Keeyask Generation Project

Fisheries Offsetting and Mitigation Plan

KEEYASK
Hydropower Limited Partnership

Manitoba Conservation and Water Stewardship Client File 5550.00
Manitoba Environment Act Licence No. 3107

June 2015

KEEYASK GENERATION PROJECT FISHERIES OFFSETTING AND MITIGATION PLAN

Prepared by

Keeyask Hydropower Limited Partnership

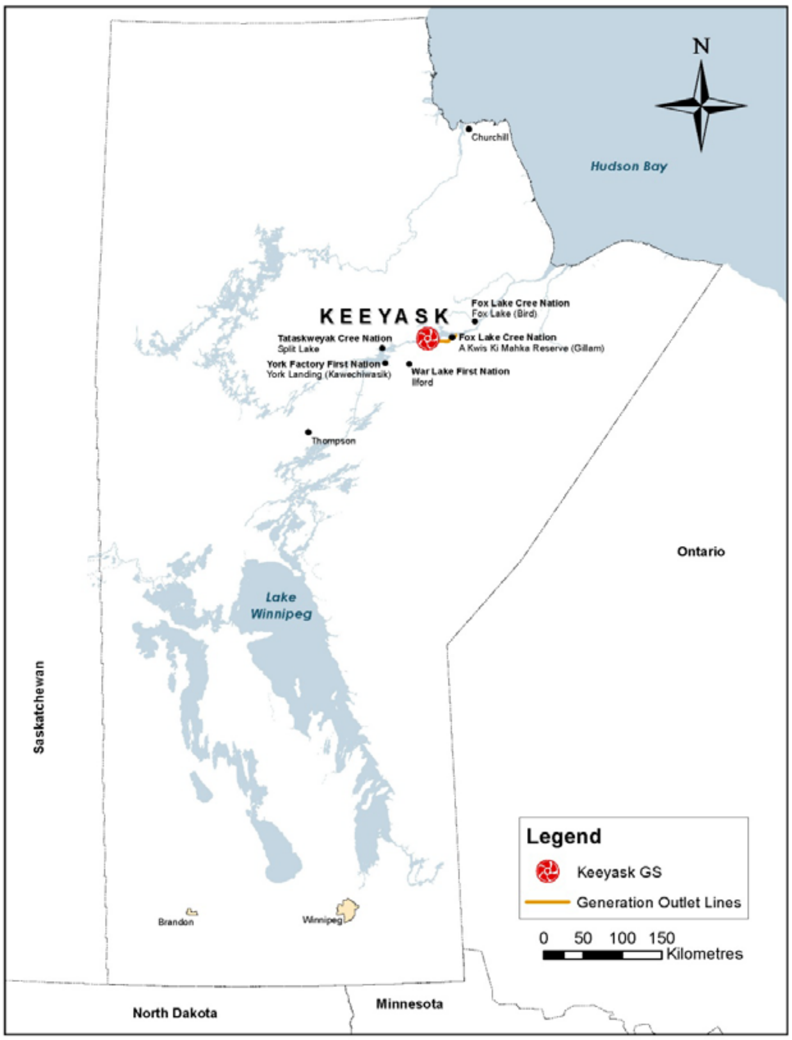
Winnipeg, Manitoba

June 2015

PREFACE

KEEYASK ENVIRONMENTAL PROTECTION PROGRAM

An Environmental Protection Program (the Program) has been developed to mitigate, manage and monitor potential environmental effects described in the *Keeyask Generation Project: Response to EIS Guidelines* during the construction and operation phases of the Keeyask Generation Project (the Project) shown on Map 1. The Program includes a collection of plans grouped in the following categories: Environmental Protection Plans, Environmental Management Plans, and Environmental Monitoring Plans.



Map 1: Location of Keeyask Generation Project

Figure 1 lists all of the plans included in the Program. It also demonstrates how the Program will be managed. The Keeyask Hydropower Limited Partnership (the Partnership) has delegated authority to Manitoba Hydro to manage construction and operation of the Project including implementation of the Program. The organizational structure of the Partnership for this aspect of the Project includes a Monitoring Advisory Committee (MAC), which includes participants from each of the Keeyask Cree Nations (KCNs) and Manitoba Hydro. Manitoba Hydro will be guided on the implementation of the Program by the MAC, the Partnership Board of Directors and ongoing discussion with Regulators.

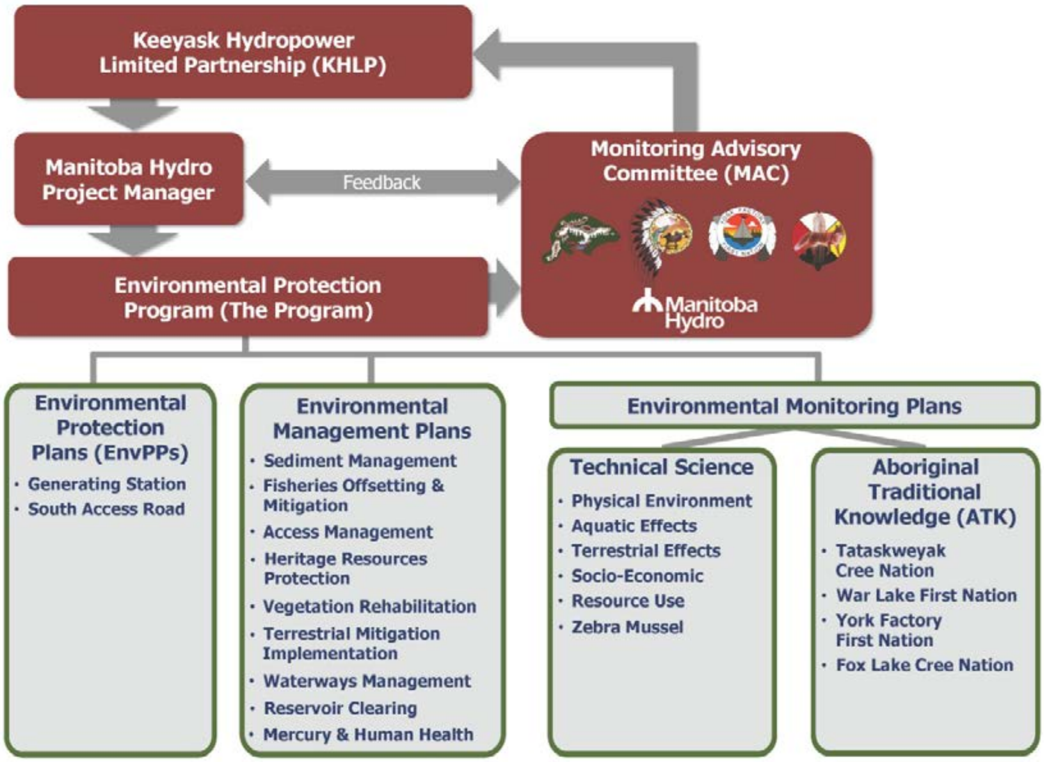


Figure 1: Environmental Protection Program

The Environmental Protection Plans (EnvPPs) provide detailed, site-specific environmental protection measures to be implemented by the contractors and construction staff to minimize environmental effects from construction of the generating station and south access road. They are designed for use as reference documents providing the best management practices to meet or exceed regulatory requirements. EnvPPs are organized by construction activity, highlighting measures to reduce the impact of a specific work activity (*e.g.,* tree clearing or material placement in water). Contractors' compliance with the EnvPPs is a contractual obligation. Under Manitoba Hydro's construction site management, a Site Environmental Lead will be responsible for monitoring compliance and determining when corrective actions are required.

The Environmental Management Plans focus on minimizing effects on specific environmental parameters. They outline specific actions that must be taken during construction and in some cases into the operational phase to mitigate Project effects. The management plans include monitoring to determine success of the actions taken and to determine other actions that need to be undertaken (adaptive management). Implementation of these plans will involve Manitoba

Hydro's staff, the KCNs, specialized consultants and contractors under the direction of the Project Manager.

The Environmental Monitoring Plans are designed to measure the actual effects of the Project, test predictions or identify unanticipated effects. During the course of the environmental assessment, numerous requirements for monitoring were identified. There will be both technical science monitoring and Aboriginal Traditional Knowledge (ATK) monitoring undertaken. The technical science monitoring will be conducted by Manitoba Hydro and specialized consultants contracted by Manitoba Hydro, who will in turn hire members of the KCNs to work with them to fulfil the monitoring activities. Manitoba Hydro will also have contracts with each of the KCNs to undertake ATK monitoring of the Project.

The activities that occur and the results generated from the Environmental Protection Program will be discussed at MAC meetings. The MAC is an advisory committee to the Partnership Board of Directors and will review outcomes of the programs and, if appropriate, provide advice and recommendations to the Partnership on additional monitoring or alternative mitigation measures that may be required. The MAC will provide a forum for collaboration among all partners. On behalf of the Partnership, the MAC will also ensure that the outcomes of the Environmental Protection Program are communicated more broadly on an annual basis to Members of the KCNs, regulators, and the general public.

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1.0 INTRODUCTION

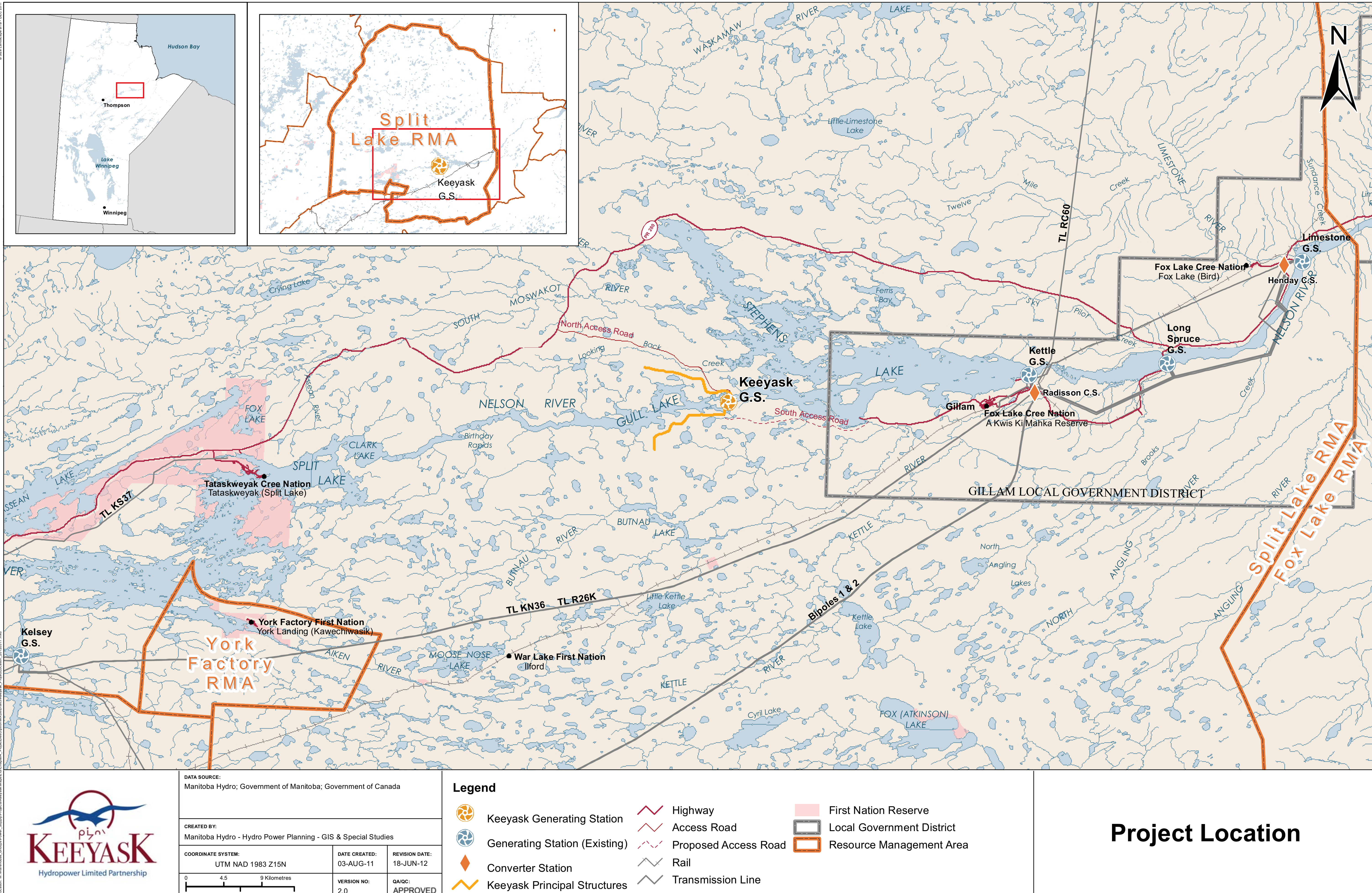
This document describes the Fisheries Offsetting and Mitigation Plan (FOMP) for the Keeyask Generation Project (the Project), a 695-megawatt (MW) hydroelectric generating station and associated facilities at Gull Rapids on the lower Nelson River in northern Manitoba immediately upstream of Stephens Lake. The Project will be located entirely within the Split Lake Resource Management Area. The Project is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, where Gull Lake flows into Stephens Lake, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gillam (Map 1 - A).

The *Keeyask Generation Project: Response to EIS Guidelines* (EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the aquatic environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs, is provided in the *Keeyask Generation Project Environmental Impact Statement: Aquatic Environment Supporting Volume* (AE SV). A detailed plan to conduct monitoring with respect to Project effects and the effectiveness of mitigation/offsetting measures, as well as a plan for determining the need for adaptive management, is provided in the Keeyask Generation Project Aquatic Effects Monitoring Plan (AEMP).

As described in the EIS, mitigation and offsetting measures were developed for the Keeyask Generation Project to ensure that habitat to support all life history stages of local fish species continues to be available upstream and downstream of the generating station for the lifetime of the Project. The FOMP provides a detailed description of the mitigation and offsetting measures that will be implemented to achieve this goal. As identified in the FOMP, mitigation will be implemented to reduce the impacts of the Project on the aquatic environment, and where mitigation is not able to completely address the impacts, habitat will be constructed to offset these losses. In addition to habitat creation, stocking will be used as an additional offsetting measure for Lake Sturgeon to address the current low population numbers, potential emigration of adult sturgeon, and temporary losses of habitat during the construction period prior to offsetting habitat being available. Monitoring carried out as described in the AEMP will identify if mitigation and offsetting measures are fulfilling the needs of fish and where deficiencies are identified, additional mitigation and offsetting measures will be implemented as part of the adaptive management process.

The FOMP addresses requirements in the *Environment Act* Licence Clause 17 for an environmental management plan to address effects to the aquatic environment, specifically a plan to develop a self-sustaining Lake Sturgeon population (Clause 17e) and a Fish Habitat Compensation Plan (Clause 17f).The original name of this document was the "Fish Habitat Compensation Plan", but due to changes in the *Fisheries Act* during the licensing phase of the Keeyask project, the document was renamed the "FOMP" to better align with the current *Fisheries Act.* The fish and fish habitat mitigation and offsetting measures presented in this document were provided to Fisheries and Oceans Canada in the *Keeyask Application for Authorization* (KAFA). In addition to measures presented in the KAFA, the FOMP provides a description of the Lake Sturgeon Conservation Stocking Plan (Section 4.1.7).

The Keeyask Fisheries Regulatory Review Committee (KFRRC) is a committee of representatives from the Keeyask Hydropower Limited Partnership (KHLP), Manitoba Conservation and Water Stewardship (Fisheries Branch) (MCWS), and Fisheries and Oceans Canada (DFO) (terms of Reference for the KFRRC are provided in Appendix 1A of the AEMP). As described in the AEMP, the KFRRC will review monitoring results and determine whether adaptive management measures, including changes to mitigation and offsetting measures, may be required. The review will also consider whether monitoring results indicate that the Fisheries Management Objectives (FMOs; Appendix A) developed by MCWS for the Keeyask Project are being met. The KFRRC will fulfill the role of the Lake Sturgeon Advisory Committee, as set out in Clause 21 of the Environment Act Licence. The Keeyask Monitoring Advisory Committee (MAC) will also discuss the effectiveness of mitigation and offsetting measures and possible need for implementing contingency measures outlined in this document.



Hudson Bay
Thompson
Lake Winnipeg
Winnipeg
Split Lake RMA
Keeyask G.S.
N
Keeyask G.S.
Limestone G.S.
Fox Lake Cree Nation
Fox Lake (Bird)
Henday C.S.
Long Spruce G.S.
Kettle G.S.
Radisson C.S.
Gillam
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
GILLAM LOCAL GOVERNMENT DISTRICT
TL RC60
North Access Road
South Access Road
NELSON RIVER
GULL LAKE
STEPHENS LAKE
SPLIT LAKE
CLARK LAKE
FOX LAKE
Birthday Rapids
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
TL KS37
York Factory First Nation
York Landing (Kawechiwasik)
York Factory RMA
Kelsey G.S.
War Lake First Nation
Ilford
TL KN36
TL R26K
Bipoles 1 & 2
Split Lake RMA
Fox Lake RMA
MOOSE NOSE LAKE
FOX (ATKINSON) LAKE
Little Limestone Lake
Little Kettle Lake
Kettle Lake
Cyril Lake
Crying Lake
BUTNAU LAKE
DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada
CREATED BY:
Manitoba Hydro - Hydro Power Planning - GIS & Special Studies
COORDINATE SYSTEM:
UTM NAD 1983 Z15N
DATE CREATED:
03-AUG-11
REVISION DATE:
18-JUN-12
VERSION NO:
2.0
QA/QC:
APPROVED
0 4.5 9 Kilometres
0 4 8 Miles
KEEYASK
Hydropower Limited Partnership
Legend
Keeyask Generating Station
Generating Station (Existing)
Converter Station
Keeyask Principal Structures
Highway
Access Road
Proposed Access Road
Rail
Transmission Line
First Nation Reserve
Local Government District
Resource Management Area
Project Location

Map 1-A

This document contains the following sections:

- Description of effects on fish and fish habitat (Section 2.0) – This section provides a high level overview of the effects assessment from the EIS and AE SV;
- Design and Mitigation Measures (Section 3.0) – This section describes Project design features to avoid/reduce harmful effects to fish and fish habitat, as well as measures to mitigate (i.e., reduce) those effects. The likelihood of success and potential contingency measures, should the mitigation be less effective than anticipated, are also described;
- Offsetting Plan (Section 4.0) – This section provides detail on the measures to offset unavoidable habitat losses as a result of the Project. The likelihood of success and potential contingency measures, should the mitigation be less effective than anticipated, are also described. Section 4.1.7 provides the Lake Sturgeon Conservation Stocking Plan, which is a key feature of the overall offsetting plan and the KHLP's commitment to restore self-sustaining Lake Sturgeon populations in the area;
- Addressing Keeyask FMOs (Section 5.0) – This section describes the manner in which the mitigation and offsetting measures address the FMOs developed by MCWS for this Project; and

2.0 PROJECT EFFECTS LIKELY TO RESULT IN SERIOUS HARM TO FISH

This section summarizes those effects that could result in serious harm to fish in a "Commercial, Recreational or Aboriginal Fishery", or "the death of fish or any permanent alteration to, or destruction of, fish habitat" as defined in Subsection 2(2) of the *Fisheries Act* during the Keeyask Generation Project.

2.1.1 DEWATERING OF COFFERDAMS

Gull Rapids provides fast-water habitat used primarily for spawning by many of the species in Stephens Lake, including Lake Sturgeon, Walleye, Northern Pike, and Lake Whitefish. Dewatering areas within the confines of cofferdams constructed in Gull Rapids has the potential to trap adult spawning fish as well as dewater eggs. The number and species of fish affected would depend on the cofferdam location in the rapids and time of year, with greater numbers of fish expected to be affected during the spring spawning season due to the prevalence of spring-spawning species. Effects would occur during three spawning periods during approximately five years of instream construction.

Mitigation through adherence to the schedule for instream construction listed in the *Keeyask Generation Project Generating Station Environmental Protection Plan* (GS EnvPP) and conducting fish salvage, moving impounded fish back into the waterbody from which they became isolated, will reduce serious harm to fish as a result of this effect (Section 3.2.1).

2.1.2 TEMPORARY CAUSEWAYS TO BORROW SITES

Two temporary causeways constructed to borrow sites could affect fish use of habitat in the vicinity of the causeways. One borrow site causeway will have a footprint of 0.21 ha and will cross what is now a perennial watercourse with a main channel comprised of scoured bedrock. This channel provides a movement corridor for fish between a small pond near the mouth of Looking Back Creek and the Nelson River below Gull Rapids. It has been in existence for less than a decade and was created when an ice dam downstream of Gull Rapids forced flow to the north of the river channel. The second causeway will have a footprint of 0.81 ha and cross the upper (western) end of a small, shallow bay on Stephens Lake.

Based on fish surveys conducted in the spring and fall in the areas near the proposed causeway locations, it is predicted the construction of the causeways may affect small numbers of adult Walleye and Northern Pike, though no population effects are expected given that access to these areas remains available via Stephens Lake. Effects would be limited to the vicinity of the causeways and occur for approximately five to eight years while the causeways are in place for construction purposes. Fish movements past the causeway sites will be maintained through either the placement of culverts and/or the construction of a channel to allow fish movements (Section 3.2.2). Offset habitat will be created when the causeways are decommissioned (Section 4.1.1).

2.1.3 ENTRAINMENT OF FISH IN INTAKE PIPES

During construction, water withdrawals will be required for a number of activities, including washing aggregate for concrete production, concrete preparation and dewatering work areas confined by cofferdams. Fish, especially small-bodied species and the young of large-bodied species, would be at risk of mortality resulting from entrainment while in the vicinity of water intakes. However, given the small volume of water that will be withdrawn, the total number of fish that would be potentially affected is small. Effects would be confined to the vicinity of the intakes and occur over approximately five years during construction.

Mitigation through the use of intake screens will reduce serious harm as a result of this effect (Section 3.2.3).

2.1.4 BLASTING

Blasting associated with instream construction may cause injury or mortality to fish in the vicinity of the blast. The majority of blasting will occur in a quarry adjacent to the intake channel of the powerhouse and in the intake and tailrace channels. The effects will be confined near the blast site and occur intermittently over five years during construction.

All fish species present in Stephens Lake could be affected; however, large numbers of fish are not expected to be present near the blast site given they will be excluded by a cofferdam and the main flow will be moving through the south channel of the Nelson River, well away from the blast site during the period when the majority of the blasting will occur. Mitigation through adherence to DFO blasting guidelines will reduce serious harm as a result of this effect (Section 3.2.4).

2.1.5 CHANGES TO WATER QUALITY

Both the construction and operation of the Project will affect water quality.

2.1.5.1 TOTAL SUSPENDED SOLIDS

Construction-related activities with the potential to affect concentrations of total suspended solids (TSS) and related variables (*i.e.*, turbidity and water clarity) include:

- Inundated excavated materials placement areas;;
- Constructing works instream (*i.e*., cofferdams and temporary causeways);
- Cofferdam dewatering;
- Impoundment and diversion during river management;
- Site drainage/runoff; and
- Various point sources (*i.e.*, wastewater effluent, settling ponds, concrete production).

Predicted effects to TSS concentrations during construction would be dominated by the effects related to river diversion and management (*i.e.*, shore erosion) and cofferdam placement and removal.

Mitigation of TSS inputs during construction will be achieved through adherence to the GS EnvPP and the *Keeyask Generation Project Sediment Management Plan for In-Stream Construction* (SMP) (Section 3.2.5.1).

Reservoir creation during the operation phase will also result in changes to TSS, with a decrease in the mainstem of the river in the long term and short term increases in flooded areas. Potential effects on aquatic life as a result of changes to TSS include:

- Effects on primary producers through changes in the characteristics and penetration of light;
- Direct effects on fish and invertebrates, including behavioural alterations, reduced growth or condition, physiological stress, and potential mortality;
- Indirect effects including changes in the food web, such as reductions in primary production due to reduced water clarity, reduced abundance of benthic invertebrates due to increased TSS and/or sedimentation causing reductions in the abundance of fish diet items;
- Potential for reduced hatching success of Northern Pike eggs in newly flooded areas of the reservoir where organic TSS will be notably elevated in the initial years of operation; and
- Potential for changes in behaviour could favour some fish species and/or life history stages in near shore areas when the TSS is elevated during the initial years of operation.

2.1.5.2 DISSOLVED OXYGEN

Flooding of land to form the reservoir will result in changes to water quality parameters; most notable with respect to effects to fish will be decreases in dissolved oxygen (DO) in some areas.

In the majority of bays where low DO develops during winter, fish will be able to escape; however, in one northern bay, formed over the area of present day Little Gull Lake (Map 3 - A), fish could become trapped as ice freezes to the bottom in shallow areas. Fish that remain in the area would be susceptible to winterkill as DO levels in the lake are predicted to decline to near zero following freeze-up. Fish favouring shallow, vegetated habitat, such as Northern Pike, would be most at risk.

Avoidance of winterkill due to low DO will be mitigated through the creation of escape channels from present-day Little Gull Lake (Section 3.2.5.2).

2.1.6 HABITAT LOSS DUE TO COFFERDAM CONSTRUCTION

Gull Rapids is currently used for spawning by fish residing in Stephens Lake (species in the fishery include Lake Sturgeon, Walleye, Northern Pike and Lake Whitefish). The construction of cofferdams will result in a sequential loss of aquatic habitat in Gull Rapids and relatively higher velocities in the south channel. Complete closure of the river through construction of cofferdams across the south channel (Stage II Diversion) will result in the loss of all remaining habitat in the rapids. Other spawning habitat is available for all species in Stephens Lake except Lake Sturgeon; however, there may be years with reduced recruitment due to the reduction in total available spawning habitat.

Although conditions in the south channel during Stage I cofferdam construction (north side cofferdam for construction of the powerhouse and spillway) may be suitable for spawning, it is not known whether fish will use this habitat. Given this uncertainty, construction processes will be managed on the basis that fish are continuing to spawn in the south channel during construction, to allow for appropriate protection of sensitive early life stages.

Mitigation measures including the use of instream timing windows, management of TSS inputs and adherence to the blasting guidelines will reduce serious harm as a result of this effect (Section 3.2.6). Given the presence of alternate spawning habitats for species other than Lake Sturgeon, disturbance of habitat in Gull Rapids is not expected to affect the long-term productivity of these populations. However, Gull Rapids is the only spawning location for Lake Sturgeon in Stephens Lake. Therefore, potential failure of natural spawning during the construction period will be offset by downstream stocking during construction (Section 4.1.7).

2.1.7 LOSS OF GULL RAPIDS

Construction of the Keeyask Generating Station (Keeyask GS) will change or eliminate all of the aquatic habitat in Gull Rapids as it exists today. The upstream section of the rapids will become a part of the reservoir, while the middle and lower section of the rapids will be covered with the structures of the Keeyask GS, modified into the intake and tailrace channels, or dewatered. The loss of Gull Rapids is an unavoidable effect of the construction of the Project and will result in the loss of spawning habitat. It will be offset through creation of constructed spawning habitat for Lake Sturgeon and Walleye (Section 4.1.5) and Lake Whitefish (Section 4.1.6).

With the construction of the Keeyask GS, fish in Stephens Lake will lose access to potential spawning and foraging habitat upstream of Gull Rapids. Based on biological and life history evaluations of those fish species that do incidentally move upstream over Gull Rapids (Lake Sturgeon, Lake Whitefish, Northern Pike and Walleye), the provision of access between

Stephens Lake and Gull Lake does not appear important to the downstream populations, provided that sufficient suitable habitat exists or will be created in the post-Project upstream and downstream environments.

Based on their review of movement data collected to date, DFO has taken the following position regarding the significance of upstream fish movement over Gull Rapids (text excerpt taken from letter dated 10 July 2013, from Mr. Dale Nicholson (Regional Director, Ecosystems Management, Central and Arctic Region, Fisheries and Oceans Canada) to Mr. Ken Adams (President, Keeyask Hydropower Limited Partnership):

> *"In review of the documents for the Keeyask Generating station and in consultation with both Manitoba Hydro, on behalf of the KHLP, and Manitoba Fisheries Branch specialists, DFO has determined that there is insufficient data at this time to conclude that there is or is not significant upstream movement of fish past the site of the proposed Keeyask generating station. It is most probable that there is movement of lake sturgeon, walleye and whitefish, among other species, in an upstream direction. However, the magnitude, timing and importance of the fish movements to a sustainable fishery have not been adequately defined for this site. Furthermore, it is recognised that this knowledge is difficult and dangerous to obtain in the conditions at the proposed site."*

The uncertainty associated with the importance of upstream fish movements over Gull Rapids will be addressed through the collection of additional movement data and through a collaborative process to determine whether mitigation of effects to upstream movement through the provision of upstream fish passage is required (Section 3.2.7).

2.1.8 FISH EMIGRATION TO STEPHENS LAKE

Creation of the Keeyask reservoir is expected to alter fish emigration from upstream of Gull Rapids to Stephens Lake. This is a result of reducing or eliminating the transport of larval Lake Sturgeon from the Clark Lake to Gull Rapids reach, downstream to Stephens Lake.

The number of larval Lake Sturgeon presently entering Stephens Lake and the importance of this potential influx to the population is not known. Recent movement studies (2011–present) have demonstrated that downstream movements of juvenile and adult Lake Sturgeon from Gull Lake to Stephens Lake are very infrequent and are not expected to affect the Stephens Lake population.

The effect of any potential reduction in the influx of larval Lake Sturgeon will be offset through stocking of Lake Sturgeon in Stephens Lake until a self-sustaining population is established and is no longer dependent on larval drift from upstream environments (Section 4.1.7).

2.1.9 MORTALITY DURING DOWNSTREAM FISH PASSAGE

Injury and mortality of fish moving downstream past the trashracks and turbines or over the spillway, as well as stranding in the dewatered area after spillway operation, will occur during station operation. Adult, large-bodied fish such as Lake Sturgeon, Walleye and Lake Whitefish are most likely to be affected by downstream passage past the station.

Turbine passage can result in mortality of fish directly through a variety of mechanisms (e.g., pressure changes, shear stress, turbulence, striking, grinding) or indirectly through increased susceptibility to disease and predation. Turbine mortality would occur for the lifespan of the generating station.

The number of fish potentially subject to injury and mortality passing through the trashracks and turbines (generating station) would be dependent on the number that are attempting to move downstream; as noted in the previous section, the number of adult fish moving downstream over present day Gull Rapids is small and therefore few adult fish may attempt to move downstream post-Project.

Fish and eggs would be vulnerable to mortality due to stranding after spillway operation ceases, and the spillway is expected to be in operation 10-20% of the time.. The number of fish vulnerable to stranding in the spillway would depend on both the number of fish passing downstream as well as fish that may move upstream from Stephens Lake into areas of the river channel wetted during operation of the spillway.

Mitigation has been provided in the selection of the turbine design and through the provision of escape channels in the spillway as well as provisions for continued spill to avoid dewatering of eggs if Lake Sturgeon spawn during spillway operation (Section 3.2.8).

2.1.10 FISH EMIGRATION FROM THE KEEYASK RESERVOIR

Emigration out of the Limestone reservoir during impoundment was linked with a sudden decrease in the abundance of fish. The relatively rapid changes in water levels and velocities in Gull Lake during construction and impoundment and a decrease in water velocity at Birthday Rapids could result in habitat changes that may cause large bodied species to emigrate out of Gull Lake. In particular, there could be a mass emigration of fish out of the reach in the first year of impoundment as fish move away from disturbed habitat.

It is anticipated that some fish will move upstream away from disturbed areas in the Keeyask reservoir, but will quickly re-colonize the reservoir once water quality conditions stabilize. Those fish that do move downstream past the Keeyask GS would be lost to the reservoir as the barrier created by the GS will prevent them from returning upstream.

As water levels in Gull Lake increase during construction, Lake Sturgeon may move upstream or potentially downstream in response to changes in water flows. This movement may result in a small increase in the number of lake sturgeon in Split Lake and/or Stephens Lake, and a decrease in adult and sub-adult lake sturgeon in the Keeyask reservoir. Over time, some Lake Sturgeon that move upstream may return downstream to the reservoir.

During the operation phase of the project, changes in aquatic habitat in the Keeyask reservoir and a decrease in water velocity at Birthday Rapids could result in increased movement of fish (Walleye, Lake Whitefish and Northern Pike) upstream into Split or Clark lakes. However, it is expected that Long Rapids, which will still have high velocities and white water in the post-Project period, will continue to function as an impediment to such movements. Therefore, emigration from the Keeyask reservoir is not expected to cause a measurable decline in fish populations in the reservoir nor an increase in upstream lakes.

Lake Sturgeon movements over Birthday Rapids may increase during operation, but this would occur in both directions and therefore, no measureable effect to the numbers in either the Keeyask reservoir or Split Lake are expected.

These changes in fish distribution as a behavioural response to a change in the environment do not meet the criteria of serious harm to fish, either as a result of mortality or due to habitat change, as the total amount of fish do not change. However, measures to offset the loss of Lake Sturgeon from the Keeyask reservoir (if it occurs) are incorporated in the stocking plan (Section 4.1.7).

2.1.11 HABITAT CHANGES IN THE BIRTHDAY RAPIDS TO GULL RAPIDS REACH

The Birthday Rapids to Gull Rapids reach of the Nelson River currently consists of approximately 4,000 ha of aquatic habitat, comprised of mainstem river channel, the lower sections of small tributaries, and Gull Lake. Of the 4,500 ha flooded for Keeyask, this reach will experience substantial changes as a result of the Project, with increases in water level and decreases in water velocity, and flooding of up to 4,000 ha of adjacent terrestrial habitat. (The remaining 500 ha of flooding will occur in the Clark Lake to Birthday Rapids reach of the river, further upstream.)

Habitat changes to the river, tributary streams, and lake habitat between Birthday Rapids and Gull Rapids as a result of increased water depth and decreased velocity will result in a reduction in spawning habitat for Lake Whitefish and Walleye in the lower reservoir and possibly young-of-the-year habitat for Lake Sturgeon. Access to tributaries by a variety of species, in particular Northern Pike, may be blocked by debris accumulation. Mitigation to address reduction in fish access to tributaries is discussed in Section 3.2.9. Offsetting measures for the reduction in Walleye and Lake Whitefish spawning habitat in the lower reservoir and potential reduction in Lake Sturgeon YOY habitat are described in sections 4.1.2 and 4.1.4, respectively.

2.1.12 HABITAT CHANGES AT BIRTHDAY RAPIDS

Birthday Rapids, which is located upstream of Gull Lake on the Nelson River and covers an area of 6.59 ha, is a known Lake Sturgeon spawning location. Impoundment of the Keeyask reservoir will lead to increased water levels that will submerge Birthday Rapids, converting them into fast-flowing habitat without visible white water. As Lake Sturgeon prefer to spawn at sites where white water is present, it is unknown whether Lake Sturgeon will continue to spawn at the Birthday Rapids location post-impoundment.

Given the uncertainty about Lake Sturgeon use of this area after reservoir impoundment, monitoring will be conducted. If through monitoring, it is determined that Lake Sturgeon no longer spawn in the vicinity of Birthday Rapids, contingency works to create hydraulic features that would be attractive to spawning sturgeon will be developed as an offsetting measure (Section 4.1.3).

2.1.13 CREATION OF NEW AQUATIC HABITAT AS THE RESULT OF FLOODING

Approximately 5,100 ha of terrestrial habitat will be inundated 30 years after reservoir impoundment. The inundated terrestrial habitat will evolve into productive habitat for foraging by Walleye, Northern Pike, Lake Whitefish and adult Lake Sturgeon, but is not expected to be highly suitable for young-of-the-year and sub adult Lake Sturgeon. In the initial 10-15 years of impoundment, backwater bays will be less suitable for fish and other aquatic life due to the erosion and breakdown of peat, resulting in elevated concentrations of total suspended solids and periodic depletion of dissolved oxygen, in particular during winter under ice. However, this is not expected to result in serious harm to fish given that potential winterkill in backbays isolated during the winter will be connected to the mainstem by excavating channels (Section 3.2.5.2).

2.1.14 INCREASED ACCESS RESULTING IN GREATER HARVEST

Construction of the Project has resulted in new road access and a constructed boat launch on the Keeyask reservoir in a formerly remote area. During the construction period, road access will be available to the construction workforce only; however, fishing is prohibited on the Keeyask project site.

Manitoba Conservation and Water Stewardship is responsible for fisheries management in the province and works with the Split Lake Resource Management Board to manage sport, domestic and commercial fisheries, and oversee the implementation of the *Manitoba Lake Sturgeon Management Strategy 2012* in the Split Lake Resource Management Area, in which the Keeyask Generation Project is located. After the Project is completed, the north and south access roads will become part of the provincial road system, linking Gillam to Split Lake and Thompson. Increased access may result in greater harvest of Walleye, Northern Pike, Lake Whitefish and Lake Sturgeon (domestic resource use only). Effects to Walleye, Northern Pike and Lake Whitefish are not considered further, as these fisheries are robust and are not anticipated to change as a result of increased access; however, the harvest of Lake Sturgeon in the Keeyask area has the potential to impede the recovery of this species. Mitigation is provided in Section 3.2.10.

3.0 DESIGN AND MITIGATION MEASURES

3.1 MEASURES TO AVOID IMPACTS BY PROJECT DESIGN

The mitigation hierarchy described in DFO's Fisheries Protection Policy stresses that whenever possible; efforts should be made to avoid impacts before they occur. When avoidance is not possible, efforts must be made to minimize (mitigate) impacts with residual effects and require offsetting measures and an authorization under the *Fisheries Act*.

Many of the impacts of the Keeyask Generating Project are related to the features of the generating station, including the location of the instream structures (cofferdams, powerhouse spillway, etc.), reservoir impoundment, and method of operating the generating station. The considerations in project design to avoid environmental impacts were provided in the EIS and are summarized below.

3.1.1 RESERVOIR LEVEL AND GENERATING STATION SITE SELECTION

A process was undertaken over many years to optimize the Project design, including consideration of alternative means to develop the Project that could avoid potential environmental effects. Based on many years of research and in consultation with Tataskweyak Cree Nation, a decision was made to pursue a single development at Gull Rapids with 159 m as the full supply level, with an operating range of 158 to 159 m. It was determined that flooding to this elevation would not impact open water levels on Split Lake. As well, this option floods less land than other options, and minimizes impacts on Lake Sturgeon and other aquatic habitats between Clark Lake and Birthday Rapids. It would also allow the formation of a stable ice cover above Gull Rapids to prevent the problems associated with frazil ice formation on generating station operation.

3.1.2 GENERAL ARRANGEMENT OF PRIMARY STRUCTURES

Though the planning process started in the 1960s, a range of different axis and station general arrangements have been studied. After much study, the final axis was chosen because it will result in less flooding, fewer construction risks, and better options for mitigating and offsetting impacts to the aquatic environment, particularly related to sturgeon spawning.

3.1.3 RESERVOIR OPERATING RANGE AND MODE OF OPERATION

The operating range selected for the Keeyask GS is 1 m with reservoir levels maintained between 158 m and 159 m. While a larger operating range would provide greater flexibility and therefore greater economic benefits, the 1 m operating range provides some operating flexibility for the KHLP as it allows the reservoir to be drawn down to produce additional energy during peak energy demand periods of the day.

Keeyask will be the fourth largest generating station in Manitoba; however, the operating range will be small relative to other hydro developments in Manitoba and Canada. The modes of operation used each day will depend on the requirements of Manitoba Hydro's Integrated Generation System but will remain within the allowable, 1 m range.

Operation of the Keeyask GS will be modified during the Lake Sturgeon spawning period such that the flow from the two northernmost units will maintain appropriate hydraulic conditions for spawning fish.

3.2 MITIGATION MEASURES AND EXPECTED EFFECTIVENESS

As described above, the Project was designed through a process undertaken over many years to optimize the Project design, including consideration of alternative means to develop the Project, which could avoid potential environmental effects. These environmental effects were "big picture", *e.g.*, reducing flooding to the extent possible and achieving relatively stable post-Project water levels on the reservoir. Effects identified in Section 2.0 were based on the station design that already addressed these "big picture" effects; therefore, avoidance (through modification of Project design) was not an option. Effects were addressed through mitigation (described in this section) or offsetting measures (Section 4.0). The effectiveness of the proposed measures will be assessed as a component of the AEMP and possibly through ATK monitoring programs, and where practical, modified as part of the adaptive management to be undertaken as part of the project.

This section provides:

- A description of the measures and standards applied to avoid or mitigate serious harm to fish;
- An evaluation of the effectiveness of the proposed measure;
- Identification of the expected outcomes, in terms of reduction in likely serious harm to fish;

and

- Identification of contingency measures, where primary mitigation measures are uncertain.

A summary table of the mitigation measures presented in the following sections is provided in Table 3 - A.

Table 3 - A: Measures to be applied at Keeyask to mitigate serious harm to fish

Project Activity/Effect	Mitigation Measures
Dewatering behind cofferdams	• Adherence to timing windows for instream construction provided in Table 3 - B • Conduct fish salvages
Temporary causeways to borrow sites	• Install culverts to allow fish passage in N-5 and G-3 causeways
Entrainment of fish in intake pipes	• Apply DFO end-of-pipe fish screening guidelines to all intakes • Review if the guideline cannot be met with federal and provincial regulatory agencies
Blasting	• Conduct blasting in accordance with DFO *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters*
Changes to Total Suspended Solids (TSS) during construction	• Follow the *Keeyask Generation Project Generating Station Environmental Protection Plan* • Follow the *Keeyask Generation Project Sediment Management Plan for In-stream Construction*
Reduction in dissolved oxygen in Little Gull Lake after reservoir flooding	• Excavate two channels for fish egress from Little Gull Lake to the main body of the Keeyask reservoir.
General disturbance due to construction activities	• Follow instream timing windows (Section 3.2.1.1) • Control TSS inputs as set out in the SMP (Section 3.2.5) • Adhere to the blasting guidelines (Section 3.2.4
Generating station at Gull Rapids	• Provision for fish passage • **This is contingent on monitoring results and ongoing dialogue with provincial and federal regulators.**
Mortality during downstream fish passage	• Trashrack design considerations • Turbine design considerations to reduce mortality
Stranding fish and eggs in the dewatered spillway	• Excavate escape channels in the spillway to allow egress for fish to Stephens Lake • Spilling to be maintained at levels sufficient to permit Lake Sturgeon egg hatch/survival of larval fish until they drift from the site to Stephens Lake
Loss of access to tributary streams in the Birthday Rapids to Gull Rapids Reach	• Remove trees prior to flooding according to the *Keeyask Generation Project Reservoir Clearing Plan* • Remove debris after flooding according to the *Keeyask Generation Project Waterways Management Program*
Increased access resulting in greater harvest	• Controlled access to the Keeyask site during construction • No fishing permitted in construction areas • Contribute to funding and support stewardship and education initiatives about Lake Sturgeon through the KHLP's membership on the Kischi Sipi Namao Committee for 20 years

3.2.1 DEWATERING OF COFFERDAMS AND FISH STRANDING

As discussed in Section 2.1.1, construction and dewatering of cofferdams could result in the death of fish and fish eggs present within impounded areas isolated by cofferdam construction.

Mitigation to reduce the effects is through:

- Adherence to timing windows for instream construction outlined in Table 3 - B; and
- Conducting fish salvages.

3.2.1.1 TIMING WINDOWS

The construction schedule has been modified, where practical, to avoid instream work during spawning and incubation periods, when fish, eggs and fry are sensitive to disturbance or sediment. The restricted activity timing windows were based on the Manitoba restricted activity timing windows for protection of fish and fish habitat (DFO 2013) for waters in northern Manitoba, and the results of fish community studies in the Keeyask area. Both were considered to create area-specific timing windows for the Keeyask Project.

Table 3 - B provides the anticipated timing of instream construction work and shows any overlap with sensitive periods. Based on the timing in Table 3 - B, effects to Northern Pike, Walleye, and Lake Sturgeon during the spawning period, when spawning fish would aggregate in the rapids and spawn would be present, will be largely avoided. Effects to Lake Whitefish cannot be completely avoided, as construction activities were shifted to the fall period to avoid the spring period, which affected more species, in particular Lake Sturgeon. If unanticipated instream construction needs to occur beyond what is included in Table 3 - B that must be authorized under the *Fisheries Act*, a request for alteration to the authorization will be made. Requests made will avoid the Lake Sturgeon spawning period (May 15 to July 15).

Table 3 - B: Keeyask Instream Construction Schedule (referenced as 4A in the Keeyask *Fisheries Act* Authorization)

Structure	Activity	Start	End	Duration (Days)	Days in Spring LKST Period [May 15-Jul. 15]	Days in LKWF Fall/Winter/Spring Period [Sep. 1-May 14]	Days in Sep. 1-15 Period[1]	Notes on Construction Activity	Notes on Downstream TSS Effects*
Causeway to borrow G-3	Construction	30-Oct-14	24-Nov-14	25	0	25	0	Occurs within permitted period, future removal dates not yet scheduled.	Construction of Stage I cofferdams and groins will have minimal effects on TSS. 1 – 6 mg/L increase downstream of Gull Rapids, increases typically 4 mg/L or less. Causeways will be constructed in areas of low flow using rock with a low fines content and would not be expected to affect downstream TSS.
Causeway to borrow N-5	Construction	11-Sep-14	30-Oct-14	49	0	49	4	Future removal dates not yet scheduled.	
Quarry Cofferdam	Construction	17-Jul-14	1-Aug-14	15	0	0	0	Occurs within permitted period.	
North Channel Rock Groin	Construction	29-Jul-14	15-Aug-14	17	0	0	0	Occurs within permitted period.	
North Channel Stage I Cofferdam	Construction	16-Aug-14	12-Sep-14	27	0	12	12	Occurs within permitted period however may extend into first 12 days of fall period.	
Powerhouse Stage I Cofferdam	Construction	5-Aug-14	30-Oct-14	86	0	60	15	Not possible to change schedule without significant construction delays and cost.	
Spillway Cofferdam	Construction	29-Nov-14	2-Sep-15	254	0	136	1	Not possible to change schedule without significant construction delays and cost – work will avoid spring spawning period.	Peak increase is 8 mg/L lasting ~1 day. 5 mg/L or larger increase would last for ~4 days. Peak is due to erosion along shorelines as a result of staging caused by construction of the spillway cofferdam. Most of the time the increases due to placement of material in river for cofferdam construction range from 2-4 mg/L.
Central Dam Cofferdam	Construction	6-Nov-14	29-Jul-15	265	0	20	0	Not possible to change schedule without significant construction delays and cost – work will avoid spring spawning period.	
Spillway Cofferdam	Removal	17-Jul-17	24-Aug-17	38	0	0	0	Occurs within permitted.	Increase of about 4 mg/L for 1 month.
South Dam Stage II Upstream Rockfill Cofferdam	Construction	24-Aug-17	24-Oct-17	61	0	54	15	Not possible to change schedule without significant construction delays and cost – this work was advanced from spring 2018 to avoid sturgeon spawning.	Peak increase of 15 mg/L for 1 day; > 10 mg/L increase for 4 days. Most TSS due to erosion of shorelines in the south channel because of increased water levels upstream of the cofferdam. Small TSS increase (<5 mg/L) due to material placement in river.
South Dam Stage II Upstream & Downstream Cofferdams	Construction	28-Aug-17	23-Nov-17	87	0	83	15	Not possible to change schedule without significant construction delays and cost.	Increases up to 2 mg/L, but predicted 1 mg/L most of the time.
Powerhouse Cofferdam	Removal	7-Sep-18	1-Dec-18	85	0	61	9	Not possible to change schedule without significant construction delays and cost.	Increase of 3 mg/L during work period.

Table 3 - B: Keeyask Instream Construction Schedule (referenced as 4A in the Keeyask *Fisheries Act* Authorization)

Structure	Activity	Start	End	Duration (Days)	Days in Spring LKST Period [May 15-Jul. 15]	Days in LKWF Fall/Winter/Spring Period [Sep. 1-May 14]	Days in Sep. 1-15 Period[1]	Notes on Construction Activity	Notes on Downstream TSS Effects*

1. Site-specific revision to fall spawning period; start date September 15.

* **notes on TSS**

- Effects are for fully mixed conditions
- Effects of material placement / removal on TSS are based on maximum predicted increases resulting from instream work during a 1:20 low flow.
- Effects of shoreline erosion on TSS based on maximum predicted increase resulting from a 1:20 year high flow.
- Where instream material placement/removal and shoreline erosion occur at the same time (spillway cofferdam construction; south dam stage II upstream rockfill cofferdam construction) the predicted effects combine the maximum predicted effects from both in-stream work and erosion even though the maximum effects of each result from a 1:20 year low flow and a 1:20 year high flow respectively.

3.2.1.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

As the timing windows (15 May to 15 July for spring spawners and emergence of larvae; and 16 September to 30 April for fall spawners) were developed using the general observations of DFO, and then further refined using the results of field studies, they are expected to effectively protect spawning fish, larvae and eggs from the direct effects of construction.

3.2.1.2 FISH SALVAGE

Fish salvages will be conducted to mitigate effects associated with fish stranding in areas isolated by cofferdams. The number of fish that would be susceptible to stranding will be minimized by avoiding instream work during the spring and fall spawning periods, where practical.

During construction, fish could also become trapped in isolated pools in the south channel after spilling ceases. When such an event occurs, a fish salvage operation will be conducted to catch and release any stranded fish back into the Nelson River.

3.2.1.2.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Fish salvage is a widely used and effective mitigation method, although it cannot be effectively implemented under ice cover.

3.2.2 TEMPORARY CAUSEWAYS TO BORROW SITES

As discussed in Section 2.1.2, construction of two temporary causeways to borrow sites could alter fish use of habitat in the vicinity. Construction of these causeways will result in infilling approximately 1.02 ha of fish habitat. This habitat loss cannot be avoided, as access to the two deposits is essential for the Project.

During construction, culverts with low internal water velocities (0.0–0.1 m/s) will be installed in the causeway to N-5 borrow area as mitigation to prevent the causeway from becoming a barrier to fish movements between Stephens Lake and the pond near Looking Back Creek.

The G-3 causeway was also fitted with culverts that will be adequately sized to allow fish passage prior to construction of the causeway, to mitigate stranding fish in the confined/isolated portion of the bay to the west of the causeway.

A portion of each causeway will be removed after they are no longer required and the remaining material will be used to develop rocky shoals at the same location (Section 4.1.1).

3.2.2.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Given the measures to permit fish movement past the causeways to avoid stranding, no mortality of fish is expected.

3.2.3 ENTRAINMENT OF FISH IN INTAKE PIPES

As described in Section 2.1.3., during construction, water withdrawal through intakes could result in the death of fish due to entrainment.

Mitigation would be provided by screening intakes according to current end-of-pipe fish screening guidelines (DFO 1995) to minimize the entrainment and impingement of fish.

3.2.3.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

It is anticipated that DFO guidelines can be followed for all required construction water intakes.

3.2.3.1.2 CONTINGENCY MEASURES

In the event that DFO's end-of pipe intake screening guidelines cannot be met, other measures to reduce entrainment (*e.g.*, position of water intake, use of screen with mesh size larger than specified in the guidelines) will be investigated. These alternatives will be reviewed and discussed with relevant federal and provincial regulatory agencies prior to use.

3.2.4 BLASTING

Blasting associated with instream construction may cause injury or mortality to fish in the vicinity of the blast (Section 2.1.4). Effects of blasting will be confined to near the blast site and occur intermittently over five years during construction. Blasting will generally be conducted in accordance with DFO *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky 1998) to facilitate compliance with various fish and fish habitat protection provisions of the *Fisheries Act* (including provisions to protect spawning beds during egg incubation).

Fish habitat setback-distances will be met for the majority of the fish species present at Keeyask. Under normal construction conditions, spawning habitat setback distances cannot be met for Lake Whitefish in two areas: a small section of the powerhouse tailrace channel and a small section of the spillway discharge channel. To mitigate impacts to Lake Whitefish, the blasting in these two areas will be conducted outside of the Lake Whitefish spawning period.

In the unusual event, that blasting cannot meet DFO's *Guidelines for the Use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky 1998), advice will be sought from the relevant federal and provincial regulatory agencies prior to the blasting taking place.

3.2.4.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Given adherence to the guidelines or application of other protective measures as described above, blasting is expected to result in minimal mortality of fish.

3.2.5 CHANGES TO WATER QUALITY

Section 2.1.5 described changes to water quality leading to high TSS levels and critically low DO levels could result in the mortality of fish and/or creation of unsuitable habitat. These effects cannot be fully mitigated; however, the planned approach to mitigate effects is described below for both the construction and operation phases.

3.2.5.1 INPUTS OF TSS DURING CONSTRUCTION

As discussed in Section 2.1.5.1, there are numerous activities during construction that result in the release of TSS to surface waters, including disposal of excavated materials, instream construction, point and non-point discharges, and cofferdam dewatering. Both the GS EnvPP and *Keeyask Generation Project Sediment Management Plan for In-stream Construction* (SMP) will be followed to reduce TSS inputs.

3.2.5.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

It is expected that following the prescribed measures in the GS EnvPP and SMP will be able to maintain TSS levels within the predicted increases and, therefore, construction-related increases in TSS are anticipated to have a negligible effect on the fish communities of the Nelson River and Stephens Lake.

3.2.5.2 TSS AND DO DURING OPERATION

During the operation period, flooding of terrestrial land is expected to result in elevated TSS and lower levels of DO in the Little Gull Lake area (Section 2.1.5). These effects to water quality cannot be mitigated; however, fish will move away from areas with unsuitable conditions if they are able.

In order to mitigate low DO and the potential winterkill of fish, channels will be excavated to allow fish to escape to areas with more suitable DO levels to support year-round movements of fish to and from the Little Gull Lake area within the reservoir. The location of the proposed channels is illustrated on Map 3 - A.

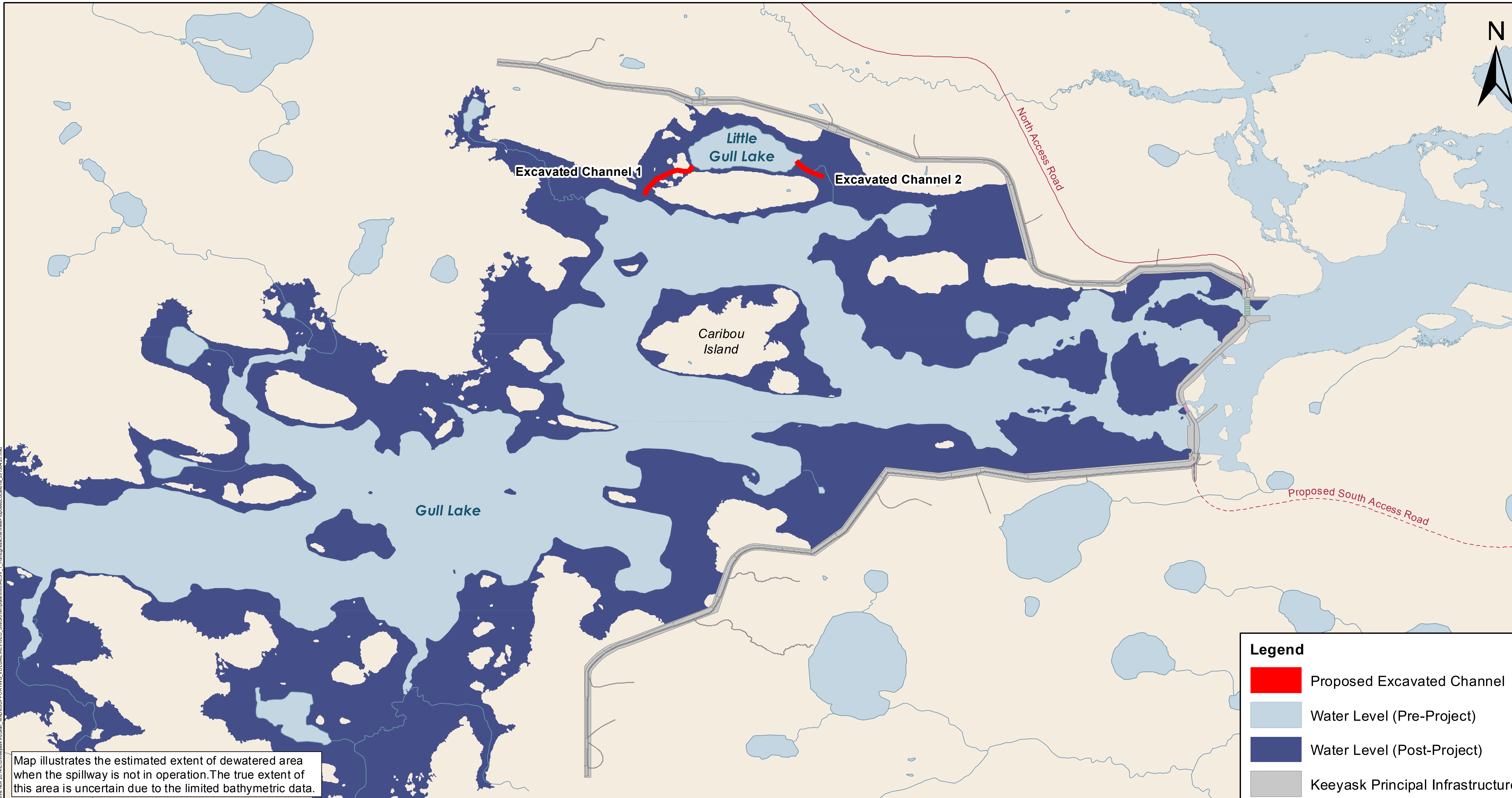
Two, 5 m base-width channels will be excavated from Little Gull Lake to the main body of the reservoir. The connection to the main body of the reservoir is key, as other locations in the reservoir will experience varying levels of DO that may deter the fish from moving out of Little Gull Lake. The channel will be accessible throughout the ice-on period, where the bottom elevation will be at 156.0 m ASL to provide water depths of between 1-2 m below the ice surface, depending on reservoir water surface elevation and ice thickness. The two channels will be approximately 800 m and 400 m long. Both channels will be excavated in the dry, before reservoir impoundment and all applicable clauses in the GS EnvPP will be followed during construction to mitigate effects.

3.2.5.2.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Constructing the two egress channels is expected to avoid winterkill of fish in the Little Gull Lake area. Monitoring will be undertaken to confirm this.

3.2.5.2.2 CONTINGENCY MEASURES

In the event that winterkill is recorded during the monitoring program, conditions in the egress channels will be checked to confirm that fish are able to pass freely. If no blockage is observed, then conditions will be examined during winter to determine if ice thickness is preventing fish escape. Depending on the outcomes and reasons for winterkill, a review will be undertaken to determine if there any possible alternatives to improve this situation. These will be reviewed and discussed with relevant federal and provincial regulatory agencies.



KEEYASK Hydropower Limited Partnership

0 1 2 3 4 Kilometres
0 0.5 1 1.5 2 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewaterd area are estimated based on the existing environment 95th percentile flow.

Fish Egress Channels - Proposed Locations

Map 3-A

3.2.6 HABITAT LOSS DUE TO COFFERDAM CONSTRUCTION

As discussed in Section 2.1.6, the construction of cofferdams will result in a sequential loss of aquatic habitat in Gull Rapids. Although conditions in portions of the rapids will remain suitable for spawning, it is not known whether fish will use this habitat. Given this uncertainty, mitigation measures, including the use of instream timing windows (Section 3.2.1.1), management of TSS inputs as set out in the SMP (Section 3.2.5) and adherence to the blasting guidelines (Section 3.2.4) will be implemented.

3.2.6.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Implementation of these mitigation measures is expected to avoid serious harm (death) to fish that continue to use Gull Rapids for spawning during the construction period. Ongoing monitoring according to the AEMP will measure the effects.

3.2.7 LOSS OF GULL RAPIDS

As discussed in Section 2.1.7, construction of the generating station will result in the unavoidable loss of spawning habitat in Gull Rapids. This effect cannot be avoided or mitigated; construction of offsetting habitat to counter this is discussed in Section 4.0.

The uncertainty associated with the importance of upstream fish movements over Gull Rapids will be addressed through a collaborative process to determine whether mitigation of effects to upstream movement through the provision of upstream fish passage is required. The KHLP, DFO and MCWS have agreed that additional data collection is necessary before it can be determined whether or not upstream fish passage should be a requirement for the Keeyask Generation Project.

This approach to mitigation for the loss of upstream fish passage at Gull Rapids is outlined in the letter from DFO dated 12 July 2013:

> *"All parties acknowledge that fish passage facilities are site specific, technically challenging and, at times, very expensive. Combined with incomplete current knowledge of fish movement at the site, it is premature to warrant installation of a long term upstream fish passage facility. However, DFO in discussion with Manitoba Hydro, on behalf of the KHLP, and MCWS has concluded that the following will be considered when determining authorization of impacts pursuant to the Fisheries Act:*
>
> 1. *The probable movement of lake sturgeon, walleye and whitefish, among other species, at the proposed Project site should be considered as important to the lifecycle and ongoing productivity of these fishes, in the absence of site-specific data to the contrary.*
> 2. *The analysis of upstream fish movement, based on currently available, multiyear data, in addition to data collected prior to construction.*

3. *The opportunity for Manitoba Hydro, on behalf of the KHLP, for additional data collection in support of the Project's Aquatic Effects Monitoring Program, to support MCWS Fisheries Management Objectives, and agreed to by MCWS and DFO. This program would determine the role of fish movement and the availability of habitat to support all life history requirements of fish such that productivity is maintained.*
4. *The results of these data and their role in the Project's Aquatic Effects Monitoring Program would be reported to DFO and the MCWS each year. Based on these results, additional studies may be required. The requirement for fish passage facilities will be determined by DFO, in consultation with MCWS, based on the results of monitoring, established fisheries management objectives and support for ongoing fisheries productivity. In the event that DFO, in consultation with MCWS, determines that all fish management objectives can be met and ongoing productivity can be supported without the installation of fish passage facilities, DFO will not require the installation of these facilities as part of the proposed development. Dependent on the long term sustainability of the fishery, as determined by regulators with input from local communities, installation of fish passage facilities may be required at a future date.*
5. *The requirement for Manitoba Hydro, on behalf of the KHLP to include in its planning and construction design, those fish passage facility elements necessary to allow for economically and technically feasible retrofits to occur. Planning would include siting of future fish passage facilities. Manitoba Hydro, on behalf of the KHLP has undertaken an examination of fish passage options and has indicated that there are technically and economically feasible retrofit options."*

3.2.7.1.1 CONTINGENCY MEASURES

As discussed above, the KHLP has identified several methods of upstream fish passage that could be implemented if monitoring demonstrates that fish passage is a requirement for sustainable fish populations.

Conceptual alternatives for upstream fish passage facilities have been developed as part of the Keeyask preliminary design studies (Manitoba Hydro 2012) and with appropriate design modifications, several of these alternatives could be implemented as a retrofit at Keeyask. If required, the selection of a fish passage method, its goals and the associated final design would be based upon the results of the aforementioned monitoring studies.

3.2.8 MORTALITY DURING DOWNSTREAM FISH PASSAGE

As discussed in Section 2.1.9, fish moving downstream past the generating station are subject to injury and mortality during passage past the trashracks and turbines, or over the spillway, as well as being vulnerable to stranding in the spillway after it ceases operation.

3.2.8.1 DOWNSTREAM FISH PASSAGE

Trash racks will be installed on the face of each intake to the powerhouse to reduce the risk of injury and mortality to fish. They will be approximately 22.7 m tall and 6.4 m wide. The trash racks for Keeyask will be comprised of vertically oriented rectangular shaped steel bars with a clear bar spacing of 16.75 cm. The spacing between the horizontal support bars will be 50 cm. The largest fish in the population (depending on species, greater than 1.4 m in fork length) will be physically excluded from passing downstream. Slightly smaller individuals would also not be expected to pass downstream as the opening would only be slightly larger than their body.

Many variables were considered in the design and selection of the turbines for the Keeyask GS, which have been demonstrated to minimize the risk of injury and mortality of fish as they pass downstream. These variables include the number, alignment, and shape of stay vanes and wicket gates, clearance at the wicket gates and runners, wicket gate overhang, number of blades, blade leading edge thickness, blade trailing edge (related to turbulence), rotation rate, and runner diameter. As a result of this process, the Keeyask turbines include features such as a low number of blades (4-bladed vertical fixed propeller units) with a low rotation rate (75 rpm) and a large runner diameter (8.35 m).

Various structural downstream passage alternatives were developed and examined as part of the fish passage feasibility study (Manitoba Hydro 2012). However, due to uncertainty regarding their likelihood of success and the immature state of technology for the downstream passage of the target species, no alternatives were found which offered a viable option when compared to turbine passage. Therefore, the preferred alternative for downstream passage was determined to be via the turbine flow (and spillway when operating), taking advantage of the high survival rates afforded by the Keeyask turbines , which were designed with an objective to achieve a minimum survival rate of 90% for fish as large as 500 mm.

3.2.8.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Based on the estimated velocities at the intake (ranging from 1.0–1.2 metres/second) and fish swimming capabilities, few fish are expected to become permanently impinged on the trash rack. Smaller fish that are moving downstream would move past the trash racks to the turbines.

Based on numerous studies and models used during turbine design, the KHLP has a high degree of certainty that the goal of 90% survival for fish < 500 mm passing through the Keeyask, 4-bladed propeller turbines will be achieved. In addition, results from turbine mortality at other locations indicate that high (>75%) rates of survival are also likely for larger fish (> 500 mm).

3.2.8.1.2 CONTINGENCY MEASURES

As discussed above, the planned trashrack and turbine design is expected to provide safe passage for the majority of fish moving downstream.

The KHLP has examined conceptual designs for trash rack modifications that could be implemented as a retrofit at Keeyask to exclude a greater range of fish sizes while also mitigating the risk of increased impingement. These measures could be implemented as an adaptive management measure if monitoring indicates that injury and mortality from fish impinged on the trash racks and/or passing through the turbines has the potential to adversely affect the sustainability of fisheries.

To date these designs have only been evaluated at a conceptual level to ensure a retrofit would be technically feasible. The current understanding of fish swimming ability and behavior around trash racks is limited. If a retrofit of fish exclusion measures is required in the future, the findings of monitoring studies at Keeyask and any associated academic or industry advancements would be incorporated into their final design.

3.2.8.2 STRANDING IN THE DEWATERED SPILLWAY

During operation of the spillway, fish may move upstream into areas of the dewatered river channel that are wetted during spillway operation. Such upstream movements are particularly common during spawning. After the spill is ended, fish and any eggs that have been deposited may be stranded.

Mitigation for stranding after spillway operation ceases will been provided by excavating 1,000 m of escape channels (minimum depth of 2 m) in the spillway to allow egress for fish to Stephens Lake.

If the spillway is operated during the Lake Sturgeon spawning period, and sturgeon deposit eggs in areas that would be dewatered post-spill, spilling will be maintained at levels sufficient to permit egg hatch and survival of larval fish until they emerge and drift from the site.

3.2.8.2.1 ANALYSIS OF EXPECTED EFFECTIVENESS

It is expected that the construction of escape channels and continuing to spill if sturgeon spawn within the spillway will avoid stranding.

3.2.8.2.2 CONTINGENCY MEASURES

In the event that monitoring after spillway operation shows that fish stranding after spillway operation has not been sufficiently addressed by channel creation, then other methods will be identified to mitigate this effect.

3.2.9 TRIBUTARY HABITAT CHANGES IN THE BIRTHDAY RAPIDS TO GULL RAPIDS REACH

As discussed in Section 2.1.11, flooding the reservoir may result in the accumulation of debris in the mouth of small tributary streams. Potential post-impoundment loss of fish access to tributary streams due to debris accumulation will be mitigated through the removal of trees as described in the *Joint Keeyask Development Agreement Reservoir Clearing Plan* and the monitoring and removal of debris will take place as described in the *Joint Keeyask Development Agreement Waterways Management Program*.

3.2.9.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

With the initial removal of standing timber and routine removal of accumulated debris, habitat within the tributaries will remain accessible to fish.

3.2.9.1.2 CONTINGENCY MEASURES

In the event that debris removal is not effective in maintaining fish access to the tributary streams, alternate methods of debris control (*e.g.*, bank stabilization, removal of falling trees prior to them entering the water) will be investigated. If required, these alternatives will be reviewed and discussed with relevant federal and provincial regulatory agencies.

3.2.10 INCREASED HARVEST

Harvest in the reach of the Nelson River downstream of Clark Lake to Gull Lake is currently limited to several domestic resource users because the area is not accessible by road. Provision of road access to the Keeyask reservoir has the potential to increase the harvest of all VEC fish species during both the construction phase (when access is restricted to construction personnel who are not allowed to fish in construction areas) and the operation phase (when the road will become part of the public road system).

Manitoba Conservation and Water Stewardship is responsible for fisheries management in the province and works with the Split Lake Resource Management Board to manage sport, domestic and commercial fisheries, and oversee the implementation of the *Manitoba Lake Sturgeon Management Strategy 2012* in the Split Lake Resource Management Area, in which the Keeyask Generation Project is located. Effects to Walleye, Northern Pike and Lake Whitefish are not considered further, as these fisheries are robust and are not anticipated to change as a result of increased access. Harvest of Lake Sturgeon in the Keeyask area has the potential to impede efforts to recreate a self-sustaining population through a stocking program. In order to promote awareness about the importance of maintaining healthy populations of stocked and wild Lake Sturgeon, the KHLP, with membership on the Kischi Sipi Namao Committee (KSNC; Section 4.1.8), will participate in a variety of core activities (including education initiatives) towards the protection and enhancement of sturgeon populations in the Lower Nelson River.

4.0 OFFSETTING PLAN

4.1 DESCRIPTION OF OFFSETTING MEASURES

Effects that could not be completely addressed through the implementation of the mitigation measures described in Section 3.0 require offsetting to counter residual effects predicted. These measures are described in the following sections. Table 4 – A provides a summary of the offsetting works to be undertaken for the project.

Table 4 - A: Summary of Offsetting Measures to be Implemented for the Keeyask Generation

Create 0.4 ha shallow rocky habitat using remnants of decommissioned N-5 causeway Intended to attract Walleye and other fish
Create of 1.3 ha shallow rocky habitat using remnants of decommissioned G-3 causeway Intended to attract Walleye and other fish
Develop 3 ha of rocky shoals in the reservoir Will provide spawning habitat for Walleye and Lake Whitefish
Create hydraulic features to encourage Lake Sturgeon Spawning near Birthday Rapids **This measure is contingent on monitoring to determine the success of Lake Sturgeon spawning in the reach of the Nelson River between Long Rapids and Birthday Rapids – if results determine no project effect on Lake Sturgeon, this measure will not be constructed.**
Construct young-of-the-year (YOY) Lake Sturgeon habitat in the Keeyask reservoir (Phase 1 = 20 ha and Phase 2 = up to 25 ha) **Constructing Phase 1 is contingent on monitoring YOY and sub-adult Lake Sturgeon abundance after flooding. If results show no effect on Lake Sturgeon, this measure will not be constructed.** **Construction of Phase 2 is contingent on monitoring YOY and sub-adult Lake Sturgeon abundance after Phase 1. If results show no remaining effect on Lake Sturgeon, Phase 2 will not be constructed.**
Phase 1 Lake Sturgeon spawning habitat will be constructed below the powerhouse during construction of the generating station. **Phase 2 and 3 may be required if monitoring confirms Phase 1 is underperforming.**
• Construct a slope on the north wall of the tailrace channel and a bench covered in spawning substrate along the north shore of the tailrace. • Intended to provide additional spawning area for Lake Sturgeon by drawing them further upstream from the Phase 1 spawning habitat constructed below the powerhouse (as above).
Leave remnants of the tailrace cofferdam in place to attract Lake Sturgeon and encourage spawning in this area. Intended to provide additional spawning area for Lake Sturgeon by drawing them further upstream from the Phase 1 spawning habitat constructed below the powerhouse (as above) **The extent of the material left in place is contingent on outflows from the generating station and will be left to the extent that outflows are not impeded.**
Construct a Lake Whitefish spawning reef (1000 m^2) along the south shore of Stephens Lake Intended to provide spawning habitat for Lake Whitefish lost at Gull Rapids.
Stocking Lake Sturgeon in the Upper Split Lake area, Keeyask reservoir and Stephens Lake for 50 years or until a

Table 4 - A: Summary of Offsetting Measures to be Implemented for the Keeyask Generation

self-sustaining population is proven to be re-established.
Support the recovery of Lake Sturgeon in the lower Nelson River by providing one third of the annual funding for 20 years in support of mitigation and stewardship activities identified by the Kischi Sipi Namao Committee.

4.1.1 DOWNSTREAM OF KEEYASK GS - ROCKY SHOALS AT CAUSEWAY LOCATIONS

To offset the temporary loss of 0.21 ha of fish habitat at the N-5 causeway location, approximately 80% of the Class C1 rockfill material will be removed when access to N-5 is no longer required. The remaining 20% (approximately 2,200 m^3) will be spread out locally over approximately 0.4 ha to create shallow rocky habitat for fish and other aquatic species. The newly created habitat will improve diversity at this otherwise low diversity, bedrock substrate habitat.

Similarly, the temporary loss of 0.81 ha of fish habitat at the G-3 causeway location, once it is no longer required, will be offset by using approximately 20% of the Class C1 rockfill (approximately 6,340 m^3) to create approximately 1.3 ha of shallow rocky habitat for fish and other aquatic species. The newly created habitat will provide habitat diversity in an area that is comprised mostly of low-diversity, silty substrate habitat.

Serious harm to fish that may result from construction of shallow rocky habitat outlined above will be mitigated using the best management practices described in the GS EnvPP. The causeways to deposits N-5 and G-3 will be removed after rehabilitation of borrow areas is largely complete. Fish use of the rocky habitat will be monitored according to the AEMP.

Analysis of Expected Effectiveness

The expected effectiveness of the habitat created is the same as that described for constructed Walleye spawning habitat described in Section 4.1.2.

Contingency Measures and Associated Monitoring

If monitoring results reveal that Walleye are not using the constructed habitat, it will be modified in an attempt to attract fish. Such modifications could include: the addition of rock with larger or smaller diameters than those use for the causeway rockfill; altering the spacing of rock substrate; or altering the slope of the habitat. These modifications will be reviewed and discussed with relevant federal and provincial regulatory agencies. Fish use of the modified habitat will continue to be monitored according to the AEMP.

4.1.2 KEEYASK RESERVOIR – SPAWNING SHOALS

The construction of rocky shoals within lacustrine portions of the reservoir would increase the certainty that Lake Whitefish and Walleye spawning habitat is available early in the development of the reservoir environment. The creation of boulder/cobble/gravel habitat would, in addition to providing spawning habitat, also provide rearing and foraging habitat, thereby improving habitat diversity within the newly-formed reservoir.

Biological design criteria for the construction of rocky shoals are provided in Table 4 - B. Potential sites were selected at locations where post-Project bottom depths ranged between 3–4 m ("shallow sites"). Additional "deeper" sites were identified at locations where post-Project water depths would be greater than 4 m. These deep locations would not provide optimal Lake Whitefish spawning habitat, but could provide feeding areas.

Table 4 - B: Biological design criteria for the construction of rocky shoals

Parameter	Design Criteria	Additional Considerations
Substrate	A mix of coarse materials as follows: 25% boulder (750-500 mm); 35% cobble (256-64 mm); 25% large gravel (64-32 mm); and 15% small gravel (32-8 mm).	Substrate layer should have minimum thickness of 0.75 m, and substrate material should be free of silt and clay. Important that there be ample interstitial space for egg incubation and larval development.
Velocity and/or Exposure	At sites with flowing water, the velocity should be between 0.2 and 1.0 m/s. If water velocity is less than 0.2 m/s, then location requires wave generated circulation (*i.e.*, exposure to northeast - northwest winds).	
Depth	Crest of spawning shoal: Walleye = 0.3–0.8 m below MOL; and Lake Whitefish = 2.0–2.5 m below MOL.	Lake Whitefish eggs incubate over winter; eggs deposited at depths less than 1.5 m below MOL will be vulnerable to freezing at maximum ice thickness.
Size of Spawning Area	Minimum crest area at preferred depth should not be less than 1000 m^2.	Shape of shoal should maximize surface area (long and rectangular as opposed to round or square).
Slope	Slope of spawning area should not exceed 10%.	
Location	Select areas where mineral soil is present, areas adjacent to bedrock, or where organic soil is thin (*i.e.*, peat veneer). Where placement occurs over organic soils, gabion basket wire should be laid over the soil prior to placement.	At standing water sites, orient shoals to maximize exposure to wave action.
Critical Annual Period	Walleye – Early May to mid-June. Lake Whitefish – Late October to late-April.	

Table 4 - B: Biological design criteria for the construction of rocky shoals

Parameter	Design Criteria	Additional Considerations

Note: Rocky shoal biological design criteria were based on spawning shoal development criteria described in Kerr *et al.* 1997 and Geiling *et al.* 1996, and based on species ecology descriptions provided in AE SV Appendix 5A.

Twenty sites (Map 4 - A) were identified for the potential development of shoals (minimum surface area of 1,000 m^2). Site selection was subsequently refined according to the following criteria:

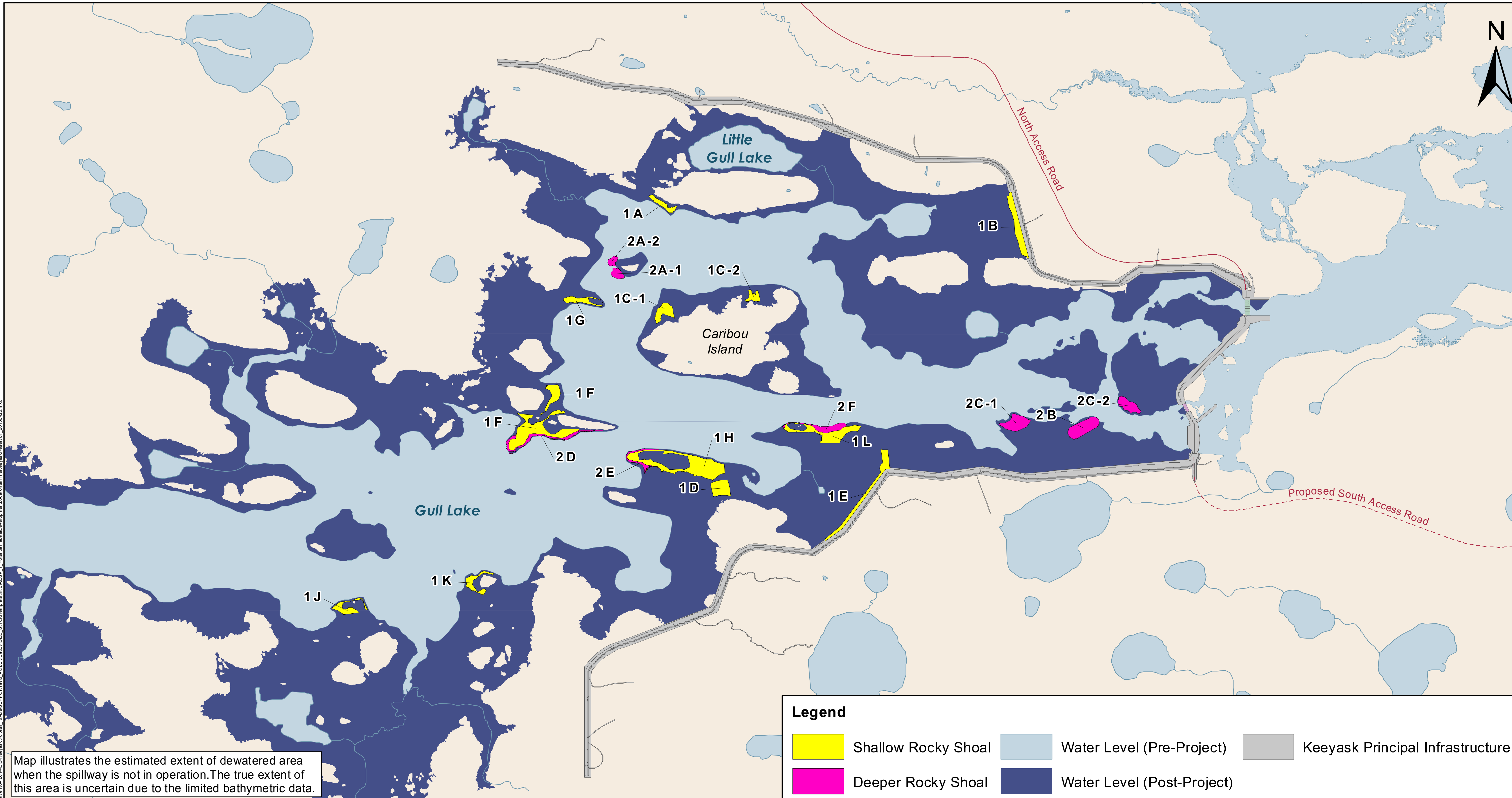
- Whether its location is adjacent to known or suspected present-day spawning habitats;
- How likely it is to be exposed to fine particulate sedimentation post-impoundment; and
- Whether it is a minimum distance of 3 km upstream of the GS and spillway intake structures so as to minimize entrainment and downstream transport of newly-hatched fish.

As shown in Map 4 - B, thirteen sites met these criteria (seven 3–4 m depth sites and six greater than 4 m depth). See Table 4 - C for details on preferred spawning shoal development zones.

Rocky shoals will be developed to provide 3 ha of spawning habitat for Walleye and Lake Whitefish on the preferred sites shown on Map 4 - B. Construction at site 1J is unlikely due to accessibility issues associated with its distance from the project site and source of rock. Shoals would be developed preferentially at sites 1F, 1D and 1H, given their proximity to known spawning habitat. These will comprise large areas that extend across a range of depths down to a couple of meters below the lowest ice level so that both Walleye and Lake Whitefish will benefit; however, the specific locations and areas covered by the shoals on each preferred site will vary depending on feasibility of construction at each location. The minimum size of each shoal will be 0.1 ha to encourage fish use.

Construction of spawning habitat at the sites will occur “in the dry” prior to reservoir impoundment, thereby avoiding potential effects to fish associated with instream construction. General environmental protection will be maintained through implementation of the GS EnvPP during construction.

Monitoring to determine whether Walleye and Lake Whitefish are successfully spawning in the reservoir will be conducted as described in the AEMP during the initial years following impoundment of the reservoir.



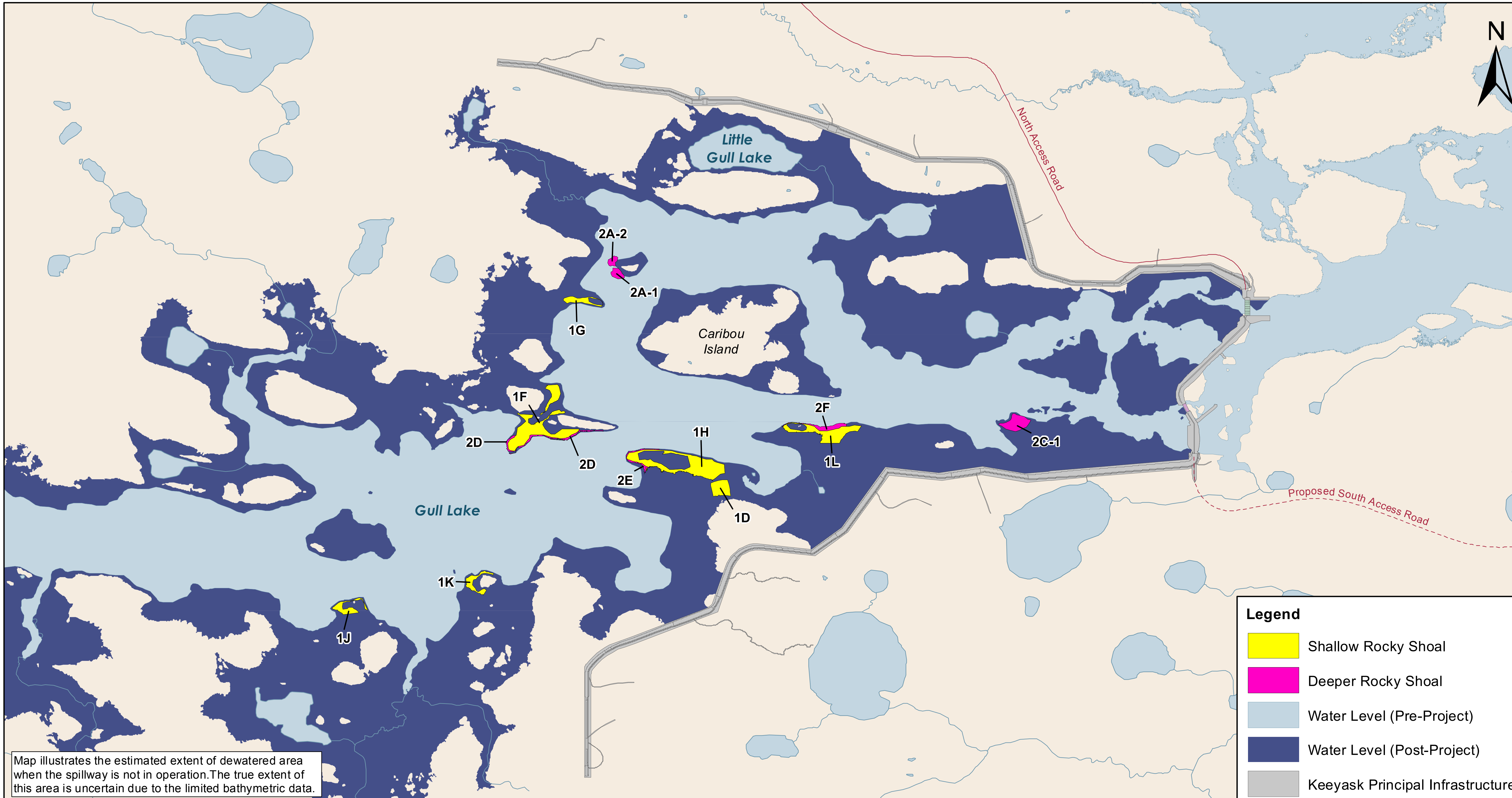
KEEYASK
Hydropower Limited Partnership

0 1 2 3 4 Kilometres
0 0.5 1 1.5 2 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewaterd area are estimated based on the existing environment 95th percentile flow.

Potential Spawning Shoal Development Locations in the Keeyask Reservoir

Map 4-A



Keeyask Hydropower Limited Partnership

0 1 2 3 4 Kilometres
0 0.5 1 1.5 2 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Preferred Spawning Shoal Development Locations in the Keeyask Reservoir

Map 4-B

Table 4 - C: Preferred spawning shoal development zones

Development Site	Post-impoundment Location Characteristics	Comment
< 4 M BOTTOM DEPTH AT SHOAL DEVELOPMENT SITE		
1D	Good velocity and exposure attributes and adjacent to a potential mineral shelf development zone.	Suitable for shoal development
1F	Possesses good velocity and exposure attributes, and is adjacent to existing known or suspected Walleye spawning habitat and a deep-water shoal development site (2D). The more downstream area may be subject to mineral sediment deposition suggesting that the focus should be on the upstream portion.	Above-average suitability
1G	Possesses good velocity and exposure attributes and is adjacent to existing known or suspected Walleye spawning habitat. No concerns regarding sediment deposition are apparent.	Above-average suitability
1H	Possesses good velocity and exposure attributes. The downstream portion is adjacent to potential mineral shelf development area and the upstream is adjacent to a deep-water shoal development site (2E). It is also adjacent to existing known or suspected Walleye spawning habitat. No concerns regarding sediment deposition are apparent.	Above-average suitability
1J	This site is in a location with good velocity and exposure attributes and adjacent to existing known or suspected Walleye spawning habitat. However, post-Project sediment deposition may be at an unacceptably high level.	Suitable for shoal development
1K	This site is in a location with good velocity and exposure attributes and adjacent to existing known or suspected Walleye spawning habitat. However, post-Project sediment deposition may be at an unacceptably high level.	Suitable for shoal development
1L	Possesses good velocity and exposure attributes, and is adjacent to a deep-water shoal development site (2F). No concerns regarding sediment deposition are apparent.	Suitable for shoal development
> 4 M BOTTOM DEPTH AT SHOAL DEVELOPMENT SITE		
2A-1 and 2A-2	The sites possess good velocity attributes. However, there is a possible sedimentation concern at this location.	Suitable location
2C-1	Located at the 3 km exclusion zone boundary, thus potentially exposing emerging fish larvae to downstream transport out of the reservoir. No concerns regarding sediment deposition are apparent.	Suitable for shoal development
2D	Possesses good velocity and exposure attributes, and is adjacent to an existing Lake Whitefish spawning area and a proposed site for shallow-water shoal construction (1F). No concerns regarding sediment deposition are apparent.	Above-average suitability

Table 4 - C: Preferred spawning shoal development zones

Development Site	Post-impoundment Location Characteristics	Comment
2E	Possesses good velocity and exposure attributes and is adjacent to an existing Lake Whitefish spawning area and a shallow-water shoal construction site (1H). No concerns regarding sediment deposition are apparent.	Above-average suitability
2F	Possesses good velocity and exposure attributes and is adjacent to shallow-water shoal construction site (1L). No concerns regarding sediment deposition are apparent.	Above-average suitability

4.1.2.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

The success of a habitat enhancement project is dependent on both the expectations and objectives established pre-construction, recognizing that habitat alterations are to some extent, experimental in nature (Minns et al. 1996). Tugend et al. (2002), in a widespread survey of U.S. state agencies responsible for fish habitat enhancement projects, found satisfaction with projects that focused on enhancing fish spawning ranged from 0.7 to 4 out of 5. Satisfaction varied with the type of material used, with an average rating for rock of 0.7/5, rip-rap 1.5/5, and all other materials: ≥2.5/5.

A majority of the scientific literature related to freshwater fish habitat enhancement in North America has focused on salmonids (predominantly salmon and trout species) and centrachids (*i.e.*, bass and sunfish) (Brown 2006 and references therein), and additionally percids (*i.e.*, perch and walleye). Species of interest occurring in the Keeyask study area and falling into one of these families include: Lake Whitefish (family Salmonidae) and Walleye (family Percidae). Both Lake Whitefish and Walleye, similar to Lake Sturgeon, are simple lithophilic broadcast spawners that provide no parental care post spawning, and are widely believed to prefer sand, gravel, cobble, boulder and/or rock substrates (Roseman et al. 2011). The eggs of these three species depend on the interstitial spaces associated with these substrate types. Walleye and whitefish spawning tends to occur in shallower waters (<3 m; Ayles 1976 and Kerr et al. 1997 and references therein) than Lake Sturgeon (<5m; Kerr et al. 2010), but the inherent similarities between whitefish, Walleye, and sturgeon spawning habitat suggests a spawning reef can be designed to benefit all three species, and this has been demonstrated in the literature.

D'amours et al. (2001) showed that Lake Sturgeon, Percidae spp., Catostomidae spp., and Mooneye (*Hiodon tergisus*) larval drift were all detected in similar habitats, close to the Des Prairie River power house and (or) in the Île de Power Rapids. Egg assessment surveys conducted by Roseman et al. (2011) on a constructed reef at Northeast Fighting Island on the Detroit River, in addition to Lake Sturgeon eggs, captured eggs of other fish including Walleye, Lake Whitefish, White Sucker (*Catostomus commersoni*), Shorthead Redhorse (*Moxostoma macrolepidotum*), and Trout-perch (*Percopsis omyscomaycus*). Similarly, Read and Morrison (2004) detected Lake Whitefish, Walleye, and eight other fish species sac-fry hatched from eggs, and a significant increase in the occurrence of spawning ready Lake Sturgeon and

Walleye (in addition to other fish species) after the installation of three Lake Sturgeon spawning reefs in the waters off Belle Isle in the Detroit River. Although evidence suggests that the occurrence of fish species of varying life stages increases after reef installation, few studies have demonstrated that increased occurrence translates into a net increase in abundance.

WALLEYE

Results of Walleye habitat improvement projects have been mixed (Katt et al. 2011). Walleye egg deposition and early survival have been demonstrated to increase on improved spawning areas in lakes (Johnson 1961; Newburg 1975; Bassett 1994), reservoirs (Weber and Imler 1974), and rivers (Armstrong and Dyke 1967; Gibson and Hughes 1977; Corbett and Powles 1986), but a subsequent increase in adult Walleye abundance has been more difficult to ascertain (Geiling et al. 1996). At least one study has demonstrated quantitatively that the addition of cobble can improve adult Walleye abundance (in addition to egg density) in a reservoir (Katt et al. 2011 but see McKnight 1975), but few studies have attempted to quantify the long-term effect of habitat enhancement on adult Walleye abundance. It is quite clear that further long term, quantitative research on this topic, especially in lake and riverine environments is required (Geiling et al. 1996).

LAKE WHITEFISH

Compared to Walleye, the published scientific literature is rather sparse when it comes to reports assessing Lake Whitefish habitat enhancement. Most of the literature relating to freshwater Salmonid habitat enhancement relates to trout species, especially Lake Trout (Brown 2006). The few reports that have mentioned Lake Whitefish reported the detection of eyed whitefish eggs. According to Roseman et al. (2007), “the construction of spawning reefs at Belle Isle on the Detroit River in June 2004 directly benefited Lake Whitefish.” While no Lake Whitefish were detected before construction (2003 and 2004), eyed Lake Whitefish eggs were detected at three sites after construction (2006) (Roseman et al. 2007). Similarly, Foster and Kennedy (1995) detected Lake Whitefish eggs at Tawas artificial reef on Lake Huron. Few, if any studies have demonstrated habitat enhancement to have a net increase in Lake Whitefish abundance.

The scientific literature provides strong evidence that many fish species use the type of spawning structures proposed for the Keeyask project. Given that the design features for the Walleye and Lake Whitefish spawning shoals to be constructed at Keeyask incorporated all of the features listed as improving success, it is anticipated the constructed structures will improve the spawning success and abundance of fish species found in the Keeyask area, especially Lake Sturgeon, Walleye and Lake Whitefish.

4.1.2.1.2 CONTINGENCY MEASURES AND ASSOCIATED MONITORING

If results indicate that recruitment is not successful, habitat and fish population data will be assessed to determine a likely cause such that appropriate contingency measures can be implemented. Targeted programs that specifically monitor fish use of the constructed habitat will be conducted as described in the AEMP and, based on the results; the spawning shoals will be modified in an effort to attract fish. Potential modifications could include: the addition of rock with larger or smaller diameters than those initially used for construction of the shoals; altering the spacing of rock substrate; altering the slope of the habitat; or constructing additional rocky shoal habitat at different water depths. These modifications would be discussed with relevant federal and provincial regulatory agencies prior to implementation. The modified spawning shoals would be monitored using the same approach described for the spawning shoals constructed prior to reservoir formation.

4.1.3 KEEYASK RESERVOIR – HYDRAULIC FEATURES NEAR BIRTHDAY RAPIDS

Lake Sturgeon prefer to spawn at sites where white water is present. Impoundment of the Keeyask reservoir will lead to changes at Birthday Rapids including increased depth, reduced velocity and loss of white water. Therefore, it is unknown whether Lake Sturgeon will continue to spawn at this site post-impoundment. Spawning habitat currently present at Long Rapids (upstream of Birthday Rapids) will continue to be available post-impoundment and it is expected that Lake Sturgeon will continue to use this area.

Monitoring will be implemented to determine the success of Lake Sturgeon spawning in the reach of the Nelson River between Long Rapids and Birthday Rapids. This monitoring is described in detail in the AEMP.

4.1.3.1.1 CONTINGENCY MEASURES AND ASSOCIATED MONITORING

Should monitoring indicate poor or no spawning success, contingency works to create hydraulic features that would be attractive to spawning sturgeon will be developed. Proposed hydraulic features would be discussed with relevant federal and provincial regulatory agencies prior to development. As construction related to the Keeyask project will be concluded by the time this contingency measure would be required, the GS EnvPP will no longer be in effect; however, environmental protection measures specific to the work would be developed and implemented by Manitoba Hydro on behalf of the KHLP prior to the work commencing

4.1.3.1.2 ANALYSIS OF EXPECTED EFFECTIVENESS

Lake Sturgeon on the Wolf River spawn at a range of sites, including ones created by bank stabilization (*e.g.*, Wolf River in Wisconsin, Bruch and Binkowski 2002) such as rip rap placed to stabilize shoreline. This increases confidence that such a measure would be successful for use in the Keeyask area. Given that little modification of the river bank appears necessary to make an area attractive, if other conditions such as velocity, depth and substrate are already suitable, it is expected that modifications to the shoreline of the river will be successful. Future monitoring will determine this.

4.1.4 KEEYASK RESERVOIR – YOUNG-OF-THE-YEAR LAKE STURGEON HABITAT

Based on known capture locations and habitat preferences of young-of-the-year (YOY) Lake Sturgeon, it is predicted that creation of a reservoir upstream of the Keeyask GS will impact Lake Sturgeon recruitment by altering or destroying existing YOY Lake Sturgeon habitat, and/or altering larval drift patterns such that larval Lake Sturgeon would no longer "settle out" in suitable habitats.

As described in the AEMP, recruitment monitoring will be conducted post-impoundment to monitor YOY and sub-adult Lake Sturgeon abundance (*i.e.*, year class strength). If it is found that missing year classes are more prevalent in the post-Project environment, or if a new year class is not detected in the reservoir for a pre-determined number of years (to be decided in consultation with federal and provincial regulatory agencies), the implementation of contingency measures, such as a sand blanket, to create YOY habitat within the reservoir will be considered.

In addition to recruitment monitoring, information on the types of aquatic habitat in the reservoir (substrate, depth and velocity) will be collected during the initial years following impoundment because although sand is widely believed to be an important substrate for YOY lake sturgeon, other substrates might also be suitable. This monitoring will also provide more precise post-impoundment substrate and velocity data to supplement the modelled results and would be used to refine locations where offsetting measures could be placed, if required.

4.1.4.1.1 CONTINGENCY MEASURES AND ASSOCIATED MONITORING

Lake Sturgeon YOY habitat preferences have been previously studied in small rivers/tributaries of the Great Lakes. These studies suggest that YOY Lake Sturgeon prefer a flat sandy substrate devoid of macrophyte cover (Kempinger 1996; Benson et al. 2005; Smith and King 2005). Habitat preferences of YOY Lake Sturgeon in large riverine systems has received considerably less attention, however, since 2008, YOY Lake Sturgeon have been captured in several large rivers including the St. Clair River (Chiotti, pers comm.), Detroit River (Chiotti pers comm.), Winnipeg River (Barth 2011; Henderson 2013), Nelson River (MacDonald 2009), and Burntwood River (Henderson and Pisiak 2012; Henderson et al. 2013). Furthermore, data that are perhaps most applicable to YOY Lake Sturgeon habitat creation in the Keeyask reservoir were collected in 2008 when many YOY Lake Sturgeon were captured in Gull Lake (MacDonald 2009). The results of these studies also suggest that sand and gravel substrates are preferred by YOY Lake Sturgeon.

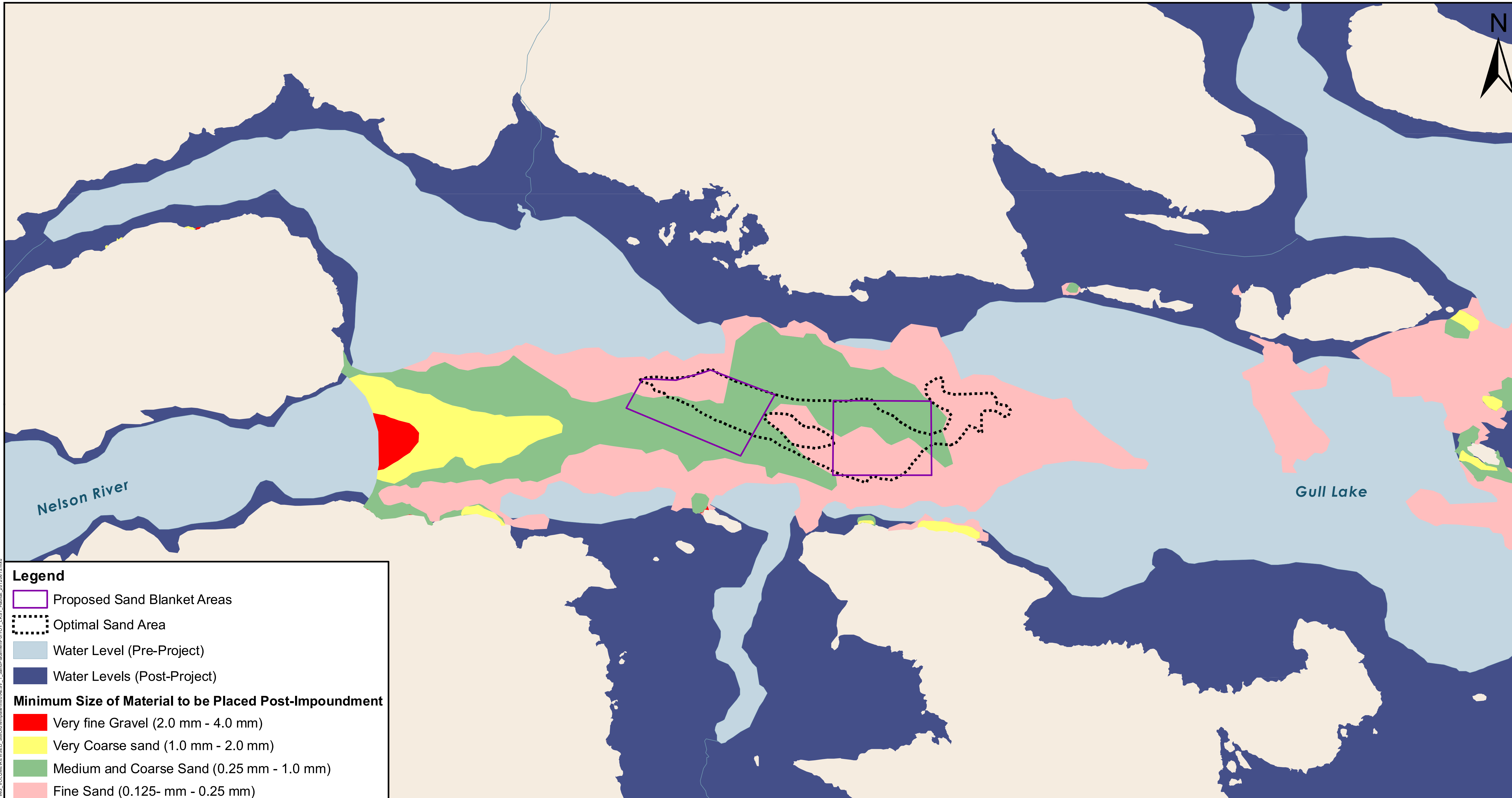
Another important consideration for creating YOY Lake Sturgeon habitat in the Keeyask reservoir is to create the habitat in a location where larvae are expected to "settle out". Once Lake Sturgeon larvae have absorbed their yolk-sac they emerge from the substrate and drift passively downstream with the current. Although little is known about the extent of larval drift in large rivers, or the ability of larvae to actively select for particular habitats, it has been suggested, based on the distribution and abundance of juveniles and the known propensity for limited movements of juveniles (Barth 2011; Barth et al. 2011; McDougall et al. 2013) that a proportion of larvae will settle out in the area nearest to the spawning location where a significant decrease in water velocity occurs (Barth 2011).

If recruitment monitoring indicates the reservoir contains insufficient YOY Lake Sturgeon habitat, the KHLP plan to create YOY habitat at the upstream end of Gull Lake, which is the first area where water velocities experience a significant drop downstream of suspected spawning areas at Long and Birthday Rapids. Phase I of this pilot program would see the placement of a sand blanket to create a 20 ha area of sandy habitat. Construction of the sand blanket would involve depositing large amounts of sand onto the river bottom at the upstream end of Gull Lake where water velocities are low enough to prevent erosion of the deposited sand, but high enough to prevent silt deposition (Map 4 - C). Invertebrates are known to colonize sandy habitats quickly and given the quantity of invertebrate drift in the Nelson River, it is likely that a food base suitable for YOY Lake Sturgeon would exist on this created habitat.

Subsequent monitoring to determine the success of the Phase I pilot program would be necessary before determining the need to implement Phase II sand placement (up to an additional 25 ha), which may or may not be adjacent to the Phase I location (Map 4 - C).

As construction related to the Keeyask project will be concluded at the time of undertaking this work, the GS EnvPP will no longer apply; however, environmental protection measures specific to this work would be developed and implemented by Manitoba Hydro on behalf of the KHLP prior to the work commencing.

Recruitment monitoring would be used to assess use of the constructed habitat by larval Lake Sturgeon as described in the AEMP.



KEEYASK Hydropower Limited Partnership

0 0.5 1 1.5 Kilometres
0 0.5 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro

Sand Placement Locations for Young-of-the-Year Lake Sturgeon Habitat

Map 4-C

4.1.4.1.2 ANALYSIS OF EXPECTED EFFECTIVENESS

Assessing the likelihood that this offsetting measure would be successful is impossible because the creation of similar YOY Lake Sturgeon habitat has never previously been attempted. However, because YOY Lake Sturgeon have been found over a variety of habitat types, aquatic invertebrates are known to colonize sand quickly and have been found to prefer sandy/gravel habitats, the design of the contingency sand blanket habitat is based on the best available information.

Another important consideration for YOY sand habitat creation is that it may not be necessary for YOY survival. In the Winnipeg River, juvenile and YOY Lake Sturgeon were captured in the Great Falls Reservoir on the Winnipeg River, a reservoir that contains very little sand substrate (McDougall 2011). Further, in the Winnipeg River, YOY Lake Sturgeon have been captured over a wide variety of substrates from boulder to fine silt/clay (Barth 2011). For this reason, it could be argued that the habitat preferences of YOY Lake Sturgeon may be somewhat plastic and are not limited to sand.

4.1.5 DOWNSTREAM OF THE KEEYASK GS - TAILRACE SPAWNING SHOAL

The creation of artificial spawning habitat downstream of the powerhouse would increase the certainty that Lake Sturgeon spawning habitat is available downstream of the GS following development of the Project. Currently, the creation of spawning habitat in proximity to where it exists today is likely to have the greatest probability of success. This spawning habitat would be designed specifically to attract Lake Sturgeon, but it could also be used by other species that spawn under similar conditions.

Phase 1 Lake Sturgeon spawning habitat will be constructed below the powerhouse during construction of the generating station. The proposed location of the constructed spawning habitat is shown on Map 4 - D. Key features to this spawning habitat are a minimum substrate thickness of 0.6 m (with 0.1–0.6 m diameter rock) and water depths of 1–10 m. Under this initiative, micro spawning sites will be created by placing three (1 m to 2 m diameter) boulders in V-shape (upstream chevron) clusters as shown in Figure 4 - A. Construction of Phase 1 habitat would occur “in-the-dry” to avoid many of the potential serious effects to fish that are associated with instream construction.

HSI modelling indicates that existing suitable spawning habitat within and below Gull Rapids tends to be found along the edges of the main channel. The spawning structure will be built on the north shore of the river below the powerhouse in order to increase the certainty of adequate and reliable flow and to be situated where Lake Sturgeon moving upstream in low velocity habitat along the river’s edge would locate it.

Studies conducted at the Pointe du Bois GS have found that, under some flow conditions, Lake Sturgeon move into the tailrace channel and that quiet waters next to turbulent fast flow create preferred microhabitats. As a result, a slope will be incorporated into the north wall of the tailrace channel (Section B-B in Figure 4 - B) and a bench covered in spawning substrate will be constructed along the north shore of the tailrace (Section A-A in Figure 4 - B). The modifications to the vertical wall of the tailrace channel are meant to guide sturgeon that move upstream past the constructed spawning structure to an additional area of suitable spawning substrate (the bench).

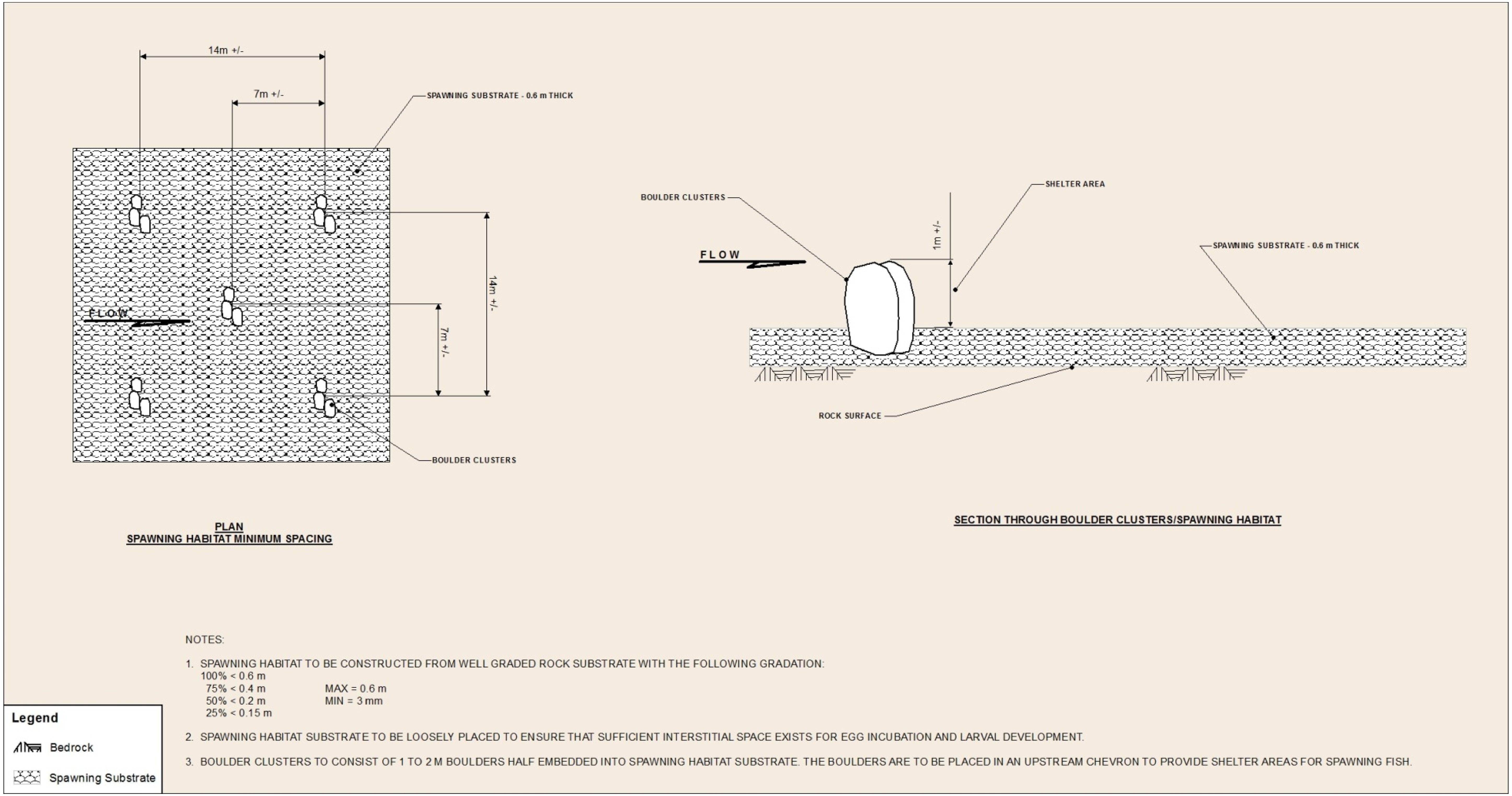


Figure 4 - A: Spawning habitat details showing the arrangement and spacing of boulder clusters

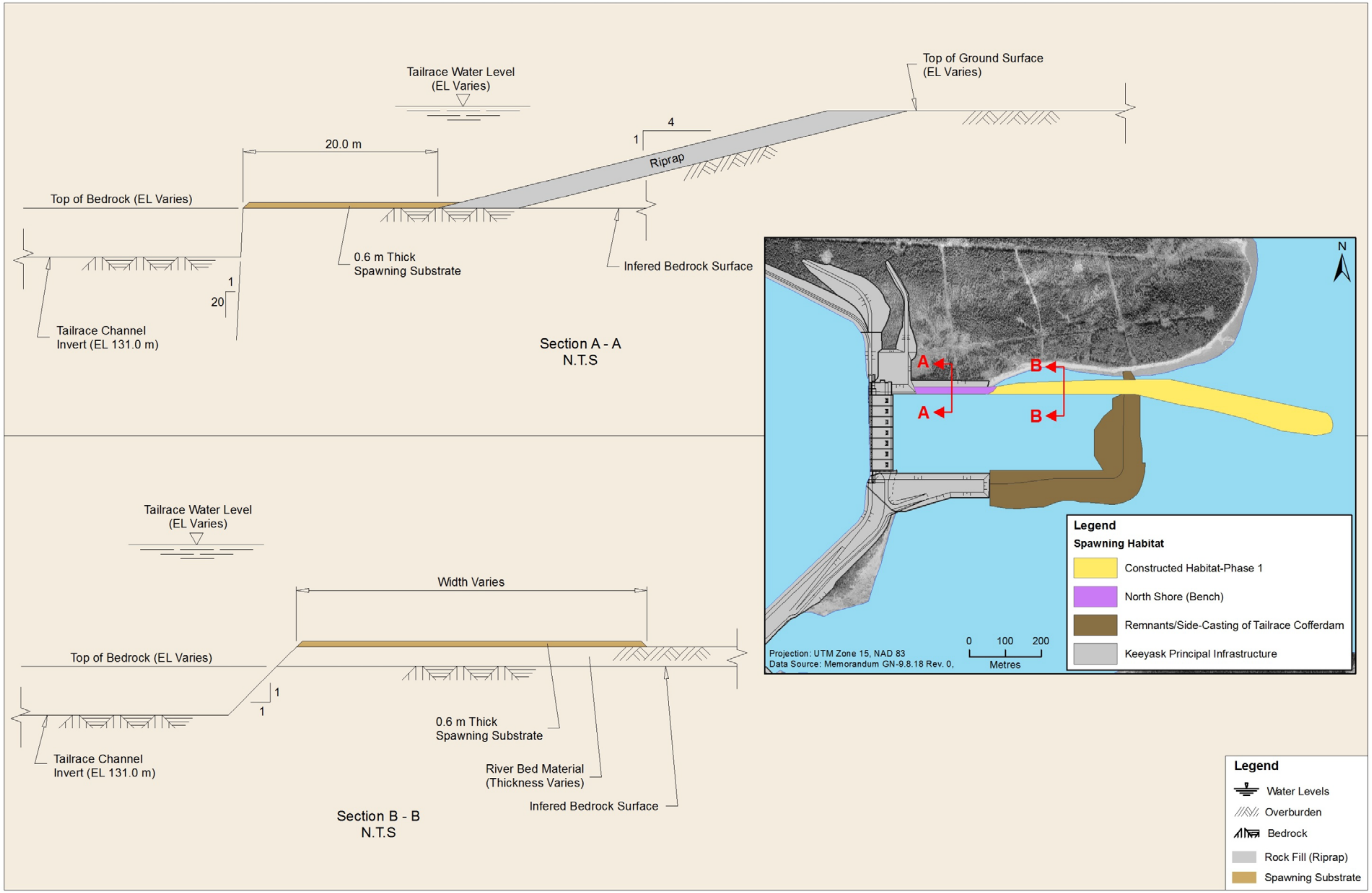
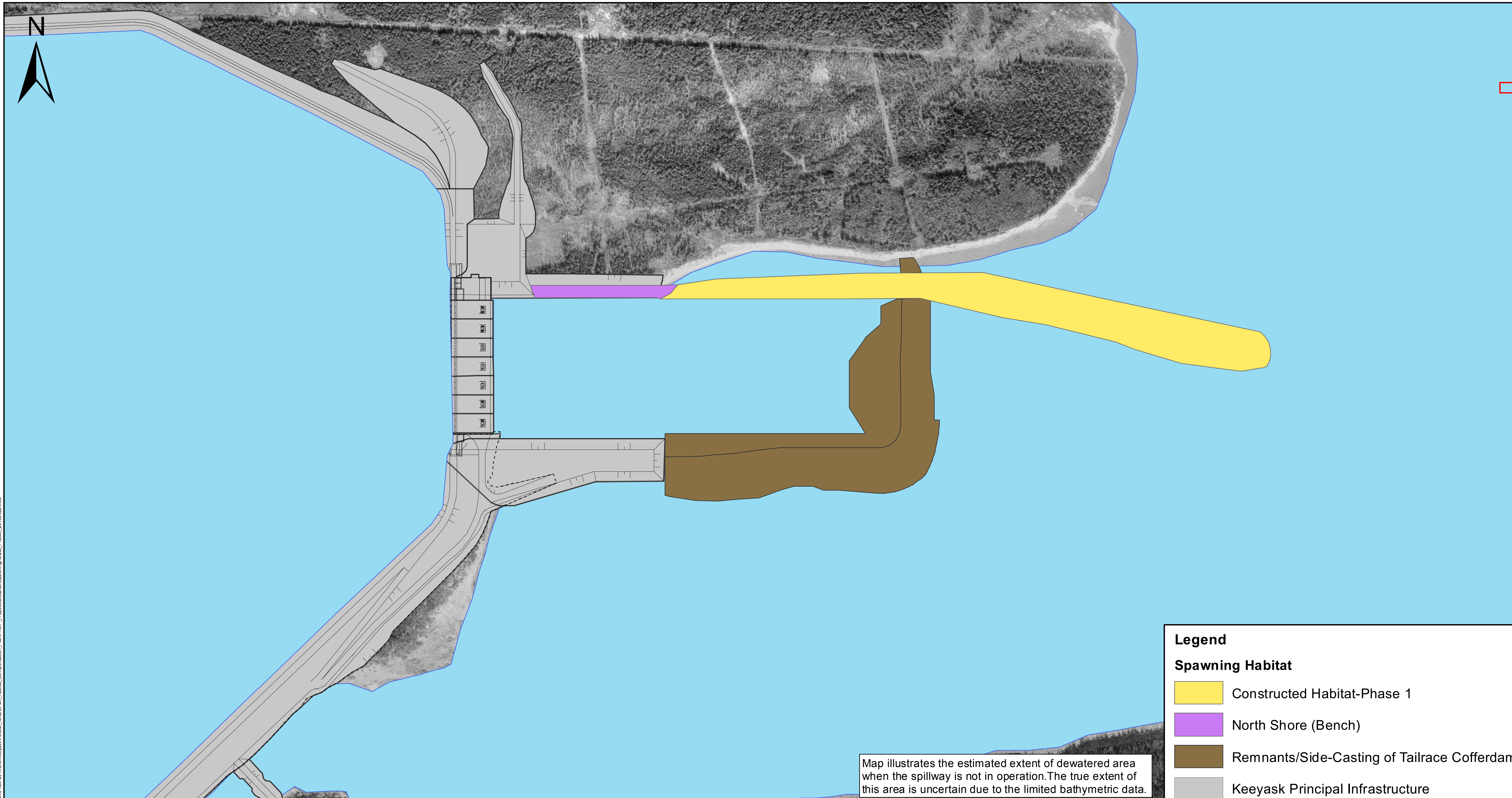


Figure 4 - B: Cross sections of modifications to north bank of tailrace channel to create sturgeon spawning habitat

The potential to create additional suitable substrate for spawning by leaving behind remnants of the cofferdam, or side-casting, was also evaluated (Map 4 - D). Due to the hydraulic effects of the cofferdam remnants, leaving a substantial amount of material is not feasible. However, where practical, coarse materials from the remnants of the tailrace cofferdam may be spread to create conditions attractive to spawning fish in areas where interference with the outflow from the GS will not be a concern.

The GS EnvPP would be followed during the above work to mitigate potential effects during construction.

The area of spawning habitat that meets the design criteria is dependent on the discharge through the powerhouse and the water elevation of Stephens Lake. For example, Phase 1 provides 0.4–4.7 ha for discharges of 1,100 m^3/s (two units, 1 and 2) to 4,000 m^3/s (seven units) respectively. During the spawning period, the operation of the Keeyask GS will be modified such that flow from the two northernmost units is continuous to maintain appropriate hydraulic conditions over the spawning structure. In addition, monitoring will be conducted to determine if the cycling mode of operation adversely affects the behaviour of spawning fish.



KEEYASK
Hydropower Limited Partnership

0 100 200 300 400 Metres
0 250 500 750 1,000 Feet

Projection: UTM Zone 15, NAD 83
Data Source: Memorandum GN-9.8.18 Rev. 0, Figure 30
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Proposed Locations of Spawning Habitat
Phase 1

Map 4-D

4.1.5.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

The proposed Lake Sturgeon Phase 1 spawning habitat design criteria (Table 4-D) are based on successful Lake Sturgeon spawning structures that have been constructed in Québec and Russia (Verdon and Gendron 1991; Dumont et al. 2009; LeHaye et al. 1992 in Kerr et al. 2010). Dumont et al. (2011) reported that Lake Sturgeon reproductive success in the Des Prairie River, Quebec, immediately below the Riviere Des Prairie GS, was improved following the addition of 8000 m^2 of appropriate substrate. The estimated mean survival rates of deposited eggs to drifting larvae improved from 0.88% and 0.93% in two years prior to the substrate addition, to 5.6%, 3.82% and 2.41% in the three years monitored following the substrate addition. Roseman et al. (2011) documented the use of a man-made spawning reef in the Detroit River between Lake St. Clair and Lake Erie. Here, a spawning reef was created at the upstream end of Fighting Island, a site not previously used by spawning Lake Sturgeon. Johnson et al. (2006) documented three consecutive years of spawning success at an artificial spawning site in the St. Lawrence River. These authors believe that maintenance of sediment-free interstitial spaces is critical for Lake Sturgeon spawning and recruitment success.

Table 4 - D: Biological design criteria for Lake Sturgeon spawning habitat creation below the Keeyask tailrace

Parameter	Design Criteria	Additional Considerations
Velocity	Min = 0.5 m/s Max = 1.5 m/s Velocities referenced to 0.6 of depth from surface.	A range of velocities should be available over the constructed habitat.
Flow	Flow should remain relatively constant during the spawning and incubation period.	Flow should be laminar downstream of the site, transitioning to more turbulent at the site.
Depth	Min = 1 m Max = 10 m Pre-construction depth of 2m–11m required for materials placement.	A range of depths should be available over the constructed habitat.
Substrate	Minimum 10 cm diameter. Maximum 60 cm diameter. Size distribution (diameter): 100% <0.6 m, 75% <0.4m, 50% <0.2 m and 25% <0.15m.	Important that there be ample interstitial space for egg incubation and larval development. Minimum thickness of 0.6 m.
Micro-habitats	65 boulder clusters (3 boulders >0.9 m diameter) will be interspersed over the spawning habitat.	Provide refuge and create turbulence.
Size of Spawning Area	A total area of 3.0 ha is recommended.	Could be made up of several areas of no less than 0.5 ha that meet hydraulic criteria.
Location	As close as possible to the north shore of the river while satisfying hydraulic criteria.	

Table 4 - D: Biological design criteria for Lake Sturgeon spawning habitat creation below the Keeyask tailrace

Parameter	Design Criteria	Additional Considerations
Critical Annual Period	Mid-May to mid-July.	Discharge would be managed during this period to satisfy velocity and depth criteria.

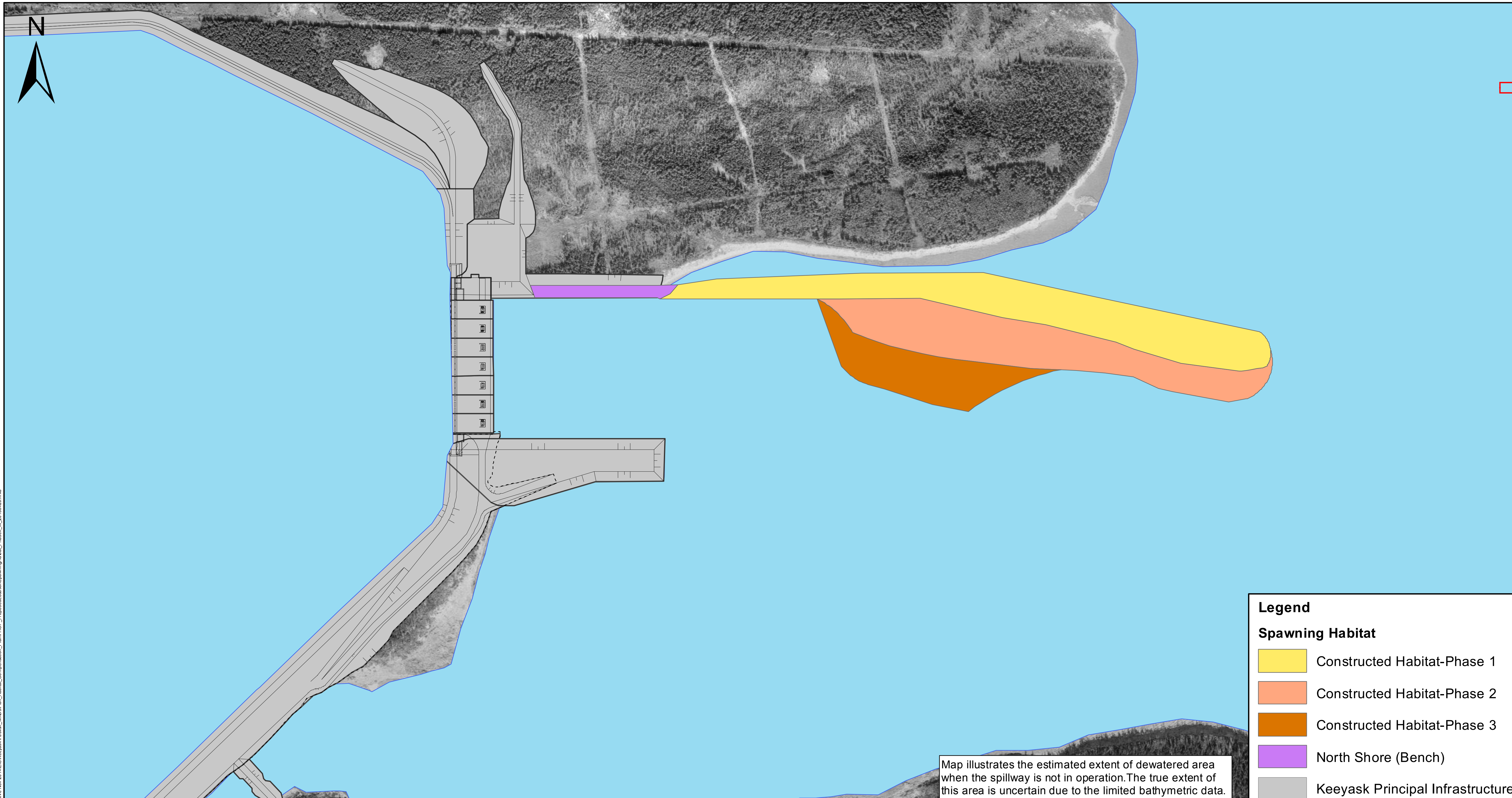
In addition, Dumont et al. (2011) list four other spawning areas that were successfully improved in the lower St. Lawrence system (Saint-Maurice, Saint-Francois, Ouareau and Chaudie`re rivers). However, they also list one site that was unsuccessful, at the Beauharnois hydroelectric generating station tailbay (St. Lawrence River). At this site periphyton quickly colonized the substrate, which was thought to be aided by the great transparency of the water. It is important to note that the substrate addition was only attempted once, and there were no attempts to improve conditions at the Beauharnois site.

In their review, Kerr et al. (2010) also list several sites as being successful examples of Lake Sturgeon artificial spawning site creation (the Detroit River, Eastmain River, Manistee River, Riviere Des Prairie, Riviere Ouareau, Riviere Saint-Maurice; St. Lawrence River (at Ogdensburg, and at the Iroquois water control structure) and the Wolf and Fox rivers). Two examples, at the Beauharnois dam in the St. Lawrence River and at developed site in the St. Louis River, are provided as examples of sites that were unsuccessful in maintaining the appropriate conditions for Lake Sturgeon spawning. Kerr et al. (2010) state that "while the construction of new or enhanced spawning grounds has proven somewhat successful, their use by sturgeon depends on a suitable water discharge regime to not only provide suitable incubation conditions but also to keep the substrate clean of silt and sediment".

Given that the proposed spawning shoal meets all the requirements of successful structures constructed elsewhere, it is likely to be used if sufficient adult Lake Sturgeon are present in Stephens Lake.

4.1.5.1.2 CONTINGENCY MEASURES AND ASSOCIATED MONITORING

Use of artificial spawning habitat by spawning Lake Sturgeon will be monitored during the initial years of station operation as outlined in the AEMP. Phases 2 and 3 (Map 4 - E) have been identified as areas that could also be developed in the tailrace as a contingency in case conditions in the initially created habitat are not suitable. These areas have been identified based on hydraulic modelling and would create up to 15.9 ha of spawning habitat adjacent to Phase 1); however, actual locations would be adjusted depending on site-specific conditions and responses of sturgeon to the flows downstream of the GS. As construction related to the Keeyask project will be concluded by the time Phase 2 and/or 3 would be potentially required, the GS EnvPP will no longer be in effect; however, environmental protection measures specific to the work would be developed and implemented by Manitoba Hydro on behalf of the KHLP prior to the work commencing. Fish use of these additional areas of habitat would be monitored following the same techniques used to monitor Phase 1 habitat use.



Keeyask Hydropower Limited Partnership

0 100 200 300 400 Metres
0 250 500 750 1,000 Feet

Projection: UTM Zone 15, NAD 83
Data Source: Memorandum GN-9.8.18 Rev. 0, Figure 30
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Proposed Locations of Spawning Habitat

Phase 2 and 3

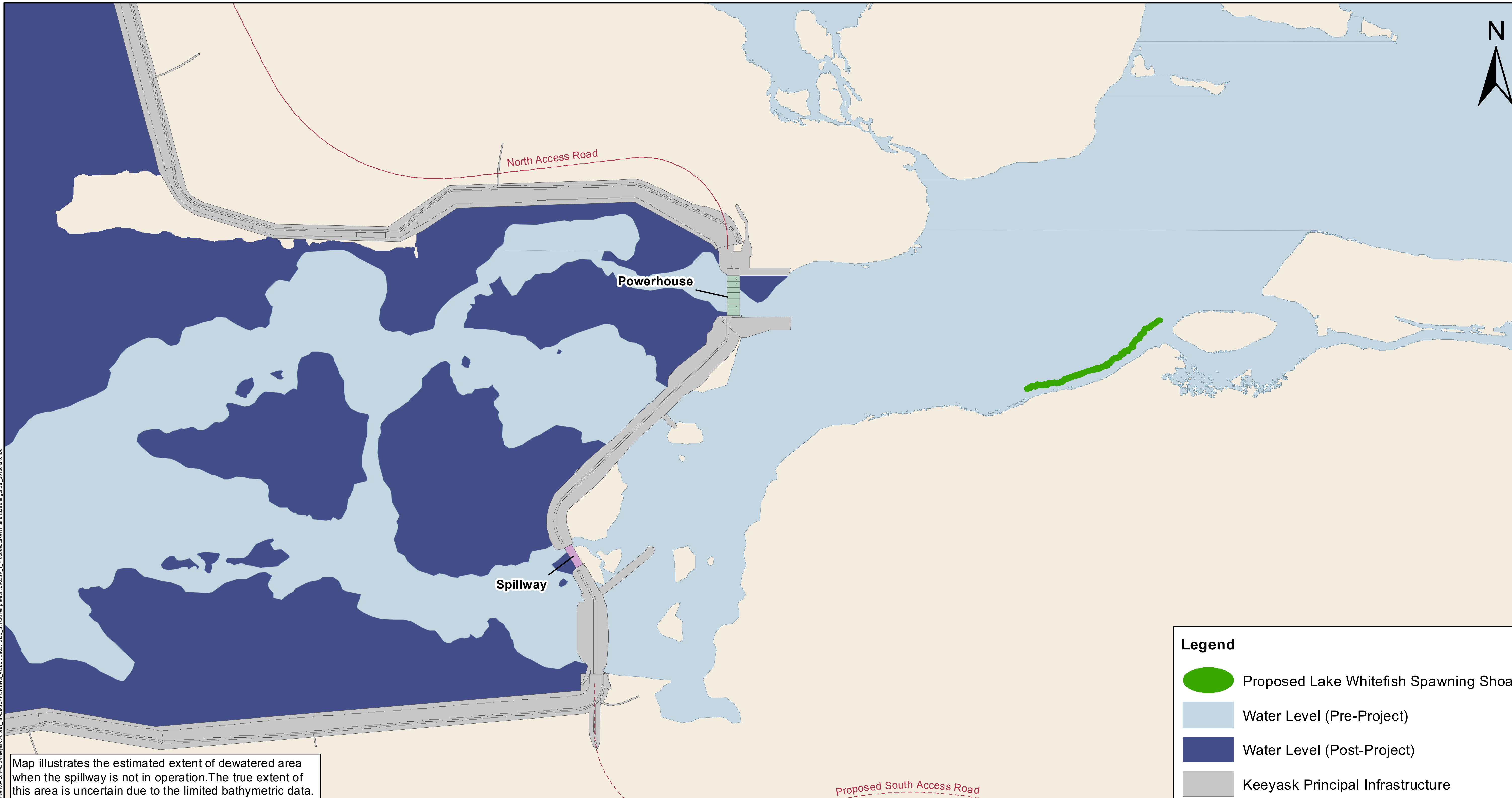
Map 4-E

4.1.6 DOWNSTREAM OF THE KEEYASK GS - SOUTH SHORE SPAWNING SHOAL

Lake Whitefish currently spawn in the South Moswakot River, Gull Rapids and Ferris Bay. The creation of a Lake Whitefish spawning reef at a location along the south shore of Stephens Lake (Map 4 - F) will mitigate the effects of the loss of Lake Whitefish spawning habitat at Gull Rapids. Biological design criteria for the spawning reef (Table 4 - E) suggest a minimum area of 1,000 m^2 of spawning habitat be created, with depths of 1.5–2.5 m below the Stephens Lake minimum operating level and depth-averaged velocities between 0.2–1.0 m/s.

Table 4 - E: Biological design criteria for the construction of Lake Whitefish spawning habitat in Stephens Lake

Parameter	Design Criteria	Additional Considerations
Substrate	A mix of coarse materials as follows: 25% boulder (750-500 mm); 35% cobble (256-64 mm); 25% large gravel (64-32 mm); and 15% small gravel (32-8 mm).	Substrate layer should have minimum thickness of 0.75 m, and substrate material should be free of silt and clay. Important that there be ample interstitial space for egg incubation and larval development.
Velocity over Spawning Habitat	Minimum = 0.2 m/s, Maximum = 1.0 m/s, at 0.6 of depth (depth-averaged). If water velocity is less than 0.2 m/s, then location requires wave generated circulation (*i.e.*, exposure to NE – NW winds).	
Depth	Crest of spawning shoal: 1.5–2.5 m below MOL.	Lake Whitefish eggs incubate over winter; eggs deposited at depths less than 1.5 m below MOL will be vulnerable to freezing at maximum ice thickness.
Size of Spawning Area	Minimum crest area at preferred depth should not be less than 1000 m^2.	Shape of shoal should maximize surface area (long and rectangular as opposed to round or square).
Slope	Slope of spawning area should not exceed 10%.	
Location	Select areas where mineral substrate is present or areas adjacent to bedrock. Where placement occurs over organic substrates, gabion basket wire should be laid over the bottom prior to placement.	At standing water sites, orient shoals to maximize exposure to wave action.
Critical Annual Period	Late October to late April	



KEEYASK Hydropower Limited Partnership

0 0.5 1 1.5 Kilometres
0 0.5 Miles

Projection: UTM Zone 15, NAD 83
Data Source: NTS base 1:50 000
Stephens Lake Shoreline - Quickbird@Digitalglobe, 2006
Nelson River Shoreline modelled by Manitoba Hydro
Extents of dewatered area are estimated based on the existing environment 95th percentile flow.

Proposed Lake Whitefish Spawning Shoal

Map 4-F

Due to the dynamic nature of the shoreline and bathymetry along the south side of this reach, the depths will need to be confirmed after construction of the generating station is complete, after which the final design phase and installation can occur. Post-Project velocity measurements collected near the proposed Lake Whitefish spawning habitat area will be needed to determine the optimum location for the spawning shoal.

As construction of the shoal will take place "in-the-wet", after the construction is complete, the GS EnvPP will no longer be in effect; however, environmental protection measures specific to the work would be developed and implemented by Manitoba Hydro on behalf of the KHLP prior to the work commencing.

Monitoring to confirm fish use of the habitat will be conducted in the initial years of operating the generating station and is described in the AEMP.

4.1.6.1.1 ANALYSIS OF EXPECTED EFFECTIVENESS

Section 4.1.2 of this document contains applicable information on the expected effectiveness of the Lake Whitefish spawning habitat.

4.1.6.1.2 CONTINGENCY MEASURES AND ASSOCIATED MONITORING

If monitoring outlined in the AEMP indicates that fish are not using the constructed spawning shoal, it will be modified in an effort to attract fish. Potential modifications could include: the addition of rock with larger or smaller diameters than those initially used for construction of the shoals; altering the spacing of rock substrate; altering the slope of the habitat; or constructing additional rocky shoal habitat at different water depths or extending the shoal into an areas with different water velocities. Modifications will be discussed with relevant federal and provincial regulators. Monitoring fish use of the modified spawning shoal would follow the same approach described for the spawning shoals that was constructed initially.

4.1.7 STOCKING LAKE STURGEON

Lake Sturgeon in the Nelson River between the Kelsey GS and the Kettle GS currently exist in low numbers. Stocking has been identified as being critically important to the overall offsetting plan amid concerns that the current population may be too low to recover unaided, even in absence of GS construction. Lake Sturgeon stocking is also of key importance to the success of other offsetting measures proposed for Keeyask (i.e., the tailrace spawning shoals described in Section 4.1.5), as the latter will be ineffective if Lake Sturgeon in the vicinity are too few to find it and reproduce.

The Keeyask conservation stocking plan was designed to address:

- Existing low population numbers due to historic effects, in particular a commercial fishery;
- Potential effects of creation of the Keeyask reservoir, including possible emigration of adult Lake Sturgeon in response to water level changes at impoundment, and reduced year class

strength in the initial years of impoundment due to changes in spawning and young-of-the-year habitat. These effects are predicted to be restricted to the first years of impoundment, if they occur at all; and

- Potential decrease in year class strength of sturgeon in Stephens Lake, due to the alteration and ultimate loss of spawning habitat in Gull Rapids during construction of the GS. (This effect is offset during the operation phase by the constructed spawning habitat.)

The initial phase of the stocking plan described in this document began in 2013/2014 and will occur over a ten year period. At present, it is anticipated that stocking will occur for at least one full generation (25 years) to restore the historically depleted population and may continue longer, until a self-sustaining population is achieved. It should be noted that the *Environment Act* Licence issued for the Project requires that a stocking plan be developed for 50 years or until a self-sustaining population is proven to be re-established, with the provision to resume stocking at any time if the Lake Sturgeon population declines as a result of the Project until the Project is decommissioned, or as otherwise approved by the Director of the Manitoba Conservation and Water Stewardship Environmental Approvals Branch. The KHLP has committed to continue to stock until a self-sustaining population is achieved; however, at this time it is not possible to provide a detailed description of activities in the future since the appropriate approach will depend on results obtained in the first ten years.

Specific stocking activities will be determined annually and will reflect results from previous years and conditions for that year. The KFRRC (which will undertake the role of the Lake Sturgeon Advisory Committee described in the *Environment Act* Licence) may decide to modify this plan. Annual spawn collection and release of fish will be determined with MCWS based on Live Fish Handling permits issued by MCWS.

4.1.7.1 STOCKING AREAS AND FREQUENCY

Stocking will be conducted in three general areas:

1. Upper Split Lake Area: which includes the Burntwood River between First Rapids and Split Lake; the Nelson River between the Kelsey GS and Split Lake; and the Grass River between Witchai Lake Falls and the Nelson River;
2. Keeyask reservoir: presently the reach of the Nelson River between Clark Lake and the Keeyask GS; and
3. Stephens Lake: the area between the Keeyask GS and the Kettle GS.

Suitable habitat for juvenile sturgeon is currently present in all three areas. It is predicted that suitable habitat will be present after Project construction; in the event that it is not present, contingency plans have been developed for its creation (Keeyask reservoir).

For the initial 10-year period, annual gamete collection and stocking is being conducted in alternate years between the Upper Split Lake area and the Keeyask reservoir/Stephens Lake. Gamete collection occurs in the Keeyask reservoir/Stephens Lake during even numbered years (*i.e.,* starting in 2014) and in Upper Split Lake during odd numbered years (*i.e.,* starting in 2013).

Fry and fingerlings are released in the same year as spawn is collected; yearlings are released the following year.

4.1.7.2 GAMETE SOURCE

Genetic analysis has indicated that stocks from the Burntwood River and Gull Lake are distinct. Juveniles in Gull Lake and Stephens Lake are from the same stock. Two spawning locations will be used to supply gametes:

1. Upper Split Lake stock: gametes will be collected from sturgeon that spawn at First Rapids in the Burntwood River; and
2. Keeyask stock: gametes will be collected from fish that spawn in the vicinity of Birthday Rapids or are captured near the mouth of Gull Lake.

Following hatch and rearing, progeny from the Upper Split Lake stock would be released into the Burntwood River.

Progeny from the Keeyask stock will be released back into suitable habitats in both the Keeyask reservoir/present day Gull Lake and Stephens Lake.

4.1.7.3 SPAWN COLLECTION

Each year, the goal will be to capture 2 males and 2 females for gamete collection, avoiding use of fish from which spawn has been collected in the previous 10 years. This will enable the release of progeny from four families annually and 40 families over the 10-year period. Following capture, fish will be held stream-side until temperatures are appropriate for spawning. Once appropriate temperatures are reached, Lake Sturgeon will be administered a dose of Gonadotropin-releasing hormone (GnRH) to initiate spawning. Eggs and milt will generally be collected 36 hours following the initial GnRH dose. Eggs will be fertilized stream side prior to being transported to the Grand Rapids Hatchery for rearing. Male and female sturgeon used for egg and milt collection will be released shortly after gamete collection.

4.1.7.4 DISEASE MANAGEMENT

Standard fish protection measures will be as specified by Manitoba Fisheries Branch in the Live Fish Handling Permit. Measures are expected to include:

- all eggs will be disinfected prior to their entry into the hatchery;
- fish will be collected using relevant Standard Operating Procedures;
- the Local Fish Health Officer will be notified if any fish at any life stage exhibits external signs of disease or a suspected mortality resulting from disease, and fish exhibiting external signs of disease will not be released;
- pathogen-free water will be used to transport all life stages, and release of transport water into receiving water bodies will be minimized;

- all vehicles, tanks, coolers and other implements used to transport fish will be disinfected with 300 ppm chlorine;
- fertilized eggs will be held in family groups, or at a minimum be separated by maternal line during spawn taking, incubation and as YOY fish and juveniles; and
- Lake Sturgeon will not be released until they have been disease tested for Namao virus and results have been forwarded to the Local Fish Health Officer.

4.1.7.5 REARING AND RELEASE OF PROGENY

Lake Sturgeon produce large numbers of eggs and hatch/survival rates of fertilized eggs are variable. As such, for the purposes of this initial 10-year plan, sturgeon will be released at a variety of stages (larval, fingerling and yearling). Numbers of sturgeon released at each developmental stage will be dependent upon:

- the number of Lake Sturgeon available at each developmental stage;
- the amount of hatchery space required to enable "normal" growth (of larvae, fingerlings or yearlings); and
- the end goal of maintaining 2000 fingerlings annually through the winter to be released as yearlings the following spring.

Larval sturgeon (fry) will be released at or near the location that the brood stock were captured (*i.e.,* First Rapids and Birthday Rapids).

In addition to collecting genetic samples from all brood stock used, genetic samples will also be collected from a subgroup of Lake Sturgeon representing each family group reared at the hatchery to facilitate future identification. Prior to release, the numbers and average size of fish will be recorded. Fingerling and yearling Lake Sturgeon will be released in locations known to provide suitable habitat. In the Keeyask reservoir, fingerling and yearlings will be released at several locations with deep-water, thalweg habitat where velocities are suitable. Prior to impoundment, preferred release locations will be where juvenile sturgeon have been found to date. In Stephens Lake, the majority of suitable juvenile rearing habitat exists within the upper 10 km of the Lake. For this reason, releases would occur in appropriate habitat 1 – 10 km downstream of the Keeyask GS site.

4.1.7.6 MARKING

To assess the effectiveness of the stocking program, all stocked Lake Sturgeon will be distinguishable from wild spawned Lake Sturgeon. Yearlings will be marked with Passive Integrated Transponder (PIT) tags. Since there is not currently an effective method for marking larvae or fingerlings, juvenile Lake Sturgeon captured in monitoring programs will be scanned for the presence of PIT tags, and samples for assessing growth chronology and/or parentage (i.e. genetics) will be collected from non PIT tagged sturgeon to determine whether the fish were spawned in the wild or reared in the hatchery. [1].

4.1.7.7 ANALYSIS OF EXPECTED EFFECTIVENESS

Stocking is a proven method for increasing Lake Sturgeon numbers and, as such, stocking is considered the cornerstone of many recovery plans (Cleator et al. 2010; McDougall et al. *in press*; Minnesota Department of Natural Resources 2002; Schram et al. 1999). The likelihood that stocking will be effective in increasing Lake Sturgeon numbers in the Keeyask reservoir/Stephens Lake and offsetting temporary decreases in reproduction that may occur as a result of construction activities and during the first years of impoundment, is high. Similarly, the likelihood that stocking will increase sturgeon numbers in the Upper Split Lake area is high. An extensive review of the literature failed to find any examples of a stocking program that did not result in increased abundances of Lake Sturgeon following the stocking initiative (Table 4-F).

Table 4 - F: A summary of Lake Sturgeon life stages that have been released during a number of stocking programs in the United States and Canada with an indication of success

Location	River/Lake	Year	Number/Life Stage	Success
Georgia	Coosa River	2002-2008	85,000/fingerlings	Juvenile growth and survival confirmed.
New York	Genesee River	2003-2004	1,900 juveniles	Juvenile growth and survival confirmed (See summary notes).
	Cayuga Lake	1995-2004	3,732 age 0 and 1	1995 year-class (YC) male ripe in 2006. Mean TL of 1995 YC =1.12 m.
	Oneida Lake	1995-1999	40,000 larvae 8,000 juveniles	High mortality of larvae (starvation). Rapid growth of juveniles. Age 8 males readily released sperm. Each YC has been recaptured.
	Oswegatchie River	?	30,857 juveniles	Downstream movement pattern of newly released fish compared with naturalized fish.
	St. Regis River	?	5,000 juveniles	LKST growing well.
Wisconsin	St. Louis River	1983-2000	762,000 fry 143,000 fingerlings	LKST growing well. Large LKST observed on historical

[1] All samples will be archived. Genetic analysis will only be conducted on samples identified as being of particular importance, given the cost of the analysis.

Table 4 - F: A summary of Lake Sturgeon life stages that have been released during a number of stocking programs in the United States and Canada with an indication of success

Location	River/Lake	Year	Number/Life Stage	Success
		  2000?	500 yearlings 120,000 eggs in Astroturf nest boxes	spawning grounds. No natural recruitment after 25 years.
	Yellow River	1995	10,000 fry 13,400 fingerlings	
	Upper Flambeau/Manitowish River	1993-2008	152,578 fry 56,946 fingerlings	Stocked fish are surviving and growing.
	Menominee River	1982 1995-1999 and onward (2004?)	? 25,300 fingerlings 600 yearlings	
	Middle Wisconsin River	1997 - ? 2003	200,000 fingerlings Yearlings	1997 cohort still present in river and growing well.
Michigan	Ontonagon River	1998-2004 2007 2008	Fingerlings Yearlings 723 fingerlings (SRF) 880 fingerlings (SRF)	Age 0 and yearling captured over soft substrates of sand and silt.
	Cheboygan River watershed	2006	7,800 fingerlings	
	Black Lake	2007	1,000 fingerlings (SRF)	Plan is to release 65,000 fingerlings over 20 years. Target is 2,000 adult sturgeon in Black Lake.
Minnesota	Detroit Lake	1998-2008	25 sub-adults 1,671 yearlings 17,998 fingerlings 22,500 fry	Angler success indicates movement and growth of stocked lake sturgeon. As of 2011, numbers of fish stocked are being reduced by half.
	Round Lake	2004-2008	33,000 fingerlings	
	White Earth Lake	2004-2008	43,000 fingerlings	
	Otter Tail Lake	2002-2008	2,031 yearlings 37,000 fingerlings	
	Otter Tail River	1998-2008	172 sub-adults 250 yearlings 10,300 fingerlings	
	Buffalo River	2002-2008	350 yearlings 10,178 fingerlings	

Table 4 - F: A summary of Lake Sturgeon life stages that have been released during a number of stocking programs in the United States and Canada with an indication of success

Location	River/Lake	Year	Number/Life Stage	Success
	Roseau River	2004-2008	345,550 fry	
	Red Lake River	2004-2008	785,000 fry	
	St. Louis Bay	2000	7,980 fingerlings	
Manitoba	Nelson River	1994-2008	491 yearlings 15,974 fingerlings 1,025 fry	
	Winnipeg River	1996-2009	221 sub-adults 24,387 fingerlings	
	Nutimik Lake	1998-2008	4,950 fingerlings	
	Assiniboine River	1996-2008	5,000 fry 11,216 fingerlings 60 sub-adults	Angler success indicates that individuals have achieved a large size. Some individuals > 800 cm.
	Saskatchewan River	2003	67 fingerlings	
Saskatchewan	Saskatchewan River	1999-2007	157,000 fry 7,850 fingerlings	
Quebec	Eastmain River Riviere l'Eau Claire	2004	114,000 fry 21,000 fingerlings 88 adults	Plans to repeat over next few years.

Given the many examples of effective reintroduction, concern remains as to whether stocked fish will reproduce successfully after being raised in a hatchery for the first few months to year of their life. To date, there is one example of a stocking program that has resulted in successful reproduction by stocked fish. This example is from the St. Louis River, a tributary of Lake Superior, where sturgeon were completely extirpated and stocking resulted in successful reproduction by stocked fish (Ron Bruch, Wisconsin Department of Natural Resources, pers comm.). However, it should be noted that for the Keeyask Project, achieving the goal of a self-sustaining population (*i.e.,* not dependent on stocking), will also require successful creation of spawning habitat in Stephens Lake and the presence of suitable spawning and YOY habitat in the reservoir (measures are presented in sections 4.1.3, 4.1.4, and 4.1.5). Habitat suitability will not affect establishment of a self-sustaining population in the Upper Split Lake area, since habitat to support all life stages is present.

To increase the likelihood of success of the stocking program, the KHLP has consulted on the stocking and release plan with a variety of experts, as described in Appendix B.

4.1.7.8 CONTINGENCY MEASURES AND ASSOCIATED MONITORING

The AEMP describes annual monitoring of the juvenile population (*i.e.,* sturgeon between one and ten years of age) that will be used to assess cohort strength, identify changes in condition factor, determine whether natural reproduction is occurring, determine the need for young-of-the-year habitat creation, and enable an evaluation of the stocking program. Juvenile population monitoring will be conducted in the Upper Split Lake area, the Keeyask reservoir, and in Stephens Lake.

Juvenile monitoring will provide the following information with respect to the stocking program:

- survival of stocked fish, several years post-release;
- need to adjust stocking rates, based on the presence of recruits, their abundance and condition; and
- need to create/modify juvenile habitat in the Keeyask reservoir if stocked fish are not recaptured in areas where they are expected.

Under existing conditions, strong year classes occur rarely in the Keeyask area. Erratic recruitment has also been observed in healthy populations, although the frequency of strong year classes is much higher than in the Upper Split Lake area or Gull Lake. Results of monitoring will be considered in terms of observed frequency and abundance of young sturgeon in both the Keeyask area prior to construction of the GS and in the Winnipeg River.

Condition factor will be compared to pre-Project data in the Keeyask area as well as the range of condition factors observed in northern Manitoba to determine whether any changes of concern are occurring.

Juvenile monitoring results will be reviewed annually, although one-year lags associated with analysis are expected (*i.e.,* young-of-the-year tend to be under represented in juvenile survey methods because they are less susceptible to capture in the gear). If stocking is unsuccessful (*i.e.,* if recruitment of stocked fish has not occurred three years into the operation phase), potential adaptive management measures include: stocking a higher proportion of larger sized fish; changing release locations; or increasing the number of fish stocked. Conversely, if survival of stocked fish is found to exceed estimates and stocking rates are too high (this has occurred in other localities), the number of fish stocked may be reduced.

If monitoring indicates only limited success of the stocking plan, or that it is unsuccessful, factors such as the number of fish stocked, the location where the fish are stocked, and rearing techniques could be modified.

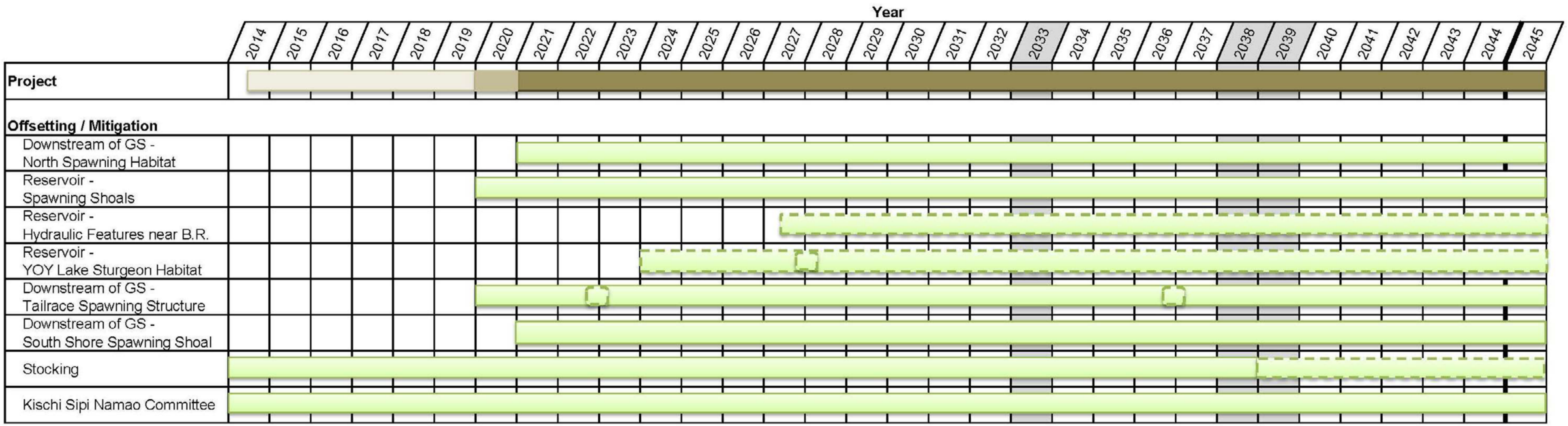
4.1.8 KISCHI SIPI NAMAO COMMITTEE - LOWER NELSON RIVER STURGEON STEWARDSHIP

In addition to the stocking program, the KHLP will support the recovery of Lake Sturgeon in the lower Nelson River by participating in the KSNC (a committee of interested stakeholders committed to implementing measures to protect and enhance sturgeon populations in the Lower Nelson River), which was established by the Lower Nelson River Sturgeon Stewardship Agreement[1]. Guaranteed core funding for the KSNC from Manitoba Hydro, which includes a contribution from the KHLP, is $110,000 annually for 20 years. The agreement includes provisions for potential renewal or extension beyond the initial 20 year term. Funding is also provided to the member communities for their participation in the Committee. Through its participation on KSNC, KHLP will endorse mitigation and stewardship activities identified by the KSNC, including educational initiatives for all age groups to promote awareness in the community about Lake Sturgeon (see section 3.2.10).

4.2 TIMELINE FOR IMPLEMENTATION OF THE OFFSETTING PLAN

The approximate timeline for implementing the offsetting plan is provided in Figure 4 - C. The construction of offsetting habitat is dependent on the overall Project schedule. Therefore, it is not feasible to construct habitats earlier than shown given that function of the habitats is dependent on impoundment of the reservoir and routing of flow through the generating station.

[1] The Lower Nelson River Sturgeon Stewardship Agreement was developed by Manitoba Hydro, 5900345 Manitoba Ltd. (on behalf of KHLP), Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation, Fox Lake Cree Nation, and Shamattawa First Nation. Through the Agreement, the Kischi Sipi Namao Committee (KSNC) was formed (formerly known as the Lower Nelson River Sturgeon Stewardship Committee). The KSNC is in the process of developing a stewardship plan that will guide the committee's future activities. The KSNC is committed to implementing measures to protect and enhance sturgeon populations in the Lower Nelson River from Kelsey Generating Station to Hudson Bay.



Notes:

Solid line = measure will be implemented; dashed line = contingency measure; heavy line = end of AEMP

Grey shading indicates increase in spawning population: 2033 (maturation of 2008 year class) and 2038/2039 (maturation of first stocked fish).

Figure 4 - C: Conceptual timeline for implementation of the Offsetting Plan during construction (2014-2019); commissioning (2020); and operation (2021+)

5.0 ADDRESSING KEEYASK FISHERIES MANAGEMENT OBJECTIVES

The Fisheries Management Objectives (October 2012) are provided in Appendix A. These objectives were developed by MCWS at the request of the KHLP and reflect objectives generally for the area bounded by Birthday Rapids to the outflow of Stephens Lake. Each objective and how it was addressed in the assessment and mitigation/offsetting planned for the Keeyask project is discussed below.

- *Target species that support local fisheries (Walleye, Northern Pike, Lake Whitefish) should exist at levels that support a sustainable harvest.*

Walleye, Northern Pike and Lake Whitefish were identified as Valued Ecosystem Components (VECs) in the assessment. For each species, the objective of the mitigation was to provide habitat to support all life history stages upstream and downstream of the Keeyask GS. The assessment considered the long-term population and found that, based on identified sources of mortality and comparisons of habitat pre and post Project, numbers should remain the same or increase post-Project. Flooding from the Keeyask GS will reduce the suitability of these species, in particular Northern Pike and Walleye, for human consumption due to elevated mercury levels for several decades. Therefore, local First Nations that harvest in the Gull and Stephens lakes areas have been provided with the opportunity to obtain fish from other lakes. In addition, a public communication program will provide information as to safe consumption levels of various species and sizes of fish.

- *Maintain self-sustaining stocks (including forage and other non target fish species) in the form they currently exist (i.e., acceptably similar or appropriate ecological structure and function).*

In addition to the VECs, the assessment also considered the fish community as a whole, including both large and small-bodied fish. No loss of abundance of forage species is predicted based on habitat models and comparison to other reservoir environments (*e.g.*, Stephens Lake). Creation of the reservoir is not expected to disproportionally favour Rainbow Smelt, an invasive species that entered the area approximately two decades ago.

- *In addition to this, it is noted that a viable whitefish population that is valued for subsistence harvest*[1] *is found in Gull Lake. This population should continue to exist at levels that support sustainable harvest.*

The relative abundance of Lake Whitefish during baseline fish surveys was low. No specific spawning area was located in Gull Lake, based on either aggregations of Lake Whitefish in fall or concentrations of larval Lake Whitefish in spring. However, suitable habitat was widespread and the assessment indicates that habitat will continue to be available in the riverine sections of

[1] The term *subsistence harvest* used here refers only to fish stock capacity and does not reflect either the health or any other measure of fish quality of the fishes within those stocks.

the reservoir. Also, shoals suitable for spawning by both Lake Whitefish and Walleye will be created in the lower portion of the reservoir.

- *A viable population of Lake Sturgeon above the proposed Keeyask Generating Station site.*

The environmental assessment was based on a three-pronged approach: alterations in habitat known to be used by Lake Sturgeon in the existing environment were evaluated; the fate of Lake Sturgeon in similar reservoir environments was considered, and post-Project habitat availability was assessed using a habitat suitability index model. With respect to the habitat, the assessment found that habitat may be available for all life history stages in the new reservoir environment without any habitat creation. However, due to uncertainty with respect to conditions for spawning and young-of-the-year, contingency measures to address these habitats have been developed if monitoring indicates that these are not adequate post-impoundment.

The assessment found that the greatest risk to Lake Sturgeon arose from the small existing population. Therefore stocking, a proven method of recovering Lake Sturgeon populations in environments where habitat exists to support all life history stages, was identified as an important offsetting option. Key features of the strategy include:

1. Use of spawn collected from local fish;
2. Stocking of a variety of ages of fish;
3. Stocking to introduce a full range of age classes (*i.e.*, for at least one generation or 25 years); and
4. Monitoring to guide annual stocking plans.

In addition to efforts related to the Keeyask Project, the KHLP has a member on the Kischi Sipi Namao Committee who will encourage the KSNC to undertake education initiatives that increase awareness about Lake Sturgeon in the lower Nelson River.

- *Conditions that support the development of a viable and self-sustaining population of Lake Sturgeon in Stephens Lake.*

The habitat assessment identified the need to create spawning habitat downstream of the GS; habitat for all other life history stages will continue to be available in Stephens Lake. The population in Stephens Lake is currently limited by the very low numbers of adult fish; therefore, stocking is a key component of the offsetting plan.

- *Determination for the need for fish passage (types, timing, mechanisms and species) to support future stocks associated with the new ecosystem should be based on scientifically experimental and defensible assessment in conjunction with provincial management goals and in consultation with provincial fisheries managers.*

The KHLP, in consultation with DFO and MCWS, has undertaken additional fish movement studies, for Lake Sturgeon and Walleye, to provide a better understanding of movements across Gull Rapids as well as in the Clark Lake to Gull Rapids reach upstream of the GS site and in Stephens Lake downstream of the GS site. These data, in conjunction with movement studies and the results of monitoring to determine whether successful reproduction and recruitment is occurring upstream and downstream of the GS in the post-Project environment will assist in determining the need for fish passage. The KHLP has made the necessary provisions in the design of the GS to allow for retrofit of fish passage, if required.

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APPENDIX A:
MANITOBA FISHERIES BRANCH - FISHERIES MANAGEMENT OBJECTIVES KEEYASK DAM / GULL LAKE AREA OCTOBER 2012

CONTEXT

The proposed Keeyask Hydroelectric project will separate Stephens Lake (the human-created reservoir for Kettle Generating Station) from the mainstem of the Nelson River, downstream of Split Lake and Clark Lake. The proposed development is expected to back-flood the Nelson River, creating a reservoir that will change hydraulic and hydrologic conditions upstream of the proposed development at least as far as Birthday Rapids – an area understood to be a significant Lake Sturgeon habitat. These changes to the hydrograph are expected to have consequential changes to the responding physical habitat and to the biota currently within the area. These fisheries management objectives have been prepared at the request of the proponent based on the assumption that the proposed project receives regulatory approval. Therefore, the objectives are based on best-case / desired outcomes under the development scenario and reflect objectives generally for the area bounded by Birthday Rapids to the outflow of Stephens Lake. Provincial fisheries management objectives are neither an endorsement nor a criticism of any project or development, but are a solicited response to proponents who seek to mitigate the effects of their work on fish stocks and habitats and contribute to Fisheries Branch management of those stocks.

Fisheries Management Objectives (FMOs)

OBJECTIVES

- Target species that support local fisheries (Walleye, Northern Pike, Lake Whitefish) should exist at levels that support a sustainable harvest.
- Maintain self-sustaining stocks (including forage and other non target fish species) in the form they currently exist (*i.e.,* acceptably similar or appropriate ecological structure and function).
- In addition to this, it is noted that a viable whitefish population that is valued for subsistence harvest[1] is found in Gull Lake. This population should continue to exist at levels that support sustainable harvest.
- A viable population of Lake Sturgeon above the proposed Keeyask Generating Station site.
- Conditions that support the development of a viable and self-sustaining population of Lake Sturgeon in Stephens Lake.
- Determination for the need for fish passage (types, timing, mechanisms and species) to support future stocks associated with the new ecosystem should be based on scientifically experimental and defensible assessment in conjunction with provincial management goals and in consultation with provincial fisheries managers.

[1] The term *subsistence harvest* used here refers only to fish stock capacity and does not reflect either the health or any other measure of fish quality of the fishes within those stocks.

MECHANISMS THAT SUPPORT FMOS

- Mitigate habitat degradation / destruction both above and below the proposed GS.
- Avoid further decline of the existing Lake Sturgeon population.
- Use stocking to recover stocks and for rehabilitation purposes (particularly in the upstream area) to the point where over the long term a self sustaining population more capable of meeting the domestic needs of the local communities is established.
- Stocked sturgeon should be recruited to brood stock to increase the contribution of natural reproduction instead of being used to increase the sustainable harvest.
- Since management and conservation efforts for this area are dependent on the support and endorsement of local First Nation harvesters, it is critical that the purpose of any stocking program be suitably communicated to users to ensure that the stocking does not undermine the conservation message.
- Local sturgeon management and conservation efforts to ensure that existing stocks are sustainable.
- Provision for future fish passage should be set aside (*i.e.*, allocated) during project planning and construction.
- Any sturgeon stocking plan should be presented to local users in a manner that supports the management and conservation messages planned within it, and does not present a false confidence in the robustness of stocks.
- Programs that compensate for lost fishing opportunities in the project area with increased fishing opportunities in other areas are considered a project effect and may require additional management or mitigation measures

APPENDIX B: EXPERTS CONSULTED DURING DEVELOPMENT OF LAKE STURGEON STOCKING AND RELEASE PROGRAM

Given the importance of the stocking program to the overall mitigation strategy for Lake Sturgeon populations in the Keeyask region, the KHLP's goal is to implement the "best" possible program by capitalizing upon experiences of similar programs, and expertise of individuals, from other jurisdictions. For this reason, the KHLP has consulted numerous experts and the scientific literature to ensure that the methods used to collect spawn, rear, and release sturgeon are based on the most successful methods/approaches known. In addition, Manitoba Hydro, in association with the partner Keeyask Cree Nations, has conducted trials of spawn collection and rearing of sturgeon for several years prior to the formation of the KHLP.

Gamete Collection

Mr. Joe Hunter from the Rainy River First Nation, who has over 25 years of experience collecting and fertilizing sturgeon eggs, has been contracted each spring from 2012 to 2014 to help with egg collection and fertilization in Manitoba. Mr. Hunter has worked at the Landing River spawning camp from 2012 to 2014, at the Burntwood River spawn camp in 2013, and at the Birthday Rapids spawn camp in 2014. Mr. Hunter has also assisted the KHLP in the design of their remote spawn camp ensuring that the fish holding techniques and equipment are the "best" available. Mr. Hunter will continue to consult for the KHLP into the foreseeable future. It should be noted that spawn collection on the Nelson River is more challenging than at many of the southern locations where stocking programs are conducted due to the remoteness of the spawning sites; this has required development of site-specific protocols through multiple years of trials.

Rearing, Disease Management and Marking

Fish culture experts involved in the production of sturgeon for the KHLP attend conferences and workshops to remain current in fish production techniques. When possible, other sturgeon culture facilities are toured. Valuable connections have been made with other sturgeon culture experts through these activities including: Mr. Steve Fajfer (Wild Rose Fish Hatchery, Wisconsin), Mr. Dave Switzer (International Centre for Sturgeon Studies, Nanaimo), and Mr. Doug Aloisi (Genoa National Fish Hatchery, Wisconsin). These individuals have been consulted on a wide variety of issues including biosecurity protocols, feeding regimes, and aquaculture equipment.

The capacity to rear sturgeon for the KHLP at Grand Rapids Fish Hatchery (GRFH) was recently assessed by HDR, Inc. During concept development, detailed production models were produced by Tom Johnson, a senior fisheries biologist with the company. Optimal rearing densities, production temperatures & feeding rates were included in the models and referenced during GRFH production decisions in 2014. Infrastructure upgrades at GRFH are planned such that optimal rearing conditions can be more easily implemented in the future.

Dr. Sharon Clouthier from Fisheries and Oceans Canada has recently identified a Lake Sturgeon virus (Numao virus) and developed a test to detect it. Since 2013, sturgeon produced at GRFH have been tested for this virus prior to release. All results are forwarded to the provincial fish health officer. New biosecurity measures have been implemented at GRFH since

Manitoba Hydro assumed staffing and were developed following consultation with Dr. Clouthier, the current provincial fish health officer and experts from the Canadian Food & Inspection Agency (CFIA). Biosecurity practices are reviewed regularly.

The KHLP recognizes the importance of being able to identify hatchery reared sturgeon following release, and is aware that methods such as passive integrated transponders (PIT) tags can be applied cost-effectively to several thousand fish annually. Dr. Bruch (Wisconsin Dept. of Natural Resources), Mr. Aloisi (Genoa National Fish Hatchery) and Dr. James Crossman (BC Hydro) have been consulted for their experiences with PIT tag retention and survival of sturgeon post-release. These individuals have also been consulted about their experiences with numbers of fish to stock.

Release

Recognized Lake Sturgeon experts from Wisconsin such as Dr. Ron Bruch and Mr. Ryan Koenigs who manage the world's largest Lake Sturgeon population, are regularly consulted regarding their experiences with releasing stocked sturgeon. Similarly, Mr. Randy Zortmann from the White Earth First Nation has been consulted with regarding the success of their stocking program in the Red River drainage. Given that Nelson River is much farther north than the environments where sturgeon are typically stocked, Manitoba Hydro has conducted research in association with the Nelson River Sturgeon Board to assess survival of stocked sturgeon. In an assessment of the post-release survival of sturgeon in the Nelson River near Sea Falls where sturgeon were released as either fingerlings or yearlings over a 20 year period, results to date suggest PIT tag retention at 74% for yearling sturgeon and a much greater survival of fish (perhaps as high as 128 times) released at the yearling stage when compared to the fingerling stage (McDougall and Pisiak 2012).

In addition to the experts and research initiates listed above, Manitoba Hydro has supported ongoing sturgeon research in Manitoba. In particular, Dr. Gary Anderson from the University of Manitoba, has been conducting ground breaking research that directly relates to the KHLP's stocking plans. Dr. Anderson's research has covered topics such as size and age at release, use of hormones in spawn collection, and mark retention in hatchery reared sturgeon. Dr. Anderson, in partnership with Manitoba Hydro, recently applied for an Industrial Research Chair in conservation aquaculture. If approved, studies will focus on producing sturgeon that have the characteristics necessary for a successful transition to the wild, marking techniques and post-stocking monitoring methods.

Additional information on Lake Sturgeon research supported by Manitoba Hydro can be found in Manitoba Hydro (2013a, 2013b).