Keeyask Generation Project

Socio-Economic Monitoring Plan

Socio-Economic Monitoring Report

SEMP-2024-01

KEEYASK

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2023 -2024

KEEYASK GENERATION PROJECT

SOCIO-ECONOMIC MONITORING PLAN

REPORT #SEMP-2024-01

SOCIO-ECONOMIC MONITORING REPORT

APRIL 2023 TO MARCH 2024:

YEAR 2 OPERATION

Prepared by

Manitoba Hydro

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SUMMARY

The Keeyask Generation Project ("the Project" or "KGP" or "Keeyask") Environmental Impact Statement (EIS), completed in June 2012, provides a description of the existing environment, a summary of predicted effects, and planned mitigation for the Project. Technical supporting information for the socio-economic environment, including a description of the existing environment, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the Socio-Economic Environment, Resource Use and Heritage Resources Supporting Volume.

The environmental assessment for the KGP used both technical science and Aboriginal Traditional Knowledge (ATK[1]). Mitigation measures were carefully planned and designed to prevent or reduce (to the extent practical), adverse effects from the Project. However, there were uncertainties associated with predicted effects and the effectiveness of planned mitigation measures. To address these uncertainties, many of the predictions and mitigation measures identified in the KGP EIS are supported by monitoring to enable testing of the predictions and timely response when actual results differ from the predictions.

The KGP Socio-Economic Monitoring Plan (SEMP) is a commitment made by the Keeyask Hydropower Limited Partnership (KHLP) in Chapter 8 of the KGP EIS. The SEMP is intended to monitor changes over time for certain socio-economic Valued Environmental Components (VECs). The SEMP report during operations reviews the monitoring outcomes and activities of 1) Population in Gillam and 2) the Mercury and Human Health Risk Management Plan. The SEMP also outlines a commitment to report on water levels at Split Lake to select communities. This information is provided in the annual Physical Environment Monitoring Plan report and also presented in the SEMP. This Year 2 Operation report focuses on SEMP monitoring activities for the Project after March 31, 2023.

Key learnings of the SEMP Program over the 2022/23 period and next steps are presented below by monitoring topic area.

POPULATION:

- The most recent changes to population observed in 2021-2022 for Gillam are consistent with trends observed over time. The slight increase in 2022 population compared to last year does not suggest a significant pattern of operation related in- or out-migration.

[1] The term 'Aboriginal Traditional Knowledge' (ATK) was used during the Keeyask planning and licensing phases and in subsequent regulatory reports. After discussing terminology with partner First Nation communities, each community indicated a different preference in using 'Aboriginal Traditional Knowledge" versus "Indigenous (Traditional) Knowledge". For consistency with past reports, the term ATK continues to be used in this report. References to 'community-based' studies or activities may also imply inclusion of ATK.

MERCURY AND HUMAN HEALTH:

- Manitoba Hydro and the partner First Nations have worked together since 2007 to study the issue of mercury and human health, and consider related past experience, Aboriginal Traditional Knowledge and scientific information. The Mercury and Human Health Implementation Group, on behalf of the KHLP, prepared a Mercury and Human Health Risk Management Plan in consultation with provincial and federal regulators and oversees its implementation. Local implementation of program activities that support the goals of the risk management plan is achieved through a 'Mercury Community Coordinator' role in each partner First Nation with support from MHHIG members.
- This reporting period's key outcomes include:
  - Mercury Community Coordinators serve as local information resources about mercury and human health and coordinate activities to build understanding about the risks and benefits of eating fish. Examples of activities include local hair sampling and information / education sessions with youth, fishing events, and preparation of Cree-informed communication materials, including a 2024 calendar.
  - To provide an opportunity to understand mercury levels in one's body, Mercury Community Coordinators hosted (free and confidential) hair sampling events and offered sampling to individuals, as requested. Results showed that out of the 66 participants who provide a hair sample, over 98% of individuals had mercury levels in hair that were within levels considered acceptable by World Health Organization and Health Canada. The remaining individual(s) marginally exceeded this level. A wild foods survey, offered in conjunction with hair testing, showed that most participants continue to harvest, share and/or eat fish locally and primarily from non-Keeyask impacted or off-system waterbodies, with some limited fishing on Stephens Lake.
  - Results from annual monitoring of fish in Gull Lake[2] show fish mercury concentrations in pickerel and jackfish are within expected levels and below predicted peak concentrations (1.0 part per million - ppm). Average concentrations in Gull Lake whitefish exceeded peak predictions (0.19 ppm). Average fish concentrations of pickerel and jackfish in Stephens Lake are higher than predicted peak concentrations (0.5 ppm). Monitoring will continue annually in both lakes.
  - A Project toxicologist reviewed fish monitoring results and in collaboration with the Mercury and Human Health Implementation Group, determined that fish consumption recommendations developed for post-impoundment (peak) conditions in Gull and Stephens lakes required updating to accommodate exceedances in predicted levels in whitefish (Gull Lake), and pickerel and jackfish (Stephen Lake). Products have been updated as noted below. Revised consumption recommendations were based on revised peak concentration estimates for these fish provided in Appendix 3.

[2] Also referred to in other monitoring reports as the Keeyask or Gull Reservoir.

- Keeyask Communication Products containing safe fish consumption recommendations include Safe Catch Posters and fish tapes for Gull and Stephens lakes. “Spring Update 2023” products for Stephens Lake have replaced all products issued in 2021. Updated Gull Lake products will be distributed by July 2024, subject to MHHIG approval, and replace those issued in 2021.
    - These products, along with information handouts to explain changes to Stephens Lake have been distributed to communities. Updated ‘Safe Catch’ signage and government-issued Public Notices were installed at two Stephens Lake boat launch locations in the Gillam area and at upstream and downstream Keeyask boat launch areas.
- Mercury levels in specified plants (e.g., blueberries and Labrador tea) and wildlife (e.g., beaver, moose, and snowshoe hare) consumed by community members were expected to remain healthy wild food options after impoundment. Mercury concentrations in beaver and muskrat samples collected in winter 2023/24 through the Terrestrial Effects Monitoring Plan remain low, showing there is no unacceptable Project-related risk in consuming these animals; Community members are also encouraged to submit samples of harvested wildlife for mercury analysis to help confirm predictions. Supplementary sampling is planned in Spring 2024 to confirm whether mercury concentrations in ducks remain within predicted levels.

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1.0 INTRODUCTION

Manitoba Hydro, on behalf of the KHLP, received regulatory approval to commence construction of the Keeyask Generation Project in July 2014. In preparation for this license, the environmental assessment for the KGP considered both technical science and Aboriginal Traditional Knowledge. Monitoring efforts and mitigation measures were carefully planned and designed to prevent or reduce (to the extent practical) adverse effects from the Project. A range of monitoring programs have been established to confirm predicted effects and effectiveness of planned mitigation measures and/or inform adaptive management, if required.

During the operations phase, the SEMP committed to reporting on the following of the socio-economic environment components including:

- Population changes in Gillam (to be implemented annually over first five years of the operation phase);
- Information on monitoring of water levels at Split Lake (to be implemented annually, reported to TCN and YFFN only); and
- Updated HHRAs (approximately every five years after peak mercury levels have been reached, until mercury levels return to baseline conditions; for review with the partner First Nations and with federal and provincial health authorities) to include:
    - Food surveys, to be undertaken in the partner First Nations communities (approximately every five years after peak mercury levels have been reached, until mercury levels return to baseline conditions; for input into the HHRAs);
    - Hair monitoring, to be undertaken on a voluntary basis in the partner First Nations communities (approximately every five years after peak mercury levels have been reached, until mercury levels return to baseline conditions; for input into the HHRAs); and
    - Documenting annual progress made of the implementation of the RMP, associated engagement with KCNs communities, other stakeholders, and summary results from the AEMP, TEMP and HHRA (where applicable).

This Year 2 Operation report focuses on SEMP monitoring activities for the Project after March 31, 2023, and reports on the monitoring outcomes and activities of 1) Population in Gillam and 2) Mercury and Human Health Risk Management Plan. The SEMP outlines a commitment to report on water levels at Split Lake to select communities. This information is provided in the Annual Physical Environment Monitoring Plan Report and included within this Report.

2.0 OVERVIEW OF PROJECT

The Keeyask Generation Project is a 695 megawatt (MW) hydroelectric generating station located approximately 180 km northeast of Thompson and 40 km southwest of Gillam at Gull Rapids on the lower Nelson River. The Project consists of four principal structures: a powerhouse complex, spillway, dams, and dykes. In 2020, a reservoir was created upstream of the principal structures. Supporting infrastructure consists of temporary facilities required to construct the principal structures and permanent facilities required to construct and operate the Project. Temporary infrastructure consisted of work areas, cofferdams, rock groins, and an ice boom. Permanent supporting infrastructure consists of North and South Access Roads, a transmission tower spur, a communications tower, some borrow areas, excavated-material placement areas, boat launches, and a portage to enable river traffic to bypass the dam.

Map 1 shows the Socio-Economic Study area applied to the environmental assessment and the SEMP construction monitoring phase. For reference during operation phase, it includes the location of partner First Nations' communities, relative to Keeyask, of Tataskweyak Cree Nation (TCN) at Split Lake, War Lake First Nation (WLFN) at Ilford, York Factory First Nation (YFFN) at York Landing and FLCN at Fox Lake/Gillam and the Town of Gillam. In addition to being home to FLCN members living on and off-reserve, the Town of Gillam is Manitoba Hydro's northern operations base.

3.0 OVERALL OBJECTIVES AND APPROACH

The KGP EIS identified primary effects to the socio-economic VECs and defined the process, scope, methods, documentation, and application of the socio-economic monitoring for the Project. Overall, the intent of Manitoba Hydro and the partner First Nations has been to reduce adverse effects of the Project and to enhance Project benefits to the extent feasible and practical. Monitoring information is intended to assist in this management task. The SEMP is intended to monitor changes over time for certain VECs to, where applicable:

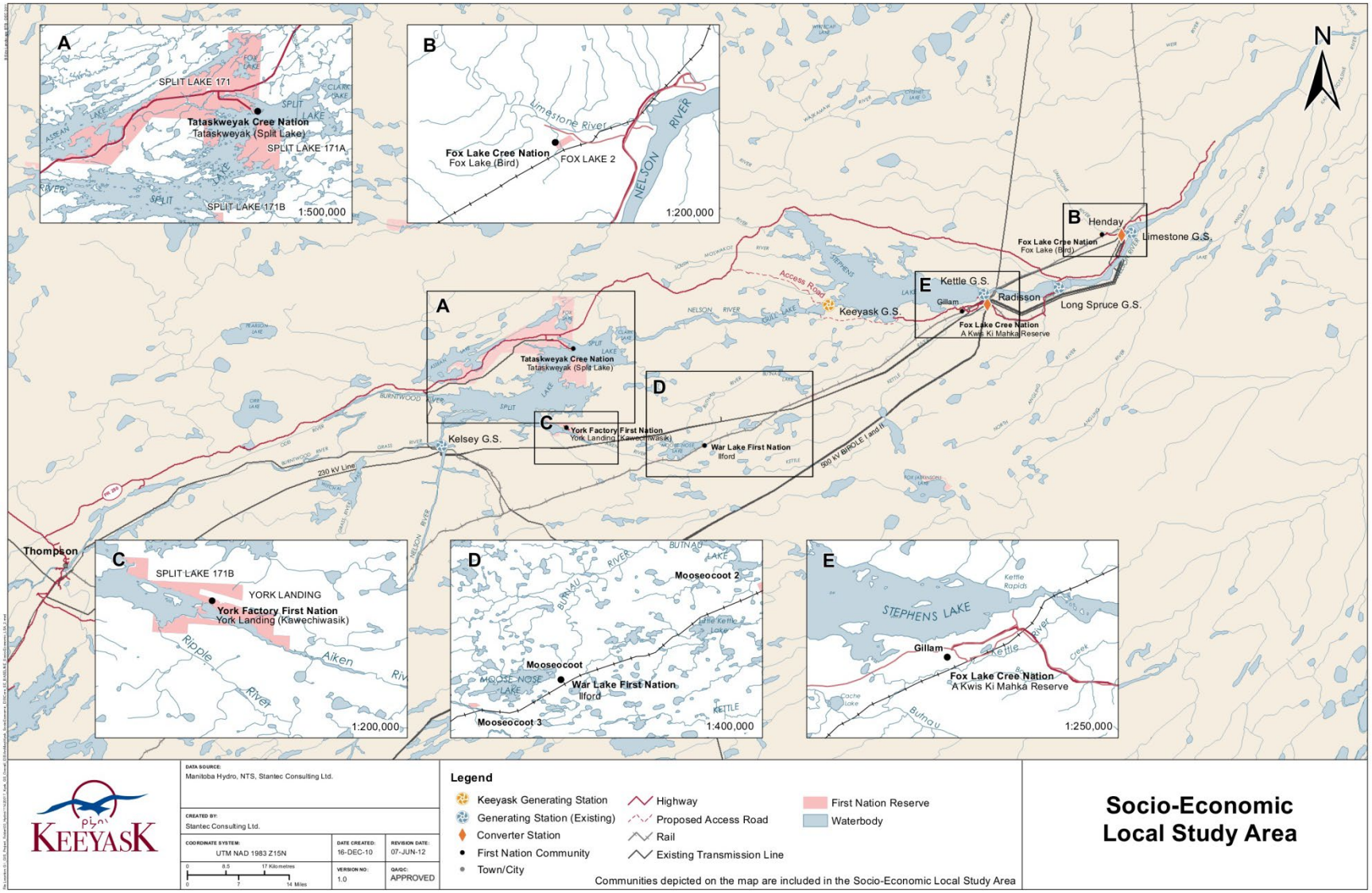
- Test predicted effects in the EIS;
- Identify unanticipated effects related to the Project;
- Monitor the effectiveness of mitigation measures;
- Determine if adaptive management is required; and
- Confirm compliance with regulatory requirements, including terms and conditions in Project approvals.

The SEMP focuses on key pathways of effect to, and components of, the socio-economic environment and builds on the assessment studies conducted for the EIS using established methods for data collection and analysis.

4.0 MONITORING REPORT

Monitoring activities are outlined in SEMP (2015) as follows:

- **Construction Phase** – SEMP monitoring during construction is related to employment and training opportunities, business opportunities, income, population changes, housing, infrastructure and services, transportation infrastructure, public safety and worker interaction, travel, access and safety, and culture and spirituality. The 2021-2022 Socio-Economic Monitoring Plan Annual Report concluded the construction monitoring phase.
- **Operation Phase** – SEMP monitoring during operation assesses population change in Gillam (first five years of operation), mercury and human health risk management activities and communicates monitored water levels at Split Lake.



Map 1: Socio-Economic Local Study Area

4.1 POPULATION – TOWN OF GILLAM

The KGP EIS predicted the Project would not result in notable change in the number of people in Gillam. However, measuring levels of in- and out-migration is difficult, with limitations existing for all related data sources. The Town of Gillam is Manitoba Hydro's northern operations base and operational staff for the Project are located in Gillam. Population is being monitored to confirm the extent of Project-induced migration to Gillam to assess and help plan for impacts on housing, services and infrastructure, if any.

Population data for the Town of Gillam is based on data from Manitoba Health's annual health statistics, which were available up to 2022. As shown in the graph below, the population of Gillam experienced annual increases between 2008 and 2011, and, with the exception of a slight increase between 2012 and 2013, small but continual annual decreases between 2012 and 2021. The slight fluctuations in population, including increase in 2022 does not suggest any additional pressure on housing, services and infrastructure related to in-migration from the operation of Keeyask.

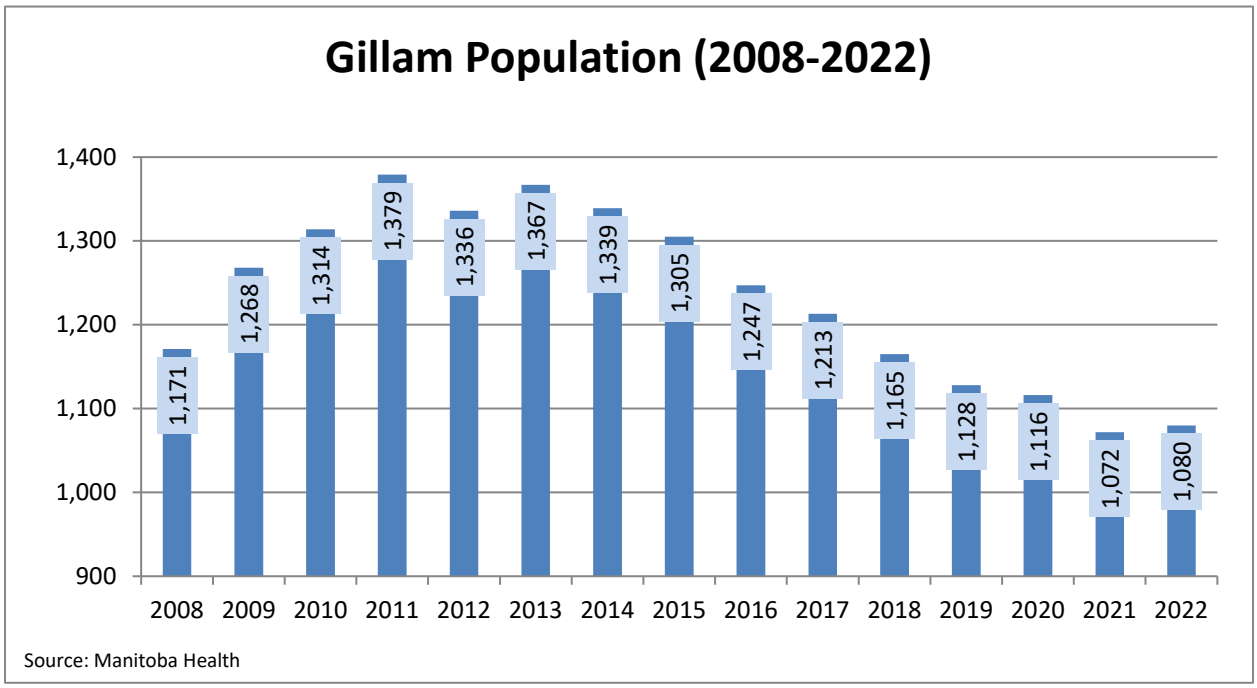


Figure 1: Gillam Population (2008-2022)

4.2 MONITORING OF WATER LEVELS ON SPLIT LAKE

The commitment to monitor water levels at Split Lake is fulfilled in the Physical Environment Monitoring Plan (PEMP). This information is reported annually to Tataskweyak Cree Nation and York Factory First Nation and included below (See figure 2).

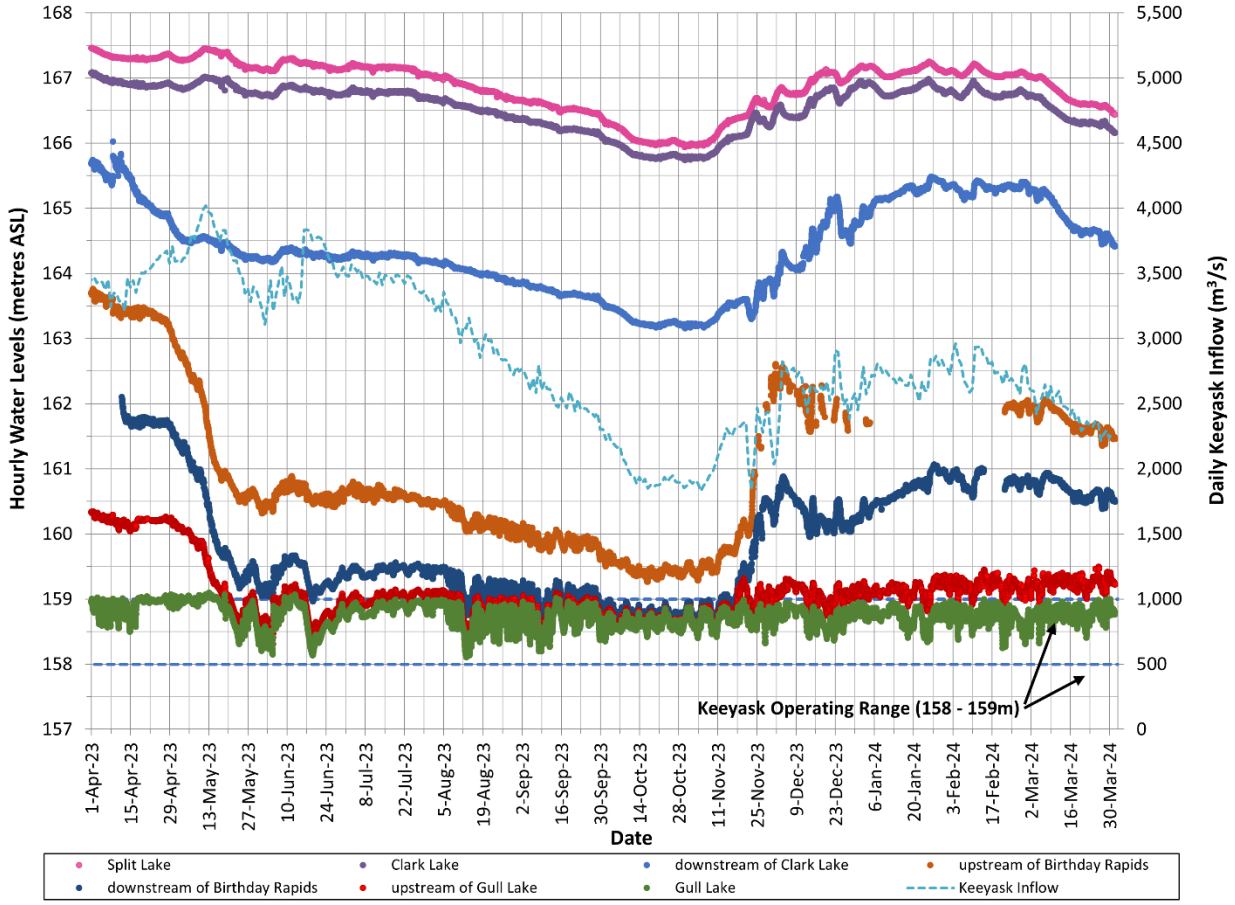


Figure 2: Split Lake Water Levels 2023-2024

4.3 MERCURY AND HUMAN HEALTH

As a result of past experiences with hydroelectric development, the partner First Nations raised the issue of mercury and human health as a primary concern in relation to the KGP. Manitoba Hydro and the partner First Nations have been working together since 2007 to study the issue and communicate information related to mercury and the Project. The KHLP, through the Mercury and Human Health Implementation Group (MHHIG), with advice from technical and health

experts, developed a Mercury and Human Health Risk Management Plan. Key components of this plan include:

- a communication strategy about fish consumption for resource users in affected waterbodies;
- voluntary hair sampling;
- monitoring of mercury in fish, wildlife, and plants; and
- periodic human health risk assessments.

Local implementation of mercury and human health programing is achieved through the hiring of Mercury Community Coordinators (or delegates) in each partner community, with support from MHHIG members.

Mercury is a metal found naturally in small amounts in rock, air, soil, water, and living organisms. It can be released into the environment through natural processes, but mainly as a result of human activity related to industrial development. When organic material such as peat is broken down by bacteria, mercury is converted to a more toxic form called methylmercury. Methylmercury becomes more concentrated as it moves up the food web from bugs to smaller fish to larger predatory fish. This process occurs in the natural environment and can be accelerated by processes such as flooding. It is most affected by unnatural causes, like the larger scale flooding caused by the creation of a hydroelectric reservoir.

It was predicted that the creation of the Keeyask reservoir in 2020 will raise mercury (methylmercury) levels in fish in Gull Lake and to a lesser extent, Stephens Lake. Mercury levels will increase, mostly due to the breakdown of peat in the reservoir. Fish mercury levels are estimated to peak 3-7 years after impoundment and gradually decrease over the next 20-30 years to levels similar to non-impacted waterbodies in the region.

People can be exposed to mercury (methylmercury) through eating fish. Larger, predatory fish, like pickerel and jackfish, generally have higher mercury levels than smaller fish. Too much mercury can cause human health problems, particularly for the developing brain (e.g., babies and children); however, all age groups are susceptible to some extent if mercury intake is too high.

Mercury in surface water does not become concentrated like it does in fish. Studies show that at current levels, drinking and recreational use of water is not a threat to human health as a result of mercury.

Because fish is an important part of a healthy traditional diet and offers many important health benefits, the MHHIG has worked to build awareness and understanding in the partner First Nation communities about mercury and the risks and benefits of eating fish.

This section focuses on the key KHLP activities related to mercury and human health from April 1, 2023 to March 31, 2024.

4.3.1 MERCURY AND HUMAN HEALTH IMPLEMENTATION GROUP MEETINGS

The MHHIG met 3 times, in-person and virtually over the course of the 2023-2024 reporting period. MHHIG discussions were supported by separate meetings with Mercury Community Coordinators, subject matter experts (toxicologist, aquatic biologist, hair monitoring consultant) and provincial health representatives (Medical Officer of Health [MOH], Manitoba Health and MOHs of the Northern Health Region and First Nation Inuit Health Branch). Key topics for discussion included:

- Community-based initiatives considered or undertaken by each community intended to build understanding about mercury and promote healthy fish food consumption, including consideration of Cree knowledge and understandings, experiences, and perspectives about eating fish (see Section 4.3.3).
- Highlights from Hair Sampling and Food Survey Program (see Section 4.3.4):
  - Preparation for and implementation of post-impoundment hair sampling events.
  - Review of post-impoundment hair sampling results.
- A review of 2023 fish monitoring results for Gull Lake and Stephens Lake (see Section Monitoring of Mercury in Fish, Wildlife and Plants 4.3.5).
- Preliminary human health risk interpretation of fish mercury concentrations (2023) and evaluation of existing fish consumption recommendations for above noted lakes (see Section 4.3.6). Key topics included:
  - Recommended adjustments to fish consumption recommendations for Gull Lake products due to an exceedance in the peak prediction for whitefish and revised peak concentration estimates provided in Appendix 3.
  - Based on revised peak concentration estimates for pickerel and jackfish, application of contingency plan for Stephens Lake communication products (resulting from Spring and Fall fish sampling results which exceeded predicted peak levels (see Appendix 3).
  - Contingency plan informed the development of conditional messaging for Stephens Lake (“Spring Update 2023”) distributed to each community and other stakeholders.

These issues and outcomes are described below.

4.3.2 COMMUNICATION STRATEGY

The Mercury and Human Health Risk Management Plan (RMP) commits to communicate potential risks to human health from increased methylmercury in the environment as a result of the Keeyask Project. Communication efforts include the provision of safe fish consumption

materials in collaboration with community-based activities. Together, these efforts are intended to support RMP goals, such as to build understanding about mercury and human health and encourage safe harvesting, sharing, and eating of healthy wild foods diet. Post-impoundment communication products include: information related to predicted mercury concentrations in fish at peak levels; consumption advice for those consuming fish from the reservoir and downstream areas; and information about hair sampling and the food survey program.

Partner First Nations experiences and knowledge and scientific / regulatory agency guidance were considered to develop accurate and meaningful messaging for partner First Nation community members and people who consume fish in the Project area. This included partner First Nation members' experiences with past hydroelectric development, the cultural importance of traditional harvesting practices and consumption of local wild foods, range of communication preferences, anticipated Project effects, observed fish mercury concentrations and hair sampling and food survey program information.

All products are reviewed annually to make sure they are current. Early in this reporting period, the MHHIG, with input from provincial and federal health representatives, developed a contingency plan for Stephens Lake post-impoundment communication products in response to 2022 fish sampling results. Conditional messaging (Spring Update 2023) was initiated in July 2023 and replaced post-impoundment products for Stephens Lake (originally issued in 2021). The Spring Update 2023 products are currently valid based on 2024 fish monitoring results.

The suite of post-impoundment communication products is shown in Appendix 1 and includes:

- "Mercury in Fish and Your Health" brochure which outlines Project effects as a results of reservoir creation, what to expect with mercury concentration in wild foods, monitoring activities and local information resources (issued in 2021).
- Conditional messaging postcard and information handout to explain changes in post-impoundment fish consumption recommendations for Stephens Lake Spring Update 2023 (compared to those issued in 2021).
- "Safe Catch" posters for Gull Lake and Stephens Lake which provide fish consumption recommendations for sensitive and general populations under post-impoundment period (peak conditions) (Proposed draft - Gull Lake, Spring Update 2024; Stephens Lake, Spring Update 2023).
    - To date, aluminium signage (Safe Catch Poster) has been installed at Stephens Lake in two public boat launch areas frequented by local resource users and Gillam area residents and at the Keeyask upstream (Gull Lake) and downstream (Stephens Lake) boat launch sites. This signage is accompanied by Manitoba Government Public Notice (Mercury in Fish). All Stephens Lake signage reflects Spring Update 2023 recommendations. Gull Lake signage will be replaced in the summer, 2024.
- Fish tapes for Gull Lake and Stephens Lake visually categorize post-impoundment (predicted peak) mercury concentrations and associated consumption categories for three fish species

(i.e., very low to high mercury) (Proposed draft – Gull Lake, Spring Update 2024; Stephens Lake, Spring Update 2023).

Spring Update 2023 products for Stephens Lake have been distributed to each community for local distribution. Outdated 2021 products were collected and replaced to the extent practicable. Mercury Community Coordinators in each community, with the support of Manitoba Hydro staff, manage the extent and nature of distribution in their respective communities. Efforts to ensure community leadership and members were aware of changes to Stephens Lake recommendations included: letter to leadership, information sheet and post-card (door to door distribution in Gillam and FLCN), display of products in high traffic public spaces, distribution of fish tape to resource users, and information provided community-based events in Gillam / FLCN and YFFN. Because of the proximity of Keeyask and Stephens Lake to Gillam, the materials noted above were provided to the Town of Gillam, as well as an offer to meet with Gillam leadership to discuss communication and engagement ideas and preferences.

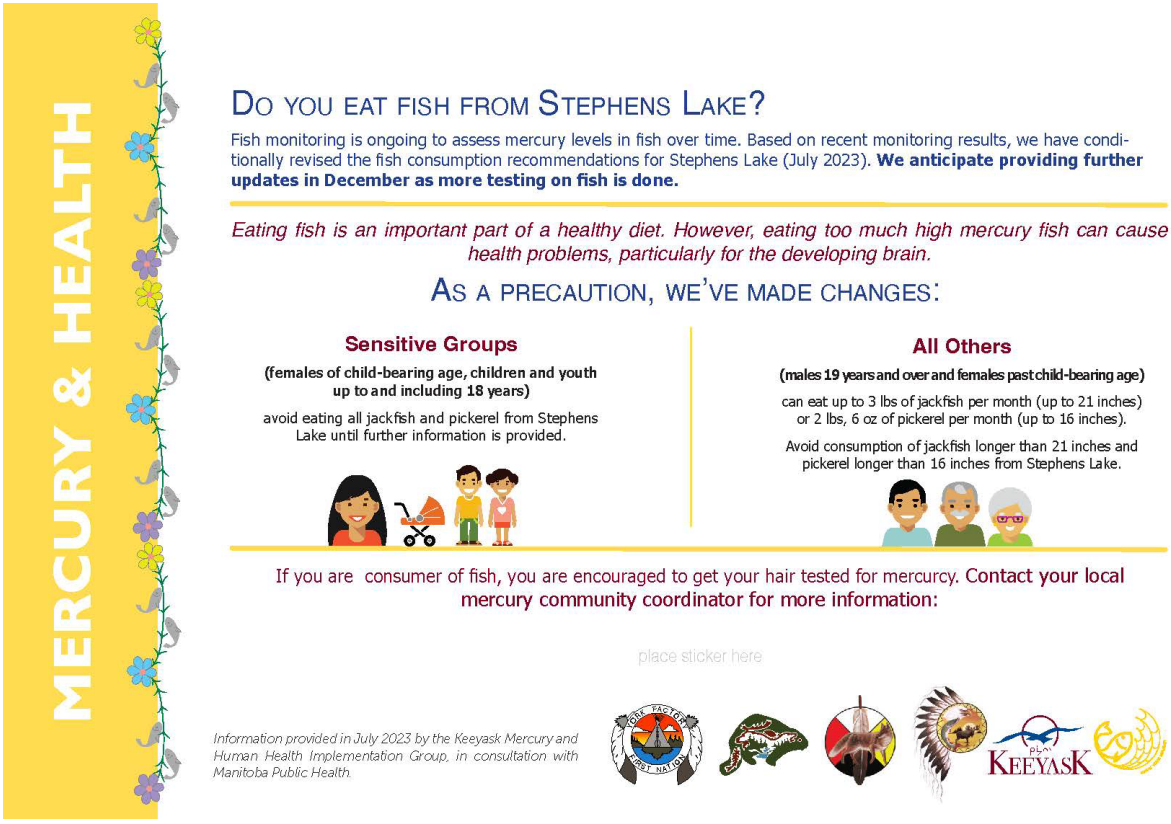


Photo 1: Postcard to Explain Changes to Stephens Lake Fish Consumption Recommendations (Spring Update 2023)

Timeline Summary of Product Adjustments since 2021

June 2022 – fish monitoring results slightly exceeded predictions for pickerel in Stephens Lake. This prompted the development of contingency plan for Stephens Lake. Contingency plan informed conditional messaging noted above.

June 2023 – fish monitoring results exceeded predictions by more than 20% for pickerel. MHHIG applied conditional messaging (Spring Update 2023) which was issued in July 2023. Consumption recommendations changed for pickerel and jackfish.

Fall 2023 – Stephens Lake: fish monitoring results indicated Spring Update 2023 remained valid. Gull Lake: whitefish levels exceeded predictions. MHHIG agreed to revise Gull Lake consumption recommendation for whitefish (proposed version included in Appendix A).

Photo 2: Safe Catch Poster for Stephens Lake, Spring Update 2023

4.3.3 COMMUNITY BASED ACTIVITIES

Individuals fulfilling the role of Mercury Community Coordinators assisted in the implementation of mercury and human health related activities and organized mercury and human health events in each partner First Nation community. The following activities were achieved:

- Community events such as fishing derbies, youth camps, and education opportunities at cultural events to generate interest and understanding about fish, mercury and human health. Coordinators met with individuals to discuss mercury-related issues and worked with school and Aboriginal Traditional Knowledge and cultural and land-based programs to deliver programming and share information.
    - FLCN hosted "Mercury and Human Health Pop Up" events in Gillam and FLCN community in October and November. These well attended events provided information and generated conversation about mercury and human health-related Project effects due to creation of the reservoir. Hair sampling and food surveys were also offered (see Section 4.3.4 for outcomes). MHHIG members, including the Project Toxicologist and Hair Sampling Lead, were in attendance to respond to questions and assist the Mercury Community Coordinator. Subsequent events took place in conjunction with a broader Gillam Open House the following week and in York Landing (hosted by YFFN) in December.
- Mercury Community Coordinators continued initiatives that integrate Indigenous knowledge, experiences and perspectives about fish consumption, mercury and human health issues and those that support the goals of the RMP. Inspired by the community calendar titled, *Fish is Good for the Soul / Kinosέw Minoskákéw* (developed by YFFN in 2021), YFFN's Mercury Community Coordinator led the development of a 2024 calendar, working with partner First Nation communities to include recipes, stories and images from all partner communities. This calendar celebrates the role of wild fish harvests to maintain good health, support cultural practices, support knowledge transfer and includes a Cree informed 'mercury in the food web' visual.
- Representatives in communities with fish replacement programming (implemented through community specific Keeyask Adverse Affects Agreement) have expressed interest in pursuing community-based fish sampling to confirm these lakes offer low mercury fish options. Discussions are ongoing with the goal to implement as soon as is practicable for relevant communities[3].

[3] During the licensing process, the KHLP committed to undertake fish sampling in newly identified offset lakes as well as monitoring of mercury levels in the catch associated with these programs on an as needed basis.

Photo 3: Mercury and Human Health Calendar Image: ***Mikisowi-písim – Eagle Moon (March)***

4.3.4 HAIR SAMPLING AND FOOD SURVEYS

The RMP provides for voluntary hair sampling and wild food surveys for partner First Nation community members, Gillam residents and other consumers of fish from Gull and Stephens Lakes.

The goals and objectives of the voluntary hair sampling and food survey program are as follows:

- For individuals who choose to participate, to characterize, with reasonable certainty, maximum monthly exposures, and in conjunction with education and/or nutritional counselling, to understand mercury levels in their bodies and manage their fish consumption.

- To understand current consumption of wild foods, in conjunction with hair mercury levels, to assess risks to human health from exposure to mercury[4]. Questions are asked about types of foods consumed, frequency of consumption and seasonal variability in diet. The food survey asks about consumption of wild and market foods, but focusses on fish, as the main source of mercury exposure, to understand the primary sources and types of fish harvested from the study area.

In 2018, the MHHIG developed a "Know your Number" campaign to generate interest and awareness of this program in partner communities and undertook sampling in 2019 and 2020. The results of these pre-impoundment hair sampling events and food surveys, as well as post-impoundment sampling events undertaken in 2022-2023 have been previously described in past SEMP reports. During the 2023-2024 period, hair sampling events were undertaken in October and November 2023, and some individual samples were collected in January 2024. The detailed 2023-2024 Hair Sampling and Food Survey Report prepared by WSP Canada Inc. (WSP, formerly called Golder Associates Ltd.) provides post-impoundment (year two operation) hair sampling and food survey results and is contained in Appendix 2. Summary outcomes are noted below.

The hair sampling and food survey program is designed to be voluntary in nature and as such results may not be representative of (or extrapolated to) the general community population. The results should be understood as informing individual mercury levels and understandings of general trends and patterns as opposed to providing detailed statistically representative information about specific age groups or sub-populations.

The mercury hair results are compared to mercury levels that are considered acceptable by World Health Organization (WHO) and Health Canada in terms of risk to human health ("thresholds")[5]:

- 2 parts per million (ppm) for sensitive population (children and teens aged 18 or under, females who may become pregnant)
- 5 ppm for non-sensitive population (male adults, and female adults who may not become pregnant).

The results of the hair sampling and food surveys are used to assess individual risk to human health, to inform ongoing communication plans and materials and to inform the formal HHRA, which will be completed in approximately 2026 to 2030.

Between April 2023 and March 2024, Mercury Community Coordinators worked with the Project's Hair Sampling Consultant (WSP) to host post-impoundment hair sampling and food survey events in October and November 2023 and collect individual samples in January 2024. The events attracted the participation of individuals from two of the four Partner First Nations, Gillam residents and other northern Manitoba communities. There was an attempt to schedule events two months following peak fish consumption periods (i.e., early summer, fall and to a lesser extent, winter), and this was achieved in 2023-2024 with the sampling events being held in the fall. As a voluntary

[4] There was an initial goal to gain insight into whether wild food consumption patterns change post-impoundment, however this may be difficult to interpret based on limited data provided pre-impoundment.
[5] The guidance provided by health agencies varies on whether male teenagers should be considered sensitive or non-sensitive. This issue was re-evaluated in discussions with health regulators and MHHIG. The MHHIG adopted the approach by WHO that considers males up to 18 years of age as sensitive.

program, hair sampling did not specifically target higher risk individuals such as those who are high fish consumers or populations that are more at risk of the health effects of mercury (i.e., sensitive individuals such as children and teens 18 years and under and females of childbearing age). Efforts were taken to increase overall participation by offering haircuts in conjunction with hair sampling, advertising on social media and hosting events at a community center. This may have resulted in an increased number of higher risk individuals than may have participated otherwise. All sampling events used the redesigned food survey workbook that was developed in 2022-2023 and similar to last year, it prompted more robust information compared to that provided in the previous survey format.

Photo 4 : Hair Sampling and Food Survey Events, Gillam (A) and York Landing (B)

A summary of outcomes from post-impoundment hair sampling and food surveys completed during this reporting period includes:

- A combined total of 67 participants[6] from Partner First Nations or residents of Gillam volunteered for post-impoundment hair sampling and/or food surveys at hair sampling events or through individual submission of hair samples. A total of 122 hair samples were collected and 58 food surveys were completed. Multiple hair samples were analyzed for some individuals with longer hair to measure monthly (vs seasonal) mercury levels or to go back further in time in previous seasons. One individual completed the food survey but chose not to provide a hair sample.
- Individual results were confidentially communicated to each participant in a personal letter, which compared their personal result with the mercury threshold that was applicable to them. The letter also included information about how to maintain a healthy fish diet and stay within an acceptable threshold as well as contact information should

[6] A total of 75 individuals took part in the 2023-2024 hair sampling and/or food survey program. There were 8 individuals who were not from local communities or did not have First Nation membership. Hair sampling was offered as a courtesy to these visitors at the events, however their hair mercury levels and food consumption patterns are not related to the Keeyask project and their results are not included in this report.

the participant have questions or wish to receive nutritional counselling. Sample letters are provided as an attachment to Appendix 2.

- Out of the 66 participants who provided a hair sample:
  - All participants had mercury levels in hair below their respective 'acceptable' thresholds, with one person marginally exceeding. Five people had moderate mercury levels (greater than 1 ppm but less than their threshold) and the remainder had mercury levels that would be considered substantially below their target level of concern (less than 1 ppm). For those individuals with very low mercury levels, they were advised that consuming two to three low mercury fish meals per week is healthy and unlikely to affect their mercury exposure.
  - While one hair mercury level was marginally exceeding the threshold, it was still within the range of statistical and analytical variability of the threshold (e.g., <5%). This person was encouraged in their personal letter to have their hair resampled to confirm results. No nutritional counselling was requested when offered.
  - The average hair mercury level was slightly higher than observed in previous years (2022-2023), but similarly all participants were below (or only marginally exceeding) their respective acceptable thresholds.
- Results from the 58 food surveys indicated:
  - 47 individuals reported that they ate local fish in the previous year. The top species of fish consumed were pickerel (walleye) (44 respondents), jackfish (northern pike) (16), brook trout (5), whitefish (7), brook trout (4), and sturgeon (3). Some individuals (5) reported eating fish organs. The top wild birds reported to be consumed were goose (20), grouse (8), duck (5), and willow ptarmigan (4). The top wild land animals were moose (33), caribou (15), snowshoe hare (3), followed by beaver, polar bear and seal[7]. Some individuals reported eating organs from wild birds or land animals (e.g., less than 5 respondents). The most common berries were blueberry (18), wild raspberry (9), followed by wild strawberry and gooseberry. Few individuals reported consuming wild plants, but those mentioned included Labrador tea, Northern Labrador tea, and wihkes (sweet flag/muskrat root).
  - Most individuals indicated that they generally do not consume large amounts (i.e., 4 or more meals per month) of local fish from the area. While not representative of all communities, data show that fish consumption occurs primarily during summer and fall (e.g., June to November), followed by spring (e.g., March to May), and to a lesser extent during winter (e.g., December to February).
  - People who reported consuming fish tended to have higher mercury levels than those who did not, but as reported above, those levels were all within, or only marginally above, acceptable ranges.

[7] Polar bear and seal were among the responses for wild land animals and are typically found outside the Keeyask area.

  - The 2023-2024 reported wild food consumption patterns (e.g., species and season) were consistent with those reported in previous years (2022-2023).
  - In general, the food survey results corroborate information collected during the environmental assessment phase and subsequent MHHIG discussions about important local wild foods consumed by partner Fish Nation members. The available information also supports general understanding about harvesting patterns on Gull and Stephens lakes; currently, there is no reported fishing in Gull Lake by partner community members[8]. Some fishing occurs in Stephens Lake, however most individuals were reporting they harvest the majority of fish from non-Project impacted or off-system waterbodies. See Appendix 2 for additional aggregate information regarding location, seasonal variation, consumption frequency and amounts.

- Results of the post-impoundment hair sampling offered during 2023-2024 indicate that hair mercury levels of those who participated in the program were within or only marginally above acceptable ranges, and such, it can be concluded there is low overall risk from exposure to mercury for these individuals. Due to the voluntary nature of the program, there is uncertainty on whether the participants included the highest resource users (attempts to encourage participation, notwithstanding) and it is possible that other individuals may be at higher risk due to higher consumption of local fish in the Project area.

Aggregate hair sampling and food survey results from 2023-2024 have been shared with all four partner First Nation communities through email communications (March 2024) and will be presented at the spring MHHIG meeting (June 2024). In addition, a graphic poster providing the aggregate results has been developed and will be shared with the communities in spring 2024. Community-level results posters will be prepared, upon request.

Hair sampling and food surveys will continue to be offered to all four partner First Nation communities over the next several years, which will allow individuals to monitor their mercury exposure through repeat hair sampling. There will continue to be a focused effort to encourage more frequent hair testing (e.g., seasonal) for people who consume fish from Keeyask affected lakes (Gull or Stephens lakes) and promote the participation of individuals who are higher consumers of fish in this program. Hair sampling will continue to be available upon request via the participant's local Mercury Community Coordinator, and nutritional counselling offered.

4.3.5 MONITORING OF MERCURY IN FISH, WILDLIFE AND PLANTS

The Aquatic Effects Monitoring Plan (AEMP) and Terrestrial Effects Monitoring Plan (TEMP) outline pre-and post-impoundment monitoring for mercury in fish, wildlife and plants in the Project area, including a voluntary sampling component, where partner First Nations' members can

[8] While there was no reported fishing in Gull Lake, "Keeyask" was among the responses, which could refer to upstream (Gull Lake) or considering access, more likely downstream (Stephens Lake) of Keeyask.

submit plant, Lake Sturgeon, and wildlife samples from the Project area for mercury analysis. The overall objective of this monitoring is to provide information used to assess risks to human health from potential exposure to mercury. Because EIS predictions informed the development of post-impoundment consumption recommendations for fish, the objectives of these monitoring programs in the context of the RMP are:

- to compare current results with predictions in the EIS,
- to provide a timely communication system if levels approach or exceed predictions, and
- to provide information for individuals to make informed consumption choices (from Gull and Stephens lakes in particular).

The following provides an overview of EIS predictions, scheduled monitoring and 2023 monitoring results of fish, wildlife, plants, and water. Available data was reviewed by the Project Toxicologist to assess risk from consumption of wild foods harvested in the Project area (see Section 4.3.6).

Fish: The Keeyask reservoir (Gull Lake) was impounded in September 2020. Mercury concentrations in pickerel, jackfish, and whitefish were expected to increase by three to five times in Gull Lake and by two times in Stephens Lake, peaking between 2023 and 2027, and then gradually decline over the next thirty years. Scheduled monitoring of mercury in fish outlined in the AEMP occurs in early fall. As of 2020, annual monitoring occurs in Split Lake[9], the reservoir and Stephens Lake – these lakes will continue to be monitored annually until determination of peak has occurred and then every three years. Scheduled sampling also occurs every three years in the Aiken River (sampling scheduled for 2024).

In consideration of the monitoring objectives noted above, the MHHIG identified there was an unavoidable lag between seasonal fishing (e.g., spring/fall) and reporting of sampling results (late winter) as mercury levels rise in fish from Gull and Stephens lakes. The time lag is an issue until peak concentrations are observed and concentrations begin to decline. To address this communication lag, the MHHIG determined it would be useful to undertake additional small-scale sampling (using non-lethal dermal punch samples) on Stephens Lake in June. It was felt this sampling which started in 2021 could provide an additional, early warning indicator, prior to the fall fishing period, about how fast the mercury concentrations are increasing and approaching the predicted peak concentrations. Samples collected in June 2022 showed that concentrations in pickerel approached predictions, prompting the development and application of a contingency peak during this reporting period.

The AEMP 2023/24: Mercury in Fish Flesh from Keeyask Study Area results show that mercury concentrations in jackfish, pickerel and whitefish caught in Gull Lake (what is now the Keeyask Reservoir) are, as expected, higher than values measured historically. While average concentrations (standard length) in jackfish and pickerel from Gull Lake remain below the predicted peak values, concentrations in whitefish exceeded the predicted peak of 0.19 ppm. The concentrations found in jackfish and pickerel from Stephens Lake in 2023 exceeded the predicted peak of 0.5 ppm and were higher than in all previous years when mercury was measured. Mercury

[9] Split Lake monitoring will continue annually until at least 2025 and then revert back to every three years under the 'Coordinated Aquatic Monitoring Program'.

concentrations were also higher in all three species sampled from Split Lake in 2023 compared to results collected in previous years. Because of this, it is unclear if higher mercury concentrations in Stephens Lake are being caused by the Project or the fluctuations that occur naturally, or both.

New contingency peak concentrations were developed for the MHHIG to inform necessary revisions to post-impoundment fish consumption recommendations for Gull and Stephens lakes (see Appendix 3, North/South Consultants, Contingency Fish Mercury Predictions for Stephens Lake, 2023; and Contingency Fish Mercury Predictions and Additional Information from the Keeyask Reservoir, 2024). Because there was no scheduled sampling in the Aiken River in 2023, communities were provided the opportunity to submit voluntary samples; no samples were received.

Wildlife & Plants: The scheduled sampling program for mercury in wildlife, as outlined in the TEMP was completed in winter 2023/24. No plant samples were scheduled to be collected in 2023. Notifications about the voluntary sampling program were offered to community representatives and members via email, meetings, in person, and via posters; no wildlife or plant samples were submitted for analysis in the reporting period.

Post-impoundment mercury levels are expected to remain low in specific plants (blueberries and Labrador tea) and wildlife (moose, beaver, snowshoe hare) consumed by people. Mercury levels in waterfowl, such as ducks, are expected to remain low with levels similar to whitefish, with lower concentrations predicted for Canada geese. While the predicted peak concentration outlined in the EIS for ducks is considered a reasonable estimate, due to whitefish concentrations in Gull Lake being higher than predicted in 2023, supplementary duck sampling in Spring 2024 will be undertaken to confirm the predicted (low) levels for ducks remains valid[10].

The 2023 results, outlined in the TEMP Mercury in Wildlife annual report, show beaver and muskrat concentrations remain low, consistent with EIS predictions. There was an increase in mercury levels in river otter and mink tissue – this was expected, as river otter and mink eat fish. To date, there is no information to suggest that people eat river otter or mink.

Monitoring for mercury in plants and wildlife (both scheduled in 2024) will continue during the operation period. Data collected will be supplemented by any samples provided by partner First Nations through the voluntary sampling program.

Water: Mercury levels in water, post-impoundment, are predicted to remain below mercury water quality guidelines as set by Manitoba and Canada for drinking and bathing. Water quality was monitored at locations upstream of the project, in Gull Lake and in Stephens Lake for a suite of parameters, including mercury. As expected, some water quality variables, including mercury, have changed since reservoir flooding. The highest mercury concentration measured in surface water collected throughout the study area was 0.0061 ug/L. This was measured in one of the remote newly flooded back bays in the reservoir where it was predicted that mercury

[10] Duck tissue samples to be provided by registered trapline holder in the Keeyask area.

concentrations in water would be the highest. This is well below the total mercury concentrations of 0.05 ug/L used as a conservative maximum value in the EIS as an input in the 2013 HHRA.

4.3.6 ASSESSMENT OF RISK TO HUMAN HEALTH

The Project toxicologist participates as a regular member on the MHHIG and met regularly with subject matter experts as well as with provincial health representatives to discuss issues informing the assessment of risk to human health (HHRA) from mercury exposure as a result of the Keeyask Project.

On an annual basis, the Project toxicologist interprets risk to human health risk through a review of available monitoring results of mercury in fish, wildlife, plants, and water, compared to predictions provided in the EIS and/or 'contingency' estimates as applicable. Wilson Scientific prepared the following technical reports (see Appendix 4):

- Attachment 4a: Preliminary Human Health Risk Interpretation of 2023 Environmental Data) contains more detailed information on the human health risks from the consumption of fish, wild foods, and water.
- Attachment 4b: Revisions to Recommended Maximum Monthly Intake Rates for Post-Impoundment Fish Consumption for Stephens and Gull lakes Based on 2023/2024 Contingency Peak Concentrations.

Key 2023-24 HHRA conclusions and activities are as follows:

Fish: The Project toxicologist concluded, based on 2023 fish mercury results from the Gull Lake and Stephens Lake and revised peak concentration estimates for certain fish (see Appendix 3), that post-impoundment consumption recommendations were no longer valid and required adjustments for specific standardized length fish. Consumption recommendations were revised, as noted below.

Post-impoundment consumption recommendations were originally developed in 2021 and were based on EIS peak concentrations predicted for Gull and Stephens lakes, Health Canada, and World Health Organization guidance on acceptable rates of intake of mercury, and Manitoba Government mercury in fish guidelines. As noted in Section 4.3.2, the Safe Catch poster (2021) presented consumption recommendations based on standardized length sizes for three fish species; the revised fish tapes presents consumption categories for pickerel and jackfish based on modelled lengths according to four mercury concentration thresholds (0.1 ppm, 0.2 ppm, 0.5 ppm and 1.5 ppm).

- Gull Lake Update:

  2023 results indicate that the post-impoundment consumption recommendations developed for pickerel and jackfish remain valid. Exceedances in standardized length whitefish concentrations prompted a recommendation to develop and apply a new contingency peak to inform consumption recommendations (see Appendix 1 and 4b for detailed discussion).

Finalization of recommendations, corresponding communication products and distribution plan is subject to review with MHHIG in June 2024.

- Stephen Lake Update:

  2023 fish monitoring results showed that average mercury concentrations pickerel from Stephens Lake, had exceeded predicted peak values by over 20% -- pickerel exceeded the 20% threshold in the Spring only, and jackfish in the Fall (see Appendix 5: Post-Impoundment Fish Mercury Communication Process)[11]. Prompted by 2022 fish monitoring results in which pickerel concentrations had approached predicted peak values, the MHHIG, in consultation with provincial and federal health representatives, developed a contingency plan which included:

  - Revised peak contingency estimates for pickerel and jackfish in Stephens Lake (Appendix 3a).
  - "Spring Update 2023" messaging for Stephens Lake: Revised Safe Catch Poster and fish tape, postcard and information handout for community distribution (as referenced in Section 4.3.3) explaining changes to consumption recommendations for jackfish and pickerel (see Appendix 1). These products were distributed prior to 2023/2024 AEMP monitoring results.
  - Fall (AEMP) 2023 results confirmed the contingency peak and 'Spring Update, 2023' products should remain in effect.

Wildlife: Concentrations provided in the TEMP 2023/2024 report indicate that eating beaver and muskrat from the Project area (based on previously reported consumption rates) would not pose unacceptable risks to people. While beaver and muskrat samples were limited and samples were not available for other wild foods (e.g., moose, snowshoe hare, and geese), there is no information to suggest that persons should be avoiding these foods, based on predicted peak estimates or potential pathways. The assessment of risk from the consumption of ducks assumed that maximum peak mercury concentrations would be equal to or less than those of whitefish in Gull Lake.

As noted above, a contingency peak for whitefish in Gull Lake was developed due to concentrations being higher in 2023 than predicted (0.19 ppm vs 0.3 ppm). Even with a revised predicted peak concentration of 0.35 ppm in Gull Lake whitefish, project biologists have confirmed that EIS estimates for ducks remain valid. As a precaution, supplementary duck sampling in Spring 2024 will be undertaken to confirm that people can continue eating ducks from the Keeyask area based on previously reported consumption rates.

Efforts will continue to encourage the voluntary submissions of wildlife samples. The MHHIG will develop an approach to update the findings from a pre-impoundment (2009) wild foods workshop

[11] In 2021, the MHHIG developed a post-impoundment protocol outlining a process for timely communication of monitoring results, interpretation of data, and decision-making protocol for assessing currency of safe fish consumption recommendations (see Appendix 5: Post-Impoundment Fish Mercury Communication Process).

to determine if identified foods and previously reported consumption rates (i.e., frequency and meal sizes) are still applicable.

Plants: Specified plants consumed by people (blueberries and Labrador tea) near the Keeyask reservoir are expected to remain low in mercury concentrations. The first post-impoundment sampling of plants noted above is scheduled to occur in 2024 and will continue into operations, which will provide more information on expected concentrations and interpretation of risk to human health. Partner First Nations are encouraged to submit plant samples from the area for mercury analysis.

Water: Mercury levels in water continue to remain below mercury water quality guidelines as set by Manitoba and Canada for drinking and bathing and below that estimated in the EIS.

A formal Human Health Risk Assessment (HHRA) will be completed upon determination of peak conditions by environment professionals (approximately 2026 - 2030) and/or discussion with MHHIG.

APPENDIX 1: POST-IMPOUNDMENT COMMUNICATION PRODUCTS

WILL MERCURY LEVELS AFFECT WILD FOODS I EAT?

FISH: After Impoundment, mercury levels in fish will gradually rise in Gull Lake, and to a lesser extent, in Stephens Lake. Within three to seven years after impoundment (~2023-2027), levels are expected to rise 3-5X in predatory fish (e.g. pickerel and jackfish) in Gull Lake and double in Stephens Lake. Levels in whitefish are expected to increase moderately. People should limit or avoid most fish from these lakes while mercury levels are high.

To help you, your family and friends make informed choices about eating fish, consumption recommendations, based on Health Canada's guidance and predicted maximum fish concentrations in Gull and Stephens lakes are available from your Mercury Community Coordinator.

WILDLIFE AND PLANTS: After impoundment, mercury levels are expected to remain low in wildlife (moose, beaver, muskrat, snowshoe hare), and plants (blueberries and Labrador Tea) consumed by people. Waterfowl, such as ducks, are expected to remain low with increases in mercury levels similar to whitefish. Evidence shows that people can expect to continue eating these wild foods as they did before impoundment. Community members are encouraged to submit wildlife samples and plants samples to test mercury levels.

WATER: Mercury levels in water, post-impoundment, will remain below mercury water quality guidelines as set by Manitoba and Canada for drinking and bathing.

HOW DO I MONITOR MERCURY LEVELS?

"Know Your Number": Free, confidential hair sampling is available to help you understand how much mercury is in your body so you can make informed decisions about eating fish.

DO YOU WANT A HAIR SAMPLE TEST?

Voluntary hair sampling (2018-2020) in partner First Nation communities has shown that average mercury levels in people are within healthy, low levels.

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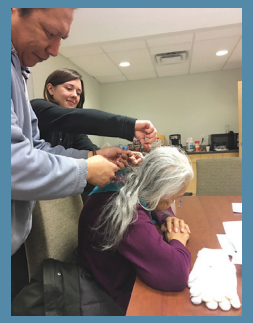


Monitoring for fish, wildlife and plants is ongoing. Community members are encouraged to submit wildlife samples or plant samples collected in the Keeyask Project area for mercury analysis. The Mercury Human Health Implementation Group will review available data annually to update, as required, fish consumption recommendations.

HOW CAN I LEARN MORE?

The Mercury and Human Health Implementation Group, consisting of representatives from each partner First Nation, Manitoba Hydro, technical experts and health agencies, oversees mercury and human health initiatives. Key activities include: voluntary hair sampling; community-based events to build understanding about mercury and human health, monitoring fish, wildlife, and plants; safe fish consumption guidance for specific lakes.

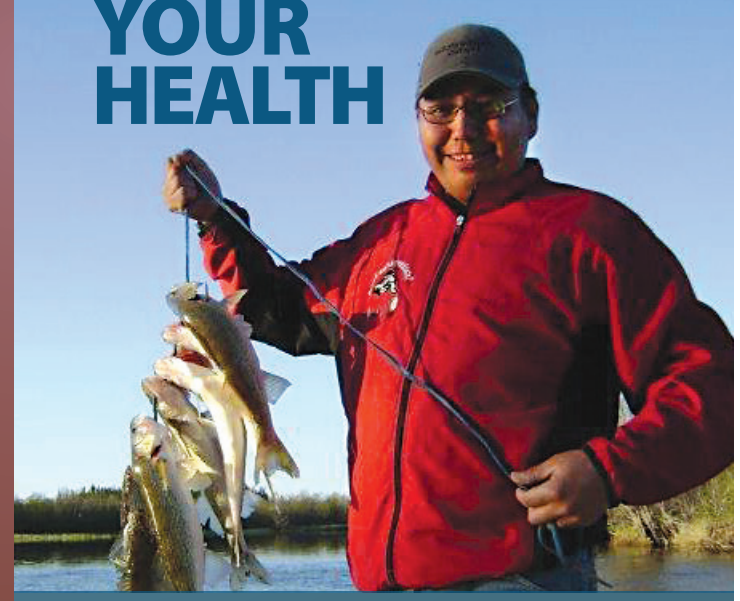
'Mercury Community Coordinators' in your area provide information about mercury and coordinate activities.

Look for the following in your community:

- "Know your Number": Free, confidential hair sampling
- Community information sessions about mercury and human health
- Information about safe fish consumption for Keeyask area lakes

Information provided in 2021 in collaboration with Manitoba Government.

MERCURY IN FISH AND YOUR HEALTH



Understanding mercury in fish resulting from the impoundment of the Keeyask reservoir

FOR GULL LAKE AND STEPHENS LAKE

KEEYASK

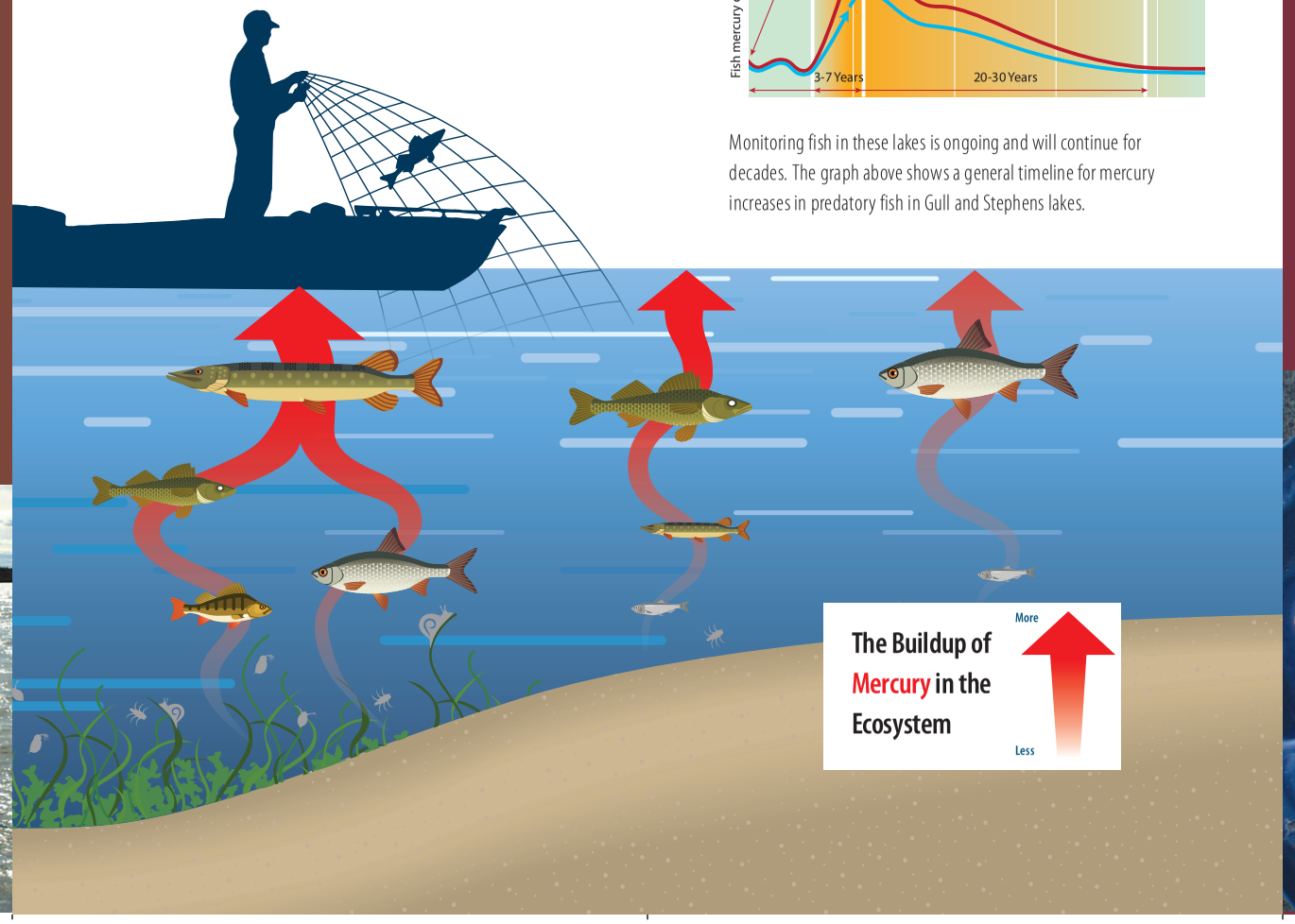
RESPECTING THE LAND AND UNDERSTANDING THE EFFECTS OF MERCURY

Development of the Keeyask Project is a collaborative effort between Manitoba Hydro and four Manitoba First Nations – Tataskweyak Cree Nation and War Lake First Nation (acting as the Cree Nation Partners), York Factory First Nation, and Fox Lake Cree Nation – working together as the Keeyask Hydropower Limited Partnership (KHLP).

As a result of past experience with hydroelectric development, the partner First Nations raised concerns about mercury and human health. **The Partnership has been working together on this issue since 2007 to study mercury** and develop strategies to build understanding about mercury and the risks and benefits of eating fish. The work is influenced by the teachings of Cree culture, spirituality and wellbeing, which is grounded in the relationship and balance between people, land, water and all other living beings. Discussions about 'mercury' cannot be separated from the larger environment and all of the connected world.

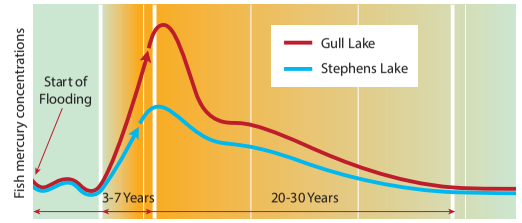
CAN MERCURY AFFECT MY HEALTH?

Mercury can get into your body by eating fish, particularly large predatory fish (such as pickerel and jackfish). High levels of mercury can cause health problems in humans, particularly for the developing brain. For this reason, children and females of childbearing age are advised to keep their mercury levels lower than adult males or post-menopausal females or Elders.



WHY ARE MERCURY LEVELS A CONCERN?

Impoundment of the Keeyask reservoir was completed in September of 2020. Mercury levels will increase in fish in Gull Lake, and to a lesser extent Stephens Lake. It will take about 3-7 years for mercury levels in fish to reach maximum levels. Levels will decrease over 20–30 years.



Monitoring fish in these lakes is ongoing and will continue for decades. The graph above shows a general timeline for mercury increases in predatory fish in Gull and Stephens lakes.

WHAT IS MERCURY?

Mercury is a metal that has always been found in small amounts naturally in the environment and in fish. Flooding of soil or wetlands creates conditions where mercury is converted into methylmercury by bacteria living in the soil. This methylmercury then makes its way through the food web into the fish.

Eating fish and other wild foods is more than just nutritious – it is part of mino pimatisiwin or "living the good life." Fish provides people with important nutrients for overall good health. In general, fish such as whitefish or small pickerel and jackfish are lower in mercury than large predatory fish.

SAFE CATCH

A Mercury-Level Guide to eating fish from Stephens Lake

KEEYASK

Spring 2023 Update

As a result of Keeyask reservoir impoundment, fish mercury concentrations are expected to rise 2x in predatory fish in Stephens Lake. Recommendations are based on the estimated maximum (average) concentrations for standardized lengths in each fish species shown below. Fish concentrations will gradually decline after reaching peak conditions (expected to occur between 2023-2027).

Recommendations in effect until approximately 2030.

VERY GOOD CHOICE | OCCASIONAL CONSUMPTION | RESTRICTED CONSUMPTION

Larger fish than shown are expected to be higher in mercury concentrations and not recommended for consumption. Smaller fish than shown are expected to have lower mercury concentrations.

Pickerel greater than 16 inches not recommended for consumption.

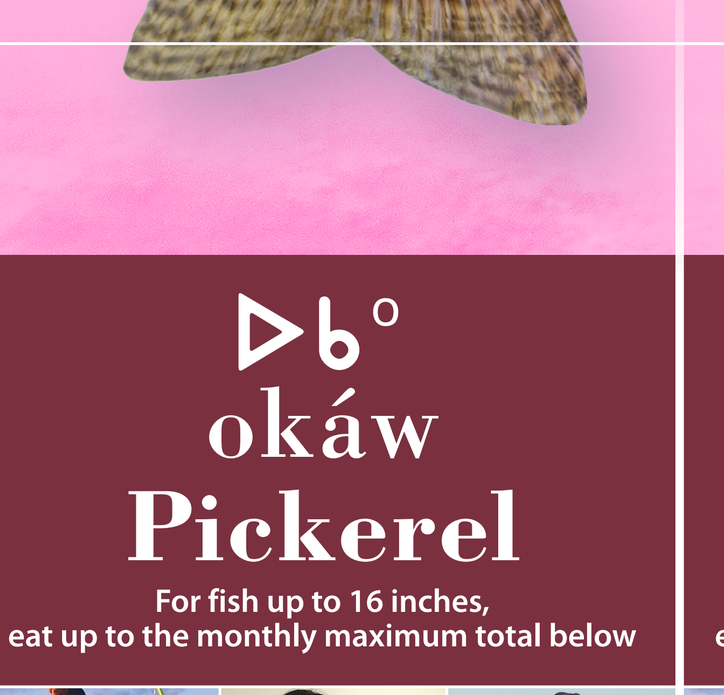
Jackfish greater than 21 inches are not recommended for consumption.

Fish are Good for You!

Remember to eat fish that are low in mercury.

ᐅᑲᐤ okáw Pickerel

For fish up to 16 inches, eat up to the monthly maximum total below



Children (under 12 years) 66 lbs (or ~30 kg)	Youth (ages 12-18) Females of Childbearing Age 132 lbs (or ~60 kg)	All Others 132 lbs (or ~60 kg)
Avoid	Avoid	2 lbs, 6 oz

ᐅᓂᒪᓯᐯᐤ onhcwápéw Jackfish

For fish up to 21 inches, eat up to the monthly maximum total below

Children (under 12 years) 66 lbs (or ~30 kg)	Youth (ages 12-18) Females of Childbearing Age 132 lbs (or ~60 kg)	All Others 132 lbs (or ~60 kg)
Avoid	Avoid	3 lbs, 0 oz

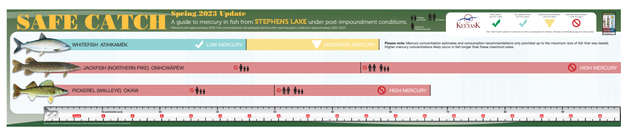
ᐊᑎᐦᑲᒉᐊᐢ atihkamék Whitefish

Get your hair tested to KNOW YOUR NUMBER!
The best indicator of mercury exposure

For fish up to 14 inches, eat up to the monthly maximum total below

Children (under 12 years) 66 lbs (or ~30 kg)	Youth (ages 12-18) Females of Childbearing Age 132 lbs (or ~60 kg)	All Others 132 lbs (or ~60 kg)
2 lbs, 10 oz	5 lbs, 5 oz	12 lbs, 7 oz

The chart shows maximum monthly fish consumption during peak conditions. Recommendations apply to total fish consumed. For example, if you eat half of the maximum monthly intake of whitefish, you can have half the recommended amount of pickerel or jackfish. Intake should be adjusted if people weigh more or less than noted here. For example, if an individual child weighs 33 lbs rather than the assumed 66 lbs, divide the maximum monthly intake by 2. Standardized lengths in each fish species are rounded to the nearest inch.



See fish tape for specific recommendations for various fish sizes.

Information provided in 2023 in collaboration with Manitoba Public Health.

To test your mercury levels through a hair sample contact:

STICKER TO BE PLACED HERE

SAFE CATCH

Spring 2023 Update

A guide to mercury in fish from **STEPHENS LAKE** under post-impoundment conditions.

Effective until approximately 2030. Fish concentrations will gradually decline after reaching peak conditions (approximately 2023–2027).

Children and Youth

All Others

Women of Childbearing Age

KEEYASK

best choice: up to 0.1 ppm	very good choice: up to 0.2 ppm	occasional consumption: up to 0.5 ppm	restricted consumption: over 0.5 ppm
✓	✓	▼	⊘

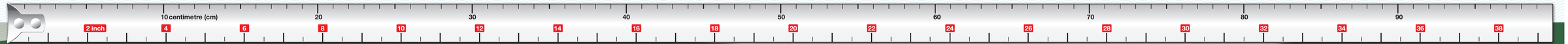
See "Safe Catch" poster for maximum monthly consumption for children, females of childbearing age and other adults.

WHITEFISH ATIHKAMÉK — LOW MERCURY | MODERATE MERCURY

JACKFISH (NORTHERN PIKE) ONHCWÁPÉW — HIGH MERCURY

PICKEREL (WALLEYE) OKÁW — HIGH MERCURY

Please note: Mercury concentration estimates and consumption recommendations only provided up to the maximum size of fish that was tested. Higher mercury concentrations likely occur in fish longer than these maximum sizes.



Based on guidelines from Manitoba Government. Contact your local community coordinator for more information.

CONDITIONAL REVISION TO FISH CONSUMPTION ADVICE FOR STEPHENS LAKE

Information provided in July 2023 by the Keeyask Mercury and Human Health Implementation Group, in consultation with Manitoba Public Health. We will provide updates as more testing on fish is done.

Do you eat fish from Stephens Lake?

Mercury exists naturally in the environment. Flooding of soil or wetlands can temporarily increase mercury levels in living organisms such as fish.

As a result of Keeyask reservoir impoundment in 2020, fish mercury concentrations are expected to rise in Gull Lake and to a lesser extent, Stephens Lake. Fish concentrations will gradually decline after reaching peak conditions (expected to occur between 2023-2027).

Fish monitoring is ongoing to assess mercury levels in fish over time. Monitoring for Keeyask affected lakes occurs annually each fall to understand actual (average) fish mercury concentrations compared to predictions. Since 2021, supplemental small-scale sampling also occurs in June in Stephens Lake. **The June sampling results in 2023 show that some predatory fish from Stephens Lake (jackfish and pickerel) may have higher mercury levels than expected.**

Eating fish is an important part of a healthy diet. However, eating too much high mercury fish can cause health problems, particularly for the developing brain. We want to err on the side of caution and respond to the most up to date information we have available.

Fish consumption recommendations have been prepared based on peak mercury estimates to help you and your family make informed choices about eating fish from these lakes. To reduce the risk from mercury exposures, we have revised the fish consumption advice on a conditional basis. As a precaution, we have changed current fish consumption advice. As of July 2023, we recommend:

- **Sensitive groups (females of childbearing age, children and youth up to and including 18 years) avoid eating all jackfish and pickerel from Stephens Lake** until further information is provided.
- All others (males 19 years and over and females past childbearing age) can eat up to 3 pounds of jackfish per month (up to and including 21 inches) or 2 pounds, 6 ounces of pickerel per month (up to and including 16 inches).
- **All groups avoid consumption of jackfish longer than 21 inches and pickerel longer than 16 inches from Stephens Lake.**
- **No changes to recommendations for whitefish.**
- If you are a regular consumer of fish, you are encouraged to get your hair tested for mercury. Contact your local mercury community coordinator for more information.
- To submit samples of local fish for mercury testing, contact your mercury community coordinator.

Mercury Community Coordinator: Name, phone number.

Annual fall sampling will help determine longer term consumption recommendations. Fall 2023 initial results will be available by December 2023.

Stay tuned for future updates and talk to your mercury community coordinator if you have questions.

MERCURY & HEALTH

Do you eat fish from Stephens Lake?

Fish monitoring is ongoing to assess mercury levels in fish over time. Based on recent monitoring results, we have conditionally revised the fish consumption recommendations for Stephens Lake (July 2023). **We anticipate providing further updates in December as more testing on fish is done.**

Eating fish is an important part of a healthy diet. However, eating too much high mercury fish can cause health problems, particularly for the developing brain.

As a precaution, we've made changes:

Sensitive Groups

(females of child-bearing age, children and youth up to and including 18 years)

avoid eating all jackfish and pickerel from Stephens Lake until further information is provided.

All Others

(males 19 years and over and females past child-bearing age)

can eat up to 3 lbs of jackfish per month (up to 21 inches) or 2 lbs, 6 oz of pickerel per month (up to 16 inches).

Avoid consumption of jackfish longer than 21 inches and pickerel longer than 16 inches from Stephens Lake.

If you are consumer of fish, you are encouraged to get your hair tested for mercurcy. Contact your local mercury community coordinator for more information:

place sticker here

Information provided in July 2023 by the Keeyask Mercury and Human Health Implementation Group, in consultation with Manitoba Public Health.

SAFE CATCH

A Mercury-Level Guide to eating fish from Gull Lake

KEEYASK

As a result of Keeyask reservoir impoundment, fish mercury concentrations are expected to rise 3-5x in predatory fish in Gull Lake. Recommendations are based on the estimated maximum (average) concentrations for standardized lengths in each fish species shown below. Fish concentrations will gradually decline after reaching peak conditions (expected to occur between 2023-2027).

Recommendations in effect until approximately 2030.

VERY GOOD CHOICE | OCCASIONAL CONSUMPTION | RESTRICTED CONSUMPTION

Larger fish than shown are expected to be higher in mercury concentrations and not recommended for consumption. Smaller fish than shown are expected to have lower mercury concentrations.

Pickerel greater than 16 inches not recommended for consumption.

Jackfish greater than 21 inches are not recommended for consumption.

Fish are Good for You!

Remember to eat fish that are low in mercury.

Whitefish greater than 14 inches are not recommended for consumption.

ᐅᒃᑲᐤ
okáw
Pickerel

For fish up to 16 inches, eat up to the monthly maximum total below

Children (under 12) 66 lbs (or ~30 kg)	Youth (ages 12-18) Females of Childbearing Age 132 lbs (or ~60 kg)	All Others 132 lbs (or ~60 kg)
Avoid	Avoid	1 lb, 14 oz

ᐅᓂᐦᒁᐧᐋᐯᐤ
onhcwápéw
Jackfish

For fish up to 21 inches, eat up to the monthly maximum total below

Children (under 12) 66 lbs (or ~30 kg)	Youth (ages 12-18) Females of Childbearing Age 132 lbs (or ~60 kg)	All Others 132 lbs (or ~60 kg)
Avoid	Avoid	1 lb, 14 oz

ᐊᐃᐦᑲᒉᐠ
atihkamék
Whitefish

Get your hair tested to **KNOW YOUR NUMBER!** The best indicator of mercury exposure

For fish up to 14 inches, eat up to the monthly maximum total below

Children (under 12) 66 lbs (or ~30 kg)	Youth (ages 12-18) Females of Childbearing Age 132 lbs (or ~60 kg)	All Others 132 lbs (or ~60 kg)
2 lbs, 1 oz	4 lbs, 3 oz	9 lbs, 13 oz

The chart shows maximum monthly fish consumption during peak conditions. Recommendations apply to total fish consumed. For example, if you eat half of the maximum monthly intake of whitefish, you can have half the recommended amount of pickerel or jackfish. Intake should be adjusted if people weigh more or less than noted here. For example, if an individual child weighs 33 lbs rather than the assumed 66 lbs, divide the maximum monthly intake by 2. Standardized lengths in each fish species are rounded to the nearest inch.

See fish tape for specific recommendations for various fish sizes.

Information provided in 2021 in collaboration with Manitoba Government.

To test your mercury levels through a hair sample contact:

STICKER TO BE PLACED HERE

SAFE CATCH

A Mercury-Level Guide to eating fish from Gull Lake

KEEYASK

As a result of Keeyask reservoir impoundment, fish mercury concentrations are expected to rise 3-5x in predatory fish in Gull Lake. Recommendations are based on the estimated maximum (average) concentrations for standardized lengths in each fish species shown below. Fish concentrations will gradually decline after reaching peak conditions (expected to occur between 2023-2027).

Recommendations in effect until approximately 2030.

VERY GOOD CHOICE | OCCASIONAL CONSUMPTION | RESTRICTED CONSUMPTION

Larger fish than shown are expected to be higher in mercury concentrations and not recommended for consumption. Smaller fish than shown are expected to have lower mercury concentrations.

Pickerel greater than 16 inches are not recommended for consumption.

Jackfish greater than 21 inches are not recommended for consumption.

Proposed Draft

Fish are Good for You!

Remember to eat fish that are low in mercury.

Whitefish greater than 14 inches are not recommended for consumption.

ᐅᒃᑲᐤ
okáw
Pickerel

For fish up to 16 inches, eat up to the monthly maximum total below

Children (under 12)	Youth (ages 12-18) Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	132 lbs (or ~60 kg)
Avoid	**Avoid**	**1 lb, 14 oz**

ᐅᓂᐦᑕᐩᐯᐧᐅ
onhcwápéw
Jackfish

For fish up to 21 inches, eat up to the monthly maximum total below

Children (under 12)	Youth (ages 12-18) Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	132 lbs (or ~60 kg)
Avoid	**Avoid**	**1 lb, 14 oz**

ᐊᑎᐦᑲᒉᐠ
atihkamék
Whitefish

For fish up to 14 inches, eat up to the monthly maximum total below

Get your hair tested to **KNOW YOUR NUMBER!** The best indicator of mercury exposure

Children (under 12)	Youth (ages 12-18) Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	132 lbs (or ~60 kg)
1 lbs, 2 oz	**2 lbs, 5 oz**	**5 lbs, 5 oz**

The chart shows maximum monthly fish consumption during peak conditions. Recommendations apply to total fish consumed. For example, if you eat half of the maximum monthly intake of whitefish, you can have half the recommended amount of pickerel or jackfish. Intake should be adjusted if people weigh more or less than noted here. For example, if an individual child weighs 33 lbs rather than the assumed 66 lbs, divide the maximum monthly intake by 2. Standardized lengths in each fish species are rounded to the nearest inch.

See fish tape for specific recommendations for various fish sizes.

Information provided in 2024 in collaboration with Manitoba Government.

To test your mercury levels through a hair sample contact:

STICKER TO BE PLACED HERE

SAFE CATCH

A guide to mercury in fish from **GULL LAKE** under post-impoundment conditions.

Effective until approximately 2030. Fish concentrations will gradually decline after reaching peak conditions (approximately 2023-2027).

Children and Youth
All Others
Women of Childbearing Age

KEEYASK

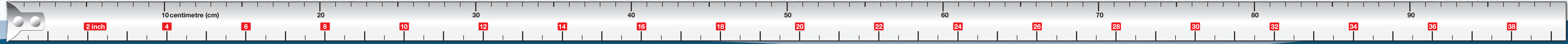
best choice: up to 0.1 ppm
very good choice: up to 0.2 ppm
occasional consumption: up to 0.5 ppm
restricted consumption: over 0.5 ppm

See "Safe Catch" poster for maximum monthly consumption for children, females of childbearing age and other adults.

WHITEFISH ATIHKAMÉK — LOW MERCURY | HIGH MERCURY

JACKFISH (NORTHERN PIKE) ONHCWÁPÉW — HIGH MERCURY

PICKEREL (WALLEYE) OKÁW — HIGH MERCURY



Based on guidelines from Manitoba Government. Contact your local community coordinator for more information.

Option 1: “DRAFT”

SAFE CATCH

A guide to mercury in fish from GULL LAKE under post-impoundment conditions.

Effective until approximately 2030. Fish concentrations will gradually decline after reaching peak conditions (approximately 2023-2027).

Children and Youth

All Others

Women of Childbearing Age

KEEYASK

best choice: up to 0.1 ppm

very good choice: up to 0.2 ppm

occasional consumption: up to 0.5 ppm

restricted consumption: over 0.5 ppm

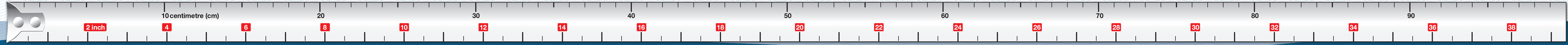
See “Safe Catch” poster for maximum monthly consumption for children, females of childbearing age and other adults.

WHITEFISH ATIHKAMÉK — MODERATE MERCURY

JACKFISH (NORTHERN PIKE) ONHCWÁPÉW — HIGH MERCURY

PICKEREL (WALLEYE) OKÁW

Please note: Mercury concentration estimates and consumption recommendations only provided up to the maximum size of fish that was tested. Higher mercury concentrations likely occur in fish longer than these maximum sizes.



Based on guidelines from Manitoba Government. Contact your local community coordinator for more information. Issued in 2024.

SAFE CATCH

Option 2: “DRAFT”

A guide to mercury in fish from GULL LAKE under post-impoundment conditions.

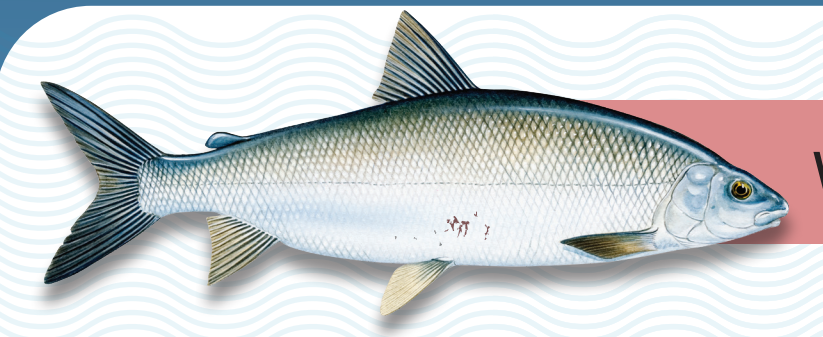
Effective until approximately 2030. Fish concentrations will gradually decline after reaching peak conditions (approximately 2023-2027).

Children and Youth
All Others
Women of Childbearing Age

KEEYASK

best choice: up to 0.1 ppm	very good choice: up to 0.2 ppm	occasional consumption: up to 0.5 ppm	restricted consumption: over 0.5 ppm

See “Safe Catch” poster for maximum monthly consumption for children, females of childbearing age and other adults.



WHITEFISH ATIHKAMÉK

HIGH MERCURY

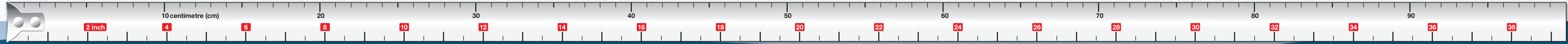
HIGH MERCURY

JACKFISH (NORTHERN PIKE) ONHCWÁPÉW

HIGH MERCURY

PICKEREL (WALLEYE) OKÁW

Please note: Mercury concentration estimates and consumption recommendations only provided up to the maximum size of fish that was tested. Higher mercury concentrations likely occur in fish longer than these maximum sizes.



Based on guidelines from Manitoba Government. Contact your local community coordinator for more information. Issued in 2024.

APPENDIX 2: WSP POST-IMPOUNDMENT BASELINE HAIR SAMPLING AND FOOD SURVEY COMMUNITY REPORT, 2024

REPORT

2023-2024 Hair Sampling and Food Survey Program

Keeyask Generation Project

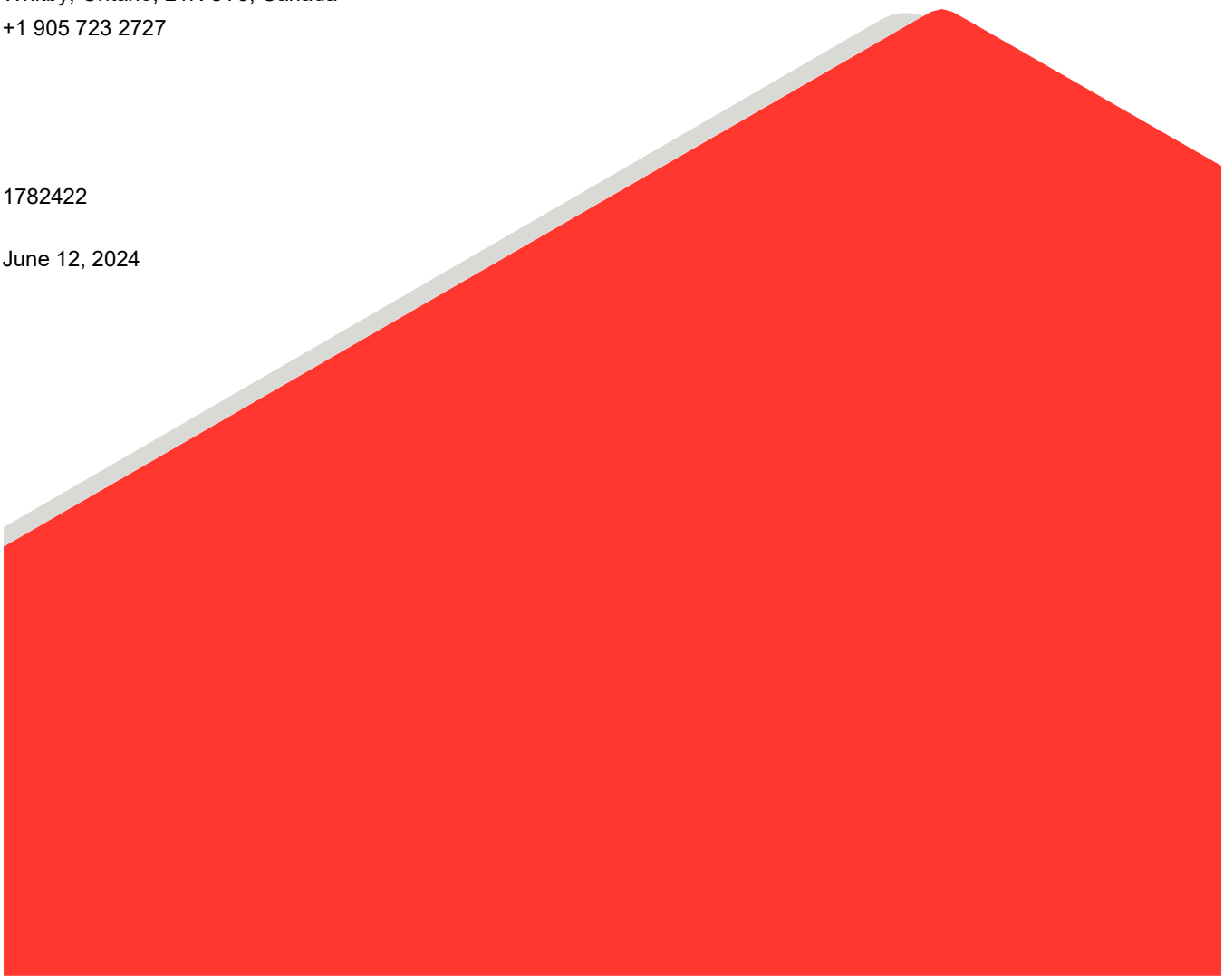
Submitted to:

Manitoba Hydro

14-360 Portage Avenue
Winnipeg, MB R3C 0G8

Submitted by:

WSP Canada Inc.
100 Scotia Court
Whitby, Ontario, L1N 8Y6, Canada
+1 905 723 2727



1782422

June 12, 2024

Distribution List

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1 electronic copy: WSP Canada Inc.

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LIST OF ABBREVIATIONS AND ACRONYMS

cm	centimetre
CVAF	Cold vapour atomic fluorescence
FLCN	Fox Lake Cree Nation
FNFNES	First Nations Food, Nutrition and Environment Study
Hg	Mercury
KHLP	Keeyask Hydropower Limited Partnership
MHHIG	Mercury and Human Health Implementation Group
mm	millimetre
MW	megawatt
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
SEMP	Socio-Economic Monitoring Plan
TCN	Tataskweyak Cree Nation
WHO	World Health Organization
WLFN	War Lake First Nation
WSP	WSP Canada Inc.
YFFN	York Factory First Nation

1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is the development of a 695 megawatt (MW) hydroelectric power generating station and the associated infrastructure on the lower Nelson River. The Project is a collaborative undertaking between Manitoba Hydro and four Manitoba First Nations – Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN) – working together as the Keeyask Hydropower Limited Partnership (KHLP).

As a consequence of impoundment, which began on August 31, 2020 and was completed over the course of 5 days, and the creation of the Keeyask reservoir, flooding of approximately 45 square kilometers is anticipated and will result in an increase in methylmercury levels in the environment. These increased methylmercury levels will primarily affect human health through the consumption of locally caught fish. The Mercury and Human Health Risk Management Plan, developed as part of the Project, includes specific mitigation and monitoring commitments to address the effects of increasing mercury levels in the environment on human health. The Keeyask Mercury and Human Health Implementation Group (MHHIG) is responsible for the implementation of the Risk Management Plan, which includes the development and implementation of a hair sampling and a food survey program, with an emphasis on wild foods. WSP Canada Inc. (WSP, formerly called Golder Associates Ltd.) has been retained by Manitoba Hydro, on behalf of the KHLP, to work with the MHHIG to design and undertake the hair sampling and food survey program.

This report provides a description of the hair sampling and food survey program and key findings for the 2023-2024 reporting period (i.e., post-impoundment, specifically year 2 operation). It is noted that this report has been prepared to maintain the confidentiality of individual-level and community-level results; as such, the results and key findings are provided as pooled data for all participants during the 2023-2024 reporting period.

1.1 Background

In 2018, the MHHIG developed a “Know your Number” campaign to generate interest and awareness of this program in partner communities and undertook sampling in 2019 and 2020. The detailed 2019 Baseline Hair Sampling and Food Survey Community Report (“Baseline Report”; Golder, 2021) was included as part of the 2021 Socio-Economic Monitoring Plan Report (“2021 SEMP Report”; Manitoba Hydro, 2022) and provided pre-impoundment hair sampling and food survey results. Despite multiple attempts, the COVID-19 pandemic situation and associated lockdowns inhibited the ability to offer hair sampling events during the majority of 2020 and 2021. Hair sampling events were undertaken again in March and December 2022, and some individual samples were collected in March 2023. These events represent post-impoundment results and are summarized in the 2022-2023 Hair Sampling and Food Survey Program Report (WSP, 2023) which was included as part of the 2023 SEMP Report (Manitoba Hydro, 2023). Additional hair sampling events were undertaken in October and November 2023 and some individual samples were collected in January 2024.

1.2 Goals and Objectives

The goals and objectives of the voluntary hair sampling and food survey program are generally consistent with those listed in the Baseline Report, but have focussed on the following objectives during post-impoundment:

- For individuals who choose to participate, to characterize, with reasonable certainty, maximum monthly exposures, and in conjunction with education and/or nutritional counselling, to understand mercury levels in their bodies and manage their fish consumption.

- To understand current consumption of wild foods, in conjunction with hair mercury levels, to assess risks to human health from exposure to mercury[1]. Questions are asked about types of foods consumed, frequency of consumption and seasonal variability in diet. The food survey asks about consumption of wild and market foods, but focusses on fish, as the main source of mercury exposure, to understand the primary sources and types of fish harvested from the study area.

The intent of this program is not to sample a representative population for the purpose of conducting a detailed statistical analysis of trends or correlations, or to draw conclusions about specific age groups or sub-populations. The primary goal of the study is to offer hair sampling to community members who wish to take part on a completely voluntary basis in order to help them manage their fish consumption, with the additional goals of fulfilling the commitments made as part of the Mercury Human Health Risk Management Plan for the Project and to help inform future human health risk assessments, which will be completed in approximately 2026 to 2030.

1.3 Project Team

Table 1 details the project team, including what organization they are affiliated with and their role on the Project.

Table 1: Project Team

Name / Organization	Role
Sharon Guin / WSP Canada Inc.	Principal Investigator, Project Manager and Technical Lead
Ruwan Jayasinghe / WSP Canada Inc.	Senior Technical Advisor
Audrey Wagenaar / WSP Canada Inc.	Senior Technical Advisor
Amica Ferras / WSP Canada Inc.	Intermediate Technical Support
Nik Davos / WSP Canada Inc.	Junior Technical Support
Dr. Eric Liberda / Toronto Metropolitan University (formerly Ryerson University)	Academic Subject Matter Expert
Mercury and Human Health Implementation Group (MHHIG) / Mercury Community Coordinators	Local subject matter experts and program implementation support

1.4 Definitions

The definitions of technical terminology used frequently throughout the report are provided below:

Food Survey: A questionnaire-based program to solicit information on community members' demographic information, as well as their food consumption habits and patterns for both locally caught wild and market foods in relation to the types of food items consumed, harvesting locations, the amounts consumed, the consumption frequency, and other aspects of food consumption habits and patterns that can provide useful study area-specific data that leads to developing reasonably accurate and realistic mercury/methylmercury exposure estimates.

Hair Sampling: For individuals who wish to participate, to characterize, with reasonable certainty, maximum monthly or seasonal exposures; and to understand and be able to confidently respond to mercury levels in their

[1] There was an initial goal in the Baseline Report to gain insight into whether wild food consumption patterns change post-impoundment, however this may be difficult to interpret based on limited data provided pre-impoundment.

bodies, before and after impoundment, in conjunction with education and nutritional counselling. In addition to the food surveys, it will be used to supplement inputs in future human health risk assessments completed for the Project.

Participant: An individual who participated in a hair sampling event and provided a hair sample to understand their mercury levels in their body.

Respondent: An individual who responded to a food survey and filled out the questionnaire about their food consumption.

Human Health Risk Assessment: A study that estimates or determines whether or not people working at, living at, or visiting a given location or area are being exposed, or are likely to be exposed, to concentrations of chemicals in environmental media and/or food items that have the potential to result in adverse human health effects (i.e., toxicity).

2.0 STUDY DESIGN AND METHODOLOGY

For the 2023-2024 reporting period, the hair sampling and food survey program followed the general study design outlined in the Baseline Report (Golder, 2021). The full details are provided in the Baseline Report and are briefly summarized below:

- The communities of interest were four partner First Nation communities in northern Manitoba: FLCN, TCN, YFFN and WLFN. Residents living near these communities, such as Gillam and Ilford, or consumers for fish from Project affected lakes were invited to participate in this program. To encourage understanding about mercury hair levels and fish consumption, no individual who expressed interest in the program was turned away.
- There were no restrictions on the number of or types of participants, who may include capable adults, minors, children, pregnant women, ethnic groups, and any other vulnerable populations.
- There was no obligation for any individual to participate in this study; it was and will continue to be completely voluntary and participants may opt out at any time.
- The overall approach to recruiting participants was initiated by the Mercury Community Coordinators through in-community information sessions, posters/pamphlets posted around the community and social media.

During 2023-2024, the hair sampling methods generally followed those outlined in the Hair Sampling Methodology memorandum (Appendix A) and summarized in the Baseline Report, which was developed based on the First Nations Food, Nutrition and Environment Study (FNFNES; UNBC, 2020). A 5 to 10 mm bundle of hair (approximately 100 strands) was cut close to the scalp from the occipital region of the head. The hair sample bag was labelled with the date, community name, and unique participant ID number. A consent form was completed by all participants who provided a hair sample. The consent forms were reviewed for currency and updated in 2023 to reflect changes in the document template for the principal investigator, but the content remained the same (see Appendix B). In addition to submitting a hair sample and completing a consent form, the participants were encouraged to complete a food survey, intended to provide information about their demographics and food consumption patterns, with a focus on locally caught fish. The current food survey is provided in Appendix C.

In conjunction with the food survey information, participants were assigned to one of the three groups outlined in Table 2, which are based upon Health Canada's fish consumption guidelines (Environment Canada, Health

Canada, 2010). The groups are based on the amount of fish that the participants consume per week. It is possible that consumption practices may exist that are not accounted for in the groupings outlined below. Professional judgement was used to assess the appropriate hair sampling methodology (specifically, peak season and 3 cm or 1 cm) for these extenuating circumstances. While the frequency of hair sample collection outlined in Table 2 was used as a guide, during 2023-2024 all participants submitted one hair sample from which multiple segments, if hair length permitted, were analysed to represent monthly or seasonal exposure.

Table 2: Proposed Frequency of Hair Collection for Participant Groupings

Rate of Fish Consumption [(a)]	Length of Hair Analysed	Proposed Frequency of Hair Sample Collection
Low (≤1)	3 cm	Seasonal
Moderate (2-3)	1 cm (up to 3 segments)	Monthly / Seasonal [(b)]
High (>3)	1 cm (3 to 12 segments)	Monthly

Notes: ≤ = less than or equal to; > = greater than; cm = centimetre.

(a) Rate of fish consumption during the peak season in terms of meals per week for the general population, and meals per month for sensitive subpopulations (i.e., toddlers 4 years of age and younger, children 12 years of age and younger, adolescents 18 years of age and younger, and women of child-bearing age (15-49 years).

(b) While seasonal has been proposed at a minimum, if there are no logistical constraints, monthly sampling for the moderate group may be completed if possible.

The hair samples were then analysed for total mercury as follows:

- For participants who indicated they do not generally consume a lot of fish (i.e., consume fish ≤1 time per week), a 3 cm length of hair was sectioned and analysed for mercury.
- For participants who consume a moderate amount of fish (i.e., consume fish 2-3 times a week), one or more 1 cm lengths of hair were submitted corresponding to the month or month(s) when exposure is expected to be the highest.
- For participants who consume a high amount of fish (i.e., ≥4 times a week), multiple 1 cm lengths of hair were submitted for analysis corresponding to the multiple months that they may be exposed and that is expected to represent a peak of exposure. The objective of multiple samples was to minimize the chance of missing the true peak of exposure.

The hair samples were sent to Bureau Veritas Laboratories in Mississauga, Ontario, which were forwarded to its Burnaby, British Columbia location for mercury analysis. The samples were analysed for total mercury using the cold vapour atomic fluorescence (CVAF) method. Once the analytical information was received from the laboratory, WSP provided each participant with a personal letter that includes what sensitivity group they fall into, whether their mercury in hair concentration was below or above the acceptable threshold, and recommendations related to future consumption of fish. Example personal letters are provided in Appendix D.

As the program was implemented during post-impoundment, there were some updates to the methodology and food survey as described below:

- In 2021, the definition of sensitive groups was updated to include male adolescents based on discussions with health regulators and the MHHIG. The MHHIG adopted the approach by World Health Organization (WHO) that considers males up to 18 years as sensitive. As such, the sensitive group is defined as females of

child-bearing age (15 to 49 years), adolescents (males and females 12 to 18 years), children (5 to 11 years), and toddlers (0 to 4 years). Non-sensitive groups were considered to be adult men and adult females that are not of child-bearing age.

- In 2022, the MHHIG reviewed the pre-impoundment experience and outcomes from the hair sampling and food survey program. A reflection of lessons learned resulted in a redesigned food survey workbook incorporating colourful graphics to make it more engaging and user-friendly. The questions were also reorganized to consider food consumption on a seasonal basis in order to help participants more easily recall their yearly food consumption. The redesigned food survey was used during all 2023-2024 hair sampling events and was well-received by participants. The redesigned food survey continued to prompt more robust information compared to that provided in the previous survey format used pre-impoundment. The redesigned food survey is provided in Appendix C.

There was an attempt to schedule events six to eight weeks following peak fish consumption periods (i.e., early summer, fall and to a lesser extent, winter), and this was achieved in 2023-2024 with the sampling events in being held in the fall. As a voluntary program, hair sampling did not specifically target higher risk individuals such as those who are high fish consumers or populations that are more at risk of the health effects of mercury (i.e., sensitive individuals such as toddlers, children and adolescents 18 years and under and females of childbearing age). Efforts were taken to increase overall participation by offering haircuts in conjunction with hair sampling, advertising on social media and hosting events at a community center. This may have resulted in an increased number of higher risk individuals than may have participated otherwise.

3.0 RESULTS FOR 2023-2024 POST-IMPOUNDMENT PERIOD

A summary of the post-impoundment hair sampling and food survey events that have taken place to date (April 2023 to March 2024) are shown in Table 3, below. The results from these sampling events are detailed in Section 3.1 (Hair Sampling) and Section 3.2 (Food Survey).

Table 3: Summary of Completed Sampling Events in Each Community

Community	Dates of Sampling Event(s) or Sample Submission (individuals)	Number of Participants	Number of Participants in Hair Sampling	Number of Respondents to Food Survey
FLCN and Gillam residents[(a)]	October/November 2023 January 2024	34	33	29
TCN	No events were held	0	0	0
YFFN	November 2023	33	33	29
WLFN	No events were held	0	0	0
Non-Local participants [(b)]	Offered during October and November 2023 events	8	8	6
Total	April 2023 – March 2024	75 total (67 from local communities)	74 total (66 from local communities)	67 total (58 from local communities)

(a) Gillam residents were grouped with FLCN because it was assumed that the fishing locations would overlap with those of FLCN community members.

(b) Hair sampling was offered as a courtesy to non-local visitors at the events. Their hair mercury levels or food consumption patterns were not included in the summary of results as they are not related to the Keeyask project.

A total of 75 individuals took part in the hair sampling and food survey program. There were 8 individuals who were not from local communities and were not members of one of the four partner First Nation communities. Hair sampling was offered as a courtesy to these visitors at the events, however their hair mercury levels and food consumption patterns are not related to the Keeyask project and their results are not included in this report.

Of the 67 total participants from local communities, 66 participants provided hair samples; 23 of whom had multiple segments analyzed due to sufficient length, for a total of 122 hair samples. Of the 67 participants, 58 participants filled out the food survey which provided demographic information. Given that nine participants did not fill out a food survey, and another eight respondents who completed a food survey did not indicate their sex, reasonable assumptions were made based on their names. The study participant information is summarized in Table 4 below.

Of the 67 participants, there were more females (39) than males (28). The majority of participants (59) were adults (i.e., ≥19 years old), along with 5 adolescents (i.e., 12 to 18 years old), 3 children (i.e., 5 to 11 years old), and no toddlers (i.e., 0 to 4 years old). Out of the 58 food survey respondents, 51 stated that they live in the community full-time, and/or belong to a First Nation.

Table 4: Study Participant Information

Category	Total Number of Study Participants
Total Number of Participants	67
Total Hair Sample Participants	66
Total Food Survey Respondents	58
Males	28[(a)]
Females	39[(a)]
Toddlers (0-4 years old)	0
Children (5-11 years old)	3
Adolescents (12-18 years old)	5
Adults (≥19 years old)	59
Live in the community full-time and/or belong to a First Nation	51[(b)]

Notes: ≥ = greater or equal to

(a) Seventeen participants did not indicate their sex or did not fill out a food survey, therefore reasonable assumptions were made based on name.

(b) There were seven respondents who did not indicate if they live in the community full-time or belong to a First Nation (i.e., left the response blank).

3.1 Hair Sampling

As described in Section 2.0, each hair sampling participant was assigned to a sensitivity group (i.e., sensitive or non-sensitive). As discussed above, not all participants who provided a hair sample completed a food survey; 58 participants filled out the food survey. Given that the required demographic information, such as age, sex, and pregnancy status, to assign participants to a sensitivity group was gathered from the food survey, assumptions were made for those participants who did not fill out a food survey (i.e., assumptions on age based on minor or

general consent form, and sex based on name). As shown in Table 5, the acceptable threshold of mercury in hair for the sensitive group is 2 parts per million (ppm) and 5 ppm for the non-sensitive group. Table 6 provides a summary of the number of participants in each sensitivity group and age category and the statistics for mercury concentrations measured in hair.

Table 5: Description of Sensitive and Non-Sensitive Characteristics and Resultant Dietary Recommendations

Group	Characteristics	Acceptable Threshold of Hg in Hair (ppm)	Recommendation	
			If < acceptable threshold	If > acceptable threshold
Sensitive	■ Toddler (age 0 to 4) ■ Child (age 5 to 11) ■ Adolescent (age 12 to 18) ■ Female of childbearing age who is pregnant, is breastfeeding, or could become pregnant.	2	Eating low mercury fish up to 2 or 3 times per week is healthy.	Encouraged to eat less fish (or different species or smaller sizes of fish) to help mercury levels come back down into the acceptable threshold.
Non-sensitive	■ Male adult ■ Female over childbearing age (50+)	5		

Notes: Hg = mercury; ppm = parts per million; < = less than; > = greater than.

Table 6: Summary Statistics of Total Mercury Concentrations in Hair for All Study Participants

Parameter	Pooled Group of Participants
Number of Non-Sensitive Adults	35[(a)]
Number of Sensitive Adults	23[(b)]
Number of adolescents (12-18 years old)	5
Number of children (5-11 years old)	3
Number of toddlers (0-4 years old)	0
Total number of Participants providing a Hair Sample	66
Number of Participants that consume locally caught fish	46[(c)]
Number hair samples analyzed	122
Minimum concentration of Hg in hair (ppm)	0.0051
Maximum concentration of Hg in hair (ppm)	5.13
Average concentration of Hg in hair (ppm)	0.39

Notes: Hg = mercury; ppm = parts per million.

(a) Six participants were assumed to be non-sensitive adults based on general consent form and/or commonly male name.

(b) Seven participants were assumed to be sensitive adults based on general consent form and commonly female name.

(c) Numbers are based on information provided in the 58 food surveys and verbal information from the individual sample submitted January 2024.

A combined total of 66 individuals submitted hair samples, voluntarily, either at community-based hair sampling events or through individual submissions to a Mercury Community Coordinator or principal investigator. A total of 122 hair samples were collected. Multiple hair samples were analyzed for 23 individuals with longer hair to measure monthly (vs seasonal) mercury levels or to go back further in time in previous seasons.

The mercury hair results were compared to mercury levels that are considered acceptable by World Health Organization (WHO; 2007) and Health Canada (2007; Environment Canada, Health Canada 2010) in terms of risk to human health ("thresholds"):

- 2 ppm for the sensitive group (i.e., toddlers, children, adolescents, and females of childbearing age) (Environment Canada, Health Canada 2010, Legrand et al. 2010)
- 5 ppm for the non-sensitive group (i.e., male adults and females over childbearing age) (Health Canada 2007, Environment Canada, Health Canada 2010)

Individual results were confidentially communicated to each participant in a sealed personal letter, in which their personal mercury result was compared to the applicable mercury threshold. The confidential letter also included information about how to maintain a healthy fish diet and stay within an acceptable threshold as well as contact information should the participant have questions or wish to receive nutritional counselling (see Appendix D for example personal letters).

Out of the 66 participants who provided a hair sample, one participant had mercury levels that marginally exceeded their acceptable threshold. There were five participants that had moderate mercury levels (i.e., greater than 1 ppm but less than their acceptable threshold), and the remainder (60 participants) had mercury levels that would be considered very low (i.e., less than 1 ppm). For those people with very low mercury levels, they were advised that consuming two to three low mercury fish meals per week is healthy and unlikely to adversely affect their mercury exposure.

One participant had a hair mercury level that was marginally exceeding their threshold during one 3-month period of the year (mid-summer to mid-fall), however it was still within the range of statistical and analytical variability of the threshold (e.g., <5%). The participant reported eating locally caught fish at low frequency (e.g., ≤1 meal per week). This person was encouraged in their personal letter to have their hair resampled to confirm results. No nutritional counselling was requested when offered.

Because of increased risk of mercury exposure from eating fish from Gull and Stephens lakes, the food survey attempted to understand important sources of local fish. At this time, there is no reported fishing in Gull Lake by partner community members, though "Keeyask" was among the responses, which could refer to upstream (Gull Lake) or considering access, more likely downstream (Stephens Lake) of Keeyask. Some individuals reported fishing in Stephens Lake (e.g., <10 participants), with most individuals reporting they harvest the majority of fish from non-Project area lakes or off-system waterbodies.

During 2023-2024, the focus was on capturing the peak mercury level for each participant rather than assessing seasonal variability. As such, no participants were selected to analyse a full year's worth of data. As a future objective to gain insights on seasonal variability and correlations to fish consumption patterns, efforts will be undertaken to analyse a year's worth of data for select participants where the length of hair allows and the accompanying food survey provides robust information. This would allow comparison to observations from previous years where those who at more fish in one season compared to other times of the year had more

variation in their hair mercury levels compared to those who ate a similar number of meals throughout the year (WSP, 2023).

Based on the food surveys, most individuals indicated that they generally do not consume large amounts (i.e., 4 or more meals per month or greater than one pound of fish per meal) of local fish from the area. The participants that reported consuming fish tended to have higher mercury levels than those who did not; however, those mercury levels were all within, or only marginally above acceptable ranges.

There was an attempt to schedule hair sampling events two months following peak fish consumption periods (i.e., early summer, fall and to a lesser extent, winter), and this was achieved in 2023-2024 with the sampling events in being held in the fall. As discussed in Section 3.2.1, the highest number of respondents reported consuming fish during summer, however timing did not align due to various logistical and community constraints. The fall season recorded the second highest number of respondents reporting fish consumption, which aligned with 2023-2024 sampling events. While there is uncertainty whether the peak exposure was captured for the individuals consuming the most fish in summer, due to the length of hair available at the time of sampling, it is expected the peak exposure was captured for individuals consuming the most fish in fall. Timing of future sampling events will continue to be encouraged to take place in summer and fall to align with periods six to eight weeks following peak fish consumption.

Results of the post-impoundment hair sampling offered during 2023-2024 indicate that hair mercury levels of those who participated in the program were within, or only marginally above acceptable ranges, and such, it can be concluded there is low overall risk from exposure to mercury for these individuals. Due to the voluntary nature of the program, there is uncertainty on whether the participants included the highest resource users (attempts to encourage participation, notwithstanding) and it is possible that other individuals may be at higher risk due to higher consumption of local fish in the Project area. The average hair mercury level in 2023-2024 was slightly higher than observed in previous years (2022-2023) (0.39 ppm versus 0.22 ppm), but similarly all participants were below (or only marginally exceeding) their respective acceptable thresholds.

Aggregate hair sampling and food survey results from 2023-2024 have been shared with all four partner First Nation communities through email communications (March 2024) and will be presented at the spring MHHIG meeting (June 2024). In addition, a graphic poster providing the aggregate results has been developed and will be shared with the communities in spring 2024. Community-level results posters will be prepared, upon request.

3.2 Food Survey

Food surveys were completed by 58 out of the 67 participants; herein referred to as respondents. Respondents were encouraged to fill out the local fish (and wild foods) sections to understand the potential of mercury exposure from local fish, in particular. Respondents were encouraged to fill out other sections if interest and time allowed, but incompletion of these sections may suggest lower consumption of other foods than in reality. Not all respondents filled out all portions of the food survey, and so the results presented herein indicate only the results of “eaters” and not of “non-eaters” or “non-respondents”.

The food survey collected information regarding type of food (i.e., species), frequency, portion size and location (wild fish only). Given that the food survey was voluntary, and primarily self-directed, there were some limitations to the data provided. For example, the results provided robust information on frequency of meals but in some cases provided limited information on portion sizes. In addition, some sections were incomplete or incorrectly filled out, therefore these were not included in the dataset. Only the most commonly reported species or foods are

presented herein to protect the confidentiality of individual participants, as there is a risk in inadvertently identifying individuals who report consuming less common foods.

3.2.1 Local Wild Foods

A total of 47 respondents (~81%) indicated that they consume local fish as part of their diet during the previous year. As indicated in Table 7, the most frequently consumed locally caught fish noted by survey respondents are pickerel and jackfish, followed by whitefish, brook trout, and sturgeon, while a few respondents reported that they also eat arctic char, drum (silver bass), lake trout and salmon. A few respondents indicated they occasionally ate wild fish, but did not specify the species. Seasonally, of the respondents who consumed local fish, most ate in the summer (77%) and fall (74%), compared to any other season, spring (57%), and winter (38%). Fish were largely caught from lakes and rivers outside of the Project area (including off-system). There was no reported fishing in Gull Lake, however “Keeyask” was among the responses, which could refer to upstream (Gull Lake) or considering access, more likely downstream (Stephens Lake) of Keeyask. Some respondents (e.g., <10) reported fishing in Stephens Lake.

Table 7: Respondents’ Consumption of Locally Caught Fish

Category	Total Number of Survey Respondents				
	Fall (Sept. - Nov.)	Winter (Dec. - Feb.)	Spring (Mar. - May)	Summer (Jun. - Aug.)	Full Year[a]
Pickerel (Walleye)	34	16	27	35	44[b]
Jackfish (Northern Pike)	13	4	8	11	16
Whitefish	7	1	0	3	7
Brook Trout[c]	2	0	1	4	4
Sturgeon	1	1	0	2	3
Fish organs	3	0	0	3	5
Seasonal Totals[c]	35	18	27	37[d]	

Notes:

(a) Number of respondents for the full year may not equal the sum of seasons as respondents may consume fish in more than one season.

(b) One respondent did not indicate which season the fish was consumed.

(c) Includes brook trout and “trout” responses.

(c) Number of respondents for seasonal totals may not equal the sum of fish categories as respondents may consume more than one type of fish in a season.

(d) One respondent did not indicate the type of fish consumed.

A total of 25 respondents (~43%) indicated that they consume local birds as part of their diet. As indicated in Table 8, the most frequently consumed locally caught wild bird noted by survey respondents was goose (e.g., Canada or snow), followed by grouse (e.g., spruce, sharp-tailed, or partridge ruffed), duck (e.g., black, canvasback, eider, mallard, pintail, greenwing teal or scoter), and willow ptarmigan. Few respondents reported that they eat organs from wild birds. Seasonally, of the respondents who consumed local birds, more ate in the spring (72%), than any other season, fall (56%), summer (40%), and winter (32%).

Table 8: Respondents' Consumption of Wild Birds

Category	Total Number of Survey Respondents				
	Fall (Sept. - Nov.)	Winter (Dec. - Feb.)	Spring (Mar. - May)	Summer (Jun. - Aug.)	Full Year[(a)]
Goose	8	2	16	9	20
Grouse	6	4	2	0	8
Duck	3	0	3	4	5
Willow Ptarmigan	2	2	0	0	4
Seasonal Totals[(b)]	14	8	18	10	

Notes:

Goose = Canada or snow

Duck = black, canvasback, eider, mallard, pintail, greenwing teal or scoter

Grouse = spruce, sharp-tailed, partridge ruffed

(a) Number of respondents for the full year may not equal the sum of seasons as respondents may consume wild birds in more than one season.

(b) Number of respondents for seasonal totals may not equal the sum of wild bird categories as respondents may consume more than one type of wild bird in a season.

A total of 34 respondents (~59%) indicated that they consume local wild land animals as part of their diet. As indicated in Table 9, moose and caribou stand out as the most frequently consumed, followed by snowshoe hare. A few respondents reported eating beaver, polar bear[2], seal or organs from wild land animals. Seasonally, of the respondents who consumed local wild land animals, more ate in the fall (91%), than any other season, winter (62%), spring (38%), and summer (35%).

Table 9: Respondents' Consumption of Wild Land Animals

Category	Total Number of Survey Respondents				
	Fall (Sept. - Nov.)	Winter (Dec. - Feb.)	Spring (Mar. - May)	Summer (Jun. - Aug.)	Full Year[(a)]
Moose	31	17	11	10	33
Caribou	9	11	5	8	15
Snowshoe Hare	2	2	1	1	3
Seasonal Totals[(b)]	31	21	13	12	

Notes:

(a) Number of respondents for the full year may not equal the sum of seasons as respondents may consume wild land animals in more than one season.

(b) Number of respondents for seasonal totals may not equal the sum of wild land animal categories as respondents may consume more than one type of wild land animal in a season.

[2] Polar bear and seal were among the responses for wild land animals and are typically found outside the Keeyask area.

A total of 19 respondents (~33%) indicated that they consume local berries and 2 respondents (~3%) indicated that they consume local terrestrial vegetation as part of their diet. As indicated in Table 10, the most frequently consumed wild berry was blueberry, followed by wild raspberry; wild strawberry and gooseberry were rarely consumed. Few individuals reported consuming wild plants, but those mentioned included Labrador tea, Northern Labrador tea, and wihkes (sweet flag/muskrat root). The survey response rate was low for this section so the results may not accurately reflect consumption patterns. Seasonally, of the respondents who consumed local berries, more ate in the summer (84%), followed by fall (63%), spring (37%), and winter (21%). Of the respondents who consumed local wild plants, they ate equally in all seasons.

Table 10: Respondents' Consumption of Wild Berries

Category	Total Number of Survey Respondents				
	Fall (Sept. - Nov.)	Winter (Dec. - Feb.)	Spring (Mar. - May)	Summer (Jun. - Aug.)	Full Year[a]
Wild Berries					
Blueberry	12	4	7	14	18
Wild Raspberry	5	1	3	8	9
Seasonal Totals[b]	12	4	7	16	

Notes:

(a) Number of respondents for the full year may not equal the sum of seasons as respondents may consume berries in more than one season.

(b) Number of respondents for seasonal totals may not equal the sum of wild berry categories as respondents may consume more than one type of wild berry in a season.

3.2.2 Market Foods

In addition to, or instead of consuming local wild fish, 26 respondents (~45%) indicated they consume market fish (i.e., fish from their local supermarkets). As shown in Table 11, the most commonly consumed market fish are salmon and canned tuna, followed breaded fish, and other unspecified fish. A few respondents occasionally ate cod, catfish, lobster, shrimp and sushi. Seasonally, of the respondents who consumed market fish, more ate in the fall (81%), followed by winter (77%), spring (65%), and summer (69%).

Table 11: Respondents' Consumption of Fish from Local Supermarkets

Category	Total Number of Survey Respondents				
	Fall (Sept. - Nov.)	Winter (Dec. - Feb.)	Spring (Mar. - May)	Summer (Jun. - Aug.)	Full Year[a]
Salmon	11	13	10	9	13
Canned Tuna	10	9	6	6	11
Breaded Fish	3	2	2	2	5
Unspecified	4	5	5	5	7[b]
Seasonal Totals[c]	21	20	17	18	

Notes:

(a) Number of respondents for the full year may not equal the sum of seasons as respondents may consume market fish in more than one season.

(b) One respondent did not indicate which season the market fish was consumed.

(c) Number of respondents for seasonal totals may not equal the sum of market fish as respondents may consume more than one type of market fish in a season.

Separate from market fish consumption, 34 respondents (~59%) indicated that they consume market livestock and poultry. As shown in Table 12, the most commonly consumed market livestock and poultry is chicken, beef (including beef, steak and ground beef), and chicken eggs, followed by pork (including pork, pork chops, roast), and turkey. Livestock/poultry organs were rarely consumed. Seasonally, of the respondents who consumed market livestock and poultry, more ate in the fall (100%), followed by winter (88%), and summer (88%) followed by spring (85%).

Table 12: Respondents' Consumption of Livestock and Poultry from Local Supermarkets

Category	Total Number of Survey Respondents				
	Fall (Sept. - Nov.)	Winter (Dec. - Feb.)	Spring (Mar. - May)	Summer (Jun. - Aug.)	Full Year[(a)]
Chicken	33	29	29	30	33
Beef (beef, steak, ground beef)	33	29	28	29	33
Chicken Eggs	30	26	26	27	31
Pork (pork, pork chops, roast)	28	24	25	26	28
Turkey	24	21	14	14	27
Seasonal Totals[(b)]	**34**	**30**	**29**	**30**	

Notes:

(a) Number of respondents for the full year may not equal the sum of seasons as respondents may consume market livestock and poultry in more than one season.

(b) Number of respondents for seasonal totals may not equal the sum of market livestock and poultry as respondents may consume more than one type of market livestock and poultry in a season.

3.3 Quality Assurance / Quality Control

Quality assurance and quality control (QA/QC) was carried out by the laboratory on each batch of hair samples submitted. The laboratory QA/QC protocol included the analysis of QC standard (i.e., a sample of known concentration), spiked blank (i.e., a blank matrix sample to which a known amount of mercury has been added) and method blank samples (i.e., a blank matrix containing all reagents used in the analytical method). No QA/QC deficiencies were reported. Based on this, it is assumed that all data (i.e., 122 hair samples) met the laboratory quality control and method performance criteria.

4.0 CONCLUSIONS

The primary goal of the hair sampling and food survey program is to offer hair sampling to community members who wish to take part on a completely voluntary basis in order to help them manage their fish consumption, with the additional goals of fulfilling the commitments made as part of the Mercury Human Health Risk Management Plan for the Project and to help inform future human health risk assessments.

Results of the post-impoundment hair sampling offered during 2023-2024 indicate that hair mercury levels of those who participated in the program were within acceptable ranges or only marginally above, and as such, it can be concluded there is low overall risk from exposure to mercury for these individuals. Due to the voluntary nature of the program, there is uncertainty on whether the participants included the highest resource users (attempts to encourage participation, notwithstanding) and it is possible that other individuals may be at higher risk due to higher consumption of local fish in the Project area. The average hair mercury level was slightly higher than observed in previous years (2022-2023), but similarly all participants were below (or only marginally exceeding) their respective acceptable thresholds.

All 2023-2024 sampling events redesigned food survey and continued to prompt more robust information compared to that provided in the previous survey format used pre-impoundment. As the redesigned food survey is used in future hair sampling events, general information regarding wild food consumption patterns (e.g., food consumption rates) at the community or aggregate level will be summarized for internal use by the MHHIG and to support the human health risk assessment. The 2023-2024 reported wild food consumption patterns (e.g., species and season) were consistent with those reported in previous years (2022-2023).

Individuals were provided with their personal letters indicating their personal result and providing general advice on whether continued fish consumption would be encouraged. The hair sampling program is part of the broader Risk Management Plan, which also includes the preparation of consumption recommendations for the Project affected lakes under peak concentrations, and annual monitoring of fish, wildlife and plants. Adjustments to hair sampling materials will be considered in the context of the broader Risk Management Plan activities and outcomes. Hair sampling and food surveys will continue to be offered to all four Partner First Nation communities over the next several years, which will allow individuals to monitor their mercury exposure through repeat hair sampling. There will continue to be a focused effort to encourage more frequent hair testing (e.g., seasonal) for people who consume fish from Keeyask affected lakes (Gull or Stephens lakes) and promote the participation of individuals who are higher consumers of fish in this program. Hair sampling will continue to be available anytime upon request via the participant's local Mercury Community Coordinator, and nutritional counselling offered.

5.0 REFERENCES

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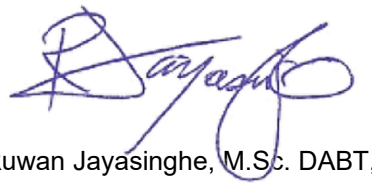
6.0 CLOSURE

We trust that this report meets your current requirements. If you have any questions, please do not hesitate to contact the undersigned.

Yours sincerely,

WSP Canada Inc.

Sharon Guin, M.Sc.
Senior Environmental Risk Assessor



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SG/RJ/lb

https://wsponline.sharepoint.com/sites/gld-15689g/deliverables/03_2023-2024 annual report/technical report/1782422-r-rev0-hair sampling report 2023-2024_12jun2024.docx

APPENDIX A

Hair Sampling Methodology Memo

TECHNICAL MEMORANDUM

DATE January 23, 2020 **Project No.** 1782422-004-L-Rev0

TO Monica Wiest
Manitoba Hydro

CC Ruwan Jayasinghe

FROM Andrea Amendola, Cameron Ollson **EMAIL Andrea_Amendola@golder.com**

KEEYASK GENERATION PROJECT – HAIR SAMPLING METHODOLOGY

Background

The Keeyask Generation Project (the project) is the development of a 695 MW hydroelectric power generating station and the associated infrastructure on the lower Nelson River. The Keeyask Generation Project is a collaborative undertaking between Manitoba Hydro and four Manitoba First Nations – Tataskweyak Cree Nation, War Lake First Nation, York Factory First Nation and Fox Lake Cree Nation – working together as the Keeyask Hydropower Limited Partnership.

As a consequence of impoundment, anticipated to begin in 2020, and the creation of the Keeyask reservoir, flooding of approximately 45 square kilometers is anticipated and will result in an increase in methylmercury levels in the environment. These increased methylmercury levels will primarily affect human health through the consumption of locally caught fish. The Mercury and Human Health Risk Management Plan developed as part of the project includes specific mitigation and monitoring commitments to address the effects of increasing mercury levels in the environment on human health, including the development and implementation of a hair sampling and a food survey study with an emphasis on wild foods.

Golder Associates Ltd. has been retained by Manitoba Hydro to undertake the hair sampling and food survey study. The purpose of this document is to provide the objectives and methodology for the hair sampling program, as well as provide justification for the methodology (via a brief literature review completed to November, 2019).

Objectives

The objectives of the hair sampling program are as follows:

- To offer hair mercury analysis to First Nation communities and Gilliam as part of the Mercury Human Health Risk Management Plan for the project. Three scheduled events (one pre-impoundment, two post-impoundment) are currently being proposed, although hair sampling will be offered in interim years, upon individual request.

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- For individuals who wish to participate, to characterize, with reasonable certainty, maximum monthly exposures; and to understand and be able to confidently respond to mercury levels in their bodies, now and after impoundment, in conjunction with education and nutritional counselling.
- In conjunction with the food surveys, to understand the primary sources and types of fish harvested from the study area and how the hair mercury results may influence the fish consumption guidance and/or advisories.
- To use the hair sampling results and results of the food surveys as supplemental information in future human health risk assessments completed for the area.

As noted, a food survey will be conducted in tandem with the hair sampling program. Briefly the objectives for that program are:

- To understand the current consumption of wild foods (i.e. what types of foods, frequency of consumption and seasonal variability in diet).
- To contribute to the planning of communication that encourages harvesting and use of wild foods, which in turn strengthens health and culture (part of living *mino pimatisiwin* or “the good life”).
- To understand how consumption patterns may change post-impoundment.

It is noted that the intent of this program is not to sample a representative population for the purpose of conducting a detailed statistical analysis of trends or correlations, or to draw conclusions about specific age groups or sub-populations. The primary goal of the study is to offer hair sampling to community members who wish to take part on a completely voluntary basis in order to help them manage their fish consumption, with the additional goals of fulfilling the commitments made as part of the Mercury Human Health Risk Management Plan for the project and to help inform future human health risk assessments.

Literature Review

Hair Sampling as a Biomarker for Mercury Exposure in Fish-Eating Populations

In fish-eating human populations, fish consumption rates are well-correlated to the concentrations of mercury in hair (often measured as total mercury) and blood (as methylmercury) (e.g. Berglund et al. 2005; Björnberg et al. 2005).

Following consumption of fish containing methylmercury, absorption of methylmercury from the gastrointestinal tract is nearly complete (95%, as cited in Berglund et al. 2005; ATSDR 1999). Once in the blood, greater than 90% of methylmercury binds to hemoglobin in red blood cells, while inorganic mercury is equally distributed between red blood cells and plasma (as cited in Berglund et al. 2005). Absorption of inorganic mercury from the gastrointestinal tract is relatively poor (7% for divalent inorganic mercury and less than 1% for metallic mercury; as cited in Berglund et al. 2005).

From the blood, methylmercury is then distributed to the various target organs, particularly the brain (methylmercury has the ability to cross the blood-brain and placental barriers) (as cited in Berglund et al. 2005). It is also distributed and incorporated into the developing hair follicle, resulting in methylmercury accumulation in hair tissue. For people who eat fish, it is estimated that approximately 80% of total mercury in hair is present as methylmercury (Cernichiari et al. 1995). In populations or individuals with no or low fish consumption, mercury in

hair would then be present as inorganic mercury rather than methylmercury (Berglund et al. 2005). As a result, measuring total mercury in hair for fish-eaters will provide a good representation of methylmercury in those individuals. Additionally, total mercury measurement in hair is the typical approach used when assessing methylmercury exposure in fish-eating human populations (e.g. Berglund et al. 2005).

Accumulation of methylmercury in hair tissue is directly proportional to methylmercury content in blood and does not appear to require a threshold blood level for hair accumulation to occur (ATSDR 1999). The World Health Organization (WHO) has cited a concentration ratio of 250 (range of 250 to 300), which translates into a mercury concentration in a segment of hair of 250 times the concentration in blood over the course of that hair segment's growth period (WHO 2008; and as cited in Bartell et al. 2004). Additionally, once mercury has been incorporated into hair, its accumulation is irreversible: no metabolism or reduction in hair mercury content occurs over time (ATSDR 1999; WHO 2008). As a result, mercury exposure can be traced back as far as the length of hair allows. Although a typical hair growth rate is approximately 1 cm/month (WHO 2008), given that hair growth rates may vary somewhat not just between individuals, but within individuals, precision in associating a given hair length to a specific time period of exposure deteriorates when the segment of hair is further from the scalp (Bartell et al. 2004).

It is noted that neither the WHO (2008) nor First Nations Food, Nutrition and Environment Study (FNFNES; UNBC 2020) have indicated that a lag time should be considered when collecting hair samples; that is, these sources indicate that the 1 cm closest to the scalp represents the previous month's exposure. However, literature related to hair sampling indicates that it takes approximately 7-10 days for hair to emerge from the follicle and reach the scalp (Kintz et al. 2015). This lag time was accounted for when interpreting exposure periods corresponding to the volunteers' hair segment(s). The preferred biomarker for chronic mercury exposure is hair sampling, given that other biomarkers such as blood sampling are more appropriately used when assessing acute exposures. For example, a study by Tsuchiya et al. (2012) investigated whether instantaneous blood samples collected 3 times over the course of one year correlated with fish consumption. While the blood concentrations collected over the three events correlated well when averaged over the entire study population, the authors reported that the instantaneous blood samples did not adequately account for individual variability in exposure, given that fish consumption varied for each person over the course of the year of study and the blood mercury levels varied largely over the three sampling events. That is, blood sampling does not accurately represent chronic mercury exposure for individuals that do not have a consistent diet over the long-term.

These conclusions were also reached by Bartell et al. (2004) and Bartell and Johnson (2011) in their investigations into errors associated with steady-state exposure assumptions where consumption rates are variable. The authors found that using instantaneous blood levels to represent a 30-day steady-state blood concentration when examining total exposures of 500 days had relatively wide 95% confidence intervals for error. For example, for a mean daily intake of 2 µg/day, the 95% confidence intervals ranged from -1.06 to 1.08 µg/day, suggesting that using the instantaneous blood levels could result in an estimated daily average ranging from 50% to 200% of the actual daily average. However, for longer-term exposures (e.g. greater than 250 days), error is close to zero when using hair as a biomarker (Bartell et al. 2004).

Recent literature (Bartell et al. 2004; Bartell and Johnson 2011) has also examined the shortcomings in conducting risk assessments when non-steady-state exposure conditions are valid. Risk assessments typically assume a continuous daily consumption rate (e.g., grams per day) when exposure may in fact vary over time, from day-to-day, week-to-week, and over the longer-term. For example, if one fish meal per week is assumed,

this fish meal may occur on a different day each week, and may occur two days in a row on occasion, both of which affect the magnitude of exposure to methylmercury. The use of statistical models to better estimate variable exposure using biomarkers have been developed and this type of analysis can be included in the uncertainty assessment of the HHRA to better understand the uncertainties surrounding the exposure and risk estimates.

Hair Sampling Methodology

The methodology used for collecting hair samples is based on that utilised by the First Nations Food, Nutrition and Environment Study (FNFNES). In brief, a 5 to 10 mm bundle of hair (approximately 100 strands) will be cut close to the scalp from the occipital region of the head. The hair bundle will then be placed into a zip closable bag (e.g. Ziploc ®) and a few staples will be used to fasten the scalp end of the hair to the bag. The hair sample bag will be labelled with the date, community name, and unique participant ID number. The hair samples will then be analysed for total mercury. Any unused sample will be handled as per individual and community preferences.

Whilst the FNFNES serves as the basis for this sampling methodology, modifications have been made in order to tailor the program to be specific to the project. The key differences are as follows:

- Based upon the literature regarding a lag time of 7-10 days between the time a hair begins to grow (i.e., incorporates mercury into the growing hair at its root within the follicle) to the time the hair emerges from the scalp), it has been assumed that the hair at the scalp end represents hair that began to grow approximately 2 weeks prior. Although hair is clipped from the scalp as closely as possible, there is typically a small amount (1 mm or thereabouts) that remains. If hair samples are collected in the first week of December from the 0-1 cm closest to the scalp, this hair is considered to represent exposure that occurred from mid-October to mid-November.
- Following the completion of the food survey, participants will be assigned to one of the three groups outlined in Table 1 which are based upon Health Canada's fish consumption guidelines. The groups are based on the amount of fish that the participants consume per week.

Table 1: Hair Sampling Methodology Participant Groupings

Rate of Fish Consumption*	Length of Hair Analysed	Frequency of Hair Sample Collection
Low (≤1)	3 cm	Seasonal
Moderate (2-3)	1 cm (up to 3 segments)	Monthly / Seasonal**
High (>3)	1 cm	Monthly

* Rate of fish consumption during the peak season in terms of meals per *week* for the general population, and meals per *month* for sensitive subpopulations (i.e., children under 12 years of age and women of child-bearing age (15-49)).

** While seasonal has been proposed at a minimum, if there are no logistical constraints, monthly sampling for the moderate group may be completed if possible.

For participants that generally indicate they do not consume a lot of fish (i.e., consume fish ≤1 time per week), a 3 cm length of hair will be sectioned and analysed for mercury. The sample collection period will correspond with the season when they are most likely to be exposed (e.g. summer). It is considered that a 3 cm length of hair is representative of this groups' exposure to mercury as the variability associated with their consumption is low and their exposure to mercury (via consumption of fish) is anticipated to be negligible.

For participants that consume a moderate amount of fish (i.e., consume fish 2-3 times a week), one or more 1 cm lengths of hair will be submitted corresponding to the month or month(s) when exposure is expected to be the highest. It is noted that the Toxicity Reference Value (TRV) for methylmercury is based on monthly exposure, and therefore submitting a 3 cm length of hair for a moderate consumer could potentially result in a false negative. In this case, the purpose of decreasing the length analyzed from 3 cm to 1 cm is to provide more certainty that maximum monthly levels are captured and to avoid potentially analysing a hair sample that is not representative of a period of moderate consumption..

For participants that consume a high amount of fish (i.e., ≥4 times a week), multiple 1 cm lengths of hair would be submitted for analysis corresponding to the multiple months that they may be exposed and that is expected to represent a peak of exposure. The objective of multiple samples is to minimize the chance of missing the true peak of exposure.

Some individuals may have very long hair where one year or more of consumption can be determined. Although the accuracy of hair segments corresponding to months of exposure deteriorates the further the hair is from the scalp (Bartell et al. 2004), those individuals with long hair and who may also have some variability in fish consumption throughout the year could be candidates for having multiple seasons analyzed to gain an understanding of seasonal variability in hair mercury concentrations. For example, if an individual with long hair tends to eat the most fish during the spring and fall, but less during the winter and summer, 12 1-cm hair lengths corresponding to the previous year's exposure could be collected and analyzed to observe the corresponding changes in mercury levels over the course of that time. Decisions on which individuals may be candidates for this type of analysis will be discussed and determined in consideration of logistical constraints in combination with food survey results.

It is noted that it is possible that consumption practices may exist that are not accounted for in the groupings outlined above. Professional judgement will be used to assess the appropriate hair sampling methodology (specifically, peak season and 3-cm or 1-cm) for these extenuating circumstances. For example, the type of fish consumed may affect when the expected peak season would occur for that individual. It is understood that there are differences in mercury concentration between different fish species (e.g. the concentrations of mercury in pike tend to be approximately 4 times greater than the mercury concentrations in whitefish in some lakes[1]). Therefore, for the same consumption rate, a participant may be exposed to 4 times more mercury if the participant is consuming pickerel or northern pike rather than lake whitefish For example, f a hypothetical individual is consuming approximately 1 fish meal of pike per week during the spring (i.e., 1 meal x 4 units of mercury exposure = 4 units of mercury exposure per week) and 3 fish meals of whitefish during the summer (i.e., 3 meals x 1 unit of mercury exposure = 3 units of mercury exposure per week), the

[1] Fish ratios of mercury levels will be based on fish tissue mercury data from lakes in the Project area. The 4:1 ratio shown for pike and whitefish was assumed for demonstration purposes only.

exposure to mercury via pike would be greater than for whitefish. As a result, the spring season would be considered the peak exposure season even though the strict number of meals per week is lower in the spring than in the summer. Consideration of known variability in mercury concentrations in fish tissue will be taken into account when selecting the hair sample interval for analysis such that it correlates with the expected exposure peak. Additionally, for this same individual, the difference in mercury exposure between the spring and summer may not be very high, since they only differ slightly in terms of the estimated units of mercury exposure (i.e., 3 vs. 4). The number of fish meals per week would fall into the "high" category considering 4 fish meals per week of whitefish during the summer, which would correspond to several 1-cm hair lengths for submissions for the peak exposure season. However, since the peak exposure may occur over the spring and summer, , hair lengths corresponding to both the spring and summer months from individuals with a sufficient length of hair available will be submitted for analysis to ensure that the true peak is not missed.

Consultation with community members indicated that peak fish consumption typically occurs during the late spring, summer and fall months (June – October). For this reason, hair sampling events are scheduled based on the most opportune times to collect data with a bias towards being most representative of peak fish consumption for most community members. It is acknowledged that the length of a participant's hair varies throughout the year and does not always line up with the timing of these collection events. For scenarios where a participant's hair is too short (i.e., < 3 cm) or the length of hair available for sampling does not align with their expected peak exposure, there is opportunity for that participant to provide hair samples during an off-cycle event. The logistics of these opportunities are explained to participants during the sampling events.

- The hair samples will be sent to Maxxam Analytics in Mississauga, ON rather than the FNIHB laboratory.
  - The analysis of hair samples will be carried out by Maxxam Analytics (Maxxam) which has been independently audited by the Standards Council of Canada (SCC) under ISO guide 17025. Details of Maxxam's accreditation can be viewed through the following link: http://maxxam.ca/about-maxxam/quality/accreditation-certification/. Maxxam is accredited for mercury analysis via cold vapour atomic absorption spectroscopy (CVAAS) on a tissue matrix by SCC.
- The hair samples will not be pre-washed with acetone and water to avoid potential removal of endogenous mercury in the sample which has been suspected in some studies as summarized by Esteban et al. (2014).

The selected analytical method for analyzing total mercury in hair is CVAAS. Based upon a review by WHO (2008), CVAAS is one of the more commonly used analytical methods which allows for comparison to other studies. Additionally, it has sufficient sensitivity with Maxxam achieving detection limits on the order of 0.005 ppm (the health effect threshold considered is 2 ppm (Legrand et al. 2010) for sensitive subgroups such as women of childbearing age and children and 5 ppm (Environment Canada, Health Canada 2010) for non-sensitive subgroups such as adult men).

Disclaimer

Due to the pandemic situation, this document could not be reviewed with the MHHIG and involved health agencies prior to submitting to meet the Project's annual reporting requirements. These parties have discussed

the contents within and while no substantive changes are anticipated, the finalization of this document is subject to review and input from MHHIG and health agencies.

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AA/CO/RJ/co/cg

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APPENDIX B

Consent Forms

PARTICIPANT ID

CONSENT TO TAKE PART IN HAIR SAMPLING / FOOD SURVEY (GENERAL – AGE 18 YEARS AND OLDER)

TITLE:	Keeyask Generation Project Hair Sampling and Food Survey
PRINCIPAL RESEARCHER:	Sharon Guin (Phone Number: 905-723-2727; Email: sharon.guin@wsp.com)
SPONSOR:	Keeyask Hydropower Limited Partnership (The Partnership)

You have been invited to participate in mercury hair sampling and a food survey being offered in your community. **Participation in this activity is voluntary. If you choose to participate in this activity you can withdraw from the activity at any time.** Before you decide, you need to understand what this activity is for, what risks you might take and what benefits you might receive. This consent form explains the activity being proposed.

Please read this carefully. Take as much time as you like. If you prefer, you may take this form home to think about for a while. Mark anything you do not understand, or want explained better. After you have read it, please ask questions about anything that is not clear.

The researchers will:

- Discuss the activity with you
- Answer your questions
- Keep confidential any information which could identify you personally
- Be available during the sampling and survey to deal with problems and answer questions

This consent form only applies to the current food survey and hair sampling program. If future sampling is undertaken, you will be asked again to provide your consent at that time.

1. INTRODUCTION / BACKGROUND

Mercury is a metal that is “naturally” present in the environment and in fish. Since industrial times (1800s), mercury levels have risen in the environment due to industries like coal-fired power generation, incinerators, metal refining, and chemical manufacturing. All of these processes release mercury into the atmosphere from where it is deposited, onto land and water. Flooding of soil or wetlands commonly results in a temporary increase in mercury and its organic form, methylmercury. Methylmercury is taken up by the organisms that live in and use those environments. Bacteria living, for example, in soils and water change inorganic mercury to ‘methylmercury’. This type of mercury builds up and becomes more concentrated at higher levels in the food web, such as in predatory fish.

The Keeyask Project will flood some forest and wetland areas through the creation of a reservoir which will increase mercury levels in fish from Gull Lake, and to a lesser extent in Stephens Lake. Mercury concentrations in fish are expected to peak three to seven years after the creation of the Keeyask reservoir, and then slowly decline over time. We want to know whether eating fish from the reservoir will increase people’s exposure to mercury and if people’s health might be affected.

2. PURPOSE OF THIS ACTIVITY

To collect information on baseline and post-flooding mercury levels from people who live or fish in the Keeyask Generation Project area.

PARTICIPANT ID

3. DESCRIPTION OF ACTIVITY PROCEDURES

The food survey will include questions about your gender and age, , the type of work and hobbies you have, and the food you and your family eat, with a focus on wild foods. After the survey, a small section of hair less than the width of a pencil eraser (about 5 mm) will be cut. The hair will be cut from near the base of your scalp. The hair samples will be collected by Mercury Community Coordinators and research assistants selected by your community who have been trained in this procedure. The hair samples will be tested for mercury only, at a certified laboratory, and any leftover hair will be returned to your community at a central location, upon request, in case you would like it back.

4. LENGTH OF TIME

The hair sampling takes about 5 minutes, and the first part of the food survey focusing on fish will take about 10 minutes. There are some portions of the food survey that are not critical to understanding mercury exposure but would be of interest to the research team; if you decide to answer those additional questions the food survey will take between 30 and 40 minutes, depending on how much wild food is eaten.

5. POSSIBLE RISKS AND DISCOMFORTS

There are no risks or discomforts to those individuals who take part in this activity. However, there is the possibility of finding out that your mercury levels are above regulatory guidelines set by health agencies. WSP will directly contact any individual whose levels exceed the regulatory guidelines (note that all participants will receive a letter with their personal results 6-8 weeks after the samples are collected).

6. BENEFITS

Knowing your mercury levels lets you know whether the exposure you have today to mercury is safe, and whether you should continue to eat wild foods (including fish) the same way you are now. It will also let you know whether you should make any changes to the amount of fish or types of fish you are eating for optimal health.

Having data on mercury levels in people before and after reservoir flooding could also be used in future human health risk assessments that the Keeyask Partnership has committed to doing. The food and hair study, along with the future human health risk assessments, will provide valuable information on mercury exposure in the communities near the project, and provide a point of comparison should there be increases in mercury exposure after flooding and after the project has begun operating. All of this information will be essential for deciding, whether changes to fish consumption recommendations are needed to protect people's health in the future.

7. LIABILITY STATEMENT

Signing this form gives us your consent to take part in this activity. It tells us that you understand the information about the activity and how the information will be used. When you sign this form, you do not give up your legal rights. Researchers or agencies involved in this activity still have their legal and professional responsibilities.

8. WHAT ABOUT MY PRIVACY AND CONFIDENTIALITY?

Protecting your privacy is an important part of this activity. Every effort to protect your privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to your records as part of this activity.

When you sign this consent form you give us permission to:

- Collect information from you
- Share information with the people conducting this activity
- Share information with the people responsible for protecting your safety

Access to your records

Some members of the research team will see records that identify you by name. Other people may need to look at the records that identify you by name. This might include the research ethics board. You may ask to see the list of these people. They can look at your records only when supervised by a member of the research team.

You may ask the researcher to see the information that has been collected about you at any time.

Use of your information

The research team will collect and use only the information they need for this activity and to support future human health risk assessments for the Keeyask Generation Project.

- This information will include your:
  - age
  - gender
  - the results of your mercury hair sampling
  - information from dietary survey questionnaires, including some personal information such as body weight
- Your name and contact information will be kept secure by the WSP research team. You will be assigned a unique participant ID number. The participant ID number will be used on the food survey and hair sample results, not your name or contact information. It will not be shared with others without your permission except as indicated above. Your name will not appear in any report or article published as a result of this activity.
- Information collected for this activity will be kept for an undetermined period because baseline and post-flooding data could be used for the future human health risk assessments, as well as in monitoring programs post-flooding and during operations.
- If you decide to withdraw from this activity, the information collected up to that time will continue to be used by the research team. It will not be removed. This information will only be used for the purposes of this activity.
- Information collected and used by the research team will be stored within the WSP team's secure and password-protected database. Sharon Guin (Principal Researcher) is the person responsible for keeping it secure.

9. QUESTIONS OR PROBLEMS

If you have any questions about taking part in this activity, you can speak with the principal researcher who is in charge of this activity. That person is Sharon Guin: 905-723-2727. Collect calls will be accepted.

Or, you can talk to someone who is not involved with this activity at all, but can advise you on your rights as a participant in this activity. You may contact:

Manager, Research Ethics Board Secretariat
70 Colombine Driveway,
9th Floor, Room 941C
Brooke Claxton Building, Postal Locator: 0909C
Tunney's Pasture
Ottawa, Ontario, K1A 0K9
Phone number (613) 941-5199;
Fax (613) 941-9093
Email: REB-CER@hc-sc.gc.ca

PARTICIPANT ID

SIGNATURE PAGE

To be filled out and signed by the participant or an authorized third party:

By signing this form, I agree that:

- The activity has been explained to me. Yes ☐ No ☐
- All my questions were answered. Yes ☐ No ☐
- The possible discomforts and the possible benefits (if any) of this activity have been explained to me. Yes ☐ No ☐
- I understand that I have the right not to participate and the right to stop my participation at any time, for any reason. Yes ☐ No ☐
- I understand that I may refuse to participate without consequence. Yes ☐ No ☐
- I have a choice of not answering any specific questions. Yes ☐ No ☐
- I am free now, and in the future, to ask any questions about this activity. Yes ☐ No ☐
- I have been told that my personal records will be kept confidential. Yes ☐ No ☐
- I understand that should I choose to withdraw from this activity my data will remain part of the data used in this activity. Yes ☐ No ☐
- I understand that no information that would identify me will be released or printed without asking me first. Yes ☐ No ☐
- I understand that I will receive a signed copy of the consent form. Yes ☐ No ☐
- I agree that my doctor/health care provider can receive the results of this activity. Yes ☐ No ☐ N/A ☐

Would you like to be contacted to take part in future food surveys/hair sampling? Yes ☐ No ☐

I hereby consent to participate in this activity:

_____ _____

Signature of Participant or Authorized Third Party | Date

_____

Name of Participant (please print)

_____

Name of Authorized Third Party, if applicable (please print)

To be signed by the researcher or person obtaining consent:

I have explained this activity to the best of my ability. I invited questions and gave answers. I believe that the participant/authorized third party fully understands what is involved in taking part in this activity, any potential risks associated with taking part in this activity and that he or she has freely chosen to take part in this activity.

Name of person who obtained consent: _____

_____ _____

Signature | Date

PARTICIPANT ID

CONSENT TO TAKE PART IN HAIR SAMPLING / FOOD SURVEY (MINOR – UNDER 18 YEARS OF AGE)

TITLE:	Keeyask Generation Project Hair Sampling and Food Survey
PRINCIPAL RESEARCHER:	Sharon Guin (Phone Number: 905-723-2727; Email: sharon.guin@wsp.com)
SPONSOR:	Keeyask Hydropower Limited Partnership

Your child/ward has been invited to participate in mercury hair sampling and a food survey being offered in your community. **Participation in this activity is voluntary. If you choose on behalf of your child/ward to participate you can withdraw your child/ward from the activity at any time.** Before you decide, you need to understand what the activity is for, what risks your child/ward might take and what benefits your child/ward might receive. This consent form explains the activity being proposed.

Please read this carefully. Take as much time as you like. If you prefer, you may take this form home to think about for a while. Mark anything you do not understand, or want explained better. After you have read it, please ask questions about anything that is not clear.

The researchers will:

- Discuss the activity with you and your child/ward
- Answer questions from you and your child/ward
- Keep confidential any information which could identify your child/ward personally
- Be available during the hair sampling and food survey to deal with problems and answer questions

If your child/ward is aged 7 to 13, please let the Mercury Community Coordinator know whether you would like to explain the activity to your child/ward yourself or if you would like the Mercury Community Coordinator to explain instead. Once the activity is explained, please have the child read and sign the attached Assent Form.

1. INTRODUCTION/BACKGROUND

Mercury is a metal that is “naturally” present in the environment and in fish. Since industrial times (1800s), mercury levels have risen in the environment due to industries like coal-fired power generation, incinerators, metal refining, and chemical manufacturing. All of these processes release mercury into the atmosphere from where it is deposited, onto land and water. Flooding of soil or wetlands commonly results in a temporary increase in mercury and its organic form, methylmercury. Methylmercury is taken up by the organisms that live in and use those environments. Bacteria living, for example, in soils and water change inorganic mercury to ‘methylmercury’. This type of mercury builds up and becomes more concentrated at higher levels in the food web, such as in predatory fish.

The Keeyask Project will flood some forest and wetland areas through the creation of a reservoir which will increase mercury levels in fish from Gull Lake, and to a lesser extent in Stephens Lake. Mercury concentrations in fish are expected to peak three to seven years after the creation of the Keeyask reservoir, and then slowly decline over time. We want to know whether eating fish from the reservoir will increase people’s exposure to mercury and if people’s health might be affected.

PARTICIPANT ID

2. PURPOSE OF THIS ACTIVITY

To collect information on baseline and post-flooding mercury levels from people who live or fish in the Keeyask Generation Project area.

3. DESCRIPTION OF ACTIVITY PROCEDURES

The food survey will include questions about your child/ward's gender and age, the type of hobbies your child/ward has, and the food your child/ward and your family eat, with a focus on wild foods. After the survey, a small section of hair less than the width of a pencil eraser (about 5 mm) will be cut. The hair will be cut from near the base of your child/ward's scalp. The hair samples will be collected from Mercury Community Coordinators and research assistants selected by your community who have been trained in this procedure. The hair samples will be tested for mercury only, at a certified laboratory, and any leftover hair will be returned to your community at a central location, upon request, in case your child's/ward would like it back.

4. LENGTH OF TIME

The hair sampling takes about 5 minutes, and the first part of the food survey focusing on fish will take about 10 minutes. There are some portions of the food survey that are not critical to understanding mercury exposure but would be of interest to the research team; if your child/ward decides to answer those additional questions the food survey will take between 30 and 40 minutes, depending on how much wild food is eaten.

5. POSSIBLE RISKS AND DISCOMFORTS

There are no risks or discomforts to those individuals who take part in this activity. However, there is the possibility of finding out that your child's/ward's mercury levels are above regulatory guidelines set by health agencies. WSP will directly contact any individual whose levels exceed the regulatory guidelines (note that all participants will receive a letter will their personal results 6-8 weeks after the samples are collected).

6. BENEFITS

Knowing your mercury levels lets you know whether the exposure your child/ward has today to mercury is safe, and whether your child/ward should continue to eat wild foods (including fish) the same way they are now. It will also let you know whether your child/ward should make any changes to the amount of fish or types of fish they are eating for optimal health.

Having data on mercury levels in people before and after reservoir flooding could also be used in future human health risk assessments that the Keeyask Partnership has committed to doing. The food and hair activity, along with the future human health risk assessments, will provide valuable information on mercury exposure in the communities near the project, and provide a point of comparison should there be increases in mercury exposure after flooding and after the project has begun operating. All of this information will be essential for deciding whether changes to fish consumption guidelines or advisories are needed to protect people's health in the future.

7. LIABILITY STATEMENT

Signing this form gives us your consent for your child/ward to take part in this activity. It tells us that you understand the information about the activity and how the information will be used. A separate assent form is available if your child/ward is able to understand the activity, which gives us their permission to participate in the activity. When you sign this form, you do not give up your legal rights or those of your child/ward. Researchers or agencies involved in this activity still have their legal and professional responsibilities.

PARTICIPANT ID

8. WHAT ABOUT MY PRIVACY AND CONFIDENTIALITY?

Protecting the privacy of your child/ward is an important part of this activity. Every effort to protect your child's/ward's privacy will be made. However, it cannot be guaranteed. For example, we may be required by law to allow access to your records as part of this activity.

When you sign this consent form you give us permission to:

- Collect information from your child/ward
- Share information with the people conducting this activity
- Share information with the people responsible for protecting your safety

Use of your information

The research team will collect and use only the information they need for this activity and to support future human health risk assessments for the Keeyask Generation Project.

- This information will include your child's/ward's:
    - age
    - gender
    - the results of your child's/ward's mercury hair sampling
    - information from dietary survey questionnaires, including some personal information such as body weight
- Your child's/ward's name and contact information will be kept secure by the WSP research team. Your child/ward will be assigned a unique participant ID number. The participant ID number will be used on the food survey and hair sample results, not your child's/ward's name or contact information. It will not be shared with others without your permission except as indicated above. Your child's/ward's name will not appear in any report or article published as a result of this activity.
- Information collected for this activity will be kept for an undetermined period because baseline and post-flooding data will be used for the future human health risk assessments, as well as in monitoring programs post-flooding and during operations.
- If your child/ward decides to withdraw from this activity, the information collected up to that time will continue to be used by the research team. It will not be removed. This information will only be used for the purposes of this activity.
- Information collected and used by the research team will be stored within the WSP team's secure and password-protected database. Sharon Guin (Principal Researcher) is the person responsible for keeping it secure.

Access to your child's/ward's records

Some members of the research team will see records that identify your child/ward by name. Other people may need to look at the records that identify your child/ward by name. This might include the research ethics board. You and your child/ward may ask to see the list of these people. They can look at your child's/ward's records only when supervised by a member of the research team.

You may ask the researcher to see the information that has been collected about your child/ward at any time.

PARTICIPANT ID

9. QUESTIONS OR PROBLEMS

If you have any questions about taking part in this activity, you can speak with the principal researcher who is in charge of the activity. That person is Sharon Guin: 905-723-2727. Collect calls will be accepted.

Or, you can talk to someone who is not involved with this activity at all, but can advise you on your rights and your child's/ward's rights as a participant in this activity. You may contact:

Manager, Research Ethics Board Secretariat
70 Colombine Driveway
9th Floor, Room 941C
Brooke Claxton Building, Postal Locator: 0909C
Tunney's Pasture
Ottawa, Ontario, K1A 0K9
Phone number (613) 941-5199
Fax (613) 941-9093
Email: REB-CER@hc-sc.gc.ca

PARTICIPANT ID

SIGNATURE PAGE

To be filled out and signed by the parent/guardian:

By signing this form, I agree that:

- The activity has been explained to me and my child/ward. Yes ☐ No ☐
- All our questions were answered. Yes ☐ No ☐
- The possible discomforts and the possible benefits (if any) of this activity have been explained to me and my child/ward. Yes ☐ No ☐
- I understand that I have the right not to have my child/ward participate and the right to stop his/her participation at any time, for any reason. Yes ☐ No ☐
- I understand that I may refuse to have my child/ward participate without consequence. Yes ☐ No ☐
- I have a choice of having my child/ward not answer any specific questions. Yes ☐ No ☐
- I and my child/ward are free now, and in the future, to ask any questions about the activity. Yes ☐ No ☐
- I have been told that my child's/ward's personal records will be kept confidential. Yes ☐ No ☐
- I understand that should I choose to withdraw my child/ward from this activity my child's/ward's data will remain part of the data used in this activity. Yes ☐ No ☐
- I understand that no information that would identify my child/ward will be released or printed without asking me first. Yes ☐ No ☐
- I understand that I and my child/ward will receive a signed copy of the consent form. Yes ☐ No ☐
- I agree that my child's/ward's doctor/health care provider can receive the results of this activity. Yes ☐ No ☐ N/A ☐

Would you like to be contacted for my child/ward to take part in future food surveys/hair sampling? Yes ☐ No ☐

I hereby consent to have my child/ward _____ participate in this activity:

_____ _____

Signature of Parent/Guardian Date

_____

Name of Parent/Guardian (please print)

Assent Form is attached: Yes ☐ N/A ☐

To be signed by the researcher or person obtaining consent:

I have explained this activity to the best of my ability. I invited questions and gave answers. I believe that the parent/guardian fully understands what is involved in taking part in this activity, any potential risks associated with taking part in this activity and that he or she has freely chosen for the child/ward to take part in this activity.

Name of person who obtained consent: _____

_____ _____

Signature Date

PARTICIPANT ID

CONSENT TO TAKE PART IN THE HAIR SAMPLING/FOOD SURVEY ACTIVITY (MINOR ASSENT FORM – 7 TO 13 YEARS OF AGE)

TITLE:	Keeyask Generation Project Hair Sampling and Food Survey
PRINCIPAL RESEARCHER:	Sharon Guin (Phone Number: 905-723-2727; Email: sharon.guin@wsp.com)
SPONSOR:	Keeyask Hydropower Limited Partnership

Why are you here?

We want to tell you about some hair sampling that we're doing for children living in this area. We want to see if you would like to participate in this sampling. This form tells you about the sampling. If there is anything you do not understand, please ask your parent, your guardian or the staff.

Why are they doing this sampling?

Eating fish is very healthy, but you can overdo it. A scientist can measure how much mercury is in your hair. We are doing the mercury hair sampling to see how much fish you're eating.

What will happen to you?

If you want to participate in the sampling, these things will happen:

- You will be asked to have a little bit of your hair taken, and you will be asked some questions about the things that you eat.
- The hair sampling will take about 5 to 10 minutes to complete.
- The questions about the foods you eat will take about another 10 to 30 minutes.
- Your parent or guardian will be with you at all times.

Will the sampling hurt?

No, it will not hurt. It is like getting a haircut.

What if you have any questions?

You can ask questions any time, now or later. You can talk to the staff, your family or someone else.

Who will know that I did the sampling?

Anything that you tell or give to the staff will be kept private (or secret). Your name will not be on any reports and no one but the staff and your family doctor will know that it was you who was in the sampling.

PARTICIPANT ID

Do I have to have my hair sampled?

No, you do not have to have your hair sampled if you don't want to.

If you don't want to have your hair sampled, just say so. We will also ask your parents if they would like you to have your hair sampled.

Even if you say yes now you can change your mind later. It's up to you.

Do you have any questions? What questions do you have?

You can also ask your questions to the sampling leader (Sharon Guin) or to someone not involved with the sampling (Research Ethics Board). Their telephone numbers are shown on the main consent form.

When you have no more questions, please print your name and sign below.

ASSENT

I want to take part in the mercury hair sampling. I know I can change my mind at any time.

_____ Verbal assent given Yes ☐

Print name of child

OR

Written assent if the child chooses to sign the assent.

_____	_____	_____
Signature of Child	Age	Date

This section must be completed:
I confirm that I have explained the mercury hair sampling to the participant to the extent compatible with the participants understanding, and that the participant has agreed to be in the mercury hair sampling.

_____	_____	_____
Printed name of Person obtaining assent	Signature of Person obtaining assent	Date

APPENDIX C

Food Survey

FOOD SURVEY

KEEYASK

AND MERCURY EXPOSURE WORKBOOK

PARTICIPANT ID

INTERVIEW DATE

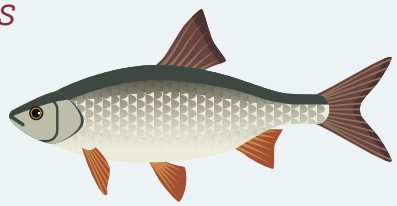
Get your hair tested to **KNOW YOUR NUMBER!** The best indicator of mercury exposure

wsp

Tansi – Hello!

Thank you for participating in the Keeyask Food Survey. This survey will ask you about your food intake and other ways you may be exposed to mercury. All your answers from this survey are confidential.

Thank you – Ekosi



Participant Information

COMMUNITY/FIRST NATION

GENDER

Do you live in the community full-time? ☐ YES ☐ NO

If no, how many months per year do you live in the community?

How long have you lived in this community?

YOUR AGE CATEGORY

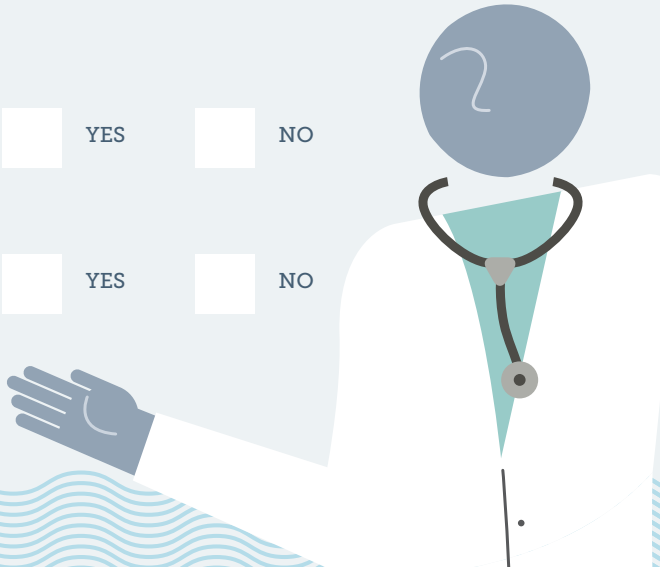
☐ 0-4 YEARS ☐ 5-11 YEARS ☐ 12-18 YEARS ☐ 19-49 YEARS ☐ 50 YEARS +

MEDICAL RECORDS

Do you want a second copy of your personal results that you can provide to your health care practitioner? ☐ YES ☐ NO

Do you want your hair sample returned to you? ☐ YES ☐ NO

Note: It may not be possible to return the hair sample if the full length was required for analysis.



Additional Information

The questions in this section are optional, but the information will help in the interpretation of your mercury hair results, especially if you are a moderate or high consumer of fish (e.g., more than 2 meals of fish per week).

BODY WEIGHT?

Body weight can affect how much mercury is stored in your body.

WHAT IS YOUR CURRENT WEIGHT? OR ENTER A WEIGHT RANGE BELOW:

- ☐ 60 LBS OR LESS
- ☐ 61-90 LBS
- ☐ 91-130 LBS
- ☐ 131-160 LBS
- ☐ 161-200 LBS
- ☐ 200 LBS OR MORE

POTENTIAL MERCURY EXPOSURE

Some jobs and hobbies have a higher exposure to mercury than others. In the past year what type of work have you done? (for example, commercial fishing, forestry, building construction, water treatment)

In your current job(s) or hobby(ies) are you exposed to any chemicals?

☐ YES ☐ NO ☐ NOT SURE

If yes, which ones? (check all that apply)

- ☐ METALS (e.g., solders, welding, wires, greases, sheet metal, arts/crafts involving carving/grinding/etching of rocks)
- ☐ PESTICIDES, INSECTICIDES, HERBICIDES, FUNGICIDES
- ☐ DYES
- ☐ PAINTS, STAINS, CAULKS, SEALANTS
- ☐ GLUES OR OTHER ADHESIVES
- ☐ FUELS, OILS, GREASES
- ☐ OFFICE PRODUCTS (E.G., INKS, TONERS, ETC.)
- ☐ CLEANING PRODUCTS
- ☐ CEMENTS, LANDSCAPING MATERIALS
- ☐ OTHER _____

Do you have any silver dental fillings?

☐ YES ☐ NO ☐ NOT SURE

Do you colour your hair?

☐ YES ☐ NO

If yes, how many times per year?

Core Questions: Wild Foods Survey

The core questions section will ask you about how often and how much you consumed of the following food in each season of the past year:

- Locally caught fish and seafood
- Market fish, seafood and other

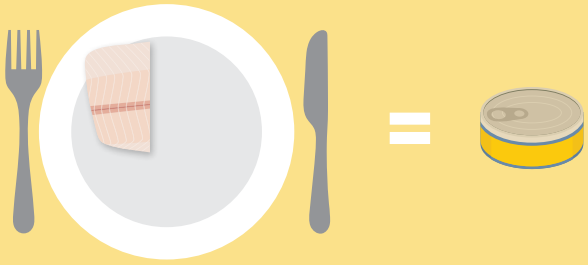
This questionnaire covers wild (or harvested/traditional) food and also market food. Wild food comes from the local land and environment (fish, birds, other animals and plants/berries). Market food comes from the supermarket or grocery store.

SERVING SIZES:

Please use the examples below to estimate the typical serving size of fish you ate at each meal.

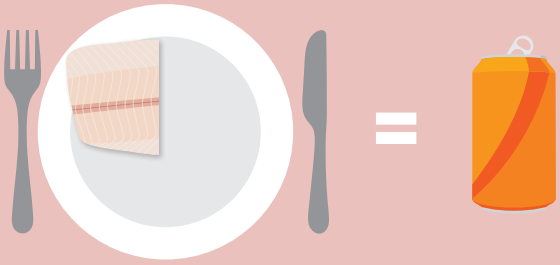
A

up to ¼ lb (3.5 oz)



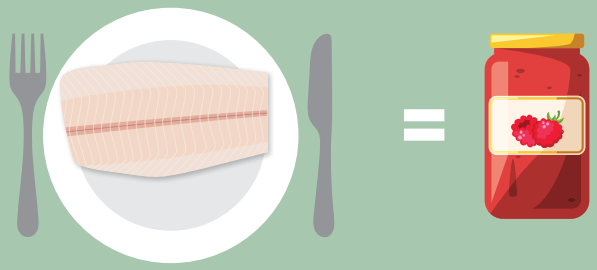
B

¼ lb to ½ lb (3.5-8 oz)



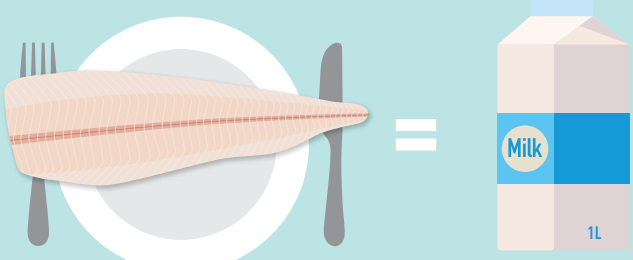
C

½ lb to 1 lb (8-16 oz)



D

more than 1 lb (16 oz)



Section 1: Fish

Have you eaten locally caught fish in the last year? ☐ YES ☐ NO

If yes, please complete pages 6-9, if no proceed to page 10.

Have you eaten market fish or seafood in the last year? ☐ YES ☐ NO

If yes, please complete pages 10-11, if no proceed to page 12.

In the last year, what month did you eat the most fish? _____

Seasonal Consumption: Wild Fish

Using the tables below, please recall how often you ate the following locally-caught fish in each season during the past year.

Fall (September-November)

	Pickerel (okáw)	Jackfish (onhcwápéw)	Whitefish (atihkamék)	Sturgeon (namao)	Other	Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
Where were the fish you ate caught? Write here, or circle on the map on page 8.						
How many times per month do you eat this fish's organs?						

Winter (December-February)

	Pickerel (okáw)	Jackfish (onhcwápéw)	Whitefish (atihkamék)	Sturgeon (namao)	Other	Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
Where were the fish you ate caught? Write here, or circle on the map on page 8.						
How many times per month do you eat this fish's organs?						

OTHER LOCALLY CAUGHT FISH AND SEAFOOD

Other common locally caught fish and seafood:

BROOK TROUT

BROWN TROUT

BURBOT (MARIAH)

TULLIBEE

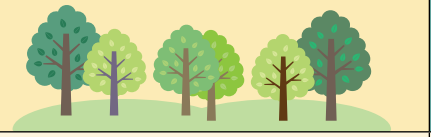
FAST FACT

Fish are healthy traditional food filled with lots of nutrients.

Spring (March-May)

	 Pickerel (okáw)	 Jackfish (onhcwápéw)	 Whitefish (atihkamék)	 Sturgeon (namao)	 Other	 Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
Where were the fish you ate caught? Write here, or circle on the map on page 8.						
How many times per month do you eat this fish's organs?						

Summer (June-August)

	 Pickerel (okáw)	 Jackfish (onhcwápéw)	 Whitefish (atihkamék)	 Sturgeon (namao)	 Other	 Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
Where were the fish you ate caught? Write here, or circle on the map on page 8.						
How many times per month do you eat this fish's organs?						


LAKE TROUT


LONGNOSE SUCKER

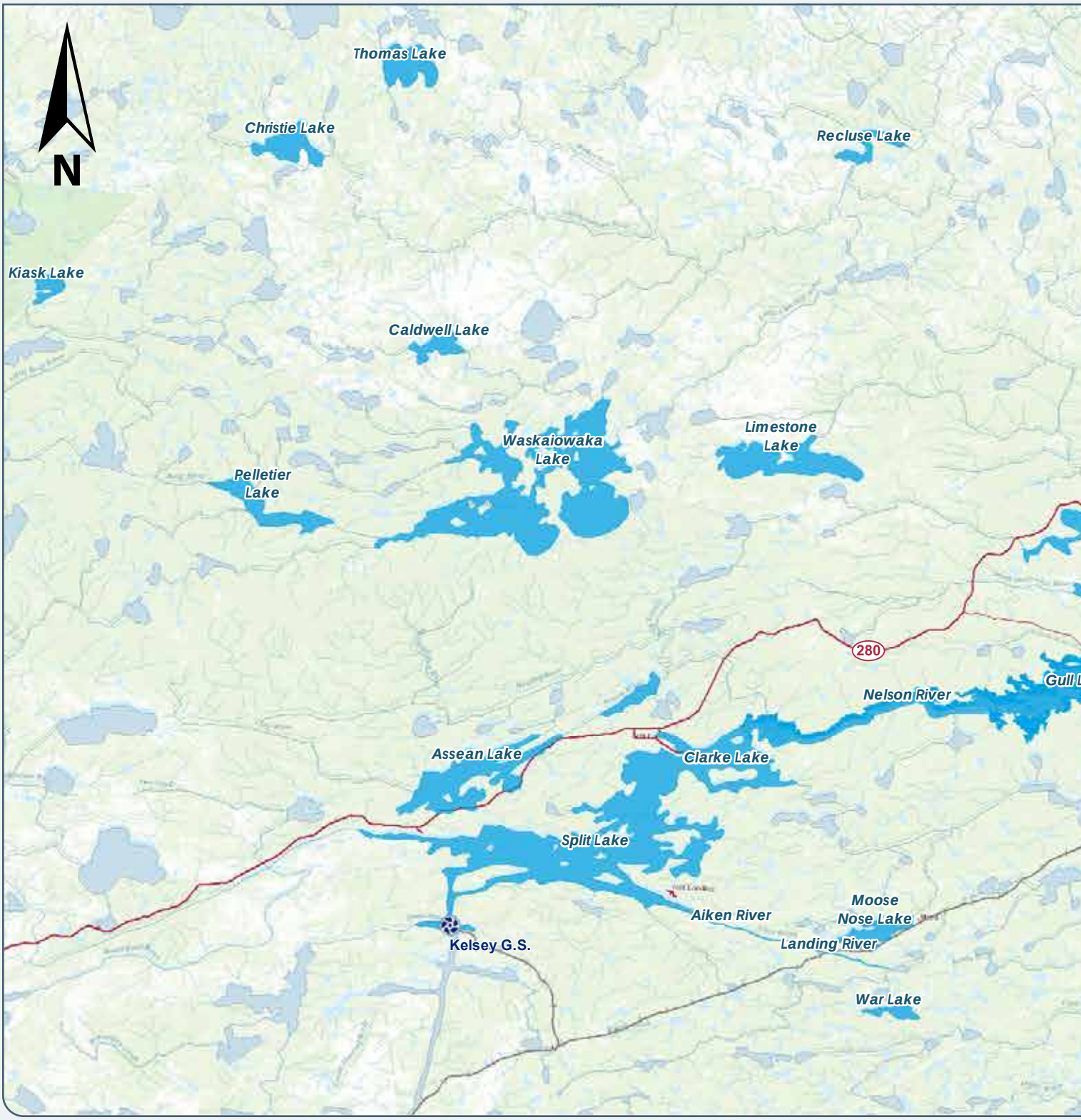

WHITE SUCKER

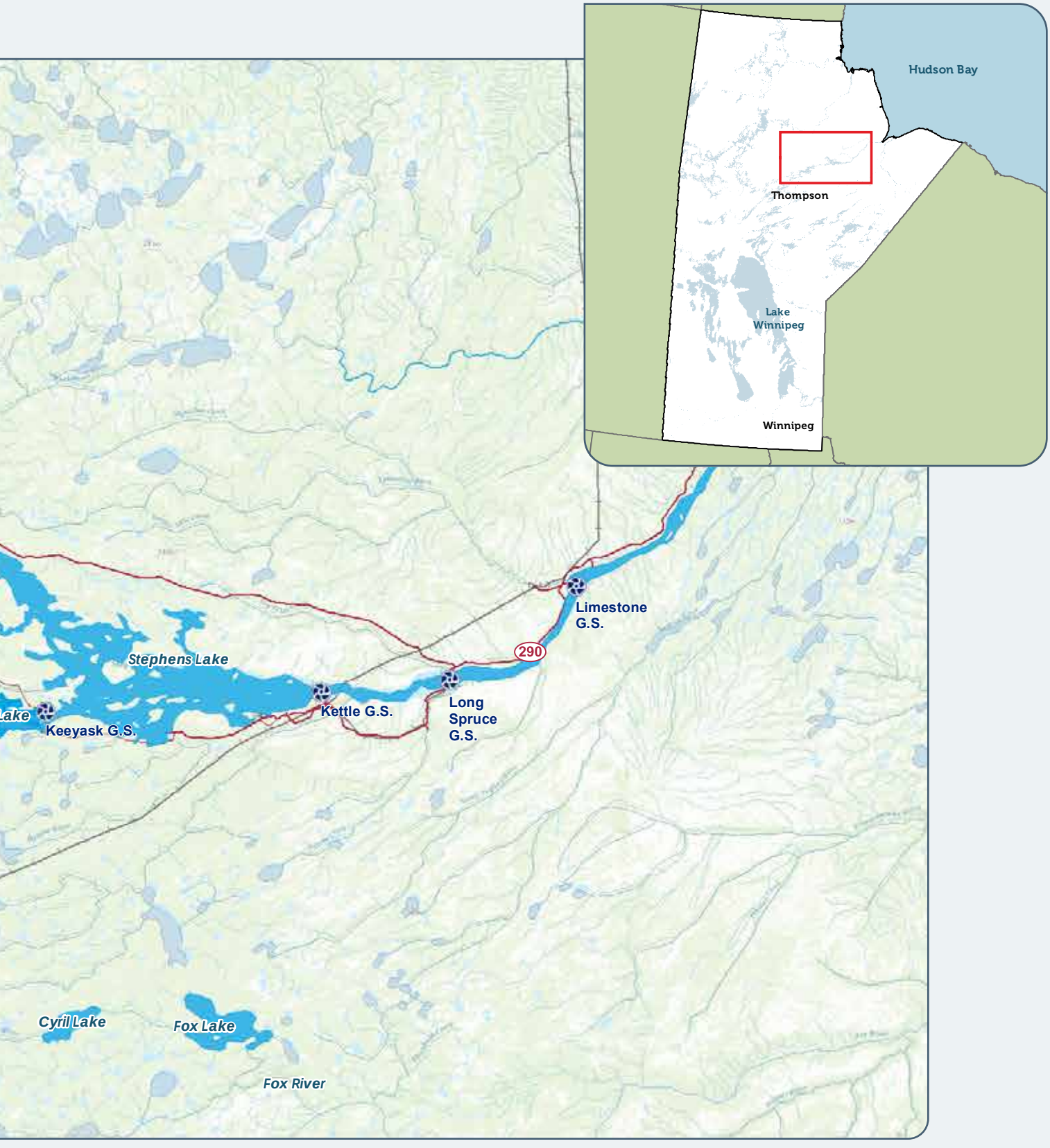

CLAMS


CRAYFISH

LOCATION MAP OF FISH CAUGHT AND CONSUMED

Circle on the map near the lake where you caught fish to eat and indicate the type of fish and the season it was caught.

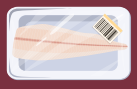
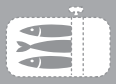



Hudson Bay
Thompson
Lake
Winnipeg
Winnipeg
Limestone
G.S.
290
Stephens Lake
Kettle G.S.
Long
Spruce
G.S.
Keeyask G.S.
Cyril Lake
Fox Lake
Fox River

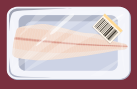
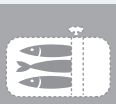
Seasonal Consumption: Market Fish and Seafood (fresh and frozen)

Using the tables below, please recall how often you ate the following market/store bought fish and seafood in each season during the past year.

Fall (September-November)

	 Arctic Char	 Cod	 Canned Tuna	 Salmon	 Breaded Fish	 Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
How many times per month do you eat this fish's organs?						

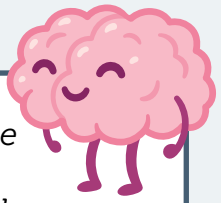
Winter (December-February)

	 Arctic Char	 Cod	 Canned Tuna	 Salmon	 Breaded Fish	 Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
How many times per month do you eat this fish's organs?						

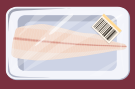
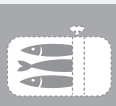
OTHER COMMON MARKET FISH AND SEAFOOD: Flounder/Turbot, Halibut, Rainbow Trout, Canned Salmon, Canned Sardines, Crab, Shrimp, Lobster, Swordfish, Tilapia, other.

FAST FACT

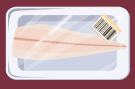
Fish is good for the brain in both the young and the old.



Spring (March-May)

	 Arctic Char	 Cod	 Canned Tuna	 Salmon	 Breaded Fish	 Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
How many times per month do you eat this fish's organs?						

Summer (June-August)

	 Arctic Char	 Cod	 Canned Tuna	 Salmon	 Breaded Fish	 Other
How many **meals per month** have you eaten this fish this season?						
What is the average serving size you ate? Use serving size examples on page 4.						
How many times per month do you eat this fish's organs?						

Optional Questions: Wild Foods Survey

The optional questions section will ask you about how often and how much you consumed of the following food in each season of the past year:

- Wild Foods – Birds
- Wild Foods – Mammals
- Market Foods – Livestock/Poultry
- Wild Foods – Wild Berries
- Wild Foods – Wild Plants

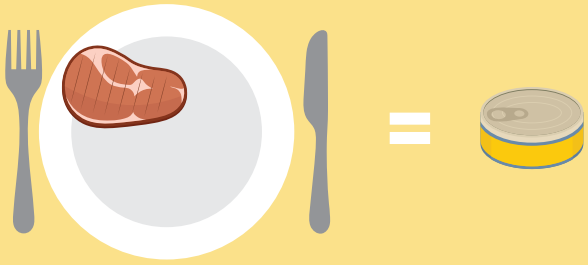
This questionnaire covers wild (or harvested/traditional) food and also market food. Wild food comes from the local land and environment (fish, birds, other animals and plants/berries). Market food comes from the supermarket or grocery store.

SERVING SIZES:

Please use the examples below to estimate the typical serving size of fish you ate at each meal.

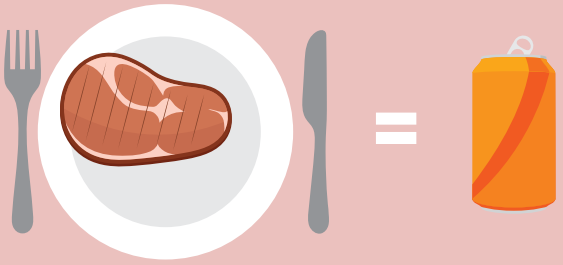
A

up to ¼ lb (3.5 oz)



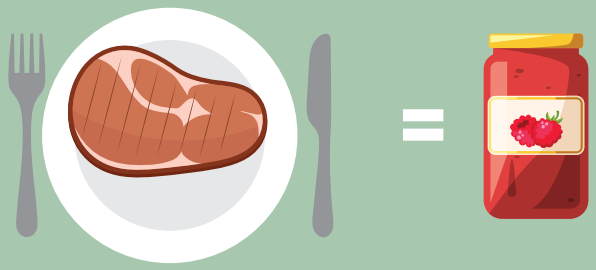
B

¼ lb to ½ lb (3.5-8 oz)



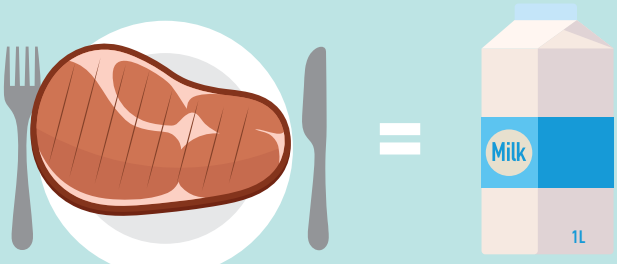
C

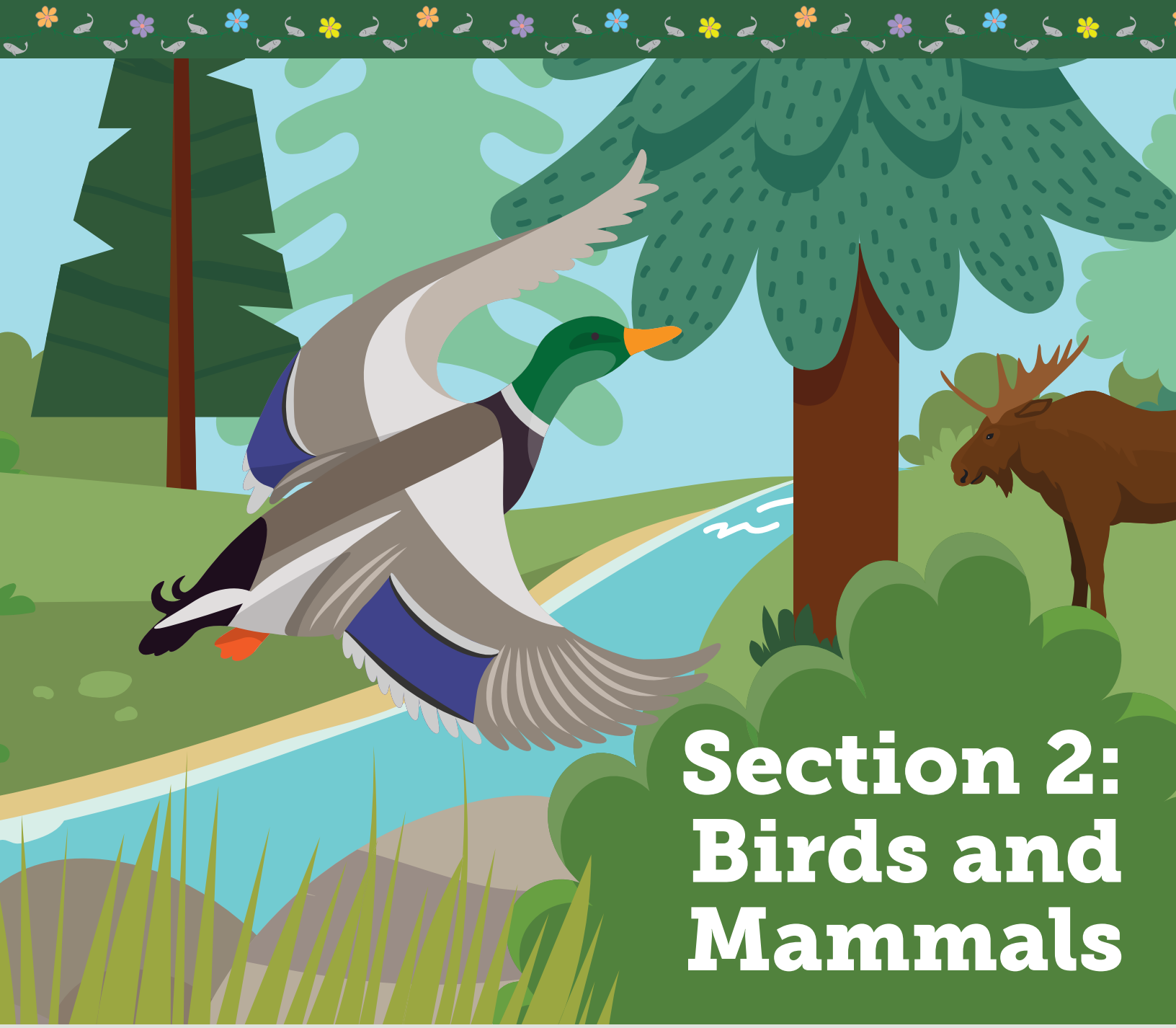
½ lb to 1 lb (8-16 oz)



D

more than 1 lb (16 oz)





Section 2: Birds and Mammals

Have you eaten locally hunted birds or mammals in the last year? ☐ YES ☐ NO

If yes, please complete pages 14-17, if no proceed to page 18.

Have you eaten market livestock and poultry in the last year? ☐ YES ☐ NO

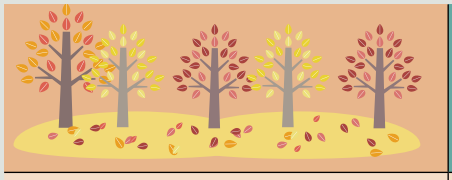
If yes, please complete pages 18-19, if no proceed to page 21.

In the last year, what month did you eat the most birds and mammals? _____

Seasonal Consumption: Wild Foods – Birds

Using the tables below, please recall how often you ate the following food in each season during the last year.

Fall (September-November)

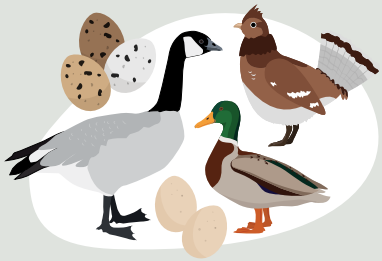
	 Duck	 Goose	 Grouse	 Willow Ptarmigan	 Other	 Other
How many **meals per month** have you eaten this bird this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this bird's organs						

Winter (December-February)

	 Duck	 Goose	 Grouse	 Willow Ptarmigan	 Other	 Other
How many **meals per month** have you eaten this bird this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this bird's organs?						

OTHER COMMON WILD BIRDS: Goose (Snow, Canada), Duck (Black, Canvasback, Eider, Mallard, Pintail, Greenwing Teal, Scoter), Grouse (Spruce, Sharp-Tailed, Partridge Ruffed), Duck Eggs*, Gull Eggs*, Tern Eggs*

** If bird eggs are consumed, indicate the number of eggs per serving*



FAST FACT

Fish that eat other fish (pickerel, jackfish) tend to be higher in mercury than fish that mainly feed on bugs.

Spring (March-May)

	 Duck	 Goose	 Grouse	 Willow Ptarmigan	 Other	 Other
How many **meals per month** have you eaten this bird this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this bird's organs?						

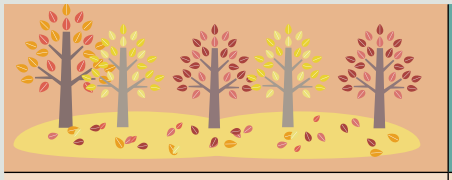
Summer (June-August)

	 Duck	 Goose	 Grouse	 Willow Ptarmigan	 Other	 Other
How many **meals per month** have you eaten this bird this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this bird's organs?						

Seasonal Consumption: Wild Foods – Mammals

Using the tables below, please recall how often you ate the following food in each season during the last year.

Fall (September-November)

	 Moose	 Caribou	 Snowshoe Hare	 Beaver	 Other	 Other
How many **meals per month** have you eaten this meat this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this mammal's organs						

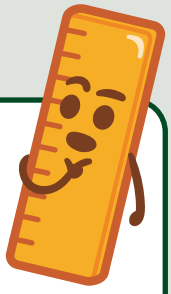
Winter (December-February)

	 Moose	 Caribou	 Snowshoe Hare	 Beaver	 Other	 Other
How many **meals per month** have you eaten this meat this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this mammal's organs?						

OTHER COMMON WILD MAMMALS: Black Bear, Muskrat, other

FAST FACT

Did you know that the hair on your head grows about 1 cm per month?



Spring (March-May)

	 Moose	 Caribou	 Snowshoe Hare	 Beaver	 Other	 Other
How many **meals per month** have you eaten this meat this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this mammal's organs?						

Summer (June-August)

	 Moose	 Caribou	 Snowshoe Hare	 Beaver	 Other	 Other
How many **meals per month** have you eaten this meat this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this mammal's organs?						

Seasonal Consumption: Market Foods – Livestock, Poultry and Other

Using the tables below, please recall how often you ate the following food in each season during the last year.

Fall (September-November)

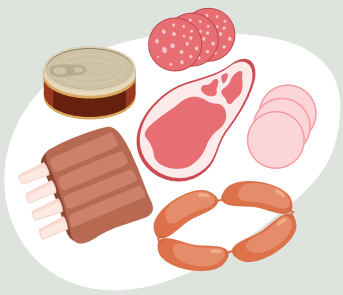
	Beef	Chicken	Pork	Turkey	Chicken Eggs*	Other
How many **meals per month** have you eaten this food this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this animal's organs						

Winter (December-February)

	Beef	Chicken	Pork	Turkey	Chicken Eggs*	Other
How many **meals per month** have you eaten this food this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this animal's organs?						

OTHER COMMON MARKET FOODS: Lamb, Veal, Processed Meat (e.g., Sandwich Meat, Canned Meat), Market Rice**, other.

** If bird eggs are consumed, indicate the number of eggs per serving*



FAST FACT

The mercury level in your hair is a good estimate of the mercury level in your body.

Spring (March-May)

	 Beef	 Chicken	 Pork	 Turkey	 Chicken Eggs*	 Other
How many **meals per month** have you eaten this food this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this animal's organs?						

Summer (June-August)

	 Beef	 Chicken	 Pork	 Turkey	 Chicken Eggs*	 Other
How many **meals per month** have you eaten this food this season?						
What is the average serving size you ate? Use serving size examples on page 12.						
How many times per month do you eat this animal's organs?						

**The proper portion size for one serving of rice is 1/2-cup cooked, which is about the size of a cupcake wrapper.

Optional Questions: Wild Foods Survey

The optional questions section will ask you about how often and how much wild berries and plants you consumed in each season of the past year.

SERVING SIZES:
Please use the examples below to estimate the typical serving size of berries/plants you ate at each meal.

A

½ cup (75 grams)

B

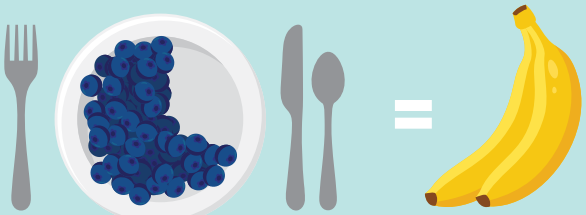
¾ cup (110 grams)

C

1 cup (150 grams)

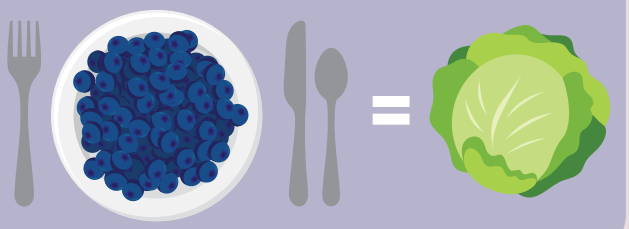
D

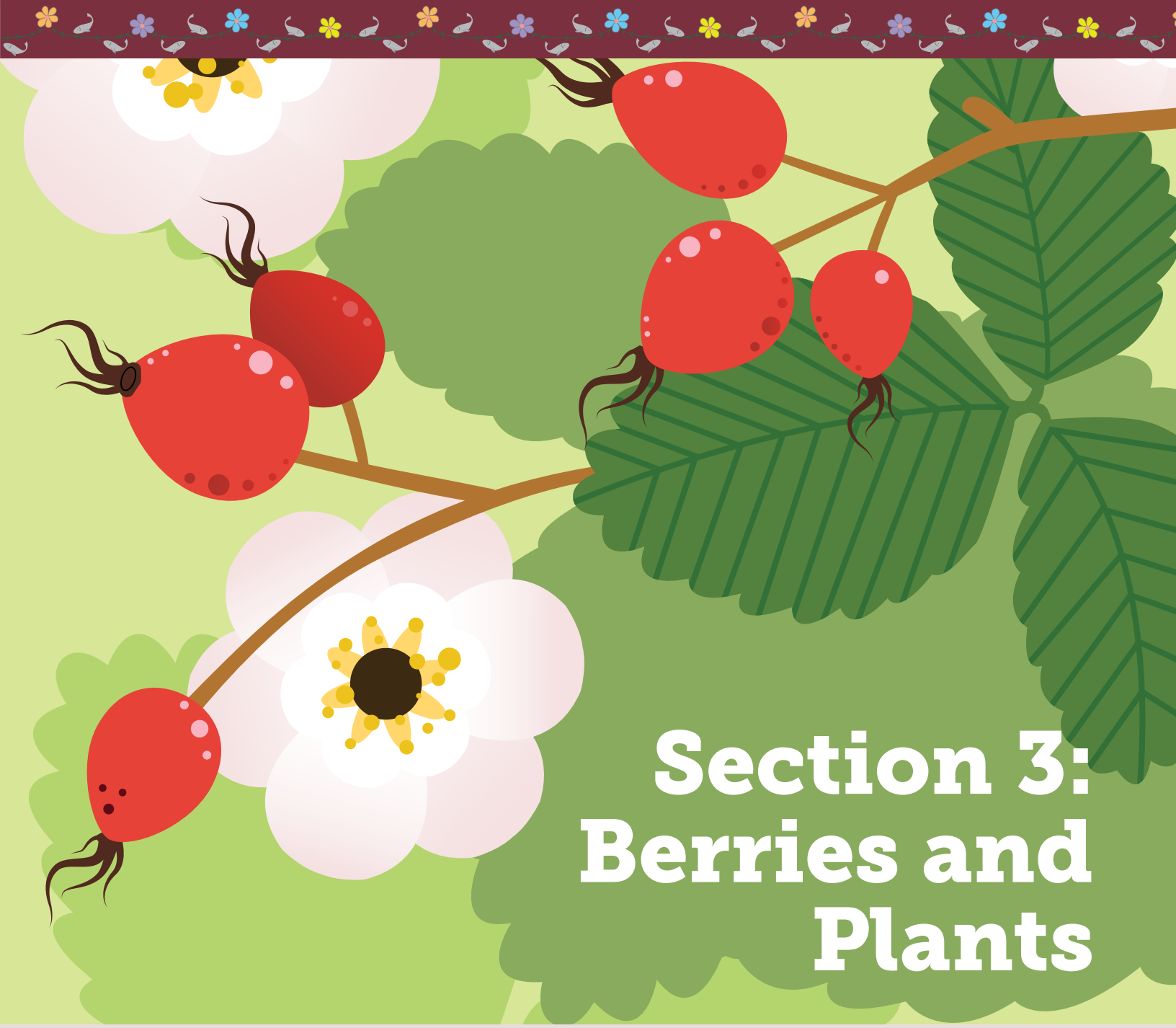
1-1/2 cup (225 grams)



E

2 cups (300 grams)





Section 3: Berries and Plants

Have you eaten locally picked berries or plants in the last year? ☐ YES ☐ NO

If yes, please complete pages 22-25.

In the last year, what month did you eat the most locally picked berries or plants?

Seasonal Consumption: Wild Foods – Wild Berries

Using the tables below, please recall how often you ate the following food in each season during the last year.

Fall (September-November)

	 Blueberry	 Cranberry	 Raspberry	 Rosehip Berry	 Juniper Berry	 Other
How many **meals per month** have you eaten this berry this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

Winter (December-February)

	 Blueberry	 Cranberry	 Raspberry	 Rosehip Berry	 Juniper Berry	 Other
How many **meals per month** have you eaten this berry this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

OTHER COMMON WILD BERRIES: Bunchberry, Crowberry, Teaberry (wintergreen), Bearberry, Wild Strawberry, Cloudberry, Gooseberry, Hawthorn Berry, other.

FAST FACT

The section of hair closest to your scalp is the newest hair growth and represents your most recent mercury exposure.

Spring (March-May)

	 Blueberry	 Cranberry	 Raspberry	 Rosehip Berry	 Juniper Berry	 Other
How many **meals per month** have you eaten this berry this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

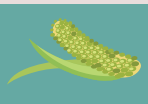
Summer (June-August)

	 Blueberry	 Cranberry	 Raspberry	 Rosehip Berry	 Juniper Berry	 Other
How many **meals per month** have you eaten this berry this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

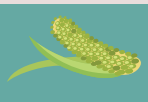
Seasonal Consumption: Wild Foods – Wild Plants

Using the tables below, please recall how often you ate the following food in each season during the last year.

Fall (September-November)

	 Wihkes (Sweetflag)	 Labrador Tea	 Northern Labrador Tea	 Jack Pine Needle	 Other	 Other
How many **meals per month** have you eaten this plant this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

Winter (December-February)

	 Wihkes (Sweetflag)	 Labrador Tea	 Northern Labrador Tea	 Jack Pine Needle	 Other	 Other
How many **meals per month** have you eaten this plant this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

OTHER COMMON WILD PLANTS wild plants: Arrowhead, Fiddleheads, Cattail, Bulrush, Fireweed, Dandelions, Dock, Raspberry Leaves, Nettle Leaves, Pine Pitch, Balsam poplar (bark, buds), Spruce (pitch, inner bark), Aspen (bark, twigs), Chanterelle, wild rice*

* Indicate serving Size of Cooked Rice

FAST FACT

Mercury binds with protein, so plants like blueberries and Labrador Tea are low mercury.

Spring (March-May)

	 Wihkes (Sweetflag)	 Labrador Tea	 Northern Labrador Tea	 Jack Pine Needle	 Other	 Other
How many **meals per month** have you eaten this plant this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

Summer (June-August)

	 Wihkes (Sweetflag)	 Labrador Tea	 Northern Labrador Tea	 Jack Pine Needle	 Other	 Other
How many **meals per month** have you eaten this plant this season?						
What is the average serving size you ate? Use serving size examples on page 20.						

Notes:

FAST FACT

Whitefish broth is a traditional meal supplement for infants.

Notes:

What did you think of this survey?

We'd love to hear your feedback. Talk to your Mercury Community Coordinator or write your comments here.

wsp

KEEYASK

V2.04.2023

APPENDIX D

Personal Letter Template

January XX, 2024 Project No. 1782422

Participant's Name
Participant's Community

KEEYASK HAIR SAMPLING RESULTS: YOUR MERCURY LEVEL IN HAIR

Dear Participant's Name

Thank you for participating in the mercury hair sampling process. A copy of your signed consent form is attached. A second copy of this letter is included for you to provide to your health care practitioner, if desired.

Your hair mercury level is **6 ppm** (parts per million), which is above the recommended range for you (0-2 ppm) because you are part of a Sensitive Group. We encourage you to have your hair re-sampled and contact me (Sharon Guin) to talk about your mercury level and receive some recommendations about how to manage it. We would also encourage you to speak with your health care provider (like a doctor or nurse) about your mercury level. Please look at **the white box in the table below** for some advice for you about eating fish. Please look at the table on the second page for your hair mercury levels for other hair segments analyzed.

PLEASE NOTE: The best type of fish to eat that is low in mercury is **whitefish of any size**. Jackfish (Northern Pike) and Walleye are still fine to eat, but be sure to choose Jackfish and Walleye that are smaller in size because they are lower in mercury than larger-sized fish.

Sensitive Groups If you are a… - **Child** (age 12 and under) - **Teenager** (age 13 to 18 years) - **Female of childbearing age** who is pregnant, is breastfeeding, or could become pregnant…	**Non-Sensitive Groups** If you are a… - **Male adult** - **Female over childbearing age**
*And if your level is **less than 2 ppm**…* Eating fish up to 2 or 3 times per week is healthy.	*And if your level is **less than 5 ppm**…* Eating fish 2 or 3 times per week is healthy if you are not already doing so.
*And your level is **more than 2 ppm**…* You are encouraged to eat less fish (or different species or smaller sizes of fish) to help your mercury levels come back down into the healthy range.	*And if your level is **more than 5 ppm**…* You are encouraged to eat less fish (or different species or smaller sizes of fish) to help your mercury levels come back down into the healthy range.

WSP Canada Inc.
100 Scotia Court, Whitby, Ontario, L1N 8Y6, Canada T: +1 905 723 2727 F: +1 905 723 2182

Your hair sample was taken on (*hair sample date*) and it shows your average mercury exposure / how much fish you ate from around (*date range the hair sample represents*). Your food survey indicated that you fall within a (*moderate / high*) fish consumption category and generally eat (*more than 3 meals per month*) in some seasons. For this reason, we analyzed multiple segments of your hair sample to look at your monthly exposure. If you eat more fish in other seasons, we encourage you to contact me (Sharon Guin) or work with your mercury community coordinator (*name of coordinator*) to figure out the best time of year to collect another sample.

Approximate Timeframe	Hair Mercury Level (ppm)
(mid January 2023 to mid February 2023)	*(6.0)*

Hair sampling and food surveys will continue to happen over the next few years. A community event to collect more hair samples and food surveys will be held sometime in 2024, but you can contact your mercury community coordinator anytime if you would like to get another hair sample before then.

If you have any questions or wish to talk about your results with a member of the project team or someone who can offer more detailed advice about eating fish, please contact the project's lead researcher Sharon Guin at 905-723-2727 or sharon.guin@wsp.com. You can also contact your mercury community coordinator (*name and email of coordinator*) or your local health provider.

To learn more about mercury and health, please visit:

General information about mercury and health: https://www.canada.ca/en/health-canada/services/healthy-living/your-health/environment/mercury-human-health.html

Information about mercury and fish: https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/environmental-contaminants/mercury/mercury-fish.html

Sincerely,
WSP Canada Inc.

DRAFT

Sharon Guin, MSc
Principal Researcher, Risk Assessor

SG/

Attachments: Signed Consent Form

January XX, 2024 Project No. 1782422

Participant's Name
Participant's Community

KEEYASK HAIR SAMPLING RESULTS: YOUR MERCURY LEVEL IN HAIR

Dear Participant's Name

Thank you for participating in the mercury hair sampling process. A copy of your signed consent form is attached. A second copy of this letter is included for you to provide to your health care practitioner, if desired.

Your hair mercury level is **1 ppm** (parts per million), which is within the recommended range for you (0-2 ppm) because you are part of a Sensitive Group. Please look at **the white box in the table below** for some advice about eating fish. Please look at the table on the second page for your hair mercury levels for other hair segments analyzed.

PLEASE NOTE: The best type of fish to eat that is low in mercury is **whitefish of any size**. Jackfish (Northern Pike) and Walleye are still fine to eat but be sure to choose Jackfish and Walleye that are smaller in size because they are lower in mercury than larger-sized fish.

Sensitive Groups If you are a… - **Child** (age 12 and under) - **Teenager** (age 13 to 18 years) - **Female of childbearing age** who is pregnant, is breastfeeding, or could become pregnant…	**Non-Sensitive Groups** If you are a… - **Male adult** - **Female over childbearing age**
*And if your level is **less than 2 ppm**…* Eating fish up to 2 or 3 times per week is healthy.	*And if your level is **less than 5 ppm**…* Eating fish 2 or 3 times per week is healthy if you are not already doing so.
*And your level is **more than 2 ppm**…* You are encouraged to eat less fish (or different species or smaller sizes of fish) to help your mercury levels come back down into the healthy range.	*And if your level is **more than 5 ppm**…* You are encouraged to eat less fish (or different species or smaller sizes of fish) to help your mercury levels come back down into the healthy range.

WSP Canada Inc.
100 Scotia Court, Whitby, Ontario, L1N 8Y6, Canada
T: +1 905 723 2727 F: +1 905 723 2182

Your hair sample was taken on *(hair sample date),* and it shows your average mercury exposure / how much fish you ate from around (*date range the hair sample represents*). Your food survey indicated that you fall within a (*moderate / high*) fish consumption category and generally eat (*2 to 3 meals per month*) in some seasons. For this reason, we analyzed multiple segments of your hair sample to look at your monthly exposure. If you eat more fish in other seasons, we encourage you to contact me (Sharon Guin) or work with your mercury community coordinator (*name of coordinator*) to figure out the best time of year to collect another sample.

Approximate Timeframe	Hair Mercury Level (ppm)
(mid January 2023 to mid February 2023)	*(1.0)*

Hair sampling and food surveys will continue to happen over the next few years. A community event to collect more hair samples and food surveys will be held sometime in 2024, but you can contact your mercury community coordinator anytime if you would like to get another hair sample before then.

If you have any questions or wish to talk about your results with a member of the project team or someone who can offer more detailed advice about eating fish, please contact the project's lead researcher Sharon Guin at 905-723-2727 or sharon.guin@wsp.com. You can also contact your mercury community coordinator (*name and email of coordinator*) or your local health provider.

To learn more about mercury and health, please visit:

General information about mercury and health: https://www.canada.ca/en/health-canada/services/healthy-living/your-health/environment/mercury-human-health.html

Information about mercury and fish: https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/chemical-contaminants/environmental-contaminants/mercury/mercury-fish.html

Sincerely,
WSP Canada Inc.

DRAFT

Sharon Guin, MSc
Principal Researcher, Risk Assessor

SG/

Attachments: Signed Consent Form

wsp.com

APPENDIX 3: CONTINGENCY FISH MERCURY PREDICTIONS

Attachment 3a: North/South Consultants: Contingency Fish Mercury Predictions for Stephens Lake, 2023

Attachment 3b: North/South Consultants: Contingency Fish Mercury Predictions and Additional Information from the Keeyask Reservoir, 2024

Subject: **Contingency Fish Mercury Predictions for Stephens Lake for Mercury and Human Health Implementation Group Purposes**

To: S. Wakelin and M. Wiest
Environmental Licensing & Protection Department
Manitoba Hydro and Indigenous and Community Relations

From: J. Holm
North/South Consultants Inc.

Date: April 20, 2023

1.0 INTRODUCTION

Post-impoundment fish consumption recommendations prepared for fish from Gull and Stephens lakes are based on predicted peak average concentrations of mercury in fish[1]. The validity of predictions about the magnitude and timing of peak mercury concentrations in fish due to the Keeyask Project are being assessed as part of the Keeyask Aquatic Effects Monitoring Program[2] (AEMP). The Project biologist is confident that the annual monitoring plan identified in the AEMP is robust and sufficient to detect if the predicted peak concentrations are exceeded.

Mercury concentrations in Pickerel sampled from Stephens Lake in 2022 as part of AEMP monitoring were at the predicted peak concentration of 0.5 ppm. While the current post-impoundment recommendations are still valid, the Mercury and Human Health Implementation Group (MHHIG) determined that it would be prudent to develop 'contingency' products for Stephens Lake in the event mercury concentrations in fish sampling in 2023 exceed predictions or a 20% threshold.

This memo provides the rationale for and new 'contingency' peak concentrations for Stephens Lake that can be used to update consumption recommendations.

[1] Split Lake products reflect existing conditions and will be updated based on annual review of fish monitoring results.

[2] Keeyask Hydropower Limited. 2015. Keeyask Generation Project aquatic effects monitoring plan. Keeyask Hydropower Limited Partnership, June 2015.

2.0 RATIONALE

The 2022 Memorandum to the MHHIG – Communication Process of Mercury Fish Data Results and Consumption Recommendations, Keeyask Project Phase 2 (Post-Impoundment)[3] outlines a process for communication and decision making should fish mercury concentrations in Gull or Stephens lakes in any species reach predicted levels and notes the MHHIG and province will meet to review available information and assess whether consumption recommendations should be adjusted. The MHHIG, including provincial health representatives, met in January 2023 to review the 2022 AEMP monitoring results of mercury concentrations of fish. Mercury concentrations of fish sampled from Gull Lake in 2022 as part of the AEMP monitoring are increasing but are still within predicted levels. Mercury concentrations in Pickerel sampled from Stephens Lake in 2022 were at the predicted peak concentration of 0.5 ppm. To ensure a rapid response in the event mercury concentrations in fish sampling in 2023 exceed predictions or 20% threshold, the MHHIG determined that it would be prudent to develop 'contingency' products for Stephens Lake. In the meantime, the MHHIG agreed the current consumption recommendations and corresponding communication products developed for post-impoundment conditions are still valid and applicable.

Three Options were considered in the development of contingency consumption recommendations: based on annual monitoring with an approximate one-year lag between the collection of mercury samples and analysis of laboratory results, based on the results of annual monitoring with a buffer added to the mercury concentrations (%), or based on the calculation of new peaks that reflect a more recent baseline than used for the predictions in the Environmental Impact Statement (EIS)[4]. The third option was selected by the MHHIG to avoid a one-year information lag and potentially frequent changes associated with the other options) and offer a more conservative estimate based on more recent pre-Project data.

[3] Keeyask Project Mercury and Human Health Risk Management Plan Communication: Process of Mercury Fish Data Results and Consumption Recommendations, Keeyask Project PHASE 2 (Post-Impoundment). Memorandum to the Mercury and Human Health Implementation Group. April 14, 2022. 10 p.

[4] Keeyask Hydropower Limited Partnership. 2012. Keeyask Generation Project: Environmental Impact Statement. Supporting volume - Aquatic Environment. Keeyask Hydropower Limited Partnership, Winnipeg, MB.

3.0 CONTINGENCY PEAK MERCURY CONCENTRATIONS

An exceedance of 20% of the peak mercury concentrations in fish from Stephens Lake predicted in the Keeyask EIS would trigger a re-evaluation of the post-impoundment fish consumption recommendations as stipulated in the post-impoundment fish mercury communication process. These values are summarized by species in the table below:

Species	Standard Length (mm)	Stephens Lake	
		Peak	20% Threshold
Whitefish	350 mm	0.15 ppm	0.18 ppm
Jackfish	550 mm	0.5 ppm	0.6 ppm
Pickerel	400 mm	0.5 ppm	0.6 ppm

If mercury concentrations in fish from Stephens Lake reach the 20% threshold during AEMP monitoring, more conservative estimates for peak mercury concentrations can be calculated using more recent pre-Project data than was used in the development of the EIS predictions. The length standardized concentrations of all three species from Stephens Lake have varied since monitoring for the Keeyask Project began in 1999 (Figure 1). Concentrations in the piscivores (Jackfish and Pickerel) were particularly low in the early 2000s, which happens to correspond to the period used as the baseline for the predictions of peak values for the EIS (2001, 2002, 2003, 2005). Therefore, a more recent time series of pre-Project values (2012, 2015, 2018) can be used to calculate a higher baseline concentration. The higher baseline can then be used to estimate a 'contingency' peak concentration using the predicted increases for the standard length of fish provided in the EIS (approximately two-fold).

The length-standardized mercury concentrations for the three species for the 2001-2005 and 2012-2018 periods are summarized below:

Metric	Years	Whitefish	Jackfish	Pickerel
EIS Baseline	2001-2005	0.09 ppm	0.26 ppm	0.29 ppm
Contingency Baseline	2012-2018	0.07 ppm	0.31 ppm	0.39 ppm
Contingency Peak	-	-	**0.62 ppm**	**0.78 ppm**

Since the contingency baseline concentration for Whitefish is lower than the baseline used in the EIS, a contingency baseline can only be estimated for the piscivorous species using this method. Because of their diet, mercury concentrations in Whitefish are expected to remain considerably lower than those in the piscivorous species. Contingency peak concentrations are 24% higher for Jackfish and 56% higher for Pickerel than those predicted in the EIS.

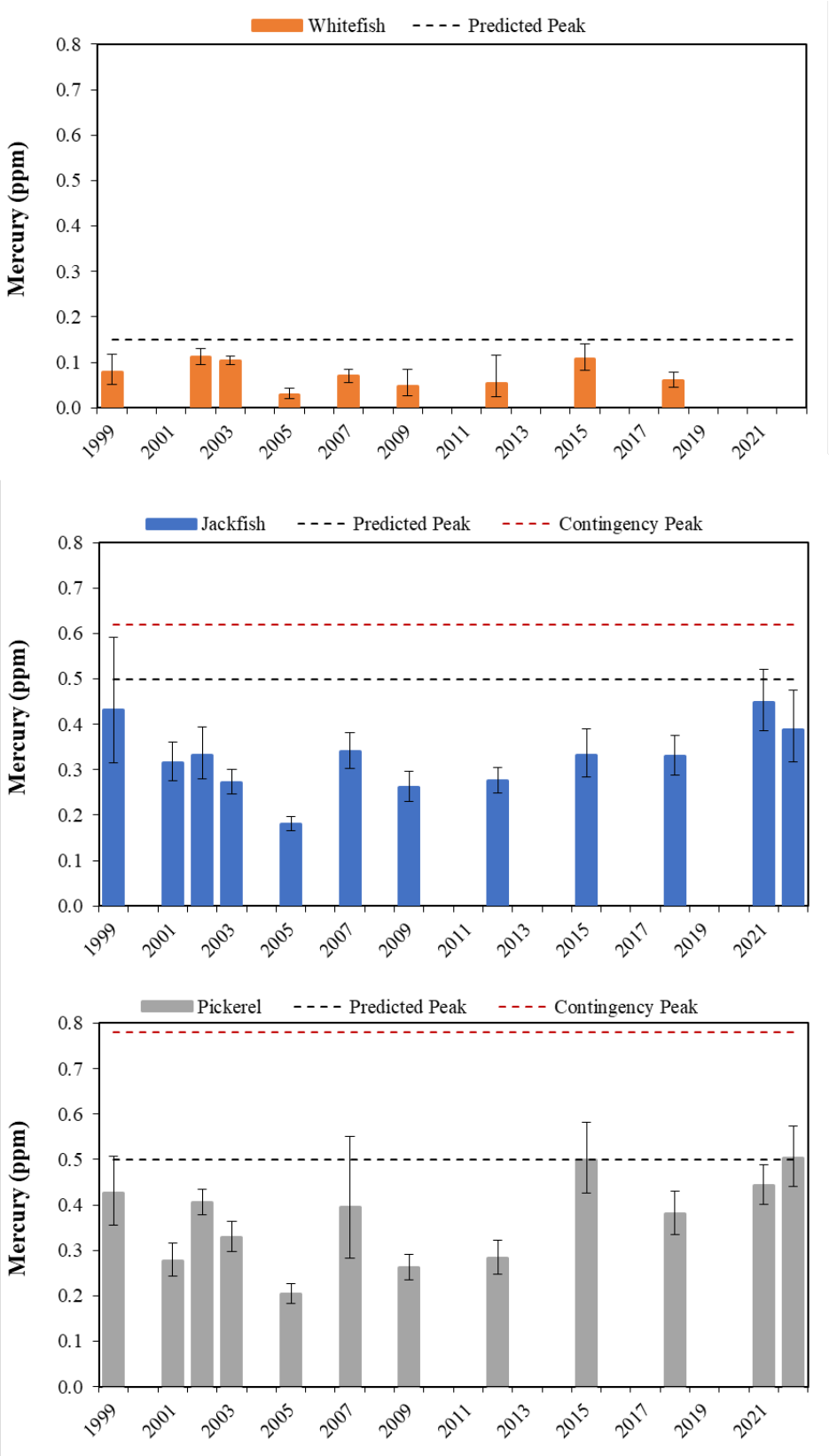


Figure 1. Length-standardized mercury concentrations in three species from Stephens Lake.

Subject: **Contingency Fish Mercury Predictions and Additional Information for Whitefish from the Keeyask Reservoir for Mercury and Human Health Implementation Group Purposes**

To: S. Wakelin and M. Wiest
Environmental Licensing & Protection Department
Manitoba Hydro and Indigenous and Community Relations

From: J. Holm
North/South Consultants Inc.

Date: April 29, 2024

1.0 INTRODUCTION

Post-impoundment fish consumption recommendations prepared for fish from Gull and Stephens lakes are based on predicted peak average concentrations of mercury in fish[1]. The validity of predictions about the magnitude and timing of peak mercury concentrations in fish due to the Keeyask Project are being assessed as part of the Keeyask Aquatic Effects Monitoring Program[2] (AEMP). The Project biologist is confident that the annual monitoring plan identified in the AEMP is robust and sufficient to detect if the predicted peak concentrations are exceeded.

Mercury concentrations in Whitefish sampled from the Keeyask reservoir in 2023 as part of AEMP monitoring had a standard mean mercury concentration of 0.30 ppm, which exceeded the predicted peak concentration of 0.2 ppm by more than the 20% threshold that would trigger a re-evaluation of the post-impoundment fish consumption recommendations as stipulated in the post-impoundment fish mercury communication process[3]. Mercury concentrations of Jackfish and Pickerel sampled from the reservoir in 2023 were increasing but were still within predicted levels (1 ppm). At a meeting of the technical members of the Mercury and Human Health Implementation Group (MHHIG) on 28 March, 2024 it was determined

[1] Split Lake products reflect existing conditions and will be updated based on annual review of fish monitoring results.

[2] Keeyask Hydropower Limited. 2015. Keeyask Generation Project aquatic effects monitoring plan. Keeyask Hydropower Limited Partnership, June 2015.

[3] Keeyask Project Mercury and Human Health Risk Management Plan Communication: Process of Mercury Fish Data Results and Consumption Recommendations, Keeyask Project PHASE 2 (Post-Impoundment). Memorandum to the Mercury and Human Health Implementation Group. April 14, 2022. 10 p.

that it would be prudent to develop 'contingency' products for Whitefish from the Keeyask reservoir similar to what was done for Stephens Lake based on the result of the 2022 monitoring[4].

This memo provides the rational for the calculation of 'contingency' peak concentrations for Whitefish in the Keeyask reservoir that can be used to update consumption recommendations.

2.0 CONTINGENCY PEAK MERCURY CONCENTRATIONS

An exceedance of 20% of the peak mercury concentrations in fish from the Keeyask reservoir predicted in the Keeyask EIS would trigger a re-evaluation of the post-impoundment fish consumption recommendations as stipulated in the post-impoundment fish mercury communication process. These values are summarized by species in the table below.

Species	Standard Length (mm)	Keeyask Reservoir	
		Predicted Peak	20% Threshold
Whitefish	350 mm	0.2 ppm	0.24 ppm
Jackfish	550 mm	1 ppm	1.2 ppm
Pickerel	400 mm	1 ppm	1.2 ppm

Standard mean mercury concentrations in Jackfish and Pickerel were still below the predicted peak in 2023 but exceeded the 20% threshold in Whitefish. A contingency estimate for peak mercury concentrations for Whitefish were calculated using the predicted increase for the piscivores. The EIS predicted a 3-fold increase for Whitefish and a 5-fold increase for the piscivores in the reservoir at peak. As shown in the table below, standard mean mercury concentrations in Whitefish in 2023 had increased by 4-times the baseline concentration, which is about the same proportional increase seen in the two piscivorous species. Applying the proportional increase predicted for the piscivores to the baseline concentration of Whitefish results in a peak concentration of 0.35 ppm. This contingency is 75% higher than the peak predicted in the EIS. Because mercury concentrations are still about 20% below the predicted peaks in the EIS, contingency peaks were not required for the Jackfish and Pickerel.

Species	EIS Baseline [Hg]	2023 [Hg]	Increase	Contingency Peak
Whitefish	0.07ppm	0.30 ppm	4.3 X	0.35 ppm
Jackfish	0.22 ppm	0.84 ppm	3.8 X	-
Pickerel	0.23 ppm	0.78 ppm-	3.4 X	-

This contingency peak is the best estimate for the most likely mercury concentrations at peak based on the available data and it is understood that these values may be utilized as part of the HHRA and communication products.

[4] Holm, J. 2023. Contingency Fish Mercury Predictions for Stephens Lake for Mercury and Human Health Implementation Group Purposes. Memorandum prepared for Manitoba Hydro and Indigenous and Community Relations by North/South Consultants Inc., 20 April, 2023. 4 p.

3.0 ADDITIONAL INFORMATION REQUESTED

In an email dated April 23, 2024, the Project toxicologist requested information for the communication materials, specifically the Gull Lake poster and fish tape, about whether it is expected that Lake Whitefish larger than the standard length would exceed 1.5 ppm, which is the concentration of the most restrictive consumption recommendation.

Larger Lake Whitefish (>350 mm) would have higher concentrations than the contingency peak. While it is not possible to make predictions for other length classes, it is possible to examine the data for larger whitefish to provide some guidance.

In 2023, three years post-impoundment, the largest whitefish (566 mm) analyzed for mercury had a concentration of 0.661 ppm. To reach 1.5 ppm, the concentration would have to more than double, which is unlikely considering the species should be reaching peak very soon (within 3-5 years post-impoundment).

Pre-Project (1999-2016), the average concentration for whitefish >550 mm was 0.21 ppm. Multiplying this value by the 5X increase used for the contingency peak prediction, the concentration becomes 1.05 ppm. Therefore, the average concentration of the largest whitefish will likely not reach 1.5 ppm. However, there is a chance that a small number of individual large whitefish could exceed 1.5 ppm.

If there is a desire to change the recommendation in the communication materials to be more conservative, 500 mm would be a good cut off based on the concentrations in the baseline data as only fish in this length category had a few individuals with mercury concentrations ≥0.3 ppm (which times the 5X increase would equal ≥1.5 ppm).

APPENDIX 4: PRELIMINARY HUMAN HEALTH RISK ASSESSMENT MATERIALS

Attachment 4a: Wilson Scientific, Preliminary Human Health Risk Assessment – Interpretation of 2023 Environmental Data, 2024

Attachment 4b: Wilson Scientific, Revisions to Recommended Maximum Monthly Intake Rates for Post-Impoundment Fish Consumption from Stephens and Gull Lakes based on 2023/2024 Contingency Peak Concentrations, 2024

Technical Memorandum

To: Manitoba Hydro, on behalf of the Keeyask Hydropower Limited Partnership

From: Ross Wilson, M.Sc., DABT, Wilson Scientific Consulting Inc.

Date: June 13, 2024

Re: Preliminary Human Health Risk Interpretation of 2023 Environmental Data

---

1.0 Introduction

This memorandum is to inform Manitoba Hydro on behalf of the Keeyask Hydropower Limited Partnership (KHLP) and the Mercury and Human Health Implementation Group (MHHIG) of the preliminary interpretation of human health risks from reported concentrations of fish and wildlife sampled in 2023. This memorandum contributes to the Socio-Economic Monitoring Plan (SEMP) report, submitted in fulfillment of annual regulatory requirements.

The Keeyask Mercury and Human Health Risk Management Plan (RMP) was prepared to fulfill the requirements of The Environment Act (Manitoba) Licence No. 3107 and outlines a range of commitments to monitor and mitigate the risks associated from increased methylmercury in the environment as a result of the operation of the Keeyask Generation Project (the Project). Key components of the RMP include the monitoring of fish, wildlife, plants; a communication strategy regarding safe fish consumption; periodic human health risk assessments (HHRA); and voluntary hair sampling. As part of this effort, Wilson Scientific Consulting Inc. (Wilson Scientific) has been retained by Manitoba Hydro (on behalf of the KHLP) as a subject matter expert (toxicology) in meeting Keeyask monitoring and licence commitments relating to mercury and human health. This includes conducting a preliminary human health risk interpretation of available environmental data. This report considers the predicted peak concentrations of mercury in fish from Gull and Stephens lakes and other environmental data on mercury from the Project-affected area.

Aquatic and terrestrial environment monitoring plans were also submitted by the KHLP in fulfillment of the licence requirements. On behalf of the KHLP, Manitoba Hydro contracted various environmental professionals to estimate peak mean mercury concentrations (as a modelling effort) during the licensing phase. Later, these same professionals were contracted to undertake monitoring to determine if predicted concentrations identified in the Keeyask Environmental Impact Statement (EIS) are exceeded. The modelled peak mercury concentrations form the basis of interpretation of risk to human health from the consumption of wild foods and, in the case of fish, maximum consumption recommendations.

Wilson Scientific has assumed all concentrations and predictions provided by the various disciplines are accurate and representative in the Keeyask Project Area, and persist, unless otherwise informed, until concentrations are in decline.

As of the date of this memorandum and since impoundment, the following environmental monitoring reports have been received which have key relevancy to the estimation of human health risks:

- fish mercury concentrations: predicted peak average fish concentrations in Gull and Stephens lakes (North/South, 2021); contingency mercury predictions for pickerel and jackfish in Stephens Lake (North/South 2023a); mercury concentrations in fish sampled from Stephens Lake in June 2023 (North/South, 2023b); contingency mercury predictions for whitefish in Gull Lake (North/South, 2024a); and, mercury concentrations in fish sampled from Gull and Stephens lakes in Fall 2023 (Holm and Aiken, 2024); and
- wildlife mercury concentrations: mercury concentrations in aquatic furbearers as both predictions and sampled from the Keeyask reservoir area in the winter of 2023/2024 (Wildlife Resource Consulting Services MB Inc. [WRCS], 2024 – component of the Terrestrial Environment Monitoring Plan).

2.0 Interim Assessment of Human Health Risks

A preliminary assessment of human health risks is presented below based on the fish and wildlife data received up until the date of this memorandum. Fish and wildlife sampling programs are ongoing during operations, and future risk interpretations will consider results, and may change, as data becomes available. While newer data are presented below, the general approach and most of the results have been part of previous presentations with health agencies and partner First Nations and their representatives. It is recommended that Manitoba Hydro and/or the MHHIG, on behalf of KHLP, continue to engage with and follow up with health agencies to discuss contents within these documents to ensure concurrence with risk interpretation prior to making final conclusions about health risks. A consistent message from all experts, including health agencies, will likely reduce confusion and skepticism regarding the safety of consuming fish, wild game and waterfowl.

Wilson Scientific has engaged in conversations with the environment professionals to clarify our interpretation of the information provided on mercury concentrations in fish and other wildlife; however, a critical analysis of their methodologies, dataset and conclusions in the cited reports is beyond the scope of the preliminary risk interpretation and Wilson Scientific's core expertise[1]. As such, all concentrations and predictions provided by Manitoba Hydro, North/South and WRCS have been assumed to be accurate and representative in the Keeyask Project Area. It is recommended that dialogue continues with communities and regulators on any issues, concerns or ideas for the environmental datasets.

With the above in mind, the primary approach to interpreting human health risks from fish consumption involved: 1) verifying the best estimate of peak concentrations for standardized length fish, provided by environmental professionals; and 2) verifying that risk assessment guidance provided by the key regulatory agencies remains valid (as discussed in more detail below, no changes were required with respect to this aspect) and then applying the guidance. The outcome of the elements is discussed below.

[1] The contents of the Keeyask EIS and all Environment Protection Plans (*e.g.*, AEMP, SEMP, TEMP) underwent critical peer and regulatory review as part of the planning and licensing process. It is understood that the 2024 AEMP, SEMP and TEMP reports will also undergo regulatory agency review and if issues are identified it is important that these are communicated and considered for human health risk interpretation.

2.1 Wild Food Consumption Patterns

A key aspect of the human health risk interpretation is understanding the amounts and frequency of consumption of wild foods from the project area. At the current time, the information is based primarily on the wild foods workshop with representatives of the partner First Nations that was held in 2009 (with about 20 participants) where participants were asked about which wild foods they enjoyed eating and provided estimates of how often and how much of each food was consumed. In addition, it is noted that the WSP (2024) hair sampling and food survey program provides additional information for consideration. Finally, consumption information is occasionally provided at MHHIG meetings. As will be discussed below, the importance of information on the wild food consumption patterns cannot be understated; however, it is also recognized that collection of such information is a sensitive issue and it is important that the communities decide how they wish for environmental professionals to proceed. As will be discussed later in this memorandum, it is highly recommended that discussions occur in the near future to determine if the human health risk input parameters describing the wild food consumption patterns accurately address the concerns of the communities (this could be accomplished in a variety of manners including but not limited to reconvening of wild foods workshop and/or meeting with Elders to discuss the specific input parameters, *etc.*).

2.2 Fish

The 2023 fish monitoring dataset showed concentrations in pickerel and jackfish in Stephens Lake and whitefish in Gull Lake exceeded the North/South (2021)/EIS predicted peak mean mercury concentrations by more than 20% at varying times. As a result, it was concluded that the peak EIS estimates for these fish were no longer valid for the purpose of the preliminary human health risk interpretation or providing consumption recommendations. In order to provide more accurate estimates of fish concentrations that are the basis of consumption recommendations, North/South developed contingency estimates for pickerel and jackfish in Stephens Lake (North/South, 2023a) and whitefish in Gull Lake (North/South, 2024a) as their best estimates of peak average mercury concentrations (while their previous peak average estimates for Stephens Lake whitefish and Gull Lake pickerel and jackfish were assumed to remain valid). The section below provides a summary of the revised dataset and approach for assumed peak average mercury concentrations.

2.2.1 Peak Mean Concentration Estimates

Wilson Scientific (2021; revised 2022) previously developed fish consumption recommendations for the post-impoundment phase based on average peak mercury concentrations predicted in the EIS and North/South (2021) for length-standardized fish for three species from Gull and Stephens lakes:

- Stephens Lake jackfish at 550 mm: 0.5 ppm;
- Stephens Lake pickerel at 400 mm: 0.5 ppm;
- Stephens Lake whitefish at 350 mm: 0.15 ppm;
- Gull Lake jackfish at 550 mm: 1.0 ppm;
- Gull Lake pickerel at 400 mm: 1.0 ppm; and
- Gull Lake whitefish at 350 mm: 0.19 ppm;

Nevertheless, due to mercury concentrations approaching or exceeding peak concentrations estimates for certain fish, North/South prepared the following contingency estimates which now replace the North/South (2021)/EIS peak mean estimates for the following fish:

- Stephens Lake jackfish at 550 mm: 0.62 ppm (North/South, 2023a);
- Stephens Lake pickerel at 400 mm: 0.78 ppm (North/South, 2023a); and
- Gull Lake whitefish at 350 mm: 0.35 ppm (North/South, 2024a).

2.2.2 2023 Measured Fish Data Compared to Predicted Peak Average Concentrations

From sampling completed in 2023, North/South indicated that the average concentrations found in Stephens Lake jackfish and pickerel and Gull Lake whitefish for the specified standardized lengths exceeded the North/South (2021) and EIS estimates and, thus, the contingency estimates were recommended to become the basis of revised consumption recommendations. Specifically, the following key results from 2023 (unless otherwise specified all data for fish of standardized size: whitefish = 350 mm; pickerel = 400 mm; and jackfish = 550 mm)[2]:

- Stephens Lake standardized size pickerel had a mean concentration of 0.67 ppm in the June 2023 sampling event and this value exceeded the North/South (2021)/EIS peak concentration estimate of 0.5 ppm by more than 20%. The MHHIG agreed to develop conditional revisions to the consumption recommendations, which were issued in August 2023. For the Fall 2023 fish sampling, Stephens Lake standardized size pickerel had a mean concentration of 0.59 ppm with a 95% confidence limit of 0.66 ppm (mean did not exceed by 20%). Overall, the contingency concentration developed for Stephens Lake pickerel of 0.78 ppm was recommended to be basis of revisions to the consumption recommendations.
- Stephens Lake standardized size jackfish had a mean concentration of 0.48 ppm for the June 2023 sampling event (*i.e.*, did not exceed the North/South (2021)/EIS peak concentration estimate of 0.5 ppm); however, these fish had a mean concentration of 0.62 ppm with a 95% confidence limit of 0.68 ppm in the Fall 2023 sampling event (*i.e.,* did exceed the North/South (2021)/EIS peak concentration estimate of 0.5 ppm by more than 20%). Overall, the contingency concentration recommended for Stephens Lake jackfish of 0.62 ppm was recommended to be basis of revisions to the consumption recommendations.
- For Stephens Lake whitefish caught in the Fall of 2023, Holm and Aiken (2024) were not able to calculate standardized size mean concentrations (due to lack of significance in the mathematical relationship size and mercury concentration possibly associated with low sample size). For the current time, it was recommended to not revise consumption recommendations for Stephens Lake whitefish which are based on an assumed peak concentration of 0.15 ppm provided in North/South (2021) and the EIS (North/South considers it unlikely that the peak concentration has been exceeded for these fish).
- Gull Lake standardized size pickerel caught in the Fall of 2023 had a mean concentration less than the North/South (2021)/EIS peak concentration predictions. Specifically, Holm and Aiken (2024) reported the standardized size mean concentration to be 0.776 ppm with a 95% confidence limit of 0.929 ppm as compared to the North/South (2021)/EIS predicted peak of 1.0 ppm. Thus, these

[2] June 2023 sampling results in North/South (2023b), Fall 2023 sampling results in Holm and Aiken (2024)

results did not trigger the recommendation of revised consumption recommendations for Gull Lake pickerel.

- Gull Lake standardized size jackfish caught in the Fall of 2023 had a mean concentration that did not exceed the North/South (2021)/EIS peak concentration predictions. Specifically, the standardized size mean concentration was reported by Holm and Aiken to be 0.884 ppm with a 95% confidence limit of 0.964 ppm as compared to the North/South (2021)/EIS predicted peak of 1.0 ppm. Thus, these results did not trigger the recommendation of revised consumption recommendations for Gull Lake jackfish.
- Gull Lake standardized size whitefish caught in the Fall of 2023 had a mean concentration of 0.300 ppm with a 95% confidence limit of 0.328 ppm. Since these results exceeded the North/South (2021)/EIS peak concentration estimate of 0.19 ppm by more than 20%, it triggered discussion of revisions to consumption recommendations for Gull Lake whitefish (*i.e.*, contingency concentration of 0.35 ppm for Gull Lake whitefish was recommended to be basis of the revisions).

Based on the above results, human health risk interpretation and fish consumption communication materials were revised for the fish that were found to exceed the North/South (2021)/EIS predicted peak concentrations. Specifically, the following changes were recommended:

- Revision of the consumption recommendations for Stephens Lake standardized size pickerel (400 mm) and jackfish (550 mm) using the North/South (2023a) contingency peak concentrations of 0.78 and 0.62 ppm, respectively.
- Revision of the consumption recommendations for Gull Lake standardized size whitefish (350 mm) using the North/South (2024a) contingency peak concentration of 0.35 ppm.

Unless future sampling results warrant new consideration of peak estimates, the fish consumption recommendations and preliminary human health risk interpretation will be based on the estimates in documents noted above until concentrations reach peak (approximately 2023-2027) which can only be determined once the concentrations are in decline. Future monitoring data will be considered in a fulsome HHRA in approximately 2026 to 2030 (exact year will be subject to MHHIG input and timing of decline).

North/South and Manitoba Hydro re-affirmed that sampling and monitoring efforts are scientifically sound and attempt to balance detection of an exceedance of predicted mercury concentrations with the conservation of fish. Both parties are aware of the importance that exceedances of the North/South (2021)/EIS and/or North/South (2023a; 2024a) contingency peak estimates are detected as soon as reasonably possible (should an exceedance occur) and have indicated they remain confident that the methods, analysis and program to measure mercury in fish tissue are reliable and accurate.

<u>Risk Interpretation for those Following Fish Consumption Recommendations</u>

Aside from the revision of peak concentrations of mercury in certain fish discussed above, the key parameters and risk assessment guidance used in Wilson Scientific (2021; revised 2022) to estimate consumption recommendations have not changed: the toxicity reference values, body weights and the dose-averaging factor of a month also remain valid and reasonable. More specifically, the Health Canada (2021) Tolerable Daily Intakes for methylmercury remain applicable for the sensitive age groups (TDI = 0.2

µg/kg bw/day) and non-sensitive groups (TDI = 0.47 µg/kg bw/day). In the case of body weight, the values used in the consumption recommendations match those used in Health Canada (2024) and/or are similar to those used in Province of Manitoba (2007). In addition, the communication materials provide information that individual body weight are recommended to be used to adjust these estimates on a personal basis. In the case of the dose-averaging factor of a month, fish consumption advice from Health Canada (2007; 2019) and Province of Manitoba (2007) have used monthly dose averaging in their recommendations and we are not aware of current information to deviate from this approach for fish consumption. Although it could be suggested that the methylmercury TDI should be dose-averaged over a week (for example, the World Health Organization (WHO) (2007) provisional tolerable weekly intake of 1.6 µg/kg bw/week), the use of monthly dose-averaging seems to be the accepted practice in Manitoba and Canada as the basis for fish consumption advice. Furthermore, past discussions with community members/MHHIG indicated a preference for monthly intakes.

Wilson Scientific (2024) outlines the rationale for revised fish consumption recommendations (from those prepared by Wilson Scientific [2021; 2022 revised), due to changes in predicted peak average concentrations for Stephens Lake jackfish and pickerel and Gull Lake whitefish). Tables 1 and 2 provide the revised consumption recommendations for Stephens and Gull lakes, respectively, while Wilson Scientific (2024) provides the technical details for how these were calculated.

A key revision in the fish consumption recommendations is that sensitive members of the population are now advised to avoid all sizes of Stephens Lake jackfish and pickerel. Since North/South (2023a) revised their peak estimate of Stephens Lake jackfish and pickerel and now predicts these fish at standardized size to be greater than 0.5 ppm, these predictions now exceed the Province of Manitoba (2007) guidance value for sensitive individuals (*i.e.*, when fish exceed 0.5 ppm, Province of Manitoba (2007) recommends that sensitive members of the population avoid consuming such fish). As a result, the fish consumption recommendations have been revised to reflect this guidance.

In addition, the North/South (2024a) contingency peak estimate for Gull Lake whitefish concentrations results in a recommendation of lower consumption amounts. Moreover, these fish are no longer classified as “very good choice” fish in the communications materials and, instead, are identified as “occasional consumption” for fish up to standardized size and restricted consumption when longer than 350 mm (*i.e.*, sensitive members of the population are recommended to avoid all Gull Lake whitefish greater than 350 mm while all others are recommended to avoid Gull Lake whitefish longer than 500 mm).

Table 1: Revised Recommended Maximum Monthly Intake of Various Fish under Predicted Contingency Peak Post-Impoundment Conditions at Stephens Lake

Fish Species	Fish Size (as fork length)	Assumed Peak Average Concentration (wet weight)	Recommended Maximum Monthly Intake Due to Mercury (pounds per month) for Fish Up to Standardized Size*		
			Children Under 12 years of Age	Youth (12 yrs to less than 19 yrs of age) and Females of Childbearing Age	All Others
Whitefish	Up to 350 mm	0.15 ppm	2.6	5.3	12.4
	Greater than 350 mm	0.318 ppm**	1.2	2.5	5.9
Pickerel	Up to 400 mm	0.78 ppm	Avoid	Avoid	2.4
	Greater than 400 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid
Jackfish	Up to 550 mm	0.62 ppm	Avoid	Avoid	3.0
	Greater than 550 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid

* Recommendations for revised Stephens Lake communication material is for sensitive individuals to avoid pickerel and jackfish of any length and all people to avoid Stephens Lake pickerel and jackfish larger than standardized sizes
** For Stephens Lake whitefish greater than 350 mm, the predicted peak mercury concentration for the largest size class of > 450 mm in North/South (2021) was assumed (*i.e.*, 0.318 ppm)

Table 2: Revised Recommended Maximum Monthly Intake of Various Fish under Predicted Contingency Peak Post-Impoundment Conditions at Gull Lake

Fish Species	Fish Size (as fork length)	Assumed Peak Average Concentration (wet weight)	Recommended Maximum Monthly Intake Due to Mercury (pounds per month) for Fish Up to Standardized Size		
			Children Under 12 years of Age	Youth (12 yrs to less than 19 yrs of age) and Females of Childbearing Age	All Others
Whitefish	Up to 350 mm	0.35 ppm	1.1	2.3	5.3
	Greater than 350 mm but less than 500 mm	1.5 ppm*	Avoid	Avoid	1.2
	Greater than 500 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid
Pickerel	Up to 400 mm	1.0 ppm	Avoid	Avoid	1.9
	Greater than 400 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid
Jackfish	Up to 550 mm	1.0 ppm	Avoid	Avoid	1.9
	Greater than 550 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid

* For Gull Lake whitefish between 350 and 500 mm, the North/South (2024a) predicted peak mercury concentration for fish at 500 mm of 1.5 ppm was assumed for all fish in this size class

For the current time, it was recommended to not revise consumption recommendations for Stephens Lake whitefish which are based on an assumed peak concentration of 0.15 ppm provided in North/South (2021) and the EIS. Although Holm and Aiken (2024) were not able to provide an estimate of the mercury concentration in standardized size for Stephens Lake whitefish, it was considered reasonable on balance to not revise the North/South (2021)/EIS predicted concentration. Nevertheless, it is suggested that this recommendation could be revisited with the MHHIG and agencies.

In terms of risks from consumption of the specified fish from Gull or Stephens lakes, for those who do not consume fish larger than standardized size and do not consume at rates greater than specified in the fish consumption recommendations in Tables 1 and 2, the intake of mercury for fish with the mean peak mercury concentration is estimated to be equal to the current TDIs specified by Health Canada and the World Health Organization (*i.e.*, TDIs of 0.2 µg/kg bw/d for children up to 18 years of age and women of childbearing age and 0.47 µg/kg bw/d for all others). For those consuming multiple fish species or from multiple locations, it is recommended that the consumer consider summing their exposures in a manner consistent with the explanation in the communication materials and Wilson Scientific (2024) (a similar summation recommendation occurs in the Province of Manitoba [2007] guidelines).

With the above in mind, there are certain cautions that should be considered based on the recent fish data.

Gull Lake Cautions

From a toxicological perspective, North/South (2021; 2024a) has predicted that certain fish in Gull Lake will have very high mercury concentrations under post-impoundment conditions and, thus, these are recommended to be avoided. As the approach for fish consumption guidance was developed for post-impoundment conditions, North/South prepared class size estimates for the three fish species based on predicted rate of increase for standard length fish in Gull and Stephens lakes (North/South, 2021). While there is some uncertainty in their size class estimates that are greater than standardized size, the values provided in North/South (2021) for Gull Lake jackfish and pickerel remain North/South's best estimates for most likely peak mercury concentrations for standardized sizes as well as the various size classes. As noted for Gull Lake whitefish of standardized size, North/South (2024a) provided a revised (*i.e.*, contingency) peak estimate and as such their previous peak estimates for standardized sizes as well as size classes are considered to be no longer applicable; however, North/South (2024a) indicated that it would be their estimate that Gull Lake whitefish longer than 500 mm could have some potential to exceed 1.5 ppm and this was used to inform communication products.

Gull Lake jackfish and pickerel larger than the standardized size are of particular concern (*e.g.*, the largest size classes of these fish in Gull Lake are predicted to potentially have average mercury concentrations that will exceed 3 ppm under peak conditions). While sensitive age groups are recommended to avoid all sizes of jackfish and pickerel in Gull Lake, it is especially important that fish larger than standardized lengths are not consumed. Information from Health Canada, World Health Organization and the Province of Manitoba would seem to support the message that consumption of such high mercury fish (*i.e.*, above standardized size) should be avoided by all age groups. Of particular concern, if sensitive age groups are consuming these fish on even an occasional basis (*e.g.*, a large serving once per month on an ongoing basis), the Health Canada (2021) and WHO (2007) toxicity reference values would likely be exceeded and elevated hair concentrations of mercury may also be expected. Nevertheless, it is emphasized that non-

sensitive age groups are also of concern and are advised to not consume Gull Lake jackfish and pickerel larger than standard size.

Holm and Aiken (2024) provided ridgeline plots for Gull Lake fish for various years between 1999 and 2023 as length-corrected mercury concentrations and were considered as part of the human health risk interpretation. Specifically, it is possible that following the consumption advice for specific fish lengths will still result in consuming fish greater than the peak concentration estimates and, thus, it illustrates the rationale for consuming smaller fish when possible (*i.e.*, the smaller the fish, the lower the mercury concentration and the lower the likelihood of consuming a fish with particularly elevated mercury concentrations) and/or participating in volunteer fish sampling program (*i.e.*, community members are invited to submit the tail portion of the fish for mercury analysis). Although Holm and Aiken (2024) re-affirmed that the North/South (2021) and EIS estimates of peak mean mercury concentrations remain valid for standardized size pickerel and jackfish from Gull Lake (*i.e.*, 1.0 ppm for jackfish and pickerel), the ridgeline plots illustrate individual fish at standardized size will have appreciable variability and some will be substantially greater than the predicted average concentrations. This should not be surprising as the North/South (2021)/EIS peak concentration estimates were provided as mean concentrations and so it would be expected that there would be individual fish concentrations higher and lower than the predicted mean peak estimates; however, the ridgeline plots provide a potentially useful indication of the modelled probability that an exceedance may occur and the possible upper bound concentrations.

From an HHRA perspective, key aspects of 2023 data in the Gull Lake ridgeline plots from Holm and Aiken (2024; see Figure 7 of this report) include[3]:

- more than 80% of jackfish at 550 mm and pickerel at 400 mm exceed 0.5 ppm (*i.e.*, the mercury concentration that sensitive members of the population are advised to avoid);
- 30% or so of jackfish at 550 mm and pickerel at 400 mm exceed the predicted peak mercury concentration of 1 ppm (with some individual jackfish at 550 mm predicted to be approaching 2 ppm and some individual pickerel at 400 mm predicted to exceed 2.5 ppm);
- approximately 10% of jackfish at 550 mm and 20% of pickerel at 400 mm exceed 1.5 ppm (*i.e.*, the mercury concentration that non-sensitive members of the population are advised to avoid);
- about 10% of Gull Lake whitefish at 350 mm exceed 0.5 ppm (*i.e.*, the mercury concentration that sensitive members of the population are advised to avoid); and
- for fish longer than standardized sizes (*i.e.*, 350 mm for whitefish, 400 mm for pickerel and 550 mm for jackfish), even greater frequencies of higher mercury concentrations would be expected than indicated above (*i.e.*, the ridgeline plots were for standardized size fish) and this should further emphasize the additional importance of avoiding fish larger than standardized sizes.

Overall, the ridgeline plots provide an estimate of the predicted frequency of mercury concentration in individual Gull Lake fish at standardized sizes. The ridgeline plots help illustrate the likelihood that individual fish will have mercury concentrations appreciably higher and lower than the North/South (2021)/EIS estimates/North/South (2024a) contingency estimates. This may result in individual fish in the avoid category being consumed even when people follow the advice of not consuming fish above standardized sizes. Nevertheless, it is stressed that Wilson Scientific is not aware of a regulatory

[3] The percentages are very approximate and may be updated in the future with more precise estimates which were not available at the time of drafting of this memorandum.

precedent on how to interpret the individualized fish concentrations (*i.e.*, provincial, federal or international guidance was not identified). Although the mean concentration in fish is still likely the most relevant statistic from a risk assessment, it is recommended that this evaluation tool and potential application for risk interpretation be discussed in future meetings with the communities and the regulatory agencies.

With the opening of the road to a boat launch area at Gull Lake occurring this year, it is especially important that persons are aware of the fish consumption advice (*i.e.*, the opening of a road to a boat launch at a lake where fish consumption is recommended to be avoided or restricted could send mixed messages). Some people may use this boat launch primarily for navigation purposes but increased access to Gull Lake could affect fishing/harvesting patterns. While signage was installed in summer 2023 at both upstream (Gull Lake) and downstream (Stephens Lake) boat launches (in addition to communication strategy outlined in SEMP report), it would also be productive to receive feedback from resource users and fish consumers of local lakes on the efficacy of communication and clarity of fish consumption recommendations. It is also noted that Manitoba Hydro staff have indicated that the existence of "peat islands" in Gull Lake may pose navigational hazards and that they consider there to be low likelihood of appreciable fishing in Gull Lake in 2024.

Stephens Lake Cautions

Although revised consumption recommendations now recommend that sensitive members of the population avoid all sizes of Stephens Lake jackfish and pickerel, the message of particularly avoiding consumption of jackfish and pickerel larger than standardized size is also important for Stephens Lake. The mercury concentrations in Stephens Lake jackfish and pickerel are not expected to be as significantly elevated as Gull Lake; however, it appears the largest size classes of these fish in Stephens Lake could approach or exceed mean concentrations of 1.5 ppm. While monitoring indicates no evidence to date, it is also possible that some jackfish and pickerel caught in Stephens Lake may have originated from Gull Lake and, thus, have mercury concentrations that are closer to the Gull Lake predictions on an individual fish basis.

Holm and Aiken (2024) ridgeline plots for Stephens Lake show data for the years 1999 to 2023 (see Figure 11 of Holm and Aiken, 2024). From these, there is reasonable expectation that individual fish will sometimes exceed the North/South (2021)/EIS estimates for whitefish (*i.e.*, 0.15 ppm) and North/South (2023a) contingency estimates for jackfish and pickerel from Stephens Lake (*i.e.*, 0.62 ppm for jackfish and 0.78 ppm for pickerel). From an HHRA perspective, key aspects of 2023 data for the Stephens Lake ridgeline plots include the following[4]:

- 30% of whitefish at 350 mm exceed 0.15 ppm (the North/South (2021) and EIS peak estimate);
- 60% of jackfish at 550 mm and 70% of pickerel at 400 mm exceed 0.5 ppm (the mercury concentration that sensitive members of the population are advised to avoid); and
- Less than 5% of jackfish at 550 mm and no pickerel at 400 mm exceed 1.5 ppm (the concentration that non-sensitive members are advised to avoid).

[4] As was the case with Gull Lake, the percentages are very approximate and may be updated in the future with more precise estimates which were not available at time of drafting of this memorandum.

As noted earlier, there is little regulatory precedent on how to interpret the individualized fish concentrations from the ridgeline plots and further discussion with the MHHIG and regulatory agencies of its application to developing consumption recommendations may also be warranted. Nevertheless, as was the case for Gull Lake, it is possible that these ridgeline plots may help emphasize the importance of consuming smaller fish where possible and/or participation in volunteer fish sampling programs.

Lake Sturgeon Cautions

As discussed in Holm and Aiken (2024), lake sturgeon are only analyzed when they inadvertently die during AEMP sampling. In addition to the AEMP work, voluntary samples can be analyzed when submitted by community members. No lake sturgeon from Stephens or Gull lakes were submitted in 2023. Information taken from the Holm and Aiken (2023) AEMP report show that in 2022, one non-juvenile lake sturgeon (~ 1,000 mm) from Stephens Lake was analyzed to have a mercury concentration of 0.32 ppm; because this concentration is between 0.2 and 0.5 ppm, it falls into the occasional consumption category. In the fall 2021 dataset, North/South (2022b) reported mercury concentrations in 2 lake sturgeons (longer than 1,200 mm) from Gull Lake that are considered to be high concentrations from a risk perspective. At0.69 and 0.70 ppm, these concentrations exceed 0.5 ppm and they fall into the 'avoid' category for those who under 18 years of age and women of child bearing age. Given such a limited dataset, no conclusions were made by North/South as to whether these concentrations are representative of typical concentrations. As noted in earlier years, there are also no current modelled estimates of lake sturgeon mercury concentrations that can be used as accurate estimates of peak concentrations. As a result, it is not possible to provide final consumption recommendations for lake sturgeon from either lake. It is recommended that MHHIG consider these results and discuss opportunities to encourage voluntary sample submission, if appropriate, in light of conservation considerations.

Other Cautions

Tributaries and other lakes are not part of this human health risk interpretation. Although it is possible that some higher mercury fish may migrate into these tributaries of Gull and Stephens lakes and Clark Lake, there is no sampling program or estimates of mercury concentrations of fish in the tributaries or Clark Lake[5]. It is recommended that the MHHIG and agencies remain aware of this issue and the outcomes of fish movement studies communicated to assess the extent of movement into these other waterbodies. This issue has been previously communicated; however, if there are concerns from agencies or the communities, they should be encouraged to provide the KHLP with their input. It is also noted that North/South (2024b) has recently provided some information that fish concentrations in Clark Lake may reasonably be approximated by Split Lake but the risk implications of fish migration from Gull Lake into Clark Lake were not evaluated as part of this assessment and this recent information from North/South (2024b) has not been discussed by the MHHIG or with agencies (*i.e.*, conclusions are not recommended until a fulsome discussion has occurred).

[5] Fish in the Aiken River, which is a tributary of Split Lake, are sampled every three years. The development of consumption guidance is outside the scope of the HHRA or related interpretation. Furthermore, the AEMP reports on fish movements, which are monitored for select species to see how many move upstream and out of the Keeyask Reservoir.

It is noted that fish species other than jackfish, pickerel and whitefish have not been evaluated in Gull and Stephens lakes. If communities or regulatory agencies desire consumption recommendations or mercury concentration information on fish species other than jackfish, pickerel and whitefish, the Project biologist would need to be able to provide estimates of mercury concentrations in these other fish. This in turn would likely involve expanding the monitoring program or voluntary submission of other fish species by the communities. The selection of fish species to be evaluated was discussed at length during the Keeyask planning phase; that jackfish, pickerel and whitefish are the only species evaluated has been discussed with the MHHIG and agencies. Keeping in mind the focus for the HHRA is on fish species harvested in the Keeyask area or offset lakes, it may be prudent to determine if there is a desire from the communities to expand the fish species list or locations[6]. With the hair sampling data showing mostly low and acceptable results (see WSP, 2024), it may be the case that the communities are satisfied with the current fish sampling effort and would object to more intrusive programs; however, it would be prudent to determine their desires.

Overall, revisions to the consumption recommendations for Stephens Lake pickerel and jackfish and Gull Lake whitefish were recommended due to the North/South (2023b) and Holm and Aiken (2024) fish dataset showing exceedances of predicted peak concentrations. In these cases, contingency peak concentrations developed by North/South (2023a; 2024a) were used in Wilson Scientific (2024) to develop revised fish consumption recommendations for these fish in Stephens and Gull lakes. For persons following these revised consumption recommendations, it is estimated that their mercury intake from these fish will remain acceptable from a human health risk perspective.

2.3 Wild Game

In October 2009, a wild foods workshop with representatives of the partner First Nations was held to gain insight into key wild game that were of primary concern to them from a mercury perspective. At the workshop, participants were asked about which wild foods they enjoyed eating and provided estimates of how often and how much of each food was consumed. For persons who consume wild game, the following foods and consumption rates were estimated and considered in the previous HHRA (Wilson Scientific, 2013) (provided as the rate when the food was in season or available):

- beaver: consumed 3 times per week (57 g/serving for young child; 200 g/serving for adult);
- muskrat: consumed once per week (57 g/serving for young child; 200 g/serving for adult);
- snowshoe hare: consumed once per week (57 g/serving for young child; 200 g/serving for adult); and
- moose: consumed 5 times per week (100 g/serving for young child; 400 g/serving for adult).

As part of the planned monitoring outlined in the Terrestrial Effects Monitoring Plan (TEMP), and the invaluable participation of a registered trapline holder and his assistants in the winter of 2023/2024, WRCS (2024) obtained and submitted 3 samples of muskrat (kidney, liver and muscle) and 5 samples of beaver (kidney, liver and muscle) from the Gull Lake area for total mercury analysis. In addition to these species, 3 samples of mink (kidney, liver and muscle) and 5 samples of river otter (kidney, liver and muscle) were received and submitted for total mercury analysis; however, there is no current knowledge

[6] Some of this could be achieved though offset lake sampling (*i.e.*, from waterbodies where community members harvest fish regularly and which are not already part of a monitoring program).

of local human consumption of mink or otter. WRCS (2024) submitted these tissues for mercury analysis to determine the accuracy of the predicted concentrations were accurate.

Although WRCS (2024) does caution that the sample size for beaver and muskrat is low, WRCS indicated that their review of the information indicates that their predicted peak concentrations from the EIS remain valid and unchanged for these species. The beaver and muskrat muscle mercury concentrations that were measured and the reaffirmed predictions in WRCS (2024) are summarized in Table 3 below.

Table 3: Summary of Measured Mercury Concentrations in Beaver and Muskrat Muscle Tissue from WRCS (2024)

Species	Range of Concentrations Reported for Winter 2023/24 Samples (ppm [mg/kg]; wet weight)	WRCS Predicted Peak Concentration – Arithmetic Mean and Most-likely Range in Parentheses (ppm [mg/kg]; wet weight)*
Beaver	0.0013 to 0.0033	0.01 (<0.01 to 0.05)
Muskrat	0.0050 to 0.0433	0.04 (<0.01 to 0.12)

*WRCS (2024) re-affirmed that the predicted peak concentrations are the same as those estimated for the EIS and used in Wilson Scientific (2013)

Since the concentrations of mercury in beaver and muskrat muscle remain below or in the range of the concentrations assumed in the previous HHRA and none of the other input assumptions have changed (*i.e.*, TRVs remain current positions of Health Canada and WHO; other input assumptions have not changed), the previous results of no unacceptable risks from consumption of these animals remain valid for those consuming wild foods at the assumed consumption rates.

In the case of the mercury concentrations in kidney and liver of beaver and muskrat, there is no current knowledge that these organs are consumed by people and so it is unlikely that these are a key concern from a mercury intake perspective. In addition, although the mercury concentrations in kidneys are higher than muscle, the maximum concentrations are still relatively low (*i.e.*, 0.0113 mg/kg [same as ppm], wet weight in beaver kidney and 0.0916 mg/kg wet weight in muskrat kidney) and these organs likely represent only a small portion of the animal even if they were consumed. As a result, there is currently a low toxicological risk from the organs of these animals. Nevertheless, information provided in the food surveys, offered in conjunction with the Project's hair sampling program or future wild foods workshop, may possibly shed light in the future on the extent that people are consuming the organs and, if so, how much.

As indicated above, there is no information suggesting that persons are consuming mink or river otter. With this in mind, the mercury concentrations reported by WRCS (2024) for mink and river otter are substantially higher than either beaver or muskrat and these animals would not be recommended for consumption by any age group but particularly not for the sensitive age group. As shown in WRCS (2024), the maximum muscle concentration of mercury was 3.53 mg/kg wet weight for mink (n=4) and 3.15 mg/kg wet weight for river otter (n=5). WRCS (2024) indicated that this is a small sample size but that concentrations were in the range predicted in the EIS. The maximum concentrations of mercury were even higher in liver (11.6 mg/kg wet weight in mink and 13.6 mg/kg wet weight for river otter) and kidney (5.35 mg/kg wet weight in mink and 6.80 mg/kg wet weight for river otter); however, once again, there is

no information suggesting that people are consuming mink or river otter. Nevertheless, it may be prudent to confirm that lack of consumption of mink and river otter remains the case and that people are aware that the mercury concentrations in mink and river otter are substantially higher than muskrat and beaver.

In the case of snowshoe hare and moose, WRCS (2024) has indicated that no samples were submitted for mercury analysis by the partner First Nations in 2023 (under the voluntary sample program outlined in the TEMP), but that WRCS has reasonable confidence in their previous estimates of mercury tissue concentrations. Although WRCS (2024) has indicated that its conclusion remains that mercury concentrations in snowshoe hare and moose are unlikely to change post-impoundment, the previous estimates were based on literature values and, thus, there may be greater uncertainty with respect to the actual tissue concentrations as compared to other species. There were no previous estimates of mercury concentrations in liver or kidney of these animals. WRCS (2024) has indicated their EIS mercury concentration estimates remain valid for snowshoe hare and moose (see Table 4). Using the same concentrations, no unacceptable risks were predicted in the previous HHRA for persons consuming 5 meals per week of moose muscle or 1 meal per week of snowshoe hare muscle; however, no risk estimates are provided from organ consumption from these animals.

Table 4: Summary of Predicted Mercury Concentrations in Moose and Snowshoe Hare Muscle Tissue from WRCS (2024)

Species	Predicted Range of Concentrations under Peak Conditions (ppm [mg/kg]; wet weight)	Predicted Arithmetic Mean Concentration under Peak Conditions (ppm [mg/kg]; wet weight)*	Predicted Change in Concentrations from Prior to Impoundment to Peak Conditions
Moose	<0.01 to 0.17	0.07	No change
Snowshoe hare	<0.01 to 0.12	0.05	No change

*WRCS (2024) re-iterated that the predicted peak concentrations are the same as those estimated for the EIS

Overall, at the current time, there is no information to suggest that persons should be avoiding any of the wild game identified as frequently consumed by the partner First Nations (*i.e.*, beaver, muskrat, snowshoe hare and moose). Nevertheless, it is a limited sample size dataset for some animals and no dataset for others and it is recommended that efforts be made to try to increase participation of the partner First Nations' voluntary submission of all wild foods for mercury testing. It is also stressed that the human health risk interpretation is based on a 2009 wild foods workshop and would benefit from any update to the consumption rates for these wild foods (*e.g.*, a future wild foods workshop).

2.4 Waterfowl

In October 2009, partner First Nations representatives participated in the wild food workshop noted above to provide consumption rates on the key waterfowl that were most likely to be consumed and of primary concern to them from a mercury perspective. For persons who consume waterfowl, the following foods and consumption rates were estimated and considered in the Wilson Scientific (2013) HHRA (when the food was in season or available):

- ducks: consumed once per week (57 g/serving for young child; 200 g/serving for adult); and
- gull eggs (no consumption rate was provided).

In the EIS, the mercury concentration in ducks was estimated to be equal to or less than whitefish (based on modelling of present and current concentrations and not actual sampled data), while no estimate of mercury concentrations in gull eggs was provided. No new data on these wild foods were reported in WRCS (2024) through the voluntary sampling program under the TEMP. WRCS (2024) has confirmed that they consider the duck estimates in the EIS to remain valid and have provided an estimate for Canada goose muscle. Table 5 provides the predicted peak mercury concentrations for waterfowl provided in WRCS (2024).

Table 5: Summary of Predicted Mercury Concentrations in Ducks and Canada Goose Muscle Tissue from WRCS (2024)

Species	Predicted Range of Concentrations under Peak Conditions (ppm [mg/kg]; wet weight)	Predicted Arithmetic Mean Concentration under Peak Conditions (ppm [mg/kg]; wet weight)	Predicted Change in Concentrations from Prior to Impoundment to Peak Conditions
Canada goose	None provided	0.03 (approximate)	No change (approximate)
Mallard duck	None provided	<0.19	Up to a 5-fold change

*WRCS (2024) re-iterated predicted peak concentrations are the same as those estimated for the EIS

In the HHRA completed for the EIS, no unacceptable risks from consumption of ducks were estimated when a mercury concentration of up to 0.19 mg/kg wet weight was assumed and one meal per week was assumed. Canada goose was not evaluated in the previous HHRA; however, with an appreciably lower predicted peak concentration of mercury, risks would be even lower for consumption of one meal per week of Canada goose (as compared to ducks). As a result, there is no current information to suggest that people should avoid consumption of mallard ducks or Canada geese. Nevertheless, similar to that discussed for mammals, it is recommended that additional efforts be explored to encourage sample submission by the partner First Nations (through the voluntary sampling program in the TEMP) for waterfowl species they may be concerned about and continue to determine if there are any refinements that could be made to estimated concentrations of mercury in waterfowl or consumption rates.

As noted above, the October 2009 workshop with the partner First Nations representatives indicated that consumption of gull eggs took place in the Spring by some individuals. In the case of gull eggs, no measurements or predicted mercury concentrations are available and, thus, it is not possible to provide an estimate of risks from this food. If it is desired by the MHHIG that a risk interpretation is provided for consumption of this food, gull eggs will likely need to be submitted for mercury analysis if risk estimates are to be calculated for this food group.

2.5 Plants

During the October 2009, partner First Nations representatives also indicated that a variety of plants could be consumed from the Project area including: Northern tea; blueberries; and Seneca root. Since that time, community members have indicated harvesting of other plants such as wihkes (sweet

flag/muskrat root), wild rice and jack pine needles (WSP, 2024). At the current time, no volunteer samples have been submitted and so it is not possible to provide a risk interpretation based on monitoring results. As noted in the TEMP, plant sampling (Labrador Tea and blueberries) is scheduled to occur in the Summer of 2024.

3.0 Recommended Future Activities

3.1 Ongoing Dialogue with Partner First Nations and Agencies

The mercury and human health risk management plan and associated monitoring was developed through detailed dialogue with the partner First Nations. It is recommended this communication continues, through the MHHIG and other mechanisms such as the Project's Monitoring Advisory Committee, for meaningful inputs into upcoming HHRAs, including comfort level regarding voluntary submission of samples (wildlife, fish and plants). Through their involvement and discussion with MHHIG representatives, health agencies have had a chance to review the preliminary fish results in relation to consumption recommendations and messaging for Stephens Lake; however, the Gull Lake revised whitefish recommendations have not had fulsome discussions. Receiving ongoing feedback from the above representatives about monitoring results and associated risk management tools (*e.g.*, fish consumption materials), the program will have the greatest likelihood of acceptance by both the communities and agencies.

3.2 Environmental Monitoring

With respect to the information used from environmental monitoring programs, a detailed HHRA requires the following:

- a strong dataset;
- firm statements on certainty (re: confirmation of predicted concentrations due to the project); and
- a mechanism to detect early exceedances of predicted concentrations due to the project.

With the above in mind, it needs to be clear that no environmental dataset is perfect and there will always be variability in the data and constraints to how much sampling can be done or is desired by the communities.

Table 6 below provides a summary of the status of the current status of wild foods mercury monitoring that were identified as consumed in a 2009 wild foods workshop. With peak concentrations possibly occurring at present or in the near future, it is an especially important time to have accurate information on mercury concentrations and consumption rates of wild foods. Thus, it is recommended that communities continue to be consulted on the status of wild foods monitoring and missing wild foods consumed from the project area as well as ideas to increase sample submissions if at all possible (and if supported by the communities and agencies).

Table 6: Status of Wild Foods Mercury Monitoring Information Obtained to Date

Wild Food	Modelling of Expected Mercury Concentration Changes (from Other Discipline Experts)	Post-Impoundment Monitoring Mercury Samples Collected?
Whitefish	Detailed quantitative estimates available for Gull and Stephens lakes (North/South, 2021; 2023a; 2024a); however, no other fish species or waterbodies evaluated	Yes
Jackfish		Yes
Pickerel		Yes
Lake Sturgeon	No estimate available	Limited
Beaver	Semi-quantitative of no expected change in mercury (WRCS, 2024)	Yes
Muskrat	Semi-quantitative of doubling of mercury concentrations (WRCS, 2024)	Yes
Moose	Semi-quantitative of no expected change in mercury (WRCS, 2024)	No
Hare	Semi-quantitative of no expected change in mercury (WRCS, 2024)	No
Duck	Semi-quantitative of up to a 5-fold increase in mercury concentrations (WRCS, 2024)	No
Geese	Semi-quantitative of no expected change in mercury (WRCS, 2024)	No
Plants	No estimate available	No
Gull Eggs	No estimate available	No

Wilson Scientific is aware that volunteer submission of samples and/or expanded formal sampling programs may raise various sensitive community and possibly conservation issues and it is not meant to imply that all wild foods require monitoring results. Instead, it is important for communities and agencies to realize that human health risk interpretation will be somewhat constrained for wild foods for which precise modelling results were not available and/or for which monitor results were not obtained. It is recommended that this aspect receives full consideration and if community members or agencies have input or ideas on how they would like to approach other foods, it would be greatly appreciated to learn of these (as noted earlier, with peak concentrations approaching or possibly even occurring at present, it is an especially important time for this consideration to occur). Nevertheless, it is stressed that human health risk interpretation will still be able to be completed on the wild foods for which precise modelling or monitoring data are available and there may be perfectly acceptable reasons for not including certain other foods (*i.e.,* community and agency input is vitally important for deciding if additional effort in obtaining samples is warranted).

In the meantime, the Project team (toxicologist, and fish and wildlife biologists) will continue to work with community members and agencies to provide timely communication of results, review areas where additional samples may add more certainty, keeping in mind added accuracy for effort, conservation, and cultural sensitivities and circumstances. For the purpose of providing strong inputs on a future HHRA, it will be important to consider scientific and regulatory requirements and reconfirm whether current monitoring plans and approaches suffice to provide communities comfort and meet these requirements.

While there is no indication of people currently eating fish at appreciable rates (subsistence or otherwise) from Gull Lake, a boat launch is now constructed upstream of the Keeyask Generating Station. For this reason, there may be merit in future years to consider June sampling in Gull Lake (similar to that established in 2021 for Stephens Lake). Nevertheless, discussions with Manitoba Hydro staff indicated that there are currently many navigational hazards due to the presence of "peat islands" in Gull Lake and they consider there to be low likelihood of appreciable fishing in Gull Lake in 2024 even with the road to the boat launch opening in April 2024.

In the case of the Fall sampling program, analysis would ideally include a reasonable likelihood that standardized size fish are estimated for all fish if possible. As discussed in Holm and Aiken (2024), it was not possible to calculate a standardized size mean for Stephens Lake whitefish due to the small number of fish that were caught. For the current time, it was recommended to not revise consumption recommendations for Stephens Lake whitefish which are based on an assumed peak concentration of 0.15 ppm provided in North/South (2021) and the EIS. Nevertheless, while previously discussed at the MHHIG, community members may have additional input on whether there is any manner to collect sufficient whitefish in the future..

It is unclear if persons are consuming fish organs but if so, these may be considered for analysis in future Fall sample datasets for both Stephens and Gull lakes (unless North/South can provide a reasonable estimate based on fish muscle concentrations).

To enhance the limited dataset of wildlife, exploring additional options to encourage sample submission by the partner First Nations under the voluntary sampling program of wildlife (mammals, waterfowl and gull eggs) and plants would contribute to the feasibility of a detailed HHRA. Furthermore, it may be reasonable to attempt to obtain mercury concentrations in wild game from unaffected areas for comparative purposes through the voluntary sampling program. It is also recommended that the Project biologist continue to determine if there are any refinements that could be made to the methods to estimate concentrations of mercury in wildlife. Nevertheless, as discussed above, it would be recommended that community input is sought for these aspects.

3.3 Wild Foods Workshop

As discussed earlier, an important aspect of the interpretation of human health risks relies on the wild foods and consumption rates that were identified in the October 2009 workshop with the partner First Nations. While a more recent food survey, developed in conjunction with the hair sampling program, provides information about commonly consumed local, wild and market foods, robust information about current consumption rates is lacking. With future hair sampling events offered in communities, food surveys may offer more information in this regard. Regardless, it would be productive to revisit the results of this workshop with the partner First Nations to determine which wild foods remain the key

concerns and if the consumption rates (*i.e.,* frequency and meal sizes) are still applicable. Specifically, if agreed to by the MHHIG and the partner First Nations, a wild foods workshop could be convened to:

- review wild foods and consumption rates identified in the 2009 workshop to determine if these remain valid;
- identify if there are any other wild foods and/or locations that should be monitored in the future (*i.e.*, other species and/or locations than listed in Table 6); and
- discuss ways to encourage volunteer wild foods submission.

As discussed earlier, with peak mercury concentrations possibly occurring or near occurring at the current time, there possibly has never been as important a time to understand the wild foods and consumption rates and so it is recommended that if the partner First Nations are in agreement that the wild foods workshop occurring as soon as possible.

3.4 Testing of the Communication of Risk Messages

As noted earlier, it is important that the risk messages are communicated in an effective manner. In particular, there are certain fish species and sizes that are recommended to be avoided and it would be helpful to assess whether the messages are well understood and being followed in the larger communities. This would also involve listening to the communities for other methods to communicate the messages. As such, it is recommended that the MHHIG would consider possible opportunities for testing of the current communication materials and other approaches that are currently in place.

4.0 Conclusions

Overall, based on the exceedances of previous predicted peak mercury concentrations, certain revisions to fish consumption recommendations for Stephens and Gull lakes were recommended in order to be protective of human health. Specifically, it was recommended that previous North/South (2021)/EIS peak concentration estimates be replaced with contingency peak mercury concentration estimates for Stephens Lake pickerel and jackfish (North/South, 2023a) and Gull Lake whitefish (North/South, 2024a). As such, it was necessary to revise the consumption recommendations for these fish. The most notable revision to consumption recommendations is that all sizes of Stephens Lake jackfish and pickerel are now recommended to be avoided by sensitive populations. In addition, Gull Lake whitefish of standardized size (*i.e.*, 350 mm) are no longer considered to be a very good choice fish and instead are now in the occasional consumption category and these fish are recommended to be avoided by sensitive members of the population when longer than 350 mm and all members of the population when longer than 500 mm.

The North/South (2023b) and Holm and Aiken (2024) dataset illustrates the toxicological importance of avoiding certain fish from both Stephens and Gull lakes. Although fish in Stephens Lake are predicted to have appreciably lower concentrations than in Gull Lake, it is important to continue and/or enhance (if opportunities are identified) communication efforts that there are fish in both Gull and Stephens lakes that people are advised to limit consumption or avoid altogether. In addition, because there is little regulatory precedent for risk interpretation of the information taken from the ridgeline plots, it is recommended that discussions with the communities and the regulatory agencies occur in the near future.

Based on environmental data and predictions provided in WRCS (2024), there is no information to suggest that persons should be avoiding consumption of any the wild mammals or waterfowl identified as frequently consumed by the partner First Nations (beaver, muskrat, snowshoe hare, moose and waterfowl). Nevertheless, it is stressed that for some of these food groups, no voluntary samples have been submitted for confirmatory sampling (*i.e.,* snowshoe hare, moose or waterfowl) while for other foods, WRCS (2024) has indicated that the sampling is somewhat limited (*i.e.,* muskrat and beaver). Finally, for some other food groups (*i.e.,* gull eggs and plants), there have been no voluntary samples submitted and the discipline experts were not able to provide concentration estimates based on quantitative or semi-quantitative modelling. It is recommended the Project team involved in providing inputs into and/or implementing the Mercury and Human Health Risk Management Plan continue to work together to maximize opportunities to secure a robust dataset for fish and wildlife and achieve regulatory agency acceptance of data for the purposes of an HHRA.

With the above noted, it is not meant to imply that all wild foods require monitoring data and it is recognized that volunteer submission of samples and expansion of formal sampling programs may raise various sensitive community and conservation issues. Nevertheless, community input is vitally important for deciding if additional effort in obtaining samples is warranted and, consequently, it is recommended that the discussions continue on sampling programs (as noted earlier, with peak concentrations approaching, it is an especially important time for these discussions to occur).

Finally, reconvening a wild foods workshop with the partner First Nations could potentially be very beneficial. Although the hair and food survey may provide useful information, other possible approaches are recommended to receive consideration including a wild foods workshop, subject to community input. As the project is nearing or possibly already experiencing peak mercury concentrations, it is an especially important time to ensure that the key food groups harvested in the Keeyask area by the partner First Nations and nearby communities are attempted to be evaluated with the most up to date information possible on both wild food consumption patterns and mercury concentrations in such foods. If the partner First Nations are willing, a reconvening of the wild foods workshop may assist in determining if the current program addresses the foods of greatest concern and identifying possible ideas for improvements. In the interim (*i.e.*, prior to a workshop being convened if this recommendation is adopted), if there are concerns or input from agencies or individuals in the communities regarding the current wild food program and assumptions, it would be very beneficial to learn of these from a human health risk perspective as soon as possible.

5.0 Statement of Limitations

This report has been prepared by Wilson Scientific Consulting Inc. (Wilson Scientific) for the sole benefit of Manitoba Hydro. Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Wilson Scientific accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional staff in accordance with generally accepted scientific practices current at the time the work was performed.

Any site-specific information provided by Manitoba Hydro, North/South Consultants Inc., Wildlife Resources Consulting MB Inc. or other parties has been assumed by Wilson Scientific to be accurate. Conclusions presented in this report should not be construed as legal advice.

This risk evaluation was undertaken exclusively for the purpose outlined herein and was limited to those contaminants, exposure pathways, receptors, and related uncertainties specifically referenced in the report. This work was specific to the site conditions and land use considerations described in the report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations.

This report describes only the applicable risks associated with the identified environmental hazards, and is not intended to imply a risk-free site. Should any conditions at the site be observed or discovered that differ from those at the sample locations, or should the land use surrounding the identified hazards change significantly, Wilson Scientific requests that to be notified immediately to reassess the conclusions provided herein.

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Technical Memorandum

To: Manitoba Hydro

From: Ross Wilson, M.Sc., DABT, Wilson Scientific Consulting Inc.

Date: June 13, 2024

Re: Revisions to Recommended Maximum Monthly Intake Rates for Post-impoundment Fish Consumption from Stephens and Gull Lakes Based on 2023/2024 Contingency Peak Concentrations

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Introduction

The Keeyask Mercury and Human Health Risk Management Plan was prepared to fulfill the requirements of The Environment Act (Manitoba) License No. 3107 and outlines a range of commitments to monitor and mitigate the risks associated from increased methylmercury in the environment as a result of the operation of the Keeyask Generation Project (the Project), including sampling of fish from Gull and Stephens lakes. As part of this effort, Wilson Scientific Consulting Inc. (Wilson Scientific) has been retained by Manitoba Hydro to assist the Keeyask Hydropower Limited Partnership in meeting Keeyask monitoring and license commitments relating to mercury and human health. This includes conducting a human health risk interpretation of predicted peak average concentrations of mercury in fish from Gull and Stephens lakes.

The 2023 fish monitoring results have demonstrated exceedances in predicted peak concentrations for specific fish species in Gull and Stephens lakes (North/South, 2023b; Holm and Aiken, 2024). As a result, the consumption recommendations developed in 2021 for post-impoundment conditions based on predicted peak concentrations in Gull and Stephens lakes fish are no longer valid for whitefish in Gull Lake and pickerel and jackfish in Stephens Lake. In order to prepare new consumption recommendations, North/South Consultants Inc. (North/South) developed revised predicted peak mercury concentrations for pickerel and jackfish in Stephens Lake (North/South, 2023a) and whitefish in Gull Lake (North/South, 2024).

This memorandum is written at a technical level and is intended to inform Manitoba Hydro and the Mercury and Human Health Implementation Group (MHHIG) regarding the recommended maximum monthly intake rates associated with the peak concentrations of mercury in fish predicted by North/South (2021; 2023a; 2024). In addition to ongoing consultations with the partner First Nations, it is important that health agencies are aware of the updated peak fish tissue model concentrations and concur with the risk interpretation. A consistent message from all experts will likely reduce confusion and skepticism regarding the safety of consuming fish.

With the above in mind, all risk interpretations provided in this memorandum should be considered preliminary. Nevertheless, the approach and results have been part of previous presentations with health agencies and the partner First Nations and their representatives. It is recommended that continued dialogue with and feedback from the partner First Nations and regulatory agencies should be considered prior to making more final conclusions. It is noted that the fish sampling program is an ongoing effort and continuing monitoring and interpretation of the dataset is planned and may result in changes to the information provided in this memorandum.

Wilson Scientific has not completed a critical analysis of the methods or conclusions of the North/South (2021; 2023a; 2024) reports and instead all fish mercury concentrations and predictions provided by North/South have been assumed to be accurate and representative in the Keeyask Project Area.

Methods for Development of Fish Consumption Recommendations

Fish consumption guidelines are established by regulatory agencies such as the Province of Manitoba (such as Manitoba Department of Conservation and Climate) and/or the Government of Canada (such as Health Canada). Therefore, this memorandum provides fish consumption recommendations rather than formal guidelines which were developed to be. generally consistent with the approach that the various agencies use in developing guidelines. With a few exceptions noted below, Wilson Scientific adopted the following approaches to inform the Keeyask fish consumption recommendations: the Province of Manitoba (2007) recreational fish consumption guidance, Health Canada's fish consumption approach (Health Canada, 2007) and risk assessment advice from Health Canada (Health Canada, 2007; 2019; 2021) and the World Health Organization (WHO, 2007). One key aspect of the identified Health Canada and WHO guidance that was not consistent with all sources was the differing definitions of age groups for sensitive populations assumed by Province of Manitoba (2007) and Health Canada (2007) versus WHO (2007) and Legrand et al. (2010) (this issue is discussed in greater detail below). In addition, rather than providing recommendations as servings per month (*e.g.*, by the Province of Manitoba [2007]), the approach provided recommendations as pounds per month. This approach was preferred by representatives of the partner First Nations) (Health Canada [2019] provides a similar approach although uses grams per month).

The methods used to develop the fish consumption recommendations are similar to those provided in Wilson Scientific (2021a,b; 2022) with the exception that the assumed peak concentrations of mercury in fish have been revised by North/South and, thus, the fish concentrations outputs have changed. Briefly, in Wilson Scientific (2021a; 2022), the mercury concentrations in fish were based on the assumption that North/South (2021)/EIS predicted peak concentrations were occurring in present day post-impoundment fish. This approach was developed through consultation with the partner First Nations and Medical Officers of Health from Manitoba Health and Northern Health Region whereby it was determined that it was most appropriate to assume that peak post-impoundment conditions were occurring immediately following impoundment. Nevertheless, the most recent June and Fall 2023 sampling events found mercury concentrations in certain fish exceed the predicted concentrations. As discussed below, North/South established revised/contingency estimates of peak mercury concentrations (2023a; 2024) which were then used by Wilson Scientific as the basis for revised consumption recommendations.

Aside from the change in predicted concentrations of mercury in fish, all other elements of the approach are similar to that presented in Wilson Scientific (2021a; 2022).

Overall, the general equation to estimate fish consumption recommendations is provided as Equation 1 below:

$$\textit{Maximum Monthly Fish Intake} = \frac{BW \times DP \times TDI}{PMC} \qquad \textit{(Equation 1)}$$

where:

BW = body weight of person of interest (kg)
DP = dose-averaging period (days)
TDI = tolerable daily intake for methylmercury (µg/kg bw/day)
PMC = peak mean concentration of mercury in fish species and size of interest (µg/g; wet weight)

The selection of the input parameters for Equation 1 were discussed at length within the MHHIG and are summarized below.

The Province of Manitoba (2007) recommends sensitive individuals avoid fish with mercury concentrations above 0.5 µg/g (*i.e.*, ppm) and all others avoid fish above 1.5 µg/g (*i.e.*, the "avoid" category). Although it was possible to calculate maximum monthly fish intake rates for fish with mercury greater than these threshold concentrations, it could create the scenario that persons consuming such fish would then need to avoid other fish lower in mercury since their monthly intake of fish would be allocated to these higher mercury fish. In addition, such an approach would be inconsistent with the Province of Manitoba (2007) approach. As a result, fish consumption recommendations were not provided for fish class sizes that have mercury concentrations greater than those that are classified in the Province of Manitoba (2007) "avoid category".

It is noted that Equation 1 assumes that all of the mercury in fish is present as methylmercury and that all of the TDI for methylmercury can result from fish intake. This approach of using 100% of the methylmercury TDI for fish intake is consistent with the Province of Manitoba (2007) and Health Canada (2007; 2019); however, agencies may consider evaluation of only the methylmercury component for fish if adequate sampling data were available that speciated the mercury as it may assist in the development of more specific consumption recommendations. It would seem that all major agencies face a similar issue regarding the difficulty accounting for other non-fish sources but have determined that the best approach is to allow for the entire methylmercury TDI to result from fish consumption

Furthermore, the above equation does not account for a person who may eat multiple fish species and/or from multiple waterbodies. This is an issue that is common with Province of Manitoba (2007) and Health Canada (2007; 2019) approaches and requires that in such cases, the person adjusts their intake based on a ratio approach (discussed in greater detail below [and Attachment 1] and as well in Province of Manitoba [2007] and Health Canada [2007; 2019]).

Finally, the approach assumes receptors are a certain body weight. It is recommended that people would adjust their intake based on their own situation, particularly for persons who weigh substantially less than assumed). Attachment 1 provides a worked example of how such an adjustment may be made.

Body Weight

In Province of Manitoba (2007), there are 3 distinct groups of people that are evaluated for protection of risks from mercury in fish:

1) children under 12 years of age;

2) females of childbearing age; and,

3) all others.

As discussed in Wilson Scientific (2021b), there was some guidance identified that adolescents who are 18 years of age and younger should also be considered to be in the sensitive age group. Following discussions with the MHHIG and Manitoba Health, it was decided that adolescents would be included in the sensitive age group.

For children under 12 years of age, females of childbearing age and all others, generic body weights used in this assessment were consistent with those used by the Province of Manitoba (2007) and, therefore, fish consumption recommendations are comparable to published recreational guidelines in this respect. In the case of adolescents (*i.e.*, 12 years to less than 19 years of age), Health Canada (2024) provides a body weight of 59.7 kg for persons between the ages of 12 years to less than 20 years of age and for the purposes of these consumption recommendations, this value was rounded to 60 kg (*i.e.*, same value as females of childbearing age). It is noted that Health Canada (2007; 2019) has evaluated age groups that included toddlers and older children split into separate age groups; however, this approach was not adopted due to lack of consistency with the Province of Manitoba (2007). Nevertheless, this is primarily a preference of communication style and other options remain a possibility for future fish consumption recommendations.

For the development of consumption recommendation, the average body weights used were as follows:

- children under 12 years of age = 30 kg (66 lbs);
- adolescents 12 years to less than 19 years of age = 60 kg (133 lbs);
- females of childbearing age = 60 kg (133 lbs); and
- all others (males over 18 years; females past childbearing age) = 60 kg (133 lbs).

Although the fish consumption calculations use the above body weights, adjustment should be made if a person has an appreciably different body weight. This is particularly important if they weigh substantially less than the body weights used in this assessment (as lower fish consumption recommendations would be applicable) (Attachment 1 provides the approach on how people can adjust consumption recommendations for different body weights and provides a specific example for a 15 kg toddler). If desired, additional communication material can be developed for the various communities to help a person calculate their own weight-specific consumption recommendations (and the mathematical approach is also presented later in Attachment 1 to this memorandum).

Dose-Averaging Period

The dose-averaging period refers to the timeframe over which mercury exposures can be averaged and then compared to the tolerable daily intake (TDI). A dose-averaging period of 30 days is used by the Province of Manitoba (2007) whereby meals per month are estimated for recreational fish consumption

guidelines. Health Canada has not specified a defined dose-averaging period for evaluation of mercury but they also provide examples of fish consumption recommendations on a monthly basis (*e.g.*, recommendations on fish consumption in amounts per month is used in Health Canada [2007; 2009; 2019] for certain types of fish). Sakamoto *et al.* (2017) evaluated this issue and documented support for dose-averaging periods of once every 14 days (*i.e.*, they showed no appreciable difference in risks when methylmercury doses were spread out over this timeframe); however, through personal communications, Dr. Sakamoto indicated that once every 14 days was about the lowest reasonable frequency of fish consumption in the Japanese population and their results should not be interpreted that a 14 day period is the maximum dose-averaging period.

With the above in mind, a dose-averaging period of 30 days was selected for the purposes of fish consumption recommendations. Monthly dose-averaging is consistent with the Province of Manitoba (2007) approach, certain fish consumption advice provided by Health Canada (2019) and various other sources in making decisions regarding fish consumption.

Tolerable Daily Intake

The tolerable daily intake (TDI), also sometimes referred to as the acceptable daily intake or ADI, refers to the average daily intake of a substance that is considered to be without appreciable risk of health effects. To develop recreational fish consumption guidelines, the Province of Manitoba (2007) approach cited Health Canada and the WHO as the source of TDI (or ADI) for methylmercury. Province of Manitoba (2007) used values of 0.2 µg/kg bw/day for sensitive members of the population (women of childbearing age and children under 12 years of age) and 0.47 µg/kg bw/day for all others. Health Canada (2021) provides provisional TDIs of 0.2 µg/kg bw/day for sensitive members of the population (women of child-bearing age, infants and children under 12 years of age) and 0.47 µg/kg bw/day (non-sensitive adults). WHO (2007) provided provisional tolerable weekly intakes (TWIs) of 1.6 µg/kg bw/week and 3.3 µg/kg bw/week for sensitive and non-sensitive members of the population, respectively, which when divided by 7 days per week result in TDIs of 0.23 and 0.47 µg/kg bw/day. Thus, the Province of Manitoba (2007) approach remains reasonably consistent with Health Canada and the WHO.

With the above in mind, the revised approach adopted in the current evaluation added female and male adolescents (*i.e.*, 12 years to less than 19 years of age) to the sensitive age group. Wilson Scientific (2021b) provides an overview of this issue and subsequent discussions with the MHHIG and Manitoba Health supported this decision.

The Province of Manitoba (2007) approach considers women of childbearing age to be sensitive receptors; however, the exact age range for women of childbearing age is not defined. Nevertheless, for the purposes of the fish consumption recommendations, females less than 50 years of age including teenagers would be a reasonable definition of this group that would add clarity. Consequently, we have adopted the term “females of childbearing age” (rather than women of childbearing age) as part of the sensitive population to represent all females less than 50 years of age.

For the purposes of these consumption recommendations, Province of Manitoba (2007) and Health Canada (2007; 2021) approaches for TDIs for methylmercury were adopted with the modification that the sensitive population was considered to include children under 19 years of age and females of childbearing age (all females less than 50 years of age) (*i.e.*, rather than children under 12 years of age and women of childbearing age). This allows consistency with the current Manitoba approach and also includes all

adolescents 18 years and under as part of the sensitive population. As is shown below, when the approach was revised to include adolescents 18 years and under in the sensitive group, fish consumption recommendations for adolescents 12 to 18 years of age were equal to those for females of childbearing age (since similar TDI of 0.2 µg/kg bw/day and body weight of 60 kg would be used for both groups). Beyond the fish consumption recommendations, this approach may also be applicable to the hair analysis.

Peak Mean Concentration of Mercury in Fish

In 2021, North/South re-affirmed its previous Environmental Impact Statement (EIS) peak concentrations for standardized size fish (whitefish, pickerel and jackfish) from Gull and Stephens lakes and then also provided predictions of peak post-impoundment fish concentrations of total mercury for three size classes of fish (North/South, 2021). Wilson Scientific (2021a; revised 2022) used these predicted peak concentrations to develop recommendations for maximum monthly intakes for whitefish, pickerel and jackfish from Stephens and Gull lakes under post-impoundment conditions. The 2023 sampling results showed that that standardized size pickerel caught in Stephens Lake in June (North/South, 2023b) and pickerel and jackfish caught in Stephens Lake in Fall 2023 (Holm and Aiken, 2023) exceeded the peak predictions for standardized size fish provided in North/South (2021)/EIS. In addition, Holm and Aiken (2024) reported that Gull Lake standardized size whitefish exceeded the peak predictions provided in North/South (2021)/EIS. As a result, it was recommended that contingency peak concentration estimates for Stephens Lake jackfish and pickerel (North/South, 2023a) and Gull Lake whitefish (North/South, 2024) replace the North/South (2021)/EIS peak concentration predictions as a basis for developing more accurate consumptions recommendations for the fish noted above.

North/South provided the following contingency estimates of peak concentrations of mercury for Stephens Lake pickerel and jackfish (North/South, 2023a) and Gull Lake whitefish (North/South, 2024) to be used as their best estimates of mercury concentrations, if the North/South (2021)/EIS estimated peak concentrations were exceeded:

- North/South (2023a) contingency Stephens Lake peak mean mercury concentrations were 0.78 ppm for pickerel at 400 mm and 0.62 ppm for jackfish at 550 mm. These concentrations were based on the same prediction of a doubling of mercury concentration under peak conditions that was used in North/South (2021)/EIS; however, revised pre-impoundment baseline concentrations of 0.39 ppm for pickerel at 400 mm and 0.31 ppm for jackfish at 550 mm were assumed based on more recent sampling completed in 2012, 2015 and 2018 (see North/South [2023a] for details); and

- North/South (2024) contingency peak mean for Gull Lake whitefish at 350 mm was 0.35 ppm. This estimate was based on a 5-fold increase in mercury concentrations over baseline (previous North/South [2021]/EIS estimate was based on a 3-fold increase).

In June 2023, North/South collected fish from Stephens Lake as part of a supplemental fish sampling event. In this sampling event, mean mercury concentrations in pickerel at 400 mm and jackfish at 550 mm were calculated by North/South to be 0.68 and 0.48 ppm, respectively. Although the mean mercury concentrations in jackfish were less than the North/South (2021)/EIS peak predicted concentration of 0.5 ppm, the mean mercury concentration of pickerel exceeded the North/South (2021)/EIS peak prediction

of 0.5 ppm. The mean mercury concentration in pickerel also exceeded the trigger concentration of 0.6 ppm (20% greater than 0.5 ppm) which had been established for prompting consideration of potential recall/revision of the communication materials. As a result, meetings were held with the MHHIG and various health agencies in July 2023 when the Group recommended to adopt the mercury concentrations in the contingency plan on a conditional basis for Stephens Lake jackfish and pickerel until the Fall fish sampling results were available.

In Fall 2023, North/South completed fish sampling in Stephens and Gull lakes as part of the annual fish sampling event (mostly in August but some whitefish sampling in October). For this sampling event reported in Holm and Aiken (2024), mean mercury concentrations were found to exceed the North/South (2021) predicted peak concentrations for Stephens Lake jackfish (0.62 ppm vs 0.5 ppm at 550 mm) and pickerel (0.59 ppm vs 0.5 ppm at 400 mm) while a standardized size mean could not be calculated for Stephens Lake whitefish. Consequently, at a meeting held with the MHHIG in December 2023, it was recommended to adopt the Stephens Lake contingency mercury concentrations for jackfish and pickerel on a permanent basis (*i.e.*, previously, the contingency concentrations were adopted on a conditional basis).

In the case of Gull Lake fish sampling in Fall 2023, it was found that whitefish exceeded the North/South (2021)/EIS predicted mean peak concentration. As described in Holm and Aiken (2024), the mean concentration of Gull Lake whitefish at 350 mm was 0.30 ppm as compared to the predicted peak concentration of 0.19 ppm. On the other hand, Gull Lake jackfish (0.84 ppm at 550 mm) and pickerel (0.78 ppm at 400 mm) were less than the North/South (2021) predicted peak concentration of 1.0 ppm for both of these fish species at standardized size. These results were also discussed at the December 2023 MHHIG meeting; however, the contingency peak of 0.35 ppm for Gull Lake whitefish had not yet been developed by North/South. Since this meeting, the MHHIG has been sent the North/South (2024) contingency estimate for Gull Lake whitefish; however, at the current time, there has not yet been a final discussion on whether or not the MMHIG will recommend adoption of the contingency estimate.

Table 1 below provides the predicted peak concentrations provided by North/South that have been used to develop the current (as of May 2024) fish consumption recommendations for Gull and Stephens lakes, respectively.

Table 1: North/South Predicted Peak Mean Concentrations for Fish Species from Stephens and Gull Lakes (Current as of May 2024)

Waterbody	Fish Species and Standardized Size	Predicted Average Peak Concentration for Standardized Size	North/South Reference
Stephens Lake	Whitefish (350 mm)	0.15 ppm	North/South (2021)/EIS
	Pickerel (400 mm)	0.78 ppm	North/South (2023a)
	Jackfish (550 mm)	0.62 ppm	North/South (2023a)
Gull Lake	Whitefish (350 mm)	0.35 ppm	North/South (2024)
	Pickerel (400 mm)	1.0 ppm	North/South (2021)/EIS
	Jackfish (550 mm)	1.0 ppm	North/South (2021)/EIS

In addition to these estimates, size class estimates provided in North/South (2021) have been used for communication products for Stephens Lake whitefish and Gull Lake pickerel and jackfish. For these fish, North/South (2021) provided the following estimates:

- Stephens Lake whitefish: 0.122 ppm for fish less than 300 mm (fork length); 0.184 ppm for fish 300 to 450 mm; and, 0.318 ppm for fish longer than 450 mm.
- Gull Lake jackfish: 0.76 ppm for fish less than 500 mm; 1.54 ppm for fish 500 to 750 mm; and, 3.55 ppm for fish longer than 450 mm.
- Gull Lake pickerel: 0.777 ppm for fish less than 400 mm; 2.38 ppm for fish 400 to 550 mm; and, 3.38 ppm for fish longer than 550 mm.

Communications with Manitoba Hydro have indicated that North/South still considers the above class sizes to represent their best estimates and thus were used to inform the fish tapes for the fish species that have not exceeded North/South (2021) peak estimates. In the case of the other fish that have exceeded the North/South (2021) peak estimates and for which North/South (2023a; 2024) developed contingency estimates (*i.e.,* jackfish and pickerel from Stephens Lake and whitefish from Gull Lake), the class estimates of North/South (2021) are no longer considered to be valid and there are no replacement estimates. Nevertheless, it would seem that predicted peak concentrations would be even greater than North/South (2021) and would likely lead to mercury concentrations in the range of or exceeding 2 ppm in the largest class sizes of jackfish (>750 mm) and pickerel (>550 mm). In the case of Gull Lake whitefish, North/South's best estimate (2024) indicates that fish longer than 500 mm could have mercury concentrations greater than or equal to 1.5 ppm**.**

Estimation of Maximum Monthly Intake

The equations used to estimate maximum monthly intake are focused on predicted average concentrations of total mercury in fish. For the purposes of these calculations, total mercury has been assumed to be present as 100% methylmercury. Although this is a conservative assumption from a toxicological perspective, it may not be optimal from a nutritional perspective. Nevertheless, at the current time, a conservative approach is consistent with the Province of Manitoba (2007) approach (it is unclear how Health Canada approaches this) and there is no methylmercury data available from either predicted peak or measured monitoring information. There may be options in the future to revisit this aspect; however, there would be various regulatory and scientific uncertainties that would need to be addressed.

The equations used to estimate maximum monthly intake are also focused on predicted average (arithmetic mean) concentrations of mercury in fish at its peak period. Within each size range, there will be variability in mercury concentrations in fish (*e.g.*, not all jackfish of standardized size of 550 mm from Stephens Lake will have a concentration of 0.62 ppm). Nevertheless, given the toxicokinetics of methylmercury (*i.e.*, with a blood half-life of 30 to 70 days or so, it takes a relatively long period of fish consumption to reach stable blood and hair concentrations), use of average mercury concentration in fish is considered to be reasonable for estimating maximum monthly intakes (as well as for predicting blood and hair concentrations that are protective of health risks). For the time being, it is reasonable to use average fish concentrations to predict these longer-term intakes[1]. Use of average concentrations also has the advantage of addressing the positive health benefits of fish consumption (*e.g.*, if say 90th percentile fish mercury concentrations were used, consumption of certain fish may be unnecessarily discouraged).

Results - Fish Consumption Recommendations

The revised receptor-specific maximum monthly intakes for the various fish species are provided in Table 2 for Stephens Lake and Table 3 for Gull Lake. A worked example of the calculation approach is provided in Attachment 1. If a person has an appreciably different body weight than assumed, it is recommended that the person makes an adjustment for their body weight using the approach provided in Attachment 1. Similarly, if a person is consuming fish of multiple species or different sources (other lakes or rivers or store-bought), it will be necessary to account for these other sources. These results are discussed in greater detail below for Gull and Stephens lakes.

As discussed in the methods section of this memorandum, fish consumption recommendations (monthly maximum intakes) were not developed for fish in the Province of Manitoba (2007) "avoid category" which includes recommendations that: 1) sensitive individuals should avoid fish with a mercury concentration greater than 0.5 µg/g; and 2) non-sensitive individuals should avoid fish with a mercury concentration greater than 1.5 µg/g.

For fish from Stephens and Gull lakes that did not fall into the "avoid category", maximum monthly intakes were calculated and are provided in Tables 2 and 3, respectively. If a person consumed fish at these monthly rates on a consistent basis, it is estimated that they would not exceed the TDIs of 0.2 µg/kg bw/day for sensitive individuals or 0.47 µg/kg bw/day for all others. Consequently, these maximum

[1] Information from ridgeline plots, discussed in Wilson Scientific, 2024 (Appendix 4a) is recommended as a discussion topic in future discussions with the MHHIG and health agencies.

monthly intakes are considered to be associated with acceptable risks from a mercury perspective and are consistent with the Province of Manitoba and Health Canada approaches.

As discussed earlier, the final consumption recommendations were based on standardized size fish. Although the size class information from North/South (2021) was useful and did a play a minor role in the consumption recommendations, it was decided through dialogue with the MHHIG and Manitoba Health that the quantitative aspect of the maximum amount of fish intake would mostly be based on standardized size fish and not the size classes; however, size class information and/or lengths based on modelled mercury concentration categories is used to some extent in the fish tapes. Based on this and the 2023 sampling events, it was recommended that communication materials be revised to provide new recommendations that: 1) sensitive individuals avoid all sizes of pickerel and jackfish in Stephens Lake; 2) all others consume lower amounts of Stephens Lake pickerel and jackfish; 3) sensitive and all others consumer lower amounts of Gull Lake whitefish; and 4) avoid Gull Lake fish longer than 350 mm and 500 mm for sensitive and all others, respectively. Tables 2 and 3 provide the recommended maximum monthly intake for protection against unacceptable risks from mercury for Stephens and Gull lakes, respectively.

As discussed earlier, the calculations in Tables 2 and 3 assume average body weights for the general population (*i.e.*, 30 kg or 66 lbs for children under 12 years; 60 kg or 133 lbs for females of childbearing age and all others); however, if a person has an appreciably different body weight than assumed in these calculations, it is recommended that an adjustment for their individual body weight is made, particularly if they weigh less than assumed. For example, for a young child who weighs 15 kg rather than the assumed 30 kg, their maximum monthly intake would be half of the values provided in Table 3. Similarly, for an adult who weighs 90 kg, their maximum monthly intake would be 1.5-times greater than provided in Table 3. Communication of proposed adjustments could be presented to community members as an additional resource to assist in making informed decisions about fish consumption (more information on the mathematical adjustments is provided in Attachment 1).

If a person is consuming fish of multiple species or obtaining fish from other lakes or rivers or store-bought, it is recommended that a person should try to account for these other sources (Province of Manitoba (2007) presents a similar mathematical approach in their guidelines). For example, if a person is consuming both whitefish and pickerel from Stephens Lake, the values provided in Table 2 are recommended to be adjusted using a ratio approach. Attachment 1 provides a worked example showing the approach that can be used to make these calculations.

Table 2: Revised Recommended Maximum Monthly Intake of Various Fish under Predicted Contingency Peak Post-Impoundment Conditions at Stephens Lake

Fish Species	Fish Size (as fork length)	Assumed Peak Average Concentration (wet weight)	Recommended Maximum Monthly Intake Due to Mercury (pounds per month) for Fish Up to Standardized Size*		
			Children Under 12 years of Age	Youth (12 yrs to less than 19 yrs of age) and Females of Childbearing Age	All Others (Females Past Childbearing Age and Adult Males)
Whitefish	Up to 350 mm	0.15 ppm	2.6	5.3	12.4
	Greater than 350 mm	0.318 ppm**	1.2	2.5	5.9
Pickerel	Up to 400 mm	0.78 ppm	Avoid	Avoid	2.4
	Greater than 400 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid
Jackfish	Up to 550 mm	0.62 ppm	Avoid	Avoid	3.0
	Greater than 550 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid

* Recommendations for revised Stephens Lake communication material is for sensitive individuals to avoid pickerel and jackfish of any length and all people to avoid Stephens Lake pickerel and jackfish larger than standardized sizes
** For Stephens Lake whitefish greater than 350 mm, the predicted peak mercury concentration for the largest size class of > 450 mm in North/South (2021) was assumed (*i.e.*, 0.318 ppm)

Table 3: Revised Recommended Maximum Monthly Intake of Various Fish under Predicted Contingency Peak Post-Impoundment Conditions at Gull Lake

Fish Species	Fish Size (as fork length)	Assumed Peak Average Concentration (wet weight)	Recommended Maximum Monthly Intake Due to Mercury (pounds per month) for Fish Up to Standardized Size		
			Children Under 12 years of Age	Youth (12 yrs to less than 19 yrs of age) and Females of Childbearing Age	All Others (Females Past Childbearing Age and Adult Males)
Whitefish	Up to 350 mm	0.35 ppm	1.1	2.3	5.3
	Greater than 350 mm but less than 500 mm	1.5 ppm*	Avoid	Avoid	1.2
	Greater than 500 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid
Pickerel	Up to 400 mm	1.0 ppm	Avoid	Avoid	1.9
	Greater than 400 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid
Jackfish	Up to 550 mm	1.0 ppm	Avoid	Avoid	1.9
	Greater than 550 mm	May exceed 1.5 ppm	Avoid	Avoid	Avoid

* For Gull Lake whitefish between 350 and 500 mm, the North/South (2024) predicted peak mercury concentration for fish at 500 mm of 1.5 ppm was assumed for all fish in this size class

It is noted that Holm and Aiken (2024) produced ridgeline plots from the 2023 dataset that predict that certain individual fish of standardized size in Gull and Stephens lakes will have appreciably greater concentrations than the mean concentrations. As a result, it is possible that following the consumption advice for specific fish lengths will result in consuming individual fish greater than the peak concentration estimates and, thus, it illustrates the rationale for consuming smaller fish when possible as these would have lower likelihood of elevated concentrations (*i.e.*, the smaller the fish, the lower the mercury concentration and the lower the likelihood of consuming a fish with particularly elevated mercury concentrations). For Gull Lake fish, Figure 7 of Holm and Aiken (2024) shows that approximately one-quarter of jackfish at 550 mm and pickerel at 400 mm are predicted to exceed mercury concentration of 1 ppm (with some individual jackfish at 550 mm approaching 2 ppm and some individual pickerel at 400 mm predicted to exceed 2.5 ppm)[2]. In the case of Gull Lake whitefish at 350 mm, it appears that about 10% of these may exceed 0.5 ppm in the 2023 dataset. It is stressed that these ridgeline plots are for standardized size fish and so fish that are greater than these standardized sizes are expected to have even higher concentrations.

In the case of Stephens Lake, the jackfish and pickerel mercury concentrations in the ridgeline plots are less severe but nevertheless there are concentrations predicted to occur for individual jackfish and pickerel of standardized size which are appreciably greater than the most recent peak contingency estimates (this is to be expected as the estimates are average concentrations and so there will be some fish higher and some fish lower). As shown in Figure 8 of Holm and Aiken (2024), Stephens Lake jackfish show upper bound ridgeline plots in the range of 1.6 ppm vs contingency peak of 0.62 ppm and pickerel upper bound ridgeline plots in the range of 1.3 ppm vs contingency peak of 0.78 ppm (all for standardized size fish of 550 mm for jackfish and 400 mm for pickerel) These ridgeline plots are potentially very useful and interesting; however, at the current time, it is difficult to interpret the impact on fish consumption recommendations and ongoing discussion with and consideration by the MHHIG and agencies is recommended. Nevertheless, with the recent changes to the fish consumption recommendations for sensitive populations to avoid all sizes of Stephens Lake pickerel and jackfish, the interpretation of the ridgeline plots is not as great of an issue (*i.e.*, there seems to be low likelihood of frequent exceedances of the 1.5 ppm in pickerel up to 400 mm and jackfish up to 550 mm).

As suggested above, it is stressed that pickerel and jackfish longer than 400 mm and 550 mm, respectively, could have higher concentrations than indicated in the ridgeline plots and so it remains important that these fish in particular are avoided for both lakes. If persons are consuming these fish on even an occasional basis (*i.e.*, a large serving once per month), the Health Canada and WHO provisional TDIs will be exceeded and elevated hair concentrations of mercury may be expected. Although it is a frequent general message that not eating enough fish can also be associated with adverse health effects, it is stressed that more harm than benefits would possibly result from eating these fish in the "avoid category" (actual risks would be dependent upon fish concentration, frequency of meals and age/body size of person but nevertheless, the most straightforward approach would be to avoid such fish). Consequently, it is important that this message of avoidance is communicated in the most effective manner possible and that consumption habits are monitored to the maximum extent reasonable.

[2] The percentages/fractions discussed in relation to the Stephens and Gull lakes ridgeline plots are very approximate and may be updated in the future with more precise estimates which were not available at the time of drafting of this memorandum.

Discussion

Since fish is considered part of a healthy diet, it is important that a balanced approach is adopted as avoiding fish consumption altogether to reduce mercury intake may result in more harm than benefit. For the purposes of this memorandum, the Province of Manitoba and Health Canada approaches were considered to strike this balance in a manner that is consistent with current scientific understanding. While the fish consumption recommendations presented herein are based on an approach that has uncertainties (*e.g.*, modelled predicted fish mercury concentrations, risk assessment methods and guidance provided by major agencies), this uncertainty is reasonable and consistent with the Province of Manitoba, Health Canada and the World Health Organization uncertainties. Nevertheless, it will be important to regularly review the science and various input parameters used to estimate the maximum monthly intakes to ensure that the partner First Nations are receiving the best and most up-to-date advice.

North/South (2021; 2023a; 2024) has estimated that under peak post-impoundment conditions that average mercury concentrations in fish may increase up to 5-fold on average in Gull Lake while fish mercury levels may double at Stephens Lake. From a toxicological perspective, certain fish in Gull and Stephens lakes under peak conditions should be avoided by both sensitive and non-sensitive members of the population due to mercury concerns. Although not eating fish can also be associated with health effects, it is stressed that more harm than benefit would likely result from eating fish in the "avoid category". For other fish, some consumption is considered to be acceptable and for these, maximum monthly intake rates have been calculated and are provided in this memorandum. If a person consumed fish at the maximum monthly intake rates on a consistent basis, it is estimated that they would not exceed the TDIs of 0.2 µg/kg bw/day for sensitive individuals or 0.47 µg/kg bw/day for all others (*i.e.*, values that Health Canada/WHO have indicated are provisionally acceptable). These TDIs are also equivalent to a hair concentration of 2 ppm for sensitive individuals and 5 to 6 ppm for all others. It follows that not exceeding these monthly intakes should help safeguard persons to maintain hair concentrations below these values; however, fish consumption recommendations are not a substitute for frequent hair testing.

Hair sampling is an important part of the plan to ensure that people remain protected; however, hair sampling is a retrospective measurement of exposure and learning of elevated hair levels may be too late to prevent harm if a pregnant woman or child is found to have a high mercury result. Consequently, it is considered important that this message of avoidance is communicated in the most effective manner possible and that consumption habits are monitored to the maximum extent reasonable.

With the exception of the most recent Gull Lake whitefish contingency peak estimate which is recommended to soon be discussed, the MHHIG has discussed most of the issues raised above to develop communication products containing consumption recommendations, as well as other materials to promote understanding about fish and mercury and human health. Wilson Scientific has used this material to provide recommendations for revisions to the consumption recommendations.

In addition to the fish consumption recommendations, other activities are ongoing to protect health risks from mercury. These efforts are overseen by the MHHIG and include but are not limited to:

- regular review and dialogue with the partner First Nations and others to determine if and how fish consumption messages are being received by the community members;
- regular review and dialogue with health agencies to determine if the fish consumption messages are supported by the health professionals;
- ongoing and timely monitoring and communication of fish concentrations by the fish biologists to determine if estimates of post-impoundment mercury concentrations remain accurate;
- ongoing and timely monitoring and communication of wild game and plant concentrations by the wildlife biologists to determine if estimates of post-impoundment mercury concentrations remain accurate; and
- regular and frequent hair mercury analysis of KCN members and risk interpretation by the hair mercury sampling professionals.

In other words, it is recognized that dissemination of the fish consumption recommendations by themselves may not sufficiently protect health and instead multiple activities are recommended to protect people's health. It will be important that these activities are completed in a timely and consistent manner by persons with appropriate experience. It is also important there be regular and timely communication with the partner First Nations and local communities with accurate, update to information so it allows for adapted plans and messaging, as required.

As discussed earlier, the current memorandum does not address other fish species or tributaries of Gull and Stephens lakes which may be affected by the Project. Additional fish mercury data would be required to develop consumption recommendations for fish caught in the tributaries of Gull and Stephens lakes, or for species other than whitefish, pickerel or jackfish. Migration fish from Gull Lake into Clark Lake is also not evaluated. Nonetheless, these issues should be revisited with the partner First Nations and other communities to explore opportunities for fish and other wild foods sampling and analysis. It is proposed that this should be discussed as part of future MHHIG activities.

Finally, it is noted that additional data could be considered for future analysis and could inform future consumption recommendations. Validation of these approaches is outside the scope of the Keeyask Project and includes but is not limited to the following:

1. Measurement of methylmercury concentrations in fish: As discussed earlier, North/South (2021; 2023a; 2024) has estimated total mercury concentrations in fish under peak conditions rather than methylmercury concentrations. If methylmercury represents a high percentage of total mercury under peak conditions, the decision to assume all of the total mercury is present as methylmercury is unlikely to be a sensitive parameter. On the other hand, if it was determined that methylmercury comprised a substantially reduced percentage of total mercury, it is possible that the maximum monthly intakes could be somewhat relaxed. The exact approach would require assessment and input from health agencies before seriously considering this approach. It would also require discussion with the partner First Nations.

2. Measurement of bioaccessibility of mercury in fish: It is also noted that there has been some recent attention to evaluating bioaccessibility of mercury in fish in the scientific literature. Nevertheless, we are unaware of any major agency that has used bioaccessibility in fish

consumption recommendations and thus it is not clear how useful such information would be (aside from perhaps use in a sensitivity analysis).

3. Measurement of selenium concentrations in fish: There have been various scientific groups that have suggested that the selenium content of fish may play a role in the effects of mercury (*i.e.*, it has been hypothesized that higher selenium concentrations may reduce the risks posed by mercury). Nevertheless, we are unaware of any major agency that has adopted this position and more thorough studies and general acceptance by the scientific community are likely needed before this approach is adopted.

Conclusions

Using an approach consistent with the Province of Manitoba (2007) and Health Canada (2007; 2009; 2019), revised maximum monthly intake rates were estimated for whitefish in Gull Lake and jackfish and pickerel in Stephens Lake using peak mean mercury concentrations estimated by North/South (2021; 2023a; 2024). The most notable revision to consumption recommendations is that all sizes of Stephens Lake jackfish and pickerel are now recommended to be avoided by sensitive populations. In addition, Gull Lake whitefish of standardized size (*i.e.*, 350 mm) are no longer considered to be a very good choice fish and instead are now in the occasional consumption group. Although the size class estimates provide useful potential boundaries, it was recommended that the fish consumptions for fish of standardized size be primarily used in the quantitative consumption recommendations (*i.e.*, aside from the fish tape which uses this size class information). Although fish in Stephens Lake are predicted to have appreciably lower concentrations than in Gull Lake, it is recommended that there are continued efforts to communicate that there are fish in both Gull and Stephens lakes that people are advised to limit consumption or avoid altogether. It continues to be important to regularly review the science and various input parameters used to estimate the maximum monthly intakes to ensure that the partner First Nations and communities are receiving the best and most up-to-date advice. It is also stressed that issuing fish consumption recommendations is part of the broader risk management strategy developed to protect health risks from elevated levels of mercury in fish from Gull and Stephens lakes.

Statement of Limitations

This report has been prepared by Wilson Scientific Consulting Inc. (Wilson Scientific) for the sole benefit of Manitoba Hydro. Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Wilson Scientific accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional staff in accordance with generally accepted scientific practices current at the time the work was performed.

Any site-specific information provided by Manitoba Hydro, North/South Consultants Inc. or other parties has been assumed by Wilson Scientific to be accurate. Conclusions presented in this report should not be construed as legal advice.

This risk evaluation was undertaken exclusively for the purpose outlined herein and was limited to those contaminants, exposure pathways, receptors, and related uncertainties specifically referenced in the report. This work was specific to the site conditions and land use considerations described in the report. This report cannot be used or applied under any circumstances to another location or situation or for any other purpose without further evaluation of the data and related limitations.

This report describes only the applicable risks associated with the identified environmental hazards, and is not intended to imply a risk-free site. Should any conditions at the site be observed or discovered that differ from those at the sample locations, or should the land use surrounding the identified hazards change significantly, Wilson Scientific requests that to be notified immediately to reassess the conclusions provided herein.

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ATTACHMENT 1 – WORKED EXAMPLES OF THE CALCULATIONS

This attachment provides the worked example calculations for: 1) calculation of maximum monthly intakes using generic assumptions; 2) calculation of maximum monthly intake using modified body weights; and 3) calculation of maximum monthly intake when multiple species of fish are consumed.

1) Worked Example of Maximum Monthly Intake Using Generic Assumptions

In this worked example, maximum monthly intake for standardized size pickerel (400 mm) from Stephens Lake (revised mean peak concentration of mercury of 0.78 µg/g; wet weight) are estimated for the three receptor groups (children under 12 years of age; adolescents between 12 years and less than 19 years of age and females of childbearing; and all others).

Children

To calculate the maximum monthly intake for children under 12 years of age, the following equation and input parameters were used:

$$\text{Maximum Monthly Fish Intake} = \frac{BW \times DP \times TDI}{PMC}$$

where:

BW = body weight of child (30 kg)
DP = dose-averaging period (30 days)
TDI = tolerable daily intake for mercury (0.2 µg/kg bw/day)
PMC = revised peak mean concentration of mercury in standardized size pickerel (400 mm) from Stephens Lake (0.78 µg/g; wet weight)

Thus,

$$\text{Maximum Monthly Fish Intake} = \frac{30\ kg \times 30\ days \times 0.2\ \mu g/kg\ bw/day}{0.78\ ug/g}$$

$$= 231\ g/month$$

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for children under 12 years of age of 231 g per month. This intake can then be calculated into the partner First Nations' preference of pounds per month by dividing by 454 g (*i.e.*, 454 g = 1 lb; and so, 231 g/month x 1 lb/454 g = 0.5 lbs per month). Although can be estimated that children under 12 years of age can consume 0.5 pounds per month of standardized size pickerel (400 mm) from Stephens Lake under peak conditions, Province of Manitoba (2007) guidance indicates that fish that are above 0.5 ppm are recommended to be avoided by sensitive members of the population. As a result, although it can be calculated that 0.5 pounds per month by children under 12 years would result in not exceeding the Health Canada TDI, the fish consumption recommendation is for children (and all other sensitive members of the population) to avoid Stephens Lake pickerel of all sizes.

Adolescents between 12 years and less than 19 years of Age and Females of Childbearing Age

To calculate the maximum monthly intake for adolescents between 12 years and less than 19 years of age and females of childbearing age, the same equation as for children but age-specific input parameters (different body weight) were used:

$$\text{Maximum Monthly Fish Intake} = \frac{BW \times DP \times TDI}{PMC}$$

where:

BW = body weight of female of childbearing age (60 kg)
DP = dose-averaging period (30 days)
TDI = tolerable daily intake for mercury (0.2 µg/kg bw/day)
PMC = revised peak mean concentration of mercury in standardized size pickerel (400 mm) from Stephens Lake (0.50 µg/g; wet weight)

Thus,

$$\text{Maximum Monthly Fish Intake} = \frac{60\ kg \times 30\ days \times 0.2\ \mu g/kg\ bw/day}{0.78\ \mu g/g}$$

$$= 460\ g/month$$

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for adolescents between 12 years and less than 19 years of age and females of childbearing age of 460 g per month. This intake can then be calculated into the partner First Nations' preference of pounds per month by dividing by 454 g (*i.e.*, 460 g/month x 1 lb/454 g = 1.0 lbs per month). Nevertheless, as discussed above, Province of Manitoba (2007) guidance indicates that fish that are above 0.5 ppm are recommended to be avoided by sensitive members of the population. As a result, although it can be calculated that 1.0 pounds per month by adolescents and females of childbearing age would result in not exceeding the Health Canada TDI for sensitive members of the population (*i.e.*, 0.2 µg/kg bw/day), the fish consumption recommendation is for all sensitive members of the population to avoid Stephens Lake pickerel of all sizes.

All Others (Non-Sensitive Individuals)

To calculate the maximum monthly intake for all others (non-sensitive individuals), the same equation as for children but different input parameters (different body weight and different TDI) were used:

$$\text{Maximum Monthly Fish Intake} = \frac{BW \times DP \times TDI}{PMC}$$

where:

BW = body weight of all others (60 kg)
DP = dose-averaging period (30 days)
TDI = tolerable daily intake for mercury (0.47 µg/kg bw/day)
PMC = peak mean concentration of mercury in standardized size pickerel (400 mm) from Stephens Lake (0.78 µg/g; wet weight)

Thus,

Maximum Monthly Fish Intake = $\frac{60 \text{ kg} \times 30 \text{ days} \times 0.47 \text{ µg/kg bw/day}}{0.78 \text{ µg/g}}$

= 1,080 g/month

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for all others of 1,080 g per month. This intake can then be calculated into the partner First Nations' preference of pounds per month by dividing by 454 g (*i.e.*, 1,690 g/month x 1 lb/454 g = 2.4 lbs per month). Thus, it is estimated that non-sensitive members of the population can consume 2.4 pounds per month for fish up to standardized size pickerel (400 mm) from Stephens Lake under peak conditions. It is noted that the Province of Manitoba (2007) guidance suggests that non-sensitive members of the population only avoid fish above 1.5 ppm and, thus, there is not the same restriction for Stephens Lake pickerel for fish up to standardize size; however, for Stephens Lake pickerel larger than 400 mm, it is recommended that these are avoided by non-sensitive members of the population.

2) Worked Example of Maximum Monthly Intake Using Revised Body Weight

In this worked example, maximum monthly intake for standardized size pickerel (400 mm) from Stephens Lake (mean peak concentration of mercury of 0.78 µg/g; wet weight) is estimated for a young child who weighs 15 kilograms rather than the assumed 30 kilograms.

To calculate the maximum monthly intake for children under 12 years of age who weighs 15 kilograms, the following equation and input parameters were used:

Maximum Monthly Fish Intake = $\frac{BW \times DP \times TDI}{PMC}$

where:

BW = body weight of child (15 kg)
DP = dose-averaging period (30 days)
TDI = tolerable daily intake for mercury (0.2 µg/kg bw/day)
PMC = peak mean concentration of mercury for standardized size pickerel (400 mm) from Stephens Lake (0.78 µg/g; wet weight)

Thus,

Maximum Monthly Fish Intake = $\frac{15 \text{ kg} \times 30 \text{ days} \times 0.2 \text{ µg/kg bw/day}}{0.78 \text{ µg/g}}$

= 115 g/month

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for children under 12 years of age weighing 15 kilograms of 115 g per month. This intake can then be calculated into the partner First Nations' preference of pounds per month by dividing by 454 g (*i.e.*, 115 g/month x 1 lb/454 g = 0.25 lbs per month). Although it can be estimated that children under 12 years of age weighing 15 kilograms can consume 0.25 pounds per month of standardized size pickerel (400 mm) from Stephens Lake under peak conditions for a mercury intake equal to the Health Canada (2021) TDI for sensitive members of the population, as discussed above, it is still recommended that children under 12

years and all other sensitive members of the population avoid all sizes of Stephens Lake pickerel to be consistent with Province of Manitoba (2007) guidance.

3) Calculation of Maximum Monthly Intake when Multiple Species of Fish are Consumed

Maximum monthly intake estimates for Stephens Lake fish in Tables 2 of the memo are provided based on the assumption that a person is primarily consuming one species of fish from only Stephens Lake; however, this may not be realistic for some and they may consume multiple species of fish or fish from multiple sources. To illustrate how a person may adjust their fish intake, the following example is provided where it is assumed that a female older than childbearing age or an adult male (*i.e.*, non-sensitive members of the population; assumed to weigh 60 kg) are consuming two pounds (lbs) per month of each of the following fish (all fish sizes are assumed to equal to or less than standardized size):

Whitefish (up to standardized size of 350 mm) consumed at 2 lbs per month (fish species 1)
Pickerel (up to standardized size of 400 mm) consumed at 2 lbs per month (fish species 2)
Jackfish (up to standardized size 550 mm) consumed at 2 lbs per month (fish species 3)

In this case, it would be recommended that a person apply the following equation to determine if they are consuming less than the maximum monthly intake (this is a similar principle provided in Province of Manitoba, 2007):

$$CFR = \frac{CFS_1}{MFS_1} + \frac{CFS_2}{MFS_2} + \frac{CFS_3}{MFS_3}$$

Where:

- CFR = cumulative fish ratio (ideally should be less than or equal to 1.0)
- CFS_1 = monthly consumption rate of fish species 1 (Stephens Lake whitefish up to standardized size) (2 lbs per month)
- MFS_1= maximum monthly intake rate of fish species 1 (Stephens Lake whitefish equal to standardized size) (12.4 lbs per month) (from Table 2 of the memo)
- CFS_2 = monthly consumption rate of fish species 2 (Stephens Lake pickerel up to standardized size) (2 lbs per month)
- MFS_2 = maximum monthly intake rate of fish species 2 (Stephens Lake pickerel equal to standardized size) (2.4 lbs per month) (from Table 2 of the memo)
- CFS_3 = monthly consumption rate of fish species 3 (Stephens Lake jackfish up to standardized size) (2 lbs per month)
- MFS_3 = maximum monthly intake rate of fish species 3 (Stephens Lake jackfish equal to standardized size) (3.0 lbs per month) (from Table 2 of the memo)

Thus, the following would be estimated:

$$CFR = \frac{2 \text{ lbs/month}}{12.4 \text{ lbs/month}} + \frac{2 \text{ lbs/month}}{2.4 \text{ lbs/month}} + \frac{2 \text{ lbs/month}}{3.0 \text{ lbs/month}}$$

$$= 0.16 + 0.83 + 0.66$$

$$= 1.65$$

Thus, in this worked example, a cumulative fish ratio of 1.65 was estimated which slightly exceeds a value of 1.0. Accordingly, although none of the maximum monthly intake rates for the individual species of fish were exceeded, the sum of the fish species resulted in a cumulative fish ratio exceeding a value of 1.0 and, thus, it would be recommended to reduce fish consumption in a manner that would not result in this value being exceeded. For example, if a person still consumed 2 lbs of whitefish but 50% less of each fish species (*i.e.*, monthly consumption of 2 lbs whitefish, 1.0 lbs pickerel and 1.0 lbs jackfish (all up to standardized size fish)), the cumulative fish ratio would be estimated to slightly less than 1.0 (*i.e.*, 0.16 + 0.42 + 0.33 = 0.91) and this would result in acceptable risks. Thus, the following would be estimated

$$CFR = \frac{2 \text{ lbs/month}}{12.4 \text{ lbs/month}} + \frac{1 \text{ lbs/month}}{2.4 \text{ lbs/month}} + \frac{1 \text{ lbs/month}}{3.0 \text{ lbs/month}}$$

$$= 0.16 + 0.42 + 0.33$$

$$= 0.91$$

In this example, a non-sensitive adult (*i.e.*, women past childbearing age and adult men) consuming 2 lbs per month of whitefish (up to standardized size of 350 mm) and 1 lbs per month each of pickerel (up to standardized size of 400 mm) and jackfish (up to standardized size of 550 mm) (all from Stephens Lake) would result in a CFR less than 1.0 and, thus, the mercury intake would be less than the TDI of 0.47 µg/kg bw/day recommended by Health Canada (2021).

APPENDIX 5: POST-IMPOUNDMENT FISH MERCURY COMMUNICATION PROCESS

Subject: Communication Process of Mercury Fish Data Results and Consumption Recommendations, Keeyask Project PHASE 2 (Post-Impoundment)

Date: April 14, 2022

To: Mercury and Human Health Implementation Group

Purpose

The purpose of this memorandum (memo) is to outline a timely communication process with Mercury and Human Health Implementation Group (MHHIG) members on:

1. Keeyask Project related fish mercury monitoring activities and associated results.
2. Interpretation of fish mercury data for post-impoundment consumption recommendations; and the rationale for changes (or no change) to fish consumption recommendations.
3. Additional information and interpretation regarding hair sampling activities and plant and wildlife mercury concentrations.

Based on the Project assessment of risk to human health from potential mercury exposure, consumption recommendations are only prepared for fish consumption. Therefore, this memo focuses primarily on fish monitoring processes. The Project team will make every effort to present technical results and risk assessment interpretation to the MHHIG and Province for discussion in a timely manner. Timely analysis, interpretation and communication is of utmost importance in the assessment of whether consumption recommendations remain protective of human health, particularly until peak fish mercury levels have been determined.

Background

The Mercury and Human Health Implementation Group (MHHIG) developed a Mercury and Human Health Risk Management Plan to address the potential health effects from increased methylmercury in the environment (Gull and Stephens lakes) as a result of the Keeyask Project. Key components of this plan include:

- a communication strategy about fish consumption for resource users in affected waterbodies for pre- and post-impoundment conditions;
- monitoring of mercury in fish, wildlife and plants;
- voluntary hair sampling;
- periodic human health risk assessments (HHRAs)
    - Information obtained on biota, as available, will be reviewed and interpreted annually to assess whether changes to consumption guidance are required; and
- community-specific offsetting programs outlined in each partner First Nations Adverse Effects Agreements.

A suite of communication products related to Split, Gull and Stephens lakes was prepared for the operations phase. In addition, the government of Manitoba will issue a ‘Public Notice’ for Gull and

Stephens lakes (anticipated by early 2022) and has requested this notice be accompanied by corresponding Keeyask Project communication materials.

Monitoring Fish Mercury Concentrations for Consumption Recommendation Purposes

On an annual basis (January - March), the MHHIG will receive an update on the scheduled activities under the Keeyask Aquatic Effects Monitoring Plan (AEMP) for the upcoming season. Details would include month of sampling, which waterbodies, which fish species and approximate sample sizes. This includes monitoring in fish in Split, Gull and Stephens lakes and Aiken River (see Appendix A for more details).

Post-impoundment consumption recommendations prepared for Gull and Stephens lakes are based on predicted peak concentrations (outlined in the Project Environmental Impact Statement, 2012 and validated in 2021) and World Health Organization (WHO) and Health Canada guidance on acceptable rates of intake of mercury. Mercury concentrations in fish from these lakes will be reviewed annually to determine whether post-impoundment consumption recommendations reflect actual peak conditions. For Split Lake, consumption recommendations reflect existing conditions. No fish consumption recommendations are prepared for Aiken (Landing) River.

Mercury concentrations in fish may differ between sampling years because of chance events related to the relatively small sample size compared to the size of the fish population and natural year to year variation in concentrations. To avoid the potential for confusion created by frequent changes in consumption recommendations (and associated communication products) based on minor changes in fish concentrations, the MHHIG, in consultation with Provincial health representatives, outlined a process during the pre-impoundment phase to determine if and when consumption recommendations would need to be changed. General guidelines outlined below are adapted for the post-impoundment phase and consider balancing encouraging healthy fish consumption with providing timely information to communities of important changes to consumption recommendations.

Analytic and interpretive process of fish data

Mercury concentrations in whitefish, pickerel (Walleye), and jackfish (Northern Pike) from Split, Gull, and Stephens lakes will be a key source of information in determining whether fish consumption recommendations remain current or need to be revised. As mercury levels in fish from Gull Lake and, to a lesser extent, Stephens Lake rise as a result of impoundment of the Keeyask reservoir, there is an unavoidable lag between seasonal fish consumption / fish sampling and availability of preliminary sampling results. There is potential that people who consume fish from these lakes could unwittingly consume fish that exceed the acceptable mercury range, if model predictions underestimate peak fish concentrations. This is unlikely given the conservative estimate used to predict the peak concentrations, but the time lag remains an issue until peak conditions are observed and begin to decline. To enhance the information collected under the AEMP, the Aquatic team has committed to undertake supplemental sampling of pickerel and jackfish in spring (June) in Stephens Lake.[1]

The MHHIG and the Province will have the opportunity to review and discuss preliminary and final monitoring results, HHRA interpretation as information becomes available, and in a timely fashion, to

[1] "Preliminary Results of 2021 Spring Mercury Sampling in Stephens Lake" (North / South, 2021) outlines the approach and rationale for June sampling.

assess the currency of consumption recommendations. Discussion will occur prior to finalization of memos or any communication products adjustments.

If fish mercury concentrations in Gull or Stephens lakes in any species reach predicted levels, the MHHIG and province will meet to review available information and assess whether consumption recommendations should be adjusted, in consideration of general guidelines outlined below.

Analysis of Fish Concentrations

- The Aquatic team will provide preliminary results from spring and fall fish sampling events, as soon as is practicable after each event is complete to the Project Toxicologist and MHHIG for review and discussion.[2]
- *Deliverables* include: A consolidated preliminary "*Fish Mercury Concentration*" *memo* describing the results of both the spring and fall sampling in a given year for comparison to predicted concentrations and for HHRA purposes (final, vetted results are typically available by February/March);
    - Fall fish monitoring results are also included in the Project's *annual regulatory report* (submitted in June).
    - For fall program dataset, a statistical analysis will be conducted to determine if any of the mercury concentrations in the three species have changed significantly from the concentrations assumed to derive the consumption recommendations that are in place at the time of the sampling program.

KEY STEPS: Interpretation of consumption recommendations

- Project Toxicologist will prepare a draft "*Human Health Risk Assessment (HHRA)" memo* based on review and interpretation of "*Fish Mercury Concentration*" *memo*(s).
    - This *annual HHRA memo* will present an interpretation of the data and provide conclusions and recommendations on whether the communication products should be revised, including rationale for proposed changes.[3]
    - **Changes to communication products will be primarily based on a 20% change threshold (see below) and consideration of MHHIG and Province feedback.** If changes to consumption recommendations are considered after review of preliminary monitoring results, a meeting will be called in a timely manner to discuss results and next steps with the MHHIG and Province. In this case, an interim HHRA memo will be prepared for discussion.
- *Deliverable*: a *final HHRA Memo* will be prepared to reflect MHHIG discussion and submitted in partial fulfilment of annual regulatory reporting requirements.

[2] Timing will vary depending on sample size and receipt of analytic data from laboratory. Preliminary spring results may be available within 14 days, while preliminary fall results, due to larger sample size, may take up to 2 months.
[3] If aggregate hair sampling results are available and considered to be representative of community members who eat the most fish at the peak time of year, the hair and fish data could be considered and cited to the MHHIG as part of a weight-of-evidence approach.

If changes to consumption recommendations are deemed necessary:

- Communication products will be promptly revised and reviewed by MHHIG and the Province. Once finalized and printed, Mercury Community Coordinators will recall previously distributed products and replace with most current.
- In 2013, Mercury concentrations in fish and other wild foods were considered in a formal Human Health Risk Assessment (HHRA) to represent the pre-Project environment. A formal HHRA will occur in approximately 2026 (or when peak concentrations have been determined by the Aquatic team) and every five years until fish mercury concentrations reach pre-Project or stable background levels.

General guidelines for determining whether communication products should be revised:

Post-Impoundment fish consumption recommendations prepared for fish from Gull and Stephens lakes,[4] are based on predicted peak average concentrations of mercury. Predicted peak concentrations are outlined in Appendix B.

- Consumption recommendations may be revised if the measured average fish concentrations of standardized size fish exceed the predicted mercury concentrations by more than 20% (see Appendix B for threshold values and below for rationale).
- This '20% rule' would apply:
  - in the case of either increasing or decreasing fish mercury concentrations (e.g., after peak conditions have been reached in Gull and Stephens lakes) and
  - at any sampling event, subject to input from Project biologist on data quality (e.g., sample size, fish variability) and discussion with MHHIG, including provincial health representatives.
    - If changes in mercury concentrations are less than 20% for any fish species and length class, it is proposed there will be no need to revise fish consumption recommendations prior to peak conditions occurring.
- In addition to the 20% change threshold, the Aquatic team will attempt to determine whether the change in fish mercury concentrations is statistically significant.
- The MMHIG and Province will consider all relevant information in a timely manner to determine whether changes to fish consumption recommendations should be made.

Rationale for 20% threshold

The 20% threshold approach for fish mercury concentrations is applied for a variety of reasons:

- To avoid confusion by frequent updates and subsequent product recalls based on minor exceedances of the predicted mercury concentration used in these products.
- To account for variability that naturally occurs in fish.
- An increase in fish concentration of up to 20% is not expected to represent an appreciable difference in health risk.

[4] Split Lake products reflect existing conditions and will be updated based on annual review of fish monitoring results. Protocol to determine currency of Split Lake consumption recommendations will follow the decision-making guidelines outlined in this memo (e.g., 20% threshold).

Health Canada (2021) and Province of Manitoba (2007) express the acceptable intake level of mercury for sensitive individuals to one significant figure (i.e., 0.2 µg/kg bw/d) while the World Health Organization (2007) provides a value equal to 0.23 µg/kg bw/d for sensitive individuals. Allowing up to a 20% increase in mercury concentrations will mean that a person who is consuming fish at exactly the maximum acceptable amount of fish but with 20% higher mercury concentrations than predicted will now have a mercury intake of 0.24 µg/kg bw/d which rounded to 1 significant figure is equal to the Health Canada acceptable intake level of 0.2 ug/kg bw/d and is only slightly greater than 0.23 µg/kg bw/d cited by the World Health Organization. These rates would be expected to be associated with hair concentrations in the range of 2.4 ppm rather than 2.0 ppm and are still well below known health effects.

Overall, by using a 20% value as the threshold for changing consumption recommendations, it is believed that health can be protected without unduly revising communication products every time new data are received.

Additional Monitoring

In addition to fish monitoring, hair sampling, in conjunction with a food survey will be available over the next decade. Hair sampling is a reliable way to measure and keep individuals informed of their mercury exposure so they can make informed choices about their fish consumption. While eating fish is the primary source of mercury exposure, an accompanying food survey may provide additional insight into sources of mercury exposure. Timing of sampling will be determined by community input (and upon individual request) in order to capture peak consumption (e.g., late fall / early winter hair sampling). The MHHIG will assess the need to continue hair sampling after fish mercury concentrations have stabilized.

Wildlife and Plant sampling will also occur as outlined in the Terrestrial Effects Monitoring Plan (TEMP), including scheduled collections (plants and aquatic furbearers) and through submission of samples by partner First Nation community members. Mercury concentrations are expected to remain low in plants and wildlife consumed by people; nonetheless, the voluntary submission of samples will assist in confirming predictions outlined in the Project Environmental Impact Statement. In addition to the scheduled monitoring outlined in the TEMP, voluntary samples will be collected for the first 10 years of operations, at which time the need to continue sampling each component will be assessed (see Appendix A for more details).

KEY STEPS

- The MHHIG will be provided a seasonal reminder about the voluntary sampling opportunity and for which plants (blueberries, Labrador tea, northern Labrador tea, and Seneca root) and wildlife (aquatic furbearers, waterfowl, and caribou/moose) samples can be submitted, from where, and the targeted sampling timeframe.
- The Mercury Community Coordinators (or delegate) and/or Manitoba Hydro representative will ensure plant and wildlife sampling protocols and collection kits are available to community members and work with the Project wildlife biologist to coordinate receipt of collected samples.
- The Mercury Community Coordinators (or delegate) and/or Manitoba Hydro representative will provide annual updates on plant and wildlife samples provided by community members for analysis of their mercury concentrations.
- Deliverables:

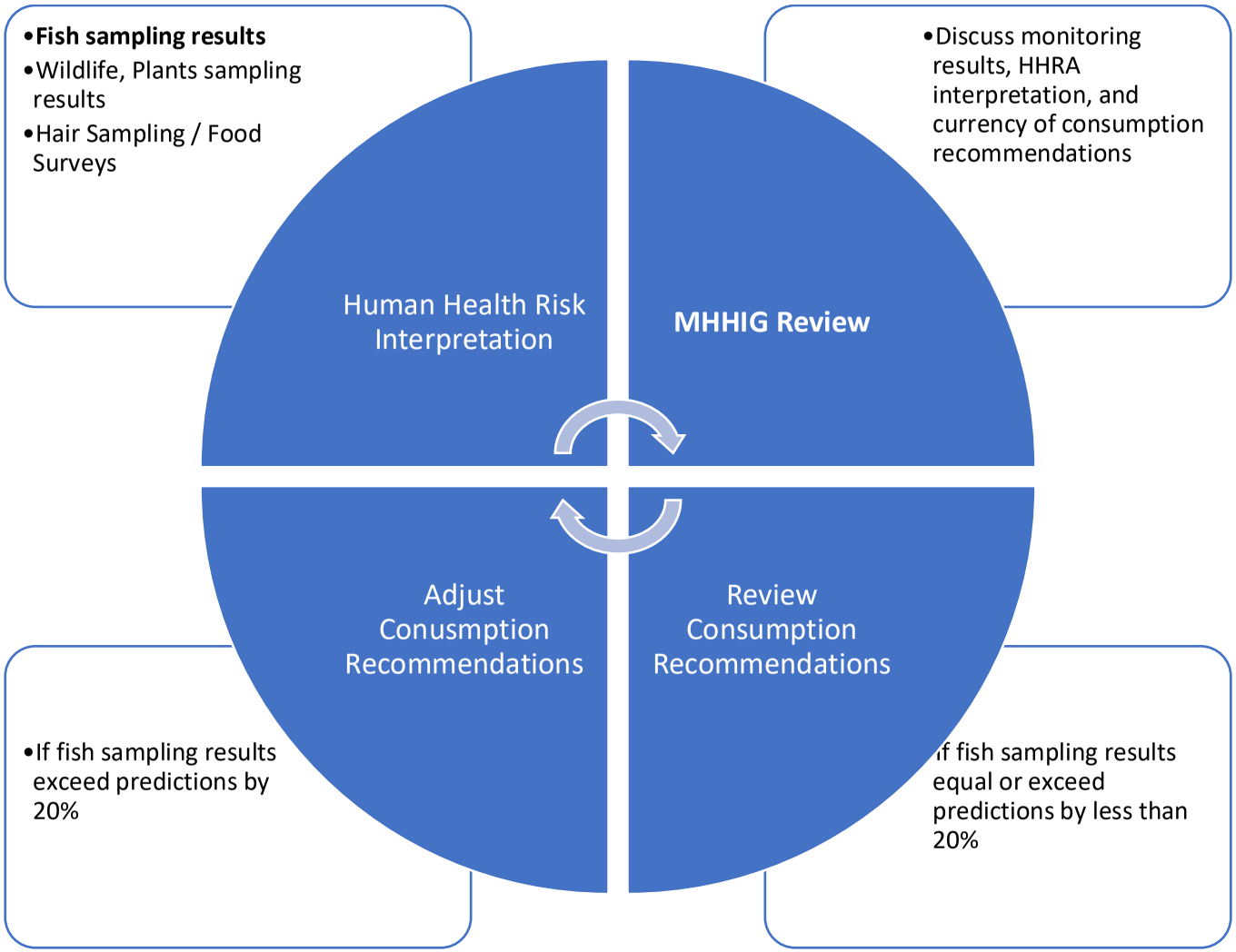
- The Project 'Hair Monitoring' consultant (Golder Associates Ltd.) will provide *confidential, individual results* within 2-6 weeks with opportunity for individualized feedback. *Aggregate results* will be shared with MHHIG (and at community level) as available and will be compiled in annual regulatory report.
- Draft "*Plant and Wildlife Mercury Concentration" memo*(s) outlining plant and wildlife concentrations, pending receipt of voluntary samples, will be prepared by Project biologist (terrestrial) within 60 days of receiving the data.
- The Project toxicologist will prepare an HHRA memo based on review the "*Plant and Wildlife Mercury Concentration*" memo(s) and submit as part of the annual regulatory report.

HIGHLIGHTS OF COMMUNICATION PROCESS

MHHIG and the Province will have the opportunity to review and discuss monitoring results, HHRA interpretation and currency of consumption recommendations prior to finalization of memos or possible communication products adjustments.

Each memo will be prepared in a standalone manner and provide as much context as possible to assist in interpretation of results. Details such as field methods, laboratory data, and quality control will be included.

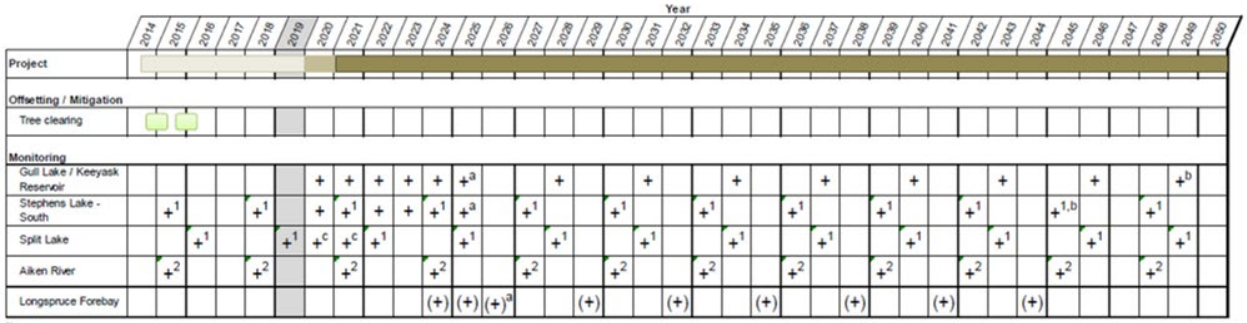
Information	Lead	Timeline / Targets	Purpose
Fish Monitoring Results / Memos for HHRA purposes	Aquatic Team (North South Consultants)	Annually: Preliminary spring results: by late July Preliminary fall results: by December Final results and memo: by March	To assess fish mercury concentrations in Gull, Stephens and Split lakes and Aiken (Landing) River. To assess validity of predicted post-impoundment peak concentrations in Gull and Stephens lakes.
HHRA Memo	Project Toxicologist, Wilson Scientific Consulting Inc.	Annually, upon receipt of available fish, wildlife and plants data. HHRA may reference aggregate hair sampling information.	Interpretation of fish concentrations to assess currency of consumption recommendations. Interim memo to be provided if consumption recommendations adjustments may be warranted after receipt of preliminary fish monitoring analysis.
HHRA (Full)	Project Toxicologist, Wilson Scientific Consulting Inc.	~2026 (after peak conditions have been confirmed to have occurred)	To assess risk to human health from consumption of wild foods harvested from the Project area.
Consumption Recommendations for Gull, Stephens and Split lakes	Project Toxicologist, Wilson Scientific Consulting Inc.	Annual review of data upon receipt (preliminary and final results); review of supplemental sampling data from Stephens Lake (~summer)	Post- Impoundment consumption recommendations for Gull and Stephens lakes reflect predicted peak conditions. Split Lake consumption recommendations reflect current conditions.
Wildlife and Plants Monitoring Results / Memos	Terrestrial Team	Annually (March), subject to monitoring schedule	To assess post-impoundment mercury concentrations in select wildlife and plant species
Hair Sampling Results / Memos	Project Hair Monitoring Consultant, Golder Associates, Ltd.	Individual results reported upon receipt of samples. Aggregate results and memo reported annually, or as available (timing and frequency determined by communities)	To understand mercury exposure in individuals to enhance informed decision making about their fish consumption.
Annual Regulatory Report	ALL	June	Submissions includes all noted reports and/or key highlights


•Fish sampling results
•Wildlife, Plants sampling results
•Hair Sampling / Food Surveys
Human Health Risk Interpretation
•Discuss monitoring results, HHRA interpretation, and currency of consumption recommendations
MHHIG Review
Adjust Conusmption Recommendations
•If fish sampling results exceed predictions by 20%
Review Consumption Recommendations
If fish sampling results equal or exceed predictions by less than 20%

Appendix A

Preliminary Fish, Plants and Wildlife Monitoring Schedules[5]

Fish Monitoring



Notes:
Grey shading indicates the year during which Keeyask reservoir will reach full supply level.
a. Assumed attainment of maximum fish mercury concentrations post-Project.
b. Assumed attainment of pre-Project mercury concentrations or concentrations that are stable at post-impoundment background levels.
c. AEMP monitoring because CAMP has no scheduled monitoring during the first two years post-flooding.
1. Ongoing monitoring carried out under CAMP; note that CAMP monitoring sites for fish mercury are all located in the south basin of the Stephens Lake.
2. Ongoing monitoring carried out due to request by War Lake First Nation and York Factory First Nation.
( ) Assumes that maximum predicted mercury concentrations in fish from Stephens Lake have been exceeded by more than 10%.

Figure 7-1: Planned schedule for mercury in fish flesh monitoring during Keeyask Generating Station construction (2014-2019); commissioning (2020); and operation (2021+). Plus = conduct monitoring activity; heavy line = end of AEMP.

Plants and Wildlife

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	Notes
5. Mercury in Plants and Wildlife Monitoring Studies																											
Plants: Collection of blueberries and Labrador tea leaves to analyze for Hg content in areas near the reservoir and in areas more than 1 km away from the reservoir and any roads. Voluntary sampling program for partner First Nations to submit samples also in place.				+			+						+														
Waterfowl: Voluntary sampling program for partner First Nations to submit waterfowl tissue samples for Hg analysis.	Voluntary submission of samples										+																
Aquatic Furbearers: Trapping program for beaver, muskrat, mink and otter, to collect tissue samples for Hg analysis in areas within 5 km of the Keeyask reservoir and Stephens Lake. Will be working with the RTL 15 trapline holder to collect samples.		+	+	+	+	+	+	+[a]			+			+			+	Results to date will be reviewed to determine if continued sampling frequency (every 3 years) is appropriate, or if it needs to be adjusted.								+	
Caribou and Moose: Voluntary sampling program for partner First Nations to submit caribou or moose tissue samples for Hg analysis.	Voluntary submission of samples										+																

[5] Schedule is provided to represent general timeline. Actual sampling years may deviate slightly due to delayed impoundment, which occurred in 2020. Graph does not show additional Gull Lake sampling (2014, 2016) or supplemental annual sampling in Stephens Lake.

Appendix B

Predicted peak fish concentrations (average, standardized length) presented in Keeyask Environmental Impact Statement, 2012 and North/South (2021).

Stephens Lake Fish

- Stephens Lake whitefish, standardized size of 350 mm: 0.15 µg/g (wet weight)
- Stephens Lake pickerel, standardized size of 400 mm: 0.5 µg/g (wet weight)
- Stephens Lake jackfish, standardized size of 550 mm: 0.5 µg/g (wet weight)

Gull Lake Fish

- Gull Lake whitefish, standardized size of 350 mm: 0.19 µg/g (wet weight)
- Gull Lake pickerel, standardized size of 400 mm: 1.0 µg/g (wet weight)
- Gull Lake jackfish, standardized size of 550 mm: 1.0 µg/g (wet weight)

20% Change Threshold based on predicted peak fish mercury concentrations. An exceedance of the values below would prompt revisions to post-impoundment fish consumption recommendations, prepared in 2021, subject to MHHIG and provincial health regulator input.

Stephens Lake Fish

- Stephens Lake whitefish, standardized size of 350 mm: 0.18 µg/g (wet weight)
- Stephens Lake pickerel, standardized size of 400 mm: 0.60 µg/g (wet weight)
- Stephens Lake jackfish, standardized size of 550 mm: 0.60 µg/g (wet weight)

Gull Lake Fish

- Gull Lake whitefish, standardized size of 350 mm: 0.23 µg/g (wet weight)
- Gull Lake pickerel, standardized size of 400 mm: 1.2 µg/g (wet weight)
- Gull Lake jackfish, standardized size of 550 mm: 1.2 µg/g (wet weight)