KEEYASK TRANSMISSION AQUATIC ENVIRONMENT TECHNICAL REPORT

OCTOBER 2012

KEEYASK TRANSMISSION

Aquatic Environment Technical Report

Report Prepared for

Manitoba Hydro

By

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PREFACE

The following is one of several technical reports for Manitoba Hydro's application for environmental licensing of the Keeyask Transmission Project. This technical report has been prepared by an independent technical discipline specialist who is a member of the Environmental Assessment Study Team retained to assist in the environmental assessment of the Project. This report provides detailed information and analyses on the related area of study. The key findings outlined in this technical report are integrated into the Keeyask Transmission Environmental Assessment Report.

Each technical report focuses on a particular biophysical or socio-economic subject area and does not attempt to incorporate information or perspectives from other subject areas with the exception of Aboriginal Traditional Knowledge (ATK). Applicable ATK is incorporated where available at time of submission. Most potentially significant issues identified in the various technical reports are generally avoided through the Site Selection and Environmental Assessment (SSEA) process. Any potentially significant effects not avoided in this process are identified in the Environmental Assessment Report along with various mitigation options that would address those potential effects.

While the format of the technical reports varies between each discipline, the reports generally contain the following:

- Methods and procedures.
- Study Area characterization.
- Description and evaluation of alternative routes and infrastructure sites.
- Review of potential effects associated with the preferred transmission routes and station sites.

Following receipt of the required environmental approvals, an Environmental Protection Plan (EnvPP) will be completed and will outline specific mitigation measures to be applied during construction, operation and maintenance of the proposed Keeyask Transmission Project. An EnvPP is typically developed from a balance of each specialist's recommendations and external input.

Each of the technical reports is based on fieldwork and analysis undertaken throughout the various stages of the SSEA process for the Project. The technical reports are as follows:

- Technical Report 1: Aquatics Environment
- Technical Report 2: Terrestrial Habitat, Ecosystems and Plants
- Technical Report 3: Amphibians
- Technical Report 4: Avian

- Technical Report 5: Mammals
- Technical Report 6: Forestry
- Technical Report 7: Socio-economic Environment
- Technical Report 8: Heritage Resources
- Technical Report 9: Tataskweyak Cree Nation Report on Keeyask Transmission Project

The technical reports contain more detail on individual subject areas than is provided in the Environmental Assessment Report. The technical reports have been reviewed by Manitoba Hydro, but the content reflects the opinions of the author. They have not been edited for consistency in format, style and wording with either the Environmental Assessment Report or other technical reports.

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

Page

LIST OF MAPS

EXECUTIVE SUMMARY

Manitoba Hydro and its partners (Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation, and York Factory Cree Nation; Keeyask Hydro Power Partnership) are proposing the development of a 695-megawatt hydroelectric generating station on the Nelson River at Gull Rapids., (i.e., the Keeyask Generation Project). To provide construction power and generation outlet transmission capacity for the Keeyask Generating Station, Manitoba Hydro is proposing the Keeyask Transmission Project. The Project consists of five major components:

- A Construction Power station, located on the north side of the Nelson River at Gull Rapids and line, running from the station to an existing transmission line located between the Butnau and Kettle rivers;
- Four Unit Lines, located within a single corridor, from the Keeyask Generating Station to the Switching Station;
- The Keeyask Switching Station located on the south side of the Nelson River by Gull Rapids;
- Three Generation Outlet Transmission Lines (GOT), located within a single corridor from the Keeyask Switching Station, parallel to the south shore of Stephens Lake, to the Radisson Converter Station (approximately 6 km northeast of the town of Gillam); and
- Radisson Converter Station Upgrades ,required to terminate the GOT.

As part of the environmental licensing application process, an environmental aquatic assessment of all Keeyask Transmission Project components was conducted. This report describes the environmental aquatic assessment of the Keeyask Transmission Project, including stream crossing assessments for proposed Keeyask construction power and generation outlet transmission line route options, and aquatic assessments of the preferred Construction Power Station and Switching Station sites. Specific objectives of the report are:

- to describe the assessment of fish habitat of streams within the vicinity of the proposed transmission line crossings and station site footprints;
- to describe the habitat features within the vicinity of the proposed stream crossings and station sites, including channel characteristics, **riparian** vegetation, instream cover and *in-situ* water quality;
- to evaluate transmission line alternative routes and station sites based on fish habitat assessments of crossings; and
- to discuss potential effects of line and station construction and operation, and to propose mitigation and monitoring.

The proposed construction power (CP 1 and CP 2) and three of the Generation Outlet Transmission line route options (GOT A, B, and C) were surveyed aerially by helicopter, with groundtruthing where possible. Desktop assessments of the fourth GOT line route option (GOT D) and the construction power and switching station sites were completed using the National Hydrologic Network water layer and digital orthographic imagery (DOI).

Thirteen watercourse crossing were identified along the Construction Power alternative routes and 27 along the GOT route options. Watercourses were not identified within the immediate vicinity of the Construction Power and switching station sites. Physical data gathered from the site assessments, as well as existing information on fish and fish habitat, were used to rate the Sensitivity of Fish and Fish Habitat from Low to High (based on DFO [2010]).

Watercourse crossings characterized as shallow wetland areas and wetland/**bog** drainages, that provided moderate spawning habitat potential only for northern pike and small-bodied **forage fish**, had *Low* Fish and Fish Habitat Sensitivity rating. Crossings with this rating included: CP 1: Sites 15, 18 and 46; CP 2: Sites 3, 4, 5, 6, 8, 9, and 10; GOT A: Sites 30, 38, 43, and 47; and GOT B: Sites 21, 22, 23, 40, 41, 42, 43, 30 and 49; GOT C: Sites 21, 22, 49 and 23; and GOT D: Site 15, 46, 54, 53, and 52.

A *Low-Moderate* Fish and Fish Habitat Sensitivity rating was assigned to one crossing: GOT A: Site 37. Although the habitat at this site is similar to crossings with a *Low* rating the watercourse is larger and has a cooler water thermal regime that is more susceptible to changes in environmental conditions.

A *Moderate* Sensitivity of Fish and Fish Habitat rating was assigned to the following crossing sites: CP 1: Site 13; CP 2: Site 11; GOT A: Sites 31, 33, and 35; GOT B: Site 31, 33 and 36; GOT C: Site 24; and GOT D: Site 13 and 51 . At these sites, the proposed ROWs crossed larger watercourses, including small to medium sized rivers and large man-made channels (i.e., sections of the Butnau River diversion). These watercourses had the potential to support more fish species than lower rated watercourses, including lake whitefish and walleye.

The highest overall sensitivity rating for the stream crossing assessments was *Moderate-High*, which included the following sites: CP 1: Site 19; CP 2: Sites 1 and 2; GOT A: Site 32 and 48; GOT C: Site 26 and 48; and GOT D: Site 48. The ROW at these sites crossed medium to large sized rivers and a section of the Butnau River diversion. Generally, fish species were more dependent on these habitats, specifically for spawning, and these sites' gravel/cobble riffle/run habitat would be more vulnerable to changes in environmental conditions.

The alternative construction line CP 1 (5 sites) had fewer crossings than CP 2 (10 sites). Most crossings on both lines were of low sensitivity with only a few of moderate-high or moderate sensitivities. Of the alternative generation outlet transmission line route options, GOT C (7 sites) and GOT D (8 sites) crossed the fewest watercourses whereas GOT A (10 sites) crossed a moderate amount , and GOT B (14 sites) crossed the most watercourses. Most of the crossings on all lines had low sensitivity ratings with few moderate-high or moderate sensitivities. CP1 and GOT C were the preferred alternative lines, due to their lower number of watercourse crossings, and their lower or equal number of potentially sensitive crossings.

Both the Construction Power and Keeyask Switching stations are preferable sites. The Nelson River at Gull Rapids is located within the Construction Power Station study area, however the station footprint is approximately 350 m away from the river, and therefore any potential effects would be minimal. The Keeyask Switching Station contained no watercourses within its footprint or study area.

The construction and operation of overhead transmission lines poses a low risk to fish habitat as indicated in DFO’s Operational Statement for overhead line construction (DFO 2007a) and maintenance of riparian vegetation in existing RoWs (DFO 2007e). The two main potential effects to fish habitat from construction and operation of overhead transmission lines are loss of riparian habitat and instream sedimentation.

Construction monitoring will be conducted to ensure the mitigation measures are effective. Temporary and permanent facilities installed to maintain natural cross-flow drainage across the construction sites will be inspected on a regular basis to ensure that drainage is not being inhibited by the construction activities. Water quality monitoring will be implemented at crossing sites where there is potential for sediment introduction into surface waters (e.g., stream bed disturbance during stream isolations).

All disturbed bed and bank sites will be restored to a state that is comparable to pre-disturbance conditions. Reclamation efforts will be monitored as required by proponent personnel. Once reclamation success is deemed acceptable, temporary erosion control structures will be removed.

With appropriate mitigation measures implemented, the residual effects from the construction and operation of the Unit Tranmsission, Construction Power and Generation Outlet Transmission Lines is expected to have no measurable effect.

A number of projects are proposed for the lower Nelson River area that have potential to interact with the Keeyask Transmission Project, including the Keeyask Generation Project, Bipole III Transmission Project, Conawapa Generation Project and the Gillam Re Development Project. The Keeyask Generation Project overlaps the Keeyask Transmission Project most directly, both temporally and spatially with the potential for effects to fish habitat in the Nelson River and a number of streams crossed by the South Access Road and the Generation Outlet Transmission lines.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

The primary function of the Keeyask Transmission Project is to provide construction power and generation outlet transmission capacity for the Keeyask Generating Station. The Keeyask Transmission Project consists of a Construction Power line and Station, four Unit lines , the Keeyask Switching Station, Three Generation Outlet Transmission lines, and upgrades to the Radisson Converter Station. Details of each of these components are provided below.

1.1.1 Construction Power Transmission Line and Station

A new construction power transmission line (138 kV and approximately 22 km long) from the existing 138-kV KN 36 transmission line to a new 138-kV to 12.47 kV construction power station to be located north of the proposed Keeyask Generating Station.

The purpose of the Construction Power transmission line and Station is to provide power for the construction activities of the Generating Station. After operation, the Construction Power transmission line will be left in place, as will a portion of the Station, to provide a contingency function for a “black start” emergency backup to diesel generation units at the Generating Station.

1.1.2 Unit Transmission Lines

Four 138-kV AC Unit Transmission lines will transmit power from the seven generators located at the Keeyask Generating Station to the new Keeyask Switching station. The four lines, each approximately 3.5 km long, will be located in a single corridor.

1.1.3 Keeyask Switching Station

A new Keeyask Switching Station will accept power from Generating Station via four Unit transmission lines from the Generating Station transformers and switch that power to three Generation Outlet Transmission lines. The switching station will be located on the south side of the Nelson River. The purpose of the switching station is to provide the terminal facilities for the electrical connection to the Generating Station, and to provide flexibility for accommodating power transmission from the Generating Station to the Radisson Converter Station.

1.1.4 Generation Outlet Transmission Lines

Three 138-kV AC Generation Outlet Transmission (GOT) lines will transmit power from the Keeyask Switching Station to the existing Radisson Converter Station 138-kV AC switchyard. The three lines, each approximately 38 km long, will be located in a single corridor. Manitoba Hydro plans to build one of these GOT lines to serve as a backup construction power line during construction and will be partially salvaged back to the Keeyask Switching Station and utilized as a generation outlet transmission line.

1.1.5 Radisson Converter Station Upgrades

The existing Radisson Converter Station will be upgraded in two stages, as follows:

1. Stage I: Radisson Converter Station will require the addition of a 138-kV breaker to accommodate the initial new 138-kV transmission line KR1 from Keeyask Switching station.

2. Stage II: Station equipment will include the addition of a 138-kV bay (Bay 1) complete with four 138-kV breakers and associated equipment for the termination of two additional lines (KR2 and KR3) from Keeyask Switching Station. KR2 and KR3 will enter the west side of the station utilizing dead-ended steel structure with line switches. KR2 and KR3 lines will proceed to underground around the station and finally terminate to Bay 1. This is done to avoid complex line crossings into the station. Thirty-one 138kV ac breakers will also need to be replaced due to fault levels exceeding existing breaker ratings.

1.2 Aquatic Ecosystems Monitoring and Assessment

This report represents an assessment of potential effects of the proposed transmission lines and associated facilities as they relate to the aquatic environment, and proposes mitigation to offset those effects. The findings in this report are intended to support the Project's Environmental Assessment Report (EA) and include the following:

- An assessment of proposed Construction Power, Generation Outlet Transmission, and Unit Transmission line watercourse crossings;

- An assessment of watercourses potentially affected by the Preferred Construction Power Station and Preferred Switching Station sites;

- An assessment of potential impacts to the aquatic environment as a result of the project and a description of management measures to avoid or mitigate those impacts; and,

- An assessment of proposed Construction Power, Generation Outlet Transmission, and Unit Transmission line water course crossings for compliance with the *Navigable Waters Protection Act* ‘minor works’ criteria.

2.0 METHODS AND PROCEDURES

2.1 STUDY AREA DEFINITION

The Keeyask Transmission Project study area is approximately 600 km^2 in size and is situated between the site of the proposed Keeyask Generating Station and the town of Gillam, MB (Map 3-1). The project study area includes the Keeyask Generating Station site encompassing Gull Rapids and the area immediately north to Looking Back Creek. Extending south from the Nelson River and the southern shoreline of Stephens Lake from Gull Rapids to Gillam, the study area extends south to beyond Butnau Lake and narrows closer to Gilliam. A description of the project study area aquatic environment is available in section 3.0.

The potential effects of an overhead transmission line to the aquatic environment are highly site-specific and largely offset through appropriate mitigation. Therefore, the extent of the study area for the alternative, Construction Power and GOT line routes were focused on their right-of-ways (ROW). The Construction Power lines have a 60 m wide ROW, and therefore a 60 m wide distance was included in the study area. The three GOT lines have a 200 m wide ROW and the UT lines a 265 m wide ROW.

The Construction Power Station requires 2.25 ha of land for development, while the Switching Station requires 35 ha for development, The study areas for both stations were 1 km^2 centered on the station footprints.

2.2 DATA COLLECTION AND ANALYSIS

2.2.1 Mapping

The Construction Power, Unit Transmission and GOT line routes and Construction Power Station and Switching Station were plotted and intersected with the National Hydro Network (NHN) layer using ArcGIS® Version 10. Stream crossings were generated using ArcGIS to create a point where the transmission line intersected the NHN watercourse (line) dataset. Where the transmission line crossed the NHN waterbody (polygon) dataset, clip function was used. The clip result line shapefile was converted to a point at the midpoint. Where a NHN watercourse intersected a station study area, this was mapped for further assessment.

2.2.2 Transmission Line Assessment

The proposed Construction Power, Unit Transmission and GOT line routes A, B, and C were surveyed aerially by helicopter from 21 to 25 July, 2009. Assessments for GOT D were restricted to desktop work due to the timing for which GOT D was identified.

Where possible, the helicopter landed at the stream crossing sites and a more detailed stream assessment was conducted on the ground. At locations where helicopter landing sites were not available within a practical distance of the crossing, estimates of physical parameters were made from the air.

A habitat survey was conducted for each watercourse. Physical stream data at the crossing area generally included the following:

- channel width;
- maximum water depth;
- **floodplain** width – estimated total width of floodplain, including channel;
- substrate composition – visually defined as fines (< 2 mm), gravels (2-64 mm), cobble (65-256 mm), boulder (>256 mm) and bedrock;
- cover – percent of wetted area with cover types including large woody debris (LWD), over hanging vegetation (within 1 m of water surface), instream vegetation, pools, boulders, undercut banks, and surface turbulence;
- riparian vegetation – dominant vegetation type (e.g., mature conifers, shrubs) or plant species;
- aquatic vegetation – presence and type of aquatic vegetation;
- barriers – any structure that may pose a barrier to fish passage;
- bank stability – high, moderate or low stability;
- *in-situ* water quality – temperature, dissolved oxygen (DO), conductivity, pH and turbidity were measured using a Horiba W-22XD water quality meter; and
- photographs of the assessed area.

Fish habitat was assessed within each surveyed watercourse, and included:

- assessment of fish overwintering, spawning, rearing and feeding potential (rated low [marginal], moderate, or high); and
- identification of areas that may be sensitive to disturbance, particularly downstream of the crossing.

General requirements (spawning, rearing/feeding, and overwintering) of fish species potentially utilizing the Project Study Area are summarized in Appendix A.

Each stream was also surveyed aerially upstream and downstream from the crossing to identify potential barriers to fish passage and to further assess habitat value on a broader scale (i.e., entire stream and/or **watershed**).

2.2.3 Station Assessment

Desktop surveys were conducted on watercourses within the Construction Power Station and Switching Station study areas. Watercourses were identified, as described in Section 2.2.1, through mapping of the NHN water layer. Digital ortho imagery (DOI) was then used to conduct a fish habitat assessment for each waterbody based on standard fish habitat assessment guidelines (e.g., DFO and BCMOE 1989). Digital ortho imagery was also used to conduct a visual assessment of the entire study area to potentially identify any watercourses not detected by the NHN layer.

2.2.4 Sensitivity of Fish and Fish Habitat

The Sensitivity of Fish and Fish Habitat rating is a method to classify or rate the fish and fish habitat at a specific site. The Sensitivity of Fish and Fish Habitat ratings were based on four criteria outlined in DFO (2010): species sensitivity; species dependence on habitat; rarity; and habitat resiliency, as described below.

Species Sensitivity

Description: Sensitivity of fish species/community to changes in environmental conditions (e.g., suspended sediments, water temperature, and dissolved oxygen).

Scale: *Low* – No "moderately or highly sensitive" species expected to be present.

Moderate – No “highly sensitive” species expected to be present.

High – At least one “highly sensitive” species expected to be present.

Comments: Ratings for fish species common in the Study Area are presented in Appendix B.

Species’ Dependence on Habitat

Description: Use of habitat by fish species. Some species may have very specific habitat requirements.

Scale: *Low* – Habitat is common and used for a range of life requisites by species that are present; not critical.

Moderate – Habitat is important and is used for a specific life function by species, but is not critical habitat.

High – Habitat is critical to the survival of the species in the area; example critical spawning habitat.

Rarity

Description: The relative strength of a fish population or prevalence of a specific habitat type.

Scale: *Low* – Habitat and/or species are prevalent.

Moderate – Habitat and/or species have a limited distribution or confined to small areas.

High – Habitat and/or species are rare. This would include SARA listed species and their habitats.

Habitat Resiliency

Description: The ability of an aquatic ecosystem to recover from changes in environmental conditions.

Scale: *Low* – Low gradient wetland streams with limited flow and abundant instream vegetation. These and other physical characteristic make the system stable and resilient to change and perturbation. Flow regime is typically ephemeral.

Moderate – Cool water thermal regime that can buffer a temperature change; physical conditions that make system moderately stable and resilient and flow regime is intermittent to perennial. This would include most moderate to large streams.

High – Cold water thermal regime that cannot easily buffer temperature changes; physical conditions make system unable to change, and flow regime is permanent. Features such as gravel/cobble riffles that, once disturbed or removed, may not recover naturally would fit into this category.

Physical data gathered from the site assessments, as well as existing information on fish and fish habitat, were used to rate the Sensitivity of Fish and Fish Habitat.

2.2.5 Navigable Waters Assessment

The *Navigable Waters Protection Act* is a federal law designed to protect the public right of navigation on water ways by prohibiting the building or placement of any work in navigable waters without the approval of the Minister of Transport. Included in the *Act* are specific criteria where construction of an aerial cable (power and communication) across a watercourse would be considered a “minor works” by Transport Canada and not require an application under the *Act*. These criteria for aerial cables include:

1. the width of the navigable waters that the cables are over or across is less than 15 m when measured from the high-water mark on one side to the high-water mark on the other side of the waters;
2. the works meet the design and construction requirements of Overhead Systems, CAN/CSA-C22.3 No. 1-10,
3. the works are more than 1,000 m from any lake or tidal waters;
4. the works are not over or across charted navigable waters;
5. the works are not over or across a canal that is accessible to the public; and
6. the works do not include towers or poles within the navigable waters high-water mark.

Following determination of preferred routes for Keeyask Transmission Lines (Unit Transmission, Construction Power and Generation Outlet Transmission), all watercourse crossings were reviewed using the six *Navigable Waters Protection Act* criteria listed above. Where all six criteria were met, an application to Transport Canada would not be required. For watercourses where one or more of the criteria could not be met, an application would be required.

Criteria 1: Channel Width

The channel width at the centerline of the ROW was used to represent the width of that watercourse, as measured during site visits. Where multiple channel width measurements were taken (multiple transects), an average of these measurements was used to represent width.

Criteria 2: CAN/CSA-C22.3 No. 1-10 Overhead Systems

Manitoba Hydro has indicated that design and construction of all watercourse crossings will meet CAN/CSA-C22.3 No 1-10 for Overhead Systems.

Criteria 3: Distance to Lakes or Tidal Waters

Each ROW was buffered by 1,000 m to identify the potential presence of lakes or tidal waters within 1,000 m of a transmission line watercourse crossing. Where a lake or tidal water was within the buffer and the lake or tidal water was connected to the watercourse intersected by the ROW, the distance from the ROW to the lake or tidal water (along the stream channel) was measured. Lakes that were entirely contained within private land (i.e. no public access) were not included as per Section 13 Private Lakes of the Minor Works and Waters Order.

Criteria 4: Charted Navigable Waters

The Canadian Hydrographic Service Nautical Charts and Services was searched for charted waters that fell within the Project transmission line ROW.

Criteria 5: Canal

Each watercourse intersected by the ROW was assessed to identify if it was a 'canal'. A canal was defined as a man-made channel designed to facilitate the movement of watercraft.

Criteria 6: Poles or Towers Within HWM

Manitoba Hydro has indicated that poles or towers will be located outside of the ordinary high water mark (HWM) for each watercourse crossed.

2.2.6 Overview of Information Sources and Data

Data compiled for both physical and biological parameters included existing data, such as remote imagery and literature, and data gathered through field studies. Remote imagery data sources included the National Hydro Network (NHN) (Geobase 2009) vector water feature data set. This data set provides **vector data** describing hydrographic features such as lakes, reservoirs, rivers, and streams, and was used to locate potential fish habitat in the vicinity of Project components. Digital orthographic images (DOI) were also used for components at which no field assessments were conducted (i.e., stations). Digital ortho imagery were collected for the Keeyask area by Manitoba Hydro in August 1999, at 1:60 000 resolution. These images were used in gathering additional physical information on watercourses identified by the NHN layer, as well as describing the general landscape in the vicinity of components.

Biological information collected as part of the larger Keeyask Environmental Studies Program (Keeyask Hydro Power Partnership 2012), was used to inform fish habitat assessments of several watercourses potentially affected by the Project, including the Nelson River, Gull Rapids Creek, and the Butnau/Kettle River system. Keeyask Studies information was also used to describe the existing environment of the Project Study Area. Additional literature and reports were used to inform fish and fish habitat sensitivity, existing environment description, and potential effects of the Project on the aquatic environment.

2.3 VALUED ENVIRONMENTAL COMPONENT SELECTION

Valued Environmental Components (VEC) are components of the biological or socio-economic environment that may be affected by the Project. VECs are species and/or environmental components that are used to highlight or focus an environmental assessment. VECs are defined as elements of the environment having scientific, social, cultural, economic, historical, archaeological or aesthetic importance and are proposed and identified and described under each environmental component. VECs are typically selected on the basis of their importance or relevance to stakeholders (e.g., species such as moose that are hunted) and/or as indicators of environmental effects to a broader range of animals. VECs are typically determined with the input from regulators and stakeholders, Aboriginal people and discipline experts, as well as literature reviews and experience with other projects. Environmental indicators and measurable parameters or variables are identified and described for each VEC. The same indicators and parameters/variables are used to describe environmental effects and residual environmental effects, and to monitor changes or trends over time during the Project construction and operation/maintenance phases.

The Keeyask Transmission Project selected VECs that were identified as being important or valued by members of the study team (e.g., species that are protected) and/or by the public and by other elements of the SSEA process. The identified VECs facilitated assessment of the interactions between the Project components and specific valued components of the environment.

2.3.1 Fish Habitat

Based on the above criteria, fish habitat was selected as a VEC. Fish habitat is generally used as a surrogate for measuring productive capacity. Section 35.1 of the *Fisheries Act* prohibits Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat. Maintaining fish habitat is best assured by minimizing short-term and avoiding long-term degradation of instream and riparian habitats. As a component of fish habitat, physical fish habitat, surface water quality, hydrology, and riparian vegetation were considered within the fish habitat VEC. Potential project-related effects on physical fish habitat include the loss of riparian vegetation, erosion, and the introduction of sediments and other contaminants from ROW surface runoff or the release of contaminants from equipment or accidental spills. These effects can all be mitigated through implementation of protection plans to protect fish habitat.

1.2.1.1 Environmental Indicators

Fish habitat is defined by a variety of biophysical parameters, including hydrology, channel and flow characteristics, substrate, cover, water and sediment quality, aquatic macrophytes and periphyton, and benthic invertebrate communities. Benthic invertebrate communities represent a large and diverse food base for higher trophic levels such as fish. They are also of indirect importance to fish populations through their effect on overall structure and function of aquatic environments. Water quality parameters key to defining fish habitat include temperature, Dissolved Oxygen (DO), total suspended solids (TSS), turbidity, and pH.

1.2.1.2 Measurable Parameters

The measurable parameters used to assess potential project and cumulative effects on fish habitat included:

- physical fish habitat (substrate composition, channel characteristics, cover composition, and habitat units);
- water quality (DO, TSS, and turbidity);
- hydrology (velocity and water depth); and
- riparian vegetation (riparian health and riparian vegetation composition).

2.4 EVALUATION OF ALTERNATIVE ROUTES

Alternative Construction Power and GOT routes were evaluated using the number of watercourse crossings per route and the rating of fish and fish habitat sensitivity for each of the watercourses crossed. Generation outlet transmission lines were evaluated for the crossings and included the entire route that would be used to span from the switching station to the Radisson Converter Station, not only in the individual segments. Routes with fewer crossings were considered preferable, as were routes with fewer higher sensitivity sites.

Only the preferred Construction Power Station and Switching Station were assessed and therefore an evaluation of alternatives was not performed for the aquatic environment. Similarly, the upgrades to the Radisson Converter Station were not evaluated as the upgrades will be confined to the existing footprint of the Radisson Converter Station.

2.5 EFFECTS ASSESSMENT AND MITIGATION MEASURES

The environmental assessment involved identifying and analyzing potential effects associated with the preferred routes that could not be avoided during the route selection process. During the route selection process, detailed socio-economic and biophysical studies were conducted to determine potential effects more precisely. Potential effects and mitigative measures are detailed in Chapter 7 of the EA Report. Appropriate mitigation measures have been identified to reduce negative effects during all phases of Project development.

2.5.1 Residual Effects significance evaluation

Residual effects are the actual or anticipated Project effects that remain after considering mitigation and the combined effects of other past and existing developments and activities. Each potential effect on a VEC is initially evaluated using the following criteria:

- Direction or nature (i.e., positive, neutral or adverse) of the effect
- Magnitude (i.e., severity) of the effect
- Duration (temporal boundaries)
- Geographic Extent (spatial boundaries)

The definitions for the above are provided in Chapter 3 of the EA Report.

3.0 STUDY AREA CHARACTERIZATION

3.1 STUDY AREA OVERVIEW

The Keeyask Transmission Project Study Area is approximately 602 km^2, and includes the reach of the Nelson River from Gull Rapids to Stephens Lake and the south shoreline of Stephens Lake to the Kettle Generating Station and extends south as far as Butnau Lake (Map 3-1). Within this area, the two Construction Power alternative routes begin on the north side of the Nelson River at Gull Rapids at the Keeyask Generating Station site and run south to an existing Manitoba Hydro transmission line (KN 36) situated between the Butnau and Kettle rivers (Map 3-1). The four GOT routes begin on the south side of the Nelson River at the switching station, with three alternatives running parallel to the south shore of Stephens Lake to the Radisson Converter Station (about 6 km northeast of the town of Gillam) and the fourth paralleling CP1 south to KN36 and then running along side of KN36 much of the way to Radisson Converter Station. The two station components are found on the north (Construction Power Station), and south (Switching Station) sides of the Nelson River near Gull Rapids.

The entire Project Study Area lies within the High Boreal Land Region characterized by a mean annual temperature of –3.4 ºC and an annual precipitation range of 415 to 560 mm. Topography is bedrock controlled overlain with fine-grained **glacio-lacustrine deposits** of clays and gravels. Depressional areas have **peat** plateaus and patterned **fens** with permafrost present. Black spruce/moss/sedge associations are the dominant vegetation (Canada-Manitoba Soil Survey 1976).

The reach of the Nelson River between Split Lake and Stephens Lake, which makes up the western portion of the study area, is characterized by: i) narrow sections with swiftly flowing water (including Birthday and Gull Rapids); and ii) wider more **lacustrine** sections, including Clark and Gull Lakes. Mean winter flow in the reach is 3,006 m^3/s and mean summer flow is 2,812 m^3/s (Manitoba Hydro 1996a).

Stephens Lake, located downstream of Gull Rapids, was created through the development of the Kettle Generating Station and has a surface area of 29,930 ha (excluding islands) and a total shoreline length, including islands, of 740.8 km. The numerous islands encompass an area of 3,340 ha and 336.2 km of shoreline. There is no detectable current throughout most of this large lake, except for the old Nelson River channel.

Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. The only other major tributary of Stephens Lake was the Butnau River. However, during construction of the Kettle Generating Station, an earth dyke was constructed at the inlet of the Butnau River at Stephens Lake, and a channel developed to divert the Butnau River through Cache Lake into the Kettle River (Manitoba Hydro 1996a). The majority of the remaining streams in the study area are small that provide drainage to small headwater lakes and areas of **bog** and fen habitat. These streams drain into larger streams such as the Butnau River or directly into the Nelson River or Stephens Lake.

3.2 ENVIRONMENTAL SETTING

3.2.1 Watershed and Hydrology

Overview

The Keeyask Transmission Project Study Area is found within the Nelson River watershed basin and the lower Nelson River sub-basin. It includes the Nelson River from Gull Rapids and the southern shore of Stephens Lake east to the Kettle Generating Station. In addition the study area includes the land south of these waterbodies, which contains numerous small lakes and streams, and several medium-sized rivers such as the Butnau and Kettle Rivers.

The Nelson River basin consists mostly of Canadian Shield; however, the easternmost extent is on the Hudson Bay coastal plain (Mills et al. 1976). **Marsh** and bog areas are common throughout and the landscape is generally hummocky and predominated by small to medium sized, oval and rounded lakes with smooth shorelines. Many larger lakes exist; often shallow with irregular rocky shorelines (Cleugh 1974, Schlick 1972, Veldhuis et al., 1979). Riparian vegetation typically consists of a combination of alders, birch, larch, Sphagnum, poplar, sedge, spruce or willow (Mills et al. 1976).

The Lower Nelson River sub-basin includes the Nelson River mainstem and Split Lake as well as numerous headwater lakes and tributaries of these water bodies. The eastern portion of this sub-basin lies within the Hudson Bay coastal plain and is notable for a number of small to medium sized tributaries of the Nelson River mainstem that, with their coarse substrate and groundwater flows, support fall spawning runs and resident populations of brook trout (*Salvelinus fontinalis*). Further west, this sub-basin consists of more typical boreal lakes and rivers such as the Crying and Assean rivers.

Stephens Lake, the main water feature of the study area, was formed by the Kettle Generating Station. This Generating Station, which was completed in 1974, raised the water level at the structure by 30 m, creating a backwater effect upstream to Gull Rapids. Approximately 22,055 ha of land were flooded in creating Stephens Lake (Manitoba Hydro 1996a). Kettle Generating Station is operated as a **peak-type plant**, cycling its forebay on a daily, weekly, and seasonal basis. The forebay is operated within an annual water level range of 141.1 m to 139.5 m ASL (Above Sea Level) (Manitoba Hydro 1996a). In addition the Kelsey Generating Station is located upstream of the study area, just upstream of Split Lake. This Generating Station began operating in 1961 as a **run-of-river plant** with very little storage or re-regulation of flows (Manitoba Hydro 1996a).

Since 1976, two water management projects, the Churchill River Diversion (CRD) and Lake Winnipeg Regulation (LWR), have influenced water levels and flows within the Study Area. These two projects augment and alter flows to generating stations on the lower Nelson River by diverting additional water into the drainage from the Churchill River (CRD) (Manitoba Hydro 1996b) and managing outflow from Lake Winnipeg (LWR). The CRD and LWR projects reversed the Nelson River pre-Project seasonal water level and flow patterns in the Keeyask Study Area by increasing water levels and flow during periods of ice cover, and reducing flows during the open-water period. Overall, there has been a net increase of 246 m^3/s in average annual flow at Gull Rapids since CRD and LWR (Manitoba Hydro 1996a).

Nelson River: Gull Rapids

Gull Rapids is located approximately 3 km downstream of Caribou Island on the Nelson River (Map 3-1). Two large islands and several small islands occur within the rapids prior to the river narrowing. The rapids are approximately 2 km in length, and the river elevation drops approximately 19 m from the downstream end of Gull Lake to the downstream end of Gull Rapids. The substrate and shoreline of the rapids are composed of bedrock and boulders. One small tributary, Gull Rapids Creek, flows into the south side of Gull Rapids, approximately 1 km downstream from the upstream end. This tributary is approximately 2.5 km long, and is fed by bogs and fens. The first 300 m of this tributary feature a diversity of pool, run, and riffle habitats and are characterized by boulder, gravel, and sand substrate with small amounts of organic material. The upper reach of this tributary is slower moving, dominated by marshy habitat and organic substrate.

Stephens Lake

The land bordering Stephens Lake includes areas of poor, moderate, and well-drained soils, dominated by black spruce forest in upland areas and black spruce bogs, peatlands, and fens in lowland areas. Trembling aspen occurs sporadically along the shoreline of Stephens Lake in areas that are well-drained. Soils are predominantly organic along the north shore, but include a section of mineral soil surrounding the north arm, and both mineral and organic soils along the south shore. Permafrost is discontinuous and sporadic, and exposed bedrock occurs at the west end of the lake (Agriculture and Agri-Food Canada 2003).

Construction of the Kettle Generating Station resulted in extensive flooding immediately upstream of the Generating Station. Moose Nose Lake (north arm) and several other small lakes that previously drained into the Nelson River became continuous with the Nelson River to form Stephens Lake. Flooded terrestrial habitats compose a large portion of the existing lake substrates, and include organic sediments as well as areas of clay and silt. Woody debris is abundant due to the extensive flooding of treed areas. Outside the flooded terrestrial areas, substrates are dominated by fine clay and silt. Sand, gravel, cobble, and areas of organic material dominate the shoreline, with much of the shoreline being prone to erosion. Riparian vegetation includes willow and alder, black spruce, tamarack, and scattered stands of trembling aspen.

Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. The only other major tributary of Stephens Lake was the Butnau River. However, during construction of the Kettle Generating Station, an earth dyke was constructed at the inlet of the Butnau River at Stephens Lake, and a channel developed to divert the Butnau River through Cache Lake into the Kettle River (Manitoba Hydro 1996a).

3.2.2 Surface Water Quality

Regional

The Study Area lies within the Nelson River basin, which is part of the Canadian Shield physiographic region of Manitoba. The quality of surface water within this area is influenced by glacio-lacustrine deposits which overly the Precambrian bedrock (Hecky and Ayles 1974). Although lakes in this region may be considered Precambrian in nature, the water is somewhat harder, more nutrient rich, and turbid than typical Shield lakes, primarily due to the presence of the glacio-lacustrine deposits (Hecky and Ayles 1974).

Lakes within this area are generally similar in chemical composition and are predominantly isothermal throughout the summer (Hecky and Ayles 1974, Cleugh 1974, Bezte and Kroeker 2000). The isothermal nature of the lakes throughout most of the open-water season can generally be attributed to relatively shallow average depths and turbulent flows throughout the riverine sections of the system. These characteristics, combined with the presence of glacio-lacustrine clays, and the potential for wind-induced mixing, result in relatively high water turbidity (Cleugh 1974). The Nelson River basin has also been dramatically altered by hydroelectric development, i.e., CRD and Lake Winnipeg regulation. Generally, notable increases in turbidity, dissolved minerals, and phosphorous have been observed since hydroelectric development (Baker 1991, Williamson 1993).

Study Area Overview

As part of studies conducted for the Keeyask Generation Project from 1999-2006 (Keeyask Hydro Power Partnership 2012), detailed water quality data was collected for the study area. These studies found that the Nelson River mainstem in the study area was moderately nutrient-rich, well-oxygenated, moderately soft to hard, and had a slightly alkaline pH largely due to the bicarbonate ion. On the basis of alkalinity and pH, the Study Area was considered ‘least sensitive’ to acidification and most sites were also classified as of ‘least sensitivity’ on the basis of calcium concentrations. Concentrations of ammonia were consistently below the Manitoba water quality objectives for the protection of aquatic life, and nitrate/nitrite were consistently below the CCME guidelines (CCME 1999) for aquatic life throughout the area. The pH was also within the Manitoba guideline for the protection of aquatic life. In general, TP (total phosphorus) and DO concentrations on the mainstem and tributaries were within the applicable water quality guidelines.

The mainstem of the study area was classified as **meso-eutrophic** to **eutrophic** based on TP levels, but only mesotrophic based on chlorophyll a (CCME 1999; updated to 2010). This suggests that factors other than phosphorus (e.g., light) limit algal growth in the area and/or that the bioavailablity of phosphorus may be limited. The dominant cations along the Nelson River were calcium and sodium. Most metals were consistently below Manitoba water quality objectives or guidelines for the protection of aquatic life (Manitoba Water Stewardship 2011). However the study area was characterized by relatively high concentrations of iron and aluminum, both of which were typically present at concentrations exceeding guidelines. Both are relatively abundant elements, and their high concentrations in aquatic environments are often considered ‘natural’ (Ramsey 1991a).

Stephens Lake

Stephens Lake was moderately alkaline, with ‘moderately soft’ water. Total phosphorous, TSS, and turbidity declined in the lake in contrast to the rest of the mainstem, likely due to settling occurring over this area. Concentrations of phosphorus and nitrogen were relatively high, with concentrations above Manitoba water quality standards, objectives, and guidelines (MWQSOG) in the southern portion of the lake. The south portion would be considered meso-eutrophic (southeast) to eutrophic (southwest), and the north arm mesotrophic on the basis of TP concentrations.

Conditions at the south end of Stephens Lake resembled those observed on the main flow of the Nelson River upstream and downstream of the lake. This area was generally more nutrient-rich, more turbid, did not stratify, and was more oxygenated over winter than the north arm of the lake. Turbidity and TSS concentrations decreased in the southern area from west to east. It was found that the north arm of the lake may stratify under atypically low wind conditions, with temporary depletion of DO potentially occurring with thermal stratification. Dissolved oxygen levels were also lower in general in the north area of the lake.

Gull Rapids

Within Gull Rapids, most areas were well-oxygenated, relatively turbid, slightly alkaline, and water was generally ‘moderately soft’. Concentrations of phosphorus and nitrogen were above MWQSOG in most samples near the mouth to Stephens Lake. All sites in the area would be classified as eutrophic on the basis of TP.

Streams south of Stephens Lake

Streams south of Stephens Lake were moderately nutrient-rich, near-neutral, and contained higher concentrations of organic carbon (OC) than the mainstem of the Nelson River. Some streams had low DO levels that did not meet, or were very close to, MWQSOG for the protection of aquatic life. This agreed with data from stream crossing assessments collected as part of the Keeyask Transmission Study in 2009, which found fish habitat in many of the streams assessed was likely limited by DO levels.

3.2.3 Lower Trophic Levels

Lower trophic levels, as discussed in this document, include all aquatic organisms apart from fish that occupy the aquatic environment; including algae, aquatic plants, zooplankton, and **macroinvertebrates**. Studies were conducted on lower trophic levels as part of the Keeyask Environmental Studies Program from 1997-2006 (Keeyask Hydro Power Partnership 2012). The overall Keeyask Transmission Study Area encompasses a diverse range of habitats, from relatively large rivers to streams, a variety of sizes of lakes, and flooded terrestrial areas, and as such harbours a diversity of lower trophic organisms. Changes in the abundance and distribution of these groups as a result of chemical and physical changes in habitat are an important linkage to effects on fish. This connection is recognized in the *Fisheries Act*, which includes in the definition of fish habitat, the food sources on which fish depend to carry out their life processes (e.g., growth). Lower trophic level organisms were divided into four broad groups (phytoplankton, aquatic macrophytes and attached algae, zooplankton, and aquatic macroinvertebrates), and discussed below. They are also discussed in regards to species at risk.

Phytoplankton

Phytoplankton consist of small, aquatic, plant-like organisms (i.e., algae) that are most often found suspended or entrained in the water column. Several groups of freshwater algae comprise the phytoplankton: chrysophytes (green or yellow-brown algae], diatoms (Diatomacea), chlorophytes (green algae), cyanophytes (blue-green algae or cyanobacteria), Peridineae (dinoflagellates), cryptophytes (cryptomonads) and euglenophytes. Many other aquatic organisms rely on phytoplankton, directly or indirectly, as a food source. Consequently, changes in phytoplankton abundance or composition can result in changes to invertebrate and fish populations.

From Keeyask environmental studies, Stephens Lake and the Keeyask area were found to be similar to other Nelson River environments in the area, with the phytoplankton community dominated by diatoms through the open-water season. Chlorophyll-a levels in Stephens Lake indicated mesotrophic trophic status, while levels in Gull Rapids indicated an **oligotrophic** status. Chlorophyll-a levels measured at several streams south of Stephens Lake indicated these streams were oligotrophic and therefore representative of relatively low productivity.

Aquatic Macrophytes and Attached Algae

Aquatic macrophytes (plants) grow within the littoral zone (the area of a lake from the highest seasonal water level to the deepest point at which there is sufficient light for photosynthesis to occur). Attached algae (non-vascular plants, including macroalgae) generally colonize the surfaces of macrophytes, rocky substrates, and open areas of fine sediment. Attached algae that grow on the surface of plants often provide the basis for a rich community (i.e., biofilm) consisting of the algae, detritus, bacteria, fungi, and microfauna. This biofilm provides nutrition for many kinds of animals such as snails, certain minnows, and aquatic insect larvae.

From Keeyask environmental studies, Stephens Lake was found to be similar to other Nelson River lacustrine environments in the area, with aquatic plants generally restricted to shallow (<2 m), nearshore areas, in sheltered bays, and channels between islands. These areas were characterized as having standing water, and soft, mineral-based bottom sediments. Pondweeds (*Potamogeton* spp., *Stukenia* spp.) were most common. Drift traps established downstream of Stephens Lake collected a relatively low amount of plant biomass. This may have been because of a paucity of plant biomass in Stephens Lake, or sampling location.

Upstream of Gull Rapids species such as *Carex* spp. (sedges) and northern watermilfoil (*Myriophyllum sibiricum)* were found; downstream species such as pondweeds and northern watermilfoil were found. Drift trap sampling upstream and downstream of the rapids collected a substantial amount of drifting plant biomass, indicating that the upstream areas (Gull Lake and Gull Rapids itself) are productive areas.

From stream crossing assessments conducted as part of the Keeyask Transmission Study in 2009, most tributaries on the south side of Stephens Lake were found to be wetland/bog drainages with abundant aquatic plants such as grasses, sedges, and marsh calla. Streams with higher water flow often had fewer aquatic plants, with the majority of plants growing along the shallow margins of the channel (willows and grasses).

Zooplankton

Zooplankton are very small invertebrates living in the water column and are consumed by larval, juvenile, and adult fish (e.g., lake cisco). Three important groups in the open water are Cladocera (water fleas), and calanoid and cyclopoid Copepoda (copepods). The availability and quality of food (e.g., phytoplankton), the number of predators, and water **residence time** affect the abundance of zooplankton. Zooplankton may reach great abundances in lakes; however they constitute a relatively unimportant component of the lower trophic level community in river and stream habitats for a number of reasons, including downstream losses. The benthic community tends to dominate invertebrate production in these environments (Horne and Goldman 1994).

From Keeyask environmental studies, Stephens Lake was found to have similar zooplankton diversity as other Nelson River lacustrine environments in the area, with Copepoda (predominately cyclopoids) dominating the community. However Stephen's Lake was found to have the lowest overall mean zooplankton abundance of the habitats sampled. In general zooplankton abundance was greatest in areas of standing water (secluded bays relatively isolated from flow in the Nelson River). Zooplankton data were not collected for Gull Rapids or smaller streams in the area. However, zooplankton abundance is expected to be low in such environments for the reasons stated above.

Aquatic Macroinvertebrates

Aquatic macroinvertebrates are small animals living on or in the substrata or within the water column of lakes and rivers. They are important food items to fish and useful bioindicators of environmental change. Macroinvertebrates are typically a diverse assemblage, and are adapted to a range of substrate types and water flow regimes.

From Keeyask environmental studies, 54 taxa of macroinvertebrates were observed in the Stephens Lake Area, and 93 taxa were observed in the Keeyask Area. The highest diversity in both areas occurred in the drift community, followed by the sediment community, and the lowest diversity was found in the plant-dwelling communities. The greatest densities of drifting invertebrates were observed upstream of Gull Rapids. Aquatic insects (mayflies, caddisflies, and chironomids) were the most abundant drift invertebrates. Chironomids, aquatic earthworms, and amphipods were commonly found in both the sediments and associated with the plants.

Aquatic insects dominated the community in south shore tributaries of Stephens Lake, with caddisflies, diptera, and mayflies typically the most common. Snails were found occasionally as well.

3.2.4 Fish Habitat and Fish Community

Fish habitat is defined in the *Fisheries Act* as "Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes". Fish habitat is typically classified on the basis of water depth, water velocity, substrate type, and cover (including large rooted plants, terrestrial debris, riparian vegetation, and other large structures). These characteristics determine whether individuals, communities, and populations of fish and other aquatic biota can find the biophysical features they need for life, such as suitable areas for reproduction, feeding sites, resting sites, cover from predators and adverse environmental conditions, movement corridors, and overwintering. The biophysical characteristics of the habitat play a large role in determining the species composition and sustainable biomass of the biotic community.

Fish habitat within the study area is largely characterized by the Nelson River, consisting of both **lotic** habitats, such as Gull Rapids, and **lentic** habitats, such as Gull and Stephens Lake. Waterbodies south of Stephens Lake, such as the Butnau and Kettle rivers, are also included. The following description of the study area is based upon that presented in the Keeyask Environmental Studies Program (Keeyask Hydro Power Partnership 2012). The existing environment was based on the period 1977 to 2006, while biological components were based on field studies conducted from 1997 to 2006.

Fish community assessments were conducted as part of the Keeyask Environmental Studies Program from 1997-2008 (Keeyask Hydro Power Partnership 2012) within the Keeyask Generation Project study area (of which the transmission study area is a part of). A total of 37 fish species were identified as occurring in the study area (Table 3-1). The principal large-bodied species included walleye, sauger, northern pike, yellow perch, burbot, lake whitefish, cisco, longnose sucker, white sucker, and lake sturgeon, while the most common small-bodied species included spottail shiner, emerald shiner, and trout-perch.

Stephens Lake

Stephens Lake can be divided into a northern and southern portion. The northern arm was formed by flooding from the Kettle Generating Station, and consists of lentic habitat. The southern portion consists of the original river channel flowing eastward into the Kettle Generating Station forebay. Lotic conditions occur in the southern portion under higher inflow conditions, especially in the western half of the reservoir. The reservoir is wider and relatively deep in the eastern half.

Both mineral and organic-based substrates are found in the lake. The western half, including the north arm, contains a large amount of flooded terrestrial habitat and has predominantly silt or fine organic material substrates. However the eastern side of the north arm is relatively deep and retains much of its original rocky shoreline and mineral-based substrates. Substrates within the eastern portion of the lake consist primarily of fine silt depositional materials; however, granular (sand/gravel) materials are found in clay along both the north and south shorelines.

Aquatic plants were found frequently in standing water areas, and showed a strong affinity for clay and organic based substrata. No plants were observed on inundated peat. Nine species of macrophytes were observed within Stephens Lake. *Potamogeton richardsonii* was most common, and showed a strong affinity for clay substrata and was found at depths mainly below the IEZ (intermittently exposed zone). *Myriophyllum sibiricum* was also common, and showed a preference for areas with fine organic deposits that are commonly found at the ends of flooded bays.

A total of 23 fish species were captured in the Stephens Lake area. The most abundant large-bodied fish included walleye, northern pike, and white sucker, and the most abundant forage species included spottail shiner, trout-perch, and rainbow smelt. Lake sturgeon were also among the species captured. Large-bodied fish **catch-per-unit-effort (**CPUE) was considerably higher in the north arm compared to the old Nelson River channel, but there was little difference in the use of nearshore and offshore habitat for foraging in either area. **Forage fish** were more abundant in offshore habitat in the north arm of the lake and in nearshore habitat in the old Nelson River channel. Cisco and burbot were found spawning in Stephens Lake.

Walleye were found throughout the Stephens Lake area and were an important component of the fish community. Potential spawning habitat existed in Gull Rapids, the upper reaches of tributaries draining into the lake, and Ferris Bay. Potential rearing habitat existed throughout the lake in nearshore areas with shallow, low velocity water and soft substrates. Potential foraging habitat existed throughout the lake, with more walleye found in the north arm compared to the old Nelson River channel. The lake also provided overwintering habitat for walleye.

Northern pike were also found throughout the Stephens Lake area and were an important component of the fish community. Potential spawning habitat existed in Gull Rapids and tributaries draining into the lake. Potential rearing habitat existed in the southern portion of the lake in nearshore habitat with shallow, low velocity waters, soft substrates, and macrophyte cover. In the northern portion of the lake rearing habitat existed in both flooded main basin and flooded bays with macrophytes/woody debris. Potential foraging habitat existed in nearshore areas with macrophytes/woody debris in both the south and North sections of the lake. Potential overwintering habitat existed throughout the lake in its numerous off-current bays with low water velocity.

Lake whitefish were found throughout the Stephens Lake area, however they did not make up a large component of the fish community. Potential spawning habitat existed in Gull Rapids and tributaries draining into the lake. Spawning may also occur along reefs and islands throughout the lake (FLCN 2010). Rearing habitat existed in the lake, however it was unclear where it occurred. Potential foraging habitat occurred in the deep open water habitat in flooded main basin areas (north arm). The lake also provided suitable overwintering habitat.

Lake sturgeon were found within Stephens Lake, although not in as large of numbers as in other areas of the Nelson River mainstem. They were captured mainly in western portion of the old Nelson River mainstem. Suitable rearing habitats existed over sand/gravel substrates and low velocity. Suitable foraging and overwintering habitats existed in low velocities. However no suitable spawning habitat existed in the lake.

Gull Rapids

Gull Rapids is the largest set of rapids in the Keeyask area. There are several islands and channels located in the rapids, with new channels being cut periodically due to the erosive forces of ice and water. Most of the flow passes through the south channel, with little to no flow through the north channel during low Nelson River discharge. However all channels include rapid and turbulent flows. Between the rapids and Stephens Lake there is an approximately 6.0 km long reach that, although affected by the Kettle reservoir, remains a lotic environment with moderate water velocity. The substrate and shoreline of Gull Rapids are composed of bedrock and boulders. Macrophyte habitat is limited within and downstream of the rapids.

A total of 32 fish species were captured in or immediately below Gull Rapids. Abundant large-bodied species below the rapids were walleye, sauger, and northern pike. Lake sturgeon was also among the large-bodied species caught. Abundant forage fish species below the rapids were emerald shiner, trout-perch, and spottail shiner. The use of riverine habitat below the rapids for foraging was approximately twice the level as in riverine habitat upstream of the rapids. Numerous species of large-bodied fish spawned in the rapids, including lake whitefish, lake sturgeon, white sucker, longnose sucker, yellow perch, freshwater drum, mooneye, northern pike, walleye, and sauger. Forage fish that spawned in the rapids included cyprinids, cottids, rainbow smelt, trout-perch, logperch, stickleback, and darters. At least seven species of forage fish were caught in Gull Rapids Creek, including longnose dace, brook stickleback, fathead minnow, and emerald shiner. Numerous young-of-the-year (YOY) of longnose sucker were caught in the creek, which were likely part of a resident population of the unnamed headwater lake.

Walleye were an important component of the fish population in the rapids. They were also found in Pond 13 but not in Gull Rapids Creek. The rapids provided important spawning and foraging habitat, however they were likely limited in potential rearing and overwintering habitat.

Northern pike were present in Gull Rapids but they did not make up an important component of the population in the rapids. They were also found in Pond 13 and Gull Rapids Creek. The rapids provided important spawning habitat, however they were likely limited in potential rearing, foraging, and overwintering habitat.

Lake whitefish were a seasonally important component of the population, with large numbers congregating in the fall for spawning. However rearing, foraging, and overwintering did not occur to a large extent within the rapids. They were also found in Pond 13.

Lake sturgeon were found throughout Gull Rapids. Suitable spawning habitat existed, with most fish spawning along the edges of the main channel. Suitable foraging habitat also existed, however no suitable rearing or overwintering habitat existed within the rapids.

Streams South of Stephens Lake

The Butnau and Kettle rivers, as well as several other smaller creeks south of Stephens Lake were assessed as part of the Keeyask Environmental Studies Program. Stream assessments were also conducted as part of the Keeyask Transmission Project in 2009. Most smaller creeks assessed were found to have pool habitat with low water velocities, and wide, saturated floodplains. They usually drained upstream bog/fen areas, and/or small headwater lakes. Beaver activity was common, and substrates were usually fine organics. Cover was abundant in the form of instream and overhanging vegetation.

The upper reaches of the Butnau and Kettle rivers were similar to the smaller creeks, with low water velocities, soft substrates, and abundant cover. Lower reaches of the Kettle River were shallow, with moderate water velocity, and rocky substrate. The Butnau River Diversion Channel's habitat was similar to the Kettle River's lower reaches (Johnson and Barth 2007).

The Butnau and Kettle rivers were found to be used extensively by northern pike, with suitable spawning habitat found in both rivers in areas with low to moderate velocity environments, variable water depths, soft substrates, and submerged vegetation. Walleye were relatively uncommon in both rivers; however suitable spawning habitat existed in the Butnau River diversion channel and the lower Kettle River. White and longnose sucker were found to spawn in both rivers as well. Lake whitefish were uncommon in the Kettle/Butnau river system.

The smaller creeks were found to support forage fish species such as brook stickleback, fathead minnow, and longnose dace. Potential forage, spawning, and rearing habitat existed for forage fish, and overwintering potentially occurred in deeper pools. Northern pike were also captured in some of the smaller creeks. These creeks were characterized by minimal flows after spring **freshet**, and stagnant conditions due to beaver dams, low stream gradients, and broad floodplains. Most creeks likely froze to the bottom in winter in most areas. Use by large-bodied fish was likely limited by these low water conditions.

Table 3-1: Fish species captured in the Keeyask Study Area (as indicated by an X), 1997–2008

Common Name	Scientific Name	Abbreviation	Keeyask Area	Stephens Lake Area
Blacknose shiner	*Notropis heterolepis*	BLSH	X	
Brook stickleback	*Culaea inconstans*	BRST	X	
Burbot (mariah)	*Lota lota*	BURB	X	X
Common carp (carp)	*Cyprinus carpio*	CMCR	X	X
Cisco (tullibee)	*Coregonus artedi*	CISC	X	X
Emerald shiner	*Notropis atherinoides*	EMSH	X	X
Fathead minnow	*Pimephales promelas*	FTMN	X	
Finescale dace	*Chrosomus neogaeus*	FNDC	X	
Freshwater drum	*Aplodinotus grunniens*	FRDR	X	X
Goldeye	*Hiodon alosoides*	GOLD	X	
Iowa darter	*Etheostoma exile*	IWDR	X	
Johnny darter	*Etheostoma nigrum*	JHDR	X	
Lake chub	*Couesius plumbeus*	LKCH	X	X
Lake sturgeon (sturgeon)	*Acipenser fulvescens*	LKST	X	X

Table 3-1: Fish species captured in the Keeyask Study Area (as indicated by an X), 1997–2008

Common Name	Scientific Name	Abbreviation	Keeyask Area	Stephens Lake Area
Lake whitefish (whitefish)	*Coregonus clupeaformis*	LKWH	X	X
Logperch	*Percina carprodes*	LGPR	X	
Longnose dace	*Rhinichthys cataractae*	LNDC	X	X
Longnose sucker (red sucker)	*Catostomus catostomus*	LNSC	X	X
Mooneye	*Hiodon tergisus*	MOON	X	X
Mottled sculpin	*Cottus bairdii*	MTSC	X	
Ninespine stickleback	*Pungitius pungitius*	NNST	X	X
Northern pearl dace	*Margariscus nachtriebi*	PRDC	X	
Northern pike (jackfish)	*Esox lucius*	NRPK	X	X
Northern redbelly dace	*Chrosomus eos*	NRDC	X	
Rainbow smelt (smelt)	*Osmerus mordax*	RNSM	X	X
River darter	*Percina shumardi*	RVDR	X	
Sauger	*Sander canadensis*	SAUG	X	X
Shorthead redhorse	*Moxostoma macrolepidotum*	SHRD	X	X
Silver lamprey	*Ichthyomyzon unicuspis*	SLLM	X	X
Slimy sculpin	*Cottus cognatus*	SLSC	X	X
Spoonhead sculpin	*Cottus ricei*	SPSC	X	
Spottail shiner	*Notropis hudsonius*	SPSH	X	X
Trout-perch	*Percopsis omiscomaycus*	TRPR	X	X
Walleye (pickerel)	*Sander vitreus*	WALL	X	X
Western blacknose dace	*Rhinichthys obtusus*	WBDC	X	
White sucker (mullet)	*Catostomus commersonii*	WHSC	X	X
Yellow perch (perch)	*Perca flavescens*	YLPR	X	X

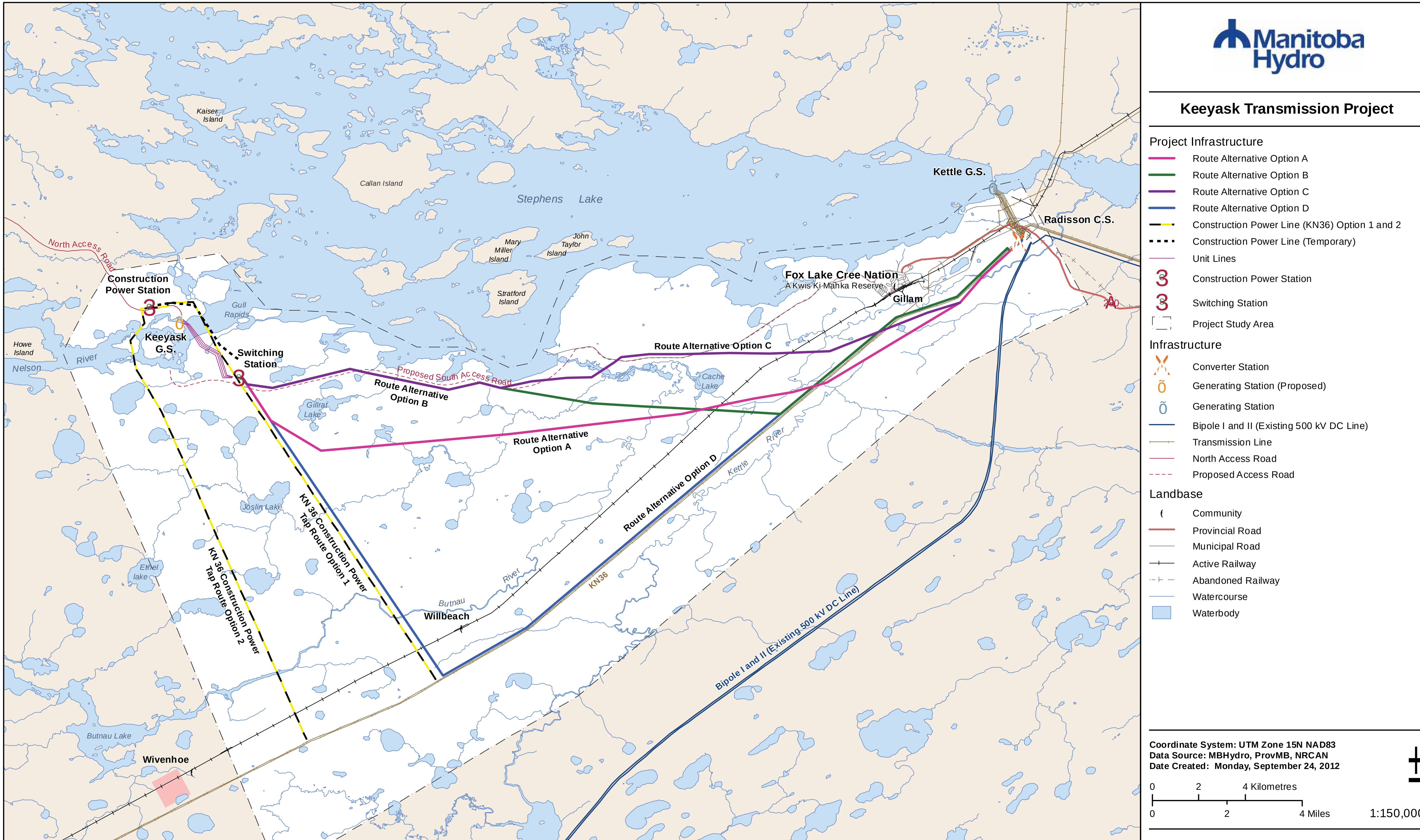
Source: Keeyask Hydro Power Partnership, 2012.

3.2.5 Aquatic Species at Risk

From a biodiversity and conservation perspective, the Keeyask Transmission Study Area is not unique. The area is similar to the aquatic environment in much of the northern boreal forest of Manitoba, Ontario, and western Quebec. Within the lower trophic communities investigated as part of the Keeyask environmental studies, no ‘species of conservation concern’ were identified.

This term includes species that are rare, disjunct (discontinuous or separated distribution), or at risk throughout their range, or the portion of their range within Manitoba, and in need of further research. Also included are species listed under *The Manitoba Endangered species Act* (MBESA) and the *Species At Risk Act* (SARA), and those that have special designation by the Committee On the Status of Endangered Wildlife In Canada (COSEWIC).

Lake sturgeon occur throughout the study area in the riverine and lacustrine portions of the Nelson River. First Nations have identified lake sturgeon as a culturally important species. It has also been assessed as a heritage species in Manitoba and recently, western Canada lake sturgeon populations (i.e., those in Manitoba, Saskatchewan, and Alberta) have been assessed as ‘endangered’ by COSEWIC. Presently, lake sturgeon is under consideration for being listed under Schedule 1 of Canada’s Species at Risk Act (SARA). The area also has one introduced species; the rainbow smelt, which was first reported in Stephens Lake in 1996 (Remnant et al. 1997).



Study Area

Map 3-1

4.0 EVALUATION OF ALTERNATIVE ROUTES AND OTHER INFRASTRUCTURE

4.1 FISH HABITAT ASSESSMENTS

Fish habitat assessments were conducted along two proposed construction power alternative routes, one unit line route and four generation outlet transmission line routing options. A description of water courses at and adjacent to the preferred construction power station and preferred switching station are also provided. Fish habitat descriptions at each watercourse crossing are summarized below and in tables 4-1 through 4-7.

4.1.1 Construction Power Alternative Route 1

Fish habitat assessments were conducted at five watercourse crossings (46, 13, 15, 18, 19) located along construction power alternate route #1 (CP 1), from 22 to 23 July, 2009. Detailed stream crossing summaries, including representative photographs, are provided in Appendix C. The habitat descriptions provided below are listed in order, travelling from south to north along the proposed route (Map 4-1).

Site 46

At Site 46, the ROW crosses an unnamed watercourse/wetland area fed by a 1 m wide man-made channel. The channel originates at a small lake located adjacent to an existing rail line. The channel may have been constructed for additional drainage of the existing rail line to prevent localized flooding. The ROW's wetland area discharges into a tributary of the Kettle River. Kettle River is approximately 9 km downstream from the crossing area and is a known fish-bearing river.

The surveyed reach consisted of pool habitat with abundant cover, dominated by LWD and submerged and emergent aquatic vegetation. In general, this wetland would have minimal water flow throughout most of the year, with discernable flows only occurring during the spring freshet. Based on the distribution of submerged and emergent aquatic vegetation, maximum water depth was estimated at 1 m deep. Due to low water flows and depths, stagnation is suspected after the spring freshet. The floodplain was approximately 40 m wide and saturated. Floodplain vegetation was predominately grasses and willows, with small stands of black spruce.

During the spring, this wetland might provide usable spawning habitat for northern pike (*Esox lucius*), based on the water depth (the majority of the area being less than 1 m deep), abundance of aquatic vegetation, and proximity to the Kettle River. However, low DO concentrations suspected during the remainder of the year would likely exclude most fish from this area. Fish species tolerant of low DO levels that might inhabit this area include brook stickleback (*Culea inconstans*), lake chub (*Couesius plumbeus*), or fathead minnow (*Pimephales promelas*). This wetland area would not provide suitable overwintering habitat for fish; during winter, DO levels would likely be unsuitable for fish and the water might freeze to the bottom.

Site 13

At Site 13 the ROW crosses the Butnau River (Map 4-1). This section of the river had a straight channel pattern, was approximately 20 m wide, and consisted of run habitat with low-moderate water flow. Substrate and depth were not assessed; however, a previous assessment conducted on the Butnau River between Butnau and Cache lakes found that substrates were generally soft and water depths variable, with shallow sections of the river interspersed with deeper pools (Johnson and Barth 2007). Channel banks were well-vegetated along the channel margins (predominantly with willows) providing the majority of cover for fish. Riparian vegetation consisted of willows and black spruce.

The Butnau River is a perennial watercourse that is known to support several large-bodied fish species, including longnose sucker (*Catostomus catostomus*), white sucker (*Catostomus commersoni*), northern pike, and walleye (*Sander vitreus*). Lake whitefish (*Coregonus clupeaformis*) have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007). Specifically, Johnson and Barth (2007) confirmed that longnose sucker, white sucker, and northern pike utilize the reach of Butnau River between Butnau and Cache lakes for spawning.

The ROW area had marginal spawning habitat: whitefish prefer coarser substrate; water velocities would generally be too slow for suckers, trout, and walleye spawning; and the lack of instream vegetation precludes pike spawning. However, rearing was rated moderate due to the area’s low water velocity and available cover. The fish overwintering potential was rated low due to the lack of pool habitat.

Site 15

At Site 15, the ROW crosses an unnamed tributary to the Butnau River. The watercourse is fed by Joslin Lake approximately 2.5 km upstream, and flows east to an unnamed lake approximately 4.5 km downstream (Map 4-1). The confluence with the Butnau River is located 16.5 km downstream.

The surveyed reach had a regular **meander** channel pattern that was approximately 10 m wide and consisted of flat/slow run habitat. At the time of the survey, the channel was flooded, creating large off-current pool habitat. Maximum water depths were estimated at 1.5 m deep, but most of the surveyed area was shallower. Instream fish cover was abundant, provided mainly by instream vegetation and LWD. Aquatic vegetation identified from the aerial survey included water arum, water lilies, and grasses. The floodplain was also saturated, containing large pools of standing water. Beyond the floodplain, vegetation consisted primarily of black spruce and willows.

Due to the high levels of instream vegetation, the watercourse might be suitable for spawning and rearing of northern pike. Presence of northern pike has not been confirmed for this watercourse or Joslin Lake; however, northern pike have been confirmed downstream in the Butnau River (Johnson and Barth 2007).

As the seasons progress during the year, it is anticipated that water levels would decrease and that deep pool areas would become limited in the surveyed area. However, water flow conditions would likely be sufficient to maintain adequate DO concentrations for fish utilization of the area year-round. Based on this, the overwintering potential of this reach was rated moderate for small-bodied fish (e.g., cyprinids) and low for large-bodied fish.

Site 18

Site 18 is located on an unnamed tributary to the Nelson River. This tributary is fed by a small lake located approximately 450 m upstream of the ROW, and flows northeast entering the Nelson River approximately 2 km downstream (Map 4-1).

This watercourse was characterized as a perennial, low gradient, bog drainage with a broad saturated floodplain. The channel width varied from 1 to 4 m wide and the floodplain was approximately 200 m wide. At the crossing, there was a large beaver dam creating pool habitat upstream. However, there was water flow around the dam that would likely permit fish passage upstream. Maximum water depth of the crossing area was estimated at 1.5 m deep, but the majority of the watercourse was likely less than 1 m deep. The substrate consisted of soft fines and organic material. Cover was abundant, dominated by instream vegetation. Floodplain vegetation was primarily floating sphagnum, grasses, rushes and water arum.

During the spring, this wetland might provide usable spawning and rearing habitat for northern pike and small-bodied forage fish (e.g., cyprinids), based on the shallow water depths, abundance of aquatic vegetation, and proximity to the Nelson River. Water flows and pool depths would likely be insufficient to provide overwintering habitat; specifically, winter DO levels would likely become unsuitable for fish or the water might freeze to the bottom. Fish passage between the crossing site and the Nelson River would be impeded by beaver dams and potential low water flows. Passage might be limited to higher freshet water levels that occur during spring.

Site 19

Site 19 is located on the Nelson River, between Gull Rapids and Stephens Lake. At the crossing site, the channel width was approximately 810 m wide. Substrate was not sampled, but presumed to be scoured by the moderate to high water current in this area and consist of bedrock, boulder and cobble. The banks were vertical, comprised of sand and generally unstable with evidence of erosion. Within the surveyed reach, riparian and floodplain vegetation was dominated by mature black spruce. Gull Rapids, located upstream from the crossing location, and the various bays/backwater areas within the vicinity of the crossing provide a diversity of aquatic habitat (i.e., pool, run, riffle habitat).

The Nelson River supports a diverse fish community, providing suitable spawning, rearing and overwintering habitats. Between Gull Rapids and Stephens Lake, common large-bodied fish species include lake whitefish, longnose sucker, northern pike, walleye, and white sucker (MacDonald 2007, Pisiak 2005). Common small-bodied species include emerald shiner (*Notropis atherinoides*), rainbow smelt (*Osmerus mordax*), spottail shiner (*N. hudsonius*), and trout perch (*Percopsis omiscomaycus*) (Pisiak 2005). Lake sturgeon (*Acipenser fulvescens*) have also been captured in this reach of the Nelson River and use the Gull Rapids area for spawning and rearing (Barth and Ambrose 2006, Barth and Murray 2005, Barth and Mochnacz 2004). Spawning and rearing habitat in this section of the Nelson River was rated moderate-high, based on the diversity of available water velocities, substrates, and water depths. Overwintering habitat was rated low as the area lacked discrete deep pool habitat.

4.1.2 Construction Power Alternative Route 2

Fish habitat assessments were conducted at ten watercourse crossings (1, 2, 3, 4, 5, 6, 8, 9, 10,11) located along construction power alternate route #2 (CP 2), from 21 to 22 July, 2009. Detailed stream crossing summaries with representative photographs are provided in Appendix C. The habitat descriptions provided below are listed in order, travelling from north to south along the proposed route.

Site 1

The ROW at Site 1 crosses a portion of the Nelson River between Gull Lake and Gull Rapids. The proposed crossing runs approximately 325 m from a point on the north side of the Nelson River to an unnamed mid-channel island located immediately upstream from William Smith Island (Map 4-1). This is a shallow, fast flowing section of water situated between sets of rapids.

Generally, substrate in this section of the Nelson River was bedrock, boulder and cobble with some clay and silt in off-current bays (MacDonald 2007). At the crossing site, shoreline substrate was mostly comprised of boulders and gravel. The channel banks were sloping and stable. Riparian vegetation was dominated by mature black spruce, which also extended beyond the riparian zone.

The Nelson River supports numerous sport and forage fish species. The water flow (moderate), depth (generally less than 5 m deep) and substrate (boulder and cobble) in this reach of the river might be suitable for lake sturgeon, sucker, and walleye spawning. Spawning was rated high. However, the high water velocities in the area would not be preferred for fish rearing/feeding, which was rated moderate. Overwintering was rated low due to the lack of off-current pool habitat.

Site 2

The Site 2 ROW begins on the south side of the Site 1 island and crosses to the south shore of the Nelson River (Map 4-1). This section of river channel was approximately 300 m wide and characterized by fast flowing water and rapids. Substrate in this section of the Nelson River was comprised mostly of bedrock and boulders. The channel banks were sloping and stable. Riparian vegetation was dominated by mature black spruce, which extended beyond the riparian zone.

High water velocities in this river reach likely precludes fish utilization. Spawning, rearing, and overwintering were rated low. However, sensitive fish habitats occur immediately downstream; i.e., sturgeon spawning and rearing (Barth and Ambrose 2006, Barth and Murray 2005, Barth and Mochnacz 2004).

Site 3

At Site 3, the ROW crosses the upper reach of Gull Rapids Creek. The creek is fed by a lake 70 m upstream of the ROW, and flows northeast approximately 2.3 km to the Nelson River. The ROW area was characterized as wetland drainage, consisting of a series of channels interconnecting shallow marshy pools. Water flow was low and the substrate was mainly organic material. Instream cover was high (estimated at 70-80%), consisting primarily of emergent, submerged and floating vegetation (e.g., grasses, sedges, rushes and marsh calla). Riparian vegetation was predominately black spruce and shrubs. The floodplain was broad and saturated with extensive areas of standing water.

Fish species most common in Gull Rapids Creek include northern pike, suckers and small-bodied species, such as brook stickleback, Iowa darter (*Etheostoma exile*), longnose dace (*Rhinichthys cataractae*), and pearl dace (*Margariscus margarita*) (Cassin and Remnant 2008, Kroeker and Jansen 2005).

During spring, the ROW area of this creek might provide usable spawning and rearing habitat for northern pike and small-bodied forage fish, based on the water depth (the majority of the area being less than 1 m deep), abundance of aquatic vegetation, and proximity to the Nelson

River. However, water flows and pool depths would likely be insufficient to provide fish overwintering habitat.

Site 4

At Site 4, the ROW crosses wetland habitat that connects two small lakes, located 160 m upstream and 710 m downstream (Map 4-1). The ROW area was mostly shallow pond habitat that had numerous interconnecting channels. Aquatic vegetation within the ROW area consisted primarily of grasses and sedges. Willows were present along the edge of the wetland, with mixed forest extending beyond the wetland boundary. The floodplain was saturated and approximately 135 m wide.

The wetland might provide suitable habitat for spawning and rearing of northern pike and small-bodied forage fish, particularly near the outlet of the upstream lake. However, fish presence in the area is unknown. Overwintering was rated poor for all fish species, as pool depths and DO levels would be inadequate. Low water levels anticipated during summer and fall might also impede fish movements to the ROW area.

Site 5

The Site 5 ROW crosses an unnamed wetland area influenced by beaver activity. This area is fed by an unnamed lake, located approximately 750 m upstream, and drains south to a tributary of Joslin Lake.

The ROW area was mostly shallow (< 1.5 m deep), vegetated pool habitat. Vegetation included floating, submerged and emergent aquatic vegetation (e.g., sedges, marsh calla, and grasses). There were willows along the wetland margins with black spruce extending beyond the floodplain.

The wetland might provide suitable habitat for spawning and rearing of northern pike and small-bodied forage fish, particularly near the outlet of the upstream lake. However, fish presence in the area is unknown. The wetland would not provide adequate water depth for overwintering fish. In general, the ROW area might provide seasonal fish habitat for small-bodied fish that overwinter in the small lake located upstream. No obstructions to fish passage were observed.

Site 6

At Site 6, the ROW crosses a wetland area that drains into Joslin Lake. This wetland also has upstream connectivity to Ethel Lake. At the crossing, the wetland was shallow pool habitat with abundant cover for fish (approximately 60%). Cover was mostly comprised of instream vegetation with small amounts of woody debris. Instream vegetation was predominately grasses, sedges, and marsh calla. Riparian vegetation was dominated by black spruce. The floodplain was 100-150 m wide and saturated.

This wetland might provide suitable habitat for spawning and rearing of northern pike and small-bodied forage fish; however, presence of fish in the area is unknown. The wetland would not provide adequate water depth for overwintering fish. Evidence of beavers was observed in the area (i.e., presence of a beaver lodge), but no obstructions to fish passage were identified.

Site 8

The Site 8 crossing is located on an unnamed watercourse that is fed by a small lake approximately 530 m upstream, and has downstream connectivity to a tributary of Joslin Lake (Map 4-1). The crossing consisted of a wetland area characterized by a series of shallow pools connected by poorly defined channels. There was abundant instream cover for fish, provided mostly by aquatic vegetation. The floodplain was saturated throughout and approximately 75-100 m wide.

During the spring, the Site 8 crossing area could provide suitable spawning and rearing habitat for northern pike and small-bodied forage fish. Overall, this wetland area might provide some seasonal habitat for pike and small-bodied fish, but was too shallow for overwintering.

Site 9

At Site 9, the ROW crosses a small, shallow unnamed lake (Map 4-1). The lake is connected to a smaller water body approximately 250 m upstream and to larger lake approximately 400 m downstream. Drainage from this lake eventually reaches Joslin Lake approximately 5.2 km downstream.

The lake was approximately 300 m long and 200 m wide and estimated to be less than 5 m deep. The substrate was soft fines and detritus and there was abundant fish cover provided by instream vegetation and water depth. In general, a 50 m wide grass margin surrounded the lake, which transitioned to willows and then mature black spruce forest.

During the spring, this watercourse might provide usable spawning and rearing habitat for northern pike and small-bodied forage fish, based on the shallow water depths, low water flows, abundance of aquatic vegetation, and proximity to potentially fish-bearing water bodies downstream. Water flows and pool depths would likely be insufficient to provide overwintering habitat; specifically, winter DO levels would likely be unsuitable for fish or the water might freeze to the bottom.

Site 10

Site 10 crosses a small unnamed watercourse situated between two small, shallow water bodies. The crossing is approximately 400 m downstream of one water body and approximately 75 m upstream from the other. At the ROW, the watercourse was a flooded wetland area, with a broad saturated floodplain. Water flow was negligible and the crossing area was mostly shallow pool habitat. Maximum water depth was estimated at 1 m deep and substrates were likely fines and organic material. Cover for fish was abundant, consisting primarily of emergent aquatic vegetation, with woody debris and overhanging vegetation being subdominant. Riparian vegetation included young and mature conifers, Labrador tea, tamarack, and sphagnum moss.

During the spring, this watercourse might provide usable spawning and rearing habitat for northern pike and small-bodied forage fish, based on the shallow water depths, low water flows, abundance of aquatic vegetation, and proximity to potentially fish-bearing water bodies downstream. Water flows and pool depths would likely be insufficient to provide overwintering habitat; specifically, winter DO levels would likely be unsuitable for fish or the water might freeze to the bottom.

Site 11

At Site 11, the ROW crosses the Butnau River, approximately 5.5 km downstream of Butnau Lake (Map 4-1). At the crossing, the channel was straight and approximately 80 m wide. The presence of floating aquatic vegetation indicated the majority of habitat was pool or flat. Stream substrates were generally soft and water depths variable in the section of river between Butnau Lake and Cache Lake (Johnson and Barth 2007). Channel banks were well-vegetated with willows. These willows and aquatic macrophyte growth along the channel margins provided the majority of cover for fish. Riparian vegetation predominately consisted of grasses, willows and black spruce.

The Butnau River is a perennial watercourse that supports several large-bodied fish species, including longnose sucker, northern pike, walleye, and white sucker. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007). Specifically, longnose sucker, northern pike, and white sucker spawn in the river (Johnson and Barth 2007). The flat/pool habitat and macrophyte beds typical of the crossing area provided suitable habitat for northern pike spawning and rearing. Water depths at the crossing site would be adequate to overwinter fish.

4.1.3 Unit Transmission Line

Fish habitat assessments were conducted at two watercourse crossings located along unit transmission line route (UT), on 21 July, 2009. The two crossings are at Sites 18 and 19. Refer to section 4.1.1 for fish habitat assessments.

4.1.4 Generation Outlet Transmission Alternative Route Option A

Fish habitat assessments were conducted along four generation outlet transmission line routing options. Descriptions of the shared crossings are not repeated in the following sections.

Stream crossing assessments were conducted at ten sites located along GOT route option A from 21 to 24 July, 2009 (48, 30, 43, 31, 32, 33, 35, 37, 38, 47). Detailed stream crossing summaries, including representative photographs are provided in Appendix C. The habitat descriptions provided below are listed in order, travelling from west to east along the proposed route.

Site 47

Site 47 is located upstream on the same watercourse as Site 38 (Map 4-1). This watercourse provides drainage of a small lake approximately 200 m upstream and flows to a larger lake 500 m downstream. Similar to Site 38, Site 47's crossing area was generally a low gradient wetland, characterized by a series of shallow pools with indiscernible water flow. A moderate amount of cover was available for fish, consisting mostly of flooded and instream vegetation. The floodplain was broad and saturated, vegetated predominately by willows and grasses. Mature black spruce forest extended beyond the riparian zone.

During the spring, this wetland might provide usable spawning habitat for northern pike and small-bodied forage fish, based on the water depth (the majority of the area being less than 1 m deep), abundance of aquatic vegetation, and proximity to larger water bodies. After the spring freshet, low DO concentrations suspected during the remainder of the year would likely exclude most fish from the area. Only small-bodied forage fish species tolerant of low DO levels likely inhabit this area. During winter, DO levels would likely be unsuitable for fish or the water might freeze to the bottom.

Site 38

At Site 38, the ROW crosses an unnamed wetland drainage that has downstream connectivity to the Butnau River (19 km downstream). This watercourse provides drainage of a small lake approximately 200 m upstream and flows to a larger lake 1 km downstream. The crossing area was characterized by a series of shallow pools with indiscernible water flow. Cover for fish was abundant, consisting of flooded/overhanging willows, instream vegetation, and LWD. The floodplain was broad and saturated, vegetated predominately by willows and grasses with lesser amounts of black spruce and tamarack. Mature black spruce forest extended beyond the floodplain. A large beaver dam was identified approximately 300 m downstream from the crossing that might impede fish passage upstream under low flow conditions.

Historical fish information for this watercourse was not available; however, unidentified small-bodied forage fish were observed in a pool located downstream from the dam during the field survey. During the spring, this crossing area might provide usable spawning habitat for northern pike and small-bodied forage fish (e.g., cyprinids and brook stickleback), based on the water depth (the majority of the area being less than 1 m deep), abundance of aquatic vegetation, and proximity to larger water bodies. After the spring freshet, stagnation would likely occur resulting in low DO concentrations, which would exclude most fish from this area. Only small-bodied forage fish species tolerant of low DO levels likely inhabit this area. During winter, DO levels would likely be unsuitable for fish or the water might freeze to the bottom.

Site 37

At Site 37, the ROW crosses an unnamed tributary to the Butnau River. At the crossing area, this watercourse had a sinuous pattern and an 8-10 m wide channel. Channel banks were low, stable, and well-vegetated with grasses and willows. Cover for fish was abundant, provided mostly by flooded/overhanging willows. The area consisted mostly of slow, moderately deep run and flat habitat, with riffles occurring at shallow locations where LWD had accumulated. The riparian area was dominated by willows, which transitioned to black spruce at the floodplain margin.

Historical fish information was not available for this watercourse. However, there was unimpeded downstream connectivity to the Butnau River (~6 km downstream), which is known to support lake whitefish, longnose sucker, northern pike, walleye, and white sucker (Johnson and Barth 2007). The ROW area provided marginal spawning habitat for most fish, e.g., water velocities would be too slow for suckers and walleye; lack of instream vegetation precludes pike spawning. Rearing habitat was rated moderate-high due to low water velocity and available cover. Overwintering potential was rated low-moderate; the water would likely remain well-oxygenated during winter, but deep pool habitat was lacking.

Site 35

At Site 35, the ROW crosses the Butnau River approximately 3.4 km upstream from Cache Lake. The site was characterized as slow, deep run habitat with a soft substrate composed of fine material. The channel was 11-14 m wide with low (< 2 m high), stable, well-vegetated banks. There was limited canopy cover in the riparian zone due to a previous forest fire. Riparian vegetation was regenerating and consisted of willows and young black spruce. Instream cover was low, provided mostly by instream and overhanging vegetation.

The Butnau River supports several large-bodied fish species, including longnose sucker, northern pike, walleye, and white sucker. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth, 2007). The ROW area had marginal spawning habitat: whitefish prefer coarse substrate; water velocities would generally be too slow for suckers, trout, and walleye spawning; and the lack of instream vegetation precludes pike spawning. However, rearing was rated moderate due to the area’s low water velocity and some available cover. The fish overwintering potential was rated low due to the lack of pool habitat.

Site 33

At Site 33, the ROW crosses the Butnau River diversion channel, approximately 970 m downstream from Cache Lake. The channel was man-made, constructed to divert flows from the Butnau River to the Kettle River. The diversion channel is a perennial watercourse.

The crossing area had a 13-15 m wide, straight channel that was comprised of deep/fast run habitat. The substrate was mostly fines, with small amounts of gravel and cobble. Cover for fish was low in abundance, provided mostly by instream, flooded, and overhanging vegetation. The surveyed area had moderately sloped, stable banks (less than 5 m high) and a narrow floodplain. Riparian vegetation was predominately black spruce with lesser amounts of dwarf alder, horsetail, and grasses. Floodplain vegetation was mostly black spruce and tamarack.

Longnose sucker, northern pike, and white sucker have been identified from the diversion channel (Johnson and Barth 2007, Lavergne 2011). Other fish identified from the Butnau River that could potentially utilize the diversion channel include lake whitefish and walleye (Johnson and Barth 2007).

The ROW area provided marginal spawning and rearing habitat for most fish due the run-type habitat, substrate of fines, and low amount of cover. Overwintering potential was rated low-moderate; the water would likely remain well-oxygenated during winter, but pool habitat was lacking.

Site 32

At Site 32, the ROW crosses the Butnau River diversion channel, 500 m upstream from its confluence with the Kettle River. The diversion channel is 4 km long and was constructed to redirect flows from the Butnau River to the Kettle River via Cache Lake.

At the crossing site, the channel was 14 m wide, characterized by riffle habitat and cobble-dominated substrate. There was a moderate amount of cover for fish, provided mostly by surface turbulence and shoreline vegetation. Generally, the area in the vicinity of the crossing had steep, unstable left banks and more gradually sloped, stable right banks. At the ROW, channel banks were vegetated to the water's edge and appeared stable. Other features at the site included: a set of rapids approximately 250 m downstream from the ROW; and a gravel side-bar approximately 85 m downstream of the ROW along the right bank.

Longnose sucker, northern pike, and white sucker have been identified from the diversion channel (Johnson and Barth 2007, Lavergne, 2011). Other fish that inhabit the Butnau River and could potentially utilize the diversion channel include lake whitefish and walleye (Johnson and Barth 2007). Small fish (unidentified) were also observed at the ROW area during the field survey.

The ROW area's relatively shallow, riffle, and cobble/gravel habitat was rated as moderate-quality spawning habitat for walleye and sucker species. However, rearing and overwintering potential was rated low due to the area's high water velocity and lack of pools, respectively.

Site 31

The ROW at Site 31 crosses the Kettle River, approximately 1 km upstream from the confluence with the Butnau River diversion channel. Within the vicinity of the ROW, the Kettle River was approximately 14 m wide, sinuous, and relatively deep with low water flow velocities. At the time of the survey, cover was moderate, provided by water depth and overhanging/flooded bank vegetation. The banks were less than 5 m high, gradually sloped, vegetated (predominantly willows) and stable. However, immediately downstream of the ROW, the left bank was high (approximately 20 m high), steep, sandy, and eroding. The riparian vegetation consisted of willows near the river and transitioned to mature black spruce at the floodplain margin. Riparian vegetation was cleared downstream of the proposed crossing site for an existing transmission line corridor.

The Kettle River supports several large-bodied species, including northern pike, sucker, and walleye. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007, Lavergne 2012, Lavergne, 2011, Swanson 1986). The ROW area would provide marginal spawning habitat for most fish (e.g., water velocities would be too slow for suckers, walleye, and lake whitefish; lack of instream vegetation precludes pike spawning). However, rearing and overwintering potential was rated moderate due to water depth and available cover.

Site 43

At Site 43, the ROW crosses the upper reach of an unnamed tributary to the Kettle River (Kettle River approximately 1.7 km downstream of crossing). This watercourse provides intermittent drainage for a low lying/boggy area. At the time of the survey, the crossing area consisted of a series of discontinuous, small, shallow pools that eventually drain to larger ponds approximately 800 m downstream. The floodplain was broad and poorly drained.

At the crossing location, potential fish utilization was considered low, based on the intermittent nature of the watercourse and discontinuous channel.

Site 30

At Site 30, the ROW crosses a small unnamed tributary to Boots Creek (Map 4-1). The watercourse drains a small headwater lake approximately 180 m upstream of the crossing site, and drains into Boots Creek approximately 2.3 km downstream. The surveyed reach had a channel width of 0.4-2.0 m, was mostly run-pool habitat, had a maximum water depth of 0.6 m, and had a cobble-dominated substrate. There was a moderate amount of cover for fish, provided mostly by LWD. Additional cover types included instream and overhanging vegetation. Crown closure was high (approximately 75%), consisting of mature black spruce. Approximately 185 m downstream of the ROW, the watercourse widened into a wetland surrounded by a broad, saturated floodplain. Approximately 110 m upstream from the crossing was an old beaver dam that could be a potential barrier to fish passage under low flow conditions.

Spawning and rearing habitat was rated low for large-bodied fish (e.g., northern pike, sucker, and walleye) and moderate for small-bodied fish (e.g., cyprinids). Fish overwintering potential of this site was also low due to the lack of deep pool habitat and the possibility of the watercourse freezing to the bottom during winter.

Site 48

At Site 48, the ROW is located on the Kettle River, 4 km downstream from the Kettle River Weir. The channel was sinuous and fast flowing in this section of the river, with the majority of habitat consisting of riffle and fast run. Channel width was approximately 20 m with a floodplain width of 30 to 40 m. Substrate was not assessed, but within this section of the Kettle River substrates generally consist of cobble, boulder and bedrock (Johnson and Barth 2007). Channel banks were approximately 3-5 m high, well-vegetated, and stable. Riparian vegetation was dominated by black spruce, with willows, grasses and aspen also present.

The Kettle River provides year-round habitat for fish, including northern pike, suckers, and walleye. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007, Lavergne 2011, 2012, Swanson 1986). The ROW area's high water velocities and water depths provided moderate spawning habitat for walleye and lake whitefish, but sucker generally prefer slower, shallower water. Rearing was rated poor for most fish species due to the high water velocities and lack of cover; the lack of pools precluded the area as potential overwintering habitat.

4.1.5 Generation Outlet Transmission Alternative Route Option B

Stream crossing assessments were conducted at 14 sites located along GOT route option B on 23 to 25 July, 2009 (21, 22, 49, 23, 40, 41, 36, 42, 33, 32, 31, 43, 30, 48). GOT B shared its eastern most alignment with GOT A (Map 4-1). This included sites 33, 32, 31, 43, 30, and 48 (Section 4.1.4). Detailed stream crossing summaries with representative photographs are provided in Appendix C. The habitat descriptions provided below are listed in order, travelling from west to east along the proposed route.

Site 21

At Site 21, the ROW crosses an unnamed tributary to Stephens Lake. The watercourse provides drainage for a small lake located approximately 300 m upstream, and flows 820 m northeast to Stephens Lake (Map 4-1).

At the crossing location, the watercourse was mostly wetland habitat with some channel formation upstream and downstream of the ROW. Water flow was minimal, water depth was generally less than 1 m deep, the substrate was mostly organic material, and instream cover was primarily aquatic vegetation. The floodplain was 150 m wide, saturated boggy area (consisted primarily of sphagnum moss and grasses). Beyond the floodplain, riparian vegetation was dominated by mature black spruce.

During the spring, this wetland might provide usable spawning habitat for northern pike and small-bodied forage fish, based on the water depth (the majority of the area being less than 1 m deep), abundance of aquatic vegetation, and proximity to Stephens Lake. However, low DO concentrations suspected during the remainder of the year would likely exclude most fish from this area. This wetland area would not provide suitable overwintering habitat for fish; during winter, DO levels would likely be unsuitable for fish or the water might freeze to the bottom.

Site 22

At Site 22, the ROW crosses an unnamed watercourse between Stephens Lake (450 m downstream) and Gilliat Lake (1.8 km upstream). The surveyed reach was a beaver influenced wetland area that was mostly pool habitat. Pools were generally shallow (< 1 m deep) with some deeper impoundments created by beaver dams (~ 2 m deep). The dams were old and unlikely a barrier to fish passage. There was moderate amounts of instream cover for fish, provided by flooded, overhanging, and instream vegetation. The floodplain was poorly drained and approximately 30 m wide.

During the spring, this wetland might provide usable spawning habitat for northern pike and some small-bodied forage fish, based on the water depth (the majority of the area being <1 m deep), abundance of aquatic vegetation, and proximity to Stephens Lake. However, low DO concentrations caused by water stagnation during the remainder of the year would likely exclude most fish from this area. This wetland area would not provide suitable overwintering habitat for fish; during winter, DO levels would likely be unsuitable for fish or the water might freeze to the bottom.

Site 49

At Site 49, the ROW crosses an unnamed watercourse that drains to Stephens Lake (600 m downstream). At the crossing area, the watercourse had a 1 m wide channel consisting of shallow (< 1 m deep) flat habitat with mostly organic substrate. Cover was moderate, composed of overhanging vegetation, instream vegetation, and undercut banks. There was pool habitat immediately downstream from the crossing location that was created by a series of old beaver dams. These dams potentially limit fish movement from Stephens Lake to the crossing area.

During the spring, the crossing area might provide usable spawning and rearing habitat for northern pike and small-bodied forage fish, based on the water depth (the majority of the area being less than 1 m deep), abundance of aquatic vegetation, and proximity to Stephens Lake; however, beaver dams likely impede upstream fish movements to this area. Fish spawning and rearing was rated low-moderate. The crossing area would not provide suitable overwintering habitat for fish due to the lack of pool habitat, potential for stagnation, and possibility of the water freezing to the bottom.

Site 23

At Site 23, the ROW crosses a man-made channel constructed from the base of the Butnau dyke at Stephens Lake to a small lake approximately 260 m inland. The channel was likely built to prevent water accumulation at the base of the dyke by backwatering drainage inland. Prior to construction of the dyke, a natural watercourse from the small inland lake drained into Stephens Lake.

At the crossing location, the channel was 2.9 m wide with a maximum water depth of 1.2 m. There was a high level of cover for fish, provided mostly by instream vegetation. The floodplain was160 m wide, poorly drained, and dominated by sedges and grasses. This vegetation transitioned to mature black spruce forest at the floodplain margins. Connectivity to other drainages was undetermined.

Fish utilization of this channel and its drainage area might be limited to what remained in the area following dyke construction. Due to the low water levels, likelihood of low winter DO levels, and the possibility of the area freezing to the bottom during winter, only small-bodied fish species tolerant of these conditions likely inhabit this area. Fish habitat was considered marginal.

Site 40

At Site 40, the ROW crosses an unnamed tributary to the Butnau River; the confluence is 1.8 km downstream. The site is located on an irregular meander section of the watercourse that drains an area of relatively new growth forest (i.e., previous forest fire area). The channel was flooded; channel width was approximately 7 m and wetted width was 20 m. Due to this area's low gradient, the construction of the Butnau Dam and consequential rise of Butnau River water levels likely caused backwater flooding of the Site 40 crossing area. The flooded channel might also be attributed to a rise in water table that can result from forest fires.

The crossing area was mostly flat habitat, with a maximum water depth of less than 1.5 m. There was a moderate level of cover that was provided by flooded vegetation (predominately willows), LWD, and instream aquatic vegetation. Substrate was not assessed, but the observed low water flow and instream plant growth was indicative of soft substrates. Riparian vegetation consisted of willows, grasses, poplar, and black spruce.

Historical fish information was not available for this watercourse. However, fish species inhabiting the Butnau River could potential utilize this tributary. Butnau River fish species include lake whitefish, longnose sucker, northern pike, walleye, and white sucker (Johnson and Barth 2007). The ROW area provided marginal spawning habitat for most fish; whitefish prefer coarse substrate; sparse instream vegetation precludes pike spawning; and water velocities would be too slow for suckers and walleye. Rearing habitat was rated moderate due to low water velocity and available cover. Overwintering potential was low due to the lack of deep pool habitat.

Site 41

Site 41 crosses a wetland area/bog drainage. The wetland is fed by a small shallow lake approximately 250 m upstream. Downstream, the wetland eventually drains to the Site 40 unnamed tributary to the Butnau River (~ 1 km downstream). Connection to upstream and downstream water bodies was discontinuous.

The open-water area was approximately 15 wide, less than 1 m deep, and had substrates composed of fines and organic material. Wetted areas contained abundant cover for fish, consisting of aquatic vegetation and LWD. The floodplain was approximately 30 m wide, saturated, with vegetation consisting primarily of sphagnum moss, grasses and willows. Young black spruce and poplar grew at the floodplain margins.

Spawning, rearing, and overwintering were rated low for all fish due to the potential stagnation of the wetland caused by low water depth and flows.

Site 36

At Site 36, the ROW crosses the Butnau River. The crossing site was situated on a straight section of the river that consisted mostly of flat habitat and slow, moderately deep, run habitat. The river bottom was composed mostly of fines. The channel was 10-15 m wide with low (~ 3 m high), stable, well-vegetated banks. Cover for fish was low, provided mainly by flooded and overhanging willows. Riparian vegetation in the surveyed reach consisted predominately of willows and grasses.

The Butnau River supports several large-bodied fish species, including longnose sucker, northern pike, white sucker, and walleye. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007). The ROW area had marginal spawning habitat for large-bodied fish: whitefish prefer coarse substrate; water velocities would generally be too slow for suckers, trout, and walleye spawning; and the lack of instream vegetation precludes pike spawning. However, rearing was rated moderate due to the area’s low water velocity and some available cover. The fish overwintering potential was rated low due to the lack of pool habitat.

Site 42

At Site 42, the ROW crosses a wetland area that provides drainage for a small, shallow lake (approximately 25 m upstream) and the adjacent low-lying boggy area. Water flows north to Cache Lake, located 660 m downstream from the crossing site. Connection to upstream and downstream water bodies was discontinuous.

The wetland’s open-water area ranged from 1-20 m wide, was less than 1 m deep, and had substrates composed of fines and organic material. Wetted areas contained abundant cover for fish, consisting of aquatic vegetation and LWD. The floodplain was approximately 50 m wide, saturated, with vegetation consisting primarily of sphagnum moss, grasses and willows.

Spawning, rearing, and overwintering were rated low for all fish due to the discontinuous channel and the potential stagnation of the wetland caused by low water depth and flows.

4.1.6 Generation Outlet Transmission Alternative Route Option C

Fish habitat assessments were conducted at seven watercourse crossings located along GOT route option C on 21 to 25 July, 2009 (21, 22, 49, 23, 24, 26, 48). GOT C option shared its western and eastern most section of ROW with the proposed GOT B and GOT A ROW (Map 4-1). This included sites 21, 22, 49, 23 (Section 4.1.5) and 48 (Section 4.1.4). Detailed stream crossing summaries with representative photographs are provided in Appendix C. The habitat descriptions provided below are listed in order, travelling from west to east along the proposed route.

Site 24

Site 24 is located on what was historically the lower reach of the Butnau River approximately 1.7 km downstream (west) of the Butnau Dam. The Butnau Dam was built at the outlet of the Butnau River to redirect water flow through Cache Creek and into the Kettle River (via the Butnau River diversion channel) (Map 4-1). Backwatering the lower reach of the Butnau River flooded the channel creating a wide, more lacustrine environment.

At the crossing area, the original channel was evident and estimated to be 40 m wide with a maximum water depth of approximately 5 m deep. Outside of the original channel, the crossing had a 100-150 m wide, shallow (< 2 m) flooded area. Cover was abundant, provided mostly by the flooded terrestrial vegetation. Additional cover types included LWD, aquatic vegetation, and pool depth.

The river is known to support longnose sucker, northern pike, walleye, and white sucker. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007). At the crossing site, aquatic and flooded terrestrial vegetation provided suitable spawning habitat for northern pike. Spawning habitat was marginal for other large-bodied fish species; whitefish prefer coarse substrate, and water velocities would generally be too slow for suckers, trout, and walleye spawning. However, rearing was rated high due to the area's low water velocity and abundant cover. The fish overwintering potential was rated moderate due to the presence of deeper water areas.

Site 26

At Site 26, the ROW crosses the Kettle River, 2.3 km downstream from the confluence with Butnau River diversion channel. The crossing is located in a straight, moderately fast flowing deep run section of the Kettle River. The channel was approximately 12 m wide, but water depth was not estimated. Substrate at the crossing location was also not assessed, but in this Kettle River area the substrate generally consists of cobble, boulder and bedrock (Johnson and Barth 2007). Cover for fish was available in low amounts, provided mainly by flooded and overhanging. Channel banks were approximately 5 m high, well-vegetated, and stable. Riparian vegetation was dominated by mature black spruce.

The Kettle River provides year-round habitat for fish, including northern pike, suckers, and walleye. Lake whitefish have also been documented from the system, and there is suitable spawning habitat available; however spawning studies have not been undertaken (Johnson and Barth 2007, Lavergne 2012, Lavergne 2011, Swanson 1986). The ROW area's moderate water velocities and water depths provided moderate spawning habitat for walleye and lake whitefish. However, sucker generally prefer shallower water depths, and pike require lower water velocity and more instream vegetation. Rearing potential was rated low based on the small amount of cover. Overwintering potential was also low due to the lack of deep pool habitat.

4.1.7 Generation Outlet Transmission Alternative Route Option D

Fish habitat assessment field studies were conducted at eight watercourse crossings located along GOT route option D (15, 13, 46, 54, 53, 52, 51, 48). GOT D option shared its northern most section of ROW with the proposed CP 1 ROW and its easter most section with GOT A (Map 4-1). This included sites 13, 15 and 46 in the CP 1 assessment (Section 4.1.1) and sites 31 and 48 in the GOT A assessment (Section 4.1.4). Detailed stream crossing summaries with representative photographs are provided in Appendix C. The habitat descriptions provided below are listed in order, travelling from west to east along the proposed route.

Site 54

Site 54 crosses an an unnamed tributary of the Kettle River. The site location is on the same watercourse as Site 46, only 4 and 2 km further downstream with similar habitat. The channel originates at a small lake located adjacent to an existing rail line. The channel may have been constructed for additional drainage of the existing rail line to prevent localized flooding. The ROW's wetland area discharges into a tributary of the Kettle River. Kettle River is approximately 4 km downstream from the crossing area and is a known fish-bearing river.

The ROW consisted of pool habitat with abundant cover. In general, this wetland stream would have minimal water flow throughout most of the year, with discernable flows only occurring during the spring freshet. Due to low water flows and depths, stagnation is suspected after the spring freshet. The floodplain was approximately 200 m wide with side channels and pools. A defined stream channel was not visible through its length to the confluence with the Kettle River, with numberous beaver dams visible.

During the spring, this wetland might provide usable spawning habitat for northern pike (*Esox lucius*). However, low DO concentrations suspected during the remainder of the year would likely exclude most fish from this area. Fish species tolerant of low DO levels that might inhabit this area include brook stickleback (*Culea inconstans*), lake chub (*Couesius plumbeus*), or fathead minnow (*Pimephales promelas*). This wetland area would not provide suitable overwintering habitat for fish; during winter, DO levels would likely be unsuitable for fish and the water might freeze to the bottom.

Site 53

Site 53 crosses an an unnamed secondary tributary of the Kettle River. The water course drains a small pond into an unnamed tributary of the Kettle River (Site 46, and 54 water course). The water course eventually drains to the Kettle River is approximately 4 km downstream from the crossing area.

The ROW consisted of wetland habitat with no apparent channel. In general, this wetland stream would have minimal water flow throughout most of the year, with discernable flows only occurring during the spring freshet. Due to low water flows and depths, stagnation is suspected after the spring freshet. The floodplain was approximately 100 m wide with small pools visible.

During the spring, this wetland might provide usable spawning habitat for northern pike (*Esox lucius*). However, low DO concentrations suspected during the remainder of the year would likely exclude most fish from this area. Fish species tolerant of low DO levels that might inhabit this area include brook stickleback (*Culea inconstans*), lake chub (*Couesius plumbeus*), or fathead minnow (*Pimephales promelas*). This wetland area would not provide suitable overwintering habitat for fish; during winter, DO levels would likely be unsuitable for fish and the water might freeze to the bottom.

Site 52

Site 52 crosses an an unnamed pond. This small pond (155 x 60 m) appears to be isolated with possible discontinuous connection to the Butnau River approximately 4 km away.

The ROW crosses the pond where the channel is 155 m. The area consists of poorly drained bog wetland habitat. Fish use would be restricted by access from downstream areas and winter DO concentrations. Species tolerant of low DO levels may make year-round use of the pond and this would be restricted to brook stickleback (*Culea inconstans*), lake chub (*Couesius plumbeus*), or fathead minnow (*Pimephales promelas*), and possibly northern pike (*Esox lucius*).

Site 51

Site 51 crosses the Kettle River immediately downstream of the KN 36 crossing and approximately 200 m downstream of Site 31 crossing. Considering the absence of field studies at Site 51 and its close proximity to Site 31, the habitat assessment for Site 51 will be considered similar to Site 31 (Section 4.1.4).

4.1.8 Construction Power Station

Desktop assessment of the Construction Power Station preferred site 6 footprint and study area were conducted. No watercourses were found within the footprint (Map 4-2). The landscape consists of forest and shrubs areas with numerous cut-lines. The area appeared to contain wet areas, but standing water or drainage was not visible.

The Nelson River at Gull Rapids lies 363 m south of the site and therefore fell within the 1 km^2 study area. This area has turbulent flow consisting of run, riffle, and rapid habitat. Substrate and shoreline consists of bedrock and boulders, and there is little macrophyte habitat. Within Gull Rapids and directly downstream common large-bodied fish species include lake whitefish, longnose sucker, northern pike, walleye, and white sucker (MacDonald 2007, Pisiak 2005). Common small-bodied species include emerald shiner, rainbow smelt, spottail shiner, and trout perch (Pisiak 2005). Lake sturgeon have also been captured in this reach of the Nelson River and use the Gull Rapids area for spawning and rearing (Barth and Ambrose 2006, Barth and Murray 2005, Barth and Mochnacz 2004). Spawning and rearing habitat in this section of the Nelson River was rated moderate-high, based on the diversity of available water velocities, substrates, and water depths. Overwintering habitat was rated low as the area lacked discrete deep pool habitat.

A small wetland area with apparent connection to Pond 13 is located 129 m north of the site. This wetland area contains standing water with a marginally discernible channel, but is not likely to provide fish habitat and was not assessed further.

4.1.9 Generation Outlet Switching Station

Desktop assessment of the Switching Station preferred site footprint and study area were performed. No watercourses were found within the footprint or the 1 km^2 study area of the site (Map 4-2). The closest watercourse is an unnamed lake 1.1 km east of the site, whereas Gull Rapids Creek lies 1.3 km west, and the Nelson River 1.9 km north. The landscape consists of forest and open shrubs areas, but did not contain standing water.

4.2 SENSITIVITY OF FISH AND FISH HABITAT

The Sensitivity of Fish and Fish Habitat ratings were based on the fish sensitivity ratings in Appendix B, the preceding crossing site habitat assessments, and professional judgement. These ratings are summarized in Tables 4-1 to 4-7 for each crossing site, by proposed routing option.

Low Sensitivity:

Sites characterized as shallow wetland areas and wetland/bog drainages, which provided moderate spawning habitat potential only for northern pike and small-bodied forage fish, were rated as Low based on the following:

- *Species Sensitivity*: Fish species potentially utilizing these watercourses had a Low-Moderate sensitivity rating (Appendix B);
- Species' Dependence on Habitat: This type of low gradient, poorly drained, shallow aquatic habitat was common in the Study Area and used for a range of life requisites by species potentially present; not critical habitat; therefore, fish species have a Low dependence on this habitat.
- Rarity: Low - Although northern pike is rated as a moderately sensitive fish species, it is prevalent in the Study Area.
- Habitat Resiliency: Low – These wetland/bog drainages have limited water flow the majority of the year, have abundant instream vegetation, and non-erodible banks. These generally make the system stable and resilient to change and perturbation.

Crossings with this rating included:

- CP 1: Sites 18 and 46;

- CP 2: Sites 3, 4, 5, 6, 8, 9, and 10;
- UT: Site 18;
- GOT A: Sites 30, 38, 43, and 47;
- GOT B: Sites 21, 22, 23, 40, 41, 42, and 49;
- GOT C: Sites 21, 22, 49, and 23; and,
- GOT D: Sites: 15, 46, 54, 53, 52.

Low-Moderate Sensitivity:

These watercourses were similar to crossings rated as Low, i.e., had a Low-Moderate Species Sensitivity, had a Low Species' Dependence on Habitat, and Rarity of the habitat and fish was Low. However, these were larger watercourses with more of a cool water thermal regime resulting in a Moderate Habitat Resiliency. This increased their overall sensitivity rating to Low-Moderate

One crossing site was rated as Low-Moderate:

- GOT A: Site 37.

Moderate Sensitivity:

At these sites, the proposed ROWs crossed larger watercourses, including small to medium sized rivers and large man-made channels (i.e., Butnau River diversion). These watercourses had the potential to support more fish species than lower rated watercourses, including lake whitefish and walleye. This increased the Species Sensitivity rating to Moderate-High, but Species Dependence on Habitat remained Low, Rarity of the habitat and fish was Low, and Habitat Resiliency was Moderate.

A Moderate Sensitivity of Fish and Fish Habitat rating was assigned to the following crossing sites:

- CP 1: Site 13;
- CP 2: Site 11;
- GOT A: Sites 31, 33, and 35;
- GOT B: Site 36, 33. Amd 31;

- GOT C: Site 24;
- GOT D: Sites 13, and 51.

Moderate-High Sensitivity:

The ROW at these sites crossed medium to large sized rivers and a section of the Butnau River diversion. At these sites, Species Sensitivity was Moderate-High, Species Dependence on the area was Low-Moderate, Rarity was Low-Moderate, and Habitat Resiliency was Moderate-High. Sites received a Moderate Species Dependence rating if the area was specifically used for spawning, but was not critical. Moderate Rarity was assigned to areas potentially utilized by lake sturgeon. Habitat Resiliency was Moderate-High based on the majority of the site's area consisting of gravel/cobble riffle/run habitat, which would be more vulnerable to changes in environmental conditions.

The highest overall sensitivity rating was Moderate-High, which included the following sites:

- CP 1: Site 19;
- CP 2: Sites 1 and 2;
- UT: Site 19
- GOT A: Sites 32, and 48;
- GOT B: Sites 32 and 48;
- GOT C: Sites 26 and 48; and
- GOT D: Site 48.

Table 4-1: Summary of Fish and Fish Habitat Sensitivity at CP 1 stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 46	unnamed tributary of Kettle River	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 13	Butnau River	Perennial	small river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Low-Moderate	Moderate
Site 15	unnamed tributary of Butnau River	Perennial	low gradient boreal stream	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low-Moderate	Low
Site 18	unnamed tributary of Nelson River	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 19	Nelson River	Perennial	large river	lake sturgeon, northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Moderate	High	Moderate-High

Table 4-2: Summary of Fish and Fish Habitat Sensitivity at CP 2 stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 1	Nelson River	Perennial	large river	lake sturgeon, northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Moderate	High	Moderate-High
Site 2	Nelson River	Perennial	large river	lake sturgeon, northern pike, suckers, walleye, whitefish	Moderate-High	Low	Moderate	High	Moderate-High
Site 3	Gull Rapids Creek	Perennial	wetland/bog drainage	cyprinids, Iowa darter, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 4	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback, suckers	Low-Moderate	Low	Low	Low	Low
Site 5	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 6	unnamed tributary of Joslin Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 8	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 9	unnamed lake	Perennial	small shallow lake	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low

Table 4-2: Summary of Fish and Fish Habitat Sensitivity at CP 2 stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 10	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low`
Site 11	Butnau River	Perennial	small river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate

Table 4-3: Summary of Fish and Fish Habitat Sensitivity at UT stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 18	unnamed tributary of Nelson River	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 19	Nelson River	Perennial	large river	lake sturgeon, northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Moderate	High	Moderate-High

Table 4-4: Summary of Fish and Fish Habitat Sensitivity at GOT A stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 47	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 38	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 37	unnamed tributary of Butnau River	Perennial	low gradient boreal stream	cyprinids, northern pike, stickleback, suckers	Low-Moderate	Low	Low	Moderate	Low-Moderate
Site 35	Butnau River	Perennial	small river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Low-Moderate	Moderate
Site 33	Butnau River diversion channel	Perennial	man-made channel	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate
Site 32	Butnau River diversion channel	Perennial	man-made channel	northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Low	Moderate-High	Moderate-High
Site 31	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate
Site 43	unnamed tributary of Kettle River	Intermittent	wetland/bog drainage	cyprinids, stickleback	Low	Low	Low	Low	Low
Site 30	unnamed tributary of Boots Creek	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 48	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Low	Moderate-High	Moderate-High

Table 4-5: Summary of Fish and Fish Habitat Sensitivity at GOT B stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 21	unnamed tributary of Stephens Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 22	unnamed tributary of Stephens Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 49	unnamed tributary of Stephens Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 23	man-made drainage channel	Perennial	man-made channel	cyprinids, stickleback	Low	Low	Low	Low	Low
Site 40	unnamed tributary of Butnau River	Perennial	low gradient boreal stream	cyprinids, northern pike, stickleback, suckers	Low-Moderate	Low	Low	Low-Moderate	Low
Site 41	unnamed watercourse	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 36	Butnau River	Perennial	small river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate
Site 42	Unnamed tributary of Cache Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 33	Butnau River diversion	Perennial	man-made channel	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate

Table 4-5: Summary of Fish and Fish Habitat Sensitivity at GOT B stream crossing sites.

	channel								
Site 32	Butnau River diversion channel	Perennial	man-made channel	northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Low	Moderate-High	Moderate-High
Site 31	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate
Site 43	unnamed tributary of Kettle River	Intermittent	wetland/bog drainage	cyprinids, stickleback	Low	Low	Low	Low	Low
Site 30	unnamed tributary of Boots Creek	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 48	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Low	Moderate-High	Moderate-High

Table 4-6: Summary of Fish and Fish Habitat Sensitivity at GOT C stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 21	unnamed tributary of Stephens Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 22	unnamed tributary of Stephens Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 49	unnamed tributary of Stephens Lake	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 23	man-made drainage channel	Perennial	man-made channel	cyprinids, stickleback	Low	Low	Low	Low	Low
Site 24	Butnau River	Perennial	small river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate
Site 26	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate-High	Moderate-High
Site 48	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Low	Moderate-High	Moderate-High

Table 4-7: Summary of Fish and Fish Habitat Sensitivity at GOT D stream crossing sites.

Site #	Watercourse	Flow Regime	General Habitat	Potential Fish Present at Crossing Area	Species Sensitivity	Dependence on Habitat	Rarity	Habitat Resiliency	Overall Sensitivity Rating
Site 15	unnamed tributary of Butnau River	Perennial	low gradient boreal stream	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low-Moderate	Low
Site 13	Butnau River	Perennial	small river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Low-Moderate	Moderate
Site 46	unnamed tributary of Kettle River	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 54	unnamed tributary of Kettle River	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 53	unnamed tributary of Kettle River	Perennial	wetland/bog drainage	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 52	Unnamed pond	Perennial	Isolated pond	cyprinids, northern pike, stickleback	Low-Moderate	Low	Low	Low	Low
Site 51	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Low	Low	Moderate	Moderate
Site 48	Kettle River	Perennial	medium sized river	northern pike, suckers, walleye, whitefish	Moderate-High	Moderate	Low	Moderate-High	Moderate-High

In summary, alternative CP 1 route crossed fewer watercourses (5), with half the number of crossings as CP 2 (10) (Table 4-8). Most of the crossings on both routes had low sensitivity ratings, with only a few moderate and moderate-high ratings. The CP 1 route had 1 moderate-high sensitivity crossings, and the CP 2 route had 2. Both routes had 1 moderate sensitivity crossing. From this analysis CP 1 is the preferred route from an aquatic environment perspective due to the lower number of water crossings.

Of the alternative GOT line routes, the GOT C route had the fewest watercourse crossing (7) and GOT D had the second fewest at 8 crossings. GOT A had a moderate number of crossings (10) and GOT B had the greatest number at 14 crossings (Table 4-8). Most of the crossings on all routes had low sensitivity ratings, with only a few moderate and moderate-high ratings. All routes had 2 moderate-high sensitivity crossings except for GOT D that only had 1 moderate-high crossing. Both GOT A and B had 3 moderate sensitivity crossings, while GOT D had 2 and GOT C had only 1. GOT A also had 1 low-moderate sensitivity crossing. From this analysis GOT C is the preferred route from an aquatic environment perspective, due to the lower number of water crossings, similar number of moderate-high sensitivity sites, and fewer moderate sensitivity sites as other alternative routes.

The Unit Transmission (UT) line had 2 water course crossings. The Nelson River crossing (Site 19) was rated as moderate-high sensitivity, whereas the unnamed tributarty (Site 18) was rated as low sensivity.

Both preferred station sites had no watercourses within their footprints. The Keeyask Switching Station also had no watercourses within its study area, while station Construction Power Station contained the Nelson River 363 m south of its footprint. The Nelson River at this location (site CPS 1) included Gull Rapids, and was given a moderate-high overall sensitivity rating. Species Sensitivity was Moderate-High, Species Dependence on the area was Moderate, Rarity was Moderate, and Habitat Resiliency was High. These ratings were based on the area’s use as a spawning area by sturgeon as well as other species, as well as the area consisting of grave/cobble rifle/run habitat, which would be more vulnerable to changes in environmental conditions.

Table 4-8: Summary of Keeyask Transmission Alternative Routes stream crossings and sensitivity ratings.

Route	Total stream crossings	Low sensitivity stream crossings	Low-Mod sensitivity stream crossings	Mod Sensitivity stream crossings	Mod-High Sensitivity stream crossings	High Sensitivity stream crossings
CP 1	5	3	0	1	1	0
CP 2	10	7	0	1	2	0
GOT A	10	4	1	3	2	0
GOT B	14	9	0	3	2	0
GOT C	7	4	0	1	2	0
GOT D	8	5	0	2	1	0

4.3 NAVIGABLE WATERS ASSESSMENT

Criteria 2 and 6, as described in Section 2.2.5 will be met for all watercourse crossings and therefore will not be included in further discussion. The remaining four criteria are discussed below for the transmission line components. A summary of sites that do not meet all the minor works criteria for aerial cables can be found in Table 4-9, and a summary of all sites can be found in Appendix E. Detailed stream crossing assessments of all sites can be found in Appendix C.

4.3.1 Unit Transmission

The UT route crossed two watercourses, one (site 19 – Nelson River) with a channel width greater than 15 m, and both within 1000 m of lakes. As such, neither site meets the criteria for inclusion as a minor works for aerial cables.

4.3.2 Construction Power

The CP 1 route crossed five watercourses, including two of the same crossed by the UT line. Two watercourses on the CP 1 route had channel widths greater than 15 m, and two were located within 1000 m of lakes. None of the watercourses crossed were charted navigable waters or canals. In total, three of the five stream crossings on the CP1 route did not meet the criteria for inclusion as a minor works for aerial cables. These included crossings of the Nelson River (site 19), the Butnau River (site 13), and a small headwater boreal stream connected to a small headwater pond (site 18).

4.3.3 Generation Outlet Transmission

The preferred GOT route crossed seven watercourses, three with channel widths greater than 15 m, and three within 1000 m of lakes. None of the watercourses crossed were charted navigable waters or canals. In total, five of the seven stream crossings on the preferred GOT route did not meet the criteria for inclusion as a minor works for aerial cables. These included crossings of three small headwater boreal streams connected to lakes (sites 21, 22, 49), the Butnau River (site 24) and the Kettle River (site 48).

Table 4-9: Watercourse crossings on Keeyask Transmission preferred routes that do not meet all the minor works criteria for aerial cables (Section 5 of Minor Works and Waters Order).

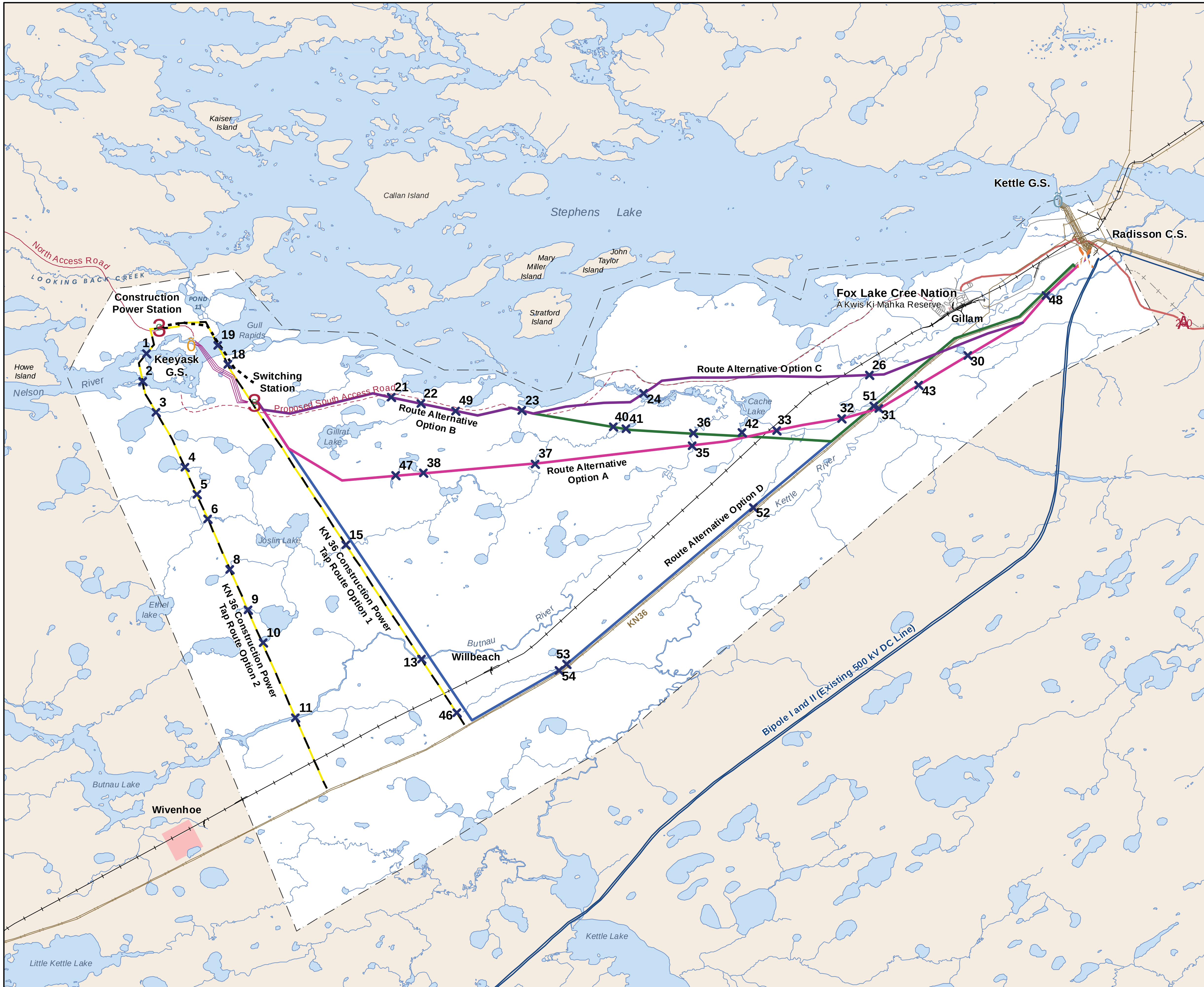
Site ID[1]	Latitude	Longitude	Waterbody	Channel Width (m)[2]	Channel Width <15 m	Meets CAN/CSA -C22-3 No 1-10	Site >1000 m from a lake	Not a Charted Water-course	Not a Canal	Poles Not in HWM
UT										
19	56° 20' 53.917" N	95° 11' 14.037" W	Nelson River	810	N	Y	N	Y	Y	Y
18	56° 20' 28.042" N	95° 10' 53.378" W	Unnamed Tributary of Nelson River	3	Y	Y	N	Y	Y	Y
CP										
19	56° 20' 53.917" N	95° 11' 14.037" W	Nelson River	810	N	Y	N	Y	Y	Y
18	56° 20' 28.042" N	95° 10' 53.378" W	Unnamed Tributary of Nelson River	3	Y	Y	N	Y	Y	Y
13	56° 13' 51.280" N	95° 4' 0.117" W	Butnau River	20	N	Y	Y	Y	Y	Y
GOT										
21	56° 19' 33.288" N	95° 4' 34.741" W	Unnamed Tributary of Stephens Lake	N/A	Y	Y	N	Y	Y	Y

Table 4-9: Watercourse crossings on Keeyask Transmission preferred routes that do not meet all the minor works criteria for aerial cables (Section 5 of Minor Works and Waters Order).

Site ID[1]	Latitude	Longitude	Waterbody	Channel Width (m)[2]	Channel Width <15 m	Meets CAN/CSA -C22-3 No 1-10	Site >1000 m from a lake	Not a Charted Water-course	Not a Canal	Poles Not in HWM
22	56° 19' 23.209" N	95° 3' 27.528" W	Unnamed Tributary of Stephens Lake	N/A	Y	Y	N	Y	Y	Y
49	56° 19' 11.146" N	95° 2' 7.071" W	Unnamed Tributary of Stephens Lake	1	Y	Y	N	Y	Y	Y
24	56° 19' 19.452" N	94° 54' 44.818" W	Butnau River	40	N	Y	Y	Y	Y	Y
48	56° 20' 54.266" N	94° 38' 50.441" W	Kettle River	20	N	Y	Y	Y	Y	Y

[1]Sites 19 and 18 appear twice since they serve both the UT and CP routes.

[2]Measured during site visit.



Manitoba Hydro

Keeyask Transmission Project

Project Infrastructure

- Route Alternative Option A
- Route Alternative Option B
- Route Alternative Option C
- Route Alternative Option D
- Construction Power Line (KN36) Option 1 and 2
- Construction Power Line (Temporary)
- Unit Lines
- Construction Power Station
- Switching Station
- Project Study Area

Infrastructure

- Converter Station
- Generating Station (Proposed)
- Generating Station
- Bipole I and II (Existing 500 kV DC Line)
- Transmission Line
- North Access Road
- Proposed Access Road

Aquatics

- Watercourse Crossings

Landbase

- Community
- Provincial Road
- Municipal Road
- Active Railway
- Abandoned Railway
- Watercourse
- Waterbody

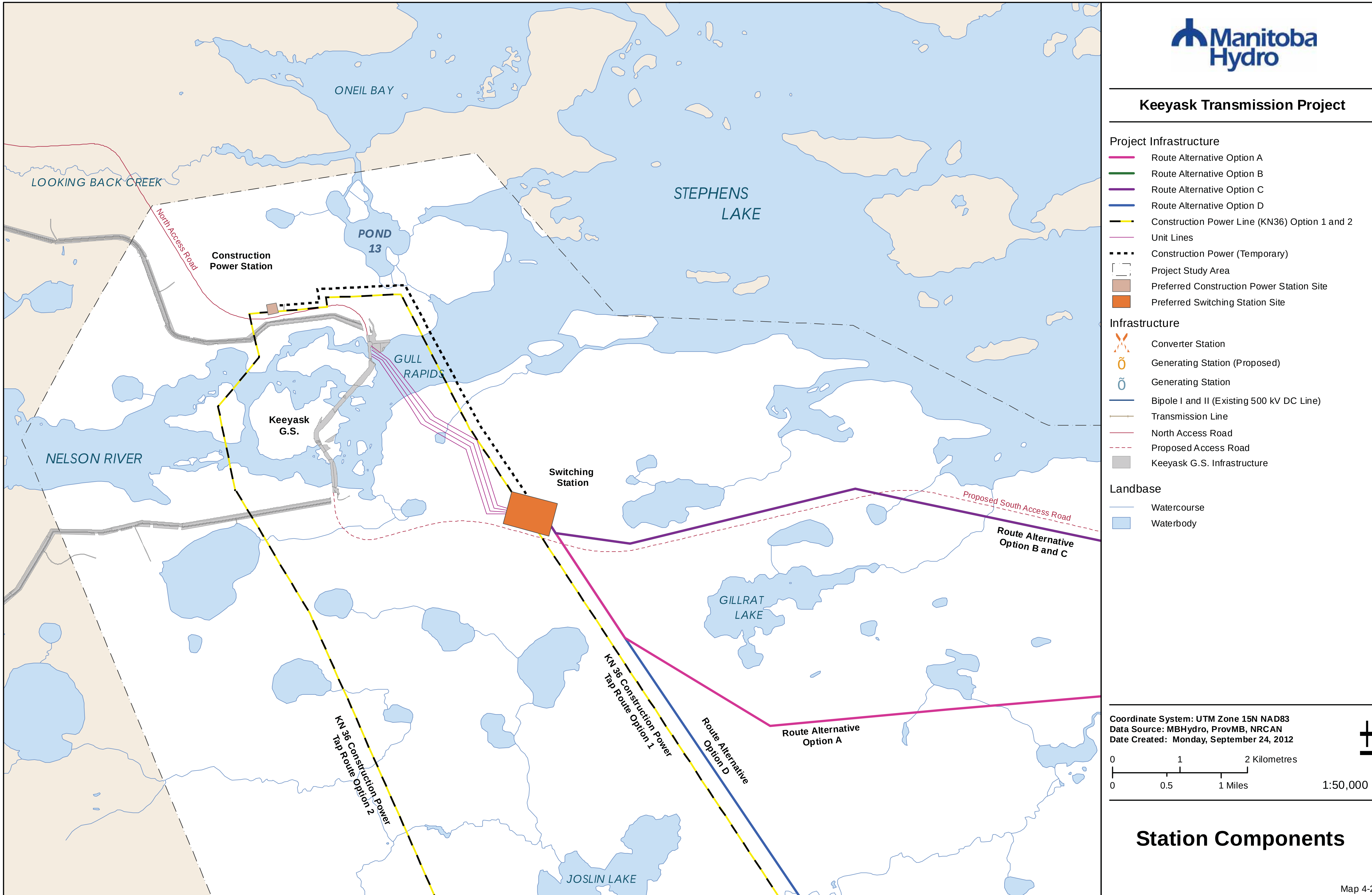
Coordinate System: UTM Zone 15N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date Created: Monday, September 24, 2012

0 2 4 Kilometres
0 2 4 Miles

1:150,000

Stream Crossing Locations

Map 4-1


ONEIL BAY
LOOKING BACK CREEK
STEPHENS LAKE
POND 13
North Access Road
Construction Power Station
GULL RAPIDS
Keeyask G.S.
NELSON RIVER
Switching Station
Proposed South Access Road
Route Alternative Option B and C
GILLRAT LAKE
KN 36 Construction Power Tap Route Option 1
KN 36 Construction Power Tap Route Option 2
Route Alternative Option D
Route Alternative Option A
JOSLIN LAKE
Manitoba Hydro
Keeyask Transmission Project
Project Infrastructure
Route Alternative Option A
Route Alternative Option B
Route Alternative Option C
Route Alternative Option D
Construction Power Line (KN36) Option 1 and 2
Unit Lines
Construction Power (Temporary)
Project Study Area
Preferred Construction Power Station Site
Preferred Switching Station Site
Infrastructure
Converter Station
Generating Station (Proposed)
Generating Station
Bipole I and II (Existing 500 kV DC Line)
Transmission Line
North Access Road
Proposed Access Road
Keeyask G.S. Infrastructure
Landbase
Watercourse
Waterbody
Coordinate System: UTM Zone 15N NAD83
Data Source: MBHydro, ProvMB, NRCAN
Date Created: Monday, September 24, 2012
0 1 2 Kilometres
0 0.5 1 Miles
1:50,000
Station Components
Map 4-2

5.0 EFFECTS AND MITIGATION

5.1 OVERVIEW

This chapter considers potential effects of the project based on the final preferred routes and sites for each project component. The selection process that resulted in the final preferred routes and sites is described in Chapter 6 of the EA Report.

The preferred GOT route follows Route B for most of the approximately 14 km of line extending eastward from the Keeyask Switching Station (Map 5-1); the remainder of the line extending to the Radisson Converter Station follows Option C. Construction Power Route 1 is the preferred option for the Construction Power line. The new Construction Power Station is located on the north side of the Nelson River and the preferred location for the new Keeyask Switching Station (Site 3) is on the south side of the Nelson River (Map 5-1). Power from the proposed Keeyask Generating Station will be delivered to the Switching Station by the four Unit transmission lines (Map 5-1).

Potential environmental effects were identified for the Valued Environmental Component (fish habitat) only. The identification of potential effects was based on the project description for each component of the project, review of available literature, and habitat assessment results. Potential effects are discussed, followed by proposed mitigation measures and then an assessment of residual effects and potential interations with future projects.

5.2 ENVIRONMENTALEFFECTS ASSESSMENT

5.2.1 Transmission Lines

There are five stream crossings on the preferred CP 1 route, two crossings on the UT route and seven crossings on the preferred GOT route. Fish and fish habitat sensitivity ratings for watercourses on the CP route are primarily Low (three) with one Moderate (Butnau River – site 13), and one Moderate-High (Nelson River – site 19). Fish and fish habitat sensitivity in watercourses on the preferred GOT route are also primarily Low (four), with one Moderate (Butnau River – site 24), and two Moderate-High (Kettle River – site 26 and Kettle River - site 48).

The loss of riparian vegetation, erosion causing sedimentation of watercourses, and the introduction of deleterious substances to watercourses are considered the greatest potential effects from the construction and operation of an overhead transmission line (BC EAO 2011, SaskPower 2009, DOE and DEQ 2008). These and other potential effects are discussed below. Moderate to Moderate-High sensitivity crossings are considered more sensitive to these effects;

if needed additional site specific precautionary protection measures will be adopted for these sites.

5.2.1.1 Erosion and Sedimentation

Vegetation removal and improper construction practices near watercourses can result in increased erosion leading to sedimentation of streams. Clearing streamside vegetation for transmission line crossings may result in decreased bank stability and exposure of bare soils that are prone to erosion. Machinery and equipment working in or near watercourses can cause rutting and erosion of floodplains, streambeds and channel banks. Increased levels of suspended sediment and deposited sediment can have multiple negative effects on the aquatic environment, including impacts to the primary producers, invertebrates, and fish.

Decreased light penetration due to higher turbidity (suspended sediment) can result in decreased photosynthesis by primary producers. Since primary producers form the base of the food chain, reductions in productivity can impact higher trophic levels, such as invertebrates and fish. Further, large influxes of sediment can bury aquatic invertebrates, an important food item for many fish species, resulting in reductions in invertebrate species diversity and abundances. Deposition of fine streambed materials over larger substrates may create unsuitable habitat for invertebrate species that anchor to coarse substrates.

Sedimentation may result in the loss of spawning habitats and/or decreased spawning success for some fish species. Fine sediment deposition may bury existing coarse or rocky substrates creating unsuitable spawning habitat. Deposited eggs can be smothered by sediments and larval emergence from spawning substrates may be inhibited by infilling of interstitial spaces (Kondolf 2000).

Short- and long-term increases in turbidity from suspended sediments can decrease feeding success by visual feeders (Berg and Northcote 1985, Gardner 1981). Suspended sediment can also be harmful to fish by clogging their gills, decreasing oxygen exchange and reducing growth rates (Wood and Armitage 1997).

5.2.1.2 Loss of Riparian Vegetation

Riparian vegetation contributes nutrients to streams and lakes through litter and terrestrial insect drop, and improves bank stability and erosion protection. The removal of riparian vegetation can result in the reduction of nutrient inputs into aquatic food webs. In many streams, terrestrial insects contribute a significant portion to the diet of fish. Leaf litter and other organic matter are consumed by aquatic invertebrates, another important food source for many fish species, including salmonids (ie; brook trout: Allan et al. 2003).

Riparian losses can result in increased water temperatures due to loss of shading by canopy species. Further, increases in plant growth can also occur due to increased light exposure. The loss of low, overhanging vegetation represents a loss of cover for fish.

5.2.1.3 Habitat Loss

Tower structures, and structure foundations, within the water body can result in:

- habitat loss and degradation, resulting in decreased productivity and fish population declines;
- Loss of migration routes limiting access to critical habitats, such as spawning areas; and
- Impacts to spawning and nursery areas decreasing fish abundance.

Loss of riparian habitats due to placement of structures may result in the reduction of allochthonous inputs (e.g., terrestrial litter and insects) and shading/cover for fish (as discussed above).

5.2.1.4 Contamination

Construction of cast in place concrete structures (e.g., foundations) near watercourses may result in accidental releases of concrete or concrete wash water into watercourses. Uncured or partly cured concrete and other lime containing materials (e.g., Portland cement, mortar and grout) have a high pH and are extremely toxic to many aquatic animals, including fish. Releases into aquatic environments can cause increases in pH of the water resulting in damage to fish tissue. Also, elevated pH levels may increase toxicity of other substance in the water, such as ammonia.

Concrete and concrete wash water also contain sediments. Discharges of these materials into waterways may result in increased turbidity and sedimentation.

1.2.2 Stations

There are no watercourses within the footprint or the areas immediately adjacent to the Construction Power Station or the Keeyask Switching Station. There are no watercourses within the Switching Station study area, and is assessed as having no potential effect on fish habitat. The Construction Power Station does have one Moderate-High rated site (Nelson River: Gull Rapids) (CPS 1) approximately 350 m south of its footprint, and therefore within its study area. Due to the large distance between the construction power station footprint and the site, no direct effects on the watercourse is expected (erosion and sedimentation, loss of riparian vegetation, habitat loss, contamination from structure foundations and installation impacts to stream bank, blockage or alteration of flow, fish stranding).

5.2.2 General

Workforce Presence and Improved Access to Sensitive Habitat

Clearing of the ROW may provide improved access to sensitive habitats by both work crews and the public. This may lead to increased fishing pressure in lakes and streams along the alignment, and motorized vehicles (trucks, ATVs) used to access these areas may cause physical disturbances (e.g., disturb riparian vegetation and stream banks, which could cause erosion and sedimentation).

Accidental Spills and Leaks of Substances Harmful to the Aquatic Environment

Hydrocarbons such as oil, fuel, gasoline, lubricants, or hydraulic fluids can enter surface waters from machinery used for instream construction, or from maintenance and fuelling activities that are conducted too close to a watercourse. Hydrocarbons are considered deleterious substances may kill fish or other aquatic biota directly, or may result in impaired health, vigor, or productive capacity. Polycyclic aromatic hydrocarbons (PAHs) can persist in stream sediments resulting in chronic exposure through direct contact or indirectly through food chain interaction (Collier et al. 2002). Effects of PAHs to fish include fin erosion, liver abnormalities, cataracts, and compromised immune systems (Fabacher et al. 1991, Weeks and Warinner 1984, 1986, O'Conner and Huggett 1988). In benthic invertebrates, PAH exposure can inhibit reproduction, delay emergence, and cause sediment avoidance and mortality.

Improper Use of Herbicides during ROW and Station Maintenance

The main pathways of herbicide entry into streams are leaching, surface run-off, and drain flow (Carter 2000). Entry is dependent on soil and herbicide properties, hydrology, application practices, and climate conditions. Many herbicides are toxic and releases of these chemicals into streams may have lethal and/or sublethal effects on aquatic organisms, including fish. Herbicides may also reduce the abundance of aquatic plants.

5.2.3 Environmental Protection Measures

To minimize potential effects of the project, aquatic resource and habitat information has been considered in project planning and the site selection process. Critical habitats have been avoided. To ensure that project-related impacts are minimal, applicable legislation, regulations, and guidelines will be adhered to. In general, construction and maintenance of the project will have the least effect on the aquatic environment when ground conditions are hard (frozen) and water levels are low (i.e., during winter, dry summer months, and early fall), especially in terrains such as bogs. Construction near waterbodies in undesirable conditions (i.e., unfrozen) will only be conducted if the environmental effects can be avoided or reduced through mitigation. Measures to mitigate or minimize the effects of project-related impacts are discussed below.

5.2.3.1 General

Hazardous Materials/Deleterious Substances

Environmental protection measures intended to mitigate the introduction of deleterious substances in aquatic environments include:

- Construction crews will be adequately trained in spill prevention and clean up procedures.
- Harmful substances, such as fuels, chemicals and herbicides will be stored greater than 100 m from the ordinary high water mark (HWM) of streams.
- Emergency spill clean-up kits will be on site at all times.
- Only clean construction materials and equipment will be used.

Construction Vehicles and Machinery

Environmental protection measures related to the operation and maintenance of construction vehicles and machinery are provided below. These measures are intended to mitigate erosion, the degradation of habitat, and the introduction of sediments and/or deleterious substances into aquatic environments.

- All vehicles, machinery, and construction materials will arrive on site clean and free of leaks.
- Equipment refuelling and maintenance will be conducted greater than 100 m from the stream's HWM.
- Machinery will remain above the HWM, unless fording is required to transport equipment across the watercourse and only in accordance with DFO Operational Statements (OS).
- Temporary crossings will be constructed so that construction vehicles and machinery remain out of watercourses and will be done in accordance with the DFO OS.

5.2.3.2 Transmission Lines

The construction, operation, and maintenance of overhead transmission lines pose a low risk to negatively affect fish habitat at watercourse crossings. To this end, DFO has developed an OS that describes mitigation measures to prevent impacts to fish and fish habitat during the construction of overhead lines (DFO 2007a, Appendix F). Specific mitigation to be implemented at watercourse crossings is described in the following sections.

Construction

Environmental protection measures related to the design and construction of transmission line stream crossings are provided below. These measures consider construction timing and practices, including vegetation removal, erosion and sediment control, temporary stream crossings and concrete works.

- Where possible, installation of lines over watercourses and poorly drained habitats such as bogs and fens will be conducted under frozen conditions or aerially;
- Where possible, transmission line approaches and crossings will be perpendicular to the watercourse and will avoid unstable features such as meander bends, braided streams, and active floodplains; and
- All structures (temporary and permanent) will be placed above the HWM.

Vegetation Removal

- Removal of riparian vegetation will be limited to select plants within the ROW required to accommodate overhead lines and uprooting of plants will be minimized);
- Vegetation will be retained for as long as possible prior to construction;
- A machine free zone (MFZ) of 7 m will be established from the HWM of all waterbodies where harvesting or clearing machinery will not enter other than to cross the stream;
- A riparian buffer (RB) of 7, 15 or 30 m (depending on fish habitat quality) will be established at all waterbodies where ground disturbance is minimized, all shrub and herbaceous vegetation is retained and all trees that do not violate Manitoba Hydro vegetation clearance requirements are retained;
- Clearing limits and sensitive areas will be clearly marked prior to vegetation removal;
- Clearing will be conducted under favourable weather conditions. Operations will be postponed under adverse weather (i.e., storm events) to minimize potential sediment introduction into the aquatic environment; and
- Slash/debris piles will be adequately stabilized and stored well above the HWM.

Erosion and Sediment Control

- Disturbed areas will be re-vegetated following completion of works; and

- Appropriate erosion and sediment control measures will be implemented to prevent sediment introduction into watercourses.

Stream Crossings

Existing stream crossings will be used whenever possible during construction of the transmission line including access trails. Where an existing crossing does not exist and/or is not practical for use a temporary stream crossing may be used. DFO's OS for "Temporary Stream Crossings" (DFO 2007b) and, if appropriate conditions exist, for "Ice Bridges and Snow Fills" (DFO 2007c) should be adhered to including:

- Temporary stream crossings will be constructed only where existing crossings do not exist or are not practical for use;
- Temporary stream crossings consist of bridges, dry streambed fords, or a one-time ford (over and back) in flowing waters;
- Whenever possible, existing trails, roads, and cut lines will be used as access routes;
- Crossings will be constructed on a straight section of the watercourse, perpendicular to the channel;
- Clean materials will be used in the construction of temporary crossings. All materials will be removed upon project completion or prior to freshet (whichever occurs first);
- One-time fording (over and back) of flowing streams and temporary bridge construction will only occur where the channel width is less than 5 m (from HWM to HWM);
- Fording in flowing waters will occur within appropriate fisheries timing windows, as outlined in DFO's "Manitoba In-water Construction Timing Windows for the Protection of Fish and Fish Habitat" (DFO 2007d; Appendix F);
- Fording will occur under low flow and favourable weather conditions and will avoid known fish spawning areas;
- Where necessary, measures to protect the streambed and banks will be in place prior to fording (e.g., pads, swamp mats). Protection measures will not impede fish passage or constrict flows; and
- If fording will likely result in erosion and degradation of the streambed and banks, a temporary bridge will be constructed.

Concrete Works

- Any uncured or partly cured concrete will be kept isolated from watercourses; and
- Concrete wash water or water that has contacted uncured or partly cured concrete will be isolated from watercourses until it has reached a neutral pH.

Operation and Maintenance

Environmental protection measures related to vegetation management, erosion and sediment control and temporary stream crossing during the operation and maintenance of transmission lines are provided below.

Vegetation Management

During the operation of the project, riparian vegetation management within the ROW will adhere to DFO's OS for "Maintenance of Riparian Vegetation in Existing Rights-of-way" (DFO 2007e; Appendix F) including the following measures:

- In riparian areas, vegetation will be maintained in a way that leaves root systems intact;
- Riparian vegetation maintenance within 30 m of the HWM will affect a maximum of 1/3 of woody vegetation (e.g., trees and shrubs) within the ROW;
- Riparian vegetation maintenance will be conducted by the method that minimizes stream bank disturbance. If rutting or erosion is likely, appropriate bank protection measures will be implemented prior to machinery use;
- All waste materials (slash) will be stabilized well above the HWM to mitigate entry into the watercourse; and
- Application of herbicides will adhere to appropriate best management practices. All chemical applications will be conducted by a certified applicator.

Erosion and Sediment Control

- Disturbed areas will be stabilized through seeding, planting, mulching, or other appropriate materials to prevent erosion and sediment transport into the watercourse; and
- Erosion and sedimentation control measures will be routinely inspected to ensure effectiveness.

Stream Crossing

Existing stream crossings will be used whenever possible during operations and maintenance. Where an existing crossing does not exist and/or is not practical for use a temporary stream crossing may be used. DFO's OS for "Temporary Stream Crossings" (DFO 2007b) and, if appropriate conditions exist, for "Ice Bridges and Snow Fills" (DFO 2007c) should be adhered to as described in Section 5.2.2.2.

5.3 RESIDUAL EFFECTS

The potential effect of each project component on each VEC was evaluated following criteria described on CEAA (1994; eg duration, magnitude etc.)

Following the consideration of prescribed mitigation, the residual effect was then assessed.

Because a significant residual adverse effect to fish habitat (a VEC) may constitute a violation of the *Fisheries Act*, the "Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff" (DFO 2010) was considered in the effects assessment. Within this framework, DFO has developed OSs for certain lower risk projects/activities. DFO OSs outline specific conditions and mitigation measures that must be followed to avoid a HADD.

Where an OS is in place for a specific activity (e.g., Overhead Line Construction), the OS's specific mitigation must be adhered to and is considered sufficient to offset any significant residual adverse effect to fish habitat and is therefore in compliance with the *Fisheries Act*.

The construction and operation of overhead transmission lines poses a low risk to fish habitat as indicated in DFO's OS for "Overhead Line Construction" (DFO 2007a). The two main potential effects to fish habitat from construction and operation of overhead transmission lines are loss of riparian habitat and instream sedimentation (Table 5-1). With appropriate mitigation measures implemented, the residual effects from the construction and operation of the Unit Tranmsission, Construction Power and Generation Outlet Transmission Lines is expected to have no measurable effect.

Table 5-1: Summary of Effects on Valued Components

Potential Effect	Project Phase	Mitigation	Residual Effect	Assessment Characteristics
Fish Habitat				
Project will cause erosion and sedimentation of streams from disturbed banks and ROW runoff. Project will result in a loss of riparian vegetation along the extent of ROW at watercourses.	Construction & Operation	• Appropriate DFO Operational Statements will be followed. • Apply Riparian Management Areas (RMAs) to waterbodies within the buffer zone adjacent to the ROW.	Loss of riparian vegetation, stream bank damage, increase in TSS.	Direction: Adverse Magnitude: Small Geographic Extent: Small Duration: Medium-term.

5.4 INTERACTIONS WITH FUTURE PROJECTS

The potential interaction of the Keeyask Transmission Project effects with future projects in the Keeyask Transmission Project study area was evaluated. This assessment emphasized the use of the same environmental indicators and measurable parameters or variables as the Keeyask Transmission Project environmental effects assessment, such as erosion and sedimentation, loss of riparian habitat, and introduction of deleterious substances to watercourses.

Future projects that were considered in evaluating the effects of the Keeyask Transmission Project included:

- Development of the Keeyask Generation Project;
- Development of the Bipole III Transmission Project;
- Development of the Conawapa Generation Project; and
- Gillam Re Development (including the potential for development of new housing within the Town of Gillam).

The proposed Keeyask Transmission Project consists of five main components: construction power line and station, Unit Lines, transmission lines, switching station, and upgrades to Radisson Converter Station. These project components may have environmental effects that act cumulatively with the effects of other components as well as the effects of future projects in the area.

The main impacts to fish habitat in the Project study area from other future projects include the direct loss of fish habitat from project infrastructure (e.g, Keeyask South Access Road, Bipole III infrastructure); changes to flow regimes and water quality in the Nelson River resulting from generating stations and changes to flow regimes of the lower reaches of tributaries; and the loss of riparian habitat and potential erosion and sedimentation from other transmission lines and roads.

Overhead transmission lines pose a small risk to fish habitat. Effects to fish habitat occur primarily through erosion and sedimentation of streams and the loss of riparian vegetation and associated function. The residual effects of construction and operation of individual overhead transmission lines are considered negligible. Where a number of transmission line or other linear ROWs occur in close proximity or the ROW becomes large, the potential significant residual effects from the loss of riparian vegetation increases.

The Keeyask Generation Project will overlap both spatially and temporally with the Keeyask Transmission Project. The Keeyask Generation Project will affect the Nelson River through development and operation of the hydro-electric generating station. The Keeyask Generation Project South Access Road will require the enhancement of existing stream crossing sites on the Butnau Road and the development of new stream crossings west of the Butnau Weir. This will result in effects to riparian vegetation and direct effects to fish habitat where instream crossing structures are required. Where the Keeyask Transmission Project Generation Outlet Lines parallel the South Access Road stream crossings, interaction between the two projects may occur.

The Bipole III Transmission Project, while occurring in the lower Nelson River area, does not directly overlap with the Keeyask Transmission Project spatially; there is however temporal overlap between the two projects. The Bipole III Project northern infrastructure is located further downstream along the Nelson River than the Keeyask Transmission Project and transmission lines (HVdc, and Collector) do not cross any of the same water courses as the Keeyask Transmission Project. The Bipole III Transmission Project has greater spatial overlap with the Conawapa Generation Project. The Conawapa Generation Project, is located further downstream on the Nelson River and does not overlap with the Keeyask Transmission Project spatially; if developed it will overlap temporally during its operation phase.

Gillam Re Development is not expected to have any aquatic environment areas of potential effect and therefore no overlap with the Keeyask Transmission Project relative to the aquatic environment.

5.5 MONITORING

5.5.1 Construction Monitoring

5.5.1.1 Drainage Patterns

Temporary and permanent facilities installed to maintain natural cross-flow drainage across the construction sites will be inspected on a regular basis so that natural drainage is not being inhibited by the construction activities.

5.5.2 Post-Construction Monitoring

All stream crossing sites will be inspected following construction to document compliance with prescribed mitigation and recommend additional remediation where deemed necessary.

Where disturbance to streambed and stream banks has occurred, all disturbed bed and bank sites will be restored comparable to pre-disturbance conditions. Restoration efforts will be monitored as required by proponent personnel. Once restoration work is deemed acceptable, temporary erosion control structures will be removed.

6.0 CONCLUSIONS

Two preferred Construction Power and four Generation Outline Transmission Lines were assessed based on their potential impacts to fish habitat. Selection of the preferred routes considered the number of watercourse crossings along each route option and the Fish and Fish Habitat Sensitivity Rating at each crossing site.

Construction Power alternative route CP 1 had fewer watercourse crossings than CP 2, with the majority of the crossings on both lines rated as low fish and fish habitat sensitivity. Only a few sites on both alternatives were rated as moderate or moderate-high. The alternative GOT C crossed the fewest watercourses (7) of the GOT lines; GOT D crossed one more than GOT C, GOT A crossed a moderate amount (10), and GOT B crossed the greatest number of watercourses (14). The majority of the crossings on all lines had low sensitivity ratings with only a few of moderate-high (e.g., Kettle River, Nelson River) or moderate sensitivities (e.g., Butnau River). Both the Construction Power Station and the Switching Station are not near any watercourses, and therefore are preferable sites. The Nelson River at Gull Rapids fell within the Construction Power Station 1 km^2 study area, however the site was still approximately 350 m away from the river, and therefore any potential effects are unlikely. The Switching Station contained no watercourses within its footprint or study area.

There are five watercourse crossings within the ROW of the preferred Construction Power Transmission Line, two on the Unit Transmission Line and seven on the preferred Generation Outlet Transmission Line. The preferred Construction Power Transmission ROW crosses two rivers with fish habitat rated as Moderate or Moderate-High sensitivity. The remaining sites were small boreal wetland streams with low sensitivity ratings. The UT line crossed the Nelson River (Moderate-High sensitivity rating) and small boreal wetland stream with Low sensitivity rating. The majority of the watercourses along the preferred GOT ROW were small headwater streams and isolated wetlands (four). One had a Moderate fish habitat sensitivity rating, and two were rated as Moderate-High.

The construction and operation of overhead transmission lines pose a low risk to fish habitat as indicated in DFO's OS for "Overhead Line Construction (DFO 2007a). The two main potential effects to fish habitat are loss of riparian habitat and instream sedimentation. With appropriate mitigation measures implemented, the residual effects from the construction and operation of the CP, UT and GOT lines is expected to have no measurable effect.

Construction monitoring will be conducted to ensure the effectiveness of mitigative measures implemented for transmission lines. All disturbed bed and bank sites will be restored comparable to pre-disturbance conditions. Restoration efforts will be monitored as required by proponent personnel. Once reclamation success is deemed acceptable, temporary erosion control structures will be removed.

In total, 14 aerial cable crossings were reviewed for the Keeyask Transmission project. It should be noted that two crossings (sites 19, 18) serve both the UT and CP1 routes. Ten did not meet the minor works criteria as defined in Transport Canada publication TP 14596 (2009). Five of these consist of wetland areas of small headwaters. The remaining five sites represent streams or rivers with physical attributes more typical of navigable waters. Application will be made to Transport Canada under the *Navigable Waters Protection Act* for review of these 10 watercourse crossings.

7.0 GLOSSARY

Aquatic environment − Areas that are permanently under water, or that are under water for a sufficient period to support organisms that remain for their entire lives, or a significant portion of their lives, totally immersed in water.

Aquatic invertebrate (s) − An animal lacking a backbone that lives, at least part of its life, in the water (e.g., aquatic insect, mayfly, clam, aquatic earthworm, crayfish).

Bog: Wetland ecosystem characterized by an accumulation of peat, acid conditions and a plant community dominated by sphagnum moss.

Catch-per-unit-effort (CPUE): The number or weight of fish caught in a given time period with a specific equipment.

Environmental impact assessment − an evaluation of the likely adverse environmental effects of a project that will contribute to decisions about whether to proceed with a project.

Eutrophic: A body of water with high concentrations of nutrients, particularly nitrogen and phosphorus, and high productivity.

Fen (s) – a peatland with the water table usually at or just above the surface; often stagnant and alkaline.

Floodplain: Relatively flat surfaces adjacent to active stream or river channels, formed by deposition of sediments during major floods.

Forage fish: Small, schooling fish that are typically eaten by larger fish. Typically less than 150 mm as adults (e.g., minnows, darters, sculpins, stickleback).

Freshet: The flood of a river from heavy rain or melted snow.

Glacio-lacustrine deposits − soil that originates from lakes that were formed by melting glaciers.

Lacustrine − Referring to freshwater lakes; sediments generally consisting of stratified fine sand, silt, and clay deposits on a lake bed.

Lentic: Pertaining to very slow moving or standing water, as in lakes or ponds.

Lotic: Pertaining to moving water.

Macroinvertebrate: Small animals without backbones living on or in the substrata of lakes and rivers that are retained by a 500 µm mesh size. Macroinvertebrates retained on 500 µm sieves are important food items to vertebrates (particularly fish) and useful bioindicators of environmental change.

Marsh: An area of soft, wet, low-lying land, characterized by grassy vegetation that does not accumulate appreciable peat deposits and often forming a transition zone between water and land.

Meso-eutrophic: Moderately eutrophic (see eutrophic).

Mesotrophic: Description of a waterbody, typically a lake, characterized by moderate concentrations of nutrients (i.e., nitrogen and phosphorus) and resulting significant productivity.

Oligotrophic: Description of a waterbody, typically a lake, characterized by extremely low concentrations of nutrients (i.e., nitrogen and phosphorus) and resulting very moderate productivity

Peak-type plant – are power plants that generally run only when there is a high demand, known as peak demand, for electricity.

Peat − material consisting of non-decomposed and only slightly decomposed organic matter found in extremely moist areas.

Residence time: The time required for a ‘parcel’ of water to flow through a lake. It generally describes the relationship between the size (or volume) of a lake and the streams or rivers that flow into it.

Run-of-river plant − a hydroelectric generating station that has no upstream storage capacity and must pass all water flows as they come.

Riparian - along the banks of rivers and streams.

Vector data - positional data in the form of points, lines, and polygons, expressed as x, y co-ordinates.

Watershed − the area within which all water drains to collect in a common channel or lake.

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