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19. CUMULATIVE EFFECTS ANALYSIS

19.1 INTRODUCTION

A unique aspect of this DAR was the approach to cumulative effects assessment. Cumulative effects are defined as changes to the environment caused by projects or activities in combination with other past, present and reasonably foreseeable projects or activities (CEAA, 1999). Cumulative Effects Assessment (CEA) is environmental assessment as it should have been; an environmental assessment done well (CEAA, 1999). It requires the consideration of effects due to developments and activities other than the one being assessed. Valued Components (VCs) are the environmental elements of an ecosystem that are identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance.

This effects assessment includes the Project-specific (or incremental) effects relative to the present day existing environment, and the cumulative effects to VCs from all overlapping historic and current and future developments and activities. The assessment of cumulative effects would have a greater degree of uncertainty (a fact acknowledged in MVEIRB, 2004) due to limited information, larger spatial and temporal scales of assessment, and assumed environmental conditions prior to human activity. However, it does lead to a better description of the overall human-caused effects to VCs. In this DAR, both the incremental and cumulative effects were described, classified, and assessed, where applicable.

19.2 APPROACH

In this effects assessment, all likely Project effects were identified, followed by a process of elimination directed towards finding the most important pathways (pathway validation), that were then quantified and classified. In this way, the DAR placed the greatest emphasis and effort on areas of greatest concern. The key steps of this approach were as follows:

- describe the existing environment, focusing on those areas where effects are expected;
- identify and justify the VCs;
- develop assessment endpoints for each VC, which would identify the particular aspects of the VC which should be protected or preserved;
- determine spatial and temporal assessment boundaries that are meaningful for each VC;
- describe the pathways through which each Project component may affect the VCs;
- list the proposed mitigation, describe how mitigation affects the pathways, and determine which pathways remain valid after mitigation;
- assess the effects of the Valid pathways to determine the Project-specific (incremental) effects;
- describe the effects from other overlapping projects and human activities, both past and present, to describe the cumulative effects to each VC;

- classify both the incremental and cumulative effects using criteria such as direction, magnitude, geographic extent, duration, frequency likelihood, and reversibility;
- group the classified pathways that affected each assessment endpoint, and assess the significance of effects to each assessment endpoint; and
- document areas of uncertainty in the assessment, the reasonably foreseeable future developments, and plans for monitoring.

These steps are described in greater detail in Section 10, Assessment Methods and Presentation. The steps of particular relevance to cumulative effects are described below.

19.2.1 Assessment Endpoints

Assessment endpoints represent the key properties of the VC that should be protected. For this DAR, the assessment endpoints served two tasks:

- to identify the key features of the VC that should be protected, and
- to illustrate how the various pathways may affect each VC.

Examples of assessment endpoints include the persistence of fish habitat, persistence of caribou abundance and distribution, continued opportunities for harvesting caribou, and persistence of wilderness character. Assessment endpoints were developed for each VC, and the pathways were grouped by these assessment endpoints.

19.2.2 Spatial and Temporal Boundaries

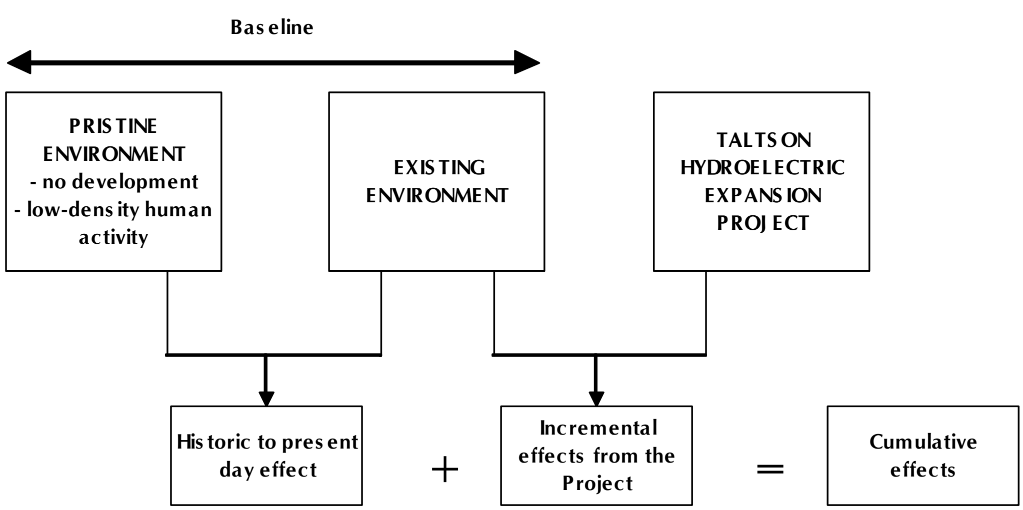
Identifying the spatial and temporal scale for assessment is key to both measuring and estimating potential effects, and in making extrapolations from other studies to this Project. This is because individuals, populations, species and communities all perceive and react to the environment (and effects from the Project) at different spatial and temporal scales. Rationale for the selection of the spatial and temporal scales of assessment is provided in Section 10. Of particular relevance to cumulative effects assessment is the temporal scale of assessment. The expected length of time that Project-related stressors would influence VCs during the construction phase is three years. Currently, the Project is expected to be in operation for 20 years to service the existing and proposed diamond mines. However, the infrastructure would have a lifespan of at least 40 years, and it is the intent of Dezé Energy Corporation 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 Corporation intends to operate the Project longer than 40 years if customers can be found, increasing the duration of the operation 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 details on decommissioning are not comprehensive enough to complete an effects assessment at this time; however, it is the plan of the Dezé Energy Corporation to complete the necessary studies seven to ten years prior to closure. Abandonment and restoration details are provided in Section 6.8 (Closure and Restoration).

19.2.3 Residual Effects Analysis

Residual effects are those Project-induced effects which remain after mitigation. Residual effects analysis was used to quantify the Project incremental effects on the existing environment, and the overall cumulative effects to VCs resulting from the Project and other projects. Incremental effects represent the Project-specific changes relative to the existing environment in 2007. These incremental effects occur at the local scale (e.g., habitat loss due to the Project footprint) and regional scale (e.g., combined habitat loss, dust, noise, and sensory disturbance from Project activities [i.e., maximum predicted zone of influence]). Cumulative effects are the sum of all changes which have occurred from a pristine environment through to the existing environment, and application of the Project. Cumulative effects were measured when there was overlapping effects from the Project, and other surrounding projects and activities (Figure 19.1).

Cumulative effects may result from both spatial and temporal overlap of projects and activities. For example, noise from two adjacent developments may have spatial overlap, creating a cumulative effect. Further, noise from two isolated developments may also create a cumulative effect if caribou interact with each project during their seasonal movements.

Figure 19.1 — Relationship between Baseline Environment, Incremental and Cumulative Effects



Where an effect to a VC was identified, overlapping effects from other development and activities were also considered. If the incremental effect is negligible, then the Project does not contribute to cumulative effects, and neither are assessed. If the Project takes place in a relatively pristine environment, then cumulative effects would be negligible.

Stressors to a VC may be human-related, or natural (such as floods, predation, and forest fires). Both may contribute to cumulative effects. In a pristine system, populations and ecosystems are driven by natural factors. Only anthropogenic effects were described in detail and included in the effects assessment. Key natural stressors were identified, and professional judgement was used to predict the relative importance of anthropogenic and natural stressors on changes to a VC.

19.2.4 Residual Effects Classification

Residual effects classification is the process of defining effects using standardized, qualitative criteria. Eight effect classification criteria, provided in the Terms of Reference, were used to classify the effects, and included:

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

Residual effects are classified using the criteria and categories above, for both the incremental and cumulative (if applicable) effects from the Project on the VC (see Section 10 for the full definitions used for each criteria). Ecological context was not classified, as it was considered to be implicit in the selection of VCs.

In many cases, there is little difference in the outcome of effects criteria between cumulative and incremental changes from the Project. For example, a incremental and cumulative effect may both have the same frequency, likelihood, and duration. Only where there were clear differences in the outcome of incremental and cumulative effects were the two classified separately. Cases where there often was a difference included the magnitude and geographic extent. The magnitude for cumulative effects involves changes from reference conditions through application of the Project, while incremental effects are based on changes from the Project relative to 2007 baseline values. Cumulative effects from the Project and other developments influence the entire spatial boundary of the effects study area. In contrast, the geographic extent of incremental effects from the Project may have a local or regional influence on the range of the populations (i.e., determined by the zone of influence from the Project).

19.2.5 Determination of Significance

Significance of effects was determined for the incremental effects of each assessment endpoint and for construction and operation phases, independently (where effects may differ between construction and operation). The following information was used in the determination of the significance of effects from the Project on VCs:

- Results from the residual effect classification of Valid pathways.
- Application of professional judgment and ecological principals, such as resilience, to predict the duration and associated reversibility of effects.
- Consideration of additional adaptive management and mitigation measures that may increase resilience, and decrease the significance of effects.

19.2.6 Reasonably Foreseeable Projects

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

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

Potential future developments of varying numbers, sizes, and types in the Project area could contribute to cumulative effects to VCs. The following proposed projects have been selected as a suite of major developments that may occur in the reasonably foreseeable future, and a description of the key components of each is provided below:

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

Other reasonably foreseeable future projects may be included within each Key Line of Inquiry and Subject of Note, if necessary. The uncertainty introduced to the effects assessment by each of these projects is discussed in the Key Line of Inquiry and Subject of Note Chapters. A summary of each project and the areas of overlap with Taltson are provided below.

Peregrine Diamonds Ltd. WO property is located in the Lac De Gras region, near the proposed transmission line route. This property contains two kimberlite pipes, DO-27 and DO-18, which have shown results that are favourable in regards to further expansion of the site (Peregrine Diamonds 2008). 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 mine site for processing. The viability of the Peregrine Diamonds property would improve with the presence of the Taltson transmission line, providing an example of the development which may be induced by the Taltson Project.

The Yellowknife Gold Project proposed by Tyhee NWT Corporation anticipates a combination open pit and underground mining operation with a lifespan of 8 to 13 years depending on production rates. It is expected that approximately 190 people would be employed at the site when in full operation (Tyhee 2008). The property is located 90 km north of the City of Yellowknife on the former Discovery Mine site, an existing contaminated area. Access would be via an existing winter road route and by air. Although this property could not be easily serviced by the Taltson Project, it also lies within the range of the Bathurst caribou herd.

The proposed BIPR Project provides access to the Arctic Ocean for projects located within the interior of the Northwest Territories and Nunavut. The proposed 211 km all weather road, which would begin at a planned port facility south of the community of Bathurst Inlet, Nunavut, would connect with the existing ice road on Contwoyto Lake (BIRP 2008). It is expected that this would reduce the fuel and supply costs for northern communities and any developments that are along the proposed route. Employment would peak during construction and opportunities would be staffed mainly by Nunavut residents. The BIPR Project could lead to cumulative effects to wildlife with the Taltson Project and other developments in the Slave Geological Province.

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 Taltson Project is well into the operations phase. There is also ambiguity in predicting the status of the existing fishing, 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 the environment, but was considered because of the changes to the natural and socio-economic environment which it may induce.

Table 19.1 scopes the major pathways in which each of the reasonably foreseeable future projects may lead to cumulative effects with the Taltson Expansion Project, and provides a summary of the validity of the pathways.

Table 19.1 — Pathways from Reasonably Foreseeable Future Projects

Project	PATHWAYS				
	Loss of Caribou Habitat And Changes to Caribou Abundance and Distribution	**Changes to Hydrology within the Taltson River**	**Improvements to Access within the Taltson Watershed, Leading to Changes in Land Use Patterns**	**Changes to Water Quality Within the Taltson Watershed**	**Changes to the Socio-Economic Environment in the South Slave Region and Yellowknife**
Effects from Taltson	The Taltson Project overlaps with the Bathurst caribou herd during all their seasonal ranges	The Taltson Project would affect hydrology within the Taltson River	Without mitigation, the Taltson Project may improve access in the South Slave Taltson watershed region	The Taltson Project may affect water quality in the Taltson River	The Taltson Project is expected to provide income and employment for the South Slave region, and may reduce the amount of transportation to the Diamond mines through Yellowknife
Peregrine Diamonds Ltd. WO Property	Valid Pathway The Peregrine Diamonds property is located within the spring and post-calving ranges of the Bathurst caribou herd	Invalid Pathway Peregrine's WO property is in a different watershed	Invalid Pathway Peregrine's WO property would not influence access in the South Slave region	Invalid Pathway Peregrine's WO property is located within a different watershed system	Valid Pathway Peregrine's WO property could affect the socio-economic environment of Yellowknife
Tyhee NWT Corp Yellowknife Gold Project	Valid Pathway The Yellowknife Gold Project is located within the Bathurst caribou winter range	Invalid Pathway Tyhee's proposed Project is in a different watershed	Invalid Pathway Tyhee's proposed Project would not influence access in the South Slave region	Invalid Pathway Tyhee's proposed Project is located within a different watershed system	Valid Pathway Could affect the socio-economic environment of Yellowknife
BIPR Project	Valid Pathway The BIPR Project is located within the spring and post-calving ranges of the Bathurst caribou herd	Invalid Pathway The BIPR Project is in a different watershed	Invalid Pathway The BIPR Project would not directly influence access in the South Slave region	Invalid Pathway The BIPR Project is located within a different watershed system	Valid Pathway Could affect the socio-economic environment of Yellowknife
Proposed East Arm National Park	Valid Pathway The proposed park lies within the Bathurst caribou range, particularly the winter range	Invalid Pathway The proposed park would not contribute to changes in the hydrology, and is not within the Taltson watershed	Invalid Pathway The proposed park would not create increased access within the Taltson Watershed	Invalid Pathway The proposed park would not affect water quality, and is not within the Taltson watershed	Valid Pathway The proposed park may affect tourism and change resource development in the South Slave and North Slave regions

19.2.7 Approach by Discipline

The sections below provide a summary of the anticipated incremental and cumulative effects to each assessment endpoint. As different approaches were required for different disciplines, the summaries are grouped into terrestrial and aquatic sections, culminating in the cumulative effect to the socio-economic environment.

Some of the Subjects of Note were not considered to have any valid pathways. In this case, the Project is not anticipated to contribute measurably to cumulative effects, and a cumulative effects assessment was not conducted.

19.2.7.1 Terrestrial Environment

To assess cumulative effects in the terrestrial environment, a database of current and historic development was developed. This database was used to investigate the existing and previous land use activities, which may have overlapping effects with the Project. Cumulative effects study areas (CESA) were developed as buffers around the Project footprint that reflect the movements patterns or approximate population boundaries of each VC.

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

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

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

19.2.7.2 Aquatic Environment

Effects to the aquatic environment were anticipated to be confined to the Taltson Watershed. Effects to VC populations in one part of the watershed may overlap with effects to other areas of the watershed. The database of existing and historic development indicated that there have been very few developments within the Taltson Watershed and no other projects, other than the existing Twin Gorges facilities were identified in the Taltson watershed that may also affect hydrology. Thus, cumulative effects within the Taltson Watershed were considered to be a result of earlier effects from the existing facility (i.e., during the Pine Point and post-Pine Point eras). Little is known about the pristine environment of the Taltson River prior to Twin Gorges construction; however, through hydrological estimates and air photo interpretation, certain characteristics of the watershed could be generated, as described in Section 13.1 – Water Fluctuations in the Taltson River Watershed and 14.1 – Ecological Changes in Trudel Creek.

19.2.7.3 SOCIO-ECONOMIC ENVIRONMENT

Cumulative effects represent the sum of all human-induced influences on the physical, biological, cultural, and economic change within a period of time and space. For assessment purposes, a pristine socio-economic and cultural environment was assumed before extended contact between Aboriginal and non-Aboriginal peoples. The pristine pre-contact Aboriginal livelihood assets are considered from a contemporary context where human, social, and natural assets were dominant and financial and physical assets limited.

The cumulative effects to the socio-economic environment is reflected in the regional economics, harvesting, and land use, and was measured using likelihood assets: human, social, physical, natural and financial capital.

"Livelihood assets serve as the basis for people's livelihoods. There are five types of asset that together enable people to pursue sustainable livelihoods:

- human – knowledge, skills, ability to labour and good health;
- social – the resources people can draw upon in pursuit of their livelihood objectives, including social networks and relationships of trust and reciprocity;
- natural – the natural resources available;
- physical – basic infrastructure and producer goods available; and
- financial – the financial resources people have available." (NZAIDs 2008).

19.3 TERRESTRIAL ECOSYSTEM CUMULATIVE EFFECTS

19.3.1 Introduction

As stated above, cumulative effects within the terrestrial ecosystem were assessed by considering current and historic human development. A database of current and historic development was thus developed, and used to investigate the existing and previous land use activities, which may have overlapping effects with the Project. CESAs were developed which were specific to each VC, and the cumulative effects of Taltson and all other existing and historic Projects.

19.3.2 Previous and Existing Developments

The extent of other projects and activities in the effects study area was estimated by the number, type, and location of previous and existing developments on the landscape. This information was obtained using the following sources:

- Mackenzie Valley Land and Water Board (MVLWB): permitted and licensed activities within the NWT;
- Indian and Northern Affairs Canada (INAC): permitted and licensed activities within the NWT and Nunavut;
- Natural Resources Canada (NRCAN): obtained a geographical information system (GIS) file of community locations from NRCAN's GeoGratis website;

- Government of the Northwest Territories (GNWT): location of parks within the NWT;
- provincial governments (Saskatchewan, Manitoba, Alberta): information related to location of mines and other developments that may occur within the spatial boundaries for VCs;
- company websites; and
- knowledge of the area and Project status.

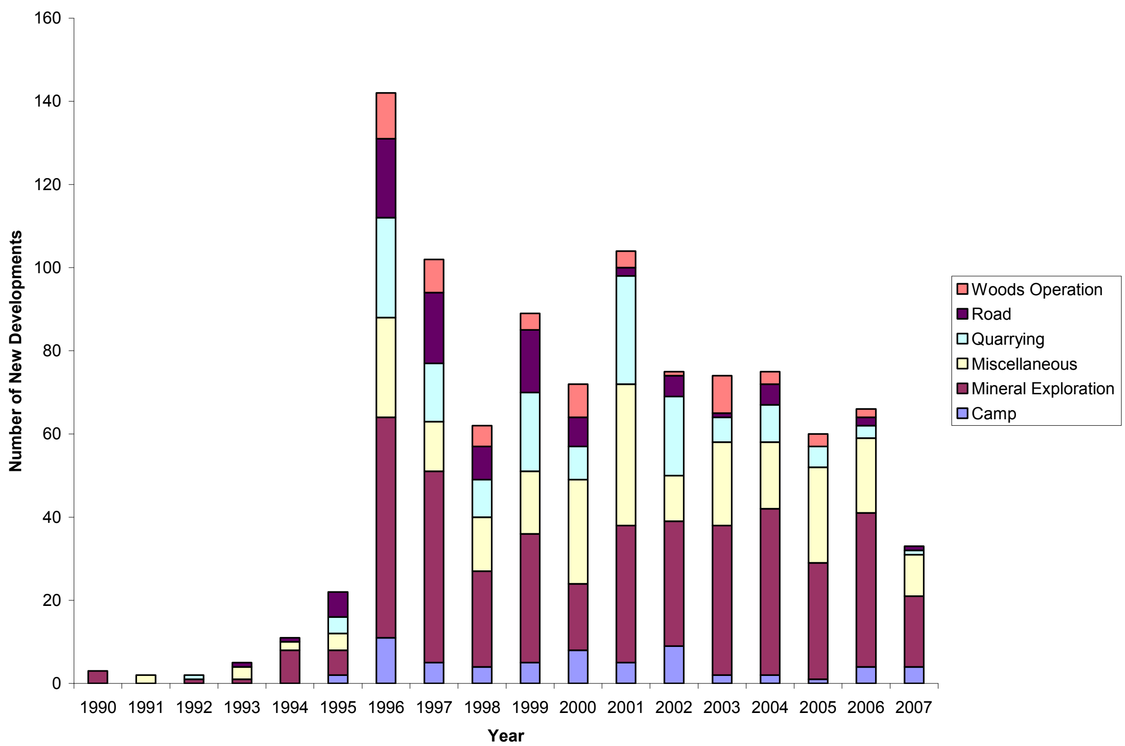
The information was used to generate a development database within a geographical information system (GIS) platform. Other data sources were added to this database either by merging it into the GIS software or digitizing the location of the development. The file was examined for duplication of information (e.g., mineral exploration camps and the associated airstrips are often permitted separately). The development database was then applied to the spatial boundary (effects study area) for applicable VCs. Some projects are seasonal (such as winter roads), and this was incorporated where possible.

Several assumptions were made concerning the temporal and spatial extent of effects from the different types of development, particularly with respect to estimating the cumulative effects on wildlife. The development database does not contain information on the duration of activities associated with land use permits. 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 the zone of influence 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 as exploration typically occurs during the non-winter period. For the cumulative effects analysis, the assumption was made that all land use permits issued more than 5 years ago (i.e., 2003) are now inactive, and may receive less weighting when considering cumulative effects from the Project. Land use permits are typically valid for 5 years, unless an extension is obtained. However, as many of the permitted activities do not utilize all five years of their permit (such as spur roads from the Tibbitt-to-Contwoyto winter road, and many exploration camps), this likely overestimates the actual level of activity.

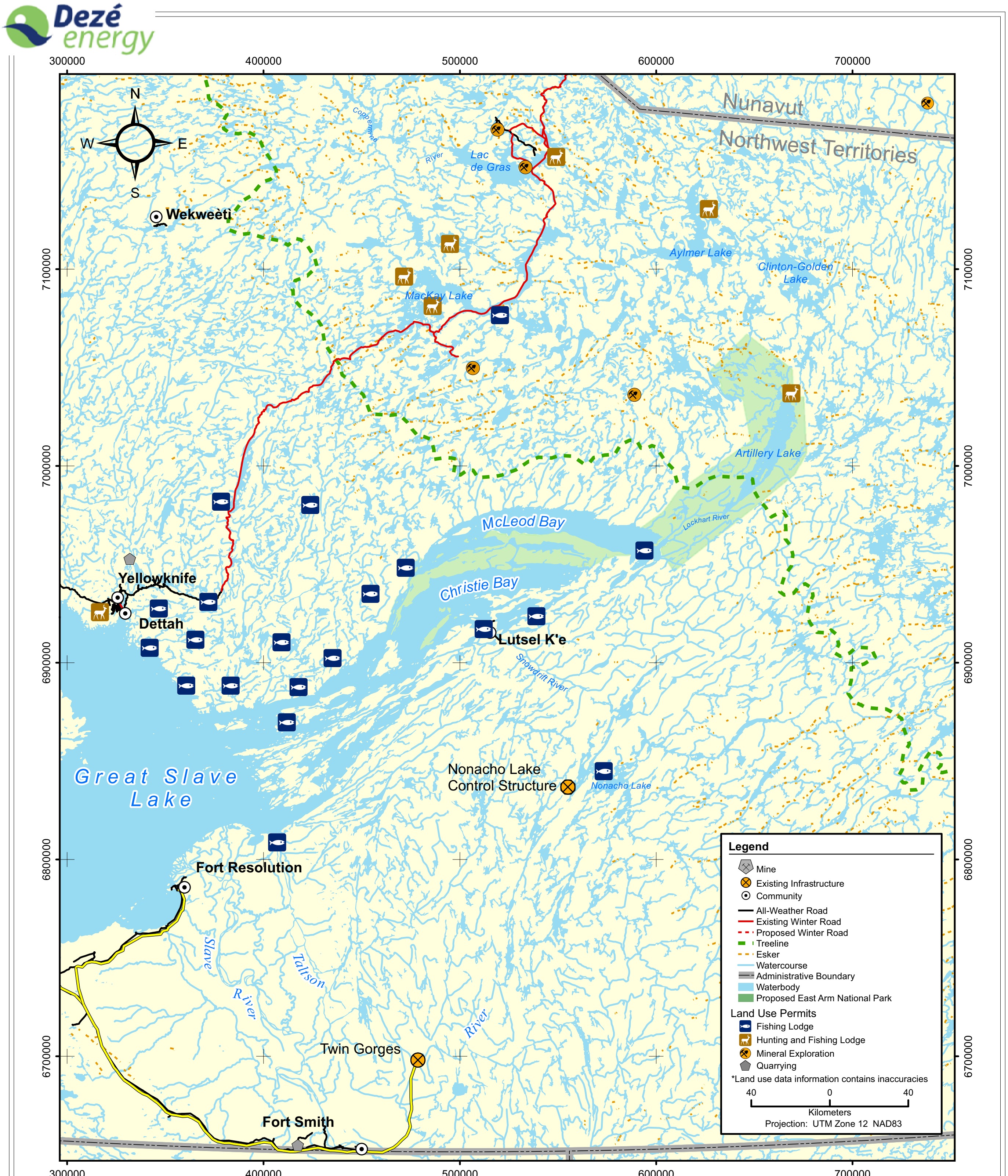
In addition, the database contains no information on the size of the physical footprint of the development. For communities, and closed and operating mines, the footprint was digitized from Landsat 7 Imagery from the Government of Canada (CanImage 2008). For all other developments, the physical area of the footprint was estimated using a number of assumptions. For example, estimated footprints for linear developments (all roads, seismic lines) were based on a 200 m corridor, while the area of the footprint for outfitting camps, wood operations, and staging areas was based on a 200 m radius (12.6 hectares [ha]). A 1,000 m radius was used to estimate the area of the footprint for exploration sites and power plants (314 ha). 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 development database reveals some interesting trends with regards to development in the Northwest Territories and Nunavut. Although there deficiencies in the data, an increase is evident in the level of activity during the diamond exploration rush which began in 1996 (Figure19.2). Since 2005, the number of new developments appears to be declining, but remains higher than pre-1996 levels.

Figure 19.2 — Number of Developments Permitted by Year from 1990 to 2007



Current existing activities include mineral exploration, outfitting lodges, winter roads, active mines, communication facilities and woods operations. Much of the mining and exploration activity is focused in the regions north of Great Slave Lake, while the Taltson River watershed contains very few developments. Figures showing active developments in 1995, 2000, and 2007 are shown in Figures 19.3, Figure 19.4, and Figure 19.5, respectively. Figure 19.6 shows all active developments in 2007 with the Expansion Project.



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Land Use Permits Active in 1995	Figure 19.3

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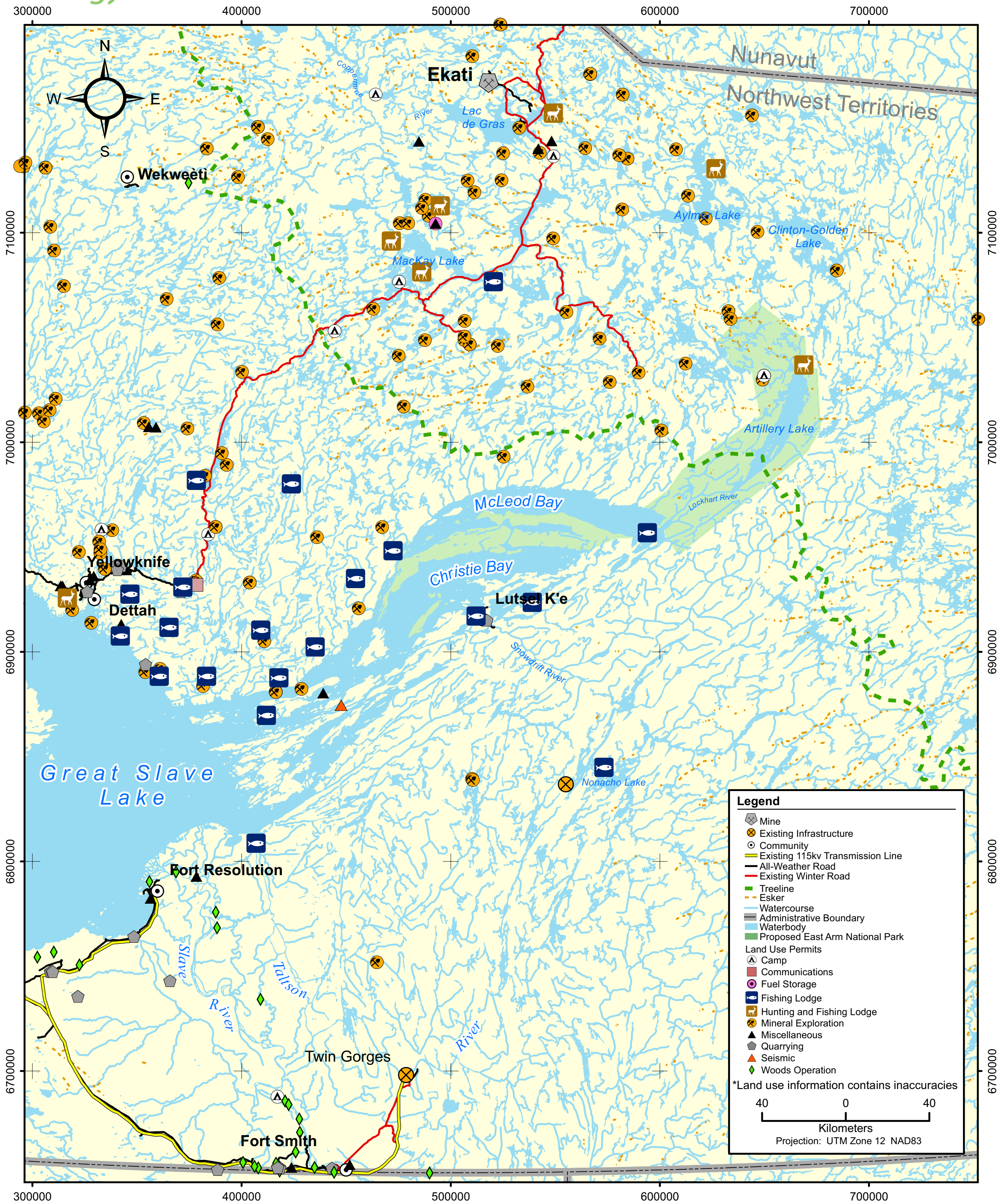

TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Land Use Permits Active in 2000	Figure 19.4

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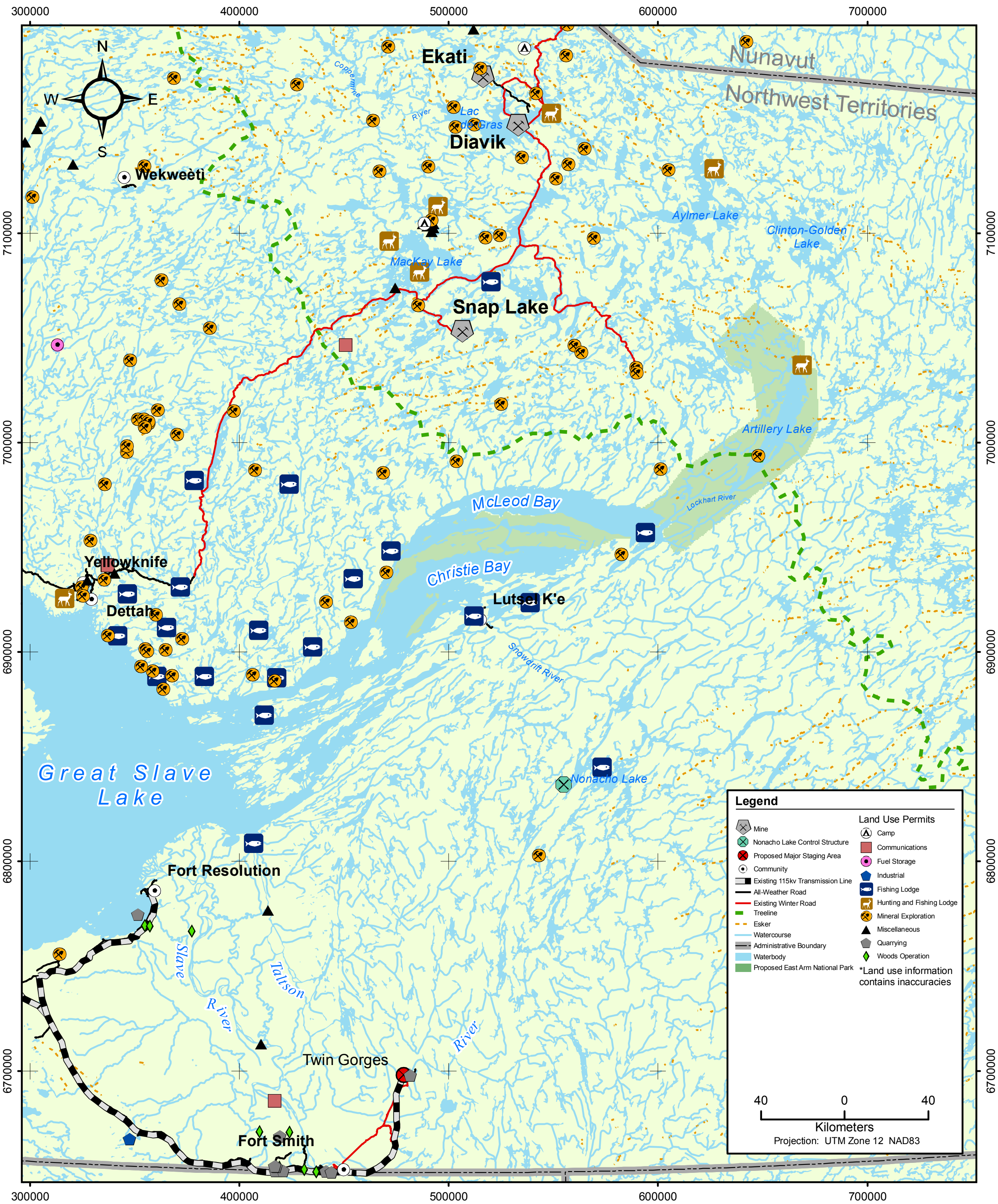
Dezé energy



TALTSON Hydroelectric Expansion Project	Developer's Assessment Report 2009	Land Use Permits Active in 2007	Figure 19.5

TALTSON Hydroelectric Expansion Project	**Developer's Assessment Report 2009**	**Land Use Permits Active in 2007 With the Taltson and Gahcho Kué Projects**	**Figure 19.6**

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19.3.3 Cumulative Effects Study Areas

The effects study area for terrestrial VCs were defined for each species using either the known distribution of the population (i.e. caribou) or estimates of natal dispersal distance around the proposed Project footprint.

Natal dispersal by immature animals is important for colonization and the maintenance of metapopulation connectivity (D'Eon et al. 2002). 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 and for carnivorous birds using the predictive allometric equations defined by Sutherland et al. (2000). Natal dispersal distances are defined here as distances beyond which only 10% of females may successfully leave the natal home range and establish a new home range. For passerines and waterfowl/loons, allometric equations for juvenile dispersal distances were not used due to the poor explanatory power of the models for herbivorous and omnivorous birds (Sutherland et al. 2000). Instead, literature values for the estimated maximum natal dispersal distances for gray jay and Canada goose were used as representative examples of passerines and waterfowl/loons, respectively.

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. Passerines, waterfowl and 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. Figures of each CESA used for the terrestrial environment are provided in Figures 15.4.1, 15.7.1 and 12.1.1 in Sections 15.4, 15.7 and 12 respectively.

Table 19.2 — 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)
Grizzly bears	158
Wolverine	176
Marten	17
Lynx	127
Beaver	39
Muskrat	7
Moose	193
Muskox	129
Raptors[2]	167
Waterfowl[3]	11
Passerines[3]	11

[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.

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

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

19.3.4 Cumulative Effects on Caribou

The classification of effects on Valid pathways for barren-ground caribou provides the foundation for determining significance from the Project on assessment endpoints (Section 12.5). Based on the residual effects analysis and classification, assessment endpoints that are linked to Valid pathways for caribou include:

- persistence of caribou abundance,
- persistence of caribou distribution, and
- persistence of traditional and non-traditional harvesting opportunities.

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 caribou 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 (e.g., magnitude of low to high). For example, a pathway with a high magnitude, large geographic extent, and long-term duration would be given more weight in determining significance, relative to pathways with smaller-scale effects. In other words, the relative effect from each pathway is considered, and pathways that are predicted to have the greatest influence on changes to assessment endpoints were also assumed to contribute the most to the determination of significance. Similar to the residual effects classification, determination of significance was completed for assessment endpoints for construction and operation phases independently (where assessed).

19.3.4.1 RESULTS

Cumulative effects from the Project, previous and existing developments, harvesting, and natural factors on caribou population abundance and distribution were analyzed and assessed through Valid pathways. The geographic extent of cumulative effects from these Project pathways was considered to occur across the seasonal ranges of caribou (i.e., beyond regional), except for the calving range. In contrast, Project-specific (incremental) effects were determined to be local to regional in spatial extent (Table 19.3).

The magnitude of these pathways is expected to be negligible to low for incremental effects from the Project, and negligible to moderate for cumulative effects from the Project and other developments (Table 19.3). Direct disturbance to habitats from the Project and previous and existing development footprints were calculated to represent less than 2% of seasonal ranges, the effect was assumed to be irreversible within the temporal boundary of the assessment. For the other pathways, the duration of effects was predicted to be reversible at the end of construction (medium-term) or operation (long-term) (Table 19.3). Considering all of the pathways, the incremental and cumulative changes from the Project and other developments were not anticipated to have a significant effect on the caribou assessment endpoints (Table 19.3).

The persistence of caribou abundance is linked to direct and indirect habitat loss, and use of linear corridors by wolves leading to changes in caribou predation rate (Table 19.3). Of these two pathways, effects from direct and indirect habitat loss were given a greater weight in the determination of significance. This pathway was assessed through population viability analysis, which determined the relative changes in the decrease and risk to the caribou population for the pristine, 2007 existing conditions, and application landscape scenarios. Changes in habitat were the focus of the analysis, but the model also varied survival (which includes predation), reproduction, and harvest rates. Results indicated that changes to the amount of quality habitat from development (i.e., carrying capacity) on the seasonal ranges had negligible effects on caribou population size relative to harvest rate, and survival and reproduction rates (Section 12.3.4.2). Thus, the magnitude was considered to be negligible for both incremental and cumulative effects, and was predicted to occur continuously during construction and operation of the Project.

The persistence of caribou distribution (or the continuation of historic caribou migratory patterns and use of travel routes) is linked to development footprints leading to habitat loss and fragmentation, and sensory disturbance (Table 19.3).

Habitat fragmentation can negatively influence individuals and populations, but fragmentation effects have less affect than habitat loss (Fahrig 1997; Andrén 1999; Fahrig 2003). The breaking apart of habitats on the landscape changes patch size and number, connectivity between similar habitat patches, and the amount of interior and edge of remnant patches. These landscape-scale changes have been shown to alter abiotic (moisture, nutrients) and biotic processes, such as dispersal and predation. However, fragmentation studies have shown that not all effects were negative (see reviews by Debinski and Holt 2000; Fahrig 2003). For example, of the 17 studies reviewed by Fahrig (2003), the likelihood of positive or negative effects from fragmentation was similar.

Incremental decreases in the amount of quality habitats from the Project footprint were estimated to be less than or equal 0.2% for each seasonal range. The cumulative decrease in the quantity of habitats within seasonal ranges from pristine conditions to application of the Project is estimated to be less than 2% for any given habitat. Although best management practices and a vegetation management plan would be integrated into the construction and operation of the Project, and are part of the land use permits and environmental agreements for existing developments, arctic terrestrial ecosystems are slow to respond to disturbance. In addition, the duration of disturbance to habitat for some components of the Project (e.g., transmission line towers and Nonacho Lake facilities) is indefinite. Therefore, development footprints and related loss of habitat for caribou were assumed to be permanent (i.e., not reversible within the temporal boundary of the assessment).

Sensory disturbance to caribou and associated changes in habitat quality was estimated using resource selection functions (i.e., habitat suitability models), and included knowledge of the local and regional effects from development activities on caribou (Section 12.3.3.3). Habitat models predicted that the cumulative decrease from the Project and other developments in preferred habitats (i.e., high and good quality habitats combined) was 5% in the spring range, 7% in the summer/post-calving range, 9% in the autumn/rut range, and 1% in the winter range.

The change in the distribution of caribou associated with the zone of influence from the Project and other developments is expected to be within the range of baseline conditions (low magnitude). There are natural environmental factors that operate over large scales of space and time (e.g., fire, snowfall, climate related changes in food abundance and quality) that likely have greater influences on seasonal distributions of caribou relative to effects from the Project and other developments.

Sensory effects likely end soon after the cessation of the stressor (i.e., noise, smells, and activity). Therefore, sensory disturbance created during construction is predicted to end shortly after construction. Overall, incremental and cumulative effects to the persistence of caribou distribution were considered to be not significant (Table 19.3). However, given the high ecological context for caribou, the likelihood of significant cumulative effects is considered to be possible during the operation of the Project.

Continued opportunities for traditional and non-traditional use of caribou are related to population abundance and distribution of caribou. Therefore, the geographic extent of the cumulative effects from development on the use of caribou by people is beyond regional (Table 19.3). Given that the duration of the cumulative effects from the Project and other developments are anticipated to occur over the medium to long term, the effects to people should also be reversible in the medium-tem to long-term.

Relative to pristine conditions, cumulative effects from development are predicted to result in lower encounter rates between humans and caribou on their seasonal ranges. Because the ecological context for human use of caribou is considered high, the predicted magnitude from cumulative development on use of caribou by people was increased from low to moderate, and negligible to low for incremental effects from the Project (Section 12.5.2.5). However, analysis of incremental and cumulative changes from direct habitat loss and fragmentation, sensory disturbance, and wolf predation are not predicted to result in significant effects to caribou abundance and distribution. Subsequently, cumulative effects from development also are not predicted to have a significant adverse affect on continued opportunities for use of caribou by people that value the animals as part of their culture and livelihood (Table 19.3).

Table 19.3 — Summary of the Significance of Effects to the Bathurst Caribou Assessment Endpoints

Valued Component Assessment Endpoints	Pathways	Project Phase	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	SIGNIFICANCE	
			Incre-mental	Cumu-lative	Incre-mental	Cumu-lative		Incre-mental	Cumu-lative
Persistence of abundance	Direct and indirect habitat loss leading to change in abundance Use of linear corridors by wolves leading to change in predation rate	Construction Operation	Negligible to low	Negligible to low	Local to regional	Beyond regional	Long-term	Not significant	Not significant
Persistence of distribution	Project footprint leading to direct habitat loss and fragmentation Sensory disturbance causing change in habitat quality, and altered movement and behaviour	Construction	Low	Low to moderate	Local to regional	Beyond regional	Medium term to irreversible	Not significant	Not significant
		Operation	Low	Low to moderate	Local to regional	Beyond regional	Long-term to irreversible	Not significant	Not significant
Persistence of harvesting opportunities	Effects to harvesting opportunities	Construction Operation	Low	moderate	Local to regional	Beyond regional	Medium to long-term	Not significant	Not significant

19.3.5 Species at Risk and Key Bird Species

19.3.5.1.1 Rare Vascular Plants

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

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

19.3.5.1.2 Grizzly Bear and Wolverine

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

The effect of the greatest magnitude for both grizzly bears and wolverine is the change in the amount of different quality habitats. Cumulative effects on the population size and distribution of grizzly bear and wolverine from changes in the amount of preferred habitat (i.e., good- and high-quality) ranged up to 11.3%, an effect of moderate magnitude. However, the incremental change from the Project is low (0.3% or less) for both grizzly bear and tundra wolverine. Effects of direct habitat loss indicated an effect of low magnitude. Boreal wolverine habitat quality could not be calculated quantitatively, however, there is less development activity in the CESA south of the treeline than north of the treeline (approximately 0.7% for the tundra wolverine, and approximately 0.3% for the boreal wolverine). The literature suggests that grizzly bear avoid areas of high human activity (Johnson et al., 2005) while wolverine may be attracted (De Beers, 2008), therefore, during construction it is anticipated that the distribution of these species may be affected during construction, but less so during operations when there would be less sensory disturbance. Much of the sensory disturbance that does occur would be mobile, dispersed, and during winter, when grizzly bears are hibernating. Therefore, the effects of the Project on the persistence of grizzly bear and wolverine abundance and distribution during both the construction and operations phases are considered not significant (Table 19.4).

Hunting of grizzly bear is not permitted within the Slave Geological Province, so effects to harvesting were considered invalid. Effects to wolverine abundance and distribution may affect traditional and non-traditional use of this species. Records of pelt sales indicate that the harvesting of wolverine is limited within the affected communities. As the Project is not likely to result in significant effect to the persistence of the abundance and distribution of wolverine in the Project footprint, effects to the availability of wolverine to hunters and trappers is also not anticipated to be significant (Table 19.4).

Table 19.4 — Determination of Significance for Grizzly Bear and Wolverine

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

19.3.5.1.3 Passerines, Waterfowl, and Raptors

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

The persistence and abundance of passerines may be affected by the pathways of habitat loss and fragmentation, and from sensory disturbance causing changes in habitat quality. Both would occur during construction and operation. Of these effects, habitat loss is predicted to have greater effects than habitat fragmentation (Andrén 1999, Fahrig 1997, 2003). Sensory disturbance to passerines would occur, particularly during construction. However, there would be limited construction activity during the passerine breeding season. Further, most disturbance would be relatively short-term as construction crews and helicopters work along the transmission line. Thus, effects of habitat loss was considered to be the most important factor affecting passerine abundance and distribution. The single greatest cause of habitat loss would be the transmission line ROW, which would constitute approximately 70% of the Project footprint south of the treeline. North of the treeline, vegetation clearing would not be required for the ROW. The magnitude of effects due to habitat loss and fragmentation were anticipated to be low, but irreversible (Table 19.5). Effects would be confined to the RSA, a regional effect. Effects from sensory disturbance are anticipated to be local to regional. Very little of the passerine CESA would be disturbed by the cumulative effects of the Project and other developments. The estimated cumulative loss of habitat in the passerines CESA is 2.2% and 0.3% within the tundra and boreal regions of the CESA, respectively. Thus, the magnitude of the cumulative effect is also low. Overall, the effect of habitat loss and fragmentation and from sensory disturbance to the persistence and abundance of passerines was anticipated to be not significant, incrementally and cumulatively.

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

Sensory disturbance would occur during both the construction and operation phase. As outlined above, most construction activity would take place outside of the breeding season, suggesting an effect of low magnitude. There may continue to be some sensory disturbance to waterfowl during operations due to maintenance activity and the presence of the transmission line, but still the effect is anticipated to be low. Further, there is other development activity within the CESA, but it is predominantly mineral exploration and other small seasonal operations. The cumulative effect of sensory disturbance to waterfowl distribution was considered to be beyond regional and long-term, but of low magnitude. Overall, incremental and cumulative effects to waterfowl distribution due to sensory disturbance are considered not significant (Table 19.5).

Waterfowl abundance may be affected by collisions with the transmission lines, and effects related to the change in hydrology (i.e., changes to submerged vegetation, an important food source for waterfowl). Both of these effects are largely confined to the operations phase (Table 19.5). Of the two, collisions with the transmission lines is anticipated to have the greater effect, as it leads to direct mortality, occurs for the entire length of the transmission line (i.e., it is not confined to specific zones of the Taltson River), and is anticipated to continue until the transmission line is removed (whereas vegetation is anticipated to recover from the change in hydrology regime). Collision mortalities, while expected to occur, are not anticipated to be at a level that could threaten the viability of the population, particularly as collision rates may decline as waterfowl become familiar with the transmission line (Harron, 2003). The overall effect is anticipated to have a low effect, and a negligible cumulative effect (as there is only one other transmission line within the CESA). Similarly, there are no other developments within the Taltson River watershed that are anticipated to cause changes to the hydrology regime, and so cumulative effects from this pathway are also negligible. Effects from both pathways are confined to the RSA, leading to a local effect. As the effects are caused by Project operation, they are long-term. Overall, the effects of hydrology regime change and collisions with the transmission line are anticipated to be not significant in the incremental and cumulative cases.

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

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

Noise modelling indicates that most Project noise would dissipate within 3 km of the Project, indicating a local-scale effect. Cumulatively, there exist other developments within the raptor CESA, some of which are active during the raptor breeding season. The existing diamond mines are likely the single greatest source of disturbance. Monitoring to date has provided some evidence that mining activity affects nesting raptors, but it remains unclear if this effect is due to the presence of mines, or other natural phenomenon (such as extreme weather events and changes in prey availability, Golder, 2008). Overall, the construction phase cumulative effect was considered to be low. Cumulative effects are beyond-regional in geographic extent, due to the likelihood of overlapping effects from adjacent developments. During operation, sensory disturbance to raptors is anticipated to be lower than during construction. There is little indication that transmission lines and towers are a source of sensory disturbance to raptors, as they are known to perch on these structures. Other sources of sensory disturbance during operation include the permanent camp at Twin Gorges, and annual inspections of the transmission line by helicopter. Operation phase effects are, however, long-term. Overall, the incremental and cumulative effects to raptors from sensory disturbance during the construction and operation phases were considered to be not significant (Table 19.5).

Table 19.5 — Determination of Significance for Passerines, Waterfowl, and Raptors

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

19.3.6 Key Furbearing Species and Ungulates

The cumulative effects for Project pathways influencing abundance and distribution were determined to be beyond regional in geographic extent, which implies that at least some portion of the populations are affected (Table 19.6). 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 (Table 19.6). 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 19.6).

Table 19.6 — 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	Construction	Low to moderate	Low	Local	Beyond regional	Medium-term to irreversible	Not significant	Not significant
	Sensory disturbance causing change in habitat quality for muskoxen, moose, marten, and lynx Effects from changes in hydrological regime to muskrat and beaver	Operation	Negligible to low	Negligible to low	Local to regional	Beyond regional	Long-term	Not significant	Not significant
Continued opportunity for traditional and non-traditional use	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.

19.3.7 Impacts on Tourism Potential and Wilderness Character

A single assessment endpoint was selected, the Preservation of Tourism Potential and Wilderness Character. Only one Valid pathway was identified, the Effects of the Project Visual Aesthetics to Tourist Enjoyment of Wilderness (Table 19.7).

The transmission line would be located within landscapes with limited visual or noise indication of human presence, and would traverse the proposed Park. The operating transmission line causes only negligible noise, and Project design considered a transmission line alignment and barge staging areas that would reduce their effects to visual aesthetics and wilderness character. Key to assessing significance of effects to wilderness character and tourism potential are the following proposed mitigations:

- barge staging areas on Great Slave Lake would be at least 300 m inland, reducing noise from these camps to Great Slave Lake;
- construction activities in the vicinity of the caribou hunting camps would take place in winter, outside of the caribou hunting season;
- the transmission line crossing of the Lockhart River within the proposed Park would be determined through discussion with the community of Łutsel K'e;
- there would be no winter roads or temporary access trails within the proposed Park; and
- adjustments were made to the transmission line alignment between Gahcho Kué and Ekati to make it less visible from MacKay Lake and Lac de Gras.

The residual effects are anticipated to be moderate in magnitude, regional in geographic extent, and medium-term in duration (Table 19.7). Ultimately, these effects would be reversed by removing the transmission line towers following Project closure. Although there would be residual effects due to the Project, overall they are not considered to be significant to the preservation of tourism potential and wilderness character within the RSA. Because of the proposed Park and the low levels of development within the RSA, cumulative effects are also anticipated to be not significant (Table 19.7).

Table 19.7 — Determination of Significance for Tourism Potential and Wilderness Character

Assessment Endpoint	Pathway	Phase	Direction	MAGNITUDE		GEOGRAPHIC EXTENT		Duration	SIGNIFICANCE	
				Incre-mental	Cumu-lative	Incre-mental	Cumu-lative		Incremental	Cumulative
Preservation of Tourism Potential and Wilderness Character	Effects of Project visual aesthetics to tourist enjoyment of wilderness	Construction and Opera-tions	Negative	Moderate	Moderate	Regional	Regional	Medium-term	Not significant	Not significant

19.4 AQUATIC ECOSYSTEM CUMULATIVE EFFECTS

The cumulative effects study area for the Taltson aquatic ecosystem includes all 5 zones and Nonacho Lake as described in Section 9.3 – Taltson Basin Hydrology.

19.4.1 Previous and Existing Developments

Prior to development of the Twin Gorges facility in 1964, the Taltson River was a non-regulated system. There was no in-stream development or flow management in the Taltson River according to the NWT license database. The hydro-electric development on the Tazin River occurred in 1929, pre-Twin Gorges, and resulted in a diversion of flows from the Tazin River and subsequently a diversion of flows from the Taltson River. The change to the biophysical components in the Taltson River watershed associated with the Tazin River development are not known; however, any changes to the biophysical components most likely stabilized over the 45 year period between the diversion of flows (1929) and the Twin Gorges development (1964). Therefore, the pre-1964 condition of the Taltson River was considered "pristine" for the cumulative effects assessment. Further, there are no reasonably foreseeable projects that would affect the Taltson River, in addition to the Expansion Project.

Limited data is available to determine pre-development or pristine conditions, as no descriptions, drawings or ground level photographs of the Taltson River were attainable. Historical flow data (in combination with modelled data), Traditional Knowledge and a review of available air photos from pre-Twin Gorges were used to describe the pristine Taltson River watershed characteristics as best as possible (summarized in Section 13.1).

In the cumulative effects assessment, incremental effects from the Expansion Project on each Valued Component (wetlands, aquatics, fish and wildlife) together with known residual effects on the Taltson River watershed from previous developments were assessed. This assessment included the identified incremental effects from the Expansion Project associated with Trudel Creek (Chapter 14) and turbine and conveyance canal operation of the North Gorge and Nonacho control structure (Chapter 15.3). These components were included to obtain a complete assessment of all cumulative effects occurring within the Taltson River watershed.

The known development that has historically affected the Taltson River watershed includes the construction (1965) and operation (1986-present) of the Twin Gorges facility. The regulated flows of the Tazin River into the Taltson River have been considered in the current Taltson hydrologic model and no further cumulative effects would occur. Initial development of the Twin Gorges facilities included damming the Taltson River at Nonacho Lake and the Twin Gorges Forebay, installing a penstock pipeline, powerhouse and tailrace at Twin Gorges, and installing a concrete apron and a spillway at the SVS. Construction and operation of the Twin Gorges facility greatly altered water levels in Nonacho Lake and the Twin Gorges Forebay. Flow rates and levels were also changed in Zones 1, 2, 3, and 4. The increased water management in the Taltson River resulted in increased winter flows and decreased summer flows. Flow began to run through Tronka Chua Gap into Zone 2 where no such flows existed previously, owing to higher water levels in the Nonacho Lake reservoir, which spilled over the gap and into Tronka Chua Lake.

The following sections first discuss the identified cumulative effects, by Valued Component, associated with the Water Fluctuations within the Taltson River. A summary discussion is then provided from the cumulative effects assessment for the Ecological Changes in Trudel Creek (Chapter 14) and Turbine and Conveyance Canal Operation Subject of Note (Chapter 15.3).

19.4.2 Taltson River Aquatic Cumulative Effects

19.4.2.1 Ecological Changes in Trudel Creek

The cumulative effects assessment for Trudel Creek indicates that, in comparison to pristine conditions, historical activities and developments resulted in changes to wetland extent and function, aquatic productivity, and availability of the preferred fish habitat structure and cover conditions. These components are anticipated to experience further changes as a result of the Expansion Project; however, it is expected that wetland extent/function and aquatic productivity would re-stabilize within 3 to 10 years. Once the habitat conditions within Trudel Creek re-stabilize, the cumulative effects to fish resources within Trudel Creek would be of low magnitude.

19.4.2.2 Turbine and Conveyance Canal Operation

The cumulative effects assessment for Turbine and Conveyance Canal Operation indicates that, the Nonacho control structure micro-hydro plant and the North Gorge canal and turbines, coupled with the existing turbine at Twin Gorges, would increase the potential for the entrainment of juvenile fish, namely lake trout. The precise increase can not be determined; however, the likelihood of the juveniles using a canal or penstock leading to a turbine is low and the survivability rates if fish pass through a turbine are high. In addition, entrainment would be limited to fish spawned at or near the canal/penstock facilities and not on the entire population found throughout the Twin Gorges Forebay or Nonacho Lake.

19.4.2.3 Water Fluctuations in the Taltson River Watershed

There are no data on wetland communities occupying the region during pristine environment conditions; however, such a major hydrological change would have inundated emergent vegetation and further covered submergent vegetation, changing ecosystem structure, distribution and function. There is a high degree of uncertainty as to how the wetland communities have changed in terms of extent, structure, and function, from pristine times to baseline (current), and exactly how future periods would compare. The proposed expansion options present incremental adverse effects including medium-term reduced wetland extent and altered wetland function; at least until mature wetland communities would be assumed to develop (3-10 years following expansion). The proposed development presents change to the Taltson River and Nonacho Lake wetlands that have likely stabilized since the initial development and would be expected to re-stabilize in approximately 10 years following proposed expansion of Twin Gorges and the Nonacho Lake control structure (based on rates of vegetative succession in emergent communities).

There are no data on primary and secondary producer communities from this pre-development period. Residual cumulative effects from the initial hydroelectric Project development include changes in habitat structure, loss of primary and secondary productivity during inundations from large rise of water levels, potentially reduced biodiversity, and mortality of existing aquatic communities. It is not possible to quantitatively assess losses from initial development due to lack of bathymetric and biological data. There is a high degree of uncertainty as to how the biological communities have changed in terms of density and diversity of primary and secondary producers, from pristine times to current baseline (post 1986) periods, and exactly how future periods would compare with respect to these parameters. The proposed development presents further change to the aquatic resources of the Taltson River. The aquatic resources would be expected to re-stabilize in approximately 10 years following the expansion of Twin Gorges (based on rates of vegetative succession in emergent communities).

The proposed expansion options present incremental adverse effects to fish populations, primarily associated with lowered water levels. For residual effects relating to lowered water levels (Zones 1 & 2), the incremental effects are not predicted to affect long term fish populations within the watershed. Effects are predicted but would be reversible in the medium-term (less than 10 years) as vegetation establishes within the new water level regime. In terms of cumulative effects, it is difficult to determine if ongoing residual effects are present. The populations of fish within the Taltson River watershed have likely stabilized following past disturbances; however, it is not known if past disturbances created a beneficial or adverse residual effect in terms of population size, distribution, health, etc. It can be inferred that the past disturbance caused a beneficial effect given that habitat extent increased and a direct link to Tronka Chua was made.

Based on Traditional Knowledge and on reference site comparisons, construction of the original Nonacho Lake control structure resulted in riparian habitat loss for furbearers and waterfowl; however, the flooding would have been an isolated event that may have been compensated by the creation of marsh habitat. Depending on the time of year when the flooding occurred, various effects may have been experienced by local wildlife. Evidence suggests that beaver populations in the area surrounding Nonacho Lake may not be very abundant, perhaps because of its high latitude. Assuming that the beaver population was small at Nonacho Lake prior to construction and operation of the original dam, the residual effects at this location from the original Project development would be considered low. Effects to beavers at Nonacho Lake for the current Project upgrades relate to changes in riparian habitat and are considered low given that the effects to riparian habitat are reversible in the medium-term. Effects to muskrat following the original flooding of Nonacho Lake would have been low if the water level rose during the summer; however, if water levels were increased during the winter, flooding may have resulted in mortality from an inability to access shelter and food and increased predation rates. Based on Traditional Knowledge, the effects to furbearers along the Taltson River following the construction and operation of the original dam was high as declines of beavers and muskrats were observed. The effects to muskrat with respect to the current Project were assessed as having a moderate residual effect at Nonacho Lake, Zone 1, and Tronka Chua Lake (Zone 2).

19.4.3 Overall Aquatics Cumulative Effects

Overall, the cumulative effects assessment of the entire Taltson River watershed indicates that, in comparison to pristine conditions, historical activities and developments resulted in changes to wetland extent and function, aquatic productivity, the availability of preferred fish habitat structure and cover, and to furbearers/waterfowl harvesting opportunities. These components are anticipated to experience further changes as a result of the Expansion Project; however, it is expected that wetland extent/function and aquatic productivity would re-stabilize within 3 to 10 years. Once the habitat conditions within the Taltson River re-stabilize, the cumulative effects to fish resources would be of low magnitude. The effects to furbearers and waterfowl would also be expected to have stabilized and re-established in response to the environmental changes.

Considerable uncertainty exists in regard to the pristine conditions of the Taltson River watershed, including habitat value and species populations. Further, uncertainty exists in regard to the long-term effects of past developments, considering the apparent stability of the current environmental conditions. The uncertainty associated with pristine conditions and past development effects lead to considerable uncertainty in predicting the cumulative effects as compared to pristine conditions.

19.5 SOCIO-ECONOMIC CUMULATIVE EFFECTS

Estimation of the cumulative effects requires some understanding of the socio-economic pristine conditions, historic effects of developments on these conditions, and possible developments that may add to the effects on VCs in the study area. Pristine conditions were presumed to have existed before contact with non-Aboriginal people. The effects of development to date are assumed to be reflected in the current socio-economic status of the study area. The possible future developments that could contribute to cumulative effects to VCs used in the Taltson assessment include:

- The Gahcho Kué Project (for the purposes of this DAR it would be considered as an existing Project),
- A small mine in the Lac de Gras region, which hauls ore to Ekati for processing,
- The Tyhee Development Corporation's Yellowknife Gold Project,
- Bathurst Inland Port and Road Project,
- East Arm National Park, and
- Tamerlane's Pine Point Project.

The livelihood pentagon found in the Sustainable Livelihoods Framework indicates the pristine condition, current condition, and cumulative condition resulting from the Project incremental effects together with potential effects of reasonably foreseeable future projects (cumulative).

Figure 19.7 shows the cumulative socio-economic effects assessment outcome using the "livelihood pentagon". Each spoke of the pentagon represents one of the five livelihood assets (human, social, physical, financial, and natural). The amount of each asset available to communities is depicted by the length of the color bars on each of the spokes. The longer the color bar, the more of that asset that exists.

Pristine assets (red lines also called Baseline condition) in Figure 19.7 are characterized by high human, natural and social capital, and minor financial and physical capital. *Current conditions (green lines)* are characterized by a moderate to low human, social, physical and financial capital, and high natural capital. Forecast *cumulative effects (yellow lines)* from this Project on the current conditions would be characterized by high natural capital and moderate social, physical, financial and natural capital.

Figure 19.7 — Cumulative Effects on Traditional Land and Resource Use