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15. SUBJECTS OF NOTE

15.7 EFFECTS TO KEY FURBEARING SPECIES AND UNGULATES

15.7.1 Introduction

This section describes effects to the Subject of Note Key Furbearing Species and Other Ungulates. In the Terms of Reference for the Project issued on March 28, 2008, the Mackenzie Valley Environmental Impact Review Board (MVEIRB, 2008) provided the following rationale for including key furbearing species and other ungulates as a SON:

Concerns were expressed during the issue scoping exercises about the potential impacts that the development could have on key furbearing species and ungulates (other than caribou), many of which are harvested by local communities. Because the proposed Expansion Project traverses both the northern boreal forest, as well as the tundra, there may be a wide range of species that could potentially be affected.

This SON section includes a detailed assessment of effects on key furbearing species (marten, lynx, beaver, and muskrat), and the two species of ungulates other than caribou (i.e., muskoxen and moose) that could potentially be affected by the Project..

15.7.2 Valued Components and Assessment Endpoints

15.7.2.1 VALUED COMPONENT SELECTION

An important aspect of the VC selection process is that it incorporates the values expressed by concerned people during the public screening sessions. During the issues scoping exercises, the potential effects that the Project could have on key furbearing species and ungulates (other than caribou), many of which are harvested by local communities, was emphasized (MVEIRB, 2008). This section includes a detailed assessment of effects on muskoxen and moose, the two species of ungulates other than caribou that could potentially be affected by the Project.

15.7.2.2 APPROACH TO SELECTION OF KEY FURBEARING SPECIES

A range of tundra and boreal furbearing species may be influenced by the Project. To define key furbearing species for this assessment, the following approach was used:

- Furbearing species present in the NWT and overlapping with the Project were identified;
- All communities within 200 km of the Project were identified to determine the communities where trapping may be affected by the Project;
- Fur records from the winters of 2005-06 and 2006-07 were obtained for each potentially affected community;
- The overall dollar value of the harvest (which is a function of pelts' market value and the number of pelts submitted to auction from each community) was summarized for each community; and
- The key furbearing species for potentially affected communities were selected.

Table 15.7.1 lists furbearing species defined by the NWT Wildlife General Regulations (GNWT, 1999).

Table 15.7.1 — Furbearing Species in the Northwest Territories

Common Name	Scientific Name	Range	Potential Interaction with the Project
Beaver	*Castor canadensis*	Boreal	Yes
River otter	*Lontra canadensis*	Boreal	Yes
Lynx	*Lynx canadensis*	Boreal	Yes
Marten	*Martes americana*	Arboreal	Yes
Fisher	*Martes pennanti*	Boreal	Possibly[1]
Striped skunk	*Mephitis mephitis*	Boreal	Unlikely[1]
Ermine	*Mustella erminea*	Boreal and Tundra	Yes
Least weasel	*Mustella nivalis*	Boreal	Yes
Mink	*Mustella vison*	Boreal	Yes
Muskrat	*Ondatra zibethicus*	Boreal	Yes
Red squirrel	*Tamiasciurus hudsonicus*	Arboreal	Yes
Wolverine	*Gulo gulo*	Boreal and Tundra	Yes
Wolf	*Canis lupus*	Boreal and Tundra	Yes
Coyote	*Canis latrans*	Boreal	Unlikely[1]
White (arctic) fox	*Alopex lagopus*	Tundra	yes
Red fox	*Vulpes vulpes*	Boreal and Tundra	yes

[1] Based on species distribution and trapping records (Banfield, 1974; Working Group on General Status of NWT Species, 2006; ITI, 2007).

Communities within 200 km of the Project include Fort Smith, Fort Resolution, Łutsel K'e, and Yellowknife. The total number of furs harvested by these communities for the winters of 2005-06 and 2006-07 and the estimated economic value for each species are presented in Table 15.7.2.

Table 15.7.2 — Total Numbers of Fur Harvested and Estimated Value for Fort Smith, Fort Resolution, Łutsel K'e, and Yellowknife: 2005 to 2007

Species	Fort Resolution		Fort Smith		Łutsel K'e		Yellowknife	
	Total Number Harvested	Total Value ($)	Total Number Harvested	Total Value ($)	Total Number Harvested	Total Value ($)	Total Number Harvested	Total Value ($)
Beaver	292	6,336.77	595	16,872.89	4	101.91	74	1,879.55
River Otter	1	20.43	3	226.38	0	0	0	0
Lynx	469	74,301.66	174	22,738.61	4	654.66	46	7,129.93
Marten	591	53,198.64	495	39,753.73	455	40,575.94	492	41,355.47
Fisher	13	1,242.28	51	4,426.49	0	0	0	0
Weasel	353	2,669.94	240	1,751.77	2	6.82	86	554.37
Mink	136	3,509.16	148	2,949.45	56	1,292.47	102	2,351.78
Muskrat	1,897	12,961.03	1,012	4,899.14	29	196.71	980	7,958.75
Squirrel	33	61.53	211	513.61	4	9.09	21	56.80
Wolverine	14	2,349.48	14	2,464.15	10	1,861.78	38	7,152.56
Wolf	13	1,164.86	21	1,986.86	6	1,012.50	4	761.00
Coyote	2	105.56	4	25.14	0	0	0	0
Arctic Fox	0	0.00	0	0.00	1	22.70	0	0
Red Fox	74	1,938.66	13	409.78	2	115.77	40	1,088.06

Source: ITI 2007

Total pelt values (i.e., dollar value of the harvest) indicate that marten, lynx, muskrat, and beaver are the key furbearing species for the affected communities. Although wolverine is also a key harvest species, the potential effects on wolverine (and grizzly bear) from the Project are discussed in Section 15.4. Therefore, this section includes a detailed assessment of effects on only marten, lynx, muskrat, and beaver.

15.7.2.3 ASSESSMENT ENDPOINTS

Assessment endpoints represent the key properties of the VC that should be protected for use by future human generations. Assessment endpoints for this section include:

- Persistence of abundance and distribution.
- Continued harvesting opportunities.

15.7.3 Spatial and Temporal Boundaries of the Assessment

The effects study area for this section was not specifically identified in the final Terms of Reference (MVEIRB, 2008). To assess the Project's potential effects on key furbearing species and other ungulates, it is necessary to define appropriate spatial and temporal boundaries. The spatial boundaries were delineated based on the predicted extent of the Project-related effects, as well as life history attributes of key furbearing and ungulate species potentially interacting with the Project. The temporal boundaries were based on the Project duration.

The spatial scales and boundaries selected for the effects assessment of the Project on other ungulates and key furbearing species include:

- Local Study Area (LSA): defined as the entire Project area (or area to be disturbed), plus a 100 m buffer on either side. The LSA was selected to assess baseline conditions and the immediate direct and small-scale indirect effects of the Project on individual animals and wildlife habitat.
- Regional Study Area (RSA): consists of the entire Project area (including both the transmission line and the winter roads), plus a 5 km buffer on either side. The boundary for the RSA was used to quantify baseline conditions at a scale that was large enough to assess the maximum predicted geographic extent of direct and indirect effects from the Project on VCs (Figure 15.7.1).
- Cumulative Effects Study Areas (CESA): the spatial boundary for quantifying baseline conditions and assessing Project-specific (incremental) and cumulative effects from development. Thus, the assessment includes both the incremental effects from the Project, and the cumulative effects from the Project and other developments that overlap with population distribution (Figure 15.7.1).

The CESA was defined as the natal dispersal distance of the VC around the Project. Natal dispersal by immature animals is important for colonization and the maintenance of metapopulation connectivity (D'Eon et al. 2002). Long-distance dispersal events are relatively rare, but are important for establishing landscape connectivity (Sutherland et al. 2000, D'Eon et al. 2002). Landscape connectivity has been established to be important to the preservation of animal populations (Fahrig and Merriam 1985). Natal dispersal distances were calculated for each mammalian species using the predictive allometric equations defined by Sutherland et al. (2000) (Table 15.7.3). Natal dispersal distances are defined here as distances at which only

90% of females successfully leave the natal home range and establish a new home range.

The study area for assessment of incremental and cumulative effects was also adjusted to account for the distribution of each VC relative to the treeline. The effects study areas for marten, lynx, moose, beaver, and muskrat were bound by the northern extent of the treeline, as these are boreal species within this region of North America. Similarly, the effects study area for grizzly bear was also bound by the treeline, but included the northern sections of the transmission line only (as this is a tundra species). Components of the Project that are located north of the treeline also were not considered in these effects study areas. Wolverine are found in both boreal and tundra areas, and so the effects study areas for these species included the entire Project footprint (boreal and tundra). Muskox are most commonly associated with tundra environments, but were observed relatively frequently in the northern extents of the boreal forest during baseline surveys for the Project. As such, the effects study area for muskox extended 100 km south of the treeline. For caribou, due to their migratory nature, the range of the Bathurst herd was used as the study area, rather than the natal dispersal distance.

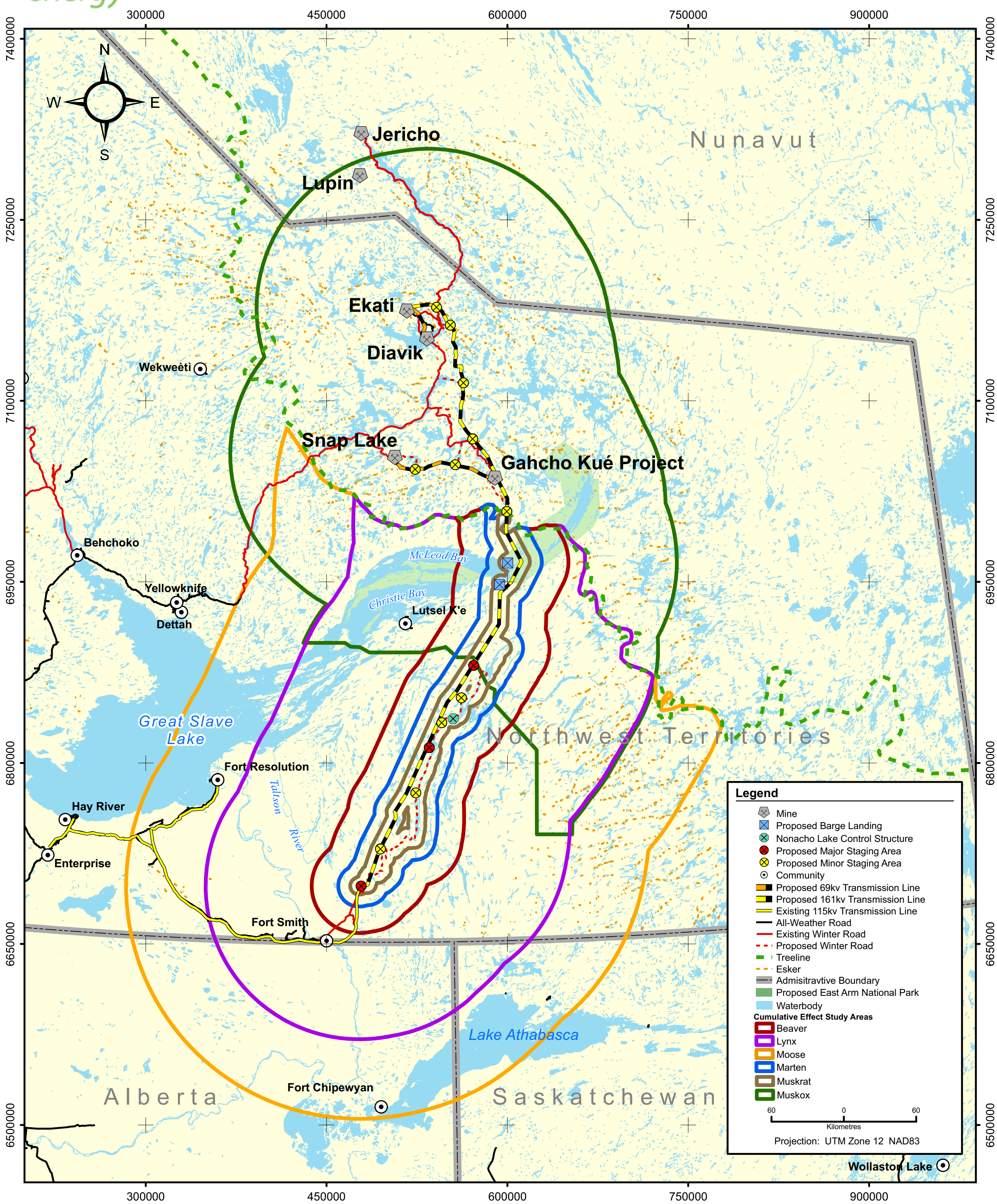
Table 15.7.3 — Natal Dispersal Distances Used to Define the Spatial Boundary of the Effects Assessment for Valued Components

Species/Species Group	Estimated Natal Dispersal Distance[1] (km)
Marten	17
Lynx	127
Beaver	39
Muskrat	7
Moose	193
Muskox	129

[1] Natal dispersal distances were estimated using female body weights and the allometric equations of Sutherland et al. (2000). Using the 'corrected' negative exponential functions of Sutherland et al (2000), estimates represent 90% of expected dispersal distances.

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 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 Energy 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.

Dezé energy



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Moose, Muskox, Lynx, Marten, Beaver and Muskrat Cumulative Effects Study Areas	Figure 15.7.1

Company/Figure ID number

15.7.4 Pathway Analysis

Pathway analysis identifies and screens the issues and linkages between Project components or activities and the potential effects on key furbearing species and other ungulates. A pathway analysis was completed for key furbearing species and other ungulates to identify valid, minor, and invalid Project-related pathways.

As previously mentioned, the spatial boundary for quantifying baseline conditions and assessing incremental and cumulative effects from development was defined by the population range or the predicted dispersal distance for the species (Figure 15.7.1). For muskoxen, the study area for incremental and cumulative effects assessment was also adjusted to account for the distribution of muskoxen relative to the treeline. Muskoxen are most commonly associated with tundra environments, but were observed frequently in the northern extents of the boreal forest, relative to the tundra regions, during baseline surveys for the Project. As such, the effects study area for muskoxen extended 100 km south of the treeline (Figure 15.7.1). The incremental and cumulative effects study area for moose, marten, lynx, muskrat, and beaver was bound by the northern limit of the boreal forest (Figure 15.7.1). Project components located north of the treeline were not considered in the effects analysis for these species.

The first part of the analysis provides a list of potential pathways without considering if they can possibly occur. This step is followed by a summary of mitigation practices and design features that remove the pathway or limit the effects on key furbearing species and other ungulates. Knowledge of the ecological system and anticipated mitigation is 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 key furbearing species and other ungulates.

The pathways presented in Table 15.7.4 were identified through reviewing concerns raised during:

- 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 (MVLWB 2007),
- public hearings hosted by the MVEIRB, and the MVEIRB TOR (MVEIRB, 2008).

15.7.4.1 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 any Project component both designed and incorporated into the Project to avoid or reduce a negative effect; mitigation measures incorporated into the Project to remove or limit effects on key furbearing species and other ungulates are listed in Table 15.7.4.

Table 15.7.4 — Mitigation for Effects to Key Furbearers and Other Ungulates

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Winter access roads Transmission line Barge landing Substations	Hazardous substances (e.g. fuel and hydrocarbons, jet fuel, and explosives) may cause 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 The following EMPs would be developed and implemented: — Spill Contingency EMP — Waste Management EMP
Twin Gorges facilities Barge landing	Attractants to site may change predator-prey dynamics for ungulates	Construction Operation	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 Management EMP would be developed and followed All employees would complete environmental awareness training

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities	Surface water runoff leading to changes in habitat quality (e.g., potential acid-generating waste rock excavated during canal construction, sedimentation from spoil piles)	Construction Operation	Spoil areas are proposed in a natural gully immediately southwest of the low point in the ground level along the canal Rock sampling would continue during excavation activities Non-acid generating rock would be deposited into low profile waste piles The following EMPs would be developed and implemented: — Material and Waste Management EMP — Spill Contingency EMP
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Winter access roads	Changes to aquatic habitat quality at water crossings (e.g. erosion, sedimentation, water withdrawal)	Construction	Project would comply with existing water licence Peak freshet flows would be lower, reducing effects to river banks and vegetation 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) Construction attempts to avoid placing towers, guys, or other infrastructure in or immediately adjacent to water bodies, and avoid wet substrate Construction of the transmission line would follow the DFO Operational Statement for Construction of Overhead Lines[1] and use proven best management practices for road construction The following EMPs would be developed and implemented: — Erosion and Sediment Control EMP — Spill Contingency EMP — Waste Management EMP
Winter access roads	Vehicle collisions may cause injury/mortality to individual animals	Construction	Human-Wildlife Conflict Management EMP would be implemented Establishing and enforcing speed limits Providing wildlife with the right-of-way

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Winter access roads Transmission line Barge landing Substations Staging areas	Project footprint leading to habitat loss and fragmentation	Construction Operation	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 and 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 staging areas would be limited to only those areas necessary to support the construction activities The conductors would be “sagged” to meet standard electrical clearance requirements above ground, and should present no shock hazard to wildlife on the ground Substations would be developed within the boundaries of existing mines Transmission line would be constructed from a combination of air support and winter road access along existing corridors Smaller crew camps would be at existing camps, to reduce infrastructure Access roads would only be used for three construction seasons (years) Use of proven best management practices for road construction The new 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 EMPs would be implemented: — Vegetation Management EMP — Material and Waste Management EMP — Human-Wildlife Conflict Management EMP

Project Component	Pathway	Pathway Duration	Mitigation
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities Winter access roads Transmission line Barge landing Substations	Sensory disturbance (e.g. combined effects from noise, dust, air emissions, physical presence of the Project, human activity) leading to changes in habitat quality	Construction Operation	Substations would be within existing mine footprints Blasting activities would only occur during the construction phase and would not involve substantial re-handling of material, which tends to decrease the fines content and enables the available particulate matter to become airborne Best management practices would be employed to limit equipment exhaust emissions (e.g., shutting off engines during extended periods of down-time) All employees would complete environmental awareness training Winter access roads would be private and access would be limited to vehicles involved in Project construction. Winter access roads would not be monitored 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 road would be established and enforced Human-Wildlife Conflict Management EMP would be implemented. Electromagnetic noise from the transmission line would likely be inaudible (Teshmont 2008). Construction would mainly occur during winter, reducing dust
Nonacho Lake control structure South Valley Spillway Twin Gorges facilities	Effects from changes in hydrological regime changes in the timing and freezing and break-up leading to injury/mortality to individual animals	Operation	Project would comply 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 the 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 excavation would be used for works at the existing Nonacho 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 Nonacho Lake control structure would 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 Continuation of annual inspections on the water conveyance and generation systems, and periodic dam safety reviews

Project Component	Pathway	Pathway Duration	Mitigation
			Reduced flows in Trudel Creek are anticipated to decrease bank erosion and downstream sediment deposition in the Taltson River The following EMPs would be implemented: — Operational Water Management EMP — Spill Contingency EMP
Winter access roads	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 would be gated, and public use would not be permitted

[1] DFO, 2007

15.7.4.2 PATHWAY VALIDATION

Potential pathways affecting key furbearing and other ungulate species include direct and indirect effects on individuals and their habitat (Table 15.7.5). These changes may ultimately affect the population size and distribution of key furbearers, muskoxen, and moose. In the pathway validation, each potential pathway was screened to assess its validity for the Project, after mitigation practices and 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 or 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, but have little effect on the population).
- Valid: a pathway that likely contributes to residual effects to a VC.

Invalid, minor, or valid pathways are determined using scientific knowledge, logic, and experience with similar developments. Invalid and minor pathways were not carried forward into the effects assessment. A pathway would be categorized as valid if a more detailed analysis is required to assess the effects.

Table 15.7.5 — Pathways to Key Furbearing Species and Ungulates

Project Component	Pathway	Pathway Duration	Valued Component	Pathway Validation
Nonacho Lake control structure South valley spillway Twin Gorges facilities	Changes in the timing and freezing; break-up leading to injury/mortality to individual animals	Operation	Muskoxen Moose Lynx Marten Beaver Muskrat	Invalid
Nonacho Lake control structure South valley spillway Twin Gorges facilities	Surface water runoff leading to changes in habitat quality	Construction Operation	Muskoxen Moose Lynx Marten Beaver Muskrat	Invalid
Nonacho Lake control structure South valley spillway Twin Gorges facilities inter Access Roads	Changes to riparian and aquatic habitat quality at water crossings	Construction	Muskoxen Moose Lynx Marten Beaver Muskrat	Minor
Winter access roads	Vehicle collisions may cause injury or mortality to individual animals	Construction	Muskoxen Moose Lynx Marten Beaver Muskrat	Minor
Winter access roads	Improved access leading to increased harvesting	Construction	Muskoxen Moose Lynx Marten Beaver Muskrat	Minor
Nonacho Lake control structure South valley spillway Twin Gorges facilities Winter access roads Transmission line Barge landing Substations	Hazardous substances may cause negative changes to health or mortality of individual animals	Construction	Muskoxen Moose Lynx Marten Beaver Muskrat	Minor
Twin Gorges facilities Barge landing	Attractants to site may change predator-prey dynamics for ungulates	Construction Operation	Muskoxen Moose	Minor

Project Component	Pathway	Pathway Duration	Valued Component	Pathway Validation
Nonacho Lake control structure South valley spillway Twin Gorges facilities Winter Access Roads Transmission Line Barge Landing Substations	Project footprint leading to habitat loss and fragmentation	Construction Operation	Muskoxen Moose Lynx Marten Beaver Muskrat	Valid
Nonacho Lake control structure South valley spillway Twin Gorges facilities Winter access roads Transmission line Barge landing Substations	Sensory disturbance leading to change in habitat quality	Construction Operation	Muskoxen Moose Lynx Marten	Valid
			Beaver Muskrat	Minor
Nonacho Lake control structure South valley spillway Twin Gorges facilities	Effects from changes in hydrological regime	Operation	Muskoxen Moose Lynx Marten	Minor
			Beaver Muskrat	Valid

15.7.4.2.1 Invalid Pathways

Pathways are invalid if the activity would not occur, the pathway does not affect furbearers or other ungulates, or has no residual effect. Invalid pathways were not assessed in the effects analysis.

15.7.4.2.1.1 Changes in the Timing and Freezing and Break-Up Leading to Injury/Mortality to Individual Animals

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. 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 the Nonacho Lake reservoir and Twin Gorges facilities operations 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, no detectable residual effects to ungulates and key furbearing VCs from changes in the freezing and break-up are predicted, making this pathway invalid.

15.7.4.2.1.2 Surface Water Runoff Leading to Changes in Habitat Quality

Water-borne chemicals can adversely affect vegetation productivity, vigour, and health (i.e., habitat quality) through surface water runoff. Mitigation has been incorporated into the Project to eliminate or reduce potential effects from surface water runoff.

Estimated rock volumes from the North Gorge canal construction would be approximately 1,000,000 m^3 (Section 6). Spoil would be placed in an isolated area between the canal and the Taltson River North Gorge, where it is relatively inaccessible to wildlife. Surficial and drill core rock from the Twin Gorges, the SVS, and the Nonacho Lake control structure sites has been tested for acid generating potential, and was found to be non-acid generating (Section 9.4.1). Therefore, no measureable changes to moose, muskox, marten, lynx, beaver and muskrat habitat quality from surface water runoff (e.g., potential acid generating waste rock excavated during canal construction, sedimentation from spoil piles) are expected, making this pathway invalid. Effects of changes to surface water runoff to fish are assessed in Section 15.2, Canal Construction.

15.7.4.2.2 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.

15.7.4.2.2.1 *Changes to Riparian and Aquatic Habitat Quality at Water Crossings*

In-stream works and construction within riparian zones, specifically upgrades to dam structures and dykes, may require disturbance near a stream or wetland and sometimes includes alterations to the substrate. Although this disturbance may periodically discharge silt into the waterway, construction and maintenance activities in and around watercourses would conform to applicable Best Management Practices for work in and around watercourses, and are expected to reduce sedimentation and limit negative effects on riparian and aquatic habitat quality.

It is possible for erosion to occur at various water crossings during the refurbishment of the former road alignment from Fort Smith to Twin Gorges and road construction from Twin Gorges to Nonacho Lake. However, incorporated mitigation practices and designs would reduce the effects of erosion on riparian and aquatic habitat quality (Table 15.7.4), and include:

- avoiding steep slopes,
- placing cut trees on slopes that have erosion potential,
- constructing the ice crossing perpendicular to the watercourse,
- constructing access points from clean snow and ice to a sufficient depth to protect the banks,
- considering bank stability and erosion potential during construction,
- notching the centre of the ice bridge to allow it to melt from the centre, which prevents ice blockages causing flooding and erosion at the end of each season,
- prohibiting the use of recreational vehicles through the installation of gates at Slave Lake and Twin Gorges, and
- stopping maintenance of the winter roads after Project construction.

A number of watercourses the Project intersects are fish-bearing and practices for the protection of fish and fish habitat (as required by the DFO), would function to mitigate potential effects from sedimentation to aquatic habitat quality. Consequently, the pathway for changes to riparian and aquatic habitat quality (and associated altered movement and behaviour) due to shoreline and in-stream works is considered minor, and should have a negligible effect on the persistence of ungulates and key furbearer populations and distributions.

15.7.4.2.2.2 *Vehicle Collisions May Cause Injury/Mortality to Individual Animals*

Project access 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 spur winter roads following the transmission line and extending to the staging areas (i.e., temporary access trails), and spur roads connecting the Northern Sector substations to the Tibbitt to Contwoyto winter road are proposed as part of the Project.

Animal mortality from vehicle collisions has been a concern for most developments. The predominant factors that contribute to road-related wildlife deaths are traffic volume and vehicle speed (EBA, 2001). An increase in either factor reduces the probability of animals crossing roads safely (Underhill & Angold, 2000).

Implementation of the Winter Road Policy, Rules, and Procedures for the Tibbitt to Contwoyto winter road is anticipated to reduce the potential for injury or mortality of wildlife from vehicle collisions (Echo Bay, 2000). For example, from 1996 to 2001, there have been two reported road-related wildlife mortalities along the Tibbitt to Contwoyto winter road. In 1996, a wolverine was killed by a pick-up truck (V. Banci, pers. comm. in EBA, 2001). In March 1999, five caribou were killed by a grocery (meat) truck on a portage near Gordon Lake (EBA, 2001). There were no animal encounters or collisions reported on the Tibbitt to Contwoyto winter road in 2007 (Tibbitt-to-Contwoyto Winter Road Joint Venture, 2008).

The following mitigation practices are expected to limit the risk from vehicle collisions with individual animals:

- access roads would be private and access would be limited to vehicles involved in Project construction,
- transmission line winter roads would be accessible only from the Twin Gorges to Nonacho Lake winter road, and
- speed limits for the Project winter access road would be established and enforced.

During the three-year construction period, haul trucks would arrive at various staging areas to offload construction equipment and supplies. The winter is a period of low activity for muskrats and beavers, as most of their time is spent sleeping and feeding (Aleksiuk, 1986; Trottier, 2003). Consequently, the risk for vehicle-related injury or mortality of individual animals is predicted to have a negligible influence on the persistence of muskrat and beaver populations.

The implementation of the Human-Wildlife Conflict Reduction EMP is anticipated to result in a negligible effect on ungulates and key furbearing species from vehicle collisions. In addition, winter road use would be limited to the winter months when the road is operational and only for the three-year construction period, after which time it is not expected to be maintained. Consequently, the pathway for vehicle-related injury or mortality of individual animals was considered minor.

15.7.4.2.2.3 Improved Access Leading to Increased Harvesting

The proposed transmission line route would pass through the southwest portion of the Wildlife Management Area U/MX/01. In this area, 33 muskoxen tags are issued annually to resident hunters (29 tags issued for Łutsel K'e and 4 tags for Yellowknife; [GNWT, 1999]). Efforts are underway to increase the market for muskoxen meat in southern Canada, but it seems unlikely that the total quota would be reached (ITI, 2007), as only four muskoxen were harvested during the 2007-08 season in the management area (J. Williams, personal communication, 18 July 2008). In addition, the total number of resident hunters in the NWT has decreased from 2,065 in 1989-90 to 1,110 in 2005-06, a decline of about 46% (S. Carriere, personal communication, September 2007). During the same time period, the number of big game licences showed a similar trend; those sold to resident hunters decreased from 1,769 in 1989-90 to 952 in 2005-06, a decline of about 54% (S. Carriere, personal communication, September 2007).

Because the winter access roads would be in operation when moose hunting season is ending for resident hunters (September 1 to January 31), there would be limited opportunity for resident hunters using the winter access roads to harvest moose. General Hunting Licence (GHL) holders may hunt moose during any season; however, it is more likely that they would hunt moose within the Taiga Plain (in which Fort Smith is located) than in the Taiga Shield, as the former supports higher densities of moose (Cluff, 2005). Aerial surveys completed in 2004 estimated an average of 2.75 moose per 100 km^2 in the Taiga Shield Ecozone (where the Twin Gorges to Nonacho Lake winter road lies), compared to 3.99 moose per 100 km^2 in the adjacent Taiga Plain (Cluff, 2004).

The use of winter roads for the Project would be limited to a two- to three-month period during the three-year construction period, after which time they are not expected to be maintained. Incorporated mitigation practices and designs should reduce the potential for increased access for traditional and non-traditional harvesting activities. Key mitigation practices includes restricting access to the winter roads to only Project-related vehicles, blocking the entrance to the winter road at the end of hauling operations each spring, and placing slash across the lower sections of the winter road when construction is complete.

The Slave River, which must be crossed to gain access to the southern sector winter roads, would also limit access. Records from the Mackenzie River crossing at Fort Providence indicate that the average opening date between 2001 and 2006 was December 23 for small traffic (less than 5 tonnes), and January 20 for heavy traffic (greater than 60 tonnes). The average closing date between 2001 and 2006 was April 18 (GNWT DOT, 2008). Opening and closing dates for an ice road crossing of Slave River are expected to be equivalent or less, indicating a maximum access period of 116 days from December 23 to April 18.

Increased access is expected to result in a minor change in the abundance and distribution of ungulates and key furbearing species. Mitigation should limit access to winter roads. Unauthorized access would likely be associated with the periodic harvesting of ungulates, marten, lynx, muskrat, and beaver. However, the number of animals harvested should be within the range of current (baseline) conditions and have a negligible effect on the persistence of populations and their distributions. Therefore, this pathway was determined to be minor.

15.7.4.2.2.4 *Hazardous Substances May Cause 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; De Beers, 2008; Golder, 2007; Golder, 2008). Chemical spills are usually localized and are quickly reported and managed. The Spill Contingency Plan and mitigation practices should prevent or limit the frequency and extent of chemical spills at the Project site and along the winter access roads. The following are examples of mitigation practices and designs are anticipated to reduce the risk from chemical spills:

- Construction machinery and vehicles would be properly maintained so that harmful chemicals are not introduced into riparian sites and waterways during construction and maintenance.
- Machinery and vehicle refuelling would be completed away from any watercourse.
- Spill containment structures 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.
- Spill Contingency EMP would be implemented and followed.
- Waste Management EMP would be implemented and followed.

The implementation of the Spill Contingency Plan, mitigation practices, and monitoring programs are anticipated to result in a negligible effect on ungulates and key furbearing VCs from spills throughout all phases of the Project. Therefore, a change in health or mortality of wildlife from exposure to chemical spills is predicted to be a minor pathway and is not assessed in the effects analysis.

15.7.4.2.2.5 *Attractants to Site May Change Predator-Prey Dynamics for Ungulates*

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

Mitigation practices and designs have been established to reduce wildlife attraction to the Project; however, based on the results from monitoring programs for other mining projects in the NWT and Nunavut, it is anticipated that not all wildlife would be deterred from the site. For example, wildlife effects monitoring programs completed at the Ekati Diamond Mine (2000 through 2006), the Diavik Diamond Mine (2002 through 2007), the Jericho Diamond Mine (2000 and 2005 through 2007), and the Snap Lake Mine (2001 through 2007) have reported attractants (e.g. non-burned food items, oil products, and food packaging) in the landfill. Most of the animals and sign observed during these landfill surveys were associated with foxes. Grizzly bears, wolverine, and wolf tracks were occasionally observed.

Human presence and activities can alter interspecific interactions such as rates of predation (Bergerud, Jakimchuk, & Carruthers, 1984; James & Stuart-Smith, 2000; Marchand & Litvaitis, 2004). The increased presence of carnivores can result in an increased frequency of predation on other ungulates. However, mitigation practices and designs have been established to reduce the numbers of carnivores that would be attracted to the Project. These strategies are outlined in the Material and Waste Management EMP and in the Human-Wildlife Conflict Reduction EMP, and are similar to management measures and policies implemented at diamond mines in the NWT and Nunavut. The following wildlife-specific mitigation strategies are included in the Material and Waste Management EMP and the Human-Wildlife Conflict Reduction EMP to reduce the numbers of carnivores attracted to the Project:

- All food waste would be disposed of according to the Materials and Waste Management EMP.
- Human-Wildlife Conflict Reduction EMP would be developed and followed.
- Educating and reinforcing proper waste management practices to all workers and visitors to the site.
- Educating people on the risks associated with feeding wildlife and careless disposal of food garbage.
- Ongoing review of the efficiency of the waste management program and improvement through adaptive management.

At the Snap Lake Mine, there were no reported waste or attractant-related incidents or mortalities from 1999 to 2005 (De Beers, 2006). In 2006, a fox was observed eating bread behind the new kitchen, and a raven was observed eating toast and an orange peel near the incinerator (De Beers, 2007). There were no incidents involving black bears, grizzly bears, or wolves. Based on the effectiveness of mitigation at the Snap Lake Mine, predation of muskoxen and moose by grizzly bears and wolves is not anticipated to increase as a result of attractants to the site. Therefore, muskoxen and moose mortality from increased predation resulting from increased carnivore attraction to the Project site is expected to be minor (i.e., have a negligible effect on population), and is not assessed in the effects analysis.

15.7.4.2.2.6 Sensory Disturbance Leading to Changes in Habitat Quality of Beaver and Muskrat

During construction, mobile and stationary equipment, blasting, and helicopters may generate noise. Helicopter operations would be most intensive during winter, and would extend from the commencement of construction until the transmission line becomes operational. There has been little study on how industrial activities affect beavers other than those related to logging and water impoundment (Jalkotzy et al., 1997). Westworth (1980) found that for the muskrat, a species with similar habits to beaver, seismic activity resulted in short-term reductions in muskrat activity levels, but apparently did not affect daily activity patterns, the number of daily movements, or the use of lodges. The Arctic ground squirrel (*Spermophilus parryii*) also did not appear to be disturbed by the simulated sounds of a diesel generator (Jalkotzy et al., 1997).

Sensory disturbance from the Project may also include changes to habitat quality from dust deposition and air emissions. Accumulation of fugitive dust (i.e., total suspended particulate [TSP] deposition) produced from the Project may result in a direct loss of vegetation ecosystems and plants. However, Auerbach, Walker, and Walker (1997) stated that although the species composition may change and the aboveground biomass is lowered because of dust deposition, the ground cover is still maintained. Thus, direct effects from dust deposition are expected to be largely confined to the Project footprint with a negligible effect on adjacent habitat. Dust sources would be limited to the Twin Gorges, the South Valley Spillway (SVS), and the Nonacho Lake control structure. In addition, dust would only be produced during the three-year construction period required to complete the upgrades.

During the winter, dust that accumulates on snow may settle on vegetation during the spring melt. Although snowmelt does not result in dust "washing away," the dust that accumulates on snow may be diluted during snowmelt and spring freshet, and eventually removed by rain. Haul trucks travelling on the winter access roads would be a source of air emissions and also have the potential to transfer dust from vehicles and loads during the winter months (i.e., dust deposited on wheels and undercarriage while at mine sites and Yellowknife). However, the relative contribution of these loads to the overall dust accumulation and air emissions in the area along the winter roads is considered to be negligible.

During the three-year construction period, haul trucks are expected to arrive at various staging areas to offload construction equipment and supplies. The winter is a period of low activity for muskrats and beavers, with most of their time spent sleeping and feeding (Aleksiuk, 1986; Trottier, 2003). Throughout the winter muskrats remain below the ice eating stored food and submerged vegetation. Similarly, beavers build lodges and store food for winter use. Beavers remain in these lodges during the winter period until early April (Trottier, 2003).

Most sensory disturbance effects from the Project on habitat quality for muskrat and beaver would likely occur during the three-year construction period. Disturbance would be localized and discontinuous along the Project footprint. For example, upgrades to the Nonacho Lake control structure, SVS, and Twin Gorges facility are independent point sources of Project activity. Disturbance from construction of the transmission line, associated winter spur roads, and staging areas would occur at different points in time and space. After completing construction of a section of the transmission line, construction activities would move onto the next section, and disturbance to muskrat and beaver at a previous section of the line could decrease with the progressive completion of each section.

Sensory disturbance from Project construction is expected to result in minor, periodic, and localized changes to habitat quality and associated movement and behaviour for muskrat and beaver. Relative to natural factors that affect habitat quality for these species (e.g., predation, water level fluctuation, and ice thickness), Project effects are predicted to have a negligible influence on the persistence of muskrat and beaver populations and distributions. The low level of activity during Project operations is anticipated to result in a negligible change to habitat quality for these species, making this pathway minor.

15.7.4.2.2.7 *Effects From Changes in Hydrological Regime to Muskox, Moose, Marten and Lynx*

Hydrological modelling was completed to predict changes in the Nonacho Dam and the Twin Gorges facility operations following the proposed Project expansion of the Twin Gorges existing facility on the Taltson River (Section 13.3. and 13.4). The annual baseline variation in the predicted monthly average water levels within each of the Zone locations were compared to the modelling results for the 36 MW and 56 MW upgrade scenarios. These water levels were managed to limit potential bank erosion and reduce potential localized changes to water quality.

The timing of water releases from Nonacho Lake would be managed to produce sufficient water flows for consistent power production. Hydrological modelling indicates that water levels would become more constant through the year than as compared to baseline, or to an unaltered river. In addition, mitigation practices and designs have been included to limit potential bank erosion, which reduces the potential for localized changes to riparian habitat.

The anticipated changes to vegetation may be viewed as a movement of 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 type 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 there are changes to the flooding regime or average water levels decline. 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 demonstrate such changes. However, the overall productivity of the shoreline is not anticipated to change. Vegetation may become more established with less seasonal variation in water levels.

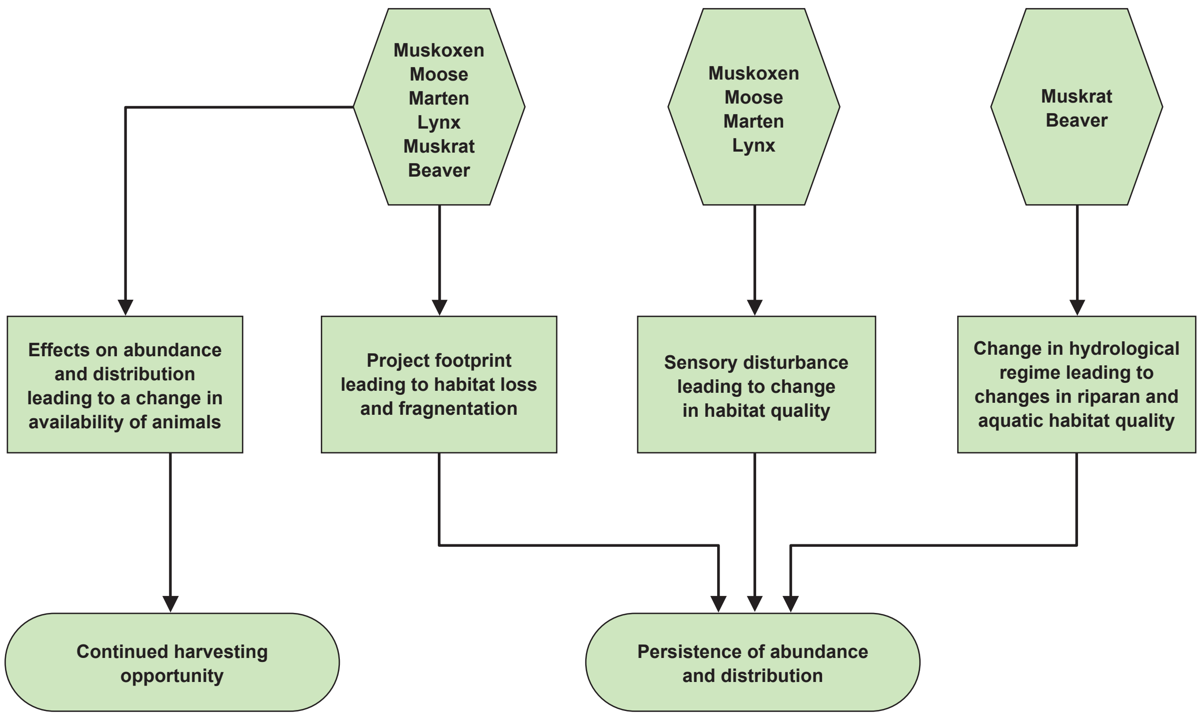
Overall, the extent of the potential effects to habitat is localized. Water level changes are not expected to reduce habitat quality and quantity for muskoxen, moose, lynx, and marten within the regional study area relative to baseline conditions, particularly considering the small magnitude of the change, the limited geographic extent of the change (along the banks of Nonacho Lake, and Zones 1, 2 and 3 of the Taltson River only, not extending to tributaries or the watershed), and the prediction that the Project would lead to less seasonal variation in water levels. Consequently, changes to downstream habitat quality and quantity (and associated effects on movement and behaviour of muskoxen, moose, lynx, and marten) from fluctuations in seasonal flow patterns and water levels from the Project are considered minor at the RSA scale, and the pathway is also considered to be minor. The effects of water level changes to moose within the local study areas of the Taltson River and within Trudel Creek are assessed in more detail in Chapters 13 and 14.

A Vegetation Environmental Management Plan (EMP) has been developed to examine the Project's potential localized effect on vegetation. This plan would involve periodic monitoring of disturbed areas to quickly identify and remedy potential problems and facilitate maintenance and re-establishment of a healthy vegetation cover.

15.7.4.2.3 Valid Pathways

All valid pathways are carried forward and assessed in the effects analysis. The following pathways (Figure 15.7.2) were determined to be valid for linking Project-related components and activities to effects on key furbearing species and other ungulates.

- Project footprint leading to habitat loss and fragmentation for ungulates and key furbearing VCs.
- Sensory disturbance causing change in habitat quality for muskoxen, moose, marten, and lynx.
- Effects from changes in hydrological regime to muskrat and beaver.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Pathways of Project Effects on Key Furbearing Species and Ungulates (503-005 / a22388w)	Figure 15.7.2

15.7.5 Effects to Muskoxen, Moose, Marten, and Lynx

The effects analysis considers all valid pathways that result in expected changes to population abundance and distribution of muskoxen, moose, marten, and lynx after implementing mitigation practices and designs. Detailed descriptions of the spatial and temporal boundaries and methods used to analyze the residual effects from the Project on muskoxen, moose, marten, and lynx are provided in the following sections.

15.7.5.1 Methods

The effects analysis was used to quantify the Project's incremental effects on the existing environment and the cumulative effects to muskoxen, moose, marten, and lynx resulting from the Project and other developments. Incremental effects represent the Project-specific changes relative to the existing environment in 2007. The LSA and RSA for Project effects are defined in Section 15.7.2.

Project-related effects at the regional scale include potential changes to downstream water quantity and quality, changes to habitat quality from sensory disturbances, and associated movement and behaviour on muskoxen, moose, marten, and lynx.

The incremental effects associated with habitat loss and fragmentation 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). These data are commonly known as Earth Observation for Sustainable Development of Forests (EOSD) 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 and the landscape types 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 Project components (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, and estimates 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 Project components' geographic extent was uncertain, 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.

Cumulative effects were measured when Project effects overlapped with other projects and activities. Study areas for the assessment of cumulative effects were defined using estimated natal dispersal distance around the proposed Project footprint

(Table 15.7.6). Natal dispersal by immature animals is important for colonization and the maintenance of metapopulation connectivity (D'Eon, Glenn, Parfitt, & Fortin, 2002). Natal dispersal distances are defined here as distances at which 90% of females may successfully leave the natal home range and establish a new home range.

Table 15.7.6 — Natal Dispersal Distances Used to Define the Cumulative Effects Assessment Boundary

Valued Component	Estimated Natal Dispersal Distance[1] (km)	Cumulative Effects Study Area (ha)
Marten	17	1,502,469
Lynx	127	10,834,507
Beaver	39	3,228,686
Muskrat	7	742,350
Moose	193	17,880,553
Muskoxen	129	13,469,523

[1] Natal dispersal distances were estimated using female body weights and the allometric equations of Sutherland, Harestad, Price, and Lertzman (2000). Using the "corrected" negative exponential functions of Sutherland et al. (2000), estimates represent 90% of expected dispersal distances.

The study area for cumulative effects assessment was also adjusted to account for the distribution of other ungulates and key furbearing species relative to the treeline. Muskoxen are most commonly associated with tundra environments, but were observed frequently in the northern extents of the boreal forest during baseline surveys for the Project relative to the tundra regions and other boreal regions of the Project (Rescan, 2004). As such, the cumulative effects study area for muskoxen extended 100 km south of the treeline (Figure 15.7.1).

Although the seasonal movements of moose extend into the tundra (i.e., during the summer, moose may move into the tundra where they feed on semi-aquatic vegetation in wetlands and shallow lakes (Bromley & Buckland, 1995), traditional knowledge and baseline studies completed at mining developments suggest that moose are not common in this area. Traditional knowledge suggests that moose are more often harvested in forested areas, such as the East Arm of Great Slave Lake around McLean Bay, the North Shore, and Wildbread Bay (Łutsel K'e Dene Elders and Land-Users et al., 2005). The lack of highly-suitable moose habitat within the tundra is likely associated with the infrequent observations of moose and moose sign during baseline and monitoring studies. For example, between 1999 and 2006, few moose were observed within the Snap Lake Mine 3,000 km^2 study area. Therefore, the cumulative effects study area for moose was bound by the northern limit of the boreal forest (Figure 15.7.1). As a result, Project components, which are located north of the treeline, were not considered in the cumulative effects study area. Similarly, the cumulative effects study areas for marten and lynx (Figure 15.7.1) were bound by the northern limit of the boreal forest.

Data on the number, type, and location of previous and existing developments on the landscape are fundamental for assessing the Project's cumulative effects on muskoxen, moose, marten, and lynx. The development layer file is mostly composed of locations representing a permitted activity within the NWT. The information was used to generate a development layer within a GIS platform. Other data sources were added to this layer either by merging it into the GIS software or digitizing the location of the development. The development layer was then applied to the cumulative effects study areas defined for muskoxen, moose, marten, and lynx.

Several assumptions were made concerning the temporal and spatial extent of effects from the different types of development. For example, the development layer database does not contain information on the duration of activities associated with land use permits. Subsequently, to estimate the temporal extent of the zone of influence from exploration sites, the analysis assumed that approved land use permits were active for five years. The assumption likely overestimates exploration activities' effects as exploration typically occurs in seasons other than winter.

In addition, the database contains no information on the development's physical footprint size. For communities and closed and operating mines, the footprint was digitized from Landsat 7 Imagery from the Government of Canada (CanImage, 2008). For all other developments, the physical area of the footprint was estimated. Estimated footprints for linear developments (i.e., all roads, seismic lines) were based on a 200 m corridor, while the footprint area for outfitting camps, wood operations, and staging areas was based on a 200 m radius (12.6 ha). A 1,000 m radius (314 ha) was used to estimate the footprint area for exploration sites and power plants. For all closed mines and inactive land use permits, the physical footprint was carried through the entire assessment as it was assumed that direct effects to the landscape had not yet been reversed.

The final determination of significance would not be limited to the incremental effects of the Project on muskoxen, but of the cumulative effects of all existing (including the Project) and historic projects and activities on muskoxen. If a project takes place in a relatively pristine environment, cumulative effects would be negligible and only the project-related incremental effects are considered.

For the effects analysis, temporal boundaries are linked to two concepts:

- The length of time that Project-related stressors would influence muskoxen during the different development phases of the Project (i.e. construction and operation).
- The predicted duration of effects from the Project on muskoxen, which may extend beyond operation.

Project-related stressors are expected to influence muskoxen for three years during the construction phase. 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 the Proponent intends to solicit new customers to extend the Project beyond 20 years. Subsequently, the expected length of time that Project-related stressors would influence muskoxen during the operations phase is assumed to be 40 years. Although the Proponent intends to operate the Project longer than 40 years if customers can be found, increasing the duration of the operations phase of the Project 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.

The duration of some Project effects, such as changes to existing noise levels and dust deposition, are expected to stop soon after the end of construction. However, the transmission line would generate stressors that would be present over a 40-year time span and effect duration is expected to last beyond operations. An example of such an effect is the loss of habitat or fragmentation of habitat caused by the Project footprint. In this case, the assessment must predict if the effect of habitat loss and fragmentation on the population during the 40-year operations phase is reversible. After removing the stressor, reversibility is the likelihood and time required for the population or system to return to a state that is similar to the state of systems of the same type, area, and time that are not affected by the Project. Thus, the temporal boundary for muskoxen is defined as the amount of time between the start and end of a relevant Project activity or stressor (which is related to development phases), plus the duration required for the effect to be reversed.

15.7.5.2 RESULTS

15.7.5.2.1 <u>Physical Footprint Leading to Habitat Loss and Fragmentation</u>

Muskoxen are most commonly associated with tundra environments, but groups were observed frequently in the northern extents of the boreal forest relative to the tundra regions and other boreal regions of the Project during baseline surveys (Rescan, 2004). As such, the total Project footprint was used to provide a conservative estimate of the incremental effects of the Project on habitat for muskoxen.

For muskoxen, the effects assessment was based on the predicted incremental changes from baseline conditions through application of the Project (i.e., a future scenario where the Project is on the landscape, see Section 10). The total Project footprint is anticipated to be approximately 2,724 ha (Table 15.7.7). At the local scale, habitat types that would be disturbed most by the Project footprint include low shrub (15.17%) and open coniferous (15.03%). These two habitats are also the most abundant terrestrial habitats within the RSA (12.46% and 16.19%, respectively). There would be little disturbance to wetlands (0.018% within the RSA), which tend to be more sensitive to disturbance. The majority of disturbance from the Project footprint is associated with the transmission line corridor (76%), which would actually have little direct effect on the tundra landscape. Approximately 24% (667 ha) of the Project footprint is associated with water (i.e., lakes, reservoirs, rivers, or streams), which represents 0.066% disturbance within the RSA. Overall, the incremental habitat-specific change from baseline to application of the Project is less than 1% in the RSA. The cumulative effects study area defined for muskoxen (based on a natal dispersal distance of 129 km around the Project) is 13,469,523 ha. Therefore, the incremental loss of habitat from the Project, relative to baseline conditions, is anticipated to be 0.02% of the cumulative effects study area defined for muskoxen.

Table 15.7.7 — Landscape Disturbance within the Regional Study Area for the Project

Habitat Type	Infrastructure[1]	Winter Access Roads	Transmission Line	Barge Landing and Staging Areas	Total Project Disturbance[2]		Total Habitat in the RSA		Disturbance in the RSA
	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	Area (ha)	%	%
Water	0.74	361.17	297.12	8.90	666.92	24.49	266,192.66	26.53	0.066
Snow/ice	0.00	0.10	0.20	0.00	0.30	0.01	201.10	0.02	0.000
Rock/rubble	0.00	4.92	85.35	1.82	92.02	3.38	28,026.23	2.79	0.009
Exposed land	15.23	21.80	206.94	13.21	256.37	9.41	87,485.56	8.72	0.026
Bryoids	0.00	13.48	180.13	5.78	198.56	7.29	67,229.82	6.70	0.020
Shrub tall	1.39	8.34	27.96	0.06	37.57	1.38	17,794.92	1.77	0.004
Shrub low	10.74	22.06	368.89	13.91	413.31	15.17	125,061.87	12.46	0.041
Wetland-treed	0.31	17.05	50.00	5.49	72.11	2.65	23,874.05	2.38	0.007
Wetland-shrub	0.06	6.09	22.88	2.10	30.99	1.14	8,699.32	0.87	0.003
Wetland-herb	0.09	8.88	67.15	2.55	78.11	2.87	25,237.00	2.52	0.008
Herb	1.69	2.57	13.33	0.28	17.58	0.65	5,461.97	0.54	0.002
Coniferous dense	2.18	11.68	110.59	4.10	128.18	4.71	70,984.29	7.07	0.013
Coniferous open	2.81	28.08	368.84	10.22	409.26	15.03	162,421.08	16.19	0.041
Coniferous Sparse	1.30	21.26	184.85	6.11	212.53	7.80	74,283.86	7.40	0.021
Broadleaf dense	0.55	0.58	2.44	0.00	3.49	0.13	1,887.84	0.19	0.000
Broadleaf open	0.00	1.16	12.87	0.38	14.23	0.52	3,765.98	0.38	0.001
Broadleaf Sparse	0.00	0.22	5.66	0.00	5.88	0.22	1,300.22	0.13	0.001
Mixedwood dense	0.65	2.23	11.06	0.44	14.15	0.52	9,006.34	0.90	0.001
Mixedwood open	0.00	4.46	58.34	0.58	63.24	2.32	22,616.99	2.25	0.006
Mixedwood sparse	0.00	0.39	2.00	0.97	3.19	0.12	861.64	0.09	0.000

Habitat Type	Infrastructure[1]	Winter Access Roads	Transmission Line	Barge Landing and Staging Areas	Total Project Disturbance[2]		Total Habitat in the RSA		Disturbance in the RSA
	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	Area (ha)	%	%
Unclassified	0.13	0.60	2.14	3.01	5.73	0.21	1,048.88	0.10	0.001
Total	**37.87**	**537.13**	**2,078.74**	**79.91**	**2,723.72**	**100.00**	**1,003,442.72**	**100.00**	**0.271**

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

[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 effects assessment for moose, marten, and lynx was based on the predicted incremental changes from baseline conditions through application of the Project below the treeline. The Project area below the treeline is anticipated to be approximately 1,522 ha (Table 15.7.8). Habitat types below the treeline that would be disturbed most by the Project footprint include open coniferous (22.65%) and exposed land (14.62%). Open coniferous habitat is one of the most abundant terrestrial habitats within the RSA (24.29%). There would be little disturbance to wetlands (0.017% within the RSA), which tend to be more sensitive to disturbance. Approximately 27% (415 ha) of the Project footprint below the treeline is associated with water. Overall, the incremental habitat-specific change, below the treeline, from baseline to application of the Project is less than 1% in the RSA. Based on the natal dispersal distances for moose, marten, and lynx the incremental loss of habitat from the Project, relative to baseline conditions, is anticipated to be less than 1% of the cumulative effects study areas defined for moose (17,880,553 ha), marten (1,502,469 ha), and lynx (10,834,507 ha).

Table 15.7.8 — Landscape Disturbance Below the Treeline for the Project

Habitat Type	Infrastructure[1]	Winter Access Roads	Transmission Line	Barge Landing and Staging Areas	Total Project Disturbance[2]		Total Habitat in the RSA Below the Treeline		Disturbance in the RSA Below the Treeline
	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	Area (ha)	%	%
Water	0.74	258.47	152.02	4.11	415.03	27.26	133,992.34	23.11	0.072
Snow/ice	0.00	0.01	0.00	0.00	0.02	0.00	125.29	0.02	0.000
Rock/rubble	0.00	1.45	9.01	0.84	11.25	0.74	3,100.67	0.53	0.002
Exposed land	15.23	18.62	177.74	11.58	222.59	14.62	76,506.51	13.19	0.038
Bryoids	0.00	0.00	0.00	0.00	0.00	0.00	427.91	0.07	0.000
Shrub tall	1.39	8.34	27.96	0.06	37.57	2.47	17,794.92	3.07	0.006
Shrub low	10.74	10.89	68.02	4.01	93.16	6.12	36,106.16	6.23	0.016
Wetland-treed	0.31	16.08	34.83	5.49	55.97	3.68	18,475.84	3.19	0.010
Wetland-shrub	0.06	4.92	3.11	1.22	9.31	0.61	2,746.46	0.47	0.002
Wetland-herb	0.09	6.46	21.84	0.78	29.15	1.91	10,643.45	1.84	0.005
Herb	1.69	1.41	5.28	0.17	8.26	0.54	3,102.69	0.54	0.001
Coniferous dense	2.18	10.48	103.50	3.92	119.72	7.86	67,553.27	11.65	0.021
Coniferous open	2.81	22.49	311.18	8.91	344.87	22.65	140,837.50	24.29	0.059
Coniferous sparse	1.30	15.11	94.07	3.67	113.64	7.46	43,579.86	7.52	0.020
Broadleaf dense	0.55	0.49	1.90	0.00	2.85	0.19	1,536.67	0.27	0.000
Broadleaf open	0.00	0.57	4.27	0.38	5.11	0.34	1,656.94	0.29	0.001
Broadleaf sparse	0.00	0.06	1.83	0.00	1.89	0.12	385.04	0.07	0.000

Habitat Type	Infrastructure[1]	Winter Access Roads	Transmission Line	Barge Landing and Staging Areas	Total Project Disturbance[2]		Total Habitat in the RSA Below the Treeline		Disturbance in the RSA Below the Treeline
	Area (ha)	Area (ha)	Area (ha)	Area (ha)	Area (ha)	%	Area (ha)	%	%
Mixedwood dense	0.65	2.14	10.33	0.44	13.33	0.88	8,588.93	1.48	0.002
Mixedwood open	0.00	1.29	28.11	0.39	29.72	1.95	10,829.05	1.87	0.005
Mixedwood sparse	0.00	0.39	2.00	0.97	3.18	0.21	827.66	0.14	0.001
Unclassified	0.13	0.60	2.14	3.01	5.73	0.38	1,043.12	0.18	0.001
Total	**37.89**	**380.26**	**1,059.17**	**49.96**	**1,522.35**	**100.00**	**579,860.28**	**100.00**	**0.26**

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

[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 number, type, and status of previous and existing developments within the cumulative effects study areas for muskoxen, moose, marten, and lynx are presented in Table 15.7.9. As previously mentioned, estimated footprints for linear developments were based on a 200 m corridor, while the footprint area for outfitting camps, fuel storage, and quarries was based on a 200 m radius (13.29 ha). A 1,000 m radius (314 ha) was used to estimate the footprint area for exploration sites. For communities and both closed and operating mines the footprint was digitized from Landsat 7 Imagery from the Government of Canada (CanImage 2008).

Table 15.7.9 — Previous and Existing Developments in the Cumulative Effects Study Areas for Muskoxen, Moose, Marten, and Lynx: 2007

Type of Development	Status	MUSKOXEN		MOOSE		MARTEN		LYNX	
		Number	Total Area Disturbed (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
Community	Active	1	160	5	1489	0	0	3	825
	Inactive	1	18	1	18	1	18	1	18
Fuel Storage	Inactive	2	13	0	0	0	0	0	0
Lodges (i.e. outfitters, tourism)	Active	9	120	0	0	0	0	0	0
	Inactive	8	107	0	0	0	0	0	0
Mine	Active	4	6,255	0	0	0	0	0	0
	Inactive	2	178	0	0	0	0	0	0
Mineral exploration/ camps/ communications	Active	53	17,212	21	6,367	2	667	8	2,032
	Inactive	92	28,243	24	5,877	2	587	10	2,565
Miscellaneous	Active	6	69	1	13	0	0	1	13
	Inactive	12	131	9	78	0	0	4	47
Quarrying	Active	0	0	13	159	1	13	11	133
	Inactive	2	27	16	177	0	0	10	115
Taltson Project	Proposed	1	1,662	1	1,522	1	1522	1	1,522
Winter roads	Active	10	20,982	4	4,183	1	602	1	1,961
Transmission line	Active	0	0	1	7,389	1	345	1	3,405
All season road	Active	0	0	6	14,225	0	0	3	5,631
Oil and gas	Active	0	0	3	38	0	0	1	13
Woods operation	Active	0	0	10	133	0	0	8	106
	Inactive	0	0	23	269	0	0	17	189

Type of Development	Status	MUSKOXEN		MOOSE		MARTEN		LYNX	
		Number	Total Area Disturbed (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
Staging area	Active	0	0	1	5	0	0	1	5
Power	Active	0	0	2	666	0	0	2	666
Industrial	Active	0	0	1	13	0	0	0	0
Total		**203**	**75,177**	**142**	**42,623**	**9**	**3,755**	**83**	**19,245**

Within the cumulative effects study area for muskoxen, the total landscape disturbance from previous and existing developments, including the Project, is estimated to be 75,177 ha. The landscape disturbance within each of the cumulative effects study areas for moose, marten, and lynx, is 42,623 ha, 3,755 ha, and 19,245 ha, respectively. The cumulative disturbance to all habitats from the Project and previous and existing developments relative to baseline conditions is less than 1% of each cumulative effects study area.

In addition to direct habitat type loss, the application of the Project would also result in some fragmentation of the existing landscape. With and Crist (1995) state that disruption to landscape connectivity may have important consequences for the distribution and persistence of populations. Although fragmentation can influence individual, population, and community processes that are coupled with biodiversity, fragmentation effects have less effect than habitat loss (Andrén, 1999; Fahrig, 1997).

Linear corridors may either create habitat or remove habitat for moose depending on the habitat types disturbed. Linear development through a closed forest would open up the canopy, creating edges that encourage the growth of shrubs, which are preferred browse species for moose (Jalkotzy et al., 1997). Concomitantly, corridors that traverse riparian areas (i.e., habitat that is already good for foraging by moose) remove habitat, reducing the carrying capacity of the landscape for moose (Jalkotzy et al., 1997). The degree of effect is proportional to the width and length of disturbance.

For small- and medium-sized carnivores, such as marten and lynx, linear developments may result in habitat enhancement rather than habitat loss. The removal of a closed-canopy forest when a seismic line is cut allows sunlight to penetrate to the ground, promoting a more diverse plant community than may occur in habitats on either side (Jalkotzy et al., 1997). These plant communities are often rich in species that are important food resources for herbivores (e.g., snowshoe hare, microtines). The abundance of small mammals and birds along these corridors may attract small- and medium-sized carnivores. Lynx have been documented preying on snowshoe hares (*Lepus americanus*) along road corridors (Jalkotzy et al., 1997). Riewe (1981) found that lynx occasionally hunt or travel along seismic lines, and have been reported to follow road edges and forest trails for considerable distances (Parker, 1981). However, biologists generally agree that below the treeline, 5 km or more of treeless land acts as an effective barrier to dispersal (Jalkotzy et al., 1997).

There are 83 and 68 existing developments within the cumulative effects study area defined for muskoxen and moose, respectively (Table 15.7.9). The mean distance between these developments (i.e. active and inactive) in the cumulative effects study area is estimated to be 11 km. Therefore, it is likely for muskoxen and moose to be in contact with more than one development during their daily or seasonal movements. A total of 5 and 40 existing developments are within the cumulative effects study areas defined for marten and lynx, respectively (Table 15.7.9). For marten, the mean distance between active and inactive developments in the cumulative effects study area is estimated to be 65 km, and the frequency of individuals interacting with more than one development is predicted to be low. For lynx, the mean distance between active and inactive developments in the cumulative effects study area is estimated to be 7.6 km. Therefore, it is likely for lynx to encounter more than one development during their daily and seasonal movements.

The presence of winter access roads may represent a barrier to muskoxen and moose, leading to population fragmentation. For example, roads may contribute to population fragmentation through modifying behaviour that makes animals less likely to cross roads (Trombulak & Frissell, 1999). In some cases, roads appear to be "leaky barriers" (i.e. some animals do manage to cross successfully), but they may restrict the landscape-scale dynamics of species (Treweek, 1999).

Conversely, road corridors may also be considered habitat enhancement, if these corridors act as travel corridors for moose in otherwise unsuitable habitat. Ease of movement along these corridors may make them attractive travel routes for moose in habitats with dense understories, or when deep snow can hinder moose movements (Jalkotzy et al., 1997). Similarly, it has been proposed that woodland caribou avoid linear disturbances in the boreal as wolves have been documented to travel faster down linear corridors than in the surrounding forest (James, 1999), and since wolf predation is more common in the vicinity of linear corridors (James & Stuart-Smith, 2000). Although winter access roads may increase habitat fragmentation, the disturbance is anticipated to be temporary and restricted to the winter period when the road is in use (approximately 116 days per year).

Marten response to linear developments varies, but evidence suggests that crossings are generally avoided or attempted unsuccessfully (Eccles & Duncan, 1986; Jalkotzy et al., 1997; Robitaille & Aubry, 2000). There is some evidence that roads might influence lynx distribution and movements (Clayton, 2000), but there is also evidence that lynx would cross highways (Mowat, Poole, & O'Donoghue, 2000). Snow tracking over a five-year period at Sheep River (Alberta) suggested that road segments that were wider, and more open on either side, were crossed less frequently by lynx than narrower segments with cover on either side (Jalkotzy et al., 1997).

The incremental loss of habitat from the Project, relative to baseline conditions, is anticipated to be less than 1% of the cumulative effects study areas defined for muskoxen, moose, marten, and lynx. The Project's cumulative disturbance to habitat and previous and existing developments is expected to be 0.55% (muskoxen), 0.23% (moose and marten), and 0.17% (lynx) of the cumulative effects study areas, which is below the 40% threshold value for habitat loss associated with expected declines in bird and mammal species (Andrén, 1994; Andrén, 1999; Fahrig, 1997; Mönkkönen & Reunanen, 1999; With, 1997). Species that live in open populations and disperse effectively over long distance are less affected by habitat fragmentation (Treweek, 1999). In addition, narrower corridors (e.g., temporary trails) have lower effects when compared to roads because their physical attributes are less disruptive (e.g., narrower ROWs, increased curvilinearity of trails) and because they are used less (Jalkotzy et al., 1997).

15.7.5.2.2 Sensory Disturbance Leading to Changes in Habitat Quality

In addition to direct habitat effects, indirect changes to habitat quality from the Project have the potential to affect the population size and distribution of muskoxen, moose, marten, and lynx through altering movement and behaviour. Sensory disturbance resulting from the construction and operation of the Project can reduce habitat quality in both the Project footprint, as well as in adjacent habitats that are not directly affected by the Project. For example, loud construction-related activities and human activity can lead to displacement and avoidance of high-quality habitats by some species and may increase stress to wildlife that remain in the area. Sensory disturbance includes both Project-specific disturbances and cumulative disturbances from other developments in each cumulative effects study area.

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 15.7.10 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 by 250 m area.

Table 15.7.10 — Construction Scenario Noise Predictions by Distance from Activity

Distance from Source to Nearest Receiver (m)	PREDICTED NOISE LEVEL L_D (dBA)[1]				
	Clearing and Preparation (Staging or ROW)	Staging Areas	Helicopter Work (hovering at 200m)	Helicopter Work (fly-by at 200m)	Blasting
250	51	49	59	50	75
500	46	46	55	47	71
1,000	41	42	47	41	64
2,000	34	35	29	34	55
3,000	30	30	33	29	49
4,000	26	25	28	25	45
5,000	22	22	25	21	41
10,000	6	6	9	6	25

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

Based on Table 15.7.10, 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 (ERBC 2007; MGP 2004) 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 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 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 6 highway-type transport trucks in an 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 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 of 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 humm 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, the proposed conductor line would have power capacity of 270 MW, but less than 20% of this capacity would be used. Typically, corona noise only occurs when a transmission line nears full capacity. Other sources of noise would include the construction of facilities at Twin Gorges and Nonacho Lake. Large-scale blasting would be required at these sites, the noise from which may not reach baseline levels until approximately 7 km from the site. The sound may be heard farther, as the character of the noise would differ from natural sounds. However, blasting noise would be of short duration and confined to a single season. Further description of construction-related noise is presented in Appendix 12C.

Various studies have documented that muskoxen are alerted by the noise from snowmobiles at distances over 1 km (McLaren, 1981; McLaren & Green, 1985). Although high wind speeds tend to mask the noise of the snowmobile, McLaren and Green (1985) found that muskoxen were alerted by the noise at distances over 1 km on calm days, even when the machine was not moving toward them. Similarly, muskoxen on Melville Island were observed to respond to the sound of a helicopter that was more than 1 km away and not visible (McLaren, 1981). Although hearing is clearly important, sight and smell are also likely involved. For example, the greater reaction distances found when animals were downwind of the approach could have resulted from early detection by scent as well as sound (McLaren & Green, 1985).

Horesji (1979) reported that moose were less likely to be found within 1 km of active seismic lines. Andersen, Linnell, and Langvatn (1996) found that sources of disturbance that could be identified as human elicited flight responses in moose at greater distances than disturbances that were recognized as mechanical. For example, the noise of a jet flying at an altitude of 150 m did not trigger any flight response in moose, while people on foot or skis flushed moose at 200 to 400 m (Andersen, 1996).

Direct evidence related to the effects of noise on marten and lynx is limited. However, marten are known to be sensitive to human disturbances, such as clearcut logging (Forsey & Baggs, 2001; Hargis, Bissonette, & Turner, 1999; Potvin, Courtois, & Belanger, 1999; Steventon & Major, 1982), but they might be able to adapt to less intense disturbances such as selective logging (Koehler, Moore, & Taylor, 1975; Soutiere, 1979). For lynx, anecdotal evidence suggests that they would tolerate moderate levels of snowmobile traffic within their home ranges (Mowat et al., 2000). In western Alberta, lynx frequently crossed a pipeline ROW before construction began, but almost completely avoided the area during the construction period (Morgantini, 1984). Snow tracking in the Bow River valley in Banff National Park has shown that suitable habitat near the town of Banff received little use by lynx (Jalkotzy et al., 1997). Conversely, tracking data demonstrated that lynx used the Whitehorn side of the Lake Louise ski hill between dawn and dusk, even though the area was used by many skiers during the day (Jalkotzy et al., 1997).

Helicopter operations to support construction would extend throughout the year, from the commencement of construction until the transmission line becomes operational. Extensive use of low-level helicopter flights would be required to place transmission line towers, string the conductor, and to respond to weather conditions. During operations, aircraft would be used to move personnel to the Twin Gorges site year-round. A maximum of two round-trip flights per week are anticipated during operation of the Twin Gorges facilities, and aircraft noise would be limited to a few minutes during take off and landing. However, disturbance from aircraft is expected to be periodic and short-term (less than five minutes) in duration.

Although muskoxen herds from different regions showed various responses to overhead helicopters and other aircraft flights, it is not clear what elements (i.e., noise or visual) of overhead flights causes the response. For example, some muskoxen herds on Bathurst Island were easily induced into stampeding by the circling of helicopters and fixed-wing aircraft (Gray 1972). Herds would often stand in a tight group when an aircraft is overhead, but in many cases, would run as the aircraft approaches (Gray 1972). McLaren (1981) found that Melville Island animals showed no visible reaction to aircraft that flew overhead at altitudes greater than 200 m (McLaren, 1981). In 1979, 43.6% of individuals on the Prince of Wales Island responded to the overhead flights at altitudes greater than 400 m (Miller & Gunn, 1979), while in 1980, there was an indication that some degree of habituation had occurred (Miller & Gunn, 1980).

Studies of noise effects from fixed-wing aircraft on moose indicate that individuals reacted visibly to aircraft 55% of the time when overhead flights were below 60 m in altitude, and 37.5% of the time when overhead flights were at altitudes between 60 and 180 m (McCourt, Feist, Doll, & Russell, 1974). Moose were not observed to react to overhead flights above 180 m of altitude (McCourt et al., 1974). Andersen et al. (1996) found that the home range size for moose increased during active military manoeuvres (e.g., helicopters and jet fighters), but no collared individuals abandoned the area.

Although direct evidence related to noise effects on marten is limited, there is some evidence that roads might influence lynx distribution and movements (Clayton, 2000). However, there is also evidence that lynx would cross highways (Mowat et al., 2000), and they have been reported to follow road edges and forest trails for considerable distances (Parker, 1981), suggesting they would tolerate this source of disturbance. Although trucks along the the sourthern sector winter access roads could alter marten and lynx movement and behaviour, the potential effects would be limited to the seasonal use of the winter access roads during the three-year construction period.

In addition to noise, sensory disturbance from the Project may also include changes to habitat quality from dust deposition and air emissions. Increased dust deposition has been documented to have varying effects on plants (Forbes, 1995; Spatt & Miller, 1981; Walker & Werbe, 1980; Walker & Everett, 1987). However, Auerbach et al. (1997) states that although the species composition may change and the aboveground biomass is lowered because of dust deposition, the ground cover is still maintained. Some vegetation species, such as cloudberry, willow, and cottongrass, were observed to be more abundant as a result of dust deposition (Forbes, 1995). Because these species have a wider range of tolerance for elevated deposition of dust, they are able to out-compete less tolerant species.

The most deleterious effects of dust are generally confined to the immediate area adjacent to the dust source (e.g., a haul road) (Everett, 1980; Walker & Everett, 1987). Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50 m buffer on either side of a road. Meininger and Spatt (1988) found that the majority of effects occurred within 5 to 50 m of a road, with less obvious effects observed between 50 and 500 m from the road. Thus, direct effects from dust deposition are expected to be largely confined within the Project footprint with a negligible effect on adjacent habitat. Project- related dust sources would be limited to the Twin Gorges, the SVS, and the Nonacho Lake control structure. In addition, dust would only be produced during the three-year construction period required to complete the upgrades.

During the winter, dust that accumulates on snow may settle on vegetation during the spring melt. Because snowmelt does not result in dust "washing away," dust that has accumulated on snow during the winter may be deposited on the vegetation until removed by rain. Haul trucks travelling on winter access roads are a source of both dust deposition (i.e., dust deposited on wheels and undercarriage while at mine sites and Yellowknife) and air emissions. However, the relative contribution of these loads to the overall dust accumulation and air emissions is anticipated to be periodic and localized in the area along the winter roads.

Woo (1984) also observed that increased dust levels accelerated snowmelt. Dust-related acceleration of snowmelt also accelerated plant phenology (e.g., plant growth) in tundra communities (Forbes, 1995). Early snowmelt could decrease the dormancy of plant species and result in early plant growth before seasonal growth conditions are optimal. As such, early plant growth may not be sustainable, which may cause stress to plants and influence their nutritional value for muskoxen.

The intensity of human activity should be greatest during the construction period, compared to the low level of activity expected during Project operations. As such, the majority of the Project's sensory disturbance effects on habitat quality for muskoxen, moose, marten, and lynx would likely occur during the three-year construction period. However, Project-related sensory disturbance effects would be localized. For example, upgrades to the Nonacho Lake control structure, SVS, and Twin Gorges facility are independent point sources of Project activity. Disturbance from transmission line construction, associated winter spur roads, and staging areas would occur at different points in time and space. After completing construction of a section of the transmission line, construction activities would move onto the next section. Therefore, disturbance to local muskoxen, moose, marten, and lynx populations at the previous sections of the line can be expected to decrease with each progressive completion of a section.

Although the indirect effects from sensory disturbance have localized effects on habitat quality, the cumulative sensory disturbance effects from other developments may affect movement and behaviour of muskoxen, moose, marten, and lynx populations. As previously discussed, a total of 83 and 68 existing developments are within the cumulative effects study areas defined for muskoxen and moose, respectively. The mean distance between inactive and active developments is estimated at 11 km. For muskoxen, this distance is similar (11.4 km) if only active developments are considered, whereas for moose, the mean distance increases to approximately 18.3 km between active developments. Therefore, it is possible for muskoxen and moose to be affected by sensory disturbance from other developments during their daily or seasonal movements.

A total of 5 and 40 existing developments are within the cumulative effects study areas defined for marten and lynx, respectively. The mean distance between inactive and active developments is estimated at 65 km for marten and 7.6 km for lynx. When considering the distance between active developments, the mean distance is expected to increase to 121.7 km for marten. Although marten are not anticipated to encounter more than one development on a daily basis, they may encounter more than one development during their seasonal movements. For lynx, the mean distance increases to approximately 10 km between active developments and individuals would be affected by sensory disturbance from these developments during their daily or seasonal movements.

15.7.6 Effects to Muskrat and Beaver

Because of the overlap in habitat preferences (wetlands) of muskrat and beaver, Project-specific effects to these two species were considered together. Cumulative effects were considered separately because of the differences in natal dispersal distance for each species. The effects analysis considers all valid pathways that result in expected changes to muskrat and beaver population size and distribution, after implementing mitigation practices and designs.

15.7.6.1 Methods

The effects analysis was used to quantify the Project incremental effects on the existing environment, and the cumulative effects to muskrat and beaver resulting from the Project and other developments. Similar to other ungulates and furbearers, the spatial boundaries of the LSA were designed to measure baseline environmental conditions and then predict direct and small-scale indirect incremental effects from the Project footprint and activities on muskrat and beaver. In addition, the RSA was designed to quantify baseline conditions at a scale that was large enough to assess the maximum predicted geographic extent (i.e., greatest zone of influence) of direct and indirect effects from the Project on muskrat and beaver. The Project footprint's direct effects on habitat loss and fragmentation, including the winter access roads, were estimated using GIS software. Detailed methods for the habitat loss and fragmentation assessment completed for other ungulates and furbearers is also applicable for muskrat and beaver, and are found in Section 15.7.7.1.

In addition, an assessment of the cumulative direct effects on habitat loss and fragmentation from the Project footprint's winter access roads and previous and existing developments in the cumulative effects study area were completed. The spatial boundary for the cumulative effects assessment to muskrat and beaver was defined using estimated natal dispersal distance around the proposed Project footprint. The estimated natal dispersal distance around the Project footprint for muskrat and beaver was 7 km and 39 km, respectively. The study area for cumulative effects assessment was also adjusted to account for the distribution of muskrat and beaver relative to the treeline. The cumulative effects study area for muskrat and beaver was bound by the northern limit of the boreal forest (Figure 15.7.1). Therefore, Project components, which are located north of the treeline, were not considered in the cumulative effects study area.

Temporal boundaries are linked to two concepts:

- The length of time that Project-related stressors would influence muskrat and beaver during the different development phases of the Project (i.e., construction and operations).
- The predicted duration of effects from the Project on muskrat and beaver, which may extend beyond operation.

Project-related stressors are expected to influence muskrat and beaver for three years during the construction phase; however, the infrastructure would have a lifespan of at least 40 years. Subsequently, the expected length of time that Project-related stressors would influence muskrat and beaver during the operation phase is assumed to be 40 years. Although the duration of some effects from the Project are expected to stop soon after the end of construction, other Project components and activities would generate stressors that would be present over a 40-year time span. Thus, the temporal boundary for muskrat and beaver is defined as the amount of time between the start and end of a relevant Project activity or stressor (which is related to development phases), plus the duration required for the effect to be reversed.

Hydrological modelling was completed to predict changes in the Nonacho Dam and the Twin Gorges facility operations following the proposed Project expansion of the Twin Gorges hydropower facility on the Taltson River. Model predictions were based on five zones within the Taltson River system (See Sections 13.3 and 13.4):

- Nonacho Lake
- Zone 1 - Nonacho Lake to Tazin River to confluence on Taltson River
- Zone 2 - Tronka Chua Gap to Lake Grey Lake

- Zone 3 - Tazin River confluence to Tsu Lake outfall
- Zone 4 - Tsu Lake outfall to Great Slave Lake
- Zone 5 - Trudel Creek (South Valley Spillway)

Here, effects were assessed within the larger study area of the RSA and the Taltson River.

15.7.6.2 RESULTS

15.7.6.2.1 Physical Footprint Leading to Habitat Loss and Fragmentation

Considering terrestrial disturbances only, the Project footprint below the treeline is anticipated to be approximately 1,522 ha. Habitat types below the treeline that would be disturbed most by the Project footprint include open coniferous (22.65%) and exposed land (14.62%). Open coniferous habitat is one of the most abundant terrestrial habitats within the RSA (24.29%). There would be little disturbance to wetlands (0.017% within the RSA), which tend to be more sensitive to disturbance. Approximately 27% (415 ha) of the Project footprint below the treeline is associated with water (i.e., lakes, reservoirs, rivers, or streams). Overall, the incremental disturbance to habitat from baseline to application of the Project (i.e., a future scenario where the Project is part of the landscape) is less than 1% in the RSA (Table 15.7.8). The anticipated total loss of habitat (below the treeline) from the Project development, relative to baseline conditions, is also less than 1% of the RSA (Table 15.7.8).

Based on a natal dispersal distance of 7 km around the Project area, the cumulative effects study area defined for muskrat is 742,350 ha. For beaver, the cumulative effects study area is 3,228,686 ha, based on a natal dispersal distance of 39 km around the Project footprint. Therefore, the incremental loss of habitat from the Project, relative to baseline conditions, is anticipated to be less than 1% of the cumulative effects study area defined for muskrat and beaver.

The number, type, and status of previous and existing developments within the cumulative effects study area defined for muskrat and beaver are presented in Table 15.7.11. As previously mentioned, estimated footprints for linear developments were based on a 200 m corridor, while the area of the footprint for quarries was based on a 200 m radius (13.29 ha). A 1,000 m radius (314 ha) was used to estimate the footprint area for exploration sites and power plants. For communities, the footprint was digitized from Landsat 7 Imagery from the Government of Canada (CanImage, 2008). Total landscape disturbance from previous and existing developments, including the Project, is estimated to be 2,802 ha for muskrat and 6,441 ha for beaver. The cumulative changes in habitat from the Project and previous and existing developments relative to baseline conditions is less than 1% of the muskrat and beaver cumulative effects study areas.

Table 15.7.11 — Previous and Existing Developments in the Cumulative Effects Study Area for Muskrat and Beaver: 2007

Type of Development	Status	MUSKRAT		BEAVER	
		Number	Area (ha)	Number	Area (ha)
Community	Inactive	1	18	1	18
Mineral exploration	Active	2	453	2	667
	Inactive	1	253	5	1395
Power	Active	0	0	2	666
Quarrying	Active	1	13	1	13
Taltson Project	Proposed	1	1522	1	1522
Transmission line	Active	1	145	1	797
Winter road	Active	1	398	1	1363
Total		**8**	**2,802**	**14**	**6,441**

Human activities have not greatly affected muskrat populations in North America. Some local populations have been extirpated because of extensive wetland draining for agriculture. Other populations have increased because of the creation of irrigation ditches and canals (Aleksiuk 1986).

Beaver are a highly resilient species able to exist in close association with human activity. The most significant factors that affect populations are excessive trapping and habitat alteration (Wooley 1974). Natural factors such as forest fires are another notable source of widespread habitat change.

In addition to direct loss of habitat types, the Project would also cause fragmentation in the existing landscape. A total of 5 and 7 existing developments are within the cumulative effects study area defined for muskrat and beaver, respectively (Table 15.7.11). Because of the life history requirements of muskrat and beaver, both species are found within and adjacent to aquatic habitats. Other developments in the study area are typically not associated with water bodies (e.g., mineral exploration, quarrying). Thus, most muskrat and beaver should be only influenced by the Project within their annual home range. Some individuals may encounter other developments while dispersing between watersheds. However, the frequency of encounters with other developments is predicted to be low given the dispersal distance for these species, and the mean distance between active developments, which is 31 km. Therefore, the effect of fragmentation on local muskrat and beaver populations is anticipated to be negligible.

Winter access roads should not fragment populations through disrupting dispersing individuals' movements between local populations. Pre-breeding and post-breeding dispersal occurs in spring and autumn when winter access roads would not be present or active.

15.7.6.2.2 Effects from Changes in Hydrological Regime to Muskrat and Beaver

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

- direct mortality leading to reduced population abundance;
- riparian habitat loss/modification leading to change in population abundance;
- sublethal effects (i.e., changes to diet/submerged aquatic plant community) leading to change in population abundance; and
- stabilized water levels leading to increased abundance.

All of the pathways above were valid for either beaver or muskrat in at least one hydrological zone. Here, the combined effects of the above pathways were grouped under the larger pathway of change in hydrological regime leading to changes in habitat quality and quantity. The total effect was assessed in the context of all effects from the entire Project footprint and changes to hydrology within the Taltson River (i.e., not limited to the Trudel Creek, as is the case with KLOI Ecological Changes in Trudel Creek, Chapter 14).

Changes to riparian and submerged vegetation would likely occur (see Section 13.7 Wetlands – modelling). During operations, large water level fluctuations are not expected. Following the drop in lake elevation, the month-to-month water level changes would be relatively constant, which would aid the recovery of wetlands following the lowering of water levels. Wetlands are created by regular flooding events during the growing season, and it is anticipated that there would be fewer such flooding events during the operations phase. Loss or modification of both riparian and submerged vetetation due to an altered flood regime and lower water levels was considered possible for Nonacho Lake and Zones 2 and 3 during the intial drop in water levels.

Some negative effects to beaver and muskrat are anticipated, within particular zones of the Taltson River (i.e., local scale effects), as a result of both the changes to water levels and changes to wetlands. Although beaver and muskrat normally contend with water level changes, Project operation would cause the seasonality of water level minimums and maximums to change. Direct mortality due to water level changes is thus considered a possibility. If water levels decline sufficiently, food may become inaccessible due to freezing. If water levels rise during winter, muskrats that built their lodges during autumn could be flooded out of their lodges. Both scenarios may occur, each in different zones. Effects may also arise from changes to wetland abundance and diet resulting from water level changes. Another possibility is increased abundance due to stabilized water levels.

Under the 56 MW option, direct mortality due to low water levels is considered a possibility at Nonacho and Tronka Chua Lakes (Zone 2) and Twin Gorges Forebay (Zone 3), for both beaver and muskrat, due to water level changes of up to 70 cm during construction. The loss or modification of riparian habitat may be sufficient to cause effects to muskrat within Nonacho Lake and Zones 2 and 3. Changes in submerged vegetation are also anticipated, also at Nonacho Lake and Zones 2 and 3. Once the new hydrological regime is established, submerged vegetation should recover. Following a reduction in annual water level variation in Zone 2 and at the Twin Gorges Forebay (Zone 3), there may be beneficial effects to muskrat. A complete summary of anticipated effects are provided in Section 13.10.

Under the 36 MW scenario, effects would be similar, but slightly different in location and magnitude. In Zone 1, muskrat mortality due to increasing water levels in the winter was considered possible, due to flooding of push-ups and lodges. In other areas (Nonacho Lake, Zone 2 and 3), water levels may drop sufficiently to cause muskrat mortality. This hydrological regime would be in effect throughout the operations phase, but it is anticipated that muskrat and beaver would adjust their behaviour and dens/lodges accordingly. Changes to riparian habitat due to water level changes are anticipated to occur in Nonacho Lake and Zones 1, 2 and 3, affecting beaver and muskrat. Similarly, changes to submergent vegetation may occur due to the water level changes in Nonacho Lake. Once the new hydrological regime is established (i.e., during operations), submerged vegetation communities would recover. Similar to the 56 MW scenario, reduced annual variation in water levels may lead to benefits to muskrat, in Zone 2 and Zone 3 (Twin Gorge Forebay). A complete summary of anticipated effects for each scenario is provided in Section 13.10.

Suitable muskrat habitat is characterized by substrate that is not rocky, a gentle shoreline, shallow water, and emergent vegetation. Such conditions are not typically found in large lakes or in large rivers. Instead, these features are typical of small ponds and lakes, and smaller, slower rivers. Although high-quality muskrat habitat within the study area is limited with a patchy distribution, muskrats are able to take advantage of localized areas of suitable habitat and would establish populations in such areas (Rescan, 2001). For example, the smaller, shallower and marshy water bodies, such as the localized regions of Nonacho Lake and Hanging Ice River and Lake, contained a higher proportion of muskrat pushups (0.282 and 0.634 muskrat pushups per linear kilometre of shoreline, respectively) compared to other areas surveyed. Areas such as Forebay Reservoir and the SVS appeared intermediate in habitat quality and contained a limited number of pushups.

Muskrats have specific habitat requirements and can be sensitive to certain disturbances, such as fluctuations in water level. In some instances, human activities may result in habitat enhancement. For example, dam construction has caused some flooding in the Nonacho Lake region, which has created suitable habitat for muskrat. Flooding within the Taltson River has covered some of the rocky habitat and created more favourable muskrat habitat than existed naturally (Rescan, 2000).

Beaver are found throughout the region with an aggregated distribution caused by high-quality habitat areas adjacent to those of poor quality. All water bodies examined during the 2000 baseline surveys supported beaver populations or had signs of previous utilization (Rescan, 2000). There were more active beaver lodges along rivers and creeks than on lakes, except in the case of Forebay Reservoir, which is simply a widening of the Taltson River into surrounding marshland. The highest density of active lodges occurred along the SVS, Taltson River, Forebay Reservoir, and Trudel Creek (Rescan, 2000). These streams provide better growing conditions for browse species, particularly willow. Beavers are likely selecting these areas because of access to higher quality and quantity of food.

Key factors that limit beaver populations are excessive trapping and habitat alteration (Wooley, 1974). Human activities adjacent to waterways may also limit beaver habitat suitability (Slough & Sadlier, 1977). In addition, sudden fluctuations in water levels can force beavers to leave their lodge, becoming vulnerable to predators (Trottier, 2003). Habitat alteration can be avoided by carefully controlling the hydrological regime of rivers that traverse beaver habitat (Wooley, 1974). Small streams occupied by beaver are the most susceptible habitats to alteration caused by changes in flows or siltation (Wooley, 1974). In northern populations, beaver numbers tend to be more responsive to food quality and quantity compared to populations in southern Canada, which are more responsive to edaphic (soil-geology) factors (Wooley, 1974). As none of the existing or historic developments within the muskrat and beaver cumulative effects study area are expected to alter hydrology, there are no cumulative effects from this pathway.

15.7.7 Residual Effects Summary

15.7.7.1 Physical Footprint Leading to Habitat Loss and Fragmentation

The Project footprint located below the treeline is anticipated to be approximately 1,522 ha. Habitat types below the treeline that would be disturbed most by the Project footprint include open coniferous (22.65%) and exposed land (14.62%). Open coniferous habitat is one of the most abundant terrestrial habitats within the RSA (24.29%). There would be little disturbance to wetlands (0.017% within the RSA), which tend to be more sensitive to disturbance. Approximately 27% (415 ha) of the Project footprint below the treeline is associated with water (i.e., lakes, reservoirs, rivers, or streams). The anticipated incremental loss of any habitat type from the Project footprint, relative to baseline conditions, is anticipated to be less than 1% of the RSA. At the scale of the population, the magnitude of the cumulative changes to habitat resulting from the Project, as well as previous and existing developments, is also expected to be less than 1% of the cumulative effects study area for key furbearers and ungulates. Both the incremental and cumulative habitat changes are below the 40% threshold value for habitat loss associated with expected declines in bird and mammal species (Andrén, 1994, 1999; Fahrig, 1997; Mönkkönen & Reunanen, 1999; With, 1997).

The total area directly disturbed by the Project was estimated to be 2,724 ha, which is a local scale effect. Below the treeline, an estimated 1,522 ha of habitat is anticipated to be disturbed by the Project. However, the combined direct effects from the Project and other developments on habitat extend to the populations within the cumulative effects study areas. Because much of the infrastructure required for the Project already exists, additional habitat disturbed by new or upgraded infrastructure is relatively small (38 ha). The majority of the disturbance from the Project footprint is associated with the transmission line corridor (76%), which would actually have little direct effect on the tundra landscape. Below the treeline, vegetation along the transmission line would be cleared during construction, and some maintenance is anticipated to maintain a safe clearance from the conductors.

In addition to direct loss of habitat types, the application of the Project (i.e., a future scenario where the Project is on the landscape), in addition to other developments, would result in some fragmentation of the existing landscape. The mean distance between previous and existing developments in the cumulative effects study areas ranges from 7.6 to 65 km. It is likely for muskoxen, moose, and lynx to be in contact with more than one development during their daily or seasonal movements. However, for marten, the mean distance between active and inactive developments in the cumulative effects study area is estimated to be 65 km, and the frequency of individuals interacting with more than one development is predicted to be low.

Although the inclusion of the winter access roads increases habitat fragmentation, the disturbance is anticipated to be temporary (active during the three-year construction period), and restricted to the winter period when the roads are in use (approximately 116 days each year). Although disturbance from the winter access roads is temporary, the effect of fragmentation on muskoxen, moose, marten, and lynx may last a few years beyond the construction period. The presence of the southern sector winter access road may represent a barrier and restrict the population dynamics of key furbearing species and other ungulates. As such, the direct effects of habitat fragmentation to key furbearing species and other ungulates from the winter access road are beyond regional.

15.7.7.2 SENSORY DISTURBANCE LEADING TO CHANGES IN HABITAT QUALITY

In addition to direct habitat effects, indirect changes to habitat quality from the Project have the potential to affect the population size and distribution of muskoxen, moose, marten, and lynx through altered movement and behaviour. Sensory disturbance (e.g., combined effects from noise, dust, air emissions, physical presence of the Project, human activity) resulting from the construction and operation of the Project can reduce habitat quality in both the Project footprint, as well as in adjacent habitats that are not directly affected by the Project. Modelling has indicated that most noise would dissipate to background levels within 2 to 3 km. Blasting noise may attenuate up to 7 km, but this would be a short term and infrequent source of noise.

The magnitude of human activity should be greatest during the construction period, compared to the low level of activity during the Project's operations phase. As such, most of the effects from sensory disturbance to altered movement and behaviour of muskoxen, moose, marten, and lynx are anticipated to stop within a few years of Project construction. Although the Project's indirect effects from sensory disturbance would have local effects on habitat quality, the effect on the movement and behaviour of wildlife may extend to the population within the RSA. Therefore, the Project-specific change in the habitat quality from sensory disturbance effects is regional in geographic extent. The cumulative sensory disturbance effects from previous and existing developments may also affect movement and behaviour of muskoxen, moose, marten, and lynx within the cumulative effects study area. Therefore, the cumulative sensory disturbance effects to habitat quality are beyond regional in geographic extent.

The potential sensory effects associated with the winter access road are also anticipated to be temporary (active during the three-year construction period), and restricted to the winter period when the road is in use. The geographic extent of sensory effects from vehicles on the winter access road is regional. Use of the winter access road is anticipated to stop after construction, and effects should be reversed in a few years.

15.7.7.3 Effects From Changes in Hydrological Regime to Muskrat and Beaver

The proposed changes to the operation of Nonacho Lake within the hydrology model resulted in modifications to the size and timing of releases from the reservoir. Overall, hydrological modelling results indicate that changes in the Nonacho Lake reservoir and Twin Gorges facilities operations decreases the seasonal variation of the predicted flows downstream of the hydropower facility compared to baseline conditions.

The effects from changes to seasonal flow patterns and water levels resulting in abundance and distribution of muskrat and beaver are anticipated to last for the duration of the 40-year operations period. However, it is anticipated that muskrat would respond to the new hydrology regime, and move or place their burrows accordingly. Increased flow during freeze-up may lead to changes in abundance and distribution of muskrat and beaver, and changes to mean water level and seasonality of maximum and minimum flows is anticipated to cause a movement of the shoreline vegetation. It is also anticipated that reduced seasonal variation in water levels would, in some areas, lead to improved conditions for muskrat. The switch from the existing hydrological regime to a new regime during operations would affect vegetation, but recovery is anticipated within the assessment period. Similar effects are anticipated in the 36 and 56 MW scenarios, although the geographic location (or zone) of the effect and difference from baseline values would vary under each scenario. All these effects would occur during operations; changes to the hydrology regime during construction are anticipated to be minor. At the local scale of the zone, effects may influence the abundance and distribution of muskrat and beaver. At the regional scale of the Taltson watershed or the Project RSA, the effects are not anticipated to noticeable. As none of the previous or existing developments within the muskrat and beaver cumulative effects study areas are expected to alter hydrology, there are no cumulative effects from this pathway.

15.7.8 Effects to People

Changes in the population size and distribution of key furbearing and ungulate species may influence the continued opportunity for traditional and non-traditional use of these species (i.e., harvesting activities, wilderness value, and wildlife viewing potential). Use of furbearers and ungulates is related to their availability (or abundance and distribution) and accessibility. Effects to furbearers and ungulates from habitat loss and fragmentation is not anticipated to affect their abundance for trapping and hunting, as the cumulative changes to habitat resulting from the Project on key furbearing species and other ungulates was less than 1%, which is below the 40% threshold value for habitat loss associated with expected declines in bird and mammal species (Andrén, 1994, 1999; Fahrig, 1997; Mönkkönen & Reunanen, 1999; With, 1997). Similarly, effects from sensory disturbance are not anticipated to affect the distribution of furbearers and ungulates for harvesting as most indirect effects from sensory disturbance and winter access roads are anticipated to stop shortly after

Project construction. However, effects on continued opportunity for traditional and non-traditional use of muskrat and beaver caused by changes in hydrology are anticipated to last beyond the 40-year operation period. Finally, changes in access roads leading to increased traditional and non-traditional harvesting was not considered to be a valid pathway, largely because use of the winter access road would be restricted to Project vehicles only.

15.7.9 Residual Effects Classification

The purpose of the residual effects classification is to describe the residual effects from the Project on key furbearing species and other ungulates 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, 2008). The following criteria must be used to assess the residual effects from the Project:

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

15.7.9.1 Methods

The effects analyses and residual effects summary presented both the incremental and cumulative changes from the Project on key furbearing species and other ungulates and their availability to people. Incremental effects represent the Project-specific changes relative to baseline values. Project-specific effects typically occur at the local (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 baseline values through application of the Project (or addition of the Project to the landscape). In contrast to Project-specific effects, the geographic extent of cumulative effects is determined by the defined distribution of the population. This is because the local and regional effects from the Project and other developments can overlap with the distribution of wildlife populations.

The final determination of significance was provided for the incremental effects of the Project on key furbearing species and other ungulates and the cumulative effects of previous and existing developments and the Project. It is the goal of the cumulative effects assessment to estimate the contribution of effects from the Project and other developments to the amount of change in key furbearers and other ungulates relative to natural factors.

To provide transparency in the DAR, the definitions for these scales were ecologically or logically based on key furbearing species and other ungulates. Although professional judgement is inevitable in some cases, a strong effort was made to classify effects using scientific principles and supporting evidence. The scale for the residual effects criteria for classifying effects from the Project are specifically defined for key furbearing species and other ungulates, and definitions for each criterion are provided in Table 15.7.12.

Table 15.7.12 — Definitions of Terms Used in the Effect Classification

Direction	Magnitude	Geographic Extent	Duration	Reversibility	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 exceeding 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., area, 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 (may 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 extending beyond the regional scale	**Short-term:** effect is reversible at end of one year **Medium-term:** effect is reversible within 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"[1] environments not influenced by the Project **Irreversible:** effect is not reversible (i.e., duration of effect 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 has at least one chance of occurring in the next 100 years **Likely:** effect is probable within a year or has at least one chance of occurring in the next 10 years **Highly Likely:** effect is very probable (100% chance) within a year

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

The effects from pathways during the construction and operations phases of the Project can be different. For example, effects from pathways such as noise and dust and winter access roads are anticipated to occur during construction. In contrast, pathways that lead to changes in hydrology regime and riparian vegetation should predominantly occur during the operations phase. Therefore, pathways that can be assigned to either construction or operation are classified for each Project phase.

15.7.9.2 RESULTS

Direct effects from the Project footprint (i.e., habitat loss) are local in geographic extent, a conclusion supported by Harron (2003). However, individuals from populations may interact with other developments and activities during daily or seasonal movements. Therefore, the cumulative effects from direct habitat loss and fragmentation from the Project and other developments on population size and distribution are expected to be beyond regional in geographic extent (Table 15.7.13).

The frequency of the direct effects from the Project to key furbearing species and other ungulates would occur periodically over the assessment period (i.e., habitat disturbance occurs periodically along different sections of the transmission line during construction). The cumulative disturbance to habitats from developments is less than 1% of the cumulative effects study areas for each species. Therefore, the cumulative effects of direct habitat loss from the Project and other developments are expected to be low in magnitude. The Project's localized incremental effect on habitats for wildlife populations is also less than 1% of the RSA, which results in a low magnitude.

The majority of the disturbance from the Project footprint is associated with the transmission line corridor (76%), which would actually have little direct effect on the tundra landscape. Below the treeline, vegetation would begin to regenerate naturally following the completion of construction activities; however, at least 80 years is required for spruce to reach maturity in the boreal forest. Although cleared vegetation along the transmission line may result in habitat enhancement (e.g., establishment of edge species) for some species (e.g., moose, lynx, and marten), the Project footprint and related loss of habitat was assumed to be permanent.

Table 15.7.13 — Classification of Pathways Resulting in Residual Effects to Abundance and Distribution of Key Furbearers and Ungulates

Valued Component	Pathway	Project Phase	Direction	MAGNITUDE		GEOGRPHIC EXTENT		Duration	Revers-ibility	Frequency	Likeli-hood
				Incre-mental	Cumu-lative	Incre-mental	Cumu-lative				
Muskoxen Moose Marten Lynx Muskrat Beaver	Project footprint leading to habitat loss and fragmentation	Construction Operation	Adverse	Low	Low	Local	Beyond regional	Irreversible	Irrevers-ible	Periodic	Highly likely
Muskoxen Moose Marten Lynx	Sensory disturbance leading to change in habitat quality	Construction	Adverse	Low	Low	Local to regional	Beyond regional	Medium-term	Revers-ible	Continuous	Highly likely
		Operation	Adverse	Neglig-ible	Neglig-ible	Local to regional	Beyond regional	Long-term	Revers-ible	Continuous	Possible
Muskrat Beaver	Effects from changes in hydrological regime to muskrat and beaver	Operation	Adverse	Low	N/a	Local	n/a	Long-term	Revers-ible	Continuous	Highly likely

Notes: n/a = not applicable

Project development is expected to cause indirect changes to the amount of different quality habitats for muskoxen, moose, marten, and lynx in the region. These changes are expected to result from sensory disturbance from the Project and are local to regional in geographic extent. The magnitude of human activity would be greatest during the construction period, compared to the low level of activity during the Project's operations phase. The effects from sensory disturbance to altered movement and behaviour of muskoxen, moose, marten, and lynx from construction are anticipated to be medium-term in duration, and long-term during Project operations. Sensory effects from the Project can also combine with similar effects from other developments in the region and decrease the amount of quality habitat for muskoxen, moose, marten, and lynx populations. Therefore, the cumulative sensory disturbance effects to habitat quality are beyond regional in geographic extent for both the construction and operations phases of the Project.

Project operations are anticipated to cause changes in seasonal flow patterns and water levels, consequently affecting the quality of habitat and altering the movement and behaviour in muskrat and beaver. The direct and indirect effects from altered hydrology have local effects on habitat quality (i.e., within specific zones of the Taltson River), and therefore, these effects are local in geographic extent. Overall, hydrological modelling results indicate that an effect ranging from low to moderate within some zones of the Taltson River between Nonacho Lake and Great Slave Lake. Considering the larger study area of the RSA (which includes tributaries to the Taltson River and other waterbodies that are not affected), the overall effect to beaver and muskrat populations is anticipated to be of low magnitude. The geographic extent of the effect is local, as it is confined to specific zones of the Taltson River only, and long-term as effects from hydrology regime changes would last the duration of operations. As none of the previous or existing developments within the muskrat and beaver cumulative effects study areas are expected to alter hydrology, there are no cumulative effects from this pathway. The hydrology regime would remain largly unchanged during construction, and so effects during the construction phase are anticipated to be negligible.

Changes in the population size and distribution of key furbearing and ungulate species may influence the continued opportunity for traditional and non-traditional use of these species (i.e., harvesting activities, wilderness value, and wildlife viewing potential). The magnitude of the Project's incremental and cumulative direct and indirect habitat effects on key furbearing species and other ungulates is less than 1%, and changes to hydrological regimes are expected to be within or slightly exceed the limit of baseline values. Therefore, the magnitude of the change from the Project and other developments on the potential for continued opportunities for traditional and non-traditional use of key furbearing species and other ungulates is expected to be negligible to low (Table 15.7.14).

The duration of the effects to key furbearing species and other ungulates is expected to range from the end of construction to a few years after operations cease, and is largely anticipated to be periodic in nature. For example, the use of winter roads would be limited to a two- to three-month period during the three-year construction period, after which time it is not expected to be maintained. The Slave River, which must be crossed to gain access to the southern sector winter roads, would also limit access. Opening and closing dates for an ice road crossing of the Slave River are expected to be equivalent or less than current dates, indicating a maximum access period of 116 days from December 23 to April 18. The effects from changes to seasonal flow patterns and water levels and altered movement and behaviour of muskrat and beaver are anticipated to stop within a few years after Project operations cease. Thus, the effects on the continued opportunity for traditional and non-traditional use of key furbearing species and other ungulates are expected to be reversible in the medium- to long term.

Table 15.7.14 — Classification of Residual Effects to Human Use of Key Furbearers and Ungulates

Pathway	Project Phase	Direction	M,AGNITUDE		GEOGRAHPIC EXTENT		Duration	Reversibility	Frequency	Likelihood
			Incremental	Cumulative	Incremental	Cumulative				
Effects on abundance and distribution changes the availability of animals	Construction	Adverse	Low	Low	Local	Beyond regional	Medium- to long-term	Reversible	Periodic	Highly likely
	Operation	Adverse	Negligible to low	Negligible to low	Local to regional	Regional to beyond regional	Long-term	Reversible	Periodic	Possible to highly likely

15.7.10 Determination of Significance

Classifying residual effects on valid pathways for key furbearing species and other ungulates provides the foundation for determining the Project's significance 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 key furbearing species and other ungulates 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 then used to predict the significance of effects. 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.

15.7.10.1 RESULTS

The cumulative effects for Project pathways influencing population size and distribution were determined to be beyond regional in geographic extent, which implies that at least some portion of the populations are affected (Table 15.7.15). For incremental effects, the geographic extent of pathways range from local to regional, which is likely a conservative estimate (Harron, 2003). Local effects to habitat are associated with the Project footprint and changes to the hydrology regime, and would likely influence individuals that inhabit the Taltson River watershed and travel near the Project during the construction phase. Regional effects from the Project to habitat, movement, and behaviour are related to sensory effects (e.g., noise and general construction activity).

The duration of effects on key furbearing species and other ungulates for two of three pathways is anticipated to be reversible over the long term (40 to 50 years). These pathways are associated with effects from the combined influences of infrastructure (sensory effects) and operation of the Project (altered hydrology) on habitat quality and quantity. Although cumulative and incremental direct disturbance to habitats from the Project footprint are low in magnitude, the effects were assumed to be permanent and irreversible within the temporal boundary of the assessment.

The magnitude for the three pathways affecting key furbearing species and other ungulates ranged from negligible to moderate (supported by Harron, 2003). The magnitude of the cumulative and incremental effects from direct habitat loss associated with the Project and other developments are expected to be low (less than 1% change from baseline conditions). The incremental and cumulative effects from indirect changes to the behaviour and movement of key furbearing species and other ungulates are expected to be negligible to low. Effects to muskrat and beaver following the change in hydrological regime are difficult to predict, and vary between Taltson River watershed zones. Direct mortality may occur in some zones, due to the anticipated increases in water level during the winter. In other areas, low water levels may reduce availability of forage for muskrat. Changes to wetland function resulting from fewer flood events would reduce the availability of riparian and submergent vegetation for muskrat and beaver, while in other zones muskrat numbers may increase due to stabilized water levels.

Overall, it is expected that both the incremental and cumulative effects from the Project and other previous and existing developments would not have a significant effect on the persistence of the population and distribution of key furbearing species and other ungulates. That is, the cumulative effect would likely be detectable at the population level, but would be reversible over a long-term duration.

There may be effects to continued opportunities for traditional and non-traditional use of key furbearing species and other ungulates caused by changes in abundance and distribution. Overall, the geographic extent of the effects on the continued opportunity for traditional and non-traditional use of key furbearing species and other ungulates are expected to be local to regional for Project-specific effects, and regional to beyond regional for the cumulative effects. The duration of these effects are expected to be reversible in the medium- to long term. The magnitude of effects on the continued opportunity for traditional and non-traditional use of key furbearing species and other ungulates are also expected to be negligible to low for incremental and cumulative effects. Thus, effects to the abundance and distribution of key furbearer species and other ungulates on the continued opportunity for traditional and non-traditional use are not expected to be significant.

Table 15.7.15 — Determination of Significance for Key Furbearing Species and Other Ungulates

Valued Component Assessment Endpoints	Pathways	Project Phase	MAGNITUDE		GEOGRAPHIC EXTENT		Duration (incremental and cumulative)	SIGNIFICANCE	
			Incremental	Cumulative	Incremental	Cumulative		Incremental	Cumulative
Persistence of abundance and distribution	Project footprint leading to habitat loss and fragmentation Sensory disturbance causing change in habitat quality for muskoxen, moose, marten, and lynx Effects from changes in hydrological regime to muskrat and beaver	Construction	Low to moderate	Low	Local	Beyond regional	Medium-term to irreversible	Not significant	Not significant
		Operation	Negligible to low	Negligible to low	Local to regional	Beyond regional	Long-term	Not significant	Not significant
Continued opportunity for harvesting	Change in population size and distribution	Construction	Low	Low	Local	Beyond regional	Medium- to long-term	Not significant	Not significant
		Operation	Negligible to low	Negligible to low	Local to regional	Regional to Beyond regional	Long-term	Not significant	Not significant

There is a moderate- to high degree of confidence in the predictions of significance of incremental and cumulative effects from the Project on key furbearing species and other ungulates. The current level of activity in the boreal region of the Project is low, and mitigation is expected to limit effects from the Project. Further, the key furbearing species and other ungulates are considered likely have a high degree of resilience to disturbance. For example, the recent muskox range expansion into boreal habitat suggests that these animals have the capability to adapt to, and resist, the current level of disturbance from development on the landscape. Moose display life history traits (e.g., high reproductive rates, ability to eat many types of plants) that provide flexibility to adapt to different ecozones and rates of development across North America. Marten and lynx also have the flexibility to adapt to different ecozones and rates of development. Lynx generally favour old growth boreal forests; however, they would inhabit other types of habitat as long as they contain adequate forest cover and adequate numbers of prey (Keith, 1993). Marten have an extremely varied diet and are classified as generalized predators, as they would eat whatever they can catch. Muskrat and beaver are two of the most widely distributed species in North America. The broad distribution of these species is closely related to their use of aquatic environments, which are common in North America. This resilience in these species populations suggests that the effects from the Project and other existing developments should be reversible and not significantly affect the future persistence of key furbearing species and other ungulates.

15.7.11 Uncertainty

The purpose of the uncertainty section is to identify the key sources of uncertainty and to discuss how uncertainty has been addressed to increase the level of confidence that effects would not be worse than expected. Confidence in the assessment of effects and 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., hydrological model inputs).
- Understanding Project-related effects on complex ecosystems that contain interactions across different scales of time and space (e.g., exactly how the Project would influence key furbearing species and other ungulates).
- Knowledge of the effectiveness of the mitigation practices and designs for reducing or removing effects (e.g., limiting access to populations from winter roads).

It is understood that Project activities would directly and indirectly affect habitat and the behaviour and movement of key furbearing species and other ungulates. Although direct disturbance from active and inactive developments was calculated to represent less than 1% of the regional habitat for the populations, long-term monitoring studies documenting the resilience of these species to development and the time required to reverse effects are lacking.

Some uncertainty exists in the description of previous and existing developments, as there is little or no information collected on parameters such as the actual dates and seasons of activities, their precise location, or their geographic extent; in some instances, this information is not readily available. Several assumptions were made concerning the temporal and spatial extent of effects from the different types of development. For example, although the land use permit for mineral exploration may be active for five years, there are no data on the actual frequency and length of time that exploration activities occurred during that period. Subsequently, to estimate the temporal extent of effects from exploration sites, the analysis assumed that approved land use permits were active for five years. The assumption likely overestimates the effect from exploration activities.

To reduce uncertainty associated with changes in habitat quality and quantity and altered movement and behaviour of key furbearers and ungulates, conservative estimates of habitat loss were incorporated into the assessment. Where uncertainty existed in the geographic extent of the Project components, the maximum expected extent was used (for example, transmission line ROW clearing was modelled at 30 m wide, but in practice would range from 15 m to 30 m wide). Above the treeline, habitat loss was calculated for the entire transmission line corridor, but in practice there would be no vegetation clearing for the transmission line ROW in treeless environments. In addition, the winter access road footprints were included in the total area directly disturbed by the Project. This overestimates direct habitat loss, as mitigation implemented in the design, construction, and operation of the Tibbitt to Contwoyto winter road have proven to be successful in limiting the effects on vegetation (EBA, 2002). As such, only minor compression of vegetation is anticipated along the winter access roads. All of these attributes provide confidence that the assessment has not underestimated the effects and significance of the incremental and cumulative effects from the Project on key furbearing species and other ungulates.

Uncertainty also exists in the hydrology modelling results used to predict the water level changes within the Taltson River during the both the construction and operations phases. Hydrology models were derived using historic water levels, lake and river bathymetry, and anticipated changes due to the Project. A full discussion of the assumptions made and the inherent uncertainties in the hydrology modelling are provided in Section 14.3 – Taltson Water Quantity.

15.7.12 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). Based on the criteria for selecting reasonably foreseeable future projects (Section 10.10.1), 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, which was considered an existing project in the effects analysis and assessment,
- A small scale diamond mine in the Lac de Gras region owned by Peregrine Diamonds Ltd., which hauls 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.

Peregrine Diamonds Ltd.'s WO property is in the Lac de Gras region, near the proposed transmission line route. 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 Taltson transmission line, exemplifying a development that may be induced by the Project. The only VC assessed in this section with a cumulative effects study area that overlaps the Peregrine Diamonds property is the muskoxen, and this project would contribute to the cumulative loss of muskoxen habitat and additional sensory disturbance.

The Yellowknife Gold Project proposed by Tyhee NWT Corporation anticipates a combination of open pit and underground mining. The property is l90 km north of Yellowknife on the former Discovery Mine site, an existing disturbed area. Access would be via an existing winter road route and by air. Without a major expansion, the Yellowknife Gold project could not be linked to the Project because of the distance from the Taltson transmission line to the Yellowknife Gold project (approximately 180 km at the nearest point). Regardless, moose, lynx, marten, beaver, and muskrat may be found in the Yellowknife Gold project's region. Because the estimated natal dispersal distance for key furbearers and other ungulates ranges between 7 and 193 km, no cumulative effects are anticipated to these VCs (i.e., the project at or beyond the cumulative effects study area boundaries of these VCs).

The proposed BIPR project would provide access to the Arctic Ocean for projects in the NWT and Nunavut interior. 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). Muskoxen are the only VC with annual ranges that may overlap the BIPR project. Likely effects would be further habitat loss, and sensory effects from traffic (as muskoxen could be near the BIPR project throughout the year).

The study area for the proposed East Arm National Park intersects the proposed Project corridor near Reliance. Depending upon the length of time for the park feasibility study to be completed and the time to negotiate the remaining stages of the park planning process, the proposed East Arm National Park may not be created until the Project is well into the operations phase. There is also uncertainty in predicting the status of the existing fishing and hunting lodges, and camps in the proposed park area. This assessment assumes that existing lodges would no longer allow hunting, but would remain as tourist lodges. Overall, the proposed East Arm National Park would likely be beneficial to muskoxen, moose, lynx, marten, beaver and muskrat, as it would place limits on future development and habitat loss within the park boundaries.

15.7.13 Monitoring

Three categories of monitoring were identified in the Terms of Reference, 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 effect predictions, to reduce uncertainty, and to determine the effectiveness of mitigation.

These programs would be undertaken as part of the land use permit or water license. 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 wildlife 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).

Monitoring beyond that described in the Human Wildlife Conflict Management Plan would be developed during the permitting process, following the environmental assessment.