape may lead to further effects.

Mining operations also reduce surrounding habitat suitability for wolverine and grizzly bear. Direct mortalities to these species from mining has occurred, but the number of such incidents has been low in recent years as mitigation has improved (Table 15.4.7). Vehicle collisions with large wildlife species have been rare, and no such incidents have been reported at the existing diamond mines for grizzly bear or wolverine. Most surface transport to the existing mines has been by winter road, thus interactions with grizzly bears has been avoided. New mines and roads within the Slave Geological Province would contribute to habitat degradation for these species. However, the overall effect is not anticipated to be significant, as habitat loss and habitat suitability metrics suggest that effects from these developments have not yet reached levels that may permanently affect the population.

The Yellowknife Gold Project proposed by Tyhee NWT Corporation anticipates a combination of open pit and underground mining operation with a lifespan of 8 to 13 years depending on production rates. It is expected that approximately 190 people would be employed at the site when in full operation (Tyhee 2008). The property is located 90 km north of the City of Yellowknife on the former Discovery Mine site, an existing disturbed area. Access would be by an existing winter road route and by air. The Yellowknife Gold Project is outside of the CESA of all the VCs, with the exception of the boreal wolverine and raptors. The Yellowknife Gold Project is outside of the range of the peregrine falcon, but within the range of the short-eared owl (Figure 9.5.23, Section 9.5.7). However, because the distance between the Yellowknife Gold Project and the Project is over 200 km, cumulative effects to boreal wolverine and raptors are anticipated to be negligible.

15.4.13 Monitoring

Three categories of monitoring were identified in the TOR as follows:

- Compliance inspection: monitoring the activities, procedures, and programs undertaken to confirm the implementation of approved design standards, mitigation, and conditions of approval and company commitments.
- Environmental monitoring: monitoring to track conditions or issues during the development lifespan, and subsequent adaptation of Project management.
- Follow-up monitoring: programs designed to verify the accuracy of impact predictions, to reduce uncertainty, and to determine the effectiveness of mitigation.

These programs would form part of the environmental management system (EMS) for the Project. If monitoring or follow-up detects effects beyond those predicted, unanticipated effects, or the need for improved or modified design features, then adaptive management would be implemented. This may include increased monitoring, changes in monitoring plans, or additional mitigation.

Environmental monitors would be hired during the Project construction phase to oversee issues such as camp waste disposal, human-wildlife conflicts, and managing any unanticipated Project conflicts with wildlife (i.e. environmental monitoring). Environmental monitors would also document the presence of carnivores and raptors near construction areas, communicate this information to construction managers, and carry out any deterrent action that may be necessary (documented in the Human Wildlife Conflict Management Plan). This type of monitoring has been demonstrated to be of great value at the Diavik, Ekati and Snap Lake Diamond Mines.

Follow-up monitoring is also proposed. Unauthorized use of the proposed winter roads from Fort Smith to Twin Gorges and from Twin Gorges to Nonacho Lake would be documented by the environmental monitors. Further, any evidence of wildlife harvesting, ice fishing, recreational snowmobiling, firewood harvesting, camping, or any other such activities would be recorded. An example of a similar monitoring program is that conducted by ENR on the Tibbitt to Contwoyto winter road (Ziemann, 2007).

Species at Risk and key bird species monitoring beyond those described in the Human Wildlife Conflict Management Plan would be outlined in the Wildlife Monitoring Plan, to be developed during the permitting process, if the Project is approved.

To avoid any disturbance of nesting raptors, the environmental monitors would identify areas where construction activity may pass within 1.5 km of a known nest site during the nesting season. Surveys would be completed to determine which nests are occupied. If a known nest is found to be occupied, or a new nest is found, construction managers would be requested to identify strategies to avoid the nest. ENR would be contacted for further advice if avoidance of the 1.5 km buffer around an active nest during the construction season is not easily achievable.

APPENDIX 15.4A

ABSOLUTE VALUES OF FRAGMENTATION STATISTICS

Pristine, Existing, and Application Landscape Metrics and Proportional Landscape Changes (%) from Development in Spring through Autumn for Grizzly Bear and Tundra Wolverine, Slave Geological Province.

Land Cover Class	Total Area (Hectares)			Proportion of Study Area (%)			Number of Patches			Total Edge (Metres)			Mean Area of Patch (Hectares)			Coefficient of Variation for Patch Area (%)			Mean Distance to Nearest Neighbour (Metres)			Coefficient of Variation for Distance to Nearest Neighbour (%)		
	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application
Esker	89,440	88,100	88,080	0.5	0.5	0.5	9,827	9,740	9,740	13,055,800	12,885,800	12,884,600	9.1	9.0	9.0	371.1	369.7	369.7	1,068.5	1,073.8	1,073.8	106.2	106.3	106.3
Lichen Veneer	617,156	615,220	614,912	3.2	3.2	3.2	33,513	33,366	33,365	67,525,800	67,269,000	67,237,800	18.4	18.4	18.4	3,826.7	3,830.2	3,832.0	704.5	705.6	705.6	103.5	103.7	103.7
Rock Association	1,438,408	1,434,720	1,434,632	7.5	7.4	7.4	43,248	43,121	43,110	114,329,200	114,062,000	114,048,800	33.3	33.3	33.3	4,016.2	4,011.4	4,011.1	687.0	687.3	687.3	86.1	85.9	85.9
Heath Tundra	4,395,936	4,377,416	4,374,616	22.8	22.7	22.7	82,411	82,252	82,353	344,519,800	343,374,200	343,379,000	53.3	53.2	53. 1	4,277.3	4,230.1	3,370.0	509.2	509.3	509.2	45.1	45.1	45.1
Heath Rock	3,102,032	3,088,300	3,087,012	16.1	16.0	16.0	91,533	91,341	91,390	298,255,000	297,208,600	297,151,000	33.9	33.8	33.8	1,965.7	1,951.6	1,952.7	511.0	511.3	511.2	46.2	46.3	46.3
Sedge Association	2,050,420	2,042,956	2,042,244	10.6	10.6	10.6	91,773	91,500	91,522	217,971,400	217,125,000	217,074,200	22.3	22.3	22.3	2,320.3	2,323.8	2,322.5	559.6	559.9	559.9	55.9	56.0	56.0
Riparian Shrub	89,100	88,832	88,824	0.5	0.5	0.5	11,705	11,672	11,670	14,195,200	14,154,000	14,152,400	7.6	7.6	7.6	196.0	196.1	196.1	986.4	987.2	987.5	146.3	146.3	146.4
Low Shrub	319,116	318,552	318,520	1.7	1.7	1.7	18,748	18,697	18,696	33,838,600	33,765,400	33,763,400	17.0	17.0	17.0	1,897.8	1,897.7	1,897.8	840.4	841.4	841.5	113.1	113.3	113.4
Forest	384,216	382,012	382,008	2.0	2.0	2.0	8,223	8,185	8,184	27,829,800	27,703,000	27,702,200	46.7	46.7	46.7	4,585.6	4,583.2	4,582.9	777.7	778.6	778.4	144.9	145.0	145.1
Peat Bog	48,004	47,800	47,800	0.2	0.2	0.2	6,390	6,372	6,372	7,782,000	7,754,400	7,754,400	7.5	7.5	7.5	116.7	116.5	116.5	748.3	748.8	748.8	87.3	87.4	87.4
Young Burn	25,804	25,804	25,804	0.1	0.1	0.1	162	162	162	943,000	943,000	943,000	159.3	159.3	159.3	573.3	573.3	573.3	4,039.4	4,039.4	4,039.4	110.8	110.8	110.8
Old Burn	46,640	46,424	46,424	0.2	0.2	0.2	2,947	2,940	2,940	5,736,400	5,712,800	5,712,800	15.8	15.8	15.8	384.6	384.0	384.0	790.2	790.1	790.1	99.0	99.1	99.1
Nonvegetated	6,663,524	6,635,180	6,633,820	34.6	34.4	34.4	88,612	88,519	88,582	359,237,400	358,225,000	358,166,600	75.2	75.0	74.9	7,394.7	7,411.3	7,413.1	485.3	485.5	485.5	29.3	29.3	29.3

Note: As the amount of unclassified land cover varies between scenarios, the total area within each season is not exact

Pristine, Existing, and Application Landscape Metrics and Proportional Landscape Changes (%) from Development in Winter for Tundra Wolverine, Slave Geological Province.

Land Cover Class	Total Area (Hectares)			Proportion of Study Area (%)			Number of Patches			Total Edge (Metres)			Mean Area of Patch (Hectares)			Coefficient of Variation for Patch Area (%)			Mean Distance to Nearest Neighbour (Metres)			Coefficient of Variation for Distance to Nearest Neighbour (%)		
	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application	Pristine	Existing	Application
Esker	89,440	87,984	87,964	0.5	0.5	0.5	9,827	9,740	9,740	13,055,800	12,874,600	12,873,400	9.1	9.0	9.0	371.1	369.8	369.9	1,068.5	1,074.5	1,074.5	106.2	106.3	106.3
Lichen Veneer	617,156	615,056	614,720	3.2	3.2	3.2	33,513	33,348	33,347	67,525,800	67,247,000	67,215,000	18.4	18.4	18.4	3,826.7	3,830.2	3,832.2	704.5	705.5	705.6	103.5	103.7	103.7
Rock Association	1,438,408	1,433,620	1,433,536	7.5	7.5	7.5	43,248	43,118	43,108	114,329,200	114,035,600	114,023,200	33.3	33.2	33.3	4,016.2	3,936.4	3,936.2	687.0	687.3	687.3	86.1	85.9	85.9
Heath Tundra	4,395,936	4,373,056	4,370,120	22.8	22.8	22.8	82,411	82,383	82,485	344,519,800	343,312,600	343,311,000	53.3	53.1	53.0	4,277.3	3,340.2	3,100.5	509.2	509.2	509.1	45.1	45.1	45.1
Heath Rock	3,102,032	3,086,740	3,085,420	16.1	16.1	16.1	91,533	91,356	91,404	298,255,000	297,103,400	297,042,200	33.9	33.8	33.8	1,965.7	1,944.6	1,945.7	511.0	511.3	511.3	46.2	46.3	46.3
Sedge Association	2,050,420	2,041,472	2,040,708	10.6	10.7	10.7	91,773	91,541	91,567	217,971,400	217,012,200	216,955,800	22.3	22.3	22.3	2,320.3	2,322.7	2,321.6	559.6	559.9	559.9	55.9	56.0	56.0
Riparian Shrub	89,100	88,792	88,780	0.5	0.5	0.5	11,705	11,664	11,661	14,195,200	14,146,400	14,144,000	7.6	7.6	7.6	196.0	196.2	196.2	986.4	987.8	987.9	146.3	147.1	147.2
Low Shrub	319,116	318,440	318,408	1.7	1.7	1.7	18,748	18,690	18,689	33,838,600	33,749,000	33,747,000	17.0	17.0	17.0	1,897.8	1,898.0	1,898.1	840.4	841.9	841.9	113.1	113.2	113.4
Forest	384,216	381,584	381,580	2.0	2.0	2.0	8,223	8,186	8,185	27,829,800	27,694,800	27,694,000	46.7	46.6	46.6	4,585.6	4,585.6	4,585.3	777.7	778.9	778.7	144.9	145.0	145.0
Peat Bog	48,004	47,780	47,780	0.2	0.2	0.2	6,390	6,372	6,372	7,782,000	7,751,200	7,751,200	7.5	7.5	7.5	116.7	116.5	116.5	748.3	748.6	748.6	87.3	87.4	87.4
Young Burn	25,804	25,804	25,804	0.1	0.1	0.1	162	162	162	943,000	943,000	943,000	159.3	159.3	159.3	573.3	573.3	573.3	4,039.4	4,039.4	4,039.4	110.8	110.8	110.8
Old Burn	46,640	46,364	46,364	0.2	0.2	0.2	2,947	2,937	2,937	5,736,400	5,706,400	5,706,400	15.8	15.8	15.8	384.6	384.3	384.3	790.2	790.2	790.2	99.0	99.1	99.1
Nonvegetated	6,663,524	6,609,984	6,607,444	34.6	34.5	34.5	88,612	88,880	88,960	359,237,400	359,935,400	359,959,000	75.2	74.4	74.3	7,394.7	7,410.1	7,415.9	485.3	485.3	485.2	29.3	29.3	29.3

Note: As the amount of unclassified land cover varies between scenarios, the total area within each season is not exact

APPENDIX 15.4B

HABITAT SUITABILITY MAPS FOR GRIZZLY BEAR AND WOLVERINE