Keeyask Generation Project

Zebra Mussel Monitoring Plan

Hydropower Limited Partnership

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

June 2015

KEEYASK GENERATION PROJECT

ZEBRA MUSSEL MONITORING PLAN

Prepared by

Keeyask Hydropower Limited Partnership

Winnipeg, Manitoba

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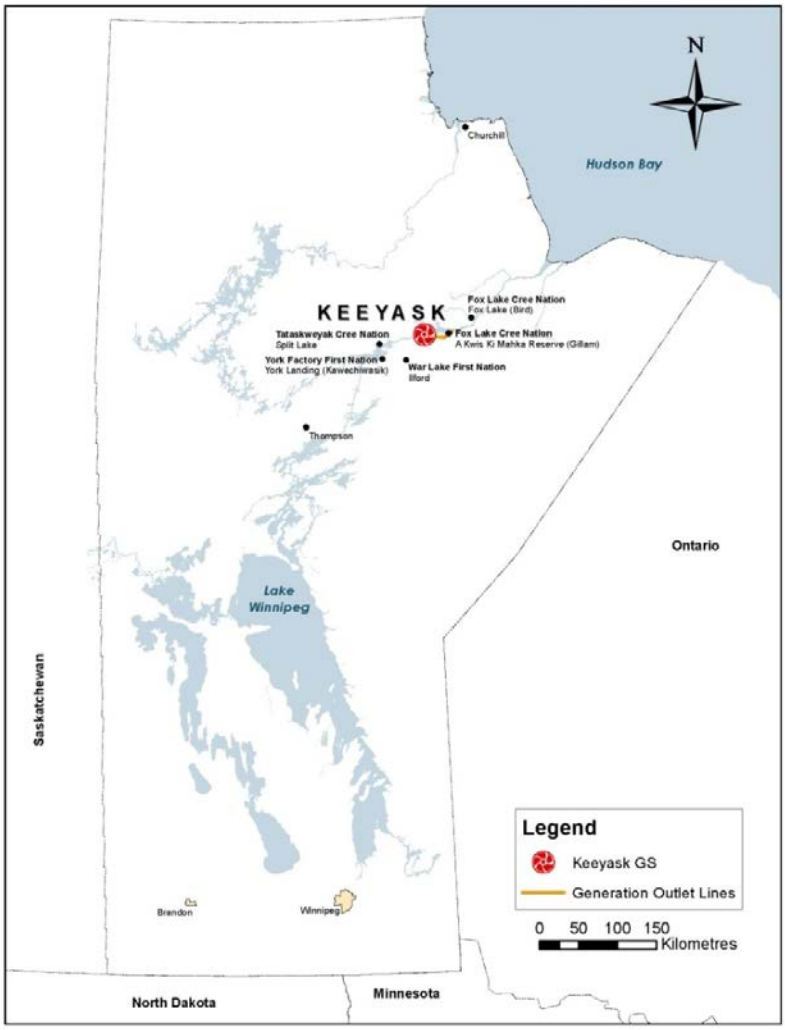
PREFACE

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.

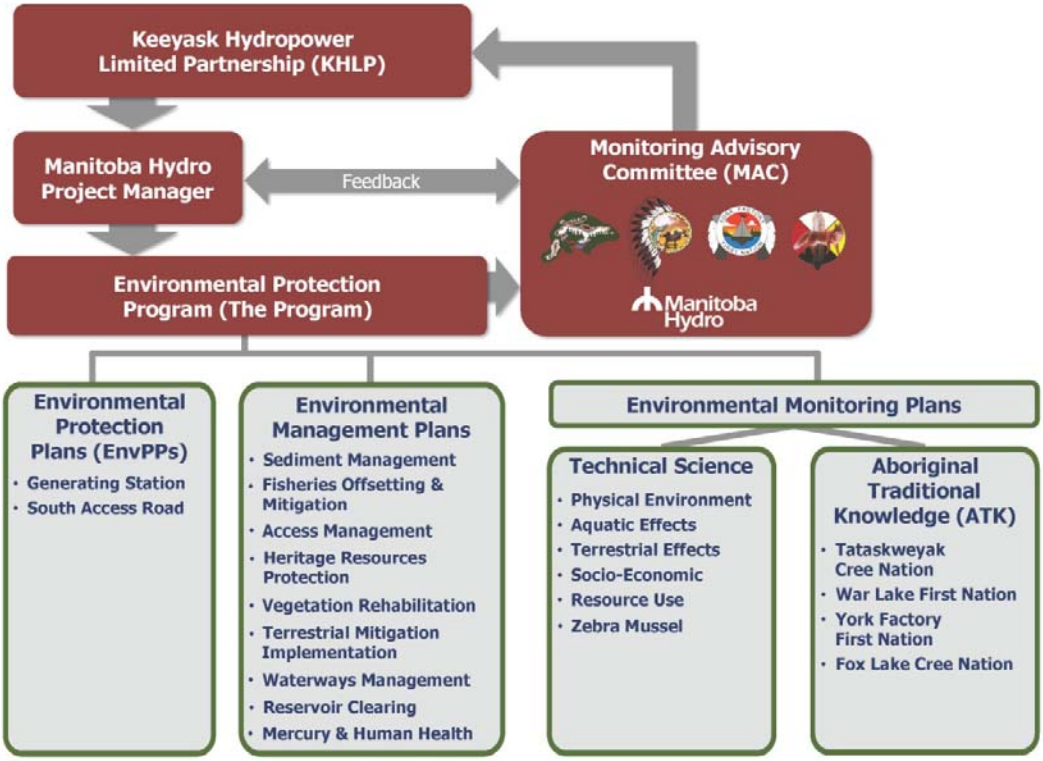


Figure 1: Environmental Protection Program

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 Zebra Mussel Monitoring Plan (the Plan) for the Keeyask Generation Project (the Project), a 695-megawatt (MW) hydroelectric generating station at Gull (Keeyask) Rapids on the lower Nelson River. The Project is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gillam. It is located entirely within the Split Lake Resource Management Area (Map 2).

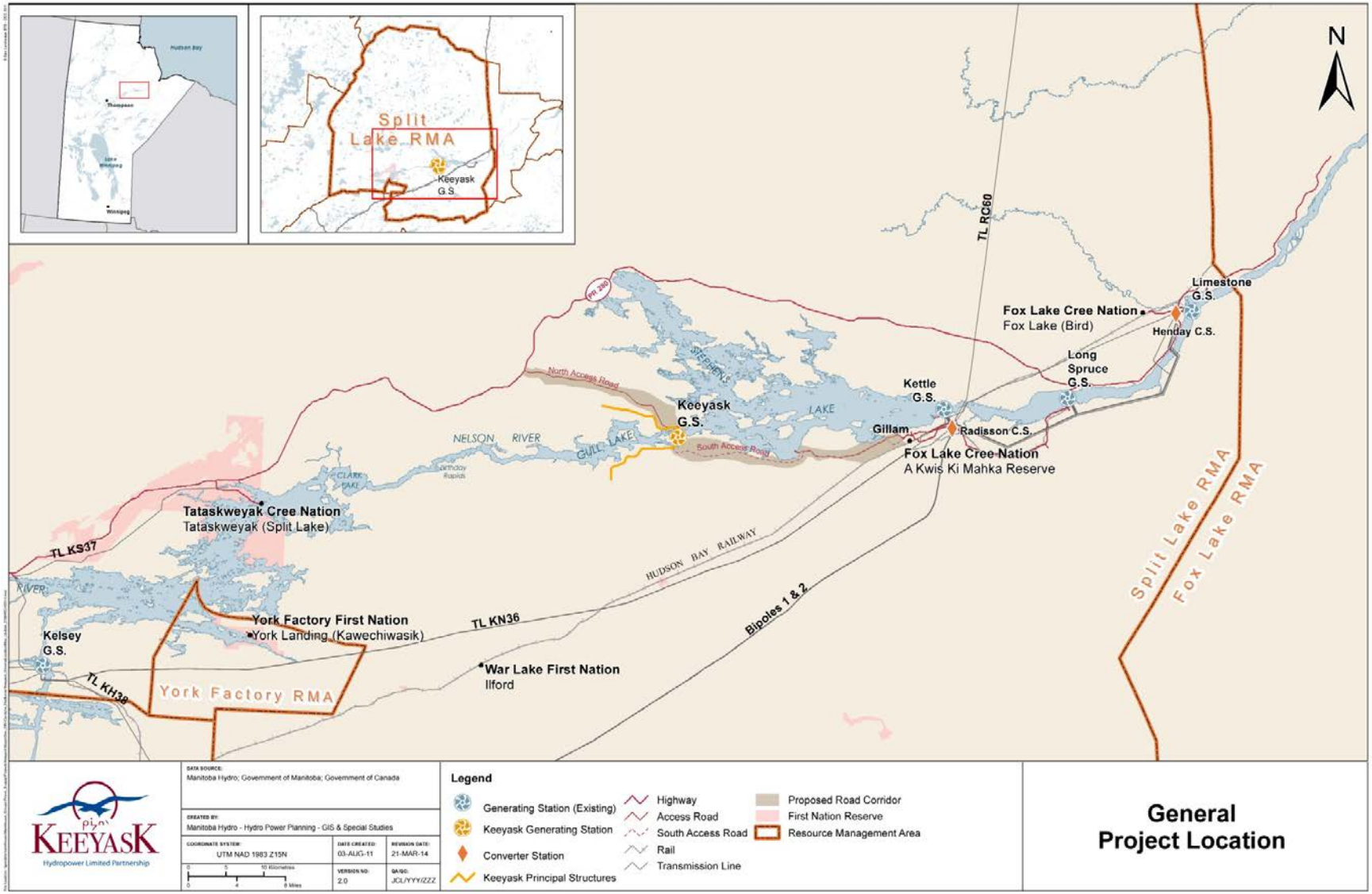
The development of the Zebra Mussel Monitoring Plan is a requirement under the Keeyask Generation Project Environment Act Licence #3107 (Clause 18(s)). Specifically, the licence states that the Partnership shall submit a report on the monitoring programs to be undertaken, which will "include a plan to monitor and adaptively manage impacts to the Development associated with zebra mussels and participate with the Government of Manitoba on treatment programs within the Keeyask reservoir."

As well, reports on the results of the monitoring plans are to be submitted to the Director (annually before June 15th). The report results will be used to assess:

- the accuracy of predictions,
- the success of mitigation actions,
- any trends in colonization or adaptive management,
- commitment to future actions.

To fulfill these requirements, the following sections describe

- the general biology and risks associated with zebra mussels,
- the proposed monitoring methodology,
- reporting plans
- conclusions.



Map 2: General Project Location

2.0 BACKGROUND

The Zebra Mussel (*Dreissena polymorpha)* is a small, clam-like aquatic animal that is native to eastern Europe and western Asia. It was introduced to North America in the late 1980s from bilge water of ocean-going vessels (McMahon, 1996). Zebra mussels are considered an Aquatic Invasive Species (AIS) in North America due to their ability to aggressively invade new areas, reproduce quickly, colonize hard surfaces, survive in sub-optimal conditions and prevent desiccation when out of water for long durations. These characteristics and a lack of natural predators can negatively impact native fish and wildlife, obstruct water-based infrastructure, and be a costly nuisance (MCWS 2015). In 2013, Manitoba Conservation and Water Stewardship identified zebra mussels in Lake Winnipeg, marking the first occurrence of this nuisance species in western Canada. Currently, Lake Winnipeg is the only known location in Manitoba with an established reproductively-active zebra mussel colony. Both adult zebra mussels and their larvae (called veligers) are considered a threat to Manitoba waters.

There are two distinct phases in the zebra mussel life cycle. Adult zebra mussels release eggs and sperms into the water. When successfully fertilized, eggs hatch into free-swimming microscopic larvae called veligers. Depending on the water temperature, this free-swimming life stage can last approximately 3-5 weeks, during which time they move with the water current, growing a shell and foot. As the shell and foot develops, the veliger is no longer able to float in the water column and settles out of the water, using its foot to seek a place to attach. Once attached it is considered a juvenile zebra mussel and may quickly mature into a reproductive adult, depending on water temperature and food availability, perpetuating the life cycle. The free-swimming veliger life stage enables zebra mussels to easily move downstream of adult colonizations; however a new reproductively-active colonization requires veligers to achieve an adult reproductive state with both sexes present.

Based on suitable calcium concentration, depth, distance to invaded habitat and boat traffic, the Lower Nelson River was assessed as having a very high ecological risk for zebra mussel colonization (Therriault *et al.* 2013, DFO 2013). Calcium is considered the most essential environmental factor when assessing long term survival (Claudi and Prescott 2015). Larval zebra mussels require high concentrations of calcium to build their shells, while adults require less to maintain them. In the Nelson River, calcium levels often reach and exceed the 24 mg/L threshold which has been documented to support high levels of infestation (100 000 individuals/m^2) in temperate zones of North America and Europe (Mackie and Claudi 2010). Together calcium and pH levels in the Nelson River could support a massive population of zebra mussels. Population size may be mitigated by periodic high Total Suspended Solids (TSS) which can interfere with mussel feeding and veliger survival (Claudi and Prescott 2015). As a result, water quality monitoring is essential to further understanding zebra mussel colonization in Manitoba.

Data collected as part of the Coordinated Aquatic Monitoring Program (CAMP) will also supplement Keeyask monitoring efforts. CAMP is a joint program between Manitoba

Conservation & Water Stewardship and Manitoba Hydro to study and monitor the health of water bodies (rivers and lakes) affected by Manitoba Hydro's generating system. Essentially, all components of the aquatic environment are studied in the program; however, those most pertinent to zebra mussel monitoring include water quality, sediment quality, hydrometrics, and lower trophic level conditions. Various parameters under these general topics will influence the success rate of zebra mussel reproduction and potential colonization, so CAMP will be an important asset to this Zebra Mussel Monitoring Program. Starting in 2015 under CAMP, zebra mussel specific monitoring will take place using zooplankton hauls in the upper Nelson River (Playgreen Lake) and Cedar Lake.

Introduction of zebra mussels into non-infested waterbodies may result from transportation of veligers or adult zebra mussels by overland movement of recreational watercraft, water-based equipment, float planes, fishing gear, release of live bait, migration of wildlife or through inter-connecting waterways. Due to their confirmed presence in Lake Winnipeg, all Manitoba Hydro generating stations downstream (i.e. along the Nelson River) are at risk to receive drifting veligers from zebra mussel reproductive activity upstream. In December 2014, the Province of Manitoba introduced amendments to *The Water Protection Act*, to include new Aquatic Invasive Species legislation, in an effort to prevent the spread of zebra mussels. These draft regulations are intended to prevent the spread of zebra mussels and other aquatic invasive species (AIS) through prohibiting possession and transportation, while increasing detection and containment efforts of these organisms.

In North America, zebra mussel colonization has typically resulted in increased toxic algal blooms, aquatic vegetation, water clarity and disruption of the food web (MCWS 2015). Physical impacts include clogging water intake structures and raw water conveyance systems, and colonization of various hard surfaces that are found opportunistically, such as concrete, PVC and other materials. The most vulnerable areas in a generating station have been identified as the systems that use raw water without any existing form of veliger exclusion, such as small pore filters or chemical control. Mussel veligers can pass through all the existing strainers and settle in the piping and components of various systems using raw water. This means that key operational systems such as unit cooling and key safety systems such as fire protection are primary areas of concern for monitoring and mitigation. Manitoba Hydro recently undertook a zebra mussel vulnerability assessment for all at-risk in-water infrastructure. Based on the results of this study, Manitoba Hydro is assessing appropriate modifications/controls for infrastructure that is at risk.

Manitoba Hydro has monitored for zebra mussels on the Winnipeg and Red Rivers since the 1990s. Since the 2013 detection of zebra mussels in Lake Winnipeg, monitoring sites have expanded to include sites on the Nelson River, which may provide optimal conditions for colonization if adults or ready-to-settle larvae are introduced by translocation or downstream transport.

This monitoring program is an essential component for mitigating zebra mussel impacts to the Keeyask Project. Conditions in the Nelson River have been identified as optimal to potentially support a massive zebra mussel population of up to 100 000 individuals/m^2. The population size

that could occur at Keeyask is thought to depend on zebra mussel colonization upstream in the Nelson River and Lake Winnipeg as well as possible mitigating effects such as TSS.

3.0 MONITORING METHODOLOGY

The intent of the Zebra Mussel Monitoring Plan is to monitor, mitigate and adaptively manage zebra mussel impacts to the Keeyask Project and complement other Government of Manitoba and Manitoba Hydro programs.

The Province has several initiatives underway to monitor, control and prevent the spread of zebra mussels in Manitoba. In addition to these programs, starting in 2015, the Province and Manitoba Hydro together will be monitoring for zebra mussels through CAMP in the upper Nelson River and Cedar Lake. CAMP data are also used to augment the assessment of environmental suitability of different waterbodies for zebra mussel colonization. Manitoba Hydro independently monitors for zebra mussel presence in the Winnipeg River, Red River, and the Nelson River. Manitoba Hydro's zebra mussel monitoring is adaptive, focusing on at-risk infrastructure and waterbodies with monitoring efforts reviewed annually and modified as necessary. Currently, adaptive monitoring methods employed are consistent between the Province and Manitoba Hydro including: water sampling for detection of veligers and colonization monitoring using artificial substrates and visual inspections. Manitoba Hydro also uses bio-boxes with substrate settlement plates at several generating stations to monitor raw water entering the station for zebra mussel colonization. To date, zebra mussels have not been found outside of Lake Winnipeg.

Due to the uncertainty of when zebra mussels will arrive at Keeyask, management will be adaptive based on the results of this monitoring program and zebra mussel monitoring programs upstream of the Keeyask GS conducted by MCWS and Manitoba Hydro. Should zebra mussels be detected, either upstream of the Keeyask GS or at the Keeyask GS, this monitoring plan will be modified as needed, to address the issues.

This program is designed to assess zebra mussel presence using four approaches:

1. Education and awareness;
2. Water-quality sampling;
3. Colonization/Adult sampling;
4. Visual inspections of in-water infrastructure.

Each of these approaches is described in detail below.

3.1 EDUCATION AND AWARENESS

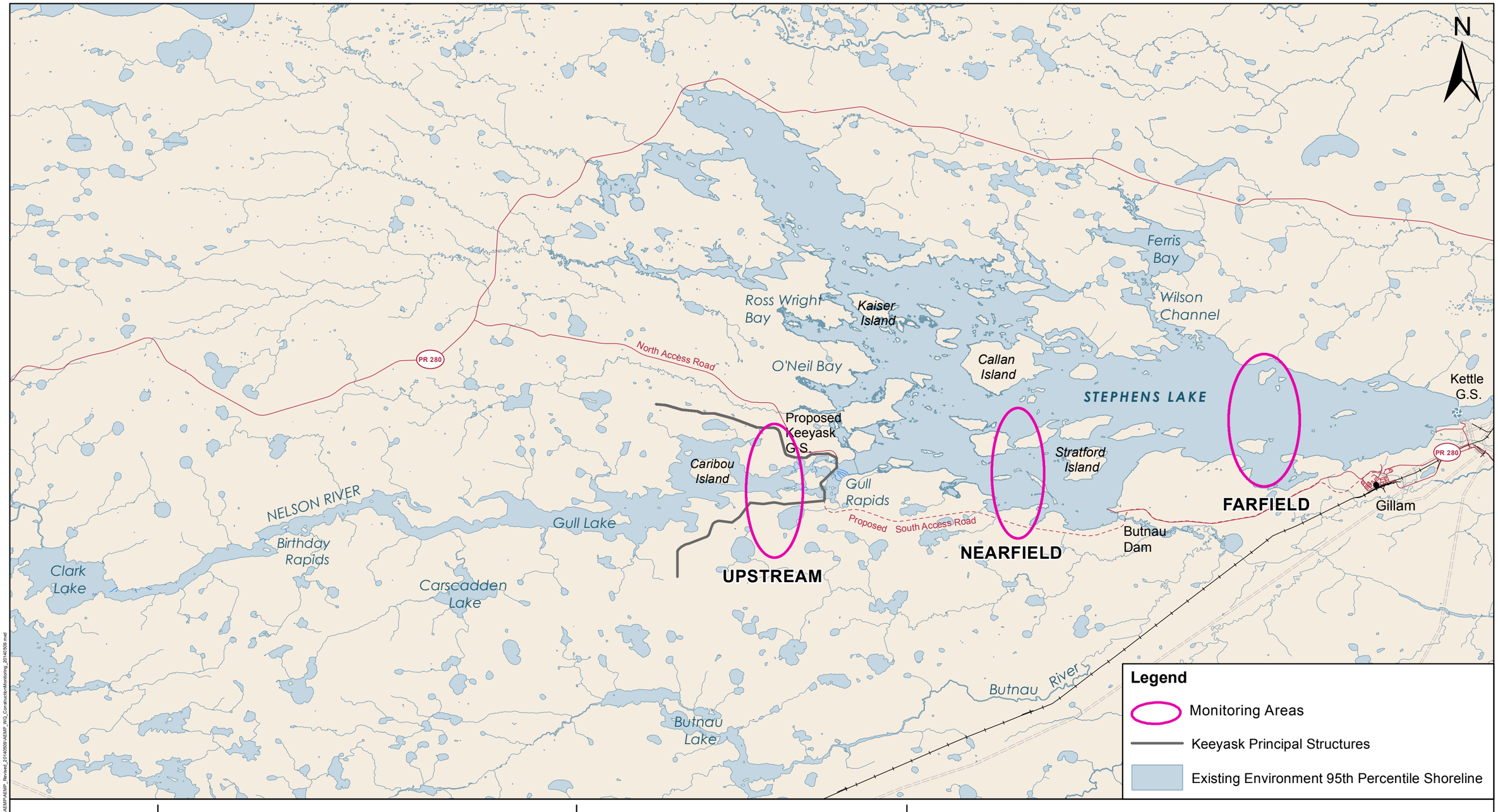
Education and awareness of zebra mussels is considered key for staff responsible for in-water infrastructure. Staff at the generating station will be provided information on zebra mussels, including how to identify zebra mussels, where to look for potential zebra mussel infestations in or near the GS, and ways to prevent the spread of zebra mussels during construction and operation.

Education and awareness information provided to construction and operation staff as part of the Keeyask Project will outline new Provincial regulations and cleaning specifications required to prevent the spread of zebra mussels. There are new requirements, which prescribe cleaning procedures required for watercraft, water related equipment, trailers and motor vehicles, which have been used in zebra mussel control zones. The Province will also have AIS control stations in the control zone around Lake Winnipeg where trailered watercraft will legally have to stop for inspection and decontamination if required. Education documents will ensure all staff understand how to comply with new Provincial regulations and methods to clean, drain and dry watercraft and water-related equipment to prevent the spread of AIS.

3.2 WATER QUALITY SAMPLING

Water quality sampling will take place under the Keeyask GS Aquatic Effects Monitoring Plan (AEMP). Water quality parameters of particular importance to zebra mussels include pH, calcium, total suspended solids, chlorophyll a, and temperature. Collection of water-quality data will assist in the risk assessments for zebra mussel infestation at or near the GS. Data collected as part of CAMP will also supplement these monitoring efforts.

As described in the AEMP, the water quality monitoring program will incorporate monitoring over the regional study area and monitoring at sampling sites immediately upstream and downstream of construction activities within the local study area (Map 3 [Map 2-3 in the AEMP]). The AEMP study design for the operation period is similar to the design described in Section 2.2.1.2 for construction monitoring (i.e. areas upstream of the reservoir, within the reservoir and downstream of the reservoir in Stephens Lake, Map 4 [Map 2-5 in the AEMP]).



KEEYASK Hydropower Limited Partnership

0 5 10 15 Kilometres
0 2 4 6 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

Water Quality Construction Monitoring
Local Study Area

Map 3

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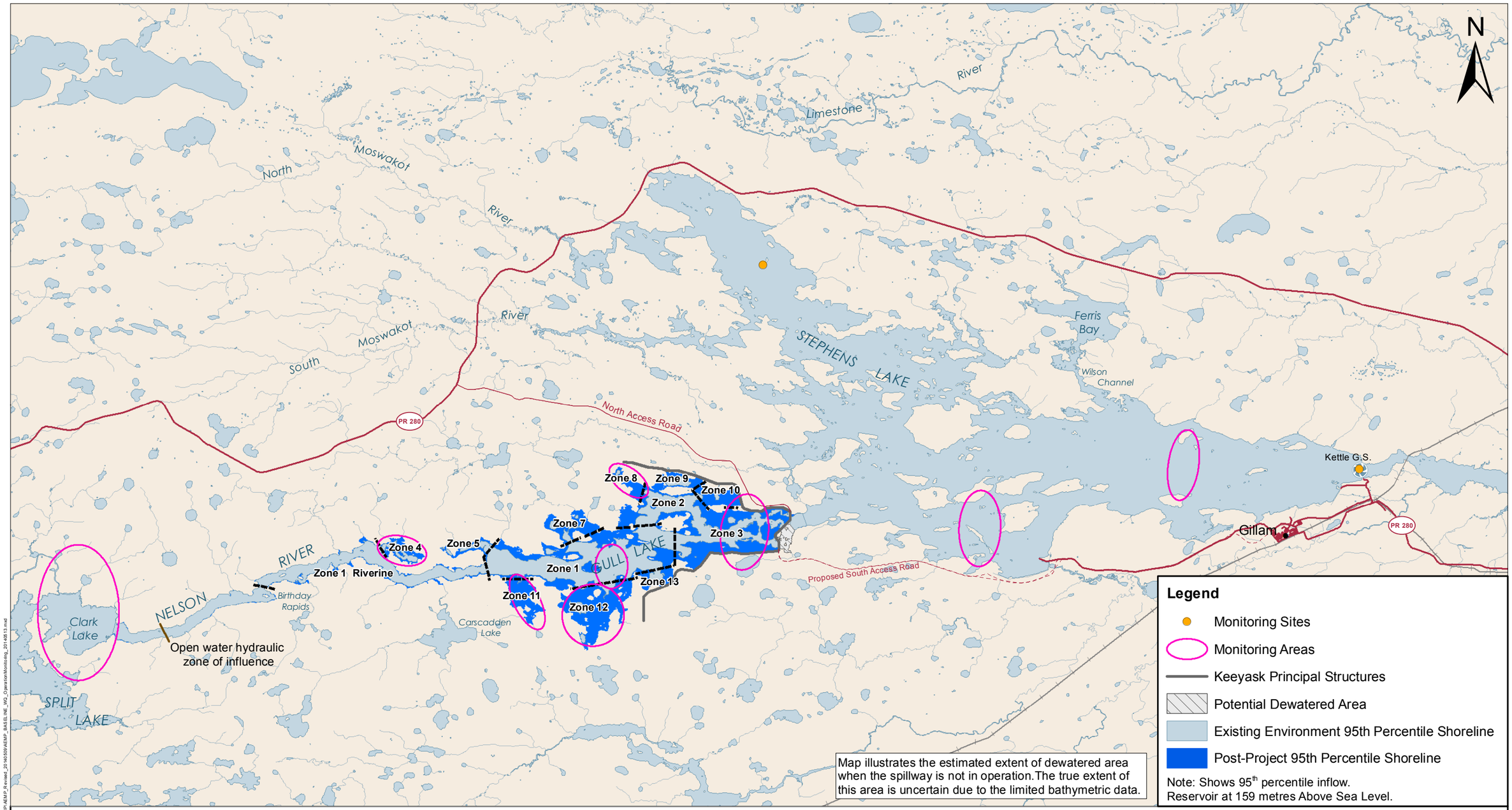

KEEYASK Hydropower Limited Partnership

0 25 50 75 100 Kilometres
0 25 50 Miles

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

Water Quality Operation Monitoring
Local Study Area

Map 4

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3.3 COLONIZATION / ADULT SAMPLING

Quantitative monitoring for adult zebra mussel colonization will be done by establishing three sites in the Keeyask reservoir for placement of artificial substrate. At each site, the artificial substrate (either a PVC settling plate or a standard-sized concrete or cinder block) will be anchored and secured by a chain at a depth of 1-3 m and clearly identified with flagging. Sites will be located in low-flowing areas (0.1-1.0 m/s) and checked monthly during the open water season for presence/absence of mussels, with a photograph taken of each side of substrate and if present adult zebra mussels counted and recorded. Site visits will also include more informal visual assessments of adjacent rocks, crevices, woody debris, docks and vegetation along shorelines in the area. The artificial substrate will be removed each fall and left outside to dry and freeze, with no runoff being allowed to flow to drains or infrastructure.

3.4 VISUAL INSPECTIONS OF IN-WATER INFRASTRUCTURE

In addition to artificial substrate sampling, staff at the GS will undertake visual inspections of in-water infrastructure, including but not limited to, trash racks, gates, service water, piping, valves, safety booms, fire water systems, docks. Visual inspections for zebra mussel presence will take place on an opportunistic basis such as plant outages, regular maintenance inspections, etc. The most vulnerable areas of the generating station will be the systems that use raw water without any existing form of mussel removal such as small pore filters or chemical treatment. Mussel veligers can pass through all the existing strainers and settle in the piping and components of various systems using raw water. This means that key operational systems such as unit cooling and key safety systems such as fire protection are at risk.

3.5 REPORTING

As indicated in the Environment Act Licence, results of the zebra mussel monitoring program will be submitted to the Director and MCWS on an annual basis before June 15th. The review of the annual monitoring results and results of other upstream zebra mussel monitoring programs, will determine whether modifications are needed to this monitoring program.

If zebra mussels are detected, staff will immediately contact the Environment Operations Support Section in the Generation Operations business unit of Manitoba Hydro. The designated representative from Manitoba Hydro will contact MCWS within 24 hours of detection and follow Provincial procedure for sample collection and/or documentation as required. A collection permit may be required so once identified, procedures should adhere to any requirements in the collection permit and the most current Provincial regulations for AIS possession and handling.

4.0 CONCLUSION

The Zebra Mussel Monitoring Plan was developed as required in the Keeyask Generation Project Environment Act License #3107. The intent of the plan is to monitor the aquatic environment and infrastructure around the Keeyask generating station for the presence of zebra mussels and to work with the province in applying adaptive management to reduce risks and impacts of this invasive species. Annual reports that explain monitoring results and analyses will be provided to the province and monitoring procedures will be modified collaboratively, as needed. The development of this plan and its implementation are important steps in managing the risks associated with zebra mussels in northern Manitoba.

5.0 LITERATURE CITED

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