# SECTION 1

# INTRODUCTION

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# 1.0 INTRODUCTION

This Terrestrial Environment Supporting Volume (TE SV) is one of six volumes produced in support of the Response to EIS Guidelines for the Keeyask Generation Project Environmental Impact Statement (EIS). The EIS has been developed by the Keeyask Hydropower Limited Partnership (the Partnership) as part of the regulatory review of the Project under the *Canadian Environmental Assessment Act* and *The Environment Act* (Manitoba).

The EIS consists of the following:

- A video, *Keeyask: Our Story*, which presents the Keeyask Cree Nations' history and perspectives related to hydroelectric development. Presented through the prism of their holistic Cree worldview, it explains the journey taken by the KCNs as they evaluated their concerns about the Project, the nature of their participation as Partners, and the decisions they ultimately made to support the Project;
- An executive summary;
- A Response to EIS Guidelines issued by Canada and Manitoba in response to an application by the Partnership for environmental approvals under the government regulatory environmental assessment process. This response includes findings and conclusions, with charts, diagrams, and maps to clarify information in the text, and a concordance table to cross reference requirements of the EIS Guidelines with information in the EIS; and
- The KCNs Environmental Evaluation Reports providing each of the KCNs own evaluation of the effects of the Project on their community and Members and including Aboriginal traditional knowledge (ATK) relevant to the Partnership's response to the EIS Guidelines.

The six supporting volumes were developed by the Manitoba Hydro environmental team in consultation with the KCNs and their Members, to provide details about the Project Description and about the research and analysis of the following topics: Public Involvement Program, Physical Environment, Aquatic Environment, Terrestrial Environment, Socio-economic Environment, Resource Use, and Heritage Resources (the latter three topics are included in one volume). The supporting volumes have been reviewed, commented on, and, as appropriate, finalized in a manner consistent with the arrangements of the Partnership.

This TE SV describes the existing terrestrial environment and assesses the anticipated effects of the construction and operation of the Project on the terrestrial environment. This document provides relevant details that are summarized in the Response to EIS Guidelines document and addresses regulatory requirements with respect to the terrestrial environment for the licensing of the Project (*i.e.*, CEAA, *The Environment Act* (Manitoba), *The Manitoba Endangered Species Act* (MESA), the federal *Species at Risk Act* (SARA) and the Project EIS guidelines).

The TE SV organizes the wide range of terrestrial environment topics into the following sections:

- terrestrial ecosystems and habitat;
- terrestrial plants;
- terrestrial invertebrates;
- amphibians and reptiles;
- birds;
- mammals; and,
- mercury in wildlife.

Each of the above sections begins with an overview of the approach and methodology, including a description of any deviations from the general assessment approach described in this introductory section. Each section then describes the environmental setting, including historical conditions, current conditions and current trends. This description is followed by an assessment of potential Project effects before mitigation and residual Project effects after mitigation. The residual effects assessment includes consideration of the cumulative combined effects of past and current developments and activities. The effects of future climate change on the Project effects predictions and the cumulative effects of the Project with reasonably foreseeable future developments and activities are then considered. Each section concludes with a summary of proposed monitoring and other follow-up measures.

This introduction provides the following information with respect to the terrestrial environment assessment:

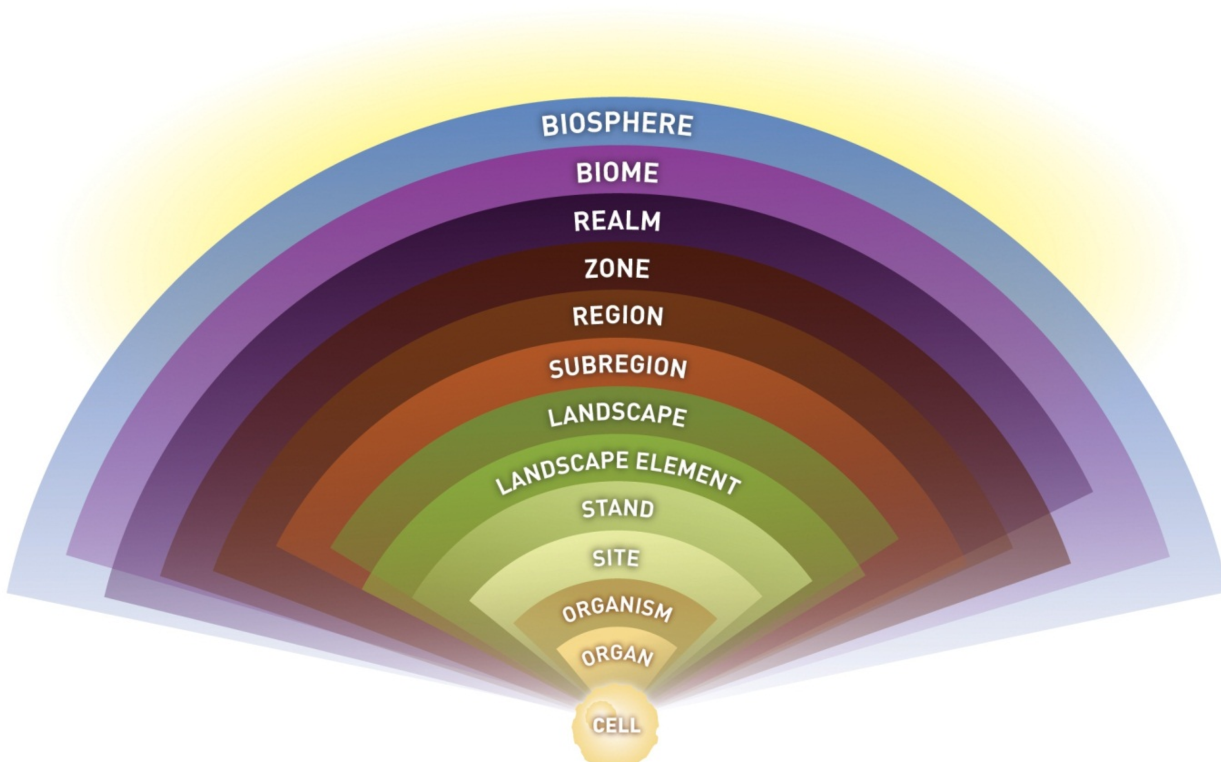
- an overview of the ecosystem-based assessment approach, including how the assessment was scoped and the basic assessment methodology (Section 1.1);
- an overview of terrestrial ecosystems in the Keeyask region (Section 1.2);
- details regarding how the environmental assessment was scoped (Section 1.3);
- the study areas used for various environmental components (Section 1.3);
- details regarding assessment methodology (Section 1.4);
- an overview of the information sources (Section 1.4); and,
- a summary of the construction and operation impacts that are relevant for the terrestrial environment assessment (Section 1.5).

## 1.1 OVERVIEW OF THE ECOSYSTEM-BASED ASSESSMENT APPROACH

This section describes the overall approach to the design and conduct of the ecosystem-based assessment of predicted Project effects on the terrestrial environment.

An **ecosystem** is a functional unit comprised of the living and the non-living things in a geographic area, as well as the relationships between all of these things (Aber and Melillo 1991). An ecosystem has patterns (*e.g.*, a habitat mosaic), structures (*e.g.*, food web, trophic structure), dynamics (*e.g.*, cycling of energy, nutrients and matter) and performs functions (*e.g.*, converts carbon dioxide into plant material, creates soil, provides wildlife habitat). Ecosystems occur in different sizes, with the size being determined by the organism or process of interest.

Ecosystems are organized hierarchically, that is, they occur at various levels nested within each other, with the various levels (*e.g.*, , stand, region, the biosphere), with boundaries being defined by substantial differences in the rates or frequencies of change in the key ecosystem drivers (Allen *et al*. 1987; King 1993). Higher level ecosystems provide the context and constraints for the lower nested levels and the lower level ecosystems provide the components and mechanisms for the higher levels (see Allan *et al*. 1987, King 1993, Rowe 1961 for components and Ehnes 1998 or Waltner-Toews *et al*. 2008 for a synthesis). For example, sites form stands, stands form landscapes, landscapes form subregions, subregions form regions and so on up to the biosphere (*e.g.*, Bailey 2009; Ehnes 2011). Figure 1-1 provides an example of a classification of hierarchical ecosystem levels.

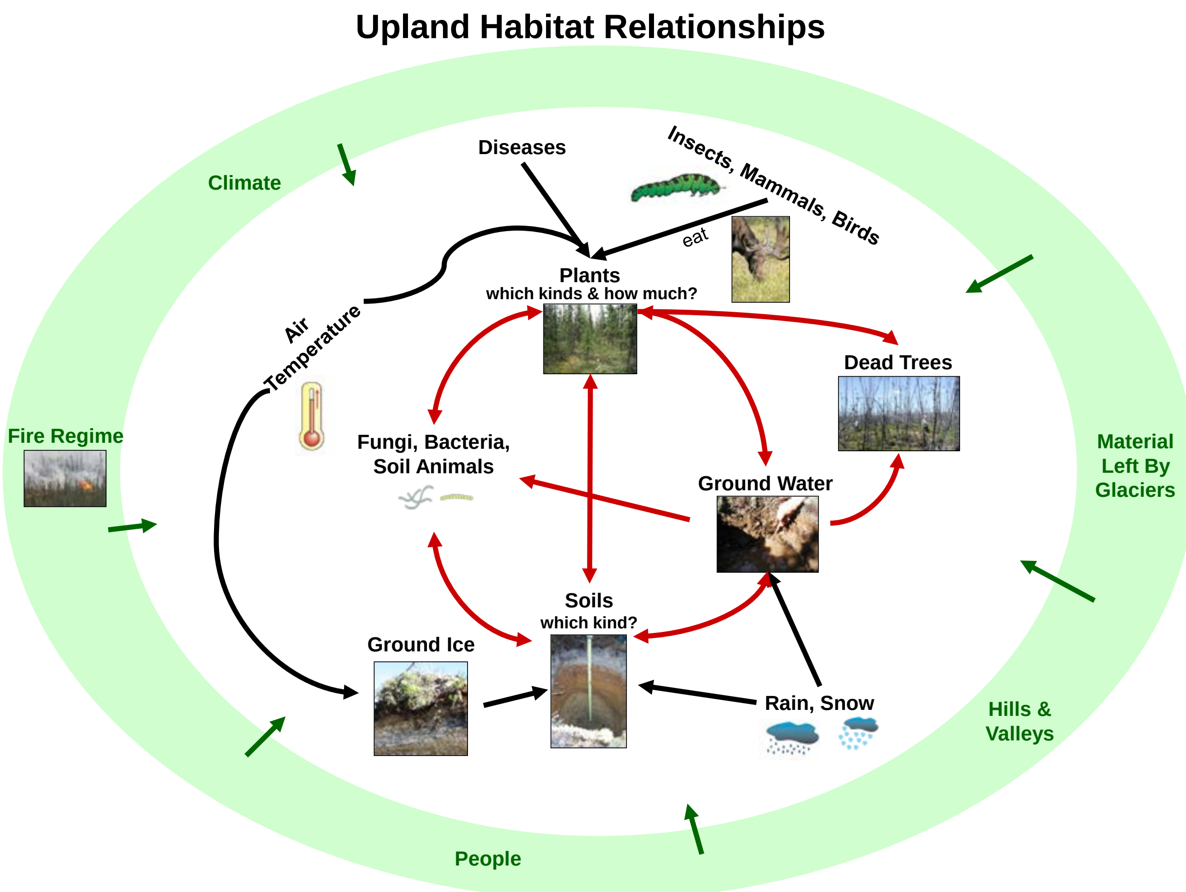



Source: Pimachiowin Aki Corporation (2012).

**Figure 1-1: Hierarchical ecosystems levels**

Climate and fire regime, which manifest variation at the region ecosystem level, constrain which plant species can survive and flourish within a site, stand or landscape.

Figure 1-2 shows a portion of the web of relationships that exist between plants and soils in a stand level ecosystem, illustrating how a change in one ecosystem component can be transferred throughout the web of ecosystem relationships. These patterns and relationships are constrained by climate, fire regime, material left by glaciers and glacial lakes, topography and people (see green outer ring in figure), which are themselves patterns and processes that are produced at higher ecosystem levels such as the biome or biosphere.




Arrows show linkages, or relationships, between ecosystem components. Red arrows are direct linkages while black arrows are indirect linkages. The outer green ring shows the factors that provide the context and constraints on site level patterns and processes.

**Figure 1-2: Plant and Soil Relationships in a Stand Level Ecosystem**

An ecosystem-based approach was used to understand the terrestrial environment and to evaluate the potential effects of the Project on it. The ecosystem-based approach recognized that the terrestrial environment is a complex, hierarchically organized system in which changes to one component directly and/or indirectly affect many other components (*i.e.*, elements, patterns, linkages, processes and functions). A key element of the ecosystem-based approach was identifying the components of Keeyask ecosystems that are particularly important for maintaining terrestrial ecosystem health.

The ecosystem-based approach used to scope and conduct the terrestrial environment assessment included the following elements:

- Cause-effect linkages between the Project and the terrestrial ecosystem were identified, including the direct and indirect effects of the Project on the environmental components of interest, while considering the hierarchical structuring of ecosystem relationships;
- The key topics selected as the focus of the assessment (see Section 1.3.4) included representation for key emergent ecosystem properties (e.g., ecosystem diversity), for the primary controlling factors in the terrestrial ecosystem (e.g., wildfire regime) and for key ecosystem functions (e.g., wetland function);
- The spatial scope of the assessment reflected both the scales at which the Project can affect the environment and the scales at which components within the ecosystem use the environment;
- Study areas for each key topic were nested to correspond with the Project's local zone of influence (i.e., the Local Study Area) and an ecologically appropriate regional comparison area (i.e., the Regional Study Area);
- The temporal scope of the assessment considered seasonal, annual and inter-year variations and long-term changes in the environment that are relevant to ecosystems;
- Given the complexity of potential interactions within the ecosystem and between the Project and the ecosystem, models were used to (i) improve the understanding of ecosystem patterns, processes and functions relevant to the assessment; (ii) predict potential changes caused by the Project; and, (iii) evaluate uncertainty in the assessment;
- The evaluation of Project effects used ecological benchmarks such as degree of change from the existing environment, degree of change from historical conditions, the range of natural variability and comparison to established thresholds, benchmarks and guidelines; and
- Uncertainties associated with the Project effects predictions are described, as are potential measures for addressing these uncertainties. Monitoring, including adaptive management, is one measure used to address uncertainty.

Details on how the ecosystem-based approach was applied during scoping, to predict Project effects and assess effects significance are provided below.

# 1.2 OVERVIEW OF KEEYASK TERRESTRIAL ECOSYSTEMS

The regional terrestrial ecosystem that encompasses the Project area is located near the northern limit of the circumpolar boreal forest. Climatic conditions include long, very cold winters and short, cool, moist summers (PE SV Section 2.3.1). The cold, humid climate has facilitated widespread peatland development. Evergreen needle-leaved trees and other cold-hardy plant species are favoured by the climate. Historically, wildfire has been the dominant driver for regional ecosystems over time frames shorter than 100 years.

The variety of **upland** and **wetland** ecosystems occurring within the Keeyask regional ecosystem support a system of primary producers (*e.g.*, plants), consumers (*e.g.*, invertebrates, birds, mammals) and decomposers (*e.g.*, fungi). Primary producers capture energy from the sun and eventually are either eaten by the consumers or die and fall to the ground where they are decomposed and contribute to soil development. Some consumers also eat invertebrates or vertebrates. Decomposers perform the critical function of releasing and cycling nutrients and other material from dead matter. At the ecosystem level, interactions between primary producers, consumers and decomposers produce a trophic structure and facilitate the cycling of nutrients, matter and energy.

Materials, plant **propagules** and wildlife move into, out of and within Keeyask terrestrial ecosystems. Precipitation is the primary water input for most areas except for the Nelson River, which carries large volumes of water from the upstream watershed. Nutrients enter the system predominantly through precipitation, dry atmospheric deposition and soil weathering. Leaching, surface-water runoff and other processes transport nutrients and substances over the surface and through the soil. Some of the transported nutrients and other substances reach water bodies and rivers where they may be carried out of Keeyask ecosystems.

There are many linkages between the Keeyask terrestrial and aquatic ecosystems. For example, birds and mammals may consume fish and shoreline wetland vegetation affects nearshore fish habitat.

People are also a part of Keeyask ecosystems. The Keeyask area has experienced subsistence harvest over the millennia and has been affected by recreational and commercial harvest over the last decades. In particular, moose, caribou, beaver, muskrat, black bear, snowshoe hare, porcupine, waterfowl and upland birds have been important wildlife for food and clothing while fox, marten, and beaver have been valued for their fur (Engin 1996). Moose and caribou continue to be important for domestic use and recreational harvest (Socio-Economic Environment Support Volume {SE SV}). More recently, human developments such as roads, communities and hydroelectric development in the Nelson River watershed have removed or altered natural habitat. The Nelson River is part of a regulated system in which water flows are managed for the purposes of operating several large hydroelectric facilities on the lower Nelson River. The resulting water regime does not follow a natural seasonal pattern, resulting in changes to shoreline wetlands. Climate change has also been altering terrestrial ecosystems in the Keeyask region, as in all northern areas (Soja *et al.* 2007).

# 1.3 SCOPE OF THE ASSESSMENT

## 1.3.1 Introduction

The main steps used to complete the terrestrial environment assessment were as follows:

- Scope the Project;

- Scope the environmental assessment in terms of key topics, spatial scope and temporal scope (for details see Appendix 1A and Figure 1.8-1);
- Describe the existing environment including historical conditions, current conditions and current trends for the key terrestrial ecosystem components, relationships and functions;
- For each key topic:
    - Describe the existing environment conditions including historical conditions, current conditions and current trends;
    - Predict and assess potential Project effects in combination with other past and current projects before considering potential mitigation;
    - Identify credible mitigation measures where potential effects are expected to be greater than desired;
        - Assess residual Project effects after mitigation;
        - Assess cumulative effects of the Project with reasonably foreseeable future developments and activities; and,
        - Evaluate the uncertainty of Project effects predictions.
- Recommend monitoring and follow-up measures.

Although presented as steps, the environmental assessment was a highly iterative process. For example, results from field studies improved the understanding of local ecosystem relationships, which modified the spatial and temporal scoping of the environmental assessment. Also, initial Project effects predictions for some key topics led to the evaluation and adoption of potential mitigation measures, which reduced residual Project effects (*e.g.*, relocating excavated material placement areas, modifying borrow area boundaries, road routing).

### 1.3.2 Project Scope

The Project components relevant for the terrestrial environment assessment included:

- Physical components that could directly remove or alter terrestrial habitat and/or ecosystems, including effects on wildlife and/or their habitat;
- Components that could indirectly remove or alter terrestrial habitat and/or ecosystems, including effects on wildlife and/or their habitat;
- Components that could disturb animals and/or cause them to avoid habitat they would otherwise use;
- Improved access since it could increase disturbance, mortality or resource harvesting;
- Conditions that could increase the risk that diseases or invasive species are introduced or further spread; and,

- Conditions that increase fragmentation or otherwise reduce regional intactness.

Section 1.5 provides details regarding Project components during construction and operation that are relevant for the terrestrial environment scoping.

### 1.3.3 Project Linkage Identification

A variety of approaches and tools were used to improve the understanding of local ecosystem relationships, identify the key ecosystem health issues of concern and complete the Project effects assessment. The specific approaches and tools that were used to implement the approach described in Section 1.3.4 and Appendix 1.6.1 varied with each key topic depending on the degree of understanding of local relationships and the ability to collect suitable data with a level of effort that is reasonable for an EIS.

During the initial stages of the assessment, literature reviews and tools such as conceptual diagrams (*e.g.*, Figure 1-2), pathway diagrams (Figure 1-3), network linkage diagrams (Figure 1-4) and checklists were used to identify which could be the issues of concern for the Project, to identify data gaps and to design field studies to address data gaps. Enhanced understanding of local relationships was obtained through field studies, statistical analysis, modeling, information received from the KCNs. This enhanced understanding was used for many purposes such as to select the key topics, recommend mitigation measures, incorporate the effects of other projects into the assessment or to identify changes to contextual and other non-Project factors.

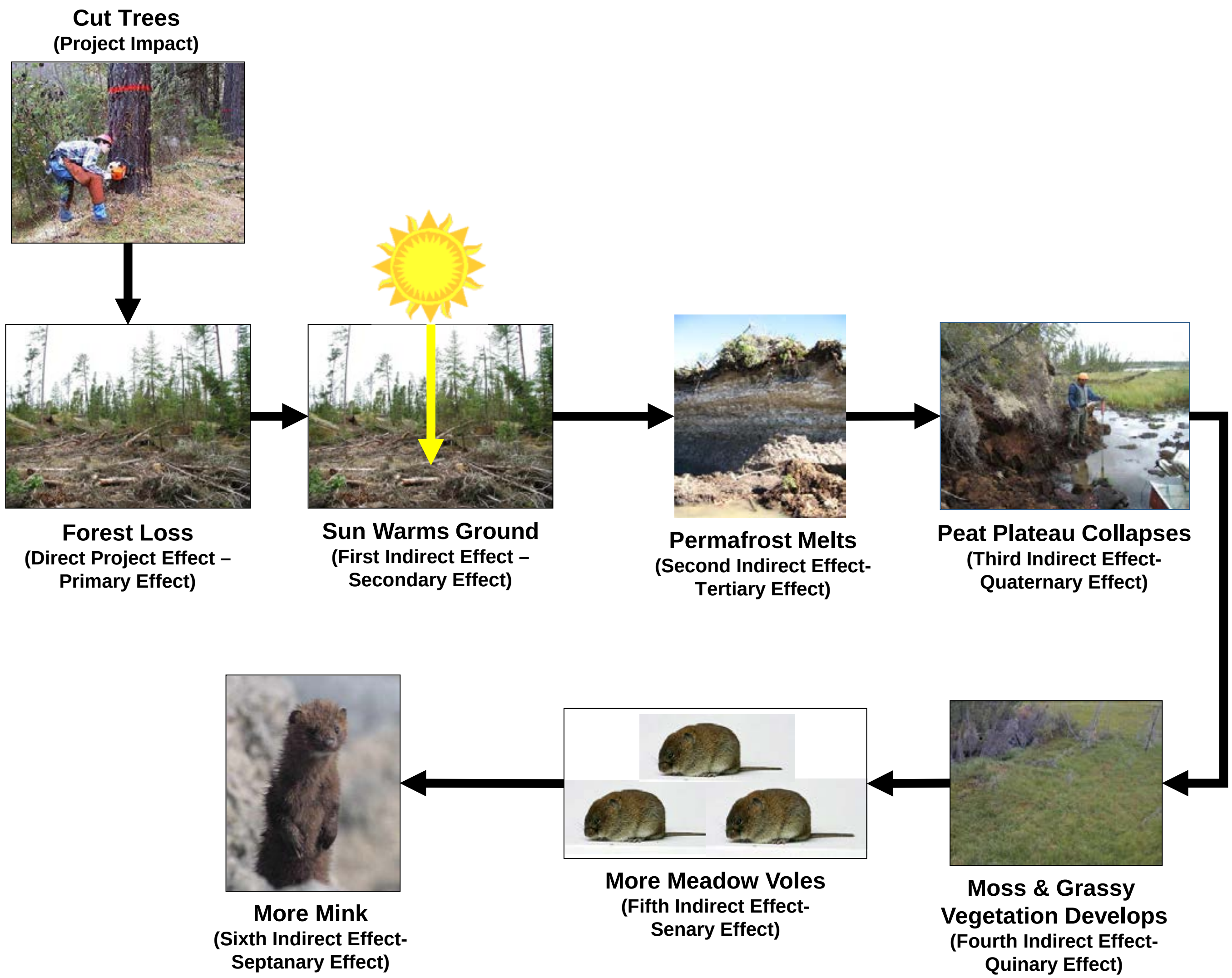



**Figure 1-3: Pathway Diagram for Direct and Indirect Linkages Between a Specific Project Impact (cutting trees) and Changes in Ecosystem Components**

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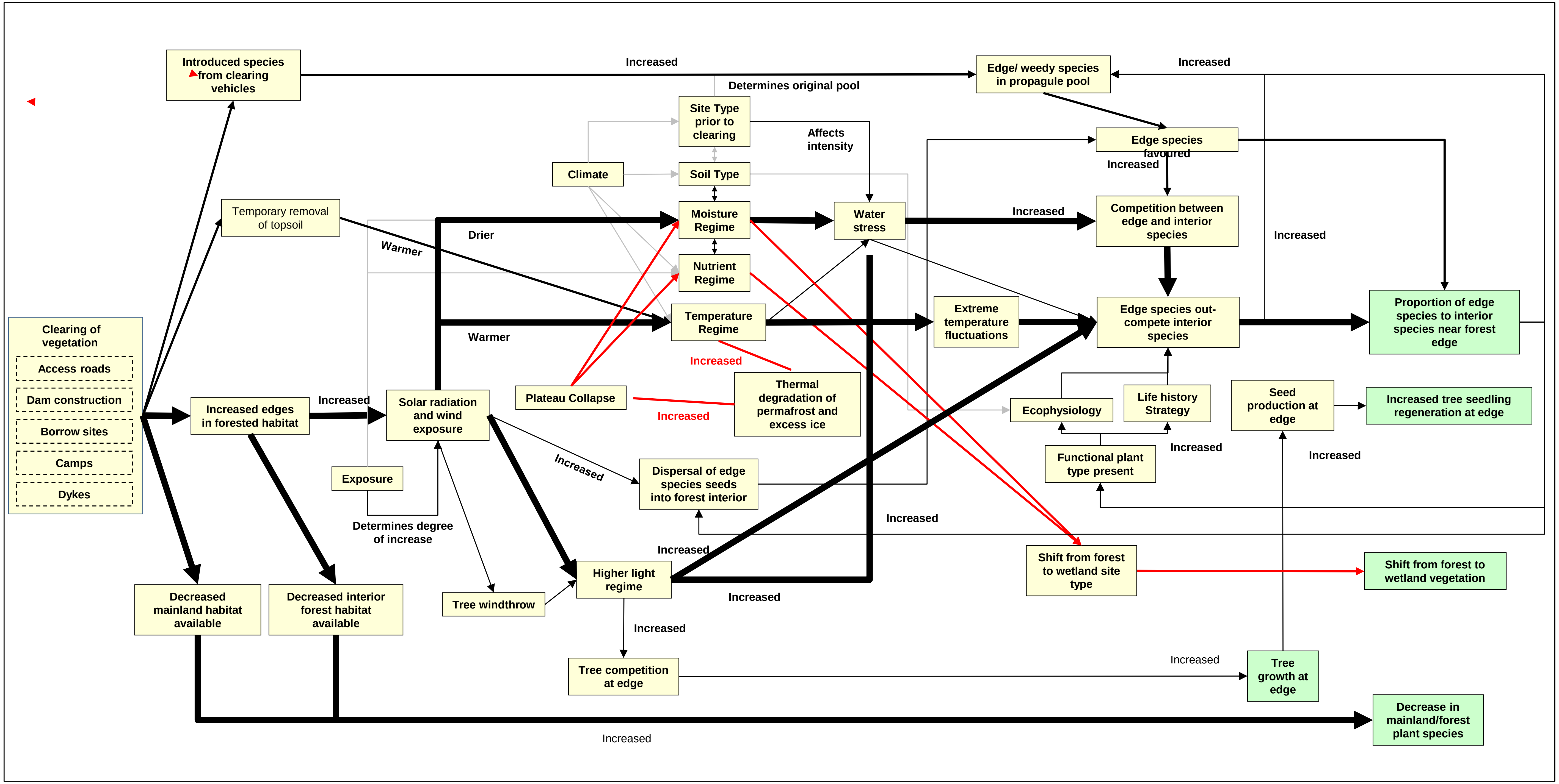


**Figure 1-4: Network Linkage Diagram for Terrestrial Vegetation Changes Caused by a Clearing for Temporary Project Footprint Components.**

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### 1.3.4 Valued Environmental Components and Supporting Topics

Keeyask terrestrial ecosystems provide numerous benefits such as: food and shelter for all terrestrial animals; cultural, social, spiritual and economic benefits to people; and perform ecological functions such as cleaning the air and water. Some components of Keeyask terrestrial ecosystems are of particular ecological and/or social interest for a variety of reasons such as they are highly valued by people, are rare, protected by legislation under *The Manitoba Endangered Species Act* (MESA) and the federal *Species at Risk Act* (SARA).

The key issues for assessing potential Project effects on the terrestrial environment were identified through a number of filtering steps that are outlined in Appendix 1-A. In short, the key terrestrial environment issues of concern related to the Project were identified using the land use sustainability framework developed by the Canadian Council of Forest Ministers (CCFM), industry and others (CCFM 1995) as a component of an international process that culminated in the Santiago Declaration (Anonymous 1995). In brief, the overall goal of the CCFM framework is to maintain long-term ecosystem health for present and future generations while conducting human activities and development. Ecosystem health is maintained when biodiversity, ecosystem condition and productivity, soil and water quantity and quality and contributions to global ecological cycles are all maintained within their ranges of natural variability (after CCFM 1995). The CCFM framework is applicable to regional ecosystems that have not already been dramatically altered by human activities. This framework is consistent with many environmental assessment regulations, policies and guidelines (*e.g.*, Canadian Environmental Assessment Agency 1996; *Federal Sustainable Development Act*) because it is a scientific approach developed by governments in partnership with stakeholder groups following extensive international, national and local consultation.

The steps taken to identify the Project specific issues of concern are described in Appendix 1A and illustrated in Figure 1.8-1. In summary, a generic checklist of ecological issues of concern was developed by applying the CCFM land use sustainability framework to federal EIA guidance documents, CCFM criteria and indicator documents, scientific literature and ecological principles. Potential Project specific issues of concern were selected from the generic checklist using input from the KCNs, observed effects from past hydroelectric developments in northern Manitoba, tools such as ecosystem linkage diagrams and local data (for details see Section 1.4).

It was expected that some of the issues on the list of potential Project issues of concern would actually experience very small Project effects in the sense that effects would be well within the range of natural variability. As well, some ecological processes and interactions are more important than others in terms of their influences on ecosystem function (Aber and Melillo 1991). For these reasons, and because it is neither practical nor necessarily instructive to decision-making to investigate and assess the possible effects of the Project on every component of the terrestrial ecosystem, the terrestrial assessment focused on the key ecosystem health and/or social issues of concern, or **key topic**s. That is, the ecosystem components (*i.e.*, patterns, processes and functions) that could potentially experience substantial Project effects and are especially important to maintaining overall ecosystem function and the benefits that these functions provide to present and future generations. The key topics collectively indicate how the Project is expected to affect terrestrial ecosystem health. Key topics of particularly high ecological and/or social interest became the **valued environmental components** (VECs) while the remaining key topics became the **supporting topics**. Appendix 1A provides details regarding the methods used to select the VECs and the supporting topics.

Table 1-1 lists the 13 VECs and nine supporting topics used to assess Project effects on the terrestrial environment.

**Table 1-1: Valued Environmental Components (VECs) and Supporting topics Used for the Keeyask Terrestrial Environment Assessment**

| Key Topics<br>(Grouped by EIS Section Where they are Addressed) | VEC | Supporting Topic |
|---|---|---|
| **Section 2 – Terrestrial Ecosystems and Habitat** | | |
| Intactness | ✓ | |
| Fire regime | | ✓ |
| Terrestrial habitat | | ✓ |
| Ecosystem diversity | ✓ | |
| Wetland function | ✓ | |
| Soil quantity and quality | | ✓ |
| **Section 2 – Terrestrial Plants** | | |
| Invasive plants | | ✓ |
| Priority plants[1] | ✓ | |
| **Section 3 – Terrestrial Invertebrates** | | |
| Invertebrate community | | ✓ |
| **Section 4 – Amphibians and Reptiles** | | |
| Priority amphibians[2] | | ✓ |
| **Section 5 – Birds** | | |
| Canada goose | ✓ | |
| Mallard | ✓ | |
| Bald eagle | ✓ | |
| Olive-sided flycatcher | ✓ | |
| Common nighthawk | ✓ | |
| Rusty blackbird | ✓ | |
| Other priority birds[3] | | ✓ |

**Table 1-1: Valued Environmental Components (VECs) and Supporting topics Used for the Keeyask Terrestrial Environment Assessment**

| Key Topics<br>(Grouped by EIS Section Where they are Addressed) | VEC | Supporting Topic |
|---|---|---|
| **Section 6 – Mammals** | | |
| Caribou | ✓ | |
| Moose | ✓ | |
| Beaver | ✓ | |
| Other priority mammals[4] | | ✓ |
| **Section 7 – Mercury** | | |
| Mercury in wildlife | | ✓ |

1. Priority plant species include those native species that are highly sensitive to human features, make high contributions to ecosystem function and/or are of particular interest to the KCNs. A species was considered to be highly sensitive to human features if it is globally, provincially or regionally rare, near a range limit, has low reproductive capacity, depends on rare environmental conditions and/or depends on the natural disturbance regime. Rare species that are endangered or threatened are of particularly high concern.
2. Includes Species at Risk.
3. Includes other Species at Risk, colonial waterbirds and species at the edge of their known breeding range.
4. Includes endangered, threatened, provincially rare and regionally rare species, small mammals and large carnivores as high contributors to ecosystem function and furbearers highly valued by local people.

### 1.3.5 Spatial Scope

Spatial scope was determined separately for each VEC and supporting topic (*i.e.*, each key topic) using a nested, cause-effect approach (FEARO 1994; CEAA 1996; Milko 1998a, 1998b; Hegmann 1999; Manitoba Hydro 2003b). The scoping approach considered the hierarchical structuring of ecosystems and the potential pathways of Project effects on the key topic, including where these pathways could interact with other past, current and reasonably foreseeable future projects.

The rationale for the nested cause-effect approach was as follows. Project **impact**s such as vegetation clearing or flooding would have direct **effect**s on the key topic. These Project impacts could also have indirect effects on the key topic through linkages such as those shown in Figure 1-4 (*e.g.*, Project-related increases in groundwater elevations lead to altered vegetation and soils). For each key topic, the spatial extent of potential direct and indirect effects defined a potential **zone of influence** on individuals (*i.e.*, the local zone of influence), which became the Local Study Area for the key topic. In the case of a wildlife key topic, individuals were the individual animals that would be affected (*e.g.*, five moose are displaced). In the case of a non-species key topic, individuals were the relevant ecosystem elements (*e.g.*, 10 jack pine stands will be cleared; two **core area**s will be fragmented).

Although effects on individuals are of interest, the question of ultimate concern for the Project effects assessment was how effects on individual animals would translate into long-term effects on population viability or how effects on individual ecosystem elements would translate into long-term effects on components of regional ecosystem health (which is a synthetic measure of ecosystem functions). For example, how would removing the habitat that supports five moose affect the long-term viability of the moose population, or, how would removing ten jack pine stands affect regional ecosystem diversity? On this basis, an area that was large enough to capture the local "population" (*i.e.*, the regional zone of influence) was used to assess the potential significance of Project effects. The spatial extent of the regional zone of influence became the Regional Study Area for the key topic. Due to the manner in which it was derived, the Regional Study Area was generally used as the cumulative effects assessment area. Figure 1-3 illustrates the conceptual approach using the potential effects of a hypothetical project on moose.

The **context area**, a third area that surrounds the Regional Study Area, was also used for some key topics. A context area was sometimes needed because ecological processes that operate over very large spatial scales or long time frames could influence the key topic and confound the interpretation of observed patterns and trends. For example, animals could migrate into the Regional Study Area if there was an unusually large burn in the surrounding area that greatly reduced available habitat there. Failure to consider the ecological context could lead to the erroneous conclusion that some changes observed in the Regional Study Area were caused by the Project, or conversely, Project effects could be obscured by broader changes.

For most of the key topics, the ecologically appropriate Local and Regional Study Areas and context area were sufficiently similar that they were selected from six nested geographic areas referred to as the study zones. Using a common set of study zones for the key topic study areas facilitated linking results from different key topics. For example, habitat information developed for the terrestrial habitat supporting topic could be used for the wildlife assessments.

Map 1-1 shows the common study zones and the Keeyask Generation Project Area. The Keeyask Generation Project Area encompasses the geographic areas where the majority of the physical, aquatic and terrestrial environment studies completed for the Project assessment were conducted. Study Zone 1 boundaries were determined as the combined potential extent of the Project Footprint during construction and operation, including areas that are unlikely to be used and before considering mitigation, habitat rehabilitation and natural habitat regeneration (Table 1.3-2).

Study Zone 2 boundaries were defined by the Project's maximum potential local zone of influence on terrestrial habitat composition, which were delineated as a 150 m buffer of Study Zone 1. Since Study Zone 2 was the maximum potential extent of altered habitat composition, this zone was used as the Local Study Area for terrestrial habitat and for species with the smallest individual home range sizes (*e.g.*, frogs, mice).

Study Zone 3 boundaries, which reflected the Project's maximum potential local zone of influence on **landscape element**s, were delineated as a 1,150 m buffer of Study Zone 1. Study Zone 3 was used as the Regional Study Area for species with the smallest population home range sizes (*e.g.*, frogs, mice) and the Local Study Area for species with small to moderate sized population home ranges (*e.g.*, olive-sided flycatcher, beaver).

Study Zone 4 was large enough to capture a repeating sequence of landscape types. Study Zone 4 was used as the Regional Study Area for species with small to moderate sized population home ranges and as the Local Study Area for species with large individual home range sizes.

The spatial limits of Study Zone 5 were determined by the area that was large enough to support the key boreal ecological processes and populations of most resident wildlife species. Consequently, Study Zone 5 was the Regional Study Area for most of the habitat and ecosystems key topics. Study Zone 5 is referred to as the Keeyask region ecosystem because it corresponds with the region ecosystem level (Section 1.1), which is the appropriate level to evaluate regional ecosystem health (Miller and Ehnes 2000). In practical terms, Study Zone 5 was an area large enough to maintain a relatively stable habitat composition in response to the natural fire regime. In other words, one large fire was unlikely to substantially change the proportion of any habitat type, thereby providing alternative habitat for species to move to when large fires occur. Appendix 2A provides details on the size and boundaries of the Keeyask region were determined.

Study Zone 6 was the area needed to characterize the fire regime. This zone was also used as the Regional Study Area for species with very large population home ranges.

Table 1-3 indicates which of the study zones were used as the Local and Regional Study Areas for most of the VECs and supporting topics.

**Table 1-2: Primary Determinants of Terrestrial Study Zone Size, Study Zone Size and Study Zone Size Land Area**

| Study Zone | Primary Determinant for Size | Size (hectares) [1] | |
|---|---|---|---|
| | | Total | Land |
| 1 | Project Footprint and areas unlikely to be used | 13,010 | 7,591 |
| 2 | Potential local zone of influence on habitat | 18,689 | 13,043 |
| 3 | Potential local zone of influence on landscape elements | 41,996 | 33,339 |
| 4 | Area large enough to capture a repeating sequence of landscape types and to support populations of species with moderately large home ranges | 221,509 | 167,255 |
| 5 | Area large enough to support the key boreal ecological processes and the population home ranges for most of the resident wildlife species | 1,420,000 | 1,240,000 |
| 6 | Area needed to characterize the fire regime | 3,050,000 | 2,700,000 |

[1] Total areas include existing Nelson River area that will be flooded. Each of the study zones includes the smaller zones nested within it.

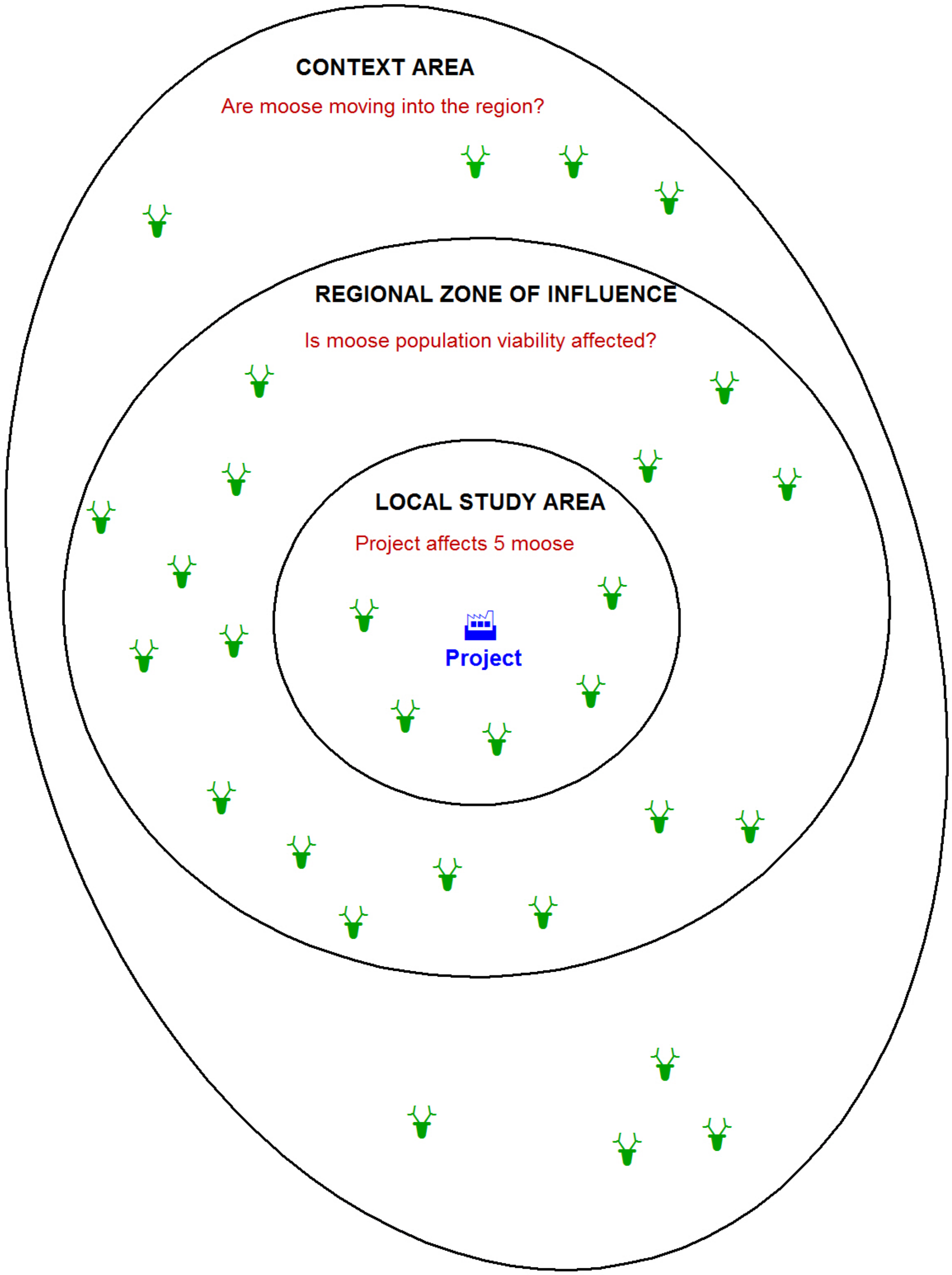



**Figure 1-5: Nested Study Area Methodology for a Hypothetical Project**

**Table 1-3: Study Zones from Map 1-1 That are Used as the Local and Regional Study Areas for each of the Valued Environmental Components (bolded) and Supporting Topics, Organized by EIS Section**

| EIS Section and Topic | Study Zone[1] in Map 1-1 | | | | |
|---|---|---|---|---|---|
| | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| **Section 2 – Terrestrial Ecosystems and Habitat** | | | | | |
| Terrestrial habitat | LSA | | | RSA | |
| Fire regime | | LSA | | | RSA |
| **Ecosystem diversity** | LSA | | | RSA | |
| **Intactness** | | LSA | | RSA | |
| Soil quantity and quality | LSA | | | RSA | |
| **Wetland function** | LSA | | | RSA | |
| **Section 2 – Terrestrial Plants** | | | | | |
| **Priority plants** | LSA | | | RSA | |
| Invasive plants | LSA | | | RSA | |
| **Section 3 – Terrestrial Invertebrates** | | | | | |
| Invertebrate community | | LSA | RSA | | |
| **Section 4 – Amphibians and Reptiles** | | | | | |
| Priority amphibians | | LSA | RSA | | |
| **Section 5 – Birds** | | | | | |
| **Canada goose** | | LSA | | RSA | |
| **Mallard** | | LSA | RSA | | |
| **Bald eagle** | | LSA | | RSA | |
| **Olive-sided flycatcher** | | LSA | RSA | | |
| **Common nighthawk** | | LSA | RSA | | |
| **Rusty blackbird** | | LSA | RSA | | |
| Other Priority birds[2] | | | | | |

**Table 1-3: Study Zones from Map 1-1 That are Used as the Local and Regional Study Areas for each of the Valued Environmental Components (bolded) and Supporting Topics, Organized by EIS Section**

| EIS Section and Topic | Study Zone[1] in Map 1-1 | | | | |
|---|---|---|---|---|---|
| | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
| **Section 6 – Mammals** | | | | | |
| **Caribou** | | | LSA | | RSA |
| **Moose** | | LSA | | RSA | |
| **Beaver** | | LSA | RSA | | |
| Other priority mammals[2] | | | | | |
| **Section 7 – Mercury** | | | | | |
| Mercury in wildlife[2] | | | LSA | RSA | |

Notes: 1 Codes in the table indicate which of the study zones shown in Map 1-1 were used as the Local Study Area (LSA) and Regional Study Area (RSA) for each VEC and supporting topic. 2 Study areas vary too greatly by species to generalize in this table.

### 1.3.6 Temporal Scope

Temporal scope was determined separately for each key topic based on potential pathways of Project effects, including where these interactions could overlap with other past, current and reasonably foreseeable future projects. An important consideration for temporal scoping was the time required for key topic indicators to return to pre-disturbance conditions. This was closely related to life cycle length for animal key topics and the length of the natural post-disturbance recovery cycle for habitat and ecosystem key topics. Where potential Project effects differed by season (*e.g.*, nesting or calving periods) or by Project phase (*e.g.*, construction, operation), these were separated in the assessment.

In general, the temporal scope for each key topic was as follows:

- For historical conditions, as far into the past as needed to describe historical conditions and trends, subject to the availability of relevant historical information;
- For current conditions, the 2001 to 2011 period, which is when the majority of the terrestrial EIS studies were conducted; and,
- For future with and without the Project conditions, as far into the future as needed to capture potential Project effects, but no less than 100 years after Project operation commences since this is the assumed life of the Project.

For key topic indicators where reasonable estimates could be developed, potential Project effects during the operation stage were examined using the following six prediction periods: Year 1, Years 2 to 5, Years 6 to 15, Years 16 to 30, Years 31 to 100. The length of the prediction periods increased with length of time from the start of Project operation since most Project-related changes are expected to be decline in magnitude with time. Year 30 roughly coincided with the duration since Kettle reservoir flooding when most terrestrial field studies were conducted at Stephens Lake (*i.e.*, the Kettle generating station reservoir).

# 1.4 ASSESSMENT METHODS

## 1.4.1 Overview

Potential Project effects on each key topic were assessed by comparing the status of indicators for the key topic with and without the Project in place. Predictions for future levels of indicators considered current trends in the indicators, future changes in non-Project drivers and the combined effects of the Project with past, current and reasonably foreseeable future projects.

Potential Project effects on the key topics were generally addressed under the broad categories of habitat change, disturbance and access effects. Habitat change includes **habitat loss** and **habitat alteration**. Improved access would bring more equipment, materials and people into the area. Among other things, this could lead to increased resource harvesting, invasive plant spread and vehicle collisions with animals. Roads, access trails, cutlines and dykes could improve access for some animals thereby increasing mortality for other species. For example, some predators use linear features to improve hunting success. Spreading invasive plants into the area could crowd out native species in localized areas. Although unlikely, improved access could also facilitate the transmission of animal and plant diseases into an area. A potential access-related effect that could affect every component of the terrestrial ecosystem is a large human-caused fire.

## 1.4.2 Use of Models

Models were essential for improving the understanding of the local terrestrial ecosystems and for predicting potential Project effects. Basic model types used in the terrestrial assessment were:

- Simple conceptual models (*e.g.*, land animals will be affected because flooding reduces available habitat);
- Complex conceptual models based on literature reviews and local information (*e.g.*, network linkage diagrams that show the web of indirect Project effects);
- Expert information qualitative numerical models based on changes in habitat area, literature reviews and observed changes in the environment following similar developments in northern Manitoba and in other northern environments (*e.g.*, classifying habitat into primary and secondary habitat for beaver and then calculating the amount of beaver habitat affected by the Project);
- Simple empirical models based on observed changes with no explicit linkage to underlying processes (*e.g.*, data from existing reservoirs and regulated areas indicates that the zone of edge and elevated groundwater effects on terrestrial habitat is generally less than 50 m wide); and/or,

- Complex multivariate quantitative models based on local data, observed changes in the environment following similar developments in comparable northern environments and literature reviews (*e.g.*, multivariate moose-habitat-quality model that relates moose numbers to changes in habitat attributes and other factors at multiple spatial levels).

The complexity of the models used for the key topics varied depending on the:

- Complexity of the relevant ecosystem linkages between the Project and the key topic;
- Relevant spatial and temporal scales; and
- Ability to collect suitable data with a level of effort that is reasonable given anticipated Project effects.

### 1.4.3 Effects Benchmarks

Currently there are no regulatory or generally accepted scientific **threshold**s or **benchmark**s for any of the terrestrial environment VECs or supporting topics (a possible exception the **hazard quotient** (see Wildlife and Mercury Section 8.2) used for mercury in wildlife). Regulatory thresholds or benchmarks may be developed in the future for plants and animals that are listed as endangered or threatened by the federal *Species At Risk Act*. These could be developed from the action plan component of a species recovery plan. At the time of EIS writing, action plans have not been released for any of the listed species that could occur in the Keeyask area.

Given the lack of regulatory thresholds and generally accepted scientific standards, the thresholds or benchmarks used to assess Project effects varied depending on the key topic and included one or more of the following:

- Principles or recommendations from federal or Provincial policies and guidelines;
- Quantitative values or qualitative conditions proposed in the scientific literature;
- Hazard quotient;
- Conditions in areas relatively unaffected by human development;
- The range of natural variability;
- Comparison to known trends;
- Comparison to conditions that existed in the past (*i.e.*, has the key topic already experienced major stress ordeclines from events that occurred in the past?);
- Relative degree of change from current conditions; and/or
- Relative degree of change from relatively natural conditions.

### 1.4.4 Evaluation of Residual Effects

Using the selected threshold or benchmark, potential Project effects on the key topic were assessed. Potential mitigation measures that could avoid or reduce potential adverse Project effects were evaluated to determine which would be incorporated into the Project. The anticipated **residual effect**s of the Project, in combination with past and current existing developments and activities, were then assessed.

Anticipated residual Project effects were described for each of the key topics in terms of nature, geographic extent, magnitude, duration, frequency and reversibility. Definitions for each of these criteria are provided in Table 1-4. As described in the following section, the likelihood that a significant effect would occur and prediction uncertainty were also evaluated for each key topic. Current and future trends in key topic indicators and contextual factors were considered in the residual effects assessment. Future trends were also considered in the cumulative effects assessment of Project effects with the anticipated effects of future reasonably foreseeable projects. The sensitivity of Project effects predictions to future climate change was also examined.

**Table 1-4: Criteria Used to Assess Residual Project Effects**

| Factor | Level | Definition |
|---|---|---|
| **Step 1 -** Each VEC is initially evaluated using the following criteria**:** | | |
| **Direction or Nature** | Positive | • Beneficial or desirable on the environment |
| | Neutral or negligible | • No measurable change in the environment |
| | Adverse | • An undesirable effect on the environment |
| **Magnitude** | Small | • No definable, detectable or measurable effect<br>• Below established thresholds of acceptable change<br>• Within range of natural variability<br>• Minimum impairment of ecosystem component's function |
| | Moderate | • Effects that could be measured and could be determined within a normal range of variation of a well designed monitoring program<br>• Generally below or only marginally beyond guidelines or other established thresholds of acceptable change<br>• Marginally beyond the range of natural variability<br>• Marginally beyond minimal impairment of ecosystem component's function |
| | Large | • Effects that are easily observable, measured and described<br>• Well beyond guidelines or other established thresholds of acceptable change<br>• Well beyond the range of natural variability<br>• Well beyond minimal impairment of ecosystem component's functions |

**Table 1-4: Criteria Used to Assess Residual Project Effects**

| Factor | Level | Definition |
|---|---|---|
| **Geographic Extent** | Small | • Effects that are confined to a small portion of one or more areas where direct and indirect effects can occur (e.g., rights-of-way or component sites) |
| | Medium | • Effects that extend into local surrounding areas where direct and indirect effects can occur |
| | Large | • Effects that extend into the wider regional area where indirect and cumulative effects may occur |
| **Duration** | Short term | • Effects that generally occur within the construction period or initial period of impoundment<br>• Occur within only one generation or recovery cycle of the VEC |
| | Medium term | • Effects extend through a transition period during the operations phase<br>• Occur within one or two generations or recovery cycles for the VEC |
| | Long-term | • Effects extend for a long-term during the operations phase or are permanent<br>• Extend for two or more generations or recovery cycles for a VEC |
| **Step 2** - VECs that meet the following criteria are examined further in step 2**:**<br>• Small in geographic extent, large in magnitude and long term in duration;<br>• Medium in geographic extent and either large in magnitude (regardless of duration) or moderate in magnitude and long-term in duration; or<br>• Large in geographic extent and either moderate or large in magnitude (regardless of duration). | | |
| **Frequency** | Infrequent | • Effects that occur only once or seldom during life of the Project |
| | Sporadic/ Intermittent | • Effects that occur only occasionally and without predictable pattern during life of the Project |
| | Regular/ Continuous | • Effects that occur continuously or at regular periodic intervals during life of Project |
| **Reversibility** | Reversible | • Effect that is reversible during the life of the Project |
| | Irreversible | • A long-term effect that is permanent |
| **Ecological context** | Low | • The VEC is not rare or unique, resilient to imposed change, or of minor ecosystem importance |
| | Moderate | • The VEC has some capacity to adapt to imposed change<br>• The VEC is moderately/seasonally fragile<br>• The VEC is somewhat important to ecosystem functions or relationship |
| | High | • The VEC is a protected/designated species |

**Table 1-4: Criteria Used to Assess Residual Project Effects**

| Factor | Level | Definition |
|---|---|---|
| | | • The VEC is fragile with low resilience to imposed change or a very fragile ecosystem |

### 1.4.5 Addressing Uncertainty

Ecosystem complexity and future changes in factors unrelated to the Project (*e.g.*, climate) were among the factors that introduced uncertainty into the Project effects assessment and predictions. Uncertainties were addressed for each key topic using some of the following methods.

Improved understanding of local ecosystem relationships, the key controlling processes and Project linkages with the key topics was achieved through field studies, data analysis and relationships modeling.

Uncertainty with respect to ecosystem responses to novel stresses was addressed by studying outcomes at other locations that were exposed to similar Project impacts. For example, several components of the terrestrial environment assessment use information from Stephens Lake (*i.e.*, the Kettle generating station reservoir) to provide an indication of the likely response of the key topic to flooding and water regulation. **Scenario analysis** was also used to test the sensitivity of predictions to assumptions including the expected pathways of Project effects.

Potential data quality issues were addressed through the careful design of field studies (*e.g.*, provision for replicate samples, sampling over multiple years to capture inter-annual variability) as well as other standard scientific approaches.

Uncertainties related to the assumed effectiveness of mitigation measures were addressed in different ways depending on the potential scope of Project effect and the degree of uncertainty. One approach was to conduct studies in local areas that had been treated with similar mitigation measures. Another approach was to study local natural ecosystems to characterize natural ecosystem relationships, which assumed that approximating nature would have the highest likelihood of producing a successful outcome (*e.g.*, should not regenerate temporarily cleared areas to vegetation types that do not naturally occur in the area). This approach echoed the KCNs view of going with rather than against nature (Manitoba Hydro 2009a). Scenario analysis was used for predictions with relatively high uncertainty.

Uncertainty could be reduced but never eliminated no matter how much the Keeyask terrestrial ecosystem was studied. The terrestrial assessment generally addressed this component of uncertainty by identifying adaptive management options that were included as a follow-up component of post-Project monitoring. Adaptive management options were credible ways to deal with outcomes that are more adverse than predicted or were not anticipated, should they arise.

### 1.4.6 Sources of Information

The sources of information for the terrestrial assessment were:

- Aboriginal traditional knowledge (ATK);
- Existing published information; and,
- EIS studies designed and conducted to address identified data gaps.

Details regarding information sources are provided in the relevant sections of this TE SV. The remainder of this section provides an overview of the information available for the terrestrial assessment.

ATK played an important role in both technical data collection and describing the existing environment. The KCNs Partners provided ATK through their Environmental Evaluation Reports and community-based studies; and individual KCN Members provided ATK and/or local knowledge that helped inform the design of technical studies (*e.g.*, the location and timing of certain wildlife surveys). The KCNs were involved in reviewing annual fieldwork plans through the Environmental Studies Working Groups and individual KCN Members participated in field data collection. Over a two year period, the KCNs were active participants in the Keeyask Mammals Working Group (primarily focused on Project effects and mitigation for caribou and moose). In addition, ATK of historic and current conditions as gathered through community-based research and workshops was incorporated into the detailed VEC and supporting topic descriptions that are presented below and in the TE SV (*e.g.*, FLCN Traditional Knowledge Report 2010 Draft; YFFN Evaluation Report (*Kipekiskwaywinan*)). FLCN's TK Report as well as the KCNs Environmental Evaluation Reports also document how the terrestrial ecosystem was impacted by past hydroelectric development.

A limited amount of existing published information was available for the Keeyask region prior to commencement of EIS studies. Most of this information originated from geotechnical investigations conducted by Manitoba Hydro and studies regarding the effects of hydroelectric development on the Nelson River aquatic environment. Although some vegetation and soil mapping was available, its usefulness for EIS purposes was limited because the mapping scale was too small, the information was outdated and/or only a small portion of the study areas was captured. Existing plant and habitat studies were not available except with regard to peatland responses to past climate change. Existing mammal studies were not available except with regard to limited aerial survey data and recreational harvest records for moose, furbearer trapping records from the Split Lake and Fox Lake Resource Management Areas, and information from the Split Lake Post-Project Environmental Review (Split Lake Cree 1996a). For birds, joint venture studies involving Manitoba, Nunavut, Minnesota, Missouri and the US Fish and Wildlife Service have provided information on waterfowl, which has been used to support and in some instances, augment data gathered during Project-related avian field studies. Ongoing studies of northern populations of amphibians by Dr. Ben Cash (Maryville College, Tennessee) have also provided useful information on the distribution and abundance of wood frogs in northern parts of their range.

Existing published information from ecologically comparable areas or areas that had experienced similar project impacts (*i.e.*, **proxy areas**) contributed to developing Project effects predictions. Studies conducted at existing hydroelectric developments in northern Manitoba and northern Quebec, supplemented by field trips to some of these locations, were particularly helpful. Because Nelson River shoreline ecosystems have already been disrupted by human activities, field studies were also conducted in relatively pristine areas (*i.e.*, **benchmark areas**) that served to improve our understanding of natural ecosystems. For example, off-system lakes and portions of the Fox River were used to characterize natural shoreline wetlands, including habitat associations of shoreline wetland plant species.

As described in the relevant sections of the TE SV, the majority of the information used for the assessment came from a wide range of Project studies, which were initiated in 2001 and continued to 2011. Most field data were collected from 2001 to 2005. Additional data were collected from 2006 to 2011 to address information needs and data gaps identified through the course of the baseline studies, preliminary effects assessment analysis, evaluation of potential mitigation and KCNs review. The majority of the studies completed for the terrestrial environment assessment were conducted within Study Zone 5 (Map 1.7-1). Stephens Lake (*i.e.*, the Kettle generating station reservoir) was the proxy area most commonly included in field studies.

# 1.5 SUMMARY OF PROJECT COMPONENTS RELEVANT TO THE TERRESTRIAL ENVIRONMENT

The Project is expected to have a wide range of impacts. Construction and operation of roads and infrastructure, reservoir flooding and operation and other associated works and activities would:

- remove vegetation, soil and **parent material**;
- alter vegetation, soil and parent material;
- convert terrestrial areas to water and shoreline wetlands;
- create activity, noise, emissions and dust;
- move equipment, material and people into the area;
- increase access to the area;
- alter groundwater levels and hydrology; and
- alter water and ice regimes on the Nelson River.

The remainder of this section provides an overview description of which Project components were considered for the terrestrial environment assessment. Separate descriptions are provided for the construction and operation stages due to the substantial differences in the nature and degree of impacts. The areas reported in this section do not include additional mitigation measures outlined to reduce Project effects in Sections 2 to 7. A detailed description of all Project impacts is provided in the Project Description Supporting Volume (PD SV) and the Water and Ice Regimes section of the Physical Environment Supporting Volume (PE SV).

### 1.5.1 Construction-Related Impacts

During construction, the Project Footprint will include borrow areas, excavated material placement areas (EMPAs), camp and work areas, river works, reservoir clearing, roads and infrastructure. Some of the individual footprints components overlap each other. For example, roads pass through borrow areas during construction and reservoir flooding covers portions of borrow areas during operation. In locations where individual footprints overlap, the footprint type used for area calculations and maps was the type that would have the more permanent terrestrial habitat effect and/or the highest potential terrestrial habitat effect.

The sizes of the areas potentially affected by the Project that are reported in this section differ from those reported in the Project Description Supporting Volume for two reasons. First, the areas in this section only include terrestrial areas whereas the Project description also includes the deeper portions of lakes and the Nelson River, which are classified as non-terrestrial areas. Second, taking a precautionary approach, most of the areas unlikely to be used during construction were included as potentially affected areas. The only exceptions were the E-1 borrow area and access road since it is quite unlikely that this borrow area will be used given its small size and distance from the Project Footprint. The sizes of the areas potentially affected by the Project that are reported in this section will also differ from some of those reported in the TE SV Section 2 because these areas include existing human infrastructure while the Section 2 area do not consider human infrastructure to be terrestrial habitat.

Map 1-2 shows the Project Footprint during construction by non-overlapping footprint type. Table 1-5 provides a breakdown of the Project Footprint by footprint type and Project stage.

**Table 1-5: Sizes of Land Areas Within the Project Footprint and Areas Unlikely to be Used by Project Stage and Footprint Component**

| Footprint Component[1,2] | Project Stage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Area (ha) | | | | | Percent of Total Area | | |
| | Construction | | | Operation Year 0 | Operation Year 30 | Construction | Operation Year 0 | Operation Year 30 |
| | Likely | Unlikely | Total | | | | | |
| Camp and Work Areas | 153 | - | 153 | 153 | 153 | 2.0 | 2.0 | 1.9 |
| Excavated Material Placement Areas | 139 | 128 | 267 | 220 | 214 | 3.5 | 2.9 | 2.7 |
| River Management | 16 | - | 16 | 1 | 1 | 0.2 | 0.0 | 0.0 |
| Borrow Areas | 1,289 | 311 | 1,600 | 1,377 | 1,355 | 21.1 | 18.1 | 17.0 |
| Infrastructure | 274 | - | 274 | 197 | 196 | 3.6 | 2.6 | 2.5 |
| Road | 615 | 10 | 625 | 644 | 641 | 8.2 | 8.5 | 8.1 |
| Road Corridor | 80 | 10 | 89 | 89 | 87 | 2.0 | 1.2 | 1.1 |

**Table 1-5: Sizes of Land Areas Within the Project Footprint and Areas Unlikely to be Used by Project Stage and Footprint Component**

| Footprint Component[1,2] | Project Stage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Area (ha) | | | | | Percent of Total Area | | |
| | Construction | | | Operation Year 0 | Operation Year 30 | Construction | Operation Year 0 | Operation Year 30 |
| | Likely | Unlikely | **Total** | | | | | |
| Construction Flooding | 277 | - | 277 | - | - | 3.6 | - | - |
| Reservoir Clearing | 3,431 | - | 3,431 | - | - | 44.4 | - | - |
| Reservoir Flooding[3] | - | - | - | 4,209 | 4,209 | - | 55.5 | 52.9 |
| Reservoir Expansion | - | - | - | - | 672 | - | - | 8.4 |
| Downstream Altered Flows[4] | 14 | - | 14 | 14 | 14 | 0.2 | 0.2 | 0.2 |
| Potential Disturbance Area | 523 | 185 | 708 | 633 | 371 | 9.3 | 8.3 | 4.7 |
| Mitigation Area | 84 | 53 | 138 | 54 | 51 | 1.8 | 0.7 | 0.6 |
| All | 6,895 | 696 | 7,591 | 7,591 | 7,964 | 100.0 | 100.0 | 100.0 |

[1] Some individual footprints overlap. Footprint type identifies the type that has the most permanent effect and/or the highest indirect effects.
[2] Some footprints have not reached Stage 5 design so an approximate footprint is used in the interim (*e.g.*, eastern portion of the south access road). Mitigation that reduces Project Footprint area is not included in the reported areas.
[3] The time period when the reservoir is filling is considered under operation since this is expected to occur over approximately one or two months starting in November. The flooded area includes the shore zone but not the portion of the existing Nelson River classified as aquatic environment for the terrestrial assessment.
[4] Only includes the dewatered river area and associated shore zone area, and terrestrial portions of downstream coffer dam diversion since the rest of the altered flow area is aquatic environment in the existing environment and will not develop into terrestrial habitat during operation. An overestimate for the size of the dewatered area is used.

Borrow areas and reservoir clearing would be the largest potential footprint components during construction (Table 1-5). The approximately 1,600 hectares (ha) of borrow areas with moderate to high likelihood of being used during construction are located near the proposed roads and dykes (Table 1-5). These borrow areas consist of two granular deposits, four rock quarries and eleven impervious deposits. All of the borrow areas except for portions of G-1 and G-3 would be decommissioned at the end of construction. Borrow material may also be extracted from the north and south access road rights-of-way.

Because the precise measurements of material volumes and quality cannot be determined until construction, larger areas than are expected to be needed are identified in the Project Description. The terrestrial assessment considers the entire borrow area footprint.

Although highly unlikely due to its small size and distance from the Nelson River, one additional borrow area located on the Ellis Esker could be utilized (Map 1-2). This borrow area and associated access road could be as large as 120 ha.

The 714 ha road and road corridor components of the Project Footprint includes the north access road, south access road, Butnau Road upgrades as well as the temporary access roads to borrow areas, EMPAs and infrastructure. The permanent access roads include a 100m right-of-way to provide for ditches, grading and safe driving visibility. Since the north access road would be built prior to the Project, the associated 231 ha footprint only includes road operation during construction, the extent of potential borrow material extraction from G-2 and small footprints whose locations cannot be determined prior to construction. Actual clearing of the 325 ha south access road footprint right-of-way would generally be 100 m (PD SV Section 3.3.3.3). The uncleared portion of this footprint may include access roads and trails to other Project Footprint components as well as other small footprints whose locations cannot be determined prior to construction. All road footprints except for the north and south access roads and the Butnau Road upgrades would be decommissioned at the end of construction.

The locations of access roads to some borrow areas and EMPAs are uncertain at this time. To account for the uncertainty and to provide flexibility in locating these roads, road corridors centered on the tentative road locations were defined. The width of the road corridors is generally 100 m. A notable exception is the road corridor to E-1, which is 300 m wide.

Access to the north and south roads during construction would be controlled where these roads meet existing public roads (see Access Management Plan (Manitoba Hydro 2012c)). A component of the Access Management Plan will be to restrict their use to construction activities and designated resource harvesters only.

The Project Footprint does not include PR 280 even though the Project will substantially increase traffic on this highway during construction. Project-related PR 280 use is expected to have negligible effects on habitat composition since upgrades are not part of the Project and this highway has been in use since 1971, which includes the construction periods of two generating stations (Socio-Economic Supporting Volume (SE SV Section 2). The terrestrial assessment still evaluates effects related to PR 280 use, such as vehicle collisions, wildlife disturbance and road dust settling on vegetation.

Camp and work areas include the construction camp, wastewater treatment plant, potable water treatment plant, diesel generator, utility corridors for electricity, sewer and water, helipad, Manitoba Hydro and contractor work areas and the general disturbance area. Portions of the camp and work area footprint were constructed as part of the Keeyask Infrastructure Project (Keeyask Limited Partnership 2009). The defined portion of the camp and work areas footprint is 153 ha. A 67 ha potential disturbance area surrounding the camp and work area footprint provides flexibility for work areas and camp features whose exact locations cannot be determined prior to construction. The camp and work areas would be decommissioned at the end of construction.

River works are supporting infrastructure features needed to control Nelson River flows and ice while constructing the dam, generating station and associated infrastructure. Coffer dams, channel excavation and ice booms are examples of river works. Approximately 16 ha of the river management footprint are outside of the existing Nelson River shoreline. Nearly all of the river management footprint will be submerged by reservoir flooding at the end of construction.

Excavated material placement areas (EMPAs) cover approximately 267 ha of land area. Materials placed in these areas originate from de-commissioned cofferdams and excavations for the principal structures, dykes, channel excavations and reservoir improvement areas. Reservoir improvement areas are potential upstream aquatic mitigation areas and gravel and/or boulder sources that could be used for those enhancements. Excavated materials will include all types of organic, mineral and rock material. All of the excavated material placement areas are located along the both sides of the dykes and the reservoir side of the dam. The EMPA located inside of the dykes and dam will be completely submerged after reservoir flooding with the exception that some may be developed into shoreline wetlands.

Infrastructure consists of the powerhouse complex, spillway, intake and tailrace channels, dams, transition structures, dykes and transmission tower spur. All of these features are permanent. Except for the dykes, all of the infrastructure would be located on or near Gull Rapids (see inset in Map 1-2).

Reservoir clearing, which will occur during the final two winters of construction, would remove woody vegetation taller than 1.3 m and downed woody debris longer than 1.3 m over an area of approximately 3,431 ha (see Reservoir Clearing Plan in Chapter 4 Appendix).

There may be small areas outside of the Project Footprint where clearing or physical disturbance occurs but their locations cannot be defined until after construction commences (*i.e.*, the undefined footprints). Undefined footprints are primarily accidental clearing, accidental disturbance and access trails to the defined Project features.

Coffer dams built to facilitate infrastructure construction would raise open water levels. During Stage I diversion, under 1:20 year flood conditions, water levels would be approximately 0.9 m higher immediately upstream of Gull Rapids, approximately 0.8 m continuing upstream through the Gull Lake reach, and then declining to nil upstream of Birthday Rapids (PE SV Surface Water and Ice Regimes Section). Under 1:20 year high winter flow conditions, water levels upstream of Gull Rapids are expected to be approximately 0.5 m to 1.5 m higher than what would be expected to occur under existing conditions. Under 1:20 year low winter flow conditions, the expected upstream water levels on Gull Lake are expected to be higher by approximately 0.4 m. Upstream of Gull Lake, winter water levels are not expected to be significantly higher than those which would be experienced in the existing environment for similar flow conditions. Stage II diversion would raise water levels immediately upstream of the Spillway structure an additional 3.5 m. the final stage of reservoir filling that initiates Project operation is addressed in the operation phase since it occurs quickly over a two month period starting in November.

### 1.5.2 Operation-Related Impacts

All of the initial flooding will be encompassed within the Project Footprint during construction (Map 1-2). The reservoir would expand over time due to peatland disintegration and mineral bank erosion (PE SV Section 6). Camp, work, borrow and other temporarily cleared areas would undergo some degree of rehabilitation somewhat decreasing the sizes of some footprints.

The 4,209 ha of initial flooding is the largest footprint during operation (Table 1-5). Initial flooding would cover the entire reservoir clearing and nearly all river works. Approximately 220 ha of EMPA, 1,377 ha of borrow area and 197 ha of infrastructure would remain above water after initial flooding.

Upstream of the dam, the water regime would change considerably (PE SV Section 4). The Project's open water upstream hydraulic zone of influence extends from the dam to slightly downstream of Clark Lake (Map 1-2). There is a low probability (one in 20 years) that winter water levels on Split Lake may be elevated by 0.2 m in a low water year (PE SV Section 4.4.2.4).

Most of the initial flooding occurs in the reach extending from the inlet to Gull Lake to the dam. This reach would be converted from a riverine to a lake environment. The upstream reach between Gull Lake and Birthday Rapids would remain riverine but with slower current and considerably less ice scouring along the new shoreline. Water levels would fluctuate over a one meter range in the **lacustrine** reach when the Project operates in a peaking mode; the range would decline further upstream due to the land gradient. Water levels would be maintained at or near 159 metres above sea-level (m ASL) when the Project operates in a base loaded mode.

Following initial flooding, the reservoir would expand over time due to peatland disintegration and mineral bank erosion. At least an additional 672 ha of land is expected to convert to aquatic area during the first 30 years of operation (PE SV Section 6).

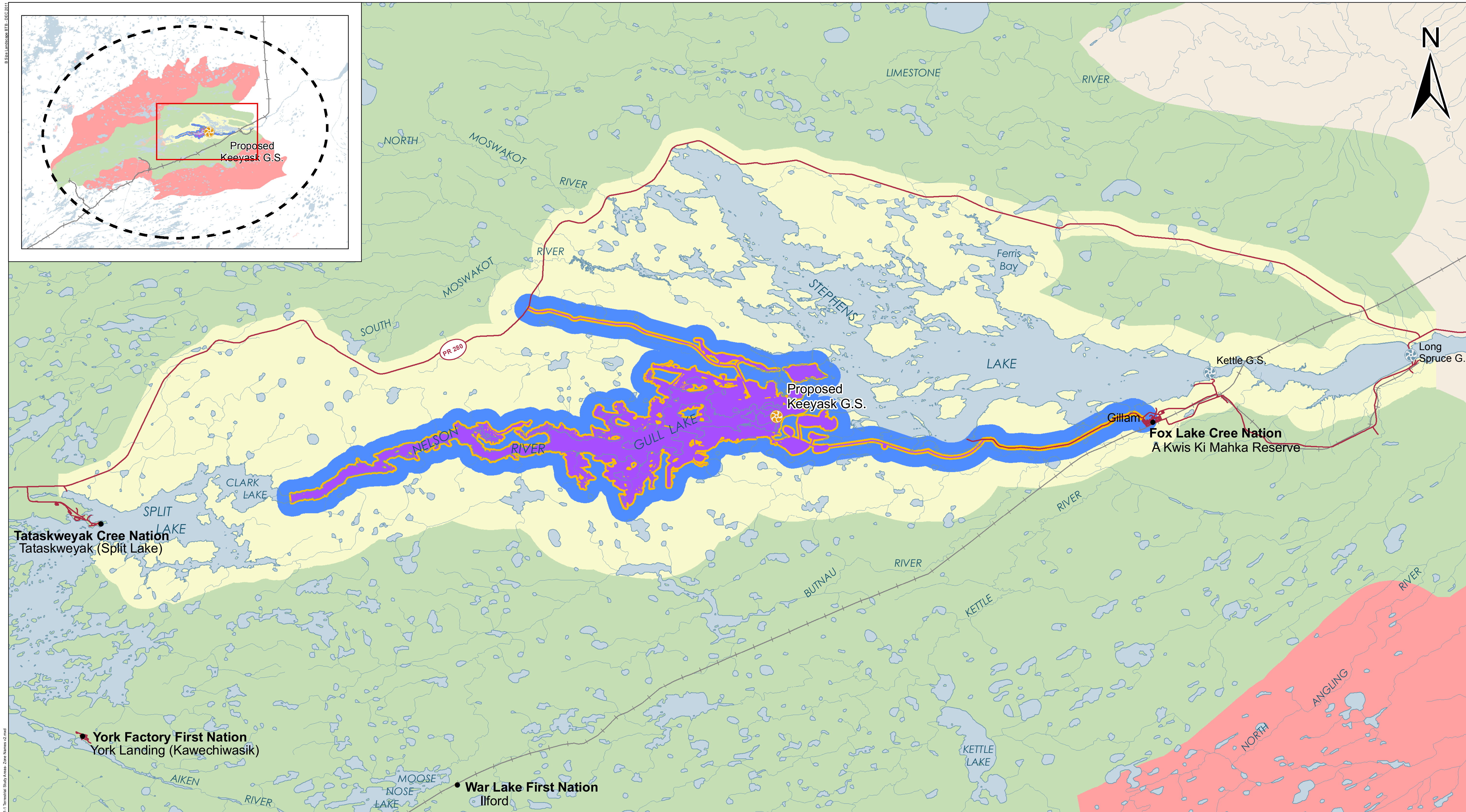
The post-Project ice regime would also change (PE SV Section 4). The nature of the changes would differ in the three river reaches. In the lacustrine reach that includes the existing Gull Lake, it is predicted that variability in ice thickness will be reduced from approximately nine meters to approximately one meter. It is likely that reservoir areas shallower than one meter will freeze to the bottom. In the reach between Portage Creek and Two Goose Creek, the ice regime should be relatively unchanged except that spring breakup is expected to occur more rapidly. Ice formation and breakup processes in the reach between Two Goose Creek and the Outlet of Clark Lake should be similar to what is currently observed with the exception that higher levels in the reservoir will allow the ice front to form earlier in the winter and to progress further upstream.

In combination, water and ice regime changes would generally lead to slower current along the new shoreline downstream of Birthday Rapids, much higher effective wave energy in the lake reach, higher shoreline erosion downstream of Birthday Rapids and the virtual elimination of shoreline ice scouring in the lacustrine portion of the reservoir.

- Water levels on creeks that flow into the Nelson River upstream of Gull Rapids are typically affected by the Nelson River. Box Creek and other small creeks located on Gull Lake would be almost completely flooded. Project-related increases to the extent of backwater effects on the major upstream creeks would be approximately from:
- 550 m to 1,400 m for Nap Creek;
- 650 m to 950 m to Portage Creek;
- 325 m to 370 m for Two Goose Creek; and
- 4,800 m to 6,000 m to Rabbit (Broken Boat) Creek.

Downstream of the dam, water and ice regimes would also change considerably (PE SV Section 4.4.2.3). The downstream hydraulic zone of influence extends to approximately three km downstream of the generating station. Open water levels further downstream are controlled by how Kettle Generating Station regulates Stephens Lake. Immediately downstream of the dam, the Project would concentrate flows to the north side of the Nelson River on most days. This would dewater a large area below the spillway for the majority of the time. High velocity discharges would periodically pass through the spillway. Water levels on the south side of the river in the downstream hydraulic zone of influence will be below existing environment conditions except during extreme flood events. The Project is expected to eliminate downstream ice dams, which would reduce shoreline erosion and channel creation events. In combination, downstream water and ice regime changes would dewater the area below the spillway most of the time, eliminate ice dams and eliminate channel creation events. Downstream creeks would not be affected since none are within the downstream hydraulic zone of influence.

Some Project impacts on the terrestrial environment would decrease shortly after operation begins. The number of Project-related people and Project activity would decline dramatically. The north and south access roads will become public roads after construction.




KEEYASK
Hydropower Limited Partnership

DATA SOURCE:
Study areas - ECOSTEM Ltd.; Water - NTS; Roads and rail - Manitoba Conservation.

CREATED BY:
ECOSTEM Ltd.

| COORDINATE SYSTEM: | DATE CREATED: | REVISION DATE: |
|---|---|---|
| UTM NAD 1983 Z15N | 13-MAR-12 | 18-MAY-12 |

0 2.5 5 Kilometres
0 3 6 Miles

| VERSION NO: | QA/QC: |
|---|---|
| 1.0 | JWE/RDB/MWZ |

**Legend**

**Geographic Zones**

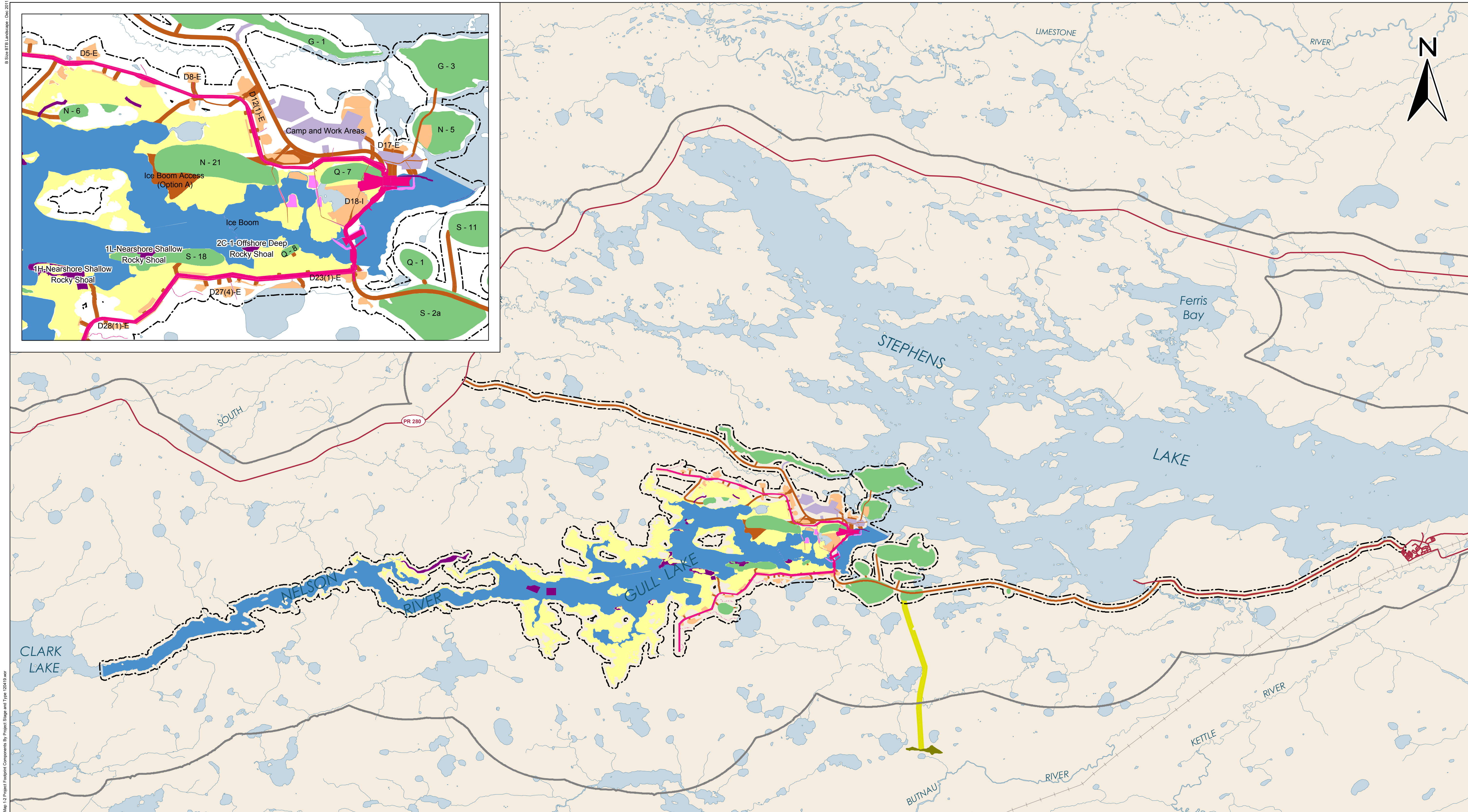
- Study Zone 1 (Project Footprint for Both Phases)
- Study Zone 2
- Study Zone 3
- Study Zone 4
- Study Zone 5
- Study Zone 6

**Project Areas**

- Keeyask Generation Project Area

Note: Each zone includes all of the smaller zones within its perimeter

# Geographic Zones Used for Terrestrial Study Areas




Hydropower Limited Partnership

**DATA SOURCE:**
Study areas - ECOSTEM Ltd.; Nelson River shoreline and footprints - Manitoba Hydro; Highways and rail - Manitoba Conservation; Water - NTS.

**CREATED BY:**
ECOSTEM Ltd.

| COORDINATE SYSTEM: | DATE CREATED: | REVISION DATE: |
|---|---|---|
| UTM NAD 1983 Z15N | 16-FEB-12 | 04-JUN-12 |
| 0 3 6 Kilometres / 0 1.5 3 Miles | **VERSION NO:** 1.0 | **QA/QC:** JWE/RDB/MWZ |

## Legend

**Project Footprint by Component**

- Borrow Area
- Camp and Work Area
- Disposal Area
- Infrastructure
- River Management
- Mitigation Area
- Road
- Reservoir Clearing Followed by Flooding
- Flooding or Altered Flows

**Project Footprint - Unlikely Additions**

- Borrow Area E - 1
- Road to E - 1

**Study Areas**

- Habitat Local Study Area
- Habitat Regional Study Area

# Project Footprint Components By Type

Map 1-2

# APPENDIX 1A
# Methodology Used to Select Valued Environmental Components and Supporting Topics

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# 1.6 APPENDIX 1A: METHODOLOGY USED TO SELECT VALUED ENVIRONMENTAL COMPONENTS AND SUPPORTING TOPICS

The development of a practical approach to identifying key topics and indicators that are relevant for predicting potential Project effects on terrestrial ecosystem health has been evolving as a result of work conducted on several projects for Manitoba Hydro and other parties (Miller and Ehnes 2000; Manitoba Hydro 2003; ECOSTEM 2004b; Ehnes 2011). In brief, the overall goal of this approach is to maintain long-term ecosystem health for present and future generations while conducting human activities and development. This approach is a practical synthesis of Canadian environmental assessment guidance literature with the land use sustainability framework developed by the Montreal Process and ratified in the Santiago Declaration (Anonymous 1995). Due to its focus on maintaining regional ecosystem health, the approach is applicable to regions that have not already been dramatically altered by human activities (*i.e.*, it is not applicable to urban or agricultural areas).

The practical approach to identifying key topics and indicators for the terrestrial assessment included the following sequence of steps, as illustrated in Figure 1-6.

1. Define ecosystem health in a way that lends itself to practical application in an effects assessment. That is, translate the overall goal of maintaining long-term ecosystem health into measurable criteria, indicators and benchmarks.
2. Develop a generic checklist of ecological issues of concern that would apply to any large project outside of the urban and agricultural zones. This was accomplished by relating the components of ecosystem health to EIS guidelines, federal EIA guidance documents and ecological principles.
3. Identify all potential project-specific ecosystem health issues of concern by selecting all of the generic issues of concern that have potential Project linkages.
4. Identify the key project-specific ecosystem health issues of concern. These key issues, along with any other topics of high social interest, become the key topics for the Keeyask environmental assessment. The two types of key topics were Valued Environmental Components (VECs) and supporting topics. The VECs provided an overview of key Project effects by directly or indirectly addressing the issues of highest concern. Supporting topics increased the reliability of the assessment by capturing the issues of moderately high concern and/or establishing how important influences on VECs would be affected by the Project. The VECs and supporting topics are collectively used to indicate how the Project is expected to affect terrestrial ecosystem health.
5. Identify generic indicators for each key topic.
6. Identify measurable indicators for each generic indicator.
7. Collect the local data needed to characterize the Project area and to improve understanding of local cause-effect relationships to the degree needed to predict Project effects with a reasonable level of uncertainty.

8. Develop Project effects prediction models based on field data, ATK, experience from other locations experiencing similar impacts and relevant literature.

9. Continue to modify the indicators and models as new information from field studies and other sources improves the understanding of Keeyask ecosystems.

10. Generate project effects predictions and maps.

Table 1-A-1 summarizes the outcome of Steps 1 to 5 for the biodiversity and ecosystem condition criteria for maintaining terrestrial ecosystem health. The following paragraphs explain the meaning of each column in the table and how the column responds to Steps 1 to 5.

Columns A and B address Step 1 by listing the four major components of ecosystem health (Column A) and detailing the elements of each ecosystem health component (Column B). The major ecosystem health components, or criteria, defined by the outcome of the Montreal Process (CCFM 1995) are maintenance of native biodiversity, ecosystem condition and productivity, soil and water quantity and quality and contributions to global ecological cycles. All four criteria need to be included when reporting on the status and trends in ecosystem condition and function. Each ecosystem health component is comprised of elements (Column B). For example, the biodiversity criterion includes maintenance of native ecosystem diversity, species diversity and genetic diversity.

Column C completes Step 2 by indicating why the element is a generic concern for project effects assessment or land use management. Some issues are of higher ecological and/or social concern than others, depending on the project and region. Column C also identifies the key drivers for the generic concerns. Anticipating changes in relevant drivers is often a reliable way of predicting Project effects on issues of concern.

Column D addresses to Steps 3 and 4 by identifying the potential Project linkages and the Project-specific concerns for each generic issue of concern. Column D also identifies the key drivers for the Project linkages.

Column E is the first stage of addressing Step 5. Column E identifies the ideal indicators, or potential key topics, for each Project-specific concern. Bold blue font identifies the most frequently identified items in Columns E and F.

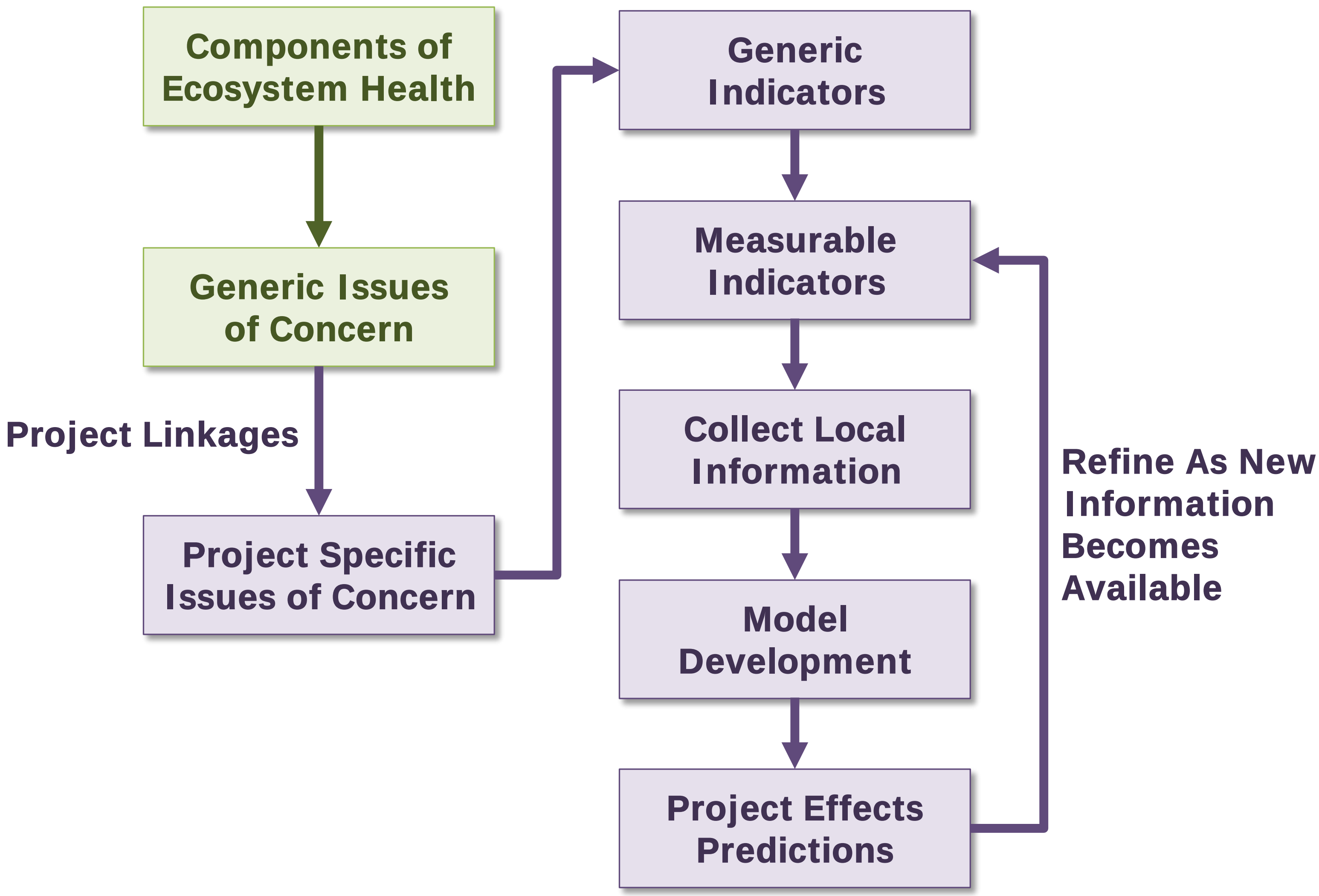


**Figure 1-6: Key topic selection steps.**

Column F identifies proxies for any potential key topics that would be difficult or impractical to measure. One such situations occurs when the scientific understanding of the associated processes may not be adequate to identify reliable measures that can be applied in the field (*e.g.*, soil microbial activity). Another of these situations occurs when the level of effort needed to collect adequate assessment data may be unreasonable given the potential Project effects. Potential Project effects on population size are an important example. Population size, which is a key concern for affected species, is either very difficult or extremely costly to estimate reliably for many species. Predicted changes in abundance indices, habitat composition, resource harvesting and other key influences on population size are collectively used as a proxy for potential project effects on population size. In other words, the Project is not expected to affect population size for a particular species if the Project is not expected to change habitat availability, resource harvesting and the other key influences on population size for that species.

Column G is the final stage of responding to Step 5 by listing all of the potential key topics that could serve as indicators for each Project-specific issue of concern. That is, column G collates all of the topics in Columns E and F.

Some potential key topics appear many times in column G. A potential key topic may appear many times because it performs particularly important roles in ecosystem function and/or is a good proxy for a number of components of ecosystem health. Habitat composition, which appears 22 times in the table, is an example of a potential key topic that satisfies both criteria.

The key topics used for the terrestrial environment assessment were selected from the potential key topics listed in column G of Table 1-A-1 by dropping potential key topics that met either one of the following two conditions:

- The potential key topic had a high degree of overlap with one or more of the other potential key topics. If both potential key topics were retained, the EIS would contain considerable repetition and not contribute substantial additional information. The potential key topic that was dropped was the one that had weaker Project linkages; or,
- Currently there is no reliable way to measure the potential topic with a reasonable level of effort given the status of scientific methods and/or understanding of ecosystem relationships.

Table 1-A-2 lists potential key topics that were dropped and the reasons for doing so. The remaining potential key topics were carried forward as the key topics. The key topics used for the terrestrial environment assessment are listed in the first column of Table 1-A-3.

Valued Environmental Components are often used to focus an environmental assessment, as recommended by the Canadian Environmental Assessment Agency (Hegmann *et al.* 1999). In short, the VECs were the key topics of highest ecological and/or social concern. The VECs were not adequate on their own to provide a reasonably reliable indication of potential Project effects on terrestrial ecosystem health. Consequently, the remaining key topics were included as supporting topics. In other words, the VECs and supporting topics collectively indicate how the Project is expected to affect terrestrial ecosystem health.

A potential key topic in Table 1-A-3 became a VEC if:

- There was potential for substantial Project effects (column A);
- It is feasible to compile suitable information with a reasonable level of effort (column B); **and**,
- **One** of the following was satisfied:
  - The high importance to local people identified in column D includes particularly high importance to KCNs; or,
  - The potential for substantial Project effects in column A refers to a species group with numerous potentially affected species that are not adequately represented by another key topic; or,
  - The regulatory requirement or guideline in column C considers the species as being at risk; or,
  - It was thought to be especially important to terrestrial ecosystem function in the Keeyask study areas (two check marks in column E); or,
  - It was thought to be a strong indicator for a number of species and/or ecosystem functions (i.e., an umbrella indicator) (two check marks in column F).

To illustrate application of the criteria, wolverine is listed as a species of Special Concern by COSEWIC but was not selected as a VEC because the potential for substantial Project effects is low (individuals have extremely large home ranges, their critical habitats would not be substantially affected by the Project and the Project is not expected to substantially increase mortality). The wolverine is addressed in the mammal section as a rare species under the other priority mammals supporting topic.

Priority species are the native species that are particularly important for ecological and/or social reasons, including importance to the KCNs (*e.g.*, for food and cultural importance; common nighthawk is a threatened species). Some priority bird and mammal species were of sufficient interest to become VECs (*e.g.*, caribou is important both scientifically and to the KCNs). The remaining priority bird and mammal species were grouped and discussed as the other priority bird and mammal supporting topics. All of the priority plant and priority amphibian species are grouped and discussed as the priority plants and priority amphibians supporting topics.

The number of species represented by the priority amphibians and other priority mammals supporting topics were low enough for each species from the groups to be individually considered in the EIS. In contrast, the number of species in the priority plant and priority bird species groups was too high to assess Project effects on each species individually. For the priority plants, a proxy approach analogous to using VECs to focus the overall assessment was used. Many of the regionally rare species were thought to be very infrequent in the Terrestrial Plants Regional Study Area because their habitats were rare to uncommon there. Species that were as common as their habitats were indirectly assessed through the ecosystem diversity effects assessment. In other words, if a species was regionally rare because it was confined to a habitat type that is regionally rare then an assessment of Project effects on the regionally rare habitat types was an indirect assessment of Project effects on plants that were as common as their habitat.

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| Biodiversity | Ecosystem | **Habitat Composition**: Changing the natural mixture of ecosystem/habitat types affects ecosystem functions and species within the ecosystem. | Flooding, clearing and other impacts would remove and indirectly alter upland and inland peatland habitat with potential effects on ecosystem diversity. | **Habitat composition**- upland and inland peatlands | Not needed | Habitat composition. |
| | | | Construction of instream works, flooding and changes to water levels and flows and sedimentation remove and indirectly alter shore zone habitat. Indirect changes to water thermal regime, light availability, substrate composition, and adjacent upland/inland peatland habitat with potential effects on ecosystem diversity. | **Habitat composition**- shore zone wetlands | Not needed | Habitat composition (especially wetlands). |
| | | **Priority Habitat Types**: Some habitat types are especially important for a variety of reasons. | Same as for **Habitat Composition**. | Rare habitat types (*i.e.*, a type of priority habitat type) such as broadleaf forest, jack pine forest, tall shrub uplands, high quality wetlands (*e.g.*, marsh); Rare enduring features | Not needed | Priority habitat types (rare); Wetlands; Rare enduring features |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| | | | | Habitat types that are critical for other species (*i.e.*, a type of priority habitat) such as caribou calving habitat, marsh wetlands for waterfowl. | Not needed | Priority habitat types (critical habitat for other species); Wetlands. |
| | | | | Habitat types that are sensitive to disturbance (*i.e.*, a type of priority habitat) such as dry jack pine forest. | Not needed | Priority habitat types (sensitive habitat); Wetlands. |
| | | | | Species rich or structurally diverse habitat types (*i.e.*, a type of priority habitat) such as broadleaf mixedwood forest. | Not needed | Priority habitat types (species rich and/or structurally diverse). |
| | | | | Habitats that make disproportionate contributions to ecosystem functions (*i.e.*, a type of priority habitat) such as wetlands. High quality wetlands are particularly important for wetland function. | Not needed | Priority habitat types (important for ecosystem function); High quality wetlands; Wetland function. |
| | | | | Habitat types that are especially important to people (*i.e.*, a type of priority habitat) | Not needed | Priority habitat types (highly valued by people) |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern/ Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | **Drivers:** | | | | |
| | | **Water Regime**: water levels, flows and other water regime parameters are the dominant influence on shore zone habitat. Water regime changes can remove and/or alter some habitat types with potential effects on ecosystem diversity and priority habitats | Project would: flood land; change the range and timing of water levels and flows; transport and deposition of materials such as organic sediment. | Water regime | Habitat attributes (*e.g.*, tree mortality along shoreline) and wetland habitat composition | Water regime; Wetland habitat composition; Habitat attributes |
| | | **Ice Regime**: Ice scouring and pressure can substantially alter shore zone habitat and adjacent inland areas. Ice regime changes can remove and/or alter some habitat types with potential effects on ecosystem diversity and priority habitats. | Project would change the nature, extent and distribution of ice scouring and other ice effects on the shore zone. Ice regime affects substrate composition and presence of plants in shore zone habitat. | Ice regime (*e.g.*, timing of ice formation and ice-off; thickness of ice, presence of ice cover) | Habitat attributes (*e.g.*, scoured vegetation along shoreline) and wetland habitat composition | Ice regime; Wetland habitat composition; Habitat attributes |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | **Intactness**: Human features affect the movement of energy, materials and organisms can alter habitats. | Project features such as the dam/generation station; culverts; and dykes affect quantity and quality of material transported in surface and overland flows (*e.g.* transport and deposition of sediments, dissolved oxygen levels, transport and deposition of organic detritus). | Intactness; Groundwater; Hydrology | Not needed | Intactness; Groundwater; Hydrology |
| | | **Fire Regime**: Large wildfires are a major influence on habitat composition in the boreal forest region. More fires and/or fires that are more severe and/or intense can dramatically change habitat composition. | Project features increase the risk that a large accidental fire will occur or that behaviour of a natural fire will be altered. | Fire regime | Habitat composition | Fire regime; Habitat composition |
| | | **Keystone Species**: Some animal species can remove or alter habitat, sometimes over large areas (*e.g.*, beavers flood land, alter stream flows and take down trees). | Reservoir creation provides beaver with new access to poplar. Project water regime reduces mortality from winter lodge inundation. | Keystone species (*i.e.*, a type of priority animal species); Beaver | Habitat composition | Priority animal species; Beaver; Habitat composition |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern/ Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| | | **Invasive Species**: Can affect the abundance and distribution of other species. | Increased access brings more equipment, materials and people into the area, which could transport invasive plants into the area or spread them further. | Invasive species. | Not needed | Invasive species |
| | | **Climate**: Over the long-term, strongly influences the abundance and distribution of many species either directly or indirectly through fire regime. | Project is not expected to affect climate but rapid climate change increases uncertainty of Project effects predictions. | Future climate | Climate change predictions | Climate change predictions |
| | Species | **Species Number**: Slowing down the rate of species extinction due to human factors is key to the conservation of biodiversity. | Project features would directly and indirectly affect individuals, change habitat availability and change habitat effectiveness which can reduce abundance and, in extreme cases, lead to extirpation. Rare species are at highest risk. | Number of species. Number of rare species. | Habitat composition. Presence of key habitats.[4] | Number of species; Habitat composition. |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| | | **Population size and distribution**: Changes to population size and distribution can change species number. Changing the natural mixture of species affects ecosystem functions and other species within the ecosystem. | Project features would directly and indirectly affect individuals, change habitat availability and change habitat effectiveness, which can reduce abundance and change distribution. | Plant community composition; Animal community composition. Strong Project linkages with wetland and water species (*e.g.*, waterfowl, shore birds, ring-billed gull, northern waterthrush, tern, bald eagle, amphibians, boreal chorus frog, beaver, aquatic furbearers) and some neotropical migrants (*e.g.*, blue-headed vireo, olive-sided flycatcher). | Habitat composition. Presence of key habitats.[4] | Plant community; Invertebrate community; Amphibian community; Bird community; Mammal community; Waterfowl; Bald eagle; Blue-headed vireo, Olive-sided flycatcher; beaver, aquatic furbearers; Habitat composition. |
| | | **Priority Species**: Some species are especially important for various reasons. | Same as for population size and distribution. Rare species are at highest risk. | Rare species (*i.e.*, a type of priority species), especially those species listed as endangered, threatened or special conservation concern. | Habitat composition. Presence of key habitats.[4] | Priority plant species (rare); Priority animal species (rare); Caribou; Habitat composition. |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern/ Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | | | Species that are highly sensitive to Project features for various reasons such as low reproductive capacity, intolerant of noise or have suffered large habitat losses throughout their range (*i.e.*, a type of priority species) such as caribou, migratory songbirds {*e.g.*, olive-sided flycatcher}, bald eagle | Habitat composition. Presence of key habitats.[4] | Priority plant species (sensitive); Priority animal species (sensitive); Caribou; Olive-sided flycatcher; Bald eagle; Habitat composition. |
| | | | | Species that can make disproportionate contributions to ecosystem functions (i.e., a type of priority plant species or priority animal species). Examples include Sphagnum mosses, predators, invertebrates, beaver, small mammals, perching birds (e.g., olive-sided flycatcher, palm warbler). | Habitat composition. Presence of key habitats.[4] | Priority plant species (ecosystem function); Priority animal species (ecosystem function); Beaver; Olive-sided flycatcher; Habitat composition. |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | | | Species highly valued by people (i.e., a type of priority plant species or priority animal species). Examples are medicinal plants, berries, caribou, moose, waterfowl, ruffed grouse, bald eagle, furbearers, snowshoe hare, gray wolf, black bear. | Habitat composition. Presence of key habitats.[4] | Priority plant species (highly valued); Priority animal species (highly valued); Caribou, Moose, Waterfowl; Habitat composition. |
| | | **Drivers:** | | | | |
| | | **Resource Harvesting**: Human activities (*e.g.*, harvest, noise) can affect species. | Project features may increase opportunities to harvest some species. Offset programs in adverse effects agreement increase harvesting in other areas. | Resource harvesting; Offset programs. | Not needed | Resource harvesting; Offset programs. |
| | | **Invasive Species**: Can affect the abundance and distribution of other species. | Increased access brings more equipment, materials and people into the area, which could transport disease or invasive species into the area or spread them further. Linear features may create migration corridors for invasive species. | Invasive species (*e.g.*, purple loosestrife); Disease. | Not needed | Invasive species; Disease. |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| | | **Predation and Herbivory**: Some species can create large changes in food availability or critical habitat attributes for other species or consume relatively large numbers of other animals or plants. | Species or processes that are important to other species | Predators (*e.g.*, gray wolf); Herbivores (*e.g.*, beaver) | Professional judgement. | Predators; Herbivores; Beaver |
| | | **Intactness**: Features affecting the movement of organisms can alter species abundance and/or distribution. Some species require large core areas to maintain population levels. | Project features reduce core area. Features such as the reservoir and roads may be impediments to the movement of some animals and plants or reduce habitat effectiveness for animals. | Intactness (includes linear disturbance) | Not needed | Intactness (includes linear disturbance) |
| | | **Water Regime**: water levels, flows and other water regime parameters are a strong influence on shore zone species and their habitats. | Project would flood land and change the water regime. | Water regime | Habitat attributes (*e.g.*, tree mortality along shoreline) and wetland habitat composition | Water regime; Wetland habitat composition; Habitat attributes |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | **Ice Regime**: Ice scouring and pressure can substantially alter shore zone habitat and adjacent inland areas. Ice regime changes can remove and/or alter some habitat types with potential effects on ecosystem diversity and priority habitats. | Project would flood land and change the ice regime. | Ice regime | Habitat attributes (*e.g.*, scoured vegetation along shoreline) and wetland habitat composition | Ice regime; Wetland habitat composition; Habitat attributes |
| | | **Fire Regime**: Changes to the fire regime can dramatically change habitat availability. | Project features increase the risk that a large accidental fire will occur or that behaviour of a natural fire will be altered. | Fire regime | Habitat composition | Fire regime; Habitat composition |
| | | **Climate**: Strongly influences habitat availability over longer time frame. | Project is not expected to affect climate but rapid climate change increases uncertainty of predictions about Project effects on species. | Future climate | Climate change predictions | Climate change predictions |
| | **Genetic** | Evolutionary processes underlie adaptation to change. Maintain capacity for gene flow. | Some project features can impede species movement and thereby reduce genetic interchange. | Intactness | None | Intactness |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| **A** | **B** | **C** | **D** | **E** | **F** | **G** |
| | | Species at a range limit may adapt better to rapid climate change. | Some project features may alter the distribution and/or abundance of range limit species. | Species at a range limit (*i.e.*, a type of priority plant species or priority animal species). | Habitat composition | Species at a range limit (*i.e.*, a type of priority plant species or priority animal species); Habitat composition |
| | | Some rare species may adapt better to rapid climate change. | Some project features may alter the distribution and/or abundance of rare species. | Rare species (*i.e.*, a type of priority plant species or priority animal species). | Habitat composition | Rare species (*i.e.*, a type of priority plant species or priority animal species); Habitat composition |
| | | Any species may contribute to adaptation to contextual change. | Some project features will alter the distribution and/or abundance of rare species. | Number of species. Number of rare species. | Habitat composition | Number of species. Number of rare species; Habitat composition. |
| | | **Drivers:** | Same as for Species Diversity | | | All of the key topics for Species Diversity drivers |
| **Ecosystem Condition and Productivity** | **Productivity** | **Primary Productivity**: Critical to function of ecosystem. Plants capture energy from sun and convert the energy into biomass. Other **autotroph**s transform energy into biomass. Changes in primary production, detrital transport and habitat will affect secondary consumers. | Flooding and changes in water levels and flows and water quality will affect primary producers. | Primary Productivity | Habitat composition | Habitat composition. |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | **Secondary Productivity**: Some animal species are important food sources in the food web. | Project features may affect key food web animals, their habitat or habitat effectiveness. | Abundances of invertebrates, small mammals and perching birds. | Habitat composition | Invertebrates; Small mammals; Perching birds; Habitat composition. |
| | | **Drivers**: | | | | |
| | | **Decomposition**: Decomposition is critical for making nutrients and material in dead organisms or their parts available in the ecosystem. | Groundwater and other habitat changes will affect decomposers, affecting water quality (organic material, dissolved oxygen, nutrients, and resulting in the mobilization of methylmercury in the food web) | Decomposition | Habitat composition | Decomposition; Habitat composition. |
| | | **Weather**: Extremes of temperature, precipitation and other weather parameters can reduce productivity and resilience. | Not affected by the Project, but climate change could result in the frequency and/or severity of extreme weather events, which increases the uncertainty, associated with Project effects predictions. | Future weather | Climate change predictions | Climate change predictions |
| | | Water Regime: Key driver affecting shore zone, species that use this zone and wetland function. | Increased wave energy in reservoir will affect survival of some shore zone species. | Surface water cover and ground water changes. | Post-project habitat composition and peatland disintegration models are based on ground water model predictions. | Habitat composition; wetland function |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern / Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | Water Quantity: Surface and groundwater amounts and movement strongly affect soil development, substrate conditions for plants and animals and wetland functions. Depth to groundwater is one of the most important influences on the rate of decomposition in soil. | Reservoir creation and operation, roads, culverts and other Project features may affect surface and groundwater amounts and movements. | Surface water; Groundwater; Wetland function. | Habitat composition | Surface water; Groundwater; Wetland function; Habitat composition. |
| | | Water Quality: Directly influences organisms. An important influence on microbial decomposition rates. | Affects shore zone, species that use this zone and wetland function. | Water quality; Wetland function. | Habitat composition | Water quality; Wetland function; Habitat composition. |
| | | Soil Quantity and Quality: One of the most important influences on primary productivity. | Project may create soil erosion and compaction, flooding. | Soil quantity and quality; enduring features. | Soil quantity and quality | Soil quantity and quality |
| | | Substrate Quality | Project may cause erosion and subsequent sedimentation in shore zone | Substrate quality | Organisms associated with specific substrate types or intolerant of sediment deposition: Benthic invertebrates, lake sturgeon, walleye, lake whitefish | Substrate quality, benthic invertebrates, lake sturgeon, walleye, lake whitefish |

**Table 1A-1: Ecosystem-Based Framework Used to Select the Ecosystem Health Indicators That Became the Valued Environmental Components and Supporting topics**

| Criterion | Element | Generic Concern/ Why is it Included? | Keeyask Linkages | Potential Key Topics Before Other Considerations (*i.e.*, potential indicators) | Proxies for Key Topic | Potential Key Topics |
|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G |
| | | Surface and Groundwater | Project may elevate groundwater along shorelines and some inland areas. | Surface water cover and ground water changes. | Habitat zone of influence indicated by studies along existing reservoir shorelines | Surface water cover; groundwater elevations |
| | | **Climate**: Strongly influences productivity over longer time frame. | Project is not expected to affect climate but rapid climate change increases uncertainty of predictions about Project effects on species. | Future climate | Climate change predictions | Climate change predictions |
| | **Incidence of disturbance and stress** | **Disturbance/Fluctuation**: Species in relatively natural areas are adapted to the existing disturbance/fluctuation regime. Functional outcomes are dependent on the natural balance. Species and functions in altered areas are adjusting to the altered conditions. | | | | |

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**Table 1A-2: Reason for Dropping Potential Key Topics Identified in Table 1A-1**

| Potential Key Topics | Reasons for Dropping |
|---|---|
| **Section 2 – Terrestrial Habitat and Ecosystems** | |
| Soil microbial activity | Not practical to measure. |
| Enduring features | Covered by ecosystem diversity. |
| Primary productivity | Covered by ecosystem diversity, wetland function and soil quantity and quality. |
| Carbon storage | Covered by ecosystem diversity, wetland function and soil quantity and quality. |
| **Section 3 – Terrestrial Plants** | |
| Plant community (includes number of species) | Covered by ecosystem diversity/habitat composition, priority habitats, resource use and priority plant species (i.e., if these key topics are not affected then effects on the plant community are not expected. |
| **Section 4 – Terrestrial Invertebrates** | |
| None dropped | |
| **Section 5 – Amphibians and Reptiles** | |
| Amphibian community (includes number of species) | Covered by ecosystem diversity/habitat composition, priority habitats, resource use and priority amphibian species (*i.e.*, if these key topics are not substantially affected then effects on the amphibian community are not expected. |
| **Section 6 – Birds** | |
| Bird community (includes number of species) | Covered by ecosystem diversity/habitat composition, priority habitats, resource use and priority bird species (*i.e.*, if these key topics are not substantially affected then effects on the bird community are not expected. |
| **Section 7 – Mammals** | |
| Mammal community (includes number of species) | Covered by ecosystem diversity/habitat composition, priority habitats, resource use and priority mammal species (*i.e.*, if these key topics are not substantially affected then effects on the mammal community are not expected. |

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**Table 1A-3: Criteria Used To Elevate Key Topics Identified in Table 1A-2 to the Valued Environmental Components (VECs)**

| Key Topics (VECs and supporting topics) | Criteria to Elevate a Key Topic to a VEC | | | | | | Outcome | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | Potential for Substantial Project Effects | Suitable Information Can Be Compiled | Regulatory Requirement or Guideline | High Importance to Local People | Ecological: Key for Ecosystem Function | Ecological: Umbrella Indicator | VEC | Supporting Topic | |
| | A | B | C | D | E | F | G | H | |
| **Section 2 – Terrestrial Habitat and Ecosystems** | | | | | | | | | |
| Fire regime | | ✓ | | | ✓✓ | | | ✓ | |
| Ecosystem diversity/ habitat composition (includes habitat attributes) | ✓ | ✓ | ✓ | | ✓✓ | ✓✓ | ✓ | | |
| Soil quantity and quality | ✓ | ✓ | | | ✓✓ | ✓✓ | | ✓ | |
| Wetland function (includes wetland habitat composition) | ✓ | ✓ | ✓ | | ✓✓ | ✓✓ | ✓ | | |
| Intactness | ✓ | ✓ | ✓ | | ✓ | ✓✓ | ✓ | | |
| **Section 3 – Terrestrial Plants** | | | | | | | | | |
| Priority plant species | ✓ | ✓ | ✓ | ✓ | | | ✓ | | Includes the following groups: endangered or threatened; provincially rare; regionally rare; range limit; keystone species; and/or highly valued by people. |
| Plant community (includes number of species) | ✓ | ✓ | ✓ | | | | | ✓ | Covered by ecosystem diversity/habitat composition, priority habitats, resource use and priority plant species (*i.e.*, if these key topics are not affected then effects on the plant community are not expected. |
| Invasive non-native plant species | ✓ | ✓ | ✓ | ✓ | | | | ✓ | |
| **Section 4 – Terrestrial Invertebrates** | | | | | | | | | |
| Invertebrate community (includes number of species) | | ✓ | | | ✓ | | | | |
| **Section 5 – Amphibians and Reptiles** | | | | | | | | | |
| Priority amphibian species (*e.g.*, boreal chorus frog) | ✓ | ✓ | ✓ | | | | | ✓ | |
| Section 6 – Birds | | | | | | | | | |
| Canada goose | ✓ | ✓ | ✓ | ✓✓ | | | ✓ | | |
| Mallard | ✓ | ✓ | ✓ | ✓✓ | | | ✓ | | |

**Table 1A-3: Criteria Used To Elevate Key Topics Identified in Table 1A-2 to the Valued Environmental Components (VECs)**

| Key Topics (VECs and supporting topics) | Criteria to Elevate a Key Topic to a VEC | | | | | | Outcome | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | Potential for Substantial Project Effects | Suitable Information Can Be Compiled | Regulatory Requirement or Guideline | High Importance to Local People | Ecological: Key for Ecosystem Function | Ecological: Umbrella Indicator | VEC | Supporting Topic | |
| | A | B | C | D | E | F | G | H | |
| Bald eagle | ✓ | ✓ | ✓ | ✓✓ | | | ✓ | | |
| Olive-sided flycatcher | ✓ | ✓ | ✓ | ✓ | | | ✓ | | |
| Common nighthawk | ✓ | ✓ | ✓ | ✓ | | | ✓ | | |
| Rusty blackbird | ✓ | ✓ | ✓ | ✓ | | | ✓ | | |
| Other priority bird species (priority birds that are notVECs) | ✓ | ✓ | ✓ | ✓ | | | | ✓ | Includes the following groups: endangered or threatened; provincially rare; regionally rare; range limit: migratory songbirds, perching birds, shore birds, colonial birds and resident birds. |
| **Section 7 – Mammals** | | | | | | | | | |
| Caribou | ✓ | ✓ | ✓ | ✓✓ | | | ✓ | | |
| Moose | ✓ | ✓ | | ✓✓ | ✓ | | ✓ | | |
| Beaver | ✓ | ✓ | | ✓ | ✓✓ | | ✓ | | |
| Other priority mammal species (priority mammals that are not VECs) | ✓ | ✓ | ✓ | ✓ | | | | ✓ | Includes the following groups: endangered or threatened; provincially rare; regionally rare; range limit: small mammals; aquatic furbearers; terrestrial furbearers and large carnivores. |

Note: A priority species is a native species that is rare, ecologically sensitive in some way, near the outer limit of its range, a keystone species, critical to the survival or reproduction of another species and/or highly valued by people. A species is considered to be ecologically sensitive if it is has low reproductive capacity, dependent on an uncommon habitat type, dependent on uncommon environmental conditions, dependent on the natural disturbance regime or highly sensitive to disturbance.