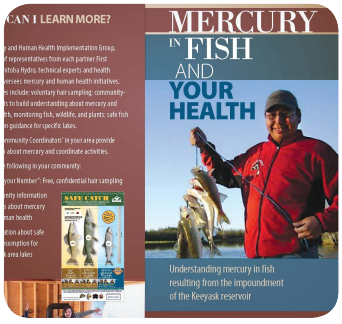
Keeyask Generation Project

Socio-Economic Monitoring Plan

Socio-Economic Monitoring Report

SEMP-2021-01



KEEYASK

Manitoba Conservation and Climate Client File 5550.00
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2020 -2021

KEEYASK GENERATION PROJECT

SOCIO-ECONOMIC MONITORING PLAN

REPORT #SEMP-2021-01

SOCIO-ECONOMIC MONITORING REPORT

APRIL 2020 TO MARCH 2021:

YEAR SIX CONSTRUCTION

Prepared by

Manitoba Hydro

2021

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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, 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). 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 focuses on key pathways of effect to, and components of, the socio-economic environment, including:

- Economy;
- Population, Infrastructure and Services; and
- Personal, Family and Community Life.

This report focuses on SEMP monitoring activities for the Project to March 31, 2021. Key learnings of the SEMP Program over the 2020/21 period and next steps are presented below by monitoring topic area.

EMPLOYMENT AND TRAINING:

- The KGP EIS predicted employment levels for the partner First Nations' members both at peak of construction and for the entire construction period. While a full comparison of person year outcomes cannot be made until the end of construction, total person years of employment to date are exceeding the range of what was predicted for the entire Project.
- Since the start of KGP construction to the end of March 2021, there were 25,962 hires on the Project. Total Manitoba hires represented 17,409 hires. Of this, 7,155 hires represented northern Manitoba (Indigenous and non-Indigenous) hires or 42% of total Manitoba hires.

- Since the start of KGP construction to the end of March 2021, the Project generated 15,993-person years of employment based on a 2000-hour person year. Of this, 9,830 represented Manitoba person years, and 3,487 represented total northern Manitoba (Indigenous and non-Indigenous) person years (35% of total Manitoba person years).
- Since the start of KGP construction to the end of March 2021, the cumulative turnover rate for the Project was 31% of total hires, 42% of Indigenous hires and 24% of non-Indigenous hires.
- Over the reporting period the Advisory Group on Employment (AGE) continued as a forum for addressing employment-related issues, in particular partner First Nation employment, related to the construction of the Keeyask Generation Project. As the project continues to ramp down, the AGE focused on maximizing Partner employment numbers and ensuring individuals in the On the Job Training (OJT) programs progress through their training.
- As of March 31, 2021, 1,853 Indigenous employees had training opportunities on the Project. 601 (32%) of these were filled by partner First Nation members.

BUSINESS OPPORTUNITIES:

- The KGP EIS predicted that Project construction would present direct and indirect business opportunities locally, regionally and across the province as a whole.
- Cumulatively, $5,260.0 million has been spent on goods and services for the KGP. Of this, $1,298.0 million were Manitoba purchases. Total northern Manitoba (Indigenous and non-Indigenous) purchases represent $824.5 million or 64% of total Manitoba purchases.
- As of the end of March 2021, 22 KGP Direct Negotiated Contracts (DNCs), ranging from camp services to heavy construction, have been awarded to partner First Nations' businesses with a total value exceeding $777 million. In addition, there have been four DNCs awarded for the Keeyask Transmission Project with a total value exceeding $88 million. Partner First Nation businesses have also received contract work on the Keeyask Project through subcontract agreements; in total 5 subcontracts for a combined value exceeding $24.5 million.

INCOME:

- Since the start of KGP construction to the end of March 2021, total labour income earned as a result of the KGP was approximately $1,741.8 million. Of this, Manitoba labour income represented $945.4 million.

KEEYASK WORKPLACE ENVIRONMENT

- Manitoba Hydro and the partner First Nations are continuing to work together at many levels to develop strategies to drive a positive and safe work environment at the Project site. Manitoba Hydro and the partner First Nations continue to collectively navigate through COVID-19 with regular dialogue on safety measures established at site and in the communities. Over the past year, the partner First Nations expressed substantial concern

regarding the potential spread of COVID-19 from the Keeyask Project site into their communities. As a result, a number of protocols were developed with guidance from Manitoba Public Health to minimize the introduction of the COVID-19 virus at site and prevent transmission between site and the local communities.

CULTURE AND SPIRITUALITY:

- During this reporting period there were five ceremonies held, including ceremonies to acknowledge the construction milestones of water-up and impoundment, and Unit 1 in-service. Thirty-four Indigenous awareness training workshops were held over this same period. Counseling services were available to employees on site on a voluntary basis. These efforts will continue throughout the remainder of construction.

WORKER INTERACTION:

- A Worker Interaction Subcommittee was established by Manitoba Hydro prior to the beginning of Keeyask construction as part of a corporate-wide initiative to address anticipated increases in the Gillam area workforce associated with several projects and activities.
- The Worker Interaction Subcommittee did not meet during this reporting period as a result of a focus on managing the spread of COVID-19 into and within Gillam and partner First Nation communities. Local efforts continued, to the extent practicable, to address priority areas of focus identified in 2019-20 such as continuation of cultural awareness training and counselling supports, and delivery of joint Gillam-FLCN community-based activities.

POPULATION:

- The changes in total population observed in 2020 for the partner First Nations and 2019 for Gillam are consistent with trends observed over time in each of the communities. The slight increases and decreases in population across the communities do not suggest a significant pattern of construction related in- or out-migration.

MERCURY AND HUMAN HEALTH:

- The KHLP has prepared a Mercury and Human Health Risk Management Plan in consultation with provincial and federal regulators. This reporting period's key activities included: a review of fish mercury concentrations predicted for post-impoundment conditions and fish monitoring plans; development of an approach to post-impoundment communication and associated materials; and idea generation regarding community-based initiatives that support the goals of the risk management plan. A 'Mercury Community Coordinator' role continued in each partner First Nation to implement mercury and human health program activities.

TRANSPORTATION INFRASTRUCTURE:

- While the KGP EIS predicted that existing transportation networks and plans for Provincial Road (PR) 280 upgrades would be able to accommodate the changes in road use associated

with Project construction, community concerns arose during construction regarding traffic safety and road conditions.

- In the period between April 2020 and March 2021, the PR 280 Joint Advisory Committee did not meet.
- A number of mitigation measures have been adopted to reduce the impact of Project traffic on PR 280 including road reconstruction and increased maintenance efforts, operation of the Provincial Trunk Highway (PTH) 6 weigh station near Thompson, the operation of a temporary weigh station located near the junction of PR 391 and PR 280, and communicating driver expectations to contractors in an effort to promote appropriate driving behavior on PR 280.
- The segment of PR 280 with the highest traffic volumes is located between PR 391 and Split Lake. At this segment, from April 2020 to March 2021, the average traffic counts (northbound and southbound combined) were 233 vehicles per day. Of the 233 vehicles per day, 29 were large trucks.
- Collision rates along PR 280 and PR 290 have remained below the industry standard threshold of 1.50 MVKT. Spot grade improvements, localized design considerations, and other road safety improvements are being implemented to address ongoing concerns and to improve the driving experience for all road users.
- The Keeyask North Access Road connects PR 280 to the construction site. On average, 32 vehicles per day used the road between April 2020 and March 2021.
- The Keeyask South Access Road connects Gillam to the Keeyask construction site. On average, 11 vehicles per day used the road between April 2020 and March 2021. Data is reflective of all traffic types including daily construction activities such as hauling.
- Over the past year, traffic monitoring data indicate that Keeyask related construction traffic varied month to month accounting for between 19% to 88% of all traffic on PR 280 near the PR 280/Keeyask North Access Road intersection; with only three of those months greater than 40%.

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1.0 INTRODUCTION

Manitoba Hydro, on behalf of the KHLP, received regulatory approval to commence construction of the KGP in July 2014.

The KGP follows the Keeyask Infrastructure Project (KIP), which included a start-up camp and associated infrastructure, a 25 kilometre (km) all weather North Access Road, and the first phase of the KGP main camp.

The KGP SEMP is intended to monitor changes over time for certain VECs. The SEMP focuses on key pathways of effect to, and components of, the socio-economic environment including:

- Economy;
- Population, Infrastructure and Services; and
- Personal, Family and Community Life.

The SEMP is part of an integrated and coordinated Environmental Protection Program that has been developed to facilitate an effective transition from planning and assessment to construction and operation of the KGP.

This report focuses on monitoring for the Project from the start of construction to March 31, 2021.

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. A reservoir will be 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 consists of work areas, cofferdams, rock groins, and an ice boom. Permanent supporting infrastructure consists of North and South Access Roads, a transmission tower spur, communications tower, some borrow areas, excavated-material placement areas, boat launches, and a portage to enable river traffic to bypass the dam.

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 for the Project is intended to monitor changes over time for certain VECs in order 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. The SEMP builds on the assessment studies conducted for the EIS using established methods for data collection and analysis.

4.0 OVERALL SCHEDULE

Monitoring activities associated with the SEMP are more intensive during construction of the Project, but will also occur during the operation phase:

- **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.
- **Operation Phase** – SEMP monitoring during operation is more limited and related to population change in Gillam during the first five years of operation; transportation infrastructure/travel safety at Split Lake; and mercury and human health.

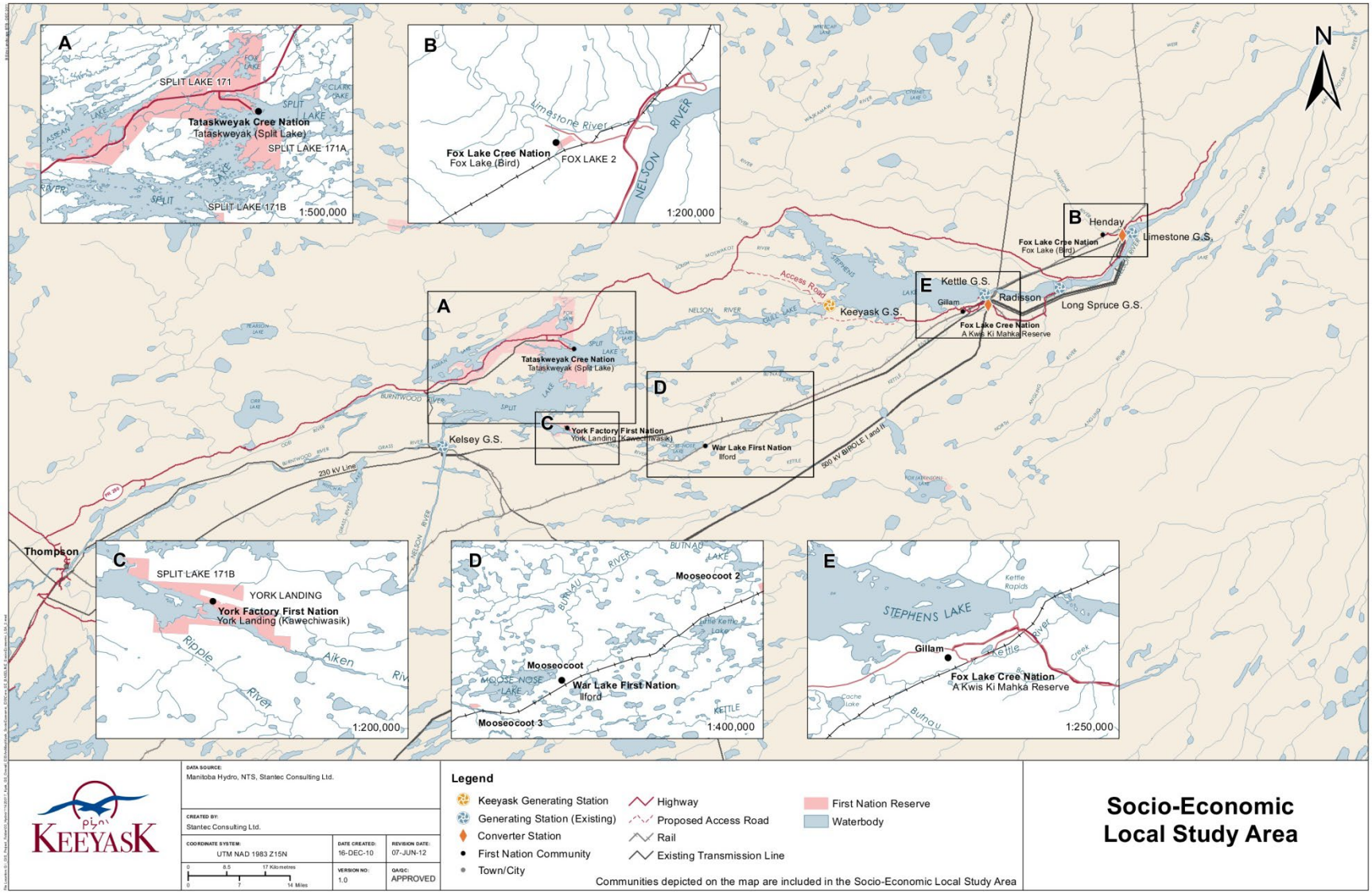
5.0 STUDY AREA

The Socio-Economic Local Study Area for the SEMP (see Map 1) incorporates the Project site and includes the partner First Nations' communities 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. The partner First Nations may be affected by the Project through the following pathways of effect:

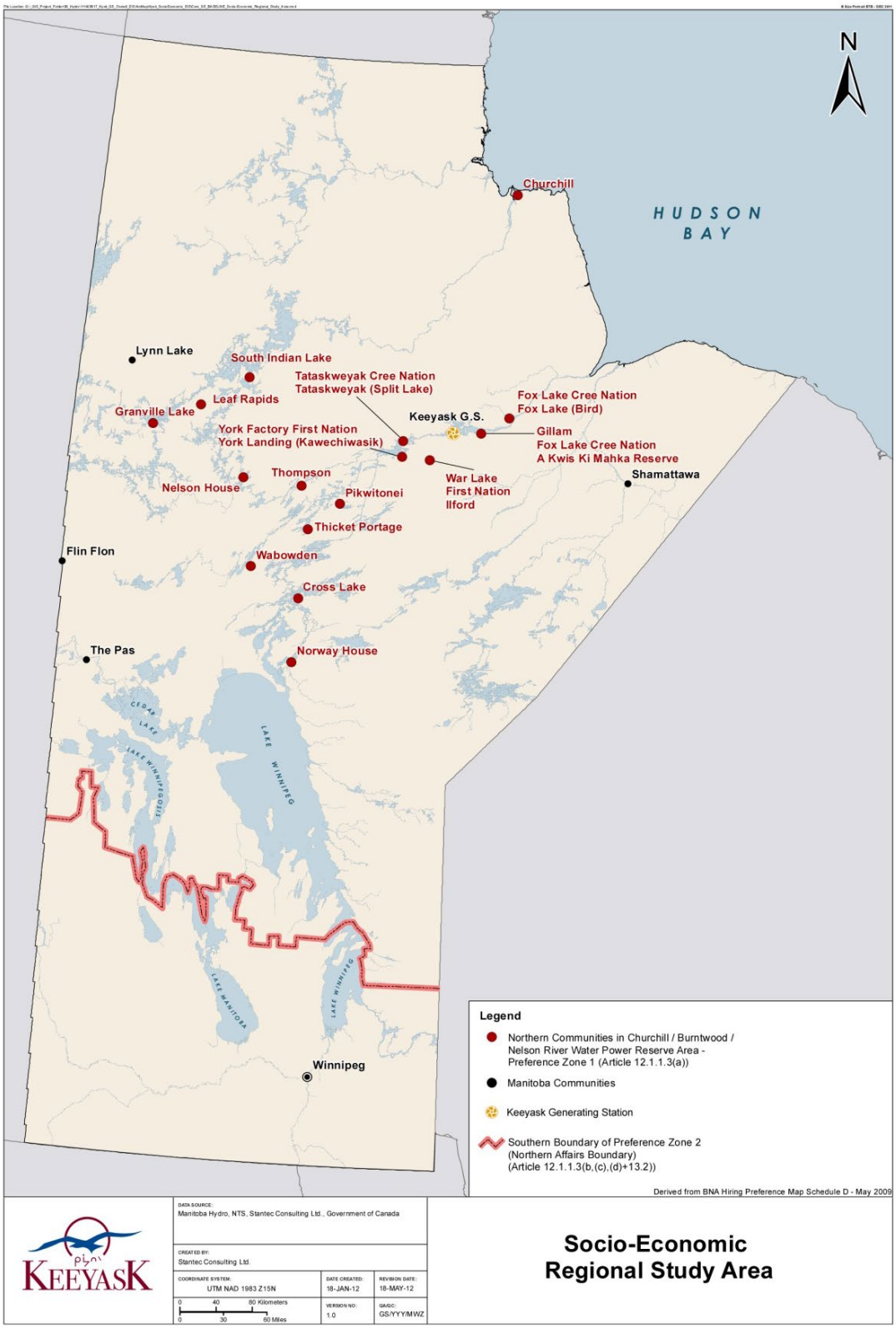
- Physical/biophysical changes to the way the landscape looks;
- Physical/biophysical effects on resource use/traditional use areas and heritage resources;
- Employment and business opportunities;
- Construction traffic;
- Interaction with non-local construction workers within the partner First Nations' home communities; and
- Investment income.

In addition to the partner First Nations' communities, the Town of Gillam and the City of Thompson are included in the Socio-Economic Local Study Area because of their proximity to the Project.

Certain project effects, in particular preferential hiring of northern Indigenous and other northern workers for construction employment, will extend beyond the Socio-Economic Local Study Area to all of northern Manitoba. For this reason, the Socio-Economic Regional Study Area has been defined as the area pertaining to northern hiring preference and using the boundary identified under Schedule D of the Burntwood Nelson Agreement (BNA) (see Map 2). This includes the Churchill-Burntwood-Nelson (CBN) communities identified in the BNA as part of hiring preference Zone 1.



Map 1: Socio-Economic Local Study Area



Map 2: Socio-Economic Regional Study Area

6.0 ECONOMIC MONITORING

Economic monitoring includes monitoring of all employment, training, business and income outcomes associated with the Project. Monitoring is conducted using a consistent methodology that Manitoba Hydro has used for other major capital projects.

All information regarding economic monitoring is provided from the start of generating station project activities (2014) to the end of March 2021.

Economic impacts can be direct, indirect or induced. Direct impacts result from project expenditures and include employment, purchases, and income generated by the Project. Indirect impacts refer to the employment, purchases and income created in other industries as the effects of project expenditures work their way through the economy. For example, there are indirect impacts on businesses supplying materials and equipment to companies in the direct impact segment. Induced impacts are created by the spending of additional income and profits earned by workers and company owners associated with the Project directly or indirectly. This includes additional spending on food, housing, entertainment, transportation, and all of the other expenses that make up a typical household budget. Adding up the direct, indirect and induced impacts, results in the total economic impact of the Project.

6.1 EMPLOYMENT AND TRAINING

The Project EIS analyzed and provided employment estimates for partner First Nations, the Indigenous workforce in the CBN area and the Indigenous workforce in the Socio-Economic Study Area as a whole (see SE SV Section 3.4.1) for the construction phase of the Project. The EIS also predicted that there would be northern participation in the operating jobs required to operate the facility.

Monitoring of employment and training is being undertaken, to determine the overall employment outcomes of the Project construction, with particular emphasis on Indigenous and northern resident participation. Monitoring is also intended to determine the extent to which recipients of Hydro Northern Training and Employment Initiative (HNTEI) pre-project training (PPT) participated in Keeyask construction jobs and received on-the-job training. It was estimated that the levels of participation would be influenced by several factors, including timing of the opportunities and the level of interest by potential workers in pursuing those opportunities.

Monitoring of employment outcomes provides data on overall success in attracting and retaining partner First Nations' members, Indigenous persons and Manitobans during Project construction.

As noted within the SEMP, the Project has an established AGE that is a forum to address employment-related issues related to the construction of the Project, and in particular Indigenous employment. The AGE is established to receive, review and find solutions to concerns and issues

and to monitor, report and make recommendations to the Project manager on employment-related matters, as required.

During construction, employment data is collected on site by contractors through an employee self-declaration form designed specifically for the Project. All completed forms are provided by on-site contractors to Manitoba Hydro and stored in a central database for the Project. Contractors also provide information to Manitoba Hydro on hours worked and labour income to enable calculations for person years and income during construction. Employment data is provided in the formats outlined below:

- Person years – When part-time and/or seasonal workers are used, it is useful to standardize the hires in terms of person years of employment. Person years of employment are defined as the amount of work that one worker could complete during twelve months of full-time employment. This usually means about 2,000 hours of work per year using a standard 40-hour work week in most industries; whereas for Keeyask construction work, a person year of employment represents 3,000 hours of work per year. The person years of employment presented below are shown both at 2,000 hours of work per year, for economic comparisons to other industries, as well as at 3,000 hours (identified in parentheses) of work per year.
- Hires – Refers to the number of times people were hired on the Project site for any duration.
- Employees – Refers to the number of individuals hired. The variance between Hires and Employees can be attributed to an individual being hired to the Project more than once.
- Type (job classifications) of work available.

Training data is collected by Manitoba Hydro through established methods utilizing contractor on-the-job reporting, and the completion of an employee self-declaration form. HNTEI PPTs are tracked by comparing self-declared Employee Report information to the Manitoba Hydro HNTEI database.

6.1.1 PERSON YEARS OF EMPLOYMENT

From the start of construction to March 31, 2021, direct employment on the Project totaled 15,993 (10,662) person-years. As shown below, 61%, or 9,830 (6,553) of these person-years, represent people already living in Manitoba.

Of the 61% of employees who are Manitobans:

- Northern Manitobans represent 35%, or 3,487 (2,325) person years;
- Other Manitobans represent 65%, or 6,342 (4,228) person years;
- Indigenous employment represents 48%, or 4,730 (3,153) person years; and
- Non-Indigenous employment represents 52%, or 5,100 (3,400) person years.

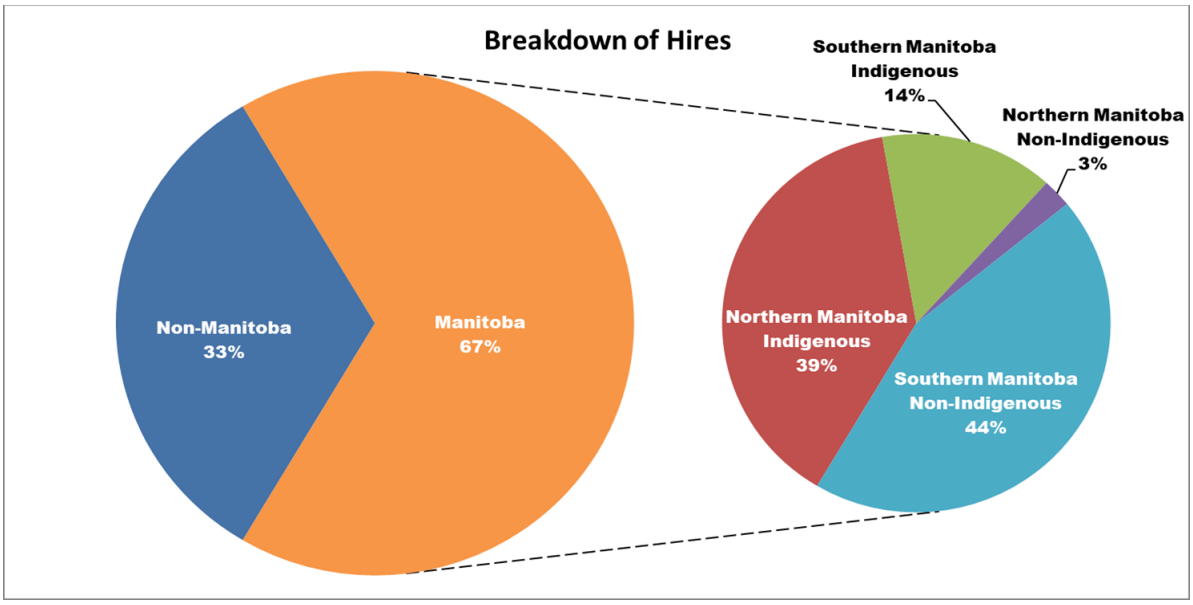


Figure 1: Person Years of Employment (Start of Construction to end of March 2021)

6.1.2 HIRES

From the start of construction to March 31, 2021, there were 25,962 hires on the work site. Of the total hires, 17,409 or approximately 67% were Manitobans:

- Total northern Manitoban hires represent 42% (7,155) of Manitoba hires;
- Indigenous hires represent 53% (9,256) of Manitoba hires; and
- Non-Indigenous hires represent approximately 47% (8,153) of Manitoba hires.

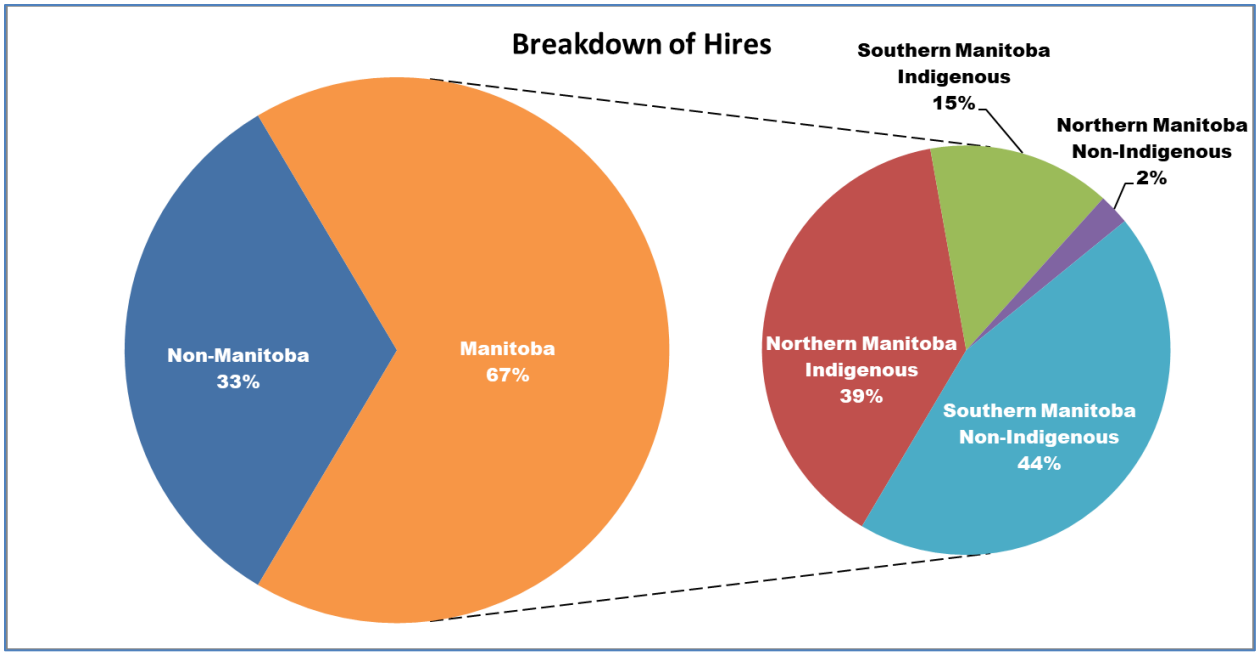


Figure 2: Number of Hires (Start of Construction to end of March 2021)

6.1.3 INDIVIDUAL EMPLOYEES

From the start of construction to March 31, 2021, a total of 10,907 individual employees were hired on the KGP. Of this, 58% (6,297 individual employee hires) were Manitobans:

- Total northern Manitoban employees represent 39% (2,434) of Manitoba hires;
- Indigenous employees represent 51% (3,177) of Manitoba employees; and
- Non-Indigenous employees represent approximately 49% (3,120) of Manitoba employees.

The total number of employees is less than the total number of hires (25,962) because the same individual may have been hired more than once. For example, an individual may have moved to work on a different contract or moved to a different job classification to improve their position. The difference of 15,055 identifies the number of re-hires at the Project site.

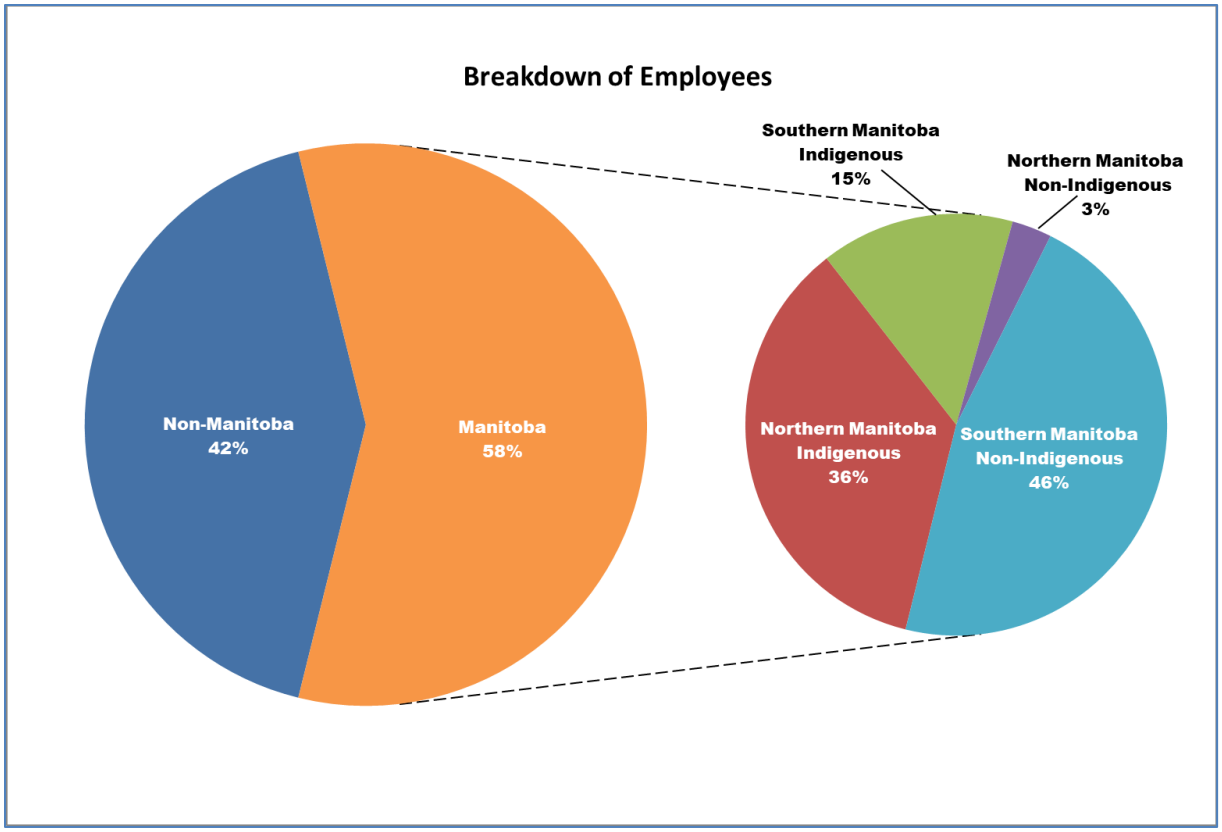


Figure 3: Total Individual Employees (Start of Construction to end of March 2021)

The number of individual employees to date does not reflect the number of employees on site at a given time. The number of employees on site at any given time varies depending on the work in progress and the time of year. The number of employees on site is usually highest during the period from late spring through early fall, which is typically the period with the highest level of construction activity and the largest workforce on site. The actual number of employees on site over the course of the year ultimately depends upon the work plans and schedules of the contractors for the various Project components, in conjunction with the provisions of the BNA, which is the collective bargaining agreement for the Project.

6.1.4 EMPLOYMENT IN THE PARTNER FIRST NATIONS

Construction of the KGP has resulted in the establishment of full- and part-time positions in each of the partner First Nations. While these positions have experienced temporary vacancies at times, overall the number of positions filled during the last reporting period (April 2020 to March 2021) included:

- Twelve positions at FLCN;
- Fifteen positions at TCN;

- Three positions at WLFN; and
- Eight positions at YFFN.

These positions were created on the basis of community specific work plans for the implementation of governance, Aboriginal Traditional Knowledge monitoring, and other commitments in the Joint Keeyask Development Agreement (JKDA). Additional term or seasonal community-based positions have also been filled annually to help with technical science and ATK monitoring activities on the land, as required.

In addition, the partner First Nations also have a total of five positions available for members associated with the Job Referral Service (i.e. Job Seeker Manager staff) who work within their respective communities to assist community members in accessing Keeyask employment opportunities. As well, each partner First Nation has one Keeyask Site Representative whose employment is reported within the construction employment statistics because they work a portion of their time in the community and at the Project site.

6.1.5 TYPE OF WORK (JOB CLASSIFICATION) AVAILABLE

The total cumulative hires by job classification (to the end of March 2021) are provided in the table below. For employee privacy and confidentiality reasons, the numbers of hires by community cannot be disclosed, as the numbers are low for some of the classifications listed.

Table 1: Total Hires by Job Classification (Start of Construction to March 2021)

Job Classification	Total Hires	% of Total Hires	CBN	Indigenous	Non-Indigenous	Northern MB	Other MB	Non-MB
Labourers	3764	14%	1064	2003	1761	1517	1525	722
Security Guards	277	1%	24	99	178	66	211	<5
Crane Operators	436	2%	9	58	378	19	277	140
Equipment Operators	2185	8%	288	665	1520	460	803	922
Teamsters	2012	8%	454	954	1058	679	855	478
Carpenters	3924	15%	142	841	3083	363	903	2658
Millwrights	281	1%	8	45	236	17	195	69
Painters	95	<1%	<5	21	74	<5	47	47
Glass Workers	<5	<1%	<5	<5	<5	<5	<5	<5
Floor Covering Installers	11	<1%	<5	<5	10	<5	10	<5
Insulator Workers	122	<1%	<5	25	97	<5	105	15
Lathing and Drywall Workers	46	<1%	<5	8	38	<5	18	27
Plasterers	<5	<1%	<5	<5	<5	<5	<5	<5
Cement Masons	564	2%	<5	59	505	6	220	338
Bricklayers	34	<1%	<5	<5	32	<5	34	<5
Sheet Metal Workers	43	<1%	<5	8	35	<5	39	<5
Roofers	76	<1%	13	19	57	17	55	<5
Sheeters, Deckers and Cladders	125	<1%	<5	32	93	<5	79	43
Boilermakers	66	<1%	<5	5	61	<5	58	8
Iron Workers	1217	5%	29	323	894	71	538	608
Rodmen	351	1%	<5	59	292	<5	58	290
Electrical Workers	1146	4%	70	218	928	143	943	60
Plumbers and Pipefitters	537	2%	24	114	423	50	393	94
Refrigeration Workers	44	<1%	<5	20	24	8	24	12
Sprinkler System Installers	32	<1%	<5	8	24	<5	30	<5
Office and Professional Employees	2113	8%	247	762	1351	486	1218	409
Caterers	2955	11%	1842	2855	100	2749	147	59
Elevator Constructors	9	<1%	<5	<5	9	<5	9	<5
Other*	3494	13%	399	691	2803	493	1458	1543
Total Hires	**25962**	**100%**	**4621**	**9895**	**16067**	**7155**	**10254**	**8553**

*The "Other" category refers to hires in job classifications not covered by the BNA, i.e. "out of scope" positions. This would include managerial and supervisory staff (both Contractor and Manitoba Hydro), other Manitoba Hydro on-site staff and certain technical staff (engineers and technicians).

6.1.6 RATES OF TURNOVER

The cumulative rate of turnover is calculated as total incidents of separation, for discharges and resignations, divided by hires[1] from the start of construction to a given point in time. The cumulative rate of turnover does not include layoffs or transfers to other positions or contracts.

From the start of construction to March 31, 2021, the cumulative turnover rate for the Project is 31% for total hires, 42% for Indigenous hires and 24% for non-Indigenous hires.

[1] Hires for calculating turnover has been modified to exclude Contract 016125 (Emergency Medical Services), Contract 16180 (Nurse Practitioners) and all environmental monitoring contracts as hiring and work scheduling practices for these contracts can misrepresent the true turnover rate.

Table 2: Turnover

	Total Discharges	Total Resignations	Total Separations	Rate of Turnover
CBN	230	1877	2107	50%
Indigenous	418	3401	3819	42%
Non-Indigenous	396	3165	3561	24%
Northern Manitoba Indigenous	288	2630	2918	47%
Northern Manitoba Non-Indigenous	19	114	133	31%
Manitoba	617	4650	5267	35%
Non-Manitoba	197	1916	2113	25%

Note: Figures above are not additive

There have been instances where individuals have been discharged or resigned, but later returned to work on the Project. This occurred 3,070 times, approximately 42% of the total discharges and resignations.

It is also useful to look at the amount of turnover within certain time periods throughout the life of the Project. When looking at a specific period within the life of the Project, turnover is expressed as total incidents of separation (for discharges and resignations), divided by hires working on site within that specific time period. Since the start of construction, and as shown in Figure 4 below, the amount of turnover within a given quarter has ranged from 3.3% to 16.3%. Of this, turnover among Indigenous employees has ranged from 3.0% to 23.0% and among non-Indigenous employees from 2.5% to 12.4%. While there has been variation in the amount of turnover across each quarter, overall, the amount of turnover for the workforce in Q1, 2021 is lower than in Q3, 2014. Among Indigenous workers the amount of turnover is lower than the Q1 turnover in previous years.

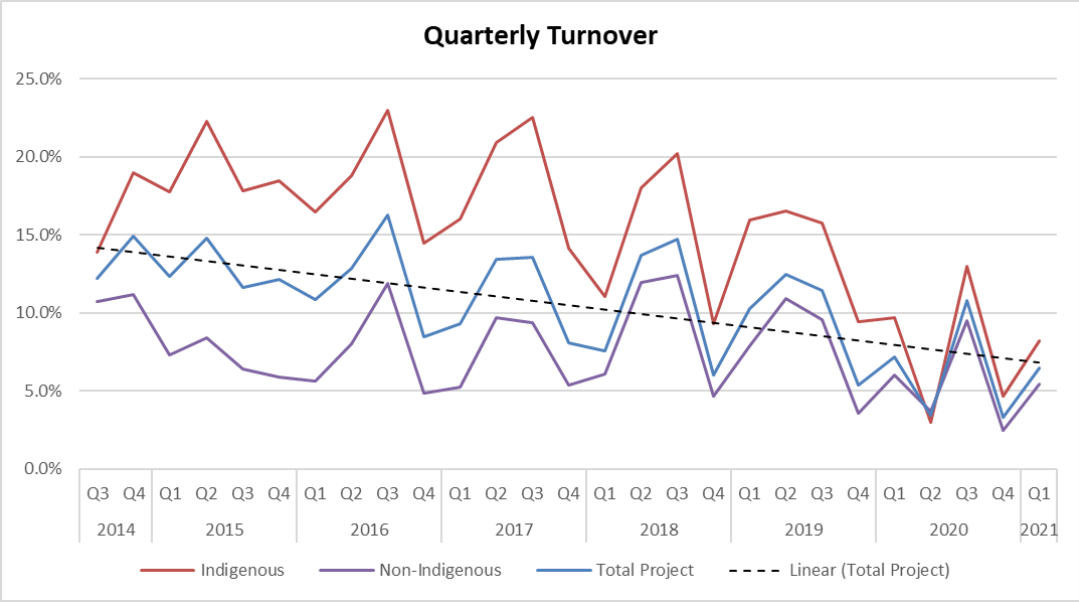


Figure 4: Quarterly Turnover (Start of Construction to end of March 2021)

6.1.7 EMPLOYMENT MITIGATION

6.1.7.1 THE ADVISORY GROUP ON EMPLOYMENT

The AGE is a forum for addressing employment-related issues, in particular Indigenous employment, related to the construction of the Project. The committee includes representatives from the Province of Manitoba, contractors, Manitoba Hydro, Hydro Projects Management Association, Allied Hydro Council and the partner First Nations.

Since the start of KGS construction, an emphasis has been placed on reaching skilled Indigenous workers in the partner First Nations, reducing the obstacles for northern Indigenous workers to enter apprenticeships and to fill open on-the-job training opportunities. The goal is to maintain the partner First Nations' peak employment numbers during the construction season and to have more Indigenous workers trained for future job opportunities beyond Keeyask. The AGE committee has created a collaborative environment for interaction, fact finding, and developing solutions to issues that are raised.

Job Seeker Managers (JSMs) are based in each of the four partner First Nations and are supported by the Province of Manitoba, Thompson Job Referral Service (JRS) team and Manitoba Hydro. Each JSM is responsible for developing an annual community employment plan. Each plan is unique to the community, but all plans have common goals including improving the ability for employers to make contact with members and ensuring that members' Job Seeker profiles are up to date. In addition, partner First Nations' Keeyask Site Representatives support the JSMs, and help contact community members referred for jobs or for open training opportunities.

The JSM's and Province, with support from Manitoba Hydro, continue to work on what the AGE committee has identified as a key factor to increasing the partner First Nations' workforce on the Project: reducing the number of job seekers who cannot be contacted. Several strategies are being used to ensure registration contact information is up to date such as: career counseling, community-based employment sessions, and assistance with updating candidate profiles. Additional methods of contacting candidates have been used including: emails; phone calls during weekends, holidays and the time preferred by job seekers; Facebook postings; and cellular text messages.

The Province of Manitoba, with community JSMs, continue to deliver career counseling through the Keeyask Employment Project (KEP) Referral List. The KEP Referral List identifies an individual's current trade and level as well as preferred trade(s) or area of interest and is used by contractors following the direct hire provisions under Letter of Agreement (LOA) 44[2] for on-the-job training opportunities. The KEP Referral List is distributed regularly to contractors who direct hire individuals into training and apprenticeship opportunities prior to posting a job order through the JRS. Use of the KEP Referral List continues to receive positive reviews from both contractors

[2] LOA 44, signed in 2016 as an amendment to the BNA, provides measures to remove barriers to the employment and retention of Indigenous apprentices and trainees.

and job seekers and has proven to be successful in identifying and filling training and apprenticeship positions in an expeditious manner.

The Keeyask Workplace Essential Skills Training (KWEST) Centre continued to operate until October 2nd, 2020. The goal of KWEST was to provide new and existing workers access to skill development support to enhance their capacity to participate in on-the-job training, to carry out workplace tasks effectively and efficiently, and to prepare for advanced training and employment opportunities. Essential skills assessment, administered by Workplace Education Manitoba, established the candidate's development plan for the trade they were in or were interested in pursuing. The tool allowed the trainer and student to address skill gaps through tutorials and small group sessions which are provided at the KWEST Centre. Contactors also used the service to deliver targeted training in support of skill development program for their workforce. These individuals benefited from the support and ongoing instruction offered through the Centre. Services are still available to Keeyask workers through an online platform.

6.1.8 TRAINING

On-the-job training programs were developed at site to hire individuals as trainees and apprentices and to enhance their qualifications for further career development. The programs offered during the last year were in the following areas:

- Catering, janitorial services and housekeeping
- Maintenance services
- General civil contract
- Intake Gates, Guides and Hoists
- Turbines, Generators and Governors

From the start of construction to March 31, 2021, 1,853 Indigenous employees had participated in training opportunities on the Project (337 in on-the-job programs). 601 of these were filled by partner First Nations' members (183 in on-the-job programs). Apprenticeship opportunities were available in trade classifications such as Mobile Crane Operators, Mechanics, Carpenters, Millwrights, Iron Workers, Plumbers & Pipefitters, Cement Masons, Electricians, Refrigeration Workers, Roofers, Painters, Insulator, Masonry, Rodmen, Water Treatment Operators, Heavy Equipment Operators, Environmental Officers, Construction Labourers, Dozer Operator, Loader and Rock Truck Drivers, Clerks, Fitness Leaders, Hospitality Management and Red Seal Cooks.

Table 3: On-the-Job Training Programs

On-the-Job (OJT) Training Programs - by Labour Type									
Labour Type	Indigenous Hires other than KCN			KCN Hires			Indigenous & KCN GS Training Totals		
	Individuals Trained*	Training Hours	Average Training Duration (Hours)	Individuals Trained*	Training Hours	Average Training Duration (Hours)	Individuals Trained*	Training Hours	Average Training Duration (Hours)
Non-Designated Trades	<5	2622	874	29	12221	421	32	14842	464
Designated Trades	132	262927	1992	88	172784	1963	220	435711	1981
Support & Service Trades	19	23264	1224	69	59287	859	88	82551	938
Staff & Supervisory	<5	740	740	<5	576	288	<5	1316	439
Total GS Training	**154**	**531799**	**3453**	**183**	**244868**	**1338**	**337**	**531799**	**1578**

**Total Individuals Trained is not additive; some individuals may have had training in multiple labour or contract types.*

Info up to March 31, 2021

Three hundred and sixty-nine (369) partner First Nation members employed on the Project site were participants of the past HNTEI PPT Program. HNTEI PPT Program trainees have gained employment in craft trade positions as labourers, security guards, crane and equipment operators, teamsters, carpenters, iron workers, rodmen, electrical workers, plumbers and pipefitters, office and professional employees, caterers, cement masons, millwrights and painters. They have also gained employment in out-of-scope positions such as safety and environmental staff, employee retention and support staff and as trade supervisors. Of the 369 partner First Nation individuals, 49 partner First Nation individuals remain active on the Project as of March 31, 2021.

6.1.9 KEEYASK WORKERS' OPPORTUNITY FUND

Through the generosity of Keeyask Project employees, this fund was created to provide opportunities to support education, training, and employment for members of the four partner First Nations.

Within the first five years of project construction, employees contributed $235,715.47 to this fund by purchasing clothing at the on-site commissary. It is anticipated that additional donations will be added to the fund by Keeyask employees and site guests over the final year of construction. The funds are maintained by Manitoba Hydro in an interest-bearing account, and are dispersed during Keeyask Project construction, to a maximum of $10,000 per year. Remaining funds will be transitioned into a legacy fund managed by the Fund Committee. once the Keeyask Project is in operation.

Since the start of construction, the Fund Committee has awarded ten bursaries to partner First Nation members; one of these was awarded during the reporting period.

6.2 BUSINESS OPPORTUNITIES

Project construction presents direct and indirect business opportunities locally, regionally and across the province as a whole. Business outcomes of Project construction are being tracked, with a particular focus on Indigenous and northern Manitoba business participation.

Direct impacts result from Project expenditures and include employment, purchases, and income generated by the Project. Indirect impacts refer to the employment, purchases and income created in other industries as the effects of Project expenditures work their way through the economy. For example, there are indirect impacts on businesses supplying materials and equipment to companies in the direct impact segment.

6.2.1 DIRECT PROJECT EXPENDITURES

From the start of construction to March 31, 2021 there was $5,259.5 million spent on goods and services for the Project. Of this, $1,298.0 (25%) million were Manitoba purchases. Total northern Manitoba (Indigenous and non-Indigenous) purchases represent $824.5 million or 64% of the total Manitoba purchases. This information reflects direct purchases of the Project for contractors and services. Indirect purchases made by contractors, in turn, would include purchases of goods and services from Manitoba based businesses. Figure 5 summarizes the breakdown of total purchases to date.

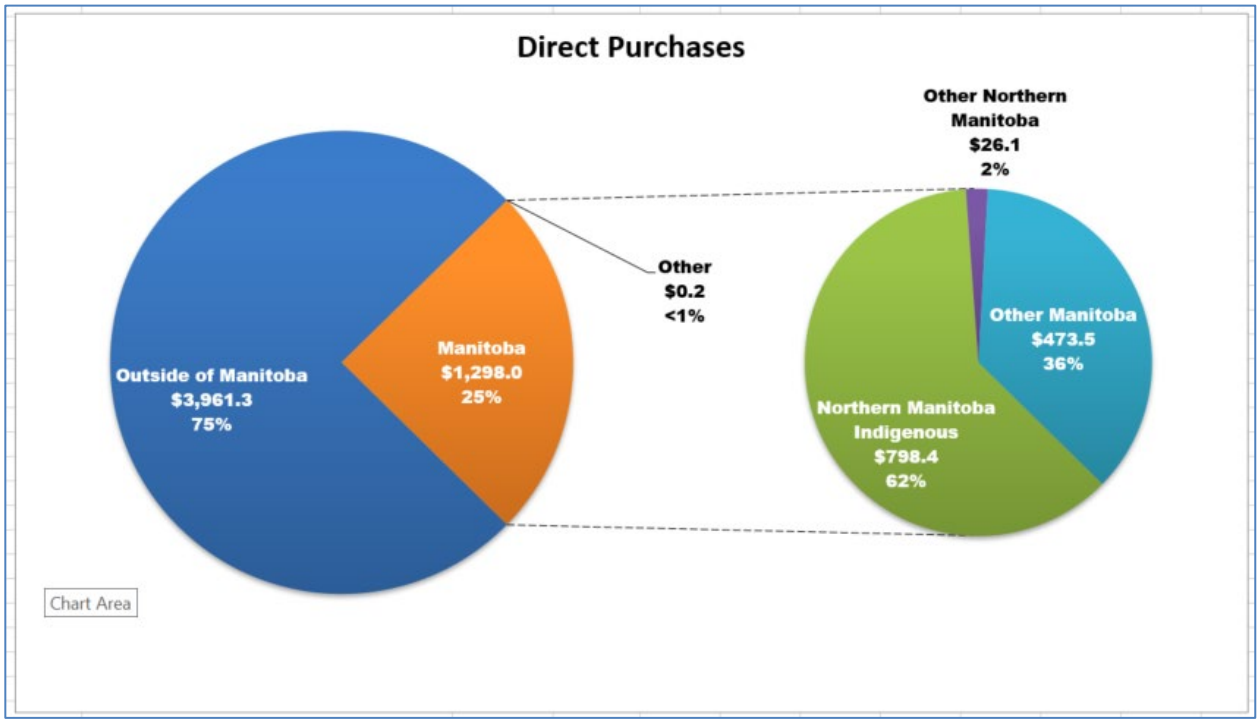


Figure 5: Direct Purchases

6.2.2 DIRECT NEGOTIATED CONTRACTS

As part of the JKDA, Manitoba Hydro and the partner First Nations committed to negotiate a series of business opportunities for the Project as DNCs with partner First Nations' businesses.

From the start of construction to March 31, 2021, 22 DNCs have been awarded to the partner First Nations, with a total value of exceeding $777 million. Some of these DNCs were specific to the KGP, and some covered both the Keeyask Infrastructure Project and KGP. DNCs awarded to partner First Nations included work undertaken on the following components of the Project:

Services (throughout Infrastructure and Generation projects)

- Catering & janitorial services
- Security services
- Camp maintenance services
- Employee retention & support services
- Emergency medical services

Supporting Infrastructure

- PR 280
- North Access Road (Part A & B)
- Start-up camp and work areas site preparation
- Looking Back Creek bridge
- Work areas site development

Generation Station

- Southside containment dykes
- South Access Road
- Reservoir clearing
- Upstream and downstream boat launches
- Reservoir spawning shoals
- Ellis Esker Winter Trail
- Placement of North Access Road organics

In addition, there have been four DNCs awarded to TCN for the Keeyask Transmission Project with a total value exceeding $88 million. The DNCs have been highly successful in providing significant employment opportunities for members of the partner First Nations.

Partner First Nations' businesses have also received work on the Keeyask Project through subcontract agreements: a total of 5 subcontracts for a combined value exceeding $24.5M.

6.3 INCOME

Project construction has generated income from a number of sources including employment, business opportunities and payment of taxes. During the operation phase, the partner First Nations will receive equity income as a result of being partners in the Project.

Labour income is an important indicator of the economic impact of a project. It is the sum of wages and salaries earned by workers.

6.3.1 LABOUR INCOME[3]

From the start of construction to March 31, 2021, the KGP generated $1,741.8. million in total labour income. Of this, Manitoba labour income represents $945.4 million or approximately 54% of total labour income. Of total Manitoba labour income, Indigenous labour income represented approximately $386.6 million (41%), northern Manitoba Indigenous labour income represented approximately $229.0 million (24%), northern Manitoba non-Indigenous labour income represented approximately $37.8 million (4%), and Manitoba non-Indigenous labour income represented $558.8 million (59%). Partner First Nations' labour income represented approximately $132.8 million (14% of total Manitoba labour income).

[3] Labour income is calculated based on information provided by contractors and Manitoba Hydro.

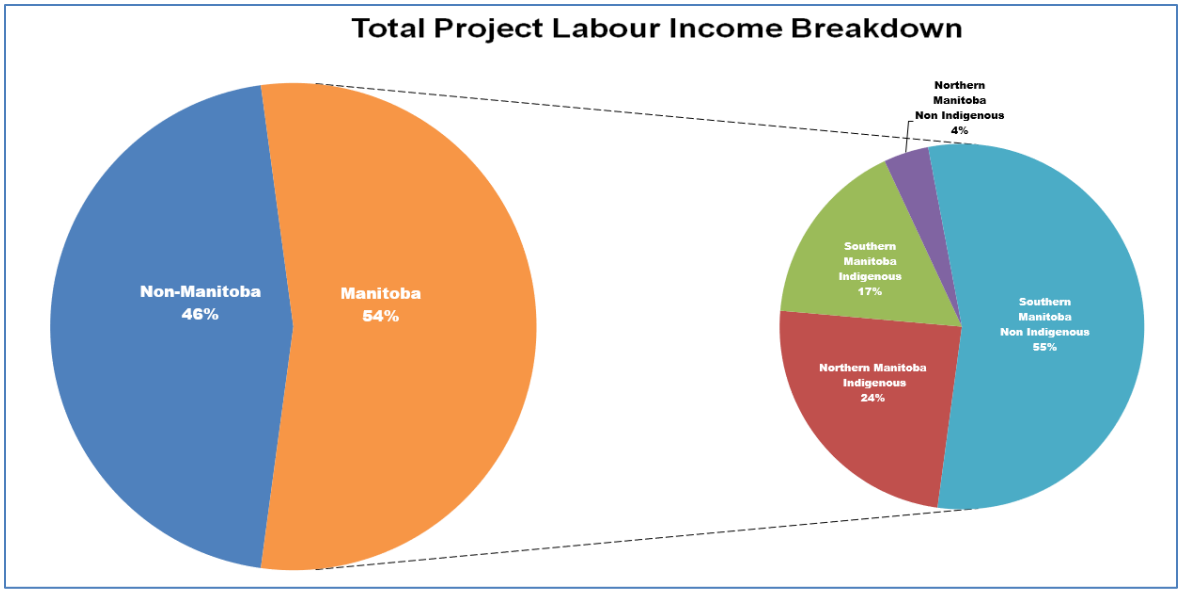


Figure 6: Labour Income

7.0 SOCIAL MONITORING

7.1 KEEYASK WORKPLACE CULTURE

As predicted in the KGP EIS, construction of the Project has required a large temporary workforce comprised of both local and non-local workers. The Keeyask workforce includes individuals from other parts of Manitoba, Canada and other countries, with diverse cultures, perspectives and experiences. The KHLP is committed to creating a respectful workplace culture for all employees at the Project site. A Harassment and Discrimination Free Standard has been implemented at the Project site. The Standard describes a strong vision for a workplace free from discrimination and harassment and emphasizes the importance of being respectful of different cultures. Achieving this goal is the responsibility of everyone involved in the Project.

Efforts to foster a positive workplace environment at the Project site are continuous and ongoing. Manitoba Hydro and the partner First Nations are continuing to work together at many levels to develop strategies to drive a positive work environment at the Project site. Forums where this work has occurred include:

- The KHLP Board;
- An Issues Sub-Committee of the Board: a committee with representation from the partner First Nations and Manitoba Hydro. The mandate of this committee is to discuss and take action on concerns raised by the partner First Nations regarding drugs and alcohol and harassment and discrimination;
- The Keeyask Project Diversity and Inclusion Committee: a site-based committee with representation from the partner First Nations' Site Representatives, Project contractors, Employee Retention Services (ERS) and Manitoba Hydro labour relations. The mandate of this committee is to develop a Diversity and Inclusion Strategy for the Project. The committee also reviews past investigations involving complaints of harassment and discrimination, violence in the workplace, personal conduct cases, and any other significant events, to identify trends that could be addressed through diversity and inclusion initiatives and actions; and
- A Harassment and Discrimination Free Workplace Implementation Task Force (HDFWIT): an advisory group to the Site Support Manager with representation from the partner First Nations, Manitoba Hydro, the Allied Hydro Council and Employee Retention Services. The HDFWIT's mandate is to understand and make recommendations on the investigation process and course of action for workplace complaints under the Harassment and Discrimination Free Standard. This includes the process for receiving, investigating and taking action on workplace complaints under the Standard.

The HDFWIT continues to monitor compliance and harassment and discrimination data. Review of 2020 harassment and discrimination data is showing less complaints being filed in comparison to 2019. Restorative Practices (healing circles) continue to be promoted as an option to

addressing workplace conflict including non-compliance of the Harassment and Discrimination and Violence in the Workplace Standards. The task force will continue to monitor compliance and look for other opportunities for enhancement of the process.

Conflict resolution training workshops are delivered regularly to supervisors and management. A Respect Campaign is also ongoing at site.

Due to the COVID-19 pandemic, the work of the Issues Sub-Committee of the Board as well as the Diversity and Inclusion Committee was suspended in 2020.

7.2 EMPLOYEE RETENTION AND SUPPORT PROGRAMS

Various measures have been in place for the KGP to support the retention of northern and Indigenous employees at the job site, and to ensure that sensitivity and respect for local culture are demonstrated throughout construction. These measures include establishing the ERS Services contract. The scope of this contract was developed jointly with the FLCN and YFFN Keeyask Joint Venture who endeavored to include all partner First Nations' interests. The ERS contractor began delivery of services during the KIP and continued into the KGP.

7.2.1 INDIGENOUS AWARENESS TRAINING

On-site Indigenous awareness training workshops are provided for staff working at the Keeyask site. Because of the dedicated team effort between Site Liaisons, ERS & project contractors, the overall site has surpassed 98% compliance between April 2020 and March 2021. During this period a total of 201 employees had completed awareness training, and 34 training workshops were held. The purposes of training workshops are to:

- Increase understanding and appreciation of the cultural differences, beliefs and values of individuals within the various parties/communities working at the site;
- Enhance comfort in living, working and/or doing business in a culturally diverse environment;
- Identify barriers and issues between the various parties working at the site;
- Identify common goals;
- Develop strategies and action plans for addressing issues/barriers, reaching common goals and developing and maintaining long-term harmonious relationships;
- Increase participants' understanding of contemporary issues facing Indigenous peoples;
- Challenge participants to re-think their assumptions and personal biases about Indigenous peoples;
- Provide participants with information that will promote understanding and respect of Indigenous cultures, enabling participants to work effectively with Indigenous peoples; and

- Increase participants understanding of what a harassment and discrimination free work environment means and what each individuals' responsibilities are to maintain a work environment that is safe for all.

7.2.2 ON-SITE COUNSELING

On-site counseling is available to help all employees, on a voluntary basis, deal with any issues experienced while working on the Project. This could include work adjustment problems, vocational/career issues, cultural adjustments, family stresses, money management, and substance use. The intent is to reduce attrition for all workers by assisting them in dealing with challenges directly affecting their work performance.

7.2.3 SITE LIAISON

The Site Liaison Team's main focus has been on engaging the partner First Nations on all KGP activities and functions. The team maintained its roster and consisted of the Site Liaison Lead, a Liaison Officer and a Site Representative from each of the partner First Nations. The Liaison Team continues to collaborate with the four partner First Nations and the site contractors with a high emphasis on employment and training opportunities, as well as cultural activities. The team works closely with the ERS team where the focus has been on providing support to all Keeyask workers. Additional key functions include membership on the Keeyask Project Diversity and Inclusion Committee and the Harassment & Discrimination Free Workplace Implementation Task Force.

The four partner First Nations' Site Representatives participated throughout this past reporting period. Over the past year, Site Liaison staff worked closely with the Site Representatives on the following activities:

- Engaging community members in employment and training opportunities;
- Assisting with communication between Keeyask Contractors and community JSMs; and
- Facilitating improved communication with partner First Nation workers at site.

Site Liaisons and partner First Nation Site Representatives are also members of the following committees:

- Construction Advisory Committee;
- Advisory Group on Employment;
- Monitoring Advisory Committee; and
- Keeyask Caribou Coordination Committee.

Engagement with these committees not only provides for direct input and feedback but it also allows the team to bridge networks and expand communications within the entire Project.

Due to pandemic measures no tours were conducted during this past year.

7.2.4 EMPLOYEE SUCCESS GUIDE

The KGP Employee Success Guide was developed in 2019 and continues to be utilized to help prospective and new employees as well as their families learn more about living and working at Keeyask prior to applying or starting employment. The Guide is an online tool, available at Keeyask.com, and has been distributed in hard copy form at key locations including in the partner First Nations. The tool consists of the following seven modules:

- Is Keeyask right for you?;
- Preparing yourself and packing;
- Preparing with your family;
- Coming to Keeyask;
- Your room;
- Camp life; and
- Safety first.

7.3 CULTURE AND SPIRITUALITY

Since the start of construction, various measures were put in place to ensure that sensitivity and respect for local culture is maintained throughout construction of the Project.

7.3.1 CULTURAL SITE CEREMONIES

Site ceremonies have been held at key construction milestones to help mitigate the effect of the Project on partner First Nations' culture, and to demonstrate respect for the land and all that is supported by the land. Attendance at ceremonies is welcome and voluntary. Due to pandemic measures, this year's attendance only consisted of site workers including partner First Nation members, staff of the contractors and Manitoba Hydro.

Between April 2020 and March 2021, five ceremonies were held. This included ceremonial events acknowledging the importance of two construction milestones: watering up and impoundment and Unit 1 In-Service. Prayers and blessing were held for watering up and impoundment to give thanks to the water for its power and life sustainability also acknowledging the changes to the environment. In February 2021, a two-day feast and ceremony were held for Unit 1 In-Service. Due to pandemic measures, members of the four partners First Nations were not able to attend in person. In lieu of this, each partner First Nation sent a message that was read at the ceremony.

Other ceremonies included a National Indigenous Peoples Day celebration, a smudge and blessing in the Powerhouse and a Fall ceremony.

7.3.2 SWEAT LODGE

A sweat lodge and teepee area were set up at the Keeyask site in September 2017. Since that time numerous sweat lodge ceremonies have been held which accommodate both night and day shift workers. The sweat lodge is a circular, dome-shaped structure used for many purposes in Indigenous culture. Through ceremonies, it offers a way of clearing, cleaning and freeing obstacles, obstructions and blockages to healing and well-being. During a purification ceremony, participants talk with and listen to the Creator and Grandfathers and Grandmothers for guidance. There are similarities between the physical body and the sweat lodge. Your skin is like the sweat lodge cover; ribs are like the willows; heartbeat is like the drumming; songs are your life lived. Due to pandemic measures between April 2020 and March 2021 no sweat ceremonies were held.

7.4 RESPONDING TO COMMUNITY CONCERNS

An important component of socio-economic monitoring is ongoing dialogue with communities to identify and address concerns or issues as they arise. Over the past year, a primary focus of the KHLP has been the global COVID-19 pandemic. Considerable concern was expressed by the partner First Nations about the potential for the COVID-19 virus to enter their communities from the Project site.

In May 2020, two of the partner First Nations blockaded public roads which provide access to the Project site due to fears the Project would introduce COVID-19 to the region. A path forward from the blockade was negotiated that included several meetings and tabletop exercises with the communities, health officials and site representatives to review prevention and response plans at both the site and in each community.

A comprehensive Pandemic Response Plan was developed by the Keeyask Project site that outlines various actions to:

- Minimize the introduction of the COVID-19 virus at site;
- Prevent its spread; and
- Prevent transmission between site and the local communities.

Weekly pandemic update meetings with MH and community leadership have occurred since April 2020. Keeyask Daily News Briefs were developed to update Keeyask workers, partner First Nations Leadership and community members on the number of workers tested for COVID -19 at site, the results, and required pandemic safety protocols. In consultation with Manitoba Public Health, leadership in each partner First Nation community also developed their own pandemic response plans. In November 2020, Manitoba Public Health recommended that northern

community workers self-isolate for 14 days before returning to their First Nation home community after working at Keeyask, as part of an outbreak management response plan. Manitoba Hydro assisted the partner First Nation communities requesting isolation accommodation support for members. This support was initially provided in November 2020 and continued into March 2021 when the isolation requirements decreased, and communities were in a position to manage isolation requirements for members. Pandemic measures at site continue to be adapted as needed to operate with the safety and well-being of the entire workforce as a priority. This includes ongoing review and enhancement of testing measures. As the Project Manager, Manitoba Hydro is committed to providing a safe and healthy work environment during the COVID-19 pandemic.

Concerns have also been raised by the partner First Nations that the Project has contributed to an increase in the presence and use of drugs and alcohol in the region (including at the Project site and in the communities), and regarding incidences of harassment, discrimination and gender-based violence at Keeyask. The Drug and Alcohol Standard continues at the Project site. The standard applies to all Manitoba Hydro employees, contractors, workers, subcontractors, and their respective employees working, living or attending the Project site. The Drug and Alcohol Standard is a component of Manitoba Hydro's commitment to providing a safe workplace for everyone on site. As part of the standard, drug and alcohol testing is conducted after:

- Safety incidents or high potential near miss;
- It is determined that there are reasonable grounds due to canine indication; or
- Information established by the direct observation of one's conduct.

Manitoba Hydro and each of the partner First Nations have had discussions on what supports can be provided at the community level to mitigate any potential increase of drugs and alcohol associated with the Project. Follow-up support by the substance abuse professional hired to support the Project site has occurred at the community level. The Project Drug and Alcohol Standard provides the opportunity for treatment where addiction is present. The treatment for addiction not only supports a safe working environment, but also improves the lives of individuals and their families.

The KHLP takes seriously any reports of discrimination, harassment or violence. Strong policies and processes are in place at the Project site aimed at preventing and addressing concerns of this nature. In planning for Keeyask, efforts occurred early on to reduce interactions between partner First Nations' members and the non-local Project workforce. In response to concerns during the Project, several committees have been established at the KHLP level and at site to continue efforts. Efforts will continue through the remainder of Project construction towards ensuring a safe and welcoming work environment for everyone at the Project site (see section 7.1 Keeyask Workplace Culture).

7.4.1 WORKER INTERACTION

A Worker Interaction Subcommittee (WIS) was established prior to Keeyask construction to deal

with anticipated increases in the Gillam area workforce resulting from Keeyask, other Manitoba Hydro projects or related work occurring concurrently in the area.

WIS is a forum for information sharing and communication. It was originally established to identify potential worker interaction concerns, prevent issues to the extent possible, and identify ways to work cooperatively to address issues as they arise. The WIS is composed of members from Manitoba Hydro, FLCN, the Town of Gillam, the Royal Canadian Mounted Police (RCMP, Gillam Detachment), the Gillam Hospital and Northern Health Region, and the Gillam School. Other stakeholder representatives attend as needed.

During peak construction periods of the KGP and Keewatinohk Convertor Station, WIS focused on addressing project effects as they related to public safety, community services and infrastructure. WIS established an 'incident tracker' to monitor and respond to specific community concerns and incidents during this time. Several mechanisms and adaptive measures were established to respond in part, to issues raised at WIS such as a "PR 280/PR290 Taskforce", provision of on-site health care services at Keeyask, including nurse practitioner and emergency medical services, and ongoing cultural awareness programming for contractors working in the Gillam area.

Since 2018, WIS has shifted its focus to identifying ways to prepare Gillam and FLCN residents for transition out of the Keeyask construction phase, including reduced economic opportunities, income and services associated with the Project.

WIS did not formally meet in 2020-21 due to the pandemic situation. Efforts to address priority areas of focus identified in 2019-20 continued at the local level to the extent practicable. This included supporting the coordination of resources and services relating to counseling supports, traditional healing opportunities, delivery of FLCN history and cultural awareness workshops and shared cultural activities for both Gillam and FLCN community residents. Priorities will be revisited, and next steps evaluated in mid-2021.

7.4.2 EMPLOYMENT TRANSITION TASK FORCE

The Employment Transition Task Force (ETTF) is a joint initiative of MH and the partner First Nations to explore potential opportunities related to employment of partner First Nations' members during the wind down of the Keeyask construction project. The focus over the past year was coordination with the Northern Manitoba Sector Council and Manitoba Skills and Employment Partnerships to secure workforce transition support for northern residents and to create connections between the Keeyask Workforce Adjustment Coordinators and the Job Seeker Managers in each of the partner communities. The Keeyask Workforce Transition office in Thompson opened its doors December 7, 2020.

7.5 POPULATION

The KGP EIS predicted the Project would not result in notable change in the number of people in the partner First Nations' communities or in Gillam. However, measuring levels of in- and out-migration is difficult, with limitations existing for all related data sources, and the partner First Nations have noted that any in-migration to their communities could stress services that are already at capacity. Population is being monitored to confirm the extent of Project-induced migration in the partner First Nations' communities and Gillam.

The changes in total population observed in 2020 for the partner First Nations and 2019 for Gillam are consistent with trends observed over time in each of the communities. The slight increases and decreases in population across the communities do not suggest a significant pattern of construction related in- or out-migration.

7.5.1 PARTNER FIRST NATIONS' COMMUNITIES

Population data for the partner First Nations is based on data from Indigenous Services Canada for on-reserve and on-own-Crown[4] land populations. As shown in the graph that follows, data for the partner First Nations from 2003 to 2020 shows periods of moderate population growth as well as moderate decline across years. In 2020, the FLCN population increased by 14 people and the WLFN population remained the same as 2019. The TCN population decreased by 3 people and the YFFN population decreased by 12 people.

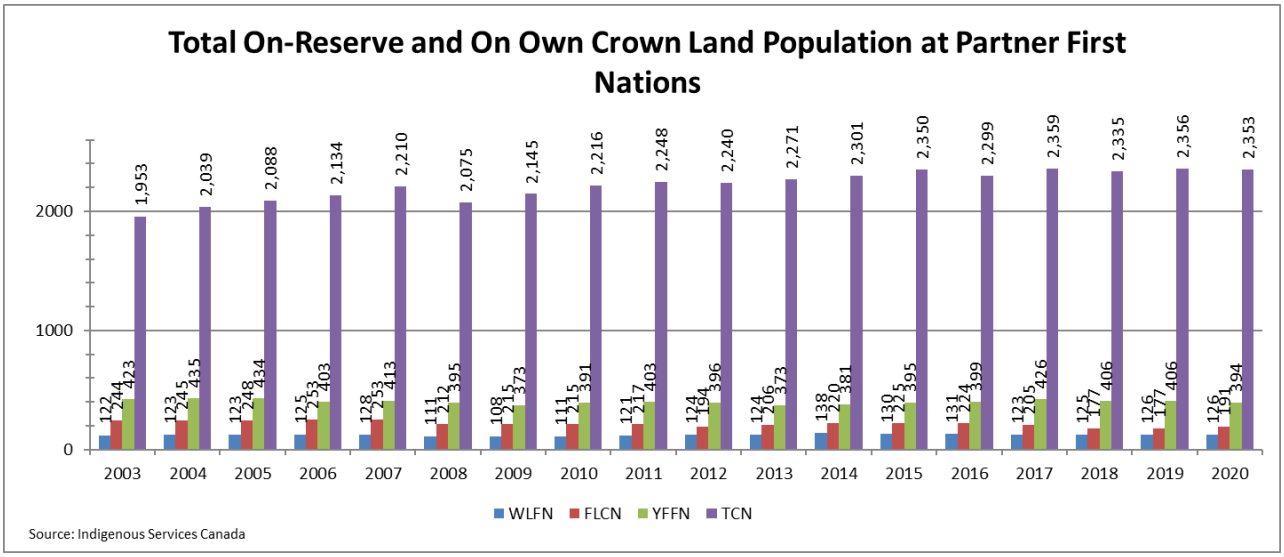


Figure 10: Total On-Reserve and On-Own-Crown Land Population at Partner First Nations (2003-2020)

[4] On-own-Crown lands are those lands not classified as reserve lands but Crown lands that have been assigned to a particular First Nation.

7.5.2 TOWN OF GILLAM

Population data for the Town of Gillam is based on data from Manitoba Health's annual health statistics, which were available up to 2019. As shown in the graph below, the population of Gillam experienced slight annual increases between 2008 and 2011, and, with the exception of a slight increase between 2012 and 2013, slight annual decreases between 2012 and 2019.

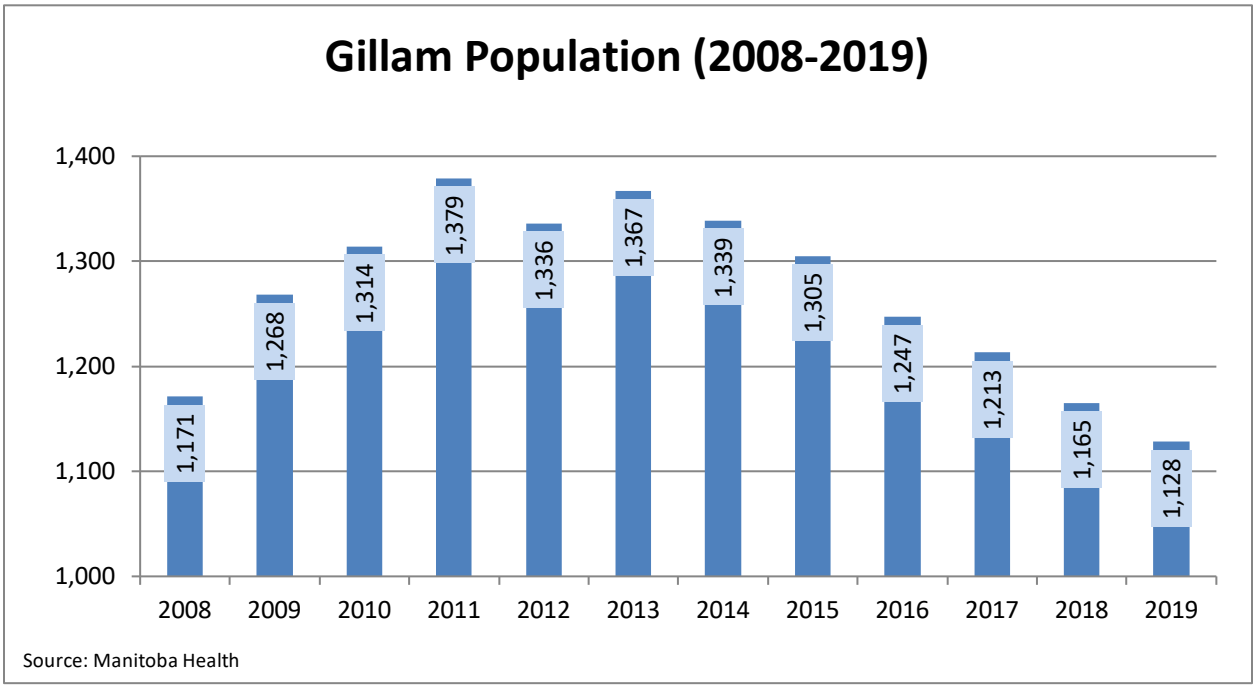


Figure 11: Gillam Population (2008-2019)

7.6 MERCURY AND HUMAN HEALTH

As a result of past experience 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;
- monitoring of mercury in fish, wildlife and plants;
- voluntary hair sampling; 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.

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.

The creation of the Keeyask reservoir in 2020 is expected to 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).

Mercury in soil and surface water does not become concentrated like it does in fish. Studies show that at current levels, recreational use of water and land 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 is working 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 in 2020-2021.

7.6.1 MERCURY AND HUMAN HEALTH IMPLEMENTATION GROUP MEETINGS

The MHHIG normally meets quarterly for in-person meetings. To accommodate pandemic-related travel restrictions, the MHHIG met virtually more frequently, totalling 10 meetings over the course of the year. Discussions focussed on: fish mercury concentrations predicted for post-impoundment conditions and fish monitoring plans; development of approach to post-impoundment communication and associated materials; and idea generation regarding community-based initiatives. Monthly MHHIG discussions were supported by regular meetings with MHHIG subject matter experts (toxicologist, aquatic biologist, hair monitoring consultant) and input on plans and products from provincial health representatives (Medical Officer of Health

(MOH), Public Health – Environment, Manitoba Health and Seniors Care and MOH, Northern Health Region). As the pandemic situation intensified, discussions with health representatives were limited to the Provincial MOH – Environment, who represented the Northern Health Region as well as First Nation Inuit Health Branch.

7.6.2 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. A suite of pre-impoundment communication products for Split, Gull and Stephens lakes were developed to help communities build understanding about mercury. Over the reporting period the MHHIG developed a variety of post-impoundment communication products to support community-based activities in this regard and promote RMP goals to build understanding about mercury and human health and encourage safe harvesting, sharing and eating of healthy wild foods diet. These products include information related to predicted mercury concentrations in fish at peak, consumption advice for those consuming fish from the reservoir and downstream areas, and information about hair sampling and food survey program. 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.
- "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).
- Update of Fish Tape for Gull Lake and Stephens Lake which visually categorizes post-impoundment (predicted peak) mercury concentrations for three fish species for various sizes (i.e., very low to high mercury).
- Postcard and equivalent poster which is intended to prompt interest in mercury and human health programming with an emphasis on consumers of fish in Stephens Lake.
- Refreshment of Split Lake products (in process): reflects new product design and updated consumption recommendations.
- Pre-impoundment products for Gull, Stephens and Split Lakes. Split Lake products (e.g., poster and fish tape) are currently being reviewed to assess whether consumption recommendation changes are required (based on recent fish mercury data) and to reflect design changes to match post-impoundment products.

Partner First Nations experiences and knowledge and scientific / regulatory agency guidance were considered in the development of 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, fish mercury concentrations and hair sampling and food survey program information.

The brochure and Safe Catch posters were developed by the MHHIG with input from provincial health representatives. Post-impoundment consumption recommendations are based on peak concentrations predicted for average Gull Lake and Stephens Lake, Health Canada and World Health Organization guidance on acceptable rates of intake of mercury, and Manitoba Government mercury in fish guidelines. See Section 7.6.5 and Appendix 2: Wilson Scientific, Inc.: Maximum Monthly Intakes for Post-Impoundment Fish Consumption in Gull and Stephens Lakes for more detailed information on development of consumption recommendations.

7.6.3 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. Provincial health representatives provided a list of pandemic related precautionary measures to be applied during community events, including hair sampling activities. Despite limited opportunities due to pandemic restrictions, the following activities were achieved:

- Community events such as fishing derbies, online fish fillet competitions, and education opportunities at cultural events to generate interest and understanding about fish, mercury and human health. Coordinators also worked with school and First Nation health staff and Indigenous traditional knowledge and land-based programs to explore potential educational opportunities in the future.
- Mercury Community Coordinators began initiatives that integrate Indigenous knowledge and mercury and human health issues and support the goals of the RMP, such as the development of a calendar and cookbook.
- Mercury Community Coordinators initiated a ‘test run’ of communication materials (e.g., postcard, brochure, posters) to promote awareness of mercury and human health related Project effects as a result of impoundment and to determine if adjustments are required prior to wider distribution.

7.6.4 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. In 2018, the MHHIG developed a “Know your Number” campaign to generate interest and awareness of this program in partner communities. The results of hair sampling and food surveys undertaken in 2019/20 were not available at the time of the June 2020 report, and are therefore

reported this year. The detailed 2019 Baseline Hair Sampling and Food Survey Community Report prepared by Golder Associates, Ltd, provides pre-impoundment hair sampling and food survey results, and is contained in Appendix 3. Summary outcomes are noted below. During the 2020/21 period, one baseline hair sampling event and all in-person community-based feedback sessions on results were deferred due to the pandemic situation.

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 and gain insight into whether wild food consumption patterns change post-impoundment. 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 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 aged 12 or under, females who may become pregnant)
- 5 ppm for non-sensitive population (male teenagers over the age of 12, 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 Human Health Risk Assessment (HHRA), which will be completed in approximately 2026.

Between February 2019 and March 2020, Mercury Community Coordinators worked with the Project's Hair Sampling Consultant (Golder Associates Ltd.) to host at least one baseline hair sampling and food survey event in each of the four Partner First Nations. There was an attempt

[5] The guidance provided by health agencies varies on whether male teenagers should be considered sensitive or non-sensitive. Appendix 1 includes males over 12 years of age in the 'sensitive' group. After development of this poster, analysis contained within Golder's baseline report and Wilson Scientific's HHRA memo (including development of consumption guidance) considers males over 12 years of age as 'non-sensitive'. This latter approach is consistent with the Province of Manitoba and certain Health Canada guidance, while the World Health Organization consider males up to 17 years of age as sensitive. This issue will be re-evaluated in future discussions with health regulators and MHHIG prior to finalization of post-impoundment communication materials and future HHRAs.

to schedule events two months following peak fish consumption periods (i.e., early summer, fall and to a lesser extent, winter). 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 children under age 12 and females of childbearing age).

A summary of outcomes from pre-impoundment hair sampling and food surveys includes:

- A combined total of 128 participants volunteered for baseline hair sampling and/or food surveys in the four partner First Nation communities. A total of 126 hair samples were collected from 123 people. Three people provided a second sample in a later event. A total of 73 food surveys were completed. Five individuals who completed the food survey did not provide hair samples due to insufficient hair length.
- 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 the participant have questions or wish to receive nutritional counselling.
- Out of the 123 participants that provided a hair sample:
    - Only three had mercury levels in hair that slightly exceeded their respective thresholds. Of the remaining 120 participants, seven 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 fish meals per week is healthy and unlikely to affect their mercury exposure.
    - One person had a slightly elevated mercury level in the first hair sample provided, but their follow-up hair sample a year later was less than their threshold. This person did not seek nutritional counselling when offered, but this person may have considered the nutritional recommendations provided in their personal letter to eat fish that were lower in mercury.
    - A second person had slightly elevated mercury levels during two months of the year (in the summer), but the hair sample segment showed the other 10 months of the year were well below their threshold. No nutritional counselling follow-up was requested when offered.
    - A third person had a slightly elevated mercury level during one month of the year (in the summer), but the hair sample segment indicated that the other 11 months of the year were well below their threshold. Again, no nutritional counselling follow-up was requested when offered.
    - Results from the 73 food surveys indicated:
        - 54 individuals reported that they ate local fish in the previous year. The top species of fish consumed were walleye (53 respondents), northern pike (40), whitefish (27), and

sturgeon (23), followed by other local species such as brook trout and burbot (maria). The top land animals reported to be consumed were moose (55) and caribou (46), and the top wild bird was Canada Goose (44), although some individuals also reportedly consumed various ducks and grouse. The most common berries were blueberry (34), wild strawberry (25), wild raspberry (19) and cranberry (13), and the top wild plants were wihkes (sweet flag/muskrat root) (20) and Labrador tea (14).

- People who reported consuming fish tended to have higher mercury levels than those who did not, but as reported above those levels were largely within healthy ranges.
- Due to limited and non-representative survey participation (including limited participation by local resource users), it is difficult to draw conclusions about wild food consumption patterns at the community or aggregate level. Nonetheless, 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. Limited fishing occurs in Stephens Lake with most individuals reporting they harvest the majority of fish from non-Project impacted or off-system waterbodies. See Appendix 3 for additional, aggregate information regarding location, seasonal variation, consumption frequency and amounts.

Aggregate hair sampling and food survey results from 2019/20 have been shared with all four partner First Nation communities through the development of posters and a presentation at a combined meeting of the MHHIG and Monitoring Advisory Committee (December 2020). Community-level results posters were prepared, upon request, for two of the four communities for distribution and discussion at the local level[6].

Hair sampling and food surveys will continue to be offered to all four partner First Nation communities over the next decade, which will allow individuals to monitor their mercury exposure through repeat hair sampling. Going forward, there will be a focused effort to encourage more frequent hair testing (e.g., seasonal) for people who consume fish from 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.

[6] One community opted out due to small community / sample size; the other requested to wait to include next round of results from planned event, which was deferred due to pandemic. Community level results were not shared with KHLP or MHHIG.

7.6.5 MERCURY IN FISH, WILDLIFE AND PLANTS: MONITORING AND ASSESSMENT OF RISK TO HUMAN HEALTH

The RMP outlines 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 submit plant, Lake Sturgeon, and wildlife samples for mercury analysis. The objectives of this monitoring program are to confirm predictions in the EIS, 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). No monitoring of fish was scheduled in 2020. Activities focussed on the review, interpretation for risk to human health of predicted fish mercury concentrations and monitoring plans and communication of these to MHHIG, MAC, partner First Nation community members and other target audiences.

The Keeyask reservoir (Gull Lake) was impounded in September 2020. It is predicted the mercury concentrations in pickerel, jackfish, and whitefish will increase by three to five times in Gull Lake and by two times in Stephens Lake. Fish mercury concentrations are expected to peak between 2023 and 2027, and then gradually decline over the next thirty years. Mercury in fish will be monitored annually in Split Lake, Gull Lake and Stephens Lake, starting in 2021, in order to measure the effect of flooding on fish mercury levels.

In consideration of the monitoring objectives noted above, the MHHIG identified there is an unavoidable lag between seasonal fishing (e.g., spring/fall) and reporting of fall sampling results (late fall/early winter). As levels rise, there is potential that people who consume fish from Stephens Lake, albeit limited, could unwittingly 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 address this communication lag and avoid unwarranted advisories for Stephens Lake, an additional small-scale sampling (using non-lethal dermal punch samples) will occur on Stephens Lake, starting in June 2021. This will provide an earlier indication of changes in mercury concentrations in Stephens Lake prior to the fall fishing period. Although peak concentrations underwent peer and regulatory review, are conservative and are based on up-to-date scientific information and modelling, June sampling may provide an additional, early warning indicator if mercury concentrations approach or exceed predicted concentrations.

Predicted concentrations in fish in Gull Lake and Stephens Lake reflect average concentrations for a specific length at the peak period and are outlined in a report prepared by North/South Consultants (see Appendix 4: "Predictions of Post-Impoundment Fish Mercury Concentrations for Application in the Mercury and Human Health Risk Management Plan Products" and supporting document "Update of Fish Mercury Information for Gull, Stephens and Split lakes for MHHIG purposes").

In consultation with the provincial health regulator, post-impoundment consumption recommendations were developed using predicted peak concentrations outlined in the North South Reports (Appendix 4), and application of WHO and HC guidance on acceptable rates of intake of mercury. See Appendix 2 prepared by Wilson Scientific, Ltd: Maximum Monthly Intakes for Post-Impoundment Fish Consumption in Gull and Stephens Lakes.

Scheduled sampling programs for wildlife and plants outlined in the Terrestrial Environment Monitoring Plan were completed in 2019. No wildlife or plant samples were collected or submitted for analysis through the voluntary sampling program in 2020.

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 mercury levels similar to whitefish. Sampling for wildlife and plants will continue during the operation period. Data collected will be supplemented by any samples provided by partner First Nations through the voluntary sampling program. All data will be reviewed by the Project Toxicologist to assess risk from consumption of wildlife and plants harvested in the Project area.

Mercury levels in water, post-impoundment, are expected 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/the Keeyask Reservoir and in Stephens Lake four times in 2020 for a suite of parameters, including mercury. To date, mercury levels in water have remained well below the guidelines.

7.7 TRANSPORTATION INFRASTRUCTURE, TRAVEL, ACCESS AND SAFETY

While the EIS predicted that existing transportation networks and plans for PR 280 upgrades would be able to accommodate the changes in road use associated with KGP construction, community concerns arose regarding traffic safety and road conditions.

In response to community concerns, the Province, which is responsible for maintenance and upgrades to PR 280, established the PR 280 Joint Advisory Committee in the fall of 2014. The committee is comprised of representatives from the Province of Manitoba, Manitoba Hydro, the Town of Gillam and the partner First Nations' communities to involve the latter directly in the planning of upgrades to PR 280. In the period between April 2020 and March 2021, the PR 280 Joint Advisory Committee did not meet.

A number of mitigation measures have been adopted to reduce the impact of project traffic on PR 280 including road reconstruction and increased maintenance efforts, operation of the PTH 6 weigh station near Thompson, the operation of a temporary weigh station located near the junction of PR 391 and PR 280 and communicating driver expectations to contractors in an effort to promote appropriate driving behavior on PR 280.

In the fall of 2016, Manitoba Hydro developed a comprehensive transportation management plan to reduce the impacts of project traffic on PR 280. The plan includes pre-hauling construction materials to site during the winter months, night hauling, reductions in Manitoba Hydro truck traffic and reductions in truck weights during periods when the road has deteriorated substantially.

Manitoba Hydro, in collaboration with Manitoba Public Insurance and the RCMP will continue to monitor traffic volumes, speeds, and vehicle types on PR 280 and PR 290 in 2020/21.

7.7.1 TRAFFIC VOLUMES

Traffic volume data is typically collected by Manitoba Infrastructure (MI) every two years. Traffic data for PR 280 is divided into three segments: PR 391 to Split Lake, Split Lake to the PR 280/PR 290 intersection, and PR 280/ PR 290 intersection to Gillam. Use of PR 280 and PR 290 steadily increased since 2003. Volumes are now declining as work on Bipole III and the Keewatinohk Converter Station are complete. The Keeyask Generating Station is now past peak construction and is winding down work force numbers and deliveries. COVID-19 has also had an impact on traffic volume declines.

To better understand traffic patterns during construction, Manitoba Hydro worked with MI to have five, permanent traffic counters installed on PR 280 and PR 290. The segment of PR 280 with the highest traffic volumes is between PR 391 and Split Lake where from April 2020 to March 2021, the average traffic counts (northbound and southbound combined) were 233 vehicles per day. Of the 233 vehicles per day, 29 were large trucks.

Further details on traffic volumes are provided in Manitoba Hydro's Northern Road Traffic Monitoring Quarterly Data Collection Summary (Appendix 5).

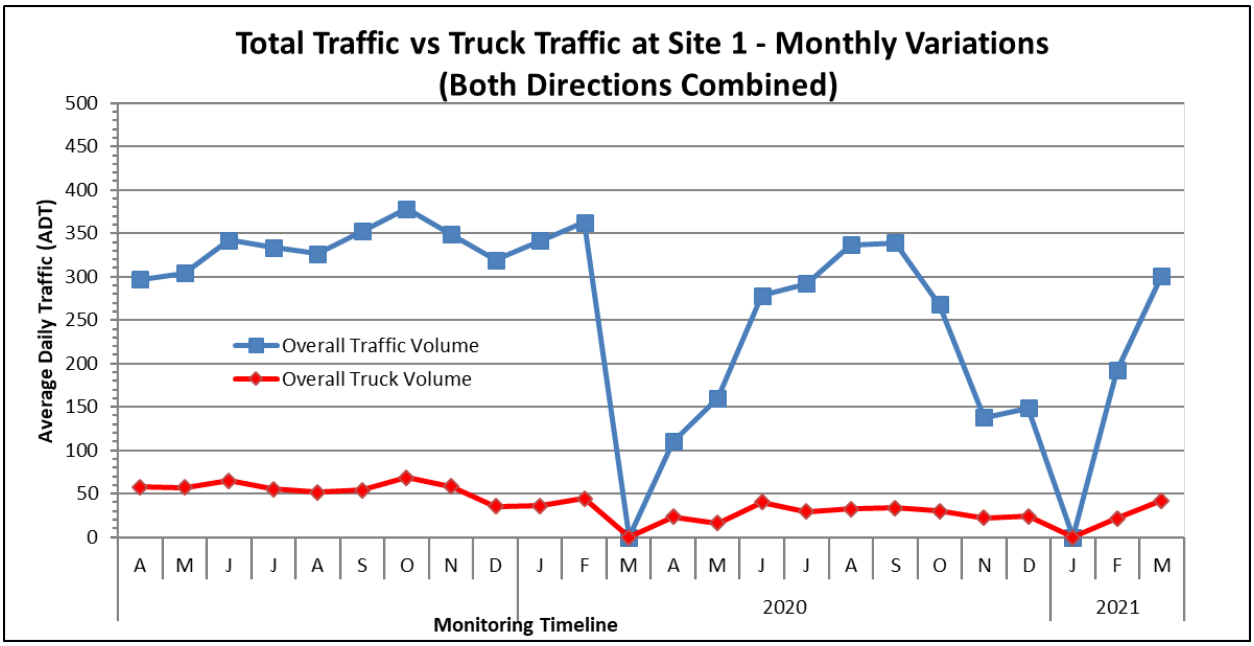


Figure 12: Monthly Variations: Overall Traffic Versus Truck Traffic[7]

7.7.2 COLLISION DATA

Collision rates along PR 280 and PR 290 have remained below the industry standard threshold of 1.50 million vehicle-kilometers of travel (MVKT). Collision rates are a factor of annual average daily traffic (AADT) volume, road length and reported collisions. Spot grade improvements, localized design considerations, and other road safety improvements are being implemented to address ongoing concerns and to improve the driving experience for all road users.

Further details on collisions are provided in Manitoba Hydro's Northern Road Traffic Monitoring Quarterly Data Collection Summary (see Appendix 5).

7.7.3 KEEYASK SITE ACCESS

The Keeyask North Access Road connects PR 280 to the construction site. It is a private road with restricted access, which is controlled by a security gate near the PR 280/North Access Road intersection. The gate office is staffed 24 hours per day, 7 days per week and security staff document all authorized vehicles entering and exiting the road. On average, 32 vehicles per day used the road between April 2020 and March 2021.

Traffic counts from the monitoring station located at PR 280 Site 2, which is the closest station to the Keeyask North Access Road, allows construction related traffic to be compared to the overall traffic on PR 280. Over the past year, these two sets of traffic counts indicate that the percentage of Keeyask related construction traffic varies monthly and accounts for 19% to 88% of all traffic on PR 280 near the PR 280/Keeyask North Access Road intersection; with only three of those months greater than 40%.

The Keeyask South Access Road makes it possible to cross the Nelson River to access the south side construction area and Keeyask camp from Gillam resulting in a reduction of construction traffic on PR 280. Traffic is restricted to authorized construction and project vehicles only and all access is documented by gate security staff. On average, 11 vehicles per day used the road between April 2020 and March 2021. Data is reflective of all traffic types including daily construction activities such as hauling.

[7] Monitoring station failure in March 2020.

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.

STICKER TO BE PLACED HERE

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

YORK FACTORY FIRST NATION

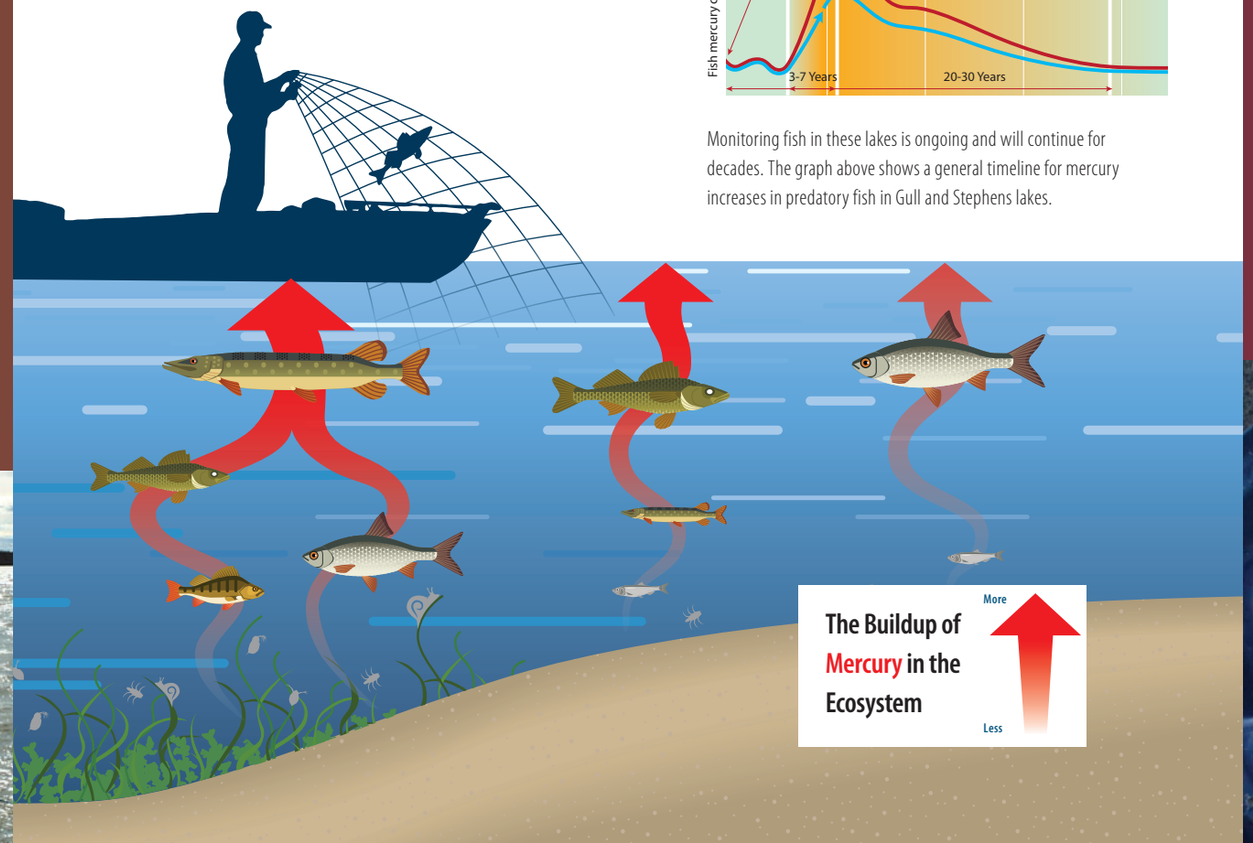
RESPECTING THE LAND AND UNDERSTANDING THE EFFECTS OF MERCURY

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.

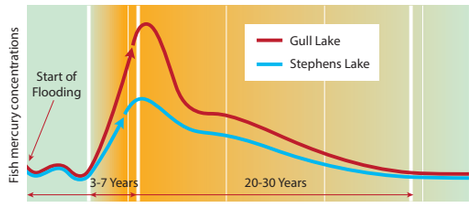
CAN MERCURY AFFECT MY HEALTH?

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

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. Smaller fish than shown are expected to have lower mercury concentrations.

Fish are Good for You!

Remember to eat fish that are low in mercury.

INCHES

CENTIMETRES

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okáw
Pickerel

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

Children	Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	132 lbs (or ~60 kg)
13 oz	1 lb, 9 oz	3 lbs, 11 oz

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onhcwápéw
Jackfish

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

Children	Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	132 lbs (or ~60 kg)
13 oz	1 lb, 9 oz	3 lbs, 11 oz

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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	Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	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 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. Smaller fish than shown are expected to have lower mercury concentrations.

Fish are Good for You!
Remember to eat fish that are low in mercury.

INCHES
CENTIMETRES

ᐅᒃᑲᐤ
okáw
Pickerel

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

Children	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

ᐅᓂᒪᓯᐯᐤ
onhcwápéw
Jackfish

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

Children	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

ᐊᑎᐦᑲᒉᐟ
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	Females of Childbearing Age	All Others
66 lbs (or ~30 kg)	132 lbs (or ~60 kg)	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

MERCURY & HEALTH

DO YOU EAT LOCAL FISH?

Fish monitoring is ongoing to assess mercury levels in fish over time.

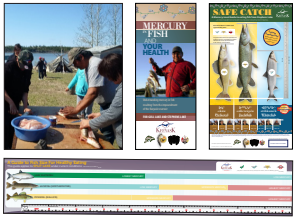
What can you do to help you and your family make informed choices about eating fish from lakes affected by the Keeyask Project?

1

LEARN ABOUT MERCURY IN FISH

Learn from local knowledge holders, and check out these resources:

- Mercury in Fish and Your Health
- Safe Catch Poster
- Fish Tape



2

"KNOW YOUR NUMBER"

Get your hair tested for mercury, especially if you eat fish from Gull Lake or Stephens Lake.

KNOW YOUR NUMBER

3

CONTACT YOUR LOCAL MERCURY COMMUNITY COORDINATOR

Place sticker here of current coordinator

Tataskweyak Cree Nation

KEEYASK

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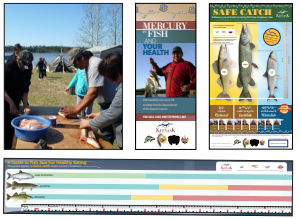

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KEEYASK

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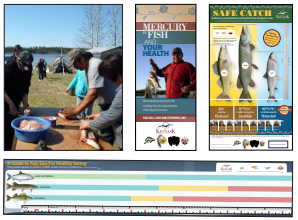

2

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Get your hair tested for mercury, especially if you eat fish from Gull Lake or Stephens Lake.

KNOW YOUR NUMBER

3

CONTACT YOUR LOCAL MERCURY COMMUNITY COORDINATOR

Place sticker here of current coordinator

Tataskweyak Cree Nation

SAFE CATCH

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

Effective until approximately 2030.

Pimicikamak Cree Nation

very low mercury: up to 0.1 ppm	low mercury: up to 0.2 ppm	moderate mercury: up to 0.5 ppm	high mercury: over 0.5 ppm
✓	✓	▽	⊖

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

LAKE WHITEFISH — LOW MERCURY | MODERATE MERCURY | HIGH MERCURY

JACKFISH (NORTHERN PIKE) — HIGH MERCURY

PICKEREL (WALLEYE) — HIGH MERCURY

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

SAFE CATCH

A guide to mercury in fish from **SPLIT LAKE** under existing conditions.

Information provided in 2021.

KEEYASK

very low mercury: up to 0.1 ppm

low mercury: up to 0.2 ppm

moderate mercury: up to 0.5 ppm

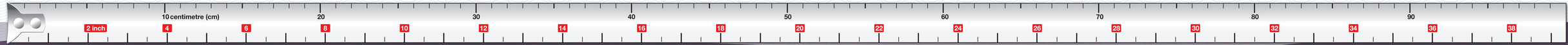
high mercury: over 0.5 ppm

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

LAKE WHITEFISH — VERY LOW MERCURY | LOW MERCURY

JACKFISH (NORTHERN PIKE) — LOW MERCURY | MODERATE MERCURY | HIGH MERCURY

PICKEREL (WALLEYE) — MODERATE MERCURY | HIGH MERCURY



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

SAFE CATCH

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

Effective until approximately 2030.

KEEYASK

very low mercury: up to 0.1 ppm

low mercury: up to 0.2 ppm

moderate mercury: up to 0.5 ppm

high mercury: over 0.5 ppm

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

LAKE WHITEFISH — LOW MERCURY | MODERATE MERCURY

JACKFISH (NORTHERN PIKE) — MODERATE MERCURY | HIGH MERCURY

PICKEREL (WALLEYE) — MODERATE MERCURY | HIGH MERCURY

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

MERCURY & HEALTH

DO YOU EAT FISH FROM STEPHENS LAKE?

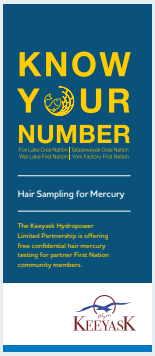
As a result of the Keeyask Project, mercury levels in fish are expected to double in Stephens Lake. After approximately 2030, they will gradually decline over 20-30 years.

What can you do to stay informed?

LEARN ABOUT MERCURY IN FISH

Monitoring in fish is ongoing to assess mercury levels in fish over time. Consumption recommendations for Stephens Lake are available.

KNOW YOUR NUMBER



KNOW YOUR NUMBER

Get your hair tested for mercury to help you make informed choices about eating fish from Stephens Lake.

CONTACT YOUR LOCAL MERCURY COMMUNITY COORDINATOR

KEEYASK

APPENDIX 2: MAXIMUM MONTHLY INTAKES FOR POST-IMPOUNDMENT FISH CONSUMPTION IN GULL AND STEPHENS LAKES BY WILSON SCIENTIFIC, LTD.

Technical Memorandum

To: Manitoba Hydro

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

Date: June 7, 2021

Re: Recommended Maximum Monthly Intake Rates for Post-impoundment Fish Consumption from Gull and Stephens Lakes

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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 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 concentrations of mercury in fish from Gull and Stephens lakes.

Recently, North/South Consultants Inc. (North/South) reported the results of the 2019 fish tissue sampling program and updated the predictions of peak post-impoundment fish concentrations of total mercury for three size classes of fish (whitefish, pickerel and jackfish) from Gull and Stephens lakes (note that predictions for the standard length of these fish remain unchanged) (North/South, 2021). Using the peak post-impoundment concentrations provided by North/South (2021), a preliminary human health risk interpretation was completed and is reported in this memorandum. 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). In addition to ongoing consultations with the Keeyask Cree Nations (KCNs), it will be 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. It is understood this memorandum, as well as related fish mercury data information prepared by North/South, will be submitted as part of the 2020-21 Socio-Economic Monitoring Plan in fulfilment of annual regulatory reporting requirements. It is recommended that Manitoba Hydro follow up with health agencies to discuss contents within these documents.

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 KCNs and their representatives. It is recommended that continued dialogue with and feedback from the KCNs 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) report and instead all 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 should be developed by regulatory agencies such as the Province of Manitoba (such as Manitoba Department of Conservation and Climate) or the Government of Canada (such as Health Canada); therefore, this memorandum provides fish consumption recommendations rather than formal guidelines. Nevertheless, the approach that was adopted to develop the fish consumption recommendations is generally consistent with the approach that the various agencies use in developing guidelines. Specifically, the Province of Manitoba's (2007) approach for developing recreational fish consumption guidelines, Health Canada's fish consumption approach (Health Canada, 2007) and risk assessment advice from Health Canada (Health Canada, 2007; 2019a; 2021) and the World Health Organization (WHO) were largely adopted by Wilson Scientific. 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 (as completed by the Province of Manitoba [2007]), the approach provided recommendations as pounds per month (as requested through dialogue with representatives of the KCNs) (Health Canada [2019a] provides a similar approach although uses grams per month).

In providing input into the development of consumption recommendations, the MHHIG assessed options in terms of the timing and frequency of recommendations while mercury levels rise. Two main options were:

> Approach 1: Issue post-impoundment fish consumption recommendations by assuming that the modeled peak mercury concentrations were occurring in present day post-impoundment fish. This approach assumes peak conditions occurred immediately post-impoundment which means that communities will receive consistent messaging with ideally no need to re-issue consumption advice until it is determined that fish concentrations are decreasing (unless fish monitoring shows appreciably different mercury concentrations than predicted by North/South [2021]). This approach has its limitations in that it likely overestimates fish concentrations before peak concentrations have been reached (3-7 years) and as a result, may result in overly stringent fish consumption recommendations prior to peak concentrations.
>
> Approach 2: Provide annually updated fish consumption recommendations based on ongoing monitoring data prior to peak concentrations. The MHHIG agreed that this approach could create confusion and cause uncertainty. Further, because of the time gap (up to 1 year) between fish data collection and interpretation of results, updated recommendations would likely underestimate mercury concentrations during the phase when increasing mercury concentrations are expected.

Through consultation with the KCNs and Medical Officers of Health from Manitoba Health and Northern Health Region, it was determined that it was most appropriate to assume that peak post-impoundment conditions were occurring immediately following impoundment (Approach 1).

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

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

where:

BW = body weight of person of interest (kg)
AP = amortization 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.

Province of Manitoba (2007) recommends fish with mercury concentrations above 0.5 µg/g be avoided by sensitive individuals and above 1.5 µg/g be avoided by all others (*i.e.*, the "avoid" category). Although it was theoretically possible to estimate monthly fish intake rates for fish with mercury greater than these 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. As a result, fish consumption recommendations were not provided for fish class sizes that have mercury concentrations that are classified in the Province of Manitoba (2007) "avoid category" (the fish species and sizes are described later in the memorandum; however, as a general rule, larger and more predatory fish tended to have the highest mercury concentrations and fish from Gull Lake are more affected than fish from Stephens Lake).

It is noted that Equation 1 assumes 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; 2019a). It would seem that all major agencies face a similar issue regarding the difficulty accounting for other non-fish sources but have nevertheless decided that the best approach is to allow for the entire methylmercury TDI to result from fish consumption. Nevertheless, separate sampling programs are in place where wild game, waterfowl, plants and other media are planned to be analyzed. If these programs identify unexpectedly high concentrations of mercury in non-fish media, it may be necessary to re-evaluate the approach of using 100% of the methylmercury TDI in development of fish consumption recommendations.

Body Weight

Consistent with Province of Manitoba (2007) , there are 3 distinct groups of people that should be 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.

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. Health Canada (2007; 2019a) has evaluated additional age groups that included toddlers, older children, teens and adults; however, they were 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. The average body weights used were as follows:

- children under 12 years of age = 30 kg (66 lbs);
- females of childbearing age = 60 kg (133 lbs); and
- all others = 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 appreciably less than the weights used in this assessment (as lower fish consumption recommendations would be applicable). Draft communication material has been 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).

Amortization Period

The amortization period refers to the timeframe over which mercury exposures can be averaged and then compared to the tolerable daily intake. An amortization period of 30 days is used by the Province of Manitoba (2007) whereby meals per month is used for recreational fish guidelines. Health Canada has not provided a defined amortization period but they 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; 2019a] for certain types of fish). Sakamoto et al. (2017) evaluated this issue and documented support for amortization 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 amortization period.

With the above in mind, an amortization period of 30 days was selected for the purposes of fish consumption recommendations. Monthly amortization is consistent with the Province of Manitoba (2007) approach, certain fish consumption advice provided by Health Canada (2019a) 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 (TWI) of 1.6 µg/kg bw/week and 3.3 µg/kg bw/week 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, it remains unclear which TDI should be applicable for female and male adolescents. In defining sensitive versus non-sensitive groups, Province of Manitoba (2007) considered children under 12 years of age and women of childbearing age to be the sensitive group and all others to be in the non-sensitive group. The age cut-off in the Province of Manitoba (2007) approach is quite similar to that used by Health Canada (2007) (*i.e.*, Health Canada only slightly varies by defining sensitive children as "up to 12 years of age" rather than "under 12 years"). On the other hand, in WHO (2007), adolescents up to 17 years of age are included in the sensitive group; however, the rationale for including this expanded age group is brief and not specific to actual observed effects in this age group due to mercury (WHO discusses that the adolescence brain continues to normally change up to about 17 years of age and, thus, the age range of sensitivity was up to 17 years despite lack of toxicological data on this age group). The WHO (2007) approach of including adolescents in the sensitive age group seems to be adopted by Legrand et al. (2010), which is a commentary paper by five senior Health Canada scientists. In their paper, Legrand et al. (2010) consider minors up to 18 years of age to be in the sensitive group; however, there is little supporting rationale provided aside from citing WHO (2007). One minor difference is that Legrand et al. (2010) paper considers the sensitive group to include children up to 18 years of age (rather than up to 17 years assumed by WHO [2007]). In Health Canada (2021), sensitive populations are defined as children under 12 years of age and women of childbearing age while non-sensitive populations are listed as adults who are not women of childbearing age (*i.e*., adolescents are not addressed in either group). The age cut-off cited in Legrand et al. (2010) is also used in certain high-profile Canadian documents (i.e., Health Canada, 2019b; Chan et al., 2019).

In addition to children under 12 years of age, 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.

As an interim measure, Province of Manitoba (2007) and Health Canada (2007; 2021) approaches for TDIs for methylmercury were adopted with the slight modification that the sensitive population was considered to include "children under 12 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; however, we have recommended dialogue with health agencies and the KCNs to reconsider including all adolescents 18 years and under as part of the sensitive population. If the current approach were revised to include adolescents 18 years and under in the sensitive group, fish consumption recommendations for adolescents 12 to 18 years of age would be 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

North/South (2021) provided an update to fish mercury concentrations predictions under peak conditions for three size classes of various fish species in Gull and Stephens lakes. Specifically, the fish evaluated were lake whitefish, pickerel (also known as walleye) and jackfish (also known as northern pike). These species were selected for historic reasons (*i.e.*, these species were commonly sampled in historic studies), because of their economic importance (they are harvested commercially and domestically), and in the case of pickerel and jackfish, because they are top predators and are, therefore, at the greatest risk for biomagnification of mercury. There is a long term, pre-Project data record from which changes to these species caused by flooding can be assessed. In their updated analysis, predictions of mercury concentrations in lake sturgeon or other species were not included (previous information from North/South had attempted to provide estimates for lake sturgeon). Lake sturgeon is not a targeted species due to their limited numbers; they are sampled opportunistically when they are inadvertently killed. Therefore, there are limited data from which post flooding impacts can be assessed. Fish mercury concentrations in tributaries of Gull and Stephens lakes were not predicted; however, this does not mean that such fish are not expected to be impacted by the impoundment, since some fish are known to move between the tributaries and Stephens Lake, (see Aquatic Environment Monitoring Plan for overview of fish movement studies).

Tables 1 and 2 below provides the key information provided by North/South (2021) that has been used to develop fish consumption recommendations for Gull and Stephens lakes, respectively. As discussed in North/South (2021), the fish from Gull Lake are predicted to increase much more substantially than in Stephens Lake. Specifically, peak mean mercury concentrations in fish are predicted by North/South (2021) to increase by a factor of 3 to 5-times over pre-impoundment conditions in Gull Lake while doubling in Stephens Lake.

Table 1: North South (2021) Predicted Peak Mean Concentrations of Mercury in Various Fish Species from Gull Lake

Fish Species	Predicted Peak Mean Total Mercury Concentration (µg/g; wet weight)			
Lake Whitefish	<300 mm	300-450 mm	>450 mm	Standardized Size of 350 mm
	0.126	0.216	0.534	0.19
Pickerel	<400 mm	400-550 mm	>550 mm	Standardized Size of 400 mm
	0.777	2.38	3.38	1.0
Jackfish	<500 mm	500-750 mm	>750 mm	Standardized Size of 550 mm
	0.760	1.54	3.55	1.0

Table 2: North South (2021) Predicted Peak Mean Concentrations of Mercury in Various Fish Species from Stephens Lake

Fish Species	Predicted Peak Mean Total Mercury Concentration (µg/g; wet weight)			
Lake Whitefish	<300 mm	300-450 mm	>450 mm	Standardized Size of 350 mm
	0.122	0.184	0.318	0.15
Pickerel	<400 mm	400-550 mm	>550 mm	Standardized Size of 400 mm
	0.444	0.922	1.48	0.5
Jackfish	<500 mm	500-750 mm	>750 mm	Standardized Size of 550 mm
	0.342	0.704	1.85	0.5

The equations used to estimate maximum monthly intake are focused on predicted 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 (and thus not conservative) from a nutritional perspective. At the current time, this approach is consistent with the Province of Manitoba (2007) approach (it is unclear how Health Canada approaches this). 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 that 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 0.5 µg/g). Nevertheless, given the toxicokinetics of methylmercury (*i.e.*, with a blood half-life of 80 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). As a result, it is reasonable to use average fish concentrations to predict these longer-term intakes. Use of average concentrations also has the advantage of addressing the positive health benefits of fish consumption (*i.e.*, if say 90th percentile fish mercury concentrations were used, consumption of certain fish may be unnecessarily discouraged).

Results - Fish Consumption Recommendations

The receptor-specific maximum monthly intakes for the various fish species are provided in Table 3 for Gull Lake and Table 4 for Stephens Lake. A worked example of the calculation 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 (Attachment 1 provides the mathematical approach with a worked example). These results are discussed in greater detail below for Gull and Stephens lakes.

Gull Lake

As discussed in the methods section of this memorandum, fish consumption recommendations 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.

All size classes of pickerel and jackfish and the largest size class of whitefish (greater than 450 mm) are predicted by North/South (2021) to have average mercury concentrations that exceed 0.5 µg/g at peak conditions. In the case of fish consumed by non-sensitive individuals, size classes of pickerel greater than 400 mm and jackfish greater than 500 mm were predicted by North/South (2021) to exceed a mercury concentration of 1.5 µg/g. As a result, maximum monthly intakes were not estimated for these fish.

For fish from Gull Lake that did not fall into the "avoid category", maximum monthly intakes were calculated and are provided in Table 3. 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 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.

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

Fish Species	Fish Size Class (as fork length)	Assumed Average Concentration (µg/g; wet weight)	Recommended Maximum Monthly Intake Due to Mercury (pounds per month)		
			Children Under 12 years of Age	Females of Childbearing Age	All Others
Whitefish	<300 mm	0.126	3.1	6.3	14.8
	300-450 mm	0.216	1.8	3.7	8.6
	>450 mm	0.534	Avoid	Avoid	3.5
	Standardized size: 350 mm	0.19	2.1	4.2	9.8
Pickerel	<400 mm	0.777	Avoid	Avoid	2.4
	400-550 mm	2.38	Avoid	Avoid	Avoid
	>550 mm	3.38	Avoid	Avoid	Avoid
	Standardized size: 400 mm	1.0	Avoid	Avoid	1.9
Jackfish	<500 mm	0.760	Avoid	Avoid	2.5
	500-750 mm	1.54	Avoid	Avoid	Avoid
	>750 mm	3.55	Avoid	Avoid	Avoid
	Standardized size: 550 mm	1.0	Avoid	Avoid	1.9

As discussed earlier, the calculations 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 only be half 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 are 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 will be necessary to account for these other sources. For example, if a person is consuming both whitefish and pickerel from Gull Lake, the values provided in Table 3 will need to be adjusted using a

ratio approach. Attachment 1 provides a worked example showing the approach that can be used to make these calculations. Province of Manitoba (2007) presents a similar mathematical approach in their guidelines.

Finally, certain fish in Gull Lake are predicted to have very high concentrations of mercury under peak conditions and it will be important that all people avoid these fish (not just sensitive individuals). Of particular concern are the largest size classes of pickerel and jackfish with average mercury concentrations predicted in the range of 3.38 and 3.55 µg/g, respectively; 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 the Gull Lake 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.

Stephens Lake

Compared to Gull Lake, fewer fish from Stephens Lake fell into the Province of Manitoba (2007) "avoid" categories. North/South (2021) indicated that all whitefish size classes had predicted mean mercury concentrations less than 0.5 µg/g at peak conditions and, consequently, none of the whitefish were in the "avoid category" for sensitive individuals. In addition, the smallest size ranges for pickerel (*i.e.*, less than 400 mm) and jackfish (less than 500 mm) did not exceed mean mercury concentrations of 0.5 µg/g and, thus, were not in the "avoid category" for sensitive individuals. In the case of pickerel and jackfish of standardized size (*i.e.*, 400 mm and 550 mm, respectively), North/South (2021) predicted mean mercury concentrations of 0.5 µg/g which is equal to the threshold for avoid for sensitive individuals; however, because it did not exceed this concentration and communication materials are recommending that people eat up to these lengths, they were not added to the "avoid" category. For non-sensitive individuals, only the largest size ranges for jackfish were included in the "avoid" category. Consistent with the methods described earlier, maximum monthly intakes were not estimated for these fish.

Maximum monthly intakes for fish from Stephens Lakes are provided in Table 4. For a person consuming fish at these monthly rates on a consistent basis, acceptable risks from a mercury perspective would be estimated in a manner consistent with the Province of Manitoba and Health Canada approaches. However, as discussed for Gull Lake, maximum monthly intakes should be adjusted if persons have different body sizes (e.g., a 15 kg child should only consume half the amount as provided for the 30 kg child assumed in Table 4) or if persons are consuming fish of multiple species or sources. Attachment 1 provides details on how these adjustments can be made.

Table 4: Recommended Maximum Monthly Intake of Various Fish under Predicted Peak Post-Impoundment Conditions at Stephens Lake

Fish Species	Fish Size Class (as fork length)	Assumed Average Concentration (µg/g; wet weight)	Recommended Maximum Monthly Intake Due to Mercury (pounds per month)		
			Children Under 12 years of Age	Females of Childbearing Age	All Others
Whitefish	<300 mm	0.122	3.2	6.5	15.3
	300-450 mm	0.184	2.2	4.3	10.1
	>450 mm	0.318	1.2	2.5	5.9
	Standardized size: 350 mm	0.15	2.6	5.3	12.4
Pickerel	<400 mm	0.444	0.9	1.8	4.2
	400-550 mm	0.922	Avoid	Avoid	2.0
	>550 mm	1.48	Avoid	Avoid	1.3
	Standardized size: 400 mm	0.5	0.8	1.6	3.7
Jackfish	<500 mm	0.342	1.2	2.3	5.4
	500-750 mm	0.704	Avoid	Avoid	2.6
	>750 mm	1.85	Avoid	Avoid	Avoid
	Standardized size: 550 mm	0.5	0.8	1.6	3.7

Although fish in Stephens Lake are predicted to have appreciably lower mercury concentrations than in Gull Lake, there will need to be communication efforts that indicate there are fish in Stephens Lake that people are advised to limit or avoid consumption. Of particular concern are the largest size class of pickerel and jackfish with average mercury concentrations predicted in the range of 1.48 and 1.85 µg/g, respectively; however, consumption of even the mid-size classes could create a concern and are recommended to be limited or avoided (even occasional consumption could result in the Health Canada and WHO provisional TDIs exceeded and elevated hair concentrations of mercury occurring). Consequently, it will be important that people are aware of these findings to the maximum extent reasonable.

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 KCNs are receiving the best and most up-to-date advice.

North/South (2021) has estimated that under peak post-impoundment conditions that average mercury concentrations in fish may increase 3 to 5-fold on average in Gull Lake while fish mercury levels may double at Stephens Lake. From a toxicological perspective, there will be fish in Gull and Stephens lakes under peak conditions that should be avoided by both sensitive and non-sensitive members of the KCNs 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 will 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 other receptor 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.

To date, the MHHIG has discussed 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.

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 KCNs 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 are unlikely to 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 KCNs of 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; however, these fish and tributaries have not been identified in various sources as representing appreciable sources of their diet. Nonetheless, this issue should be revisited with the KCNs 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.

It will be important to resolve whether adolescents 18 years and under should be considered to be member of the sensitive population. If this were adopted, fish consumption recommendations for adolescents 12 to 18 years of age would be 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). It is noted that since female adolescents are already considered in this group, this issue primarily affects the consumption recommendations for male adolescents. Dialogue with health agencies and representatives of the KCNs is recommended to help resolve the preferred approach.

Finally, it is noted that additional data could be considered for future analysis and could inform future consumption recommendations. This includes but is not limited to the following:

1. Measurement of methylmercury concentrations in fish: As discussed earlier, North/South (2021) 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 KCNs.

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. Although there is no regulatory

agency endorsement of such an approach, it may provide useful information that could be considered as part of a sensitivity analysis in an eventual human health risk assessment. Nevertheless, we are unaware of any major agency that has used bioaccessibility in fish consumption recommendations.

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; 2021), maximum monthly intake rates were estimated for fish in Gull and Stephens lakes at estimated peak conditions. Although fish in Stephens Lake are predicted to have appreciably lower concentrations than in Gull Lake, there will need to be communication efforts that there are fish in both Gull and Stephens lakes that people are advised to limit consumption or avoid altogether. It will be important to regularly review the science and various input parameters used to estimate the maximum monthly intakes to ensure that the KCNs 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.

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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 smallest size pickerel from Stephens Lake (mean peak concentration of mercury of 0.444 µg/g; wet weight) are estimated for the three receptor groups (children under 12 years of age; 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:

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

where:

BW = body weight of child (30 kg)
AP = amortization period (30 days)
TDI = tolerable daily intake for mercury (0.2 µg/kg bw/day)
PMC = peak mean concentration of mercury in pickerel less than 400 mm from Stephens Lake (0.444 µg/g; wet weight)

Thus,

$$\text{Maximum Monthly Fish Intake} = \frac{30\ kg \times 30\ days \times 0.2\ \mu g/kg\ bw/day}{0.444\ ug/g}$$

$$= 405\ g/month$$

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for children under 12 years of age of 405 g per month. This intake can then be calculated into the KCNs' preference of pounds per month by dividing by 454 g (*i.e.*, 454 g = 1 lb; and so, 405 g/month x 1 lb/454 g = 0.9 lbs per month). Thus, it is estimated that children under 12 years of age can consume 0.9 pounds per month of small pickerel (less than 400 mm) from Stephens Lake under peak conditions.

Females of Childbearing Age

To calculate the maximum monthly intake for females of childbearing age, the same equation as for children but age-specific input parameters (different body weight) were used:

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

where:

BW = body weight of female of childbearing age (60 kg)
AP = amortization period (30 days)
TDI = tolerable daily intake for mercury (0.2 µg/kg bw/day)
PMC = peak mean concentration of mercury in pickerel less than 400 mm from Stephens Lake (0.444 µg/g; wet weight)

Thus,

$$\text{Maximum Monthly Fish Intake} = \frac{60\text{ kg} \times 30\text{ days} \times 0.2\ \mu\text{g/kg bw/day}}{0.444\ \mu\text{g/g}}$$

$$= 810\text{ g/month}$$

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for females of childbearing age of 810 g per month. This intake can then be calculated into the KCNs' preference of pounds per month by dividing by 454 g (*i.e.*, 454 g equals 1 pound; and so, 810 g/month x 1 lb/454 g = 1.8 lbs per month). Thus, it is estimated that females of childbearing age can consume 1.8 pounds per month of small pickerel (less than 400 mm) from Stephens Lake under peak conditions.

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:

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

where:

BW = body weight of all others (60 kg)
AP = amortization period (30 days)
TDI = tolerable daily intake for mercury (0.47 µg/kg bw/day)
PMC = peak mean concentration of mercury in pickerel less than 400 mm from Stephens Lake (0.444 µg/g; wet weight)

Thus,

$$\text{Maximum Monthly Fish Intake} = \frac{60\text{ kg} \times 30\text{ days} \times 0.47\ \mu\text{g/kg bw/day}}{0.444\ \mu\text{g/g}}$$

$$= 1{,}910\text{ g/month}$$

Thus, substituting these values into the equation results in a maximum monthly intake of pickerel for all others of 1,910 g per month. This intake can then be calculated into the KCNs' preference of pounds per month by dividing by 454 g (*i.e.*, 454 g equals 1 pound; and so, 1,910 g/month x 1 lb/454 g = 4.2 lbs per month). Thus, it is estimated that all others can consume 4.2 pounds per month of small pickerel (less than 400 mm) from Stephens Lake under peak conditions.

2) Worked Example of Maximum Monthly Intake Using Revised Body Weight

In this worked example, maximum monthly intake for smallest size pickerel from Stephens Lake (mean peak concentration of mercury of 0.444 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:

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

where:

BW = body weight of child (15 kg)
AP = amortization period (30 days)
TDI = tolerable daily intake for mercury (0.2 µg/kg bw/day)
PMC = peak mean concentration of mercury in pickerel less than 400 mm from Stephens Lake (0.444 µg/g; wet weight)

Thus,

$$\text{Maximum Monthly Fish Intake} = \frac{15\ kg \times 30\ days \times 0.2\ \mu g/kg\ bw/day}{0.444\ \mu g/g}$$

$$= 203\ g/month$$

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 203 g per month. This intake can then be calculated into the KCNs preference of pounds per month by dividing by 454 g (*i.e.*, 454 g = 1 lb; and so, 203 g/month x 1 lb/454 g = 0.4 lbs per month). Thus, it is estimated that children under 12 years of age weighing 15 kilograms can consume 0.4 pounds per month of small pickerel (less than 400 mm) from Stephens Lake under peak conditions.

3) Calculation of Maximum Monthly Intake when Multiple Species of Fish are Consumed

In this example, it is assumed that a female of childbearing age is consuming whitefish, pickerel and jackfish from Stephens Lake at the following rates:

Whitefish in the 300-450 mm range at 2 lbs per month (fish species 1)
Pickerel in the less than 400 mm range at 1.5 lbs per month (fish species 2)
Jackfish in the less than 500 mm range at 1.5 lbs per month (fish species 3)

Maximum monthly intake estimates are provided based on the assumption that a person is primarily consuming one species of fish from one source; however, this may not be realistic for some and they may consume multiple species of fish or fish from multiple sources. In these cases, it would be advised that a person apply the following equation to determine if they are consuming less than the maximum monthly intake:

$$CFR = \frac{CFS1}{MFS1} + \frac{CFS2}{MFS2} + \frac{CFS3}{MFS3}$$

Where:

CFR = cumulative fish ratio (ideally should be less than or equal to 1.0)
CFS1 = monthly consumption rate of fish species 1 (2 lbs per month)
MFS1 = maximum monthly intake rate of fish species 1 (6.5 lbs per month) (from Table 3 of the memo)
CFS2 = monthly consumption rate of fish species 2 (1.5 lbs per month)
MFS2 = maximum monthly intake rate of fish species 2 (1.8 lbs per month) (from Table 3 of the memo)
CFS3 = monthly consumption rate of fish species 3 (1.5 lbs per month)
MFS3 = maximum monthly intake rate of fish species 3 (2.3 lbs per month) (from Table 3 of the memo)

Thus, the following would be estimated

$$CFR = \frac{2 \text{ lbs/month}}{6.5 \text{ lbs/month}} + \frac{1.5 \text{ lbs/month}}{1.8 \text{ lbs/month}} + \frac{1.5 \text{ lbs/month}}{2.3 \text{ lbs/month}}$$

$$= 0.31 + 0.83 + 0.65$$

$$= 1.79$$

Thus, in this worked example, a cumulative fish ratio of 1.79 was estimated which 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 only whitefish and jackfish were consumed in the manner described above (*i.e.*, no pickerel), the cumulative fish ratio would 0.96 (*i.e.*, 0.31 + 0.65 = 0.96) and this would result in acceptable risks.

APPENDIX 3: BASELINE HAIR SAMPLING AND FOOD SURVEY COMMUNITY REPORT

REPORT

Baseline Hair Sampling and Food Survey Community Report

Keeyask Generation Project

Submitted to:

Mercury and Human Health Implementation Group

Submitted by:

Golder Associates Ltd.

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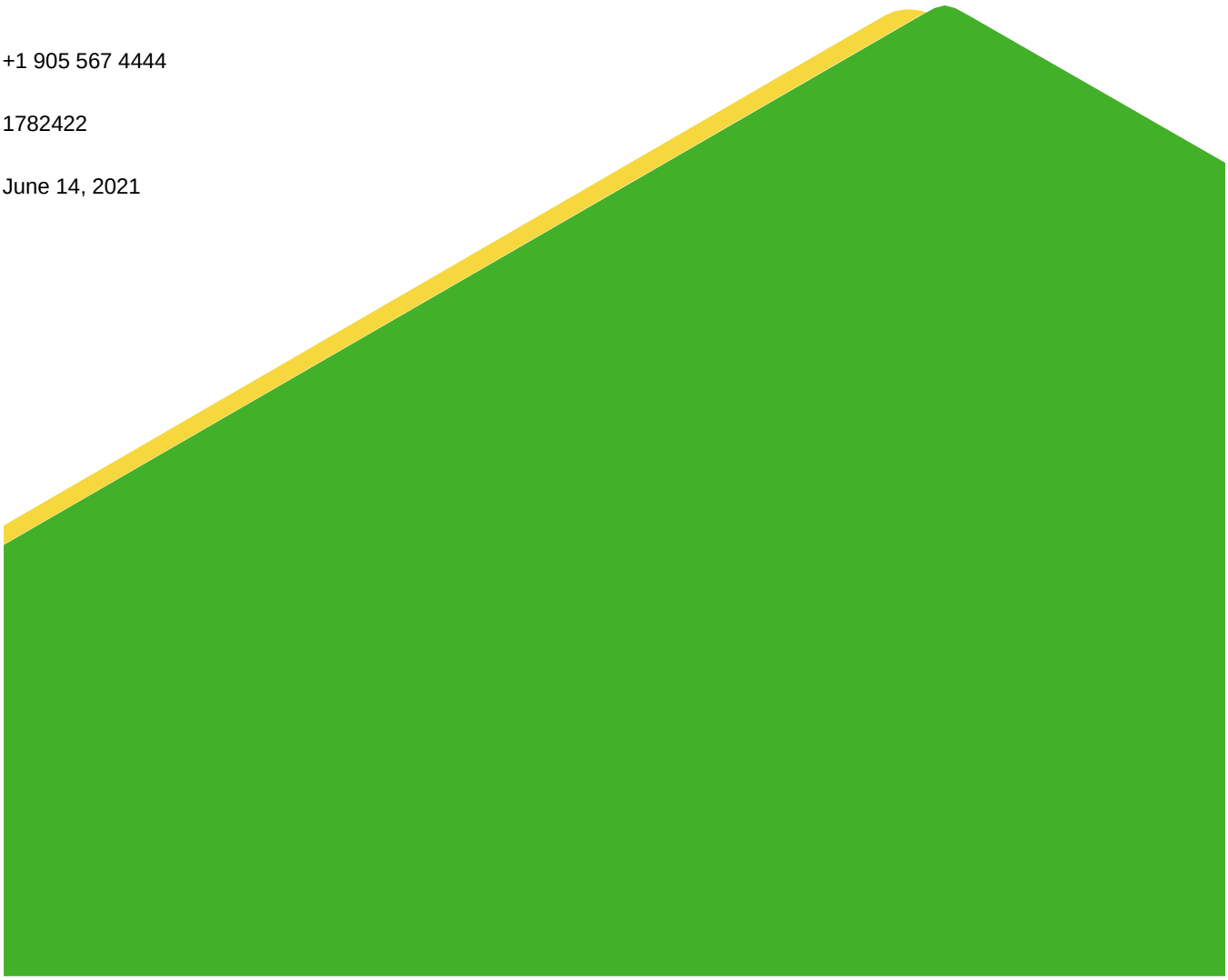

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1.0 INTRODUCTION

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 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.

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. Golder Associates Ltd. (“Golder”, a WSP company) has been retained by Manitoba Hydro, on behalf of the Keeyask Hydropower Limited Partnership (KHLP), to work with the MHHIG to design and undertake the hair sampling and food survey study. The objectives of the hair sampling program are as follows:

- To offer hair mercury analysis to First Nation communities and the Town of Gilliam as part of the Mercury Human Health Risk Management Plan for the Project. Three scheduled events (one pre-impoundment, two post-impoundment) have been proposed, although hair sampling will be offered in interim years, upon individual request.
- 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, prior to 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 interpret personal hair sampling results to assess individual risk from mercury exposure and to use the hair sampling results and results of the food surveys as supplemental information in future human health risk assessments completed for the Project.

The objectives for the food survey, conducted in tandem with the hair sampling program, are as follows:

- 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.

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 (HHRAs).

This report provides a description of the hair sampling and food survey program and key findings for the pre-impoundment (baseline) phase. 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.

1.1 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
Andrea Amendola / Golder Associates Ltd.	Principal Investigator (PI), Project Manager and Technical Lead
Audrey Wagenaar / Golder Associates Ltd.	Senior Technical Advisor
Ruwan Jayasinghe / Golder Associates Ltd.	Senior Technical Advisor
Victoria Hart / Golder Associates Ltd.	Intermediate Technical Support
Cam Ollson / Golder Associates Ltd.	Intermediate Technical Support
Amica Ferras / Golder Associated Ltd.	Junior Technical Support
Dr. Eric Liberda / Ryerson University	Academic Subject Matter Expert
Mercury and Human Health Implementation Group (MHHIG) / Mercury Community Coordinators	Local subject matter experts and program implementation support

2.0 DEFINITIONS, ABBREVIATIONS AND ACRONYMS

2.1 Definitions

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 country and store-bought foods in relation to the types of food items consumed, the amounts consumed, the consumption frequency, the preparation and cooking methods, 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 Hg/MeHg exposure estimates.

Hair Sampling: 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 addition to the food surveys, it will be used to supplement inputs in future HHRAs completed for the Project.

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).

2.2 Abbreviations and Acronyms

CVAAS	Cold vapour atomic absorption spectroscopy
FLCN	Fox Lake Cree Nation
FNFNES	First Nations Food, Nutrition and Environment Study
FNIHB	First Nations and Inuit Health Branch
Golder	Golder Associates Ltd.
HHRA	Human Health Risk Assessment
Hg	Mercury
Maxxam	Maxxam Analytics Laboratory (now Bureau Veritas)
HC	Health Canada
KHLP	Keeyask Hydropower Limited Partnership
MCC	Mercury Community Coordinator
MeHg	Methylmercury
MHHIG	Mercury and Human Health Implementation Group
NRHA	Northern Regional Health Authority
PHAC	Public Health Agency of Canada
PI	Principal Investigator
REB	Health Canada and Public Health Agency of Canada Research Ethics Board
RMP	Risk Management Plan
TCN	Tataskweyak Cree Nation
TDI	Tolerable Daily Intake

TRV	Toxicity Reference Value
WHO	World Health Organization
WLFN	War Lake First Nation
YFFN	York Factory First Nation

3.0 ETHICS CONSIDERATIONS

Because the Keeyask Generation Project – Hair Sampling and Food Survey Program involves participation of humans in research, Golder prepared an ethics submission for Health Canada and Public Health Agency of Canada Research Ethics Board (REB). Although Health Canada communicated that its ethics submission process was intended to be used by internal departments, it accepted our application to accommodate that Manitoba health authorities were not equipped to review the application. The timeline of the approval process was as follows:

- On July 25th, 2018, Golder and MMHIG participated in a teleconference with Health Canada to determine whether the scope of the hair sampling and food survey program could fall under Health Canada's authority. The scope was presented to the REB chair and was approved.
- On August 8th, 2018, Golder submitted the ethics application to REB. The submission included project details related to the following:
  - Study identification
  - Type of study
  - Study population
  - Health Canada / Public Health Agency of Canada Involvement
  - Department approval (Health Canada / Public Health Agency of Canada)
  - Funding
  - Study protocol
  - Confidentiality and security of data
  - Privacy legislation
  - Third party implication
  - Legal advice
  - Contract / agreement information
  - Conflict of interest
- On September 13th, 2018, Golder, Manitoba Hydro and REB participated in a teleconference in which the PI provided a detailed presentation on the ethics submission.

- On September 18th, 2018, REB provided formal comments and questions to the PI. These comments were addressed via an email response on October 29, 2018.
- On December 3rd, 2018, REB responded (via email) with additional comments related to background information, the food survey and hair sampling methodology, informed consent form, privacy concerns, protocol revisions, and other permissions from the Government of Manitoba. A response to these additional comments was provided to REB via a letter on December 21, 2018.
- REB granted ethics approval for the work on January 14, 2019 (see **Appendix A**).
- As part of the annual review process, on November 20, 2019, the PI submitted Annual Progress Report to maintain the ethics approval granted by REB. However, Health Canada responded by email that unless there is a substantial change to the work, no annual renewal is required.

4.0 CONSULTATION WITH STAKEHOLDERS

Prior to initiating the baseline hair sampling and food survey program in the communities of interest, Golder (as a member of the Mercury and Human Health Implementation Group (MHHIG)) carried out consultations on the work plan with the MHHIG which includes representation from the following stakeholders:

- Representatives from each of the partner First Nations (TCN, WLFN, FLCN and YFFN), including local Mercury Community Coordinators;
- Manitoba Hydro (MHHIG Chair);
- Wilson Scientific, Inc. (Project Toxicologist);
- North/South Consultants (Aquatic and Terrestrial Biologists);

and in consultation and participation with:

- Manitoba Health (MOH, Environment).
- Northern Regional Health Authority (MOH, NHRA);
- Manitoba Agriculture and Resource Development (formerly Sustainable Development)
- First Nations and Inuit Health Branch (MOH, FNIHB); and
- Health Canada (HC);

Table 2 includes details of the feedback received from community members (and other stakeholders, as appropriate) related to the baseline hair sampling and food survey program:

Table 2: Feedback from Stakeholders

Type	Date	Location	Purpose	Community Feedback
MHHIG meeting	July 11, 2018	Manitoba Hydro office (Winnipeg)	This presentation introduced Golder and explained the following: ■ Objectives of project; ■ The implementation plan, including methodology, communication plan, confidentiality, timeline, and logistics; and ■ Lessons learned from previous similar projects.	■ No objections to the program ■ Concerns raised about communication of results, because historical hair sampling carried out in the 1980s by government did not report the results to individuals ■ Prefer to use the term “food survey” rather than “dietary survey” ■ Began to receive feedback on the types of harvested local foods that are targeted for inclusion on the food survey questionnaire ■ Overall feedback on the food survey indicated that it was too long, so the survey was split into “core” questions which focused on local and market fish, with the remainder of questions on other traditional and market foods not anticipated to contribute to mercury exposure
Report review	July 25 to August 8, 2018	Not applicable	Golder sought feedback from MHHIG members on the ethics submission package.	■ No specific feedback was received from community members. ■ Review comments from Wilson Scientific, third-party peer reviewers,

Type	Date	Location	Purpose	Community Feedback
				and Manitoba Hydro were incorporated into the ethics submission.
MHHIG meeting	October 4, 2018	Manitoba Hydro office (Winnipeg)	Golder provided an overview of the progress with the ethics submission process with HC and discussion was raised on planning the future hair sampling/food survey events in-community.	■ Training session was scheduled in mid-November with Mercury Community Coordinator (MCCs) in Thompson ■ Initial discussions on the best time to target hair sampling in the communities (i.e., a month or two following peak fish consumption for most individuals)
Hair Sampling Training Session	November 14, 2018	Thompson	To provide training to MCCs on the hair sampling protocol and the objectives of the food survey and how to administer it	■ General feedback indicated that the hair sampling protocol was simple to implement ■ Initial feedback on the food survey indicated that it was still considered to be long, but the core questions only were more focussed ■ Regarding the consent forms, concerns were raised for children that are wards and who would consent on behalf of the children to participate.
MHHIG meeting	January 8, 2019	Teleconference	Planning of in-community hair sampling events in February 2019	■ Confirmation of dates still to be obtained

Type	Date	Location	Purpose	Community Feedback
In-community	February 5-9, 2019	Gillam, Fox Lake (Bird), Spilt Lake	Hair Sampling and Food Surveys	■ No specific feedback received ■ Some concerns that the results would not be communicated to individuals
MHHIG meeting	March 14, 2019	Manitoba Hydro office (Winnipeg)	Provided a summary of the in-community sessions held in Fox Lake/Gillam and Split Lake in February 2019	■ Feedback on how the in-community sessions progressed was generally favourable ■ Participation in TCN was a bit lower than expected, likely due to many people that fish off-system and many that were on the land rather than available for hair sampling
MHHIG meeting	June 14, 2019	Manitoba Hydro office (Winnipeg)	Presentation of the draft Tables of Contents for the Baseline regulatory/community reports; planning for fall/winter hair sampling events	■ Personal results letters were not available yet from the winter sessions, but communities were looking forward to receiving them in the coming week or two
MHHIG meeting	September 24, 2019	Manitoba Hydro office (Winnipeg)	This presentation provided an update on the hair sampling events that were completed at Fox Lake, Gillam and Split Lake from February 5 to February 9, 2019. The presentation provided an update on participation levels, for both hair sampling and completion of food surveys for the aforementioned locations. The presentation concluded with slide	■ No specific feedback; the results seemed to agree with what most people understood about fish consumption (i.e., that it was generally low in Split Lake, and low to moderate in Fox Lake/Gillam)

Type	Date	Location	Purpose	Community Feedback
			of tips for future events that would add to the success of the project.	■ Communities were to confirm dates for in-community sessions to discuss results
In-community	December 9-10, 2019	York Landing	Hair Sampling and Food Surveys (planned sessions for Split Lake and War Lake but had to be cancelled)	■ One individual pointed out that the food survey questionnaire indicates "gender" rather than "sex" – this change will be made in future iterations of the materials
MHHIG meeting	July 22, 2020	Teleconference	Update from all participants on hair sampling/food survey progress/ planning	■ Given the COVID-19 pandemic, all planned in-community events (hair sampling/food surveys, results sessions) were cancelled ■ No concrete plans to undertake sampling as yet, but fall sampling is being considered (*it is noted that no further hair sampling took place pre-flooding*)
Ministry of Health meeting	September 22, 2020	Teleconference	*Note: Golder did not participate* Meeting between Manitoba Hydro and Dr. Mike Isaac (MOH NRHA and FNIHB) and Dr. Susan Roberecki (MOH Environmental Health, MB Health) to provide an update of hair sampling and food survey activities and provide input on communication materials and	■ Communities were not involved ■ MOH staff were supportive of preparing communication products that focussed on pooled results ■ Provided advice on pandemic precautions

Type	Date	Location	Purpose	Community Feedback
			pandemic-related precautions for future hair sampling events.	(e.g., use COVID screening tool, wearing masks/maintain physical distancing with close proximity no more than 15 minutes, etc.)
MAC/ MHHIG meeting	December 2, 2020	Teleconference	Communication of results – Golder provided an overview of the pooled results	■ No specific feedback received from the communities

5.0 DESIGN OF THE STUDY

5.1 Target Communities

The communities of interest for the baseline study were four partner First Nation communities in northern Manitoba (note: population data from 2016 Canadian Census (Statistics Canada, 2016; Fox Lake Cree Nation, 2021)):

- Fox Lake Cree Nation – Population ~160 in Bird and ~340 in Gillam;
- Tataskweyak Cree Nation – Population ~2040 in Split Lake;
- York Factory First Nation – Population ~445 in York Landing; and
- War Lake First Nation – Population ~105 in Ilford.

The community locations and the Project location are identified on Figure 1.

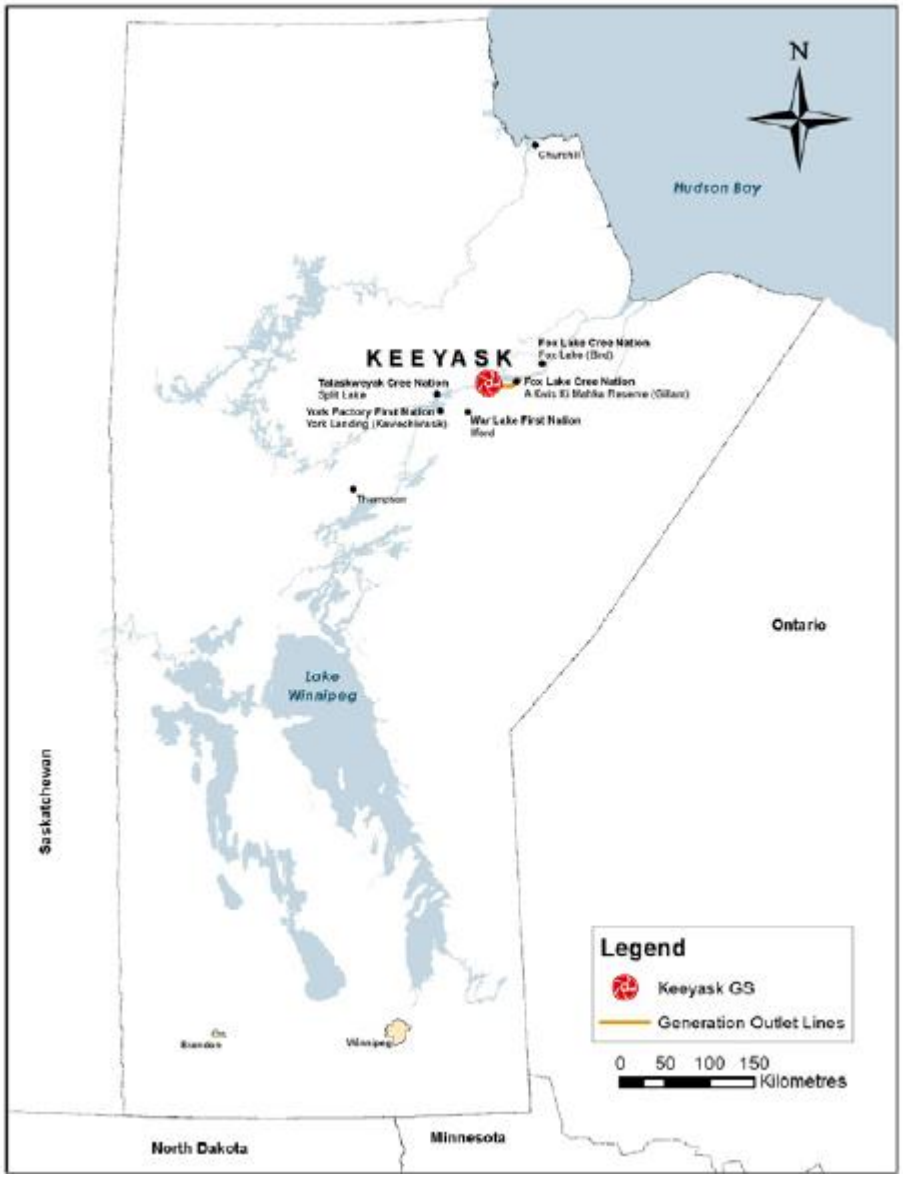

Figure 1. Location of Keeyask Generation Project and Communities Included in Study (source: Keeyask Hydropower Limited Partnership, 2015)

The Hair Sampling and Food Survey Program was offered to the partner First Nation community members as the primary audience. 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.

5.2 Study Participant Sample Size

There are 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.

5.3 Study Participant Recruitment Strategy

The overall approach to recruiting participants was through in-community information sessions and posters/pamphlets posted around the community. Because WLFN / Ilford is a very small community, the community's MCC went door-to-door rather than hold an event in the community. Some example materials are provided in **Appendix B**.

5.4 Baseline Food Survey and Hair Sampling Methodology

Appendix C contains a detailed description of the hair sampling methodology. Briefly, the methodology used for collecting hair samples is based on that utilised by 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. The hair samples were then analysed for total mercury.

Following the completion of the food survey, participants were assigned to one of the three groups outlined in **Table 3**, 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. A blank copy of the food survey and the consent/assent forms are available in **Appendix D**.

Table 3: Frequency of Hair Collection for 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

Notes:

* 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 12 years of age and younger, and women of child-bearing age (15-49); note that for the purposes of simplicity and in the absence of guidance for adolescents, it has been assumed that females between 12 and 15 years of age would also belong to the "sensitive" group).

** 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 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.

It is possible that consumption practices may exist that are not accounted for in the groupings outlined above. Professional judgement was used to assess the appropriate hair sampling methodology (specifically, peak season and 3-cm or 1-cm) for these extenuating circumstances.

Consultation with community members indicated that peak fish consumption typically occurs during the late spring, summer and fall months (June – October) and to a lesser extent, in the winter months. For this reason, hair sampling events were 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 was too short (i.e., < 3 cm) or the length of hair available for sampling did not align with their expected peak exposure, there is a continued opportunity for that participant to provide hair samples during an off-cycle event. The logistics of these opportunities were explained to participants during the sampling events.

The hair samples were sent to Maxxam Analytics (now Bureau Veritas) in Mississauga, ON, which were forwarded to its Burnaby, BC location for mercury analysis.

- The analysis of hair samples was carried out by Bureau Veritas which has been independently audited by the Standards Council of Canada (SCC) under ISO guide 17025. Details of Bureau Veritas's accreditation can be viewed at the following website: https://www.bvna.com/environmental-laboratories/resources/certifications-accreditations. Bureau Veritas is accredited for mercury analysis via cold vapour atomic absorption spectroscopy (CVAAS) on a tissue matrix by SCC.
- The hair samples were not 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 Bureau Veritas achieving detection limits on the order of 0.005 ppm (the health effect threshold considered is 2 ppm (Environment Canada, Health Canada 2010) for sensitive subgroups such as women of childbearing age and children (Legrand et al. 2010 defines children as 18 years and younger) and 5 to 6 ppm (Health Canada 2007; Environment Canada, Health Canada 2010) for non-sensitive subgroups such as adult men). For this baseline report, the sensitive subgroups were defined as females of child-bearing age (15 to 49 years) and children 12 years and younger (for simplicity, we have included adolescent females of all ages (i.e., 12 to 18 years) within the sensitive subgroup). Non-sensitive subgroups were considering to be adult men, adult females that are not of child-bearing age, and teenage males (age 13 to 18). Golder and the MHHIG continue to discuss the definition of the sensitive subgroups with regional health authorities particularly for adolescents and as such, the application of the thresholds is subject to change.

Once the analytical information is received from the laboratory, Golder provides each participant with a personal letter that includes what fish consumption category they fall into, whether their mercury in hair concentration was below the safe levels or above the safe levels, and recommendations related to future consumption of fish. A example personal letter is provided in **Appendix E**.

6.0 RESULTS OF THE BASELINE PROGRAM

Table 4 provides a summary of the baseline hair sampling and food survey events that have taken place prior to flooding (i.e., pre-impoundment). The results from these sampling events are detailed in Sections 6.1 (Food survey and questionnaire) and Section 6.2 (Hair sampling).

Table 4: Summary of Completed Sampling Events in Each Community.

Community	Dates of Sampling Event(s)	# of Participants in Hair sampling	# of Food Surveys Collected
FLCN	Event 1: Feb 5 – Feb 6, 2019 Event 2: Dec 9 – Dec 10, 2019	58	31
TCN	Event 1: Feb 8 – Feb 9, 2019	15	10
YFFN	Event 1: Dec 2 – Dec 4, 2019	43	22
WLFN	Event 1: Feb 25, 2020	12	10

Notes: # = number.

A total of 128 individuals participated in the baseline hair sampling and food survey program. 123 people provided hair samples, in which three people provided a second sample in a later event for a total of 126 hair samples; 73 people participated in the food survey, five of whom did not provide hair samples due to insufficient hair length.

Table 5 below provides an overview of the pooled demographic information from the participants from all four communities. There were nearly twice the number of females (80) that participated compared to the number of males (46). The majority of participants were adults and elders (i.e., ≥18 years old), with 18 participants under the age of 18. Given that the questionnaires on the food surveys were required to obtain information regarding female age (i.e., between 15 and 49 years, pregnancy/breastfeeding status), residency in the community, and belonging to an Indigenous organization, this information was not available for all individuals who provided a hair sample if they did not also provide a food survey. Of the 73 participants that completed a food survey/questionnaire, 70 noted that they live in the community full-time, and 65 reported they belong to an Indigenous Organization. Thirty females identified as being of child-bearing age (i.e., between 15 and 49 years of age), 2 indicated they were pregnant, and none indicated they were breastfeeding.

Table 5: Study Participant Information

Category	Total Number of Study Participants
Total number of Participants	128
Total Hair Sample Participants	123
Total Food Survey Respondents	73
Males	48
Females	80

Category	Total Number of Study Participants
Children (1-12 years)	17
Adolescents (13-17 years)	1
Adults (≥18)	110
Females between 15 and 44 years	30[a]
Pregnant Females	2[b]
Breastfeeding Females	0
Live in the community full-time	70
Belong to an Indigenous Organization	65

Notes:

[a] There were a further 28 adult females who did not provide a food survey, and thus it has been assumed that they may be sensitive (i.e., between the ages of 15 and 44).

[b] One woman that provided a food survey indicating she was between the ages of 15 to 44 did not indicate whether she was pregnant or breastfeeding.

6.1 Food Survey

Food surveys were completed by 73 participants. Not all participants filled out all portions of the questionnaire, and so the results presented herein indicate only the results of “eaters” and not of “non-eaters” or “non-respondents”. Please also note that 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.

6.1.1 Local Wild Foods

A total of 54 participants indicated that they consume local fish as part of their diet. As indicated in **Table 6**, the most frequently consumed locally caught fish noted by survey participants are pickerel, jackfish, whitefish, sturgeon and brook trout, while at least six participants reported that they also eat fish organs. Fish were largely caught from lakes and rivers outside of the Project area (including off-system); no fishing was reported in Gull Lake by community members who participated in the food surveys.

Table 6: Participants’ Consumption of Locally Caught Fish

Category	Total Number of Survey Respondents
Local Fish	
Pickerel	53
Jackfish	40

Category	Total Number of Survey Respondents
Whitefish	27
Sturgeon	23
Brook Trout	17
Local Fish Organs	At least 6

Table 7 details the most consumed wild bird species, with the Canada goose standing out as the most frequent response, followed by mallard, willow ptarmigan, spruce grouse, sharp tailed grouse, snow geese. At least 14 participants reported that they also eat organs from wild birds.

Table 7: Participants' Consumption of Wild Birds

Category	Total Number of Survey Respondents
Wild Birds	
Canada Goose	44
Mallard	16
Willow Ptarmigan	14
Spruce Grouse	13
Sharp Tailed Grouse	12
Snow Goose	12
Wild Bird Organs	At least 14

Table 8 details the most consumed wild land animals, including the moose, caribou, snowshoe hare and beaver. Additionally, at least seven respondents reported consuming organs from wild land animals.

Table 8: Participants' Consumption of Wild Land Animals

Category	Total Number of Survey Respondents
Wild Land Animals	
Moose	55
Caribou	46
Snowshoe Hare	14

Category	Total Number of Survey Respondents
Beaver	12
Wild Land Animal Organs	At least 7

Table 9 details the most consumed wild berries and wild terrestrial vegetation. For berries, participants most frequently reported consumption of blueberries, strawberries, raspberries and cranberries. For terrestrial vegetation, participants most frequently reported consumption of wihkes and Labrador tea.

Table 9: Participants' Consumption of Wild Berries and Terrestrial Vegetation

Category	Total Number of Survey Respondents
Wild Berries	
Blueberries	34
Strawberries	25
Raspberries	19
Cranberries	13
Wild Terrestrial Vegetation	
Wihkes (sweet flag/muskrat root)	20
Labrador Tea	14
Northern Labrador Tea	8

6.1.2 Market Foods

In addition to, or instead of consuming local wild fish, participants indicated they consume market fish (i.e., fish from their local supermarkets). As shown in **Table 10**, the most common fish are canned salmon, cod, canned tuna, fish sticks, shrimp and canned sardines.

Table 10: Participants' Consumption of Fish from Local Supermarkets

Category	Total Number of Survey Respondents
Market Fish	
Canned Salmon	16
Cod	14
Canned Tuna (including tuna	13

Category	Total Number of Survey Respondents
light and tuna white)	
Fish Sticks	9
Shrimp	9
Canned Sardines	8

Separate from fish consumption, participants indicated that they commonly consume chicken, ground beef, turkey, beef / steak, processed meat, chicken eggs and pork / roasts from their local supermarkets. **Table 11** includes the commonly consumed livestock or poultry dishes from the supermarkets.

Table 11: Participants' Consumption of Livestock and Poultry from Local Supermarkets

Category	Total Number of Survey Respondents
Market Livestock & Poultry	
Chicken	48
Ground Beef	46
Turkey	44
Beef / Steak	42
Processed Meat	39
Chicken Eggs	39
Pork Chops / Roast	37

It is noted that direct comparisons between the communities was not presented as representative sampling was not achieved.

6.2 Hair Sampling

As described in Section 5.0, as part of the food survey and questionnaire, each participant was assigned to sample group (i.e., sensitive or non-sensitive), based on characteristics such as age, sex, and pregnancy status. **Table 12** details the recommended levels of mercury in hair. It is emphasized that these results were provided pre-impoundment, and as such the fish consumption recommendations also apply to the pre-impoundment period.

Table 12: Description of Sensitive and Non-Sensitive Characteristics and Resultant Dietary Recommendations

Group	Characteristics	Recommended Level of Hg in Hair (ppm)	Recommendation	
			If < recommended level	If > recommended level
Sensitive	■ Child (age 12 and under) ■ Female teenager ■ Female of childbearing age who is pregnant, is breastfeeding, or could become pregnant.	2	Eating 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 healthy range.
Non-sensitive	■ Male teenager[1] ■ Male adult ■ Female over childbearing age	5		

Notes: Hg = mercury; < = less than; > = greater than.

Table 13 provides a summary of level of participation in each community, and summary statistics for mercury concentrations measured in hair.

Table 13: Summary Statistics of Total Mercury Concentrations in Hair for All Study Participants

Parameter	Pooled Group of Participants
Total number of Participants providing a Hair Sample	123
Number of Non-Sensitive Adults	47
Number of Sensitive Adults	58
Number of teenagers (i.e., 12 to <18 years old)	1
Number of children (i.e., <12 years old)	17
Number fish consumers	54
Number hair samples analyzed	184

[1] The guidance provided by health agencies varies on whether male teenagers should be considered sensitive or non-sensitive. Appendix F includes males between 12 and 17 years of age in the 'sensitive' group. After development of this poster, analysis contained within Golder's baseline report and Wilson Scientific's HHRA memo (including development of consumption guidance) considers males over 12 years of age as 'non-sensitive'. This latter approach is consistent with the Province of Manitoba and some Health Canada consumption advice, while the World Health Organization consider males up to 17 years of age as sensitive and some Health Canada advice considers anyone less than 18 years of age to be sensitive (male and female). This issue will be re-evaluated in future discussions with health regulators and MHHIG prior to finalization of post-impoundment communication materials and future HHRAs.

Parameter	Pooled Group of Participants
Minimum concentration of Hg in hair (ppm)	0.0075
Maximum concentration of Hg in hair (ppm)	5.6
Average concentration of Hg in hair (ppm)	0.54

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

A combined total of 128 participants volunteered for the hair sampling and food surveys in the four partner First Nation communities: 123 people provided hair samples, in which three people provided a second sample in a later event for a total of 126 hair samples. Some individuals had sufficient hair length to offer more than a single hair sample, and so some individuals included 2 or more 3-cm lengths (n=7) or 2 or more 1-cm lengths (n=4). As such, a total of 184 individual hair samples were analyzed.

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"):

- 2 parts per million (ppm) for sensitive people (children aged 12 or under, females of childbearing age)
- 5 ppm for non-sensitive people (male teenagers over the age of 12, male adults, and females of childbearing age).

Individual results were confidentially communicated to each participant in a sealed personal letter, which compared their personal mercury result with the mercury threshold that was applicable to them. 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 E** for example personal letters).

Out of the 123 participants that provided a hair sample, three had mercury levels in hair that slightly exceeded their thresholds. Out of the remaining 120 participants, seven had moderate mercury levels (i.e., greater than 1 ppm but less than their threshold) and the remainder had mercury levels that would be considered very low (i.e., less than 1 ppm). For those people with very low mercury levels, they would be advised that consuming two to three fish meals per week is healthy and unlikely to adversely affect their mercury exposure.

Three participants had a second hair sample collected; one of these individuals had an initial elevated mercury level as described below; the other two individuals had hair mercury levels that were both below their thresholds.

The three participants with mercury levels greater than their respective thresholds are described below:

- One participant had a slightly elevated mercury level in the first hair sample provided (2.57 ppm compared to their threshold of 2 ppm), but their follow-up hair sample a year later and during the same season as the previous exceedance was less than their threshold (0.75 ppm). This participant did not seek nutritional counselling when asked, but this participant may have considered the nutritional recommendations provided in their personal letter to eat fish that were lower in mercury. This participant's food survey did not provide an estimate for the number of meals per month that they consumed local fish, although they did report to

consume 400 g serving sizes of five different species including jackfish, pickerel, sturgeon, brook trout and whitefish, largely downstream from the Project area.

- A second participant had slightly elevated mercury levels during two months of the year (2.04 and 2.38 ppm in the summer), but the other 10 months of the year were well below their threshold of 2 ppm. No nutritional counselling follow-up was requested when asked. This participant filled out a food survey which indicated that they consume 4 meals per month of each of jackfish and pickerel in the spring and summer, with serving sizes of 800 g or more. The participant did not report which lake/river from which they obtained their fish.
- A third participant had a slightly elevated mercury level during one month of the year (5.61 ppm in the summer), but the other 11 months of the year were well below their threshold of 5 ppm, and as low as 1.02 ppm in the winter. Again, no nutritional counselling follow-up was requested when asked. This person's food survey indicated they consumed pickerel in the spring and summer, and jackfish in the spring and fall, and whitefish in the winter, summer and fall; however, this participant did not report the number of meals per month they consumed, their typical meal size, nor the lake/river from which they obtained their fish.

Because of increased risk of mercury exposure from eating fish from Gull and Stephens lakes, post-impoundment, the food survey attempted to understand important sources of local fish. Currently, there is no reported fishing in Gull Lake by partner community members. Some individuals reported fishing in Stephens Lake with most individuals reporting they harvest the majority of fish from non-Project area lakes or off-system waterbodies.

Seasonal variability was observed in 3-cm (seasonal) or 1-cm (monthly) hair samples for which up to a year's worth of data was collected for some individuals (n=5). For example, one individual for which seasonal samples were collected showed that concentrations increased from approximately 0.6 ppm to 2.6 ppm between spring and summer samples; the fall and winter samples decreased to 2.1 and 0.9 ppm, respectively. For that individual, seasonal variability ranged up to a factor of 4 within the tested year. A change of nearly 10x was seen within one year for one individual: This person's lowest concentration was measured in February at 0.255 ppm, then nearly doubled each month until it reached a peak of 2.38 ppm by June, after which it decreased month by month (2.04 ppm, 1.27 ppm, 0.981 ppm, 0.808 ppm from July to October). This individual consumed 4 meals per month of each of jackfish and pickerel, with serving sizes of 800 g or more (although whether the fish were obtained near the Project area was not reported).

Based on the food surveys, 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. The participants that did consume fish tended to have higher mercury levels than those that did not, but as reported above those levels were largely within acceptable ranges.

Three individuals who did not provide hair samples filled out surveys. Results indicated that they did eat local fish, although the number of meals per month were not reported for two of those individuals (the third participant indicated one meal per month of pickerel throughout the year). These participants were encouraged to return to have a hair sample collected after a high fish-consuming season (i.e., to collect a sample 30-60 days after high fish consumption has decreased).

All but two participants are likely to have captured peak exposure in their hair results; the two individuals who may have had their peak exposure missed due to the length of hair available were encouraged to contact their MCC to have a follow-up hair sample collected after a high fish-consumption season.

Baseline hair sampling events and community feedback sessions on results were scheduled for the late winter/spring, but were deferred due to the COVID-19 pandemic situation in March 2020. However, aggregate level hair sampling and food survey results have been shared with two of the four partner First Nation communities through the development of posters that include a summary of pertinent information (**Appendix F**).

6.3 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 Hg 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., 184 hair samples) met the laboratory quality control and method performance criteria.

7.0 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 HHRAs.

Results of the pre-impoundment (baseline) phase indicate that most participants do not consume large quantities (i.e., 4 meals per month or more) of local fish and had reported hair mercury concentrations below their respective thresholds. While this does suggest a low overall risk for individuals who have participated in the baseline program, because of the voluntary nature of the program, it is possible that other individuals may be at higher risk due to higher consumption of local fish in the Project area. For example, the baseline program did not specifically target high fish consumers or populations that are more at risk of the health effects of mercury (i.e., sensitive individuals such as children age 12 and younger and females of childbearing age). Although there was good representation of participants from the sensitive category, there was a lack of individuals that could be considered high fish consumers. As such, it has been recommended that future community events attempt to target those individuals to encourage their participation in this program. Furthermore, it is recommended there be a focussed effort to identify fish consumers from Project affected lakes (Gull and Stephens lakes), particularly while mercury levels are increasing. All individuals are encouraged to reach out to their Mercury Community Coordinator to schedule a hair sampling and food survey appointment.

For the pre-impoundment phase, individuals were provided with their personal letters indicating their personal result and providing general advice on whether continued fish consumption would be encouraged. It is noted that for the post-impoundment phase, this personal letter will likely require an update to more accurately reflect that mercury concentrations in the affected lakes will rise. New fish consumption advice for the affected lakes is currently ongoing and that advice will be harmonized with the communications through the hair sampling.

Nonetheless, individuals will be able to monitor changes to their mercury exposure through repeat hair sampling throughout the Project (at scheduled events or otherwise), and nutritional counselling will continue to be offered. The results from the baseline hair sampling and food survey events will serve as a point of reference for subsequent post-impoundment hair samples on an individual basis.

Following impoundment, hair sampling and food surveys will continue to be offered to all four Partner First Nation communities, as will nutritional counselling. The first post-impoundment events are anticipated to occur in late 2021/2022. Hair sampling is available anytime upon request via the participant's local Mercury Community Coordinator.

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Signature Page

Golder Associates Ltd.

Andrea Amendola, B.Sc.(Hons), QPRA
Risk Assessor, Principal Researcher

Ruwan Jayasinghe, M.Sc., DABT, QPRA
Senior Risk Assessor & Toxicologist

RJ/AA/cg

https://golderassociates.sharepoint.com/sites/15689g/deliverables/baseline report draft/1782422-r-rev0 final community report-2021june14.docx

APPENDIX A

Ethics Certificate

CERTIFICATE OF ETHICS REVIEW

Type of Review: Initial Review of Research

Principal Investigator:
Name: Andrea Amendola
Title: Principal Investigator & Risk Assessor
Branch/Institution: Golder Associates Ltd.
Address: 6925 Century Avenue, Suite 100
Mississauga, ON L5N 7K2

Project Title: Keeyask Generation Project – Hair Sampling and Food Survey

Project File Number: 2018-0011

Contact Department/Agency: FNIHB

Document Name:

Date:
August 8, 2018

List of all documents submitted to the REB on:
Cover Letter
Study Identification
Appendix A - Terms of Reference
Appendix B - Peer Reviews and PI Responses to reviewers
Appendix C - Hair Sampling Method
Appendix D – Recruitment Materials
Appendix E – Consent Forms
Appendix F – Questionnaire and Food Survey
Appendix G – Storage and Personal Health Data
Appendix H – PI CV

Answers to the REB questions/observations and additional material provided on October 29 and December 21, 2018
PI response to Secretariat
Revised Consent Forms
Revised Assent Form
Revised Questionnaire

ETHICS REVIEW:
Your application and responses submitted to the Health Canada and Public Health Agency of Canada's Research Ethics Board (REB) regarding the above-referenced research project were reviewed on January 14, 2019. The most recent versions of the documents listed above were found to meet ethical requirements for research involving humans.

Barbara McGillivray

Barbara McGillivray, MD, FRCPC, FCCMG
Chair, Research Ethics Board

JAN 14 2019
Date

Canada

Certificate Expiry Date:
January 14, 2020

Principal Investigator's responsibilities:

I confirm that I will:

1. Carry-out the research in accordance with the above-referenced protocol by the REB;
2. Obtain an annual ethical review until the research is complete (The certificate is given for one year);
3. Seek ethics review of the REB for any amendment or modification of the research protocol or consent form;
4. Report immediately to the REB Secretariat, any adverse or unexpected events resulting from the research involving humans; and
5. Submit an end of project report to the REB Secretariat upon termination or completion of the project

_____ _____

Principal Investigator Date

Once signed, please return a copy of this certificate to the REB Secretariat.

Research Ethics Board Secretariat
9th Floor, Room 941C (0909C)
70 Colombine Driveway
Brooke Claxton Building
Tunney's Pasture
Ottawa, ON K1A 0K9
Tel: (613) 946-2306
Fax: (613) 941-9093
Email: hc.reb-cer.sc@canada.ca

APPENDIX B

Examples of Communication Materials

What should I know?

- Participation is completely voluntary.
- The place on your head where the hair is cut should not be noticeable.
- Voluntary food surveys will be conducted at the same time to understand mercury exposure.
- Your results are confidential and will be returned to you in a private letter.

How do I participate?

You can talk to your mercury community coordinator if you would like more information:

[redacted]

Or

Andrea Amendola, Team Lead
Phone: +1 905 567 6100 x1318
Email: Andrea_Amendola@golder.com

You can also contact your local health care provider.

How will the information be used?

This confidential information will help you understand if you should consider changing the amount, size or type of fish you eat to stay within safe limits. Hair sampling associated with the Keeyask project will be offered over the next decade to help Members understand if their mercury levels have changed over time.

Is fish a healthy food choice?

YES! Fish is more than just nutrition – it is part of mino pimatisiwin or "living the good life". It's about a way of life, connecting with nature, harvesting locally, sharing meals with family and community members. Fish is a traditional food that provides people with important nutrients for overall good health.

Fish is a high-protein, low-fat food and an excellent source of omega-3 fatty acids, which are very important for a healthy pregnancy and growing bodies. Studies have shown that pregnant women who eat fish two to three times per week tend to have healthier babies than women who avoid fish. Fish is also good for cardiovascular health. When possible, choose fish that are lower in mercury (e.g., choose whitefish or smaller pickerel and pike).

KNOW YOUR NUMBER

Fox Lake Cree Nation | Tataskweyak Cree Nation
War Lake First Nation | York Factory First Nation

Hair Sampling for Mercury

The Keeyask Hydropower Limited Partnership is offering free confidential hair mercury sampling for partner First Nation community members.

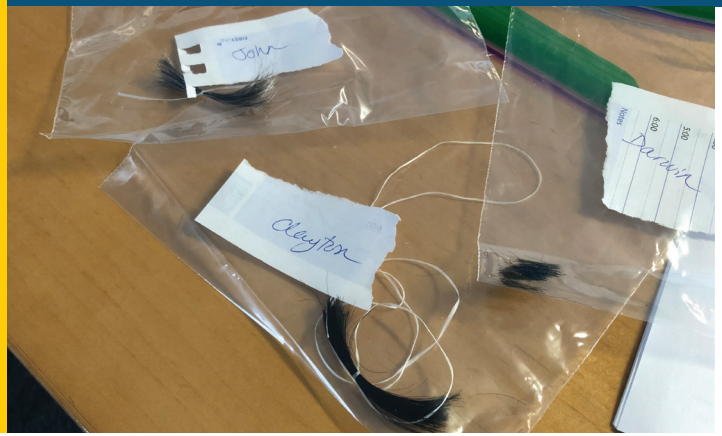
KEEYASK

The Keeyask Hydropower Limited Partnership is offering free confidential hair mercury sampling for partner First Nation community members.

Why know your number?

Knowing your number – your mercury level – will help you make your own decisions about whether to adjust the amount, type or size of fish you eat to stay within safe limits.

High levels of mercury can cause human health problems, particularly for the developing brain. Babies (even before they are born) and children into their teenage years are especially vulnerable to mercury exposure. Eating fish with lower mercury concentrations is important, particularly if you are or could become pregnant.



How does mercury get into your body?

Mercury occurs naturally in the environment in rock, soil, water and living organisms. Flooding of soil or wetlands commonly results in a temporary increase in organic form of mercury, called methylmercury, by the bacteria living in those soils and wetlands. This type of mercury becomes more concentrated as it moves up the food chain. People can be exposed to mercury through eating fish, especially predatory fish (fish that eat other fish).

Keeyask is expected to raise mercury levels in fish in Gull Lake (the Keeyask reservoir) and to a lesser extent, downstream in Stephens Lake. Fish mercury levels are expected to peak three to seven years after flooding and then reduce gradually over 20-30 years.

Who can participate?

Hair Sampling is offered to Keeyask partner First Nations community members. Even if you don't eat traditional foods and think you probably have very little exposure to mercury, it is helpful to know your number as health information.

Why are we collecting hair?

Mercury is incorporated into hair as it grows and remains in hair until your next haircut. Having your hair tested can tell you about your mercury exposure and whether you want to consider dietary changes.

What will happen if I choose to participate?

If you choose to participate, a small sample of about 50 hairs (or about the size of this dot ●) will be cut at the back of your head close to your scalp.

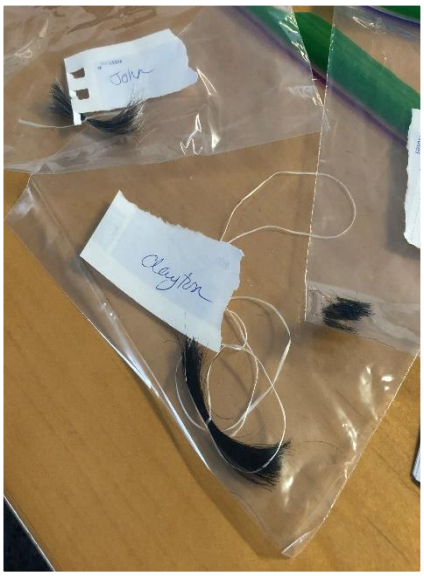
The sample will be sent to a lab to be tested for mercury. Your results will be returned to you privately by letter. If you choose, your health care provider will receive a letter with your results which s/he can discuss with you. Your mercury community coordinator can also assist to arrange nutritional counseling for you.

KNOW YOUR NUMBER

Fox Lake Cree Nation | Tataskweyak Cree Nation
War Lake First Nation | York Factory First Nation

The Keeyask Mercury and Human Health Implemention Group

Invites you to listen in to our Informational Session on Hair Testing for Mercury and Food Survey



kiskenihta kitahkitasowin

January 31 2019 at 1pm- 3pm at Tataskweyak Traditional Resource Centre

More info: Clayton Flett 1-431-751-1291 or Lindsey Keeper 1-431-751-1303

APPENDIX C

Hair Sampling Methodology

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 D

Questionnaire, Food Survey and Consent Forms

GOLDER

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:	Andrea Amendola (Phone Number: (905) 567-4444)
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.

GOLDER

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 (Andrea Amendola) 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

GOLDER

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:	Andrea Amendola (Phone Number: (905) 567-4444)
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 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 the number of people in your home and their ages, if anyone is pregnant or breastfeeding, 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 0.75 cm) 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 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 baseline mercury levels are above regulatory guidelines set by health agencies. Golder will directly contact any individual whose levels exceed the regulatory guidelines (note that all participants will receive a letter will their personal results a few 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 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

<u>Access to your records</u>

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 how many people live with you and whether you are pregnant
- Your name and contact information will be kept secure by the Golder 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 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 Golder team's secure and password-protected database. Andrea Amendola (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 Andrea Amendola: 905-567-4444. 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

GOLDER

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 _____

GOLDER

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:	Andrea Amendola (Phone Number: (905) 567-4444)
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.

2. Purpose of this Activity

To collect information on baseline 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 the number of people in your child/ward's home and their ages, if anyone is pregnant or breastfeeding, 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 0.75 cm) 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 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 baseline mercury levels are above regulatory guidelines set by health agencies. Golder will directly contact any individual whose levels exceed the regulatory guidelines (note that all participants will receive a letter will their personal results a few 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 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.

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

<u>Use of your information</u>

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 how many people live with your child/ward and whether your child/ward is pregnant
- Your child's/ward's name and contact information will be kept secure by the Golder 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 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 Golder team's secure and password-protected database. Andrea Amendola (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.

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 Andrea Amendola: 905-567-4444. 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

GOLDER

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

GOLDER

PARTICIPANT ID

Keeyask Generation Project Food Survey and Hair Sampling

Participant Information

---

1. ***Date of Interview (D/M/Y):*** _____
2. ***Community Name:*** _____
3. ***Participant's Gender:*** _____
4. ***Age Category:*** 0-4 years _____ 5-11 years _____ 12-15 years _____ 16+ years _____
5. ***Female Aged 15-49:*** Yes ____ No _____ Not applicable _____
   a. **If yes, are you pregnant?** Yes____ No ____
   b. **Are you breastfeeding?** Yes____ No ____

---

6. ***Do you live in the community full-time?*** Yes ____ No ____
   a. ***If no, how many months in the year do you live in the community?*** _____
7. ***How long have you lived in this community?*** _____
8. ***What First Nation are you a part of?*** _____
9. ***How many people, including yourself, currently live in your household (include children and adults, but not visitors or guests)?*** _____
   a. ***Of the above number, how many are female between 15 and 49 years?*** _____
   b. ***How many people living in your household are:*** 0-4 years _____ 5-11 years _____ 12-15 years _____ 16+ years _____
10. ***What type of work have you had in the past year (for example, commercial fishing, forestry, building construction, water treatment):***

_____ _____

_____ _____

GOLDER

PARTICIPANT ID

11. ***Do you have any hobbies?*** Yes ____ No ____

    a. ***If yes, what are they?*** _____

    _____

    b. ***How long have you had these hobbies?*** _____

    c. ***How often are they practiced?*** Daily ____ Weekly ____ Monthly ____

12. ***In your current job(s) or hobby(ies) are you exposed to any chemicals?*** Yes ____ No ____ Don't Know ____

    a. ***If yes, which ones?***

    ☐ 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 _____

13. ***Do you colour your hair?*** Yes ____ No ____

    a. ***If yes, how many times per year?*** _____

14. ***What is your current weight?*** _____

    a. ***Or, please select range:***

    50 lbs or less ____
    51 to 100 lbs ____
    101 to 150 lbs ____
    151 to 200 lbs ____
    200 lbs or more ____

15. ***Do you have any silver dental fillings?*** Yes ____ No ____ Don't Know ____

16. ***Do you wish to receive a copy of the full report?*** Yes ____ No ____

17. ***Do you wish to have your personal results sent to your doctor?*** Yes ____ No ____

GOLDER

PARTICIPANT ID

For the Mercury Community Coordinator

The Wild Foods Survey component of this service asks for information about the participant's consumption of wild foods, including the type of food, how much they are eating, and when.

You can tell the survey participant that answering the "core questions" (pages 4, 5, 6 and 7), which are the most important ones, will take about 10 minutes. These are questions about harvested fish and fish organs/seafood, and market fish and fish organs/seafood.

The rest of the questions are "optional" (pages 8 to the end) and will take about 30-40 minutes, depending on how many other wild foods the participant eats. You will see that those sections are marked with "optional" in the heading and are in italicized font.

If the participate is unable to remember whether they eat a certain type of food, you can use the following questions to help them remember:

1. *If they are unsure about **where** their harvested food comes from, you can ask:*
   a. *Do you collect the food yourself?*
   b. *Does someone else collect the food for you?*
   c. *If yes, do you know if they personally go somewhere close by to collect it or if they may get it from a community freezer?*
   d. *Does someone else prepare the food you eat?*
   e. *When you visit people in your community (e.g. visiting friends or at community events), do you think the food you eat could be locally harvested?*

2. *If they are unsure about **which types of food** they eat, you can ask:*
   a. *Think about what you eat at each meal:*
      i. *Breakfast: Locally harvested eggs? Local meats or fish?*
      ii. *Lunch/Dinner: Local meats or fish? Local plants?*
      iii. *Snacks: Local berries or other plants?*
      iv. *Beverages: Local teas?*
   b. *Think about the different ways you prepare your food before you eat it – do you trim away fat or skin?*
   c. *Think about what different ways your food is cooked – frying, grilling, smoking, drying/curing, raw?*
   d. *Do you eat the food on its own? Or as an ingredient in other dishes (e.g. soup, stew, sandwich, salad, etc.)?*

3. *When asking about berries and plants, you can ask:*
   a. *Do you eat local berries/plants raw?*
   b. *Do you cook local berries/plants? For example, into pies, cakes, cookies, treats?*
   c. *Do you use local berries/plants as a side dish in your meals? E.g. in salads, with other vegetables, with grains like rice or noodles?*
   d. *Do you make teas out of local berries or plants?*
   e. *Do you make medicines that you swallow out of local berries or plants?*

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PARTICIPANT ID

Core Questions: Wild Foods Survey

This questionnaire concerns wild (or harvested/traditional) food: wild food comes from the local land and environment (fish, birds, other animals and plants/berries).

*For each season: **winter** (December, January, February), **spring** (March, April, May), **summer** (June, July, August), and **fall** (September, October, November), please recall as exactly as you can, how often **you personally** ate the following food **in the last year**:*

Fish

Have you eaten locally caught fish in the last year? Yes ____ No ____

If yes, from where (see map): _____ ***Off-system?*** Yes ____ No ____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Fish	Ate in the last year?	Frequency (# meals per month)				Size of Whole Fish (inch)	Serving Size (g)	Location
		Winter	Spring	Summer	Fall			
Brook Trout								
Brown Trout								
Burbot (Maria)								
Cisco								
Lake Trout								
Northern Pike (Jackfish)								
Walleye (Pickerel)								
Longnose Sucker								
White Sucker								
Sturgeon								
Tullabee								
Whitefish								
Other:								

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PARTICIPANT ID

Core Questions: Fish Organs, Seafood or Shellfish

Have you eaten locally caught seafood in the last year? Yes ____ No ____

Organs? Yes ____ No ____
If yes, which organs?
_____

If yes, from where (see map):
_____

Off-system? Yes ____ No ____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Fish Organs, Seafood, Shellfish	Ate in the last year?	Frequency (# meals per month)				Size of Fish (inch)	Serving Size (g)	Location
		Winter	Spring	Summer	Fall			
Burbot (Maria) Organs								
Northern Pike Organs								
Pickerel Organs								
Whitefish Organs								
Clams								
Crayfish								
Other:								
Other:								
Other:								

You have completed the core portion of this survey.

Would you like to answer additional questions about other wild and market foods?

Yes ____ No ____

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PARTICIPANT ID

Core Questions: Market Food Survey

*This questionnaire concerns market food: market food comes from the supermarket or grocery store. For each season: **winter** (December, January, February), **spring** (March, April, May), **summer** (June, July, August), and **fall** (September, October, November), please recall as exactly as you can, how often **you personally** ate the following food **in the last year**:*

Market Fish and Seafood (Fresh or Frozen)

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Fish	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Size of Whole Fish, if known (inch)
		Winter	Spring	Summer	Fall		
Arctic Char							
Cod							
Flounder/Turbot							
Halibut							
Rainbow Trout							
Salmon							
Swordfish							
Tilapia							
Fish sticks							
Canned tuna (light)							
Canned tuna (white)							
Canned salmon							
Canned sardines							
Crab							
Shrimp							
Other:							
Other:							

GOLDER

PARTICIPANT ID

Core Questions: Market Fish Organs (Fresh or Frozen)

Have you eaten fish organs (e.g. liver, kidney, gonads, heart) in the last year? Yes ____ No ____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Fish	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Size of Fish, if known (inch)
		Winter	Spring	Summer	Fall		
Arctic Char Organs							
Cod Organs							
Flounder/Turbot Organs							
Halibut Organs							
Rainbow Trout Organs							
Salmon Organs							
Swordfish Organs							
Tilapia Organs							
Other:							
Other:							

GOLDER

PARTICIPANT ID

Optional Wild Foods: Birds

Have you eaten locally caught birds in the last year? Yes ____ No ____

If yes, from where (see map): _____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28
E – more than 800 g (28 oz
If more than 800 g, please specify

Bird Organs	Ate in the last year?	Frequency (# meals per month)				Serving Size* (g)	Location
		Winter	Spring	Summer	Fall		
Black Duck							
Canada Goose							
Canvasback							
Eider Duck							
Greenwing Teal							
Spruce Grouse							
Sharp tailed Grouse							
Ruffed Grouse							
Mallard							
Partridge							
Pintail Duck							
Scoters							
Snow Goose							
Willow Ptarmigan							
Duck Eggs							
Gull Eggs							
Tern Eggs							
Other:							
Other:							
Other:							

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

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PARTICIPANT ID

Optional Wild Foods: Bird Organs

Have you eaten locally caught bird organs in the last year (e.g. liver, kidney, gonads, heart)? Yes ____ No ____

If yes, from where (see map): _____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Bird Organs	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Location
		Winter	Spring	Summer	Fall		
Black Duck							
Canada Goose							
Canvasback							
Eider Duck							
Greenwing Teal							
Spruce Grouse							
Sharp tailed Grouse							
Ruffed Grouse							
Mallard							
Partridge							
Pintail Duck							
Quail							
Scoters							
Snow Goose							
Willow Ptarmigan							
Other:							
Other:							
Other:							

GOLDER

PARTICIPANT ID

Optional Wild Foods: Mammals

Have you eaten locally caught mammals in the last year? Yes ____ No ____

If yes, from where (see map): _____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Mammals	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Location
		Winter	Spring	Summer	Fall		
Beaver							
Black Bear							
Caribou							
Moose							
Muskrat							
Snowshoe Hare							
Other:							
Other:							
Other:							

GOLDER

PARTICIPANT ID

Optional Wild Foods: Mammal Organs

Have you eaten locally caught mammal organs in the last year (e.g. liver, kidney, gonads, heart)? Yes ____ No ____

If yes, from where (see map): _____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Mammal Organs	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Type of organ(s)	Location
		Winter	Spring	Summer	Fall			
Beaver								
Black Bear								
Caribou								
Moose								
Muskrat								
Snowshoe Hare								
Other:								
Other:								
Other:								

GOLDER

PARTICIPANT ID

Optional Wild Foods: Berries

Have you eaten locally harvested berries in the last year? Yes ____ No ____

If yes, from where (see map): _____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 75 g (1/2 cup)
B – 110 g (3/4 cup)
C – 150 g (1 cup)
D – 225 g (1-½ cups)
E – 300 g (2 cups)
F – More than 300 g (specify)

Berries	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Location
		Winter	Spring	Summer	Fall		
Bunchberry							
Crowberry							
Teaberry (wintergreen)							
Bearberry							
Wild strawberry							
Cloudberry							
Wild raspberry							
Blueberry							
Cranberry							
Gooseberry							
Rosehips berry							
Hawthorn berry							
Juniper berry							
Other:							
Other:							
Other:							

GOLDER

PARTICIPANT ID

Optional Wild Foods: Plants

Have you eaten locally harvested plants (food or medicinal purposes e.g. tea) in the last year? Yes ____ No ____

If yes, from where (see map): _____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 75 g (1/2 cup)
B – 110 g (3/4 cup)
C – 150 g (1 cup)
D – 225 g (1-½ cups)
E – 300 g (2 cups)
F – More than 300 g (specify)

Plants	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)	Location
		Winter	Spring	Summer	Fall		
Wihkes (sweet flag/muskrat root							
Arrowhead							
Fiddleheads							
Cattail							
Bulrush							
Fireweed							
Dandelions							
Dock							
Raspberry leaves							
Labrador tea							
Norther Labrador tea							
Nettle leaves							
Jack pine needle tea							
Pine pitch							
Balsam poplar (bark, buds)							
Spruce (pitch, inner bark)							
Aspen (bark, twigs)							
Chanterelle							
Other:							
Other:							
Other:							

GOLDER

PARTICIPANT ID

Optional Market Foods: Livestock/Poultry

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Fish	Ate in the last year?	Frequency (# meals per month)				Serving Size (g)
		Winter	Spring	Summer	Fall	
Beef/steak						
Chicken						
Chicken Eggs						
Ground Beef						
Lamb chops / roast						
Pork chops / roast						
Turkey						
Veal chops / roast						
Processed meat*:						
Other:						
Other:						

* Processed meat can include cold cuts / sandwich meat, canned meat (e.g. corned beef, Spam), etc.

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PARTICIPANT ID

Optional Market Foods: Livestock/Poultry Organs

Have you eaten meat/bird organs (e.g. liver, kidney, gonads, heart) in the last year? Yes ____ No ____

Frequency:
N/A – does not eat
0 – Less than once a month
X – X times per month (specify)

Serving Size:
A – up to 100 g (3.5 oz / ¼ lb.)
B – 100 to 400 g (3.5-14 oz)
C – 400 g (14 oz / 1 lb.)
D – 400 to 800 g (14 to 28 oz)
E – more than 800 g (28 oz)
If more than 800 g, please specify

Meat	Ate in the last year?	Frequency (# meals per month)				
		Winter	Spring	Summer	Fall	Serving Size (g)
Beef						
Chicken						
Lamb						
Pork						
Turkey						
Veal						
Turkey						
Other:						
Other:						

APPENDIX E

Personalized Letters with Mercury Results (templates)

GOLDER
MEMBER OF WSP

March 22, 2019 Project No. 1782422

Participant Name
Sent via email: participant@email.com

KEEYASK HAIR SAMPLING RESULTS: YOUR MERCURY LEVEL IN HAIR

Participant:

Thank you for participating in the mercury hair sampling process. A copy of your signed consent form is attached.

Your hair mercury level is **3 ppm** (parts per million), which is above the recommended range for you (0-2 ppm) because you are part of a Sensitive Group. A member of our study team will contact you soon to talk about your mercury level with you and offer 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 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) - **Female teenager** - **Female of childbearing age** who is pregnant, is breastfeeding, or could become pregnant…	**Non-Sensitive Groups** If you are a… - **Male teenager** - **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 up to 2 or 3 times per week is healthy.
*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.

Golder Associates Ltd.
6925 Century Avenue, Suite #100, Mississauga, Ontario, L5N 7K2, Canada T: +1 905 567 4444 F: +1 905 567 6561

Your hair sample was taken on *February 5, 2019* and it shows your average mercury exposure / how much fish you ate from around *November 2018* to *January 2019*. If you eat more fish in other seasons, we encourage you to contact me or work with your mercury community coordinator (**INSERT NAME**) to figure out the best time of year to collect another sample.

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 2021, 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 Andrea Amendola at 905-567-6100 extension 1318 or Andrea_Amendola@golder.com. You can also contact your mercury community coordinator **NAME** at **PHONE OR EMAIL** or your local health provider, your local **TITLE** is **NAME** and their contact info is **PHONE OR EMAIL**.

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,

Golder Associates Ltd.

Andrea Amendola, BSc, QPRA
Principal Researcher, Risk Assessor

AA/aa

Attachments: Signed Consent Form

https://golderassociates.sharepoint.com/sites/15689g/deliverables/baseline report draft/apx e - example result letter/letter_sample_highresult_finaldraft_2019march22.docx

March 22, 2019 Project No. 1782422

Participant Name

Sent via email: participant@email.com

KEEYASK HAIR SAMPLING RESULTS: YOUR MERCURY LEVEL IN HAIR

Participant:

Thank you for participating in the hair sampling for the Keeyask Generation Project. A copy of your signed consent form is enclosed.

Your hair mercury level is **1 ppm** and you are in the acceptable range. Please look at the table below for some advice for you about eating fish (the white box).

Sensitive Groups	Non-Sensitive Groups
If you a child (age 12 and under), a female teenager, or a woman of childbearing age who is pregnant, is breastfeeding or who could become pregnant… *And if your level is **less than 2 ppm**…* Eating fish 2 or 3 times per week is healthy if you are not already doing so.	*If you are an adult or teenage male, or a woman over childbearing age…* *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.
If you a child (age 12 and under), a female teenager, or a woman of childbearing age who is pregnant, is breastfeeding or who could become pregnant… *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.	*If you are an adult or teenage male, or a woman over childbearing age…* *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.

* The best species of fish to eat is whitefish of any size. Northern pike and walleye are still okay to eat, but make sure you choose fish that are smaller in size because they are lower in mercury than larger sized fish.

Golder Associates Ltd.
6925 Century Avenue, Suite #100, Mississauga, Ontario, L5N 7K2, Canada T: +1 905 567 4444 F: +1 905 567 6561

Your hair sample was taken on February 5, 2019 and shows your average mercury exposure / fish consumption from approximately November 2018 to January 2019. If you eat more fish in other seasons, we encourage you to contact me or work with your mercury community coordinator (**INSERT NAME**) to identify the best time of year to collect another sample.

Hair sampling and food surveys will continue to be offered for the next few years. A community event to collect more hair samples and food surveys will be held sometime in 2021, but you can contact your mercury community coordinator anytime if you would like to arrange something before then.

If you have any questions or wish to discuss your results with a member of the project team or someone who can provide more detailed advice about eating fish, please contact the project's principal researcher Andrea Amendola at 905-567-6100 extension 1318 or Andrea_Amendola@golder.com. You can also contact your mercury community coordinator **NAME** at **PHONE OR EMAIL** or your local health provider, your local **TITLE** is **NAME** and their contact info is **PHONE OR EMAIL**.

To learn more about mercury and health, please visit:

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

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

Sincerely,

Golder Associates Ltd.

Andrea Amendola, BSc, QPRA
Principal Researcher, Risk Assessor

AA/aa

Attachments: Signed Consent Form

https://golderassociates-my.sharepoint.com/personal/hashe_golder_com/documents/letter_sample_lowresult_finaldraft_2019march22.docx

APPENDIX F

Results Poster

Mercury Hair Sampling 2018-2020 Results

Mercury & Human Health Implementation Group

128 Participants from: TCN, WLFN, FLCN, & YFFN

184 Hair Samples Analyzed*

*some people had samples collected twice; some samples of long hair were analyzed in many segments to measure previous seasons

73 Food Surveys Completed

Non-Sensitive Group

Healthy Range: up to 5 ppm

This group includes:

- Men over 18 years old
- Women who are post-menopausal

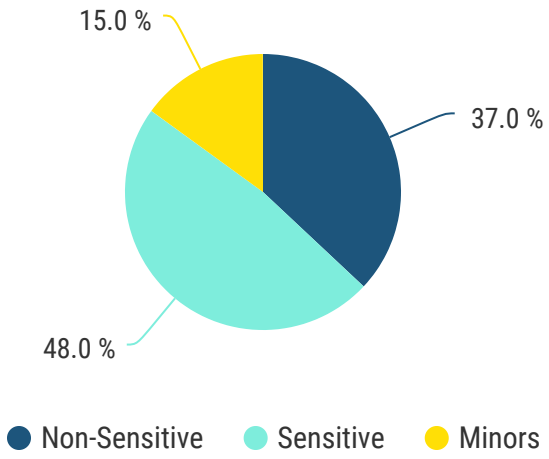
Sensitive Group

Healthy Range: up to 2 ppm

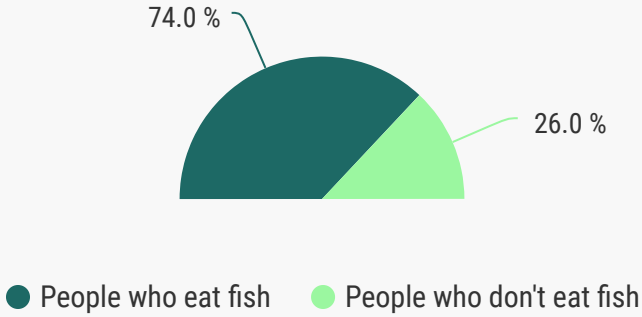
This group includes:

- Women who are of child-bearing age
- All **minors** (under age 18)

Types of Participants



% of Participants Who Eat Fish



0.5 ppm (ppm = parts per million)
is the average mercury level for hair sampling participants

0.01 to 5.6 ppm
is the range of mercury levels found in participants

Most participants had a low level of mercury. Three people (2% of those tested) had higher levels than what is considered a healthy range. These people were advised to eat less of the types of fish that often have higher levels of mercury.

If you have any questions about mercury or the health benefits of safely keeping fish in your diet, contact:

- Andrea Amendola, Mercury & Health Specialist: (905) 567-6100 ext. 1318 or Andrea_Amendola@golder.com

If you want to get your mercury levels tested anytime, please contact your First Nation's Community Mercury Coordinator:

- Lyndsey Keeper (Tataskweyak Cree Nation)
- Joanne Lavallee (Fox Lake Cree Nation)
- Darwin Flett (War Lake First Nation)
- Nellie Redhead (York Factory First Nation)

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APPENDIX 4: PREDICTIONS OF POST-IMPOUNDMENT FISH MERCURY CONCENTRATIONS FOR APPLICATION IN THE MERCURY AND HUMAN HEALTH RISK MANAGEMENT PLAN PRODUCTS

Subject: **Updated Fish Mercury Information for Gull, Stephens, and Split Lakes 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: November 24, 2020

1.0 INTRODUCTION

This memorandum provides updated length-class specific fish tissue mercury concentrations for application to the Mercury and Human Health Risk Management Plan products (e.g., Human Health Risk Assessment [HHRA]) and related communication products.

Fish mercury concentrations for three species, Lake Whitefish, Northern Pike, and Walleye, from three waterbodies, Split Lake, Gull Lake (including a reach of the Nelson River below Birthday Rapids), and Stephens Lake, were initially calculated for the Human Health Risk Assessment (HHRA) of mercury (Wilson 2012, 2013) provided as part of the Keeyask Environmental Impact Statement (EIS) and was mainly based on mercury data collected up to 2009 (KHLP 2012). Data was presented separately for three species-specific size classes (i.e., small, medium, and large), which allows consumers to make fish consumption choices in terms of mercury exposure based on fish species and fish size. This information was updated in 2015 and 2017 to reflect fish mercury concentrations up to 2013 (Jansen 2015 in KHLP 2015a) and 2016 (Jansen 2017). The current memorandum includes a further update with data collected in 2018 and 2019.

2.0 FISH MERCURY SAMPLING

The Keeyask Project's Aquatics Effects Monitoring Plan (AEMP; KHLP 2015b) commits to sampling for fish mercury concentrations on an annual basis starting in the first year after full impoundment (2021). Until that time, Split and Stephens lakes were to be sampled every three years as part of Coordinated Aquatic Monitoring Program (CAMP). Under the auspices of these programs, sampling occurred most recently in 2019 at Split Lake and in 2018 at Stephens Lake. To supplement Gull Lake data collected between 1999–2006 for the EIS, additional monitoring of fish mercury concentration was completed in 2014 and 2016 (as a condition of the licence issued for the Keeyask Project) and again in 2019 to document mercury concentrations prior to full impoundment (reported in Jansen 2016; Jansen 2018; Holm 2020). After full impoundment, fish mercury monitoring will be conducted yearly in the Keeyask

reservoir (including the former Gull Lake) and Stephens Lake, starting in 2021, until maximum fish mercury concentrations are reached. Thereafter, monitoring will revert to a 3-year cycle until concentrations have reached pre-Project levels or are considered stable at a new background level. Monitoring on Split Lake will continue under CAMP at 3-year intervals until it is apparent that concentrations are stable (as defined in the AEMP and described below in Section 4.3).

Fish species sampled for mercury analysis at Split, Gull, and Stephens lakes include Lake Whitefish, Northern Pike, and Walleye. One-year old Yellow Perch have also been collected from Gull and Stephens lake historically for mercury analysis; however, due to low abundance of perch caught over the years, this component of the mercury program will not be continued and is not included in this document. Target numbers of fish for mercury analysis consist of up to 36 Northern Pike, Walleye, and Lake Whitefish in a sampling year. The actual number of fish from each species to be analyzed will largely depend on their availability within the different waterbodies. It is expected that numbers will occasionally differ from the target sample size. For details of sampling and analytical methods, and general results refer to published AEMP reports.

3.0 UPDATE OF CURRENT LENGTH-CLASS SPECIFIC FISH MERCURY CONCENTRATIONS

This section presents the general methodology for length-class specific analysis of fish mercury data and the calculation of the current estimates of mercury concentrations for three length classes of Lake Whitefish, Northern Pike, and Walleye from Gull, Stephens, and Split lakes. It also includes a comparison to time periods presented as part of two previous assessments (the Keeyask Mercury and Human Health Working Group fish mercury and human health communication product prepared in 2014 [Jansen 2015] and an update prepared in 2017 [Jansen 2017] containing data collected in 2014 and 2016) with the current estimates based on the period 2012–2019. The means presented for these two periods were recalculated as part of this assessment using the most recent database, so there are some minor differences in the numbers presented in Tables 1 and 2 for the first two periods compared to those in the 2014 and 2017 reports.

To calculate mean arithmetic mercury concentration for each length-class of the three species, data from two or more sampling years are used to increase the sample size of fish in each class to more reliably estimate average mercury concentrations and account for inter-annual variability. Three periods are included: period 1 used in the original calculation that included data from 2001–2013; period 2 used in the 2017 update that included data from 2005–2016; and period 3 used in the current analysis that uses data from 2013–2019. The years included in each period varies by species and waterbody. Results are made more current by including data from the most recent sampling year while deleting data from the oldest sampling year(s), thereby calculating a running average of mercury concentrations by species and length class.

The difference in the arithmetic means between periods was calculated as the percent change, which is calculated by subtracting the old value from the new value, then expressing the difference as a percentage

of the old value. A positive number indicates an increase, while a negative number indicates a decrease. Since it is assumed that changes to the communications materials will be based on the results of each subsequent update to the length-class specific mercury concentrations, the percent change was calculated between periods 1 and 2, and again for periods 2 and 3. Cases where a difference of 20% was calculated between periods[1] are indicated in red in the summary tables. A statistical analysis was conducted using a Mann-Whitney test (XLStat 2019.4.2) to determine if mercury concentrations of each of the length classes were significantly different among periods ($p \leq 0.05$). Since mercury concentration is typically a function of fish length, the percent change in the arithmetic mean fork length was also calculated as a supporting value.

The following provides a summary of the results of length class mercury analysis for Lake Whitefish, Northern Pike, and Walleye from Split, Gull, and Stephens lakes. All figures show fish muscle mercury concentrations as total mercury based on wet weights (ppm) and fish length measured as fork length (mm). The tables summarize changes in fish mercury concentrations between the time periods applied to the previous communications products and the period that incorporates the most current data for Gull, Split, and Stephens lakes.

3.1 GULL LAKE

The mean arithmetic mercury concentrations of all three species have been updated with data collected in 2019 such that the data used for the most recent period includes data from 2014, 2016, and 2019 (Table 1).

For Lake Whitefish, most of the fish analyzed for mercury over the 2014–2019 period belong to the largest size class (>450 mm) (Figure 1). No fish were captured in the smallest size class (<300 mm) and only a few fish were captured in the intermediate length class (300–450 mm). The percent change in the arithmetic mean mercury concentration was less than 20% for the intermediate size class, but was 31% higher in the largest size class (Table 1). The fork length does not explain the increase in mercury concentration as the average size of the fish in the largest size class is consistent with the previous period. The difference in mercury concentrations of fish in the largest size class between period 2 and 3 was significant ($U = 1233.500$, $p = 0.007$). Lake Whitefish belonging to the smallest size class were only captured in 2001 and 2002, which explains why there was no change in either the size or mercury concentration between periods 1 and 2. A change greater than 20% was observed between periods 2 and 3 when the lengths were pooled.

[1] Discussed in Keeyask Project Mercury and Human Health Risk Management Plan Memo: Communication Process of Mercury Fish Data Results and Consumption Recommendations, Keeyask Project PHASE-1 (Pre-Impoundment 2019).

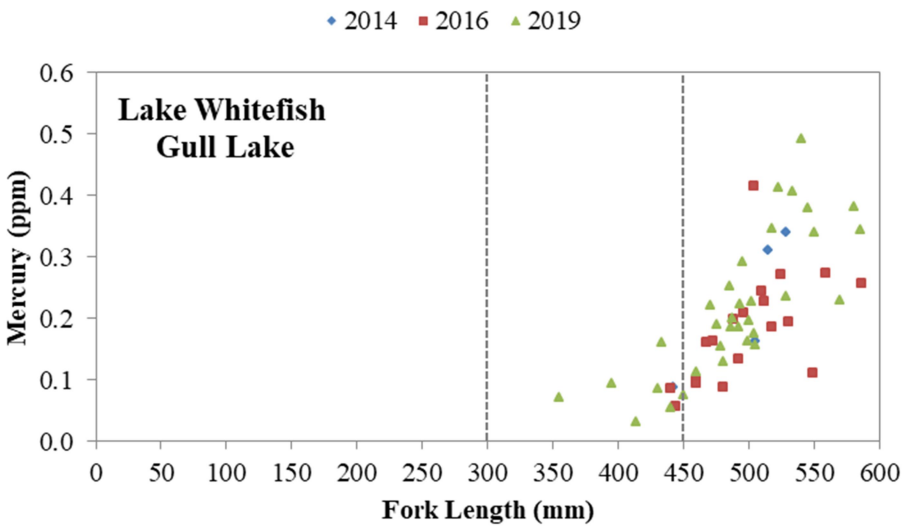

Figure 1. Mercury concentration and fork length of Lake Whitefish from Gull Lake: 2014–2019. The dashed lines indicate the division of the three size classes.

For Northern Pike, there was good representation of samples of all three size classes over the 2014–2019 period (Figure 2). There has been an increase in the arithmetic mean mercury concentration in each size class (Table 1). In the case of the smallest (<500 mm) and intermediate (500–750 mm) size classes, this difference is notably higher than 20% and these differences were significant (U = 913.500, p <0.0001; U = 2800.500, p <0.001, respectively). The mean length of each size class is generally consistent among periods. A change greater than 20% was observed between periods 2 and 3 when the lengths were pooled.

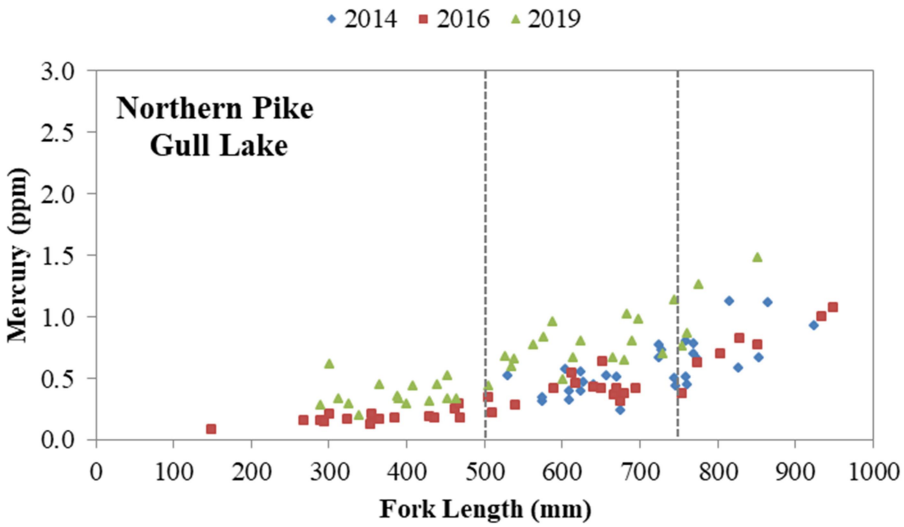

Figure 2. Mercury concentration and fork length of Northern Pike from Gull Lake: 2014–2019. The dashed lines indicate the division of the three size classes.

For Walleye, there was good representation of samples in the smallest (<400 mm) and intermediate (400–550 mm) size classes over the 2014–2019 period, but few fish were sampled in the largest (>550 mm) size class (Figure 3). There was a notable increase in mercury concentrations in the smallest size class that exceeded 20% (Table 1). The difference in mercury concentrations of fish in the smallest size class between period 2 and 3 was significant (U = 2024.500, p = 0.011). The average size of fish sampled has remained consistent over the three sampling periods. There was no change in the mercury concentration greater than 20% between periods 2 and 3 when the lengths were pooled.

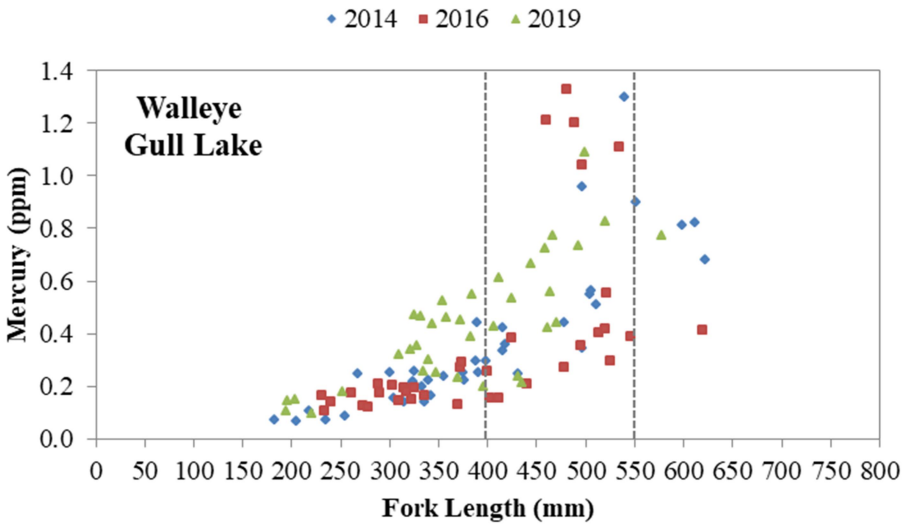

Figure 3. Mercury concentration and fork length of Walleye from Gull Lake: 2014–2019. The dashed lines indicate the division of the three size classes.

Table 1. Sample size (n) and arithmetic mean mercury concentration ([Hg], ppm) and fork length (FL, mm) for three size classes of Lake Whitefish, Northern Pike, and Walleye from Gull Lake during three time periods and the percent change between periods. Mercury samples were collected from Gull Lake in 2001, 2002, 2004 (Northern Pike only), 2006 (Walleye and Northern Pike), 2014, 2016, and 2019.

Lake Whitefish		<300 mm			300-450 mm			>450 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	N	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2001-2006	14	0.042	212	13	0.071	386	20	0.149	514	47	0.096	389
2	2001-2016	14	0.042	212	16	0.072	396	40	0.178	511	70	0.126	425
% Change 1 to 2			0	0		1	3		19	-1		32	9
3	2014-2019	0	-	-	10	0.079	424	46	0.234	510	56	0.206	494
% Change 2 to 3			-	-		10	7		31**	0		63	16
Northern Pike		<500 mm			500-750 mm			>750 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	N	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2001-2006	33	0.141	370	86	0.255	626	35	0.683	865	154	0.328	625
2	2006-2016	37	0.150	340	70	0.338	634	26	0.669	821	133	0.350	589
% Change 1 to 2			6	-8		33**	1		-2	-5		7	-6
3	2014-2019	30	0.272	370	51	0.546	633	22	0.818	815	103	0.525	596
% Change 2 to 3			81**	9		62**	0		22	-1		50	1
Walleye		<400 mm			400-550 mm			>550 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	N	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2001-2006	36	0.118	313	41	0.417	474	25	0.667	593	102	0.373	446
2	2006-2016	51	0.175	313	49	0.503	478	18	0.698	596	118	0.391	424
% Change 1 to 2			48**	0		21	1		5	1		5	-5
3	2014-2019	62	0.233	312	42	0.572	470	6	0.733	597	110	0.390	388
% Change 2 to 3			33**	0		14	-2		5	0		0	-9

** indicates a significant difference among periods ($p < 0.05$) using Mann-Whitney test

3.2 STEPHENS LAKE

The mean arithmetic mercury concentration of all three species have been updated with data collected in 2018 such that the data used for the most recent period includes data from 2012, 2015, and 2018 (Table 2).

Few Lake Whitefish have been analyzed for mercury over the 2012–2018 period (Figure 4). Only the arithmetic mean of the smallest size class (<300 mm) showed an increase higher than 20% (Table 2). However, the mean for this size has been highly variable in previous periods, showing a 75% decrease in mercury concentration in period 2 compared to period 1. Unlike the other size classes, the mean length has also been highly variable, showing an almost 60% decrease between periods 2 and 1 and a 30% increase between periods 2 and 3. The five fish representing the size class in the period 2 were all young-of-the-year (<100 mm), and are not relevant in terms of human consumption.

There was a good representation of Northern Pike in the smallest (<500 mm) and intermediate (500–750 mm) size classes over the 2012–2018 period (Figure 5). There has only been an increase in the arithmetic mean mercury concentration of the largest (>750 mm) size class exceeding 20% (Table 2). The mean length of the samples analyzed was similar among periods.

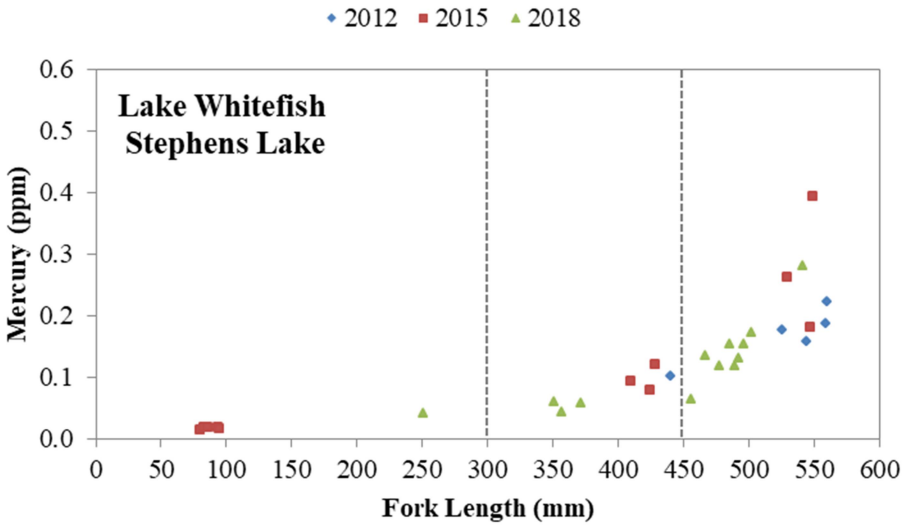

Figure 4. Mercury concentration and fork length of Lake Whitefish from Stephens Lake: 2012–2018. The dashed lines indicate the division of the three size classes.

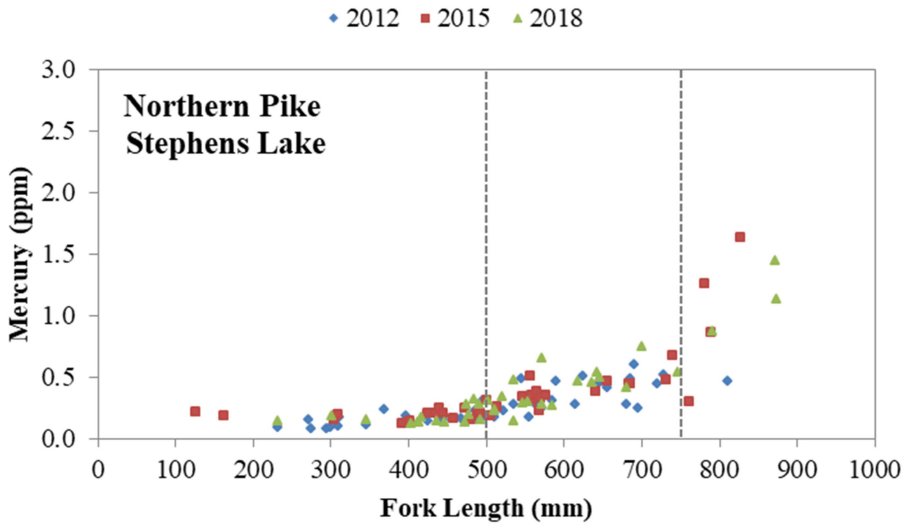

Figure 5. Mercury concentration and fork length of Northern Pike from Stephens Lake: 2012–2018. The dashed lines indicate the division of the three size classes.

For Walleye, there was good representation of samples in the smallest (<400 mm) and intermediate (400–550 mm) size classes over the 2012–2018 period, but few fish were sampled in the largest (>550 mm) size class (Figure 6). Mercury concentrations in all three size classes remained consistent from period 2 (Table 2).

Mercury concentrations of fish in all three length classes for all three species were not significantly different between periods 2 and 3 at Stephens Lake. There was no change in the average mercury concentration greater than 20% between periods 2 and 3 for any of the species when the lengths were pooled.

Table 2. Sample size (n) and arithmetic mean mercury concentration ([Hg], ppm) and fork length (FL, mm) for three size classes of Lake Whitefish, Northern Pike, and Walleye from Stephens Lake during three time periods and the percent change between periods. Mercury samples were collected from Stephens Lake in 2003, 2004 (Lake Whitefish only), 2005, 2007, 2009, 2012, 2015, and 2018.

Lake Whitefish		<300 mm			300-450 mm			>450 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2003-2012	21	0.068	201	44	0.088	401	93	0.156	507	158	0.126	437
2	2005-2015	5	0.017	88	23	0.086	407	53	0.158	510	81	0.129	455
% Change 1 to 2			-75**	-56		-2	1		1	1		3	4
3	2012-2018	6	0.021	115	7	0.078	397	16	0.181	514	29	0.123	403
% Change 2 to 3			24	31		-9	-2		15	1		-5	-11
Northern Pike		<500 mm			500-750 mm			>750 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2003-2012	77	0.151	409	123	0.334	608	46	0.806	853	246	0.365	591
2	2007-2015	61	0.170	390	67	0.369	606	26	0.805	843	154	0.364	560
% Change 1 to 2			13	-5		10	0		0	-1		0	-5
3	2012-2018	49	0.174	397	57	0.377	598	8	0.999	814	114	0.333	527
% Change 2 to 3			2	2		2	-1		24	-3		-9	-6
Walleye		<400 mm			400-550 mm			>550 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2003-2012	74	0.173	305	131	0.409	471	30	0.720	587	235	0.374	433
2	2007-2015	40	0.297	318	69	0.506	477	22	0.722	583	131	0.478	446
% Change 1 to 2			72**	4		24**	1		0	-1		28	3
3	2012-2018	43	0.306	316	56	0.554	476	14	0.779	584	113	0.488	429
% Change 2 to 3			3	-1		9	0		8	0		2	-4

** indicates a significant difference among periods ($p < 0.05$) using Mann-Whitney test

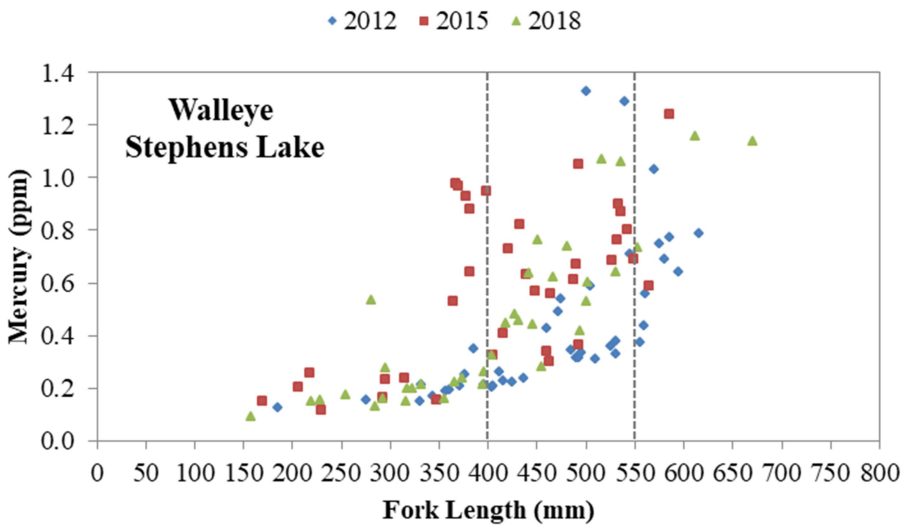

Figure 6. Mercury concentration and fork length of Walleye from Stephens Lake: 2012–2018. The dashed lines indicate the division of the three size classes.

3.3 SPLIT LAKE

The mean arithmetic mercury concentration of all three species have been updated with data collected in 2019 such that the data used for the most recent period includes data from 2013, 2016, and 2019 (Table 3).

Lake Whitefish analyzed for mercury over the 2013–2019 period were well represented in the intermediate (300–450 mm) and largest size class (>450 mm) (Figure 7) and the arithmetic mean mercury concentration of fish in these size classes has remained consistent from period 2 (Table 3). As observed in Gull Lake, no Lake Whitefish belonging to smallest size class (<300 mm) were sampled over the 2013–2019 period.

There was good representation of Northern Pike in the smallest (<500 mm) and intermediate (500–750 mm) size classes, but few samples belonging to the largest size class (>750 mm) over the 2013–2019 period (Figure 8). There has only been an increase in the arithmetic mean mercury concentration of the largest (>750 mm) size class exceeding 20% (Table 3). This increase was notable, at 74%, despite the similarity in the mean length among periods. The arithmetic mean was heavily influenced by one larger fish (875 mm) captured in 2019 that had a high mercury concentration (2.4 ppm). A Northern Pike with notably high mercury concentration (1.167 ppm, 867 mm) was previously captured in Split Lake in 2002, prior to the year ranges included in all of the size class analysis. Thus, the increase in mercury of the largest size may be a result of sampling variation rather than an increase in mercury concentrations.

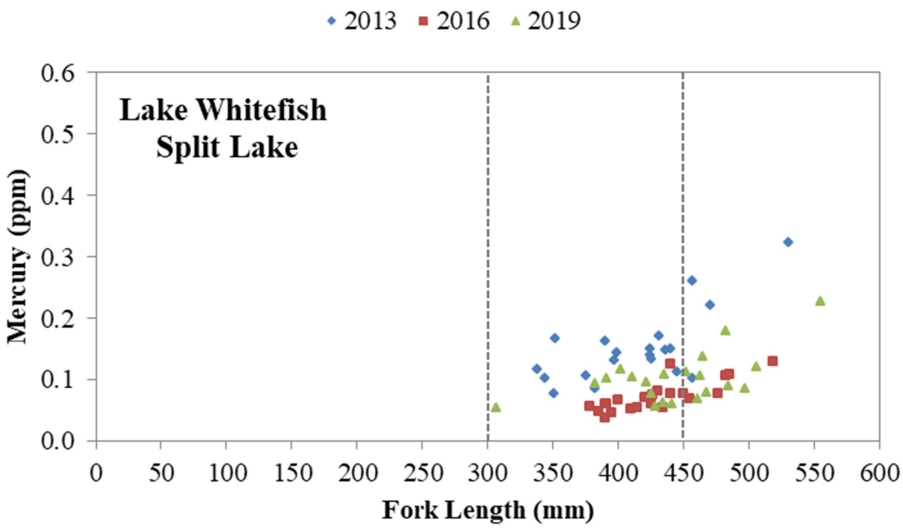

Figure 7. Mercury concentration and fork length of Lake Whitefish from Split Lake: 2013–2019. The dashed lines indicate the division of the three size classes.

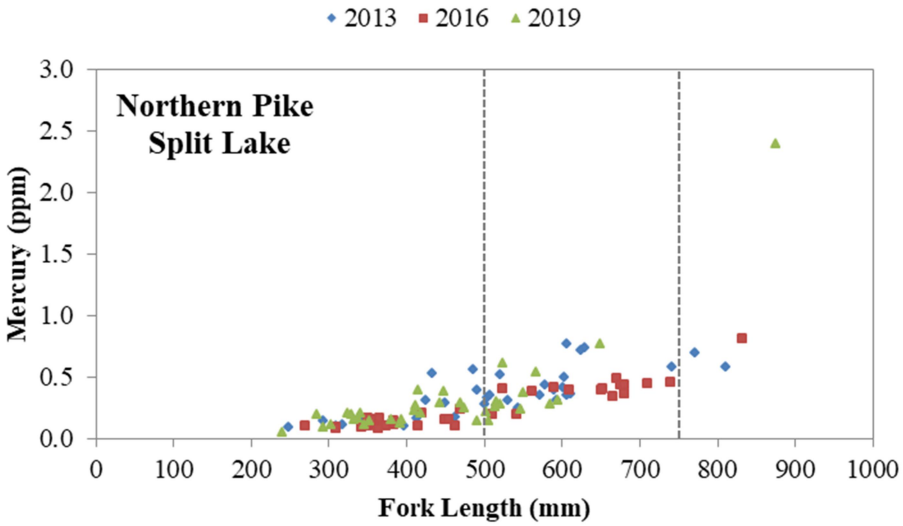

Figure 8. Mercury concentration and fork length of Northern Pike from Split Lake: 2013–2019. The dashed lines indicate the division of the three size classes.

For Walleye, there was good representation of only the smallest size class (<400 mm) and fewer fish in the intermediate (400–550 mm) and largest (>550 mm) size classes over the 2013–2019 period (Figure 9). Mercury concentrations in all three size classes remained consistent from period 2 (Table 3).

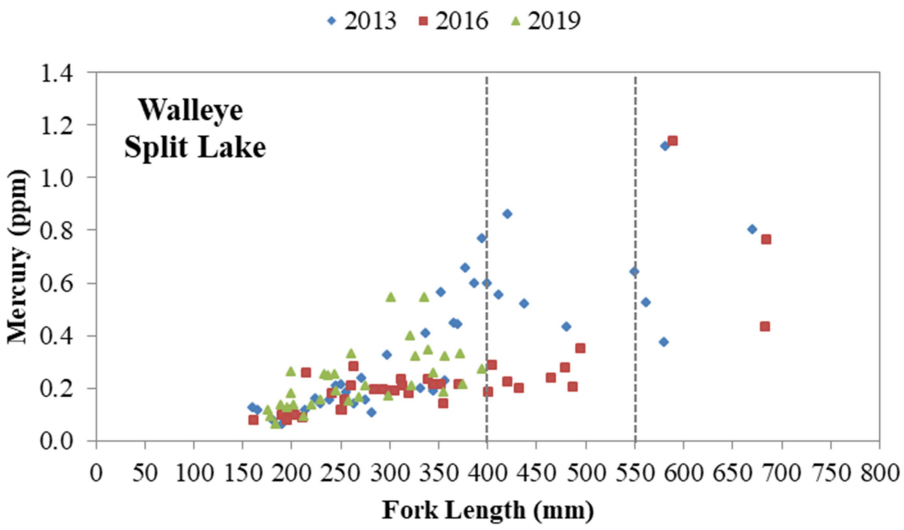

Figure 9. Mercury concentration and fork length of Walleye from Split Lake: 2013–2019. The dashed lines indicate the division of the three size classes.

Mercury concentrations of fish in all three length classes for all three species were not significantly different between periods 2 and 3 at Split Lake. There was no change in the average mercury concentration greater than 20% between periods 2 and 3 for any of the species when the lengths were pooled.

3.4 LENGTH CLASS CONSIDERATIONS

Currently there is no lower limit for the smallest size class. The inclusion of very small Lake Whitefish (<100 mm, likely young-of-the-year) in Stephens Lake appears to have affected the arithmetic mean fork length for the smallest size class. In this case, the percent change in mercury concentration among periods exceeded 20% but may have occurred due to the inclusion of very small fish as opposed to a real change in mercury concentration. Estimates for the largest size class of the piscivorous fish are not as reflective of actual mercury concentrations in large fish because of the large range of mercury concentrations in fish of the same length and the smaller number of samples. For example, a single, very large Northern Pike in Split Lake resulted in an increase in the average mercury concentration in the largest size class.

Table 3. Sample size (n) and arithmetic mean mercury concentration ([Hg], ppm) and fork length (FL, mm) for three size classes of Lake Whitefish, Northern Pike, and Walleye from Split Lake during three time periods and the percent change between periods. Mercury samples were collected from Split Lake in 2001, 2002, 2004 (Walleye only), 2005, 2007, 2010, 2013, 2016, and 2019.

Lake Whitefish		<300 mm			300-450 mm			>450 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2001-2013	18	0.031	218	72	0.086	407	51	0.125	487	141	0.093	412
2	2002-2016	7	0.037	241	80	0.083	412	49	0.121	487	136	0.094	430
% Change 1 to 2			19	11		-3	1		-3	0		1	4
3	2013-2019	0	-	-	43	0.094	405	20	0.134	481	63	0.107	429
% Change 2 to 3			-	-		13	-2		11	-1		14	0
Northern Pike		<500 mm			500-750 mm			>750 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2005-2013	34	0.161	397	101	0.367	600	12	0.576	832	147	0.336	572
2	2007-2016	41	0.171	386	81	0.421	609	8	0.644	846	130	0.356	553
% Change 1 to 2			6	-3		15**	2		12	2		6	-3
3	2013-2019	57	0.183	379	46	0.398	587	4	1.121	822	107	0.310	485
% Change 2 to 3			7	-2		-5	-4		74	-3		-13	-12
Walleye		<400 mm			400-550 mm			>550 mm			All Lengths		
Period	Year Range	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL	n	[Hg]	FL
1	2004-2013	125	0.222	308	73	0.270	452	6	0.649	590	204	0.252	368
2	2007-2016	115	0.255	315	48	0.351	453	9	0.692	611	172	0.305	369
% Change 1 to 2			15**	2		30**	0		7	4		21	0
3	2013-2019	84	0.225	275	14	0.398	449	7	0.736	622	105	0.282	322
% Change 2 to 3			-12	-13		13	-1		6	2		-7	-13

** indicates a significant difference among periods ($p < 0.05$) using Mann-Whitney test

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Subject: **Predictions of Post-Impoundment Fish Mercury Concentrations for Application in the Mercury and Human Health Risk Management Plan Products**

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 23, 2021

1.0 INTRODUCTION

This memorandum provides details on the methodology and rationale for the prediction of length-class specific peak fish mercury concentrations resulting from Project operations and updated fish mercury concentrations in Split Lake for application to the Mercury and Human Health Risk Management Plan products (e.g., Human Health Risk Assessment [HHRA]) and related communication products.

Post-impoundment, peak mercury concentrations predicted in the Keeyask EIS (KHLP 2012) for three fish species, Lake Whitefish, Northern Pike, and Walleye, can be used to inform consumption recommendations for the Keeyask reservoir (formerly Gull Lake including a reach of the Nelson River below Birthday Rapids) and Stephens Lake, where mercury levels are expected to increase over first three to seven years as a result of Project operation followed by a slow decline for up to 30 years. Predicted concentrations are presented separately for standardized lengths and three species-specific size classes (i.e., small, medium, and large), which allows consumers to make fish consumption choices in terms of mercury exposure based on fish species and fish size.

2.0 RELEVANCY OF EIS PREDICTIONS FOR PEAK MERCURY VALUES IN GULL AND STEPHENS LAKES

The peak mercury values estimated in the Keeyask EIS in June 2012 are still relevant at the present time. Peak mercury values for a species-specific standard length for Lake Whitefish, Northern Pike, and Walleye from both Gull Lake and Stephens Lake are summarized in Table 7-2 of the EIS Aquatic Environment Supporting Volume (KHLP 2012). The estimates were calculated using two empirical models, one based on the model developed by Johnston et al. (1991) based on recorded increases in mercury concentrations in numerous waterbodies along the Churchill River Diversion Route and a proxy model using estimates of mercury concentrations in Stephens Lake prior to and after impoundment. The modelling approaches and methodologies are described in Appendix 7E of the EIS Aquatic Environment

Supporting Volume (KHLP 2012). The dataset used as the pre-impoundment mercury concentrations to input into the model included mercury concentrations from the last three years of baseline data for Gull Lake (2001, 2002, and 2006) and the last four years of data for Stephens Lake (2001, 2002, 2003, and 2005).

There are several limitations to the Johnston et al. (1991) model(s) that must be considered when interpreting its predictions for fish mercury levels in the Keeyask reservoir and Stephens Lake:

- *"Few of the reservoirs used to build the model(s) had extensive in-lake flooding with no upstream effects, as is predicted to occur in the Keeyask reservoir;*

- *The Percentage Flooding model explained between 38% (for Northern Pike) and 57% (for Walleye) of the variation in fish mercury burden (Johnston et al. 2001), resulting in considerable uncertainties when the model is applied to predict mercury concentrations;*

- *The measurement of fish mercury concentrations used in the Johnston et al. (1991) model(s) generally began after peak concentrations occurred, such that maximum mercury burdens used for modelling were likely lower than actual burdens. This may have resulted in an underestimation of predicted concentrations in the Keeyask reservoir; and*

- *The model(s) does not include the effect of flow rate.*

The last issue may be of particular relevance for the Keeyask reservoir, which is expected to have a relatively short hydraulic residence time of up to 30 hours within the mainstem, approximately 30 days within the newly formed back-bay, and only longer in more sheltered, shallower areas farthest from the river mainstem (PE SV, Section 4.4.2.2). Fast flows and a short reservoir residence time have the potential to dilute and/or remove newly generated methylmercury in the water column before it enters the food web and is biomagnified in consumers at higher trophic levels. For a given amount of flooding, fish mercury concentrations will be lower where flow through the reservoir is high. Although most reservoirs used to build the Johnston et al. (2001 [sic][1]) models were riverine in nature, the hydraulic residence times and the ratios of lacustrine to riverine areas were likely larger than is expected for the Keeyask reservoir. Such differences in hydrology also apply to the Stephens Lake proxy model, and suggest that based on flow rates alone, the predicted fish mercury concentrations for the Keeyask reservoir tend to be an overestimate.

When considering all of the above factors that could not be (fully) accounted for in the models used to make quantitative predictions of mercury concentrations in Keeyask reservoir fish, maximum concentrations in Northern Pike and Walleye can be expected to reach or slightly exceed 1.0 ppm." (p. 7-19 of KHLP 2012)

[1] Johnston et al. (1991)

As noted in the EIS, it must be emphasized that the predictions should be used as indicators rather than absolute post-Project numbers:

"It must be emphasized that although an attempt was made to provide quantitative estimates of future mercury concentrations in the Keeyask reservoir and downstream areas, all predicted values should be treated more as indicators and not as precise quantitative predictions." (p. 7-20 of KHLP 2012)

A range of peak values is presented in the EIS based on the results of the modelling (summarized in Table 1). For example, the peak value for Walleye from Gull Lake is 1.46 ppm based on the Stephens Lake proxy model, while the most likely peak value was estimated at just over 1.0 ppm based on conditions in the reservoir. As discussed in the EIS, the peak values based on the Stephens Lake proxy model are quite high and are unlikely to occur given the relatively high rate of water flow through the reservoir (KHLP 2012). The ranges presented in the EIS are considered robust and are expected to be sufficiently high to account for any natural variations in mercury concentrations that may have occurred in since 2006. It is understood that these values may be utilized as part of the HHRA and communication products.

There is little value in re-running the models. Many of the variables used by Johnston (1991) remain unchanged: the estimate of %PF (the percentage of reservoir flooding); and b_1 (the regression constant related to the flooding contribution to the burden was taken directly from the Johnston paper). Likewise, many of the variables from the Stephens Lake proxy model also remain unchanged: percent flooding; and maximum concentrations in Stephens Lake after impoundment by Kettle GS. The one variable in both models that that could have changed over time is the baseline mercury concentrations in the three species in Gull and Stephens lakes (presented in Table 7-2 of the EIS Aquatic Environment Supporting Volume). In the case of Gull Lake, these values were calculated using the most recent mercury concentrations prior to construction; mercury concentrations were not collected again from Gull Lake until 2014, the year that construction began for the Project.

Including data collected during the construction period shows concentrations that are generally higher in the piscivorous species in 2019, but concentrations measured in 2014 and 2016 were only marginally higher than in 1999 (Figure 1 and discussed in Holm 2020a). While more recent, pre-construction mercury concentrations are available for Stephens Lake (2007, 2009, 2012, and 2018), concentrations in Stephens Lake have varied considerably without showing a consistent increasing or decreasing trend over the 1999–2018 period (Figure 2 and discussed in Holm 2020a). For example, the mean concentration in Northern Pike in 2015 was approximately twice that in 2005, but estimates in both 2012 and 2018 were considerably lower than 2015. Mercury concentrations in Lake Whitefish from both lakes have been consistently low and have not changed much over time, including between 2014 and 2019 after construction of Keeyask began.

Table 1. Estimates of mean maximum mercury concentration (ppm) of three fish species for the Keeyask reservoir and Stephens Lake (based on Table 7-2 of KHLP 2012).

Species	Lake Whitefish	Northern Pike	Walleye
Fork Length	350 mm	550 mm	400 mm
Keeyask Reservoir			
Range of Modelled[1] Means	0.18-0.19	0.81-1.33	0.83-1.46
Most Likely	0.19	1.0	1.0
Stephens Lake			
Range of Modelled[2] Means	0.12	0.40-0.41	0.43
Maximum (conservative)	0.15	0.5	0.5

[1] Estimated using the modified percent flood regression model (Johnson et al. 1991) and Stephens Lake proxy model
[2] Estimated using a proportion of flooded area to the combined area of Stephens Lake and the Keeyask reservoir

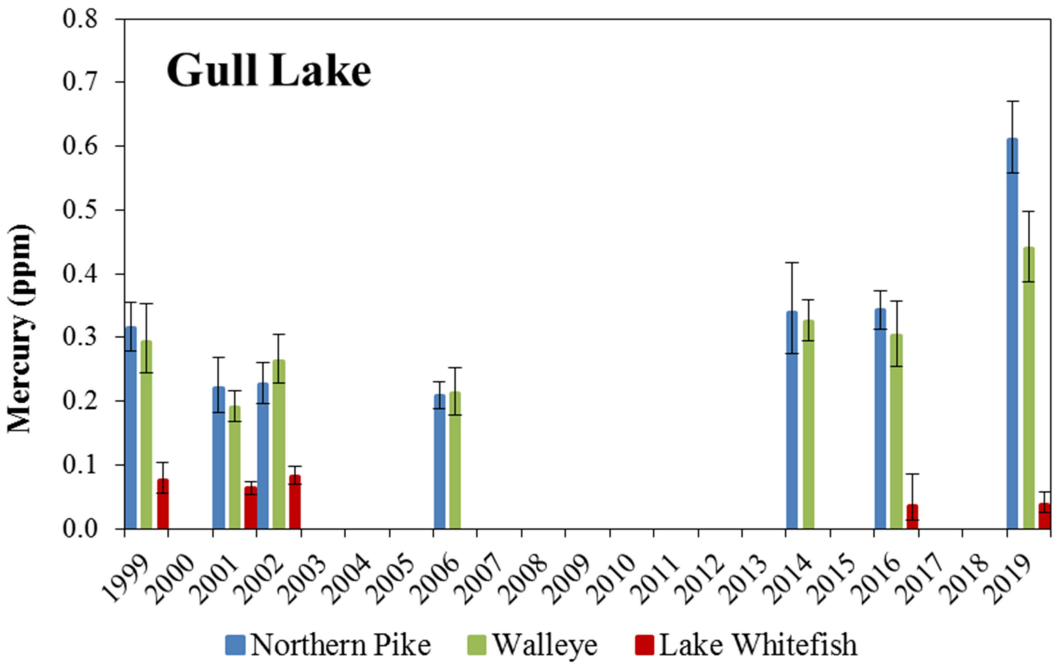

Figure 1. Standard mean mercury concentrations (± 95% confidence limits) measured in fish from Gull Lake from 1999–2019.

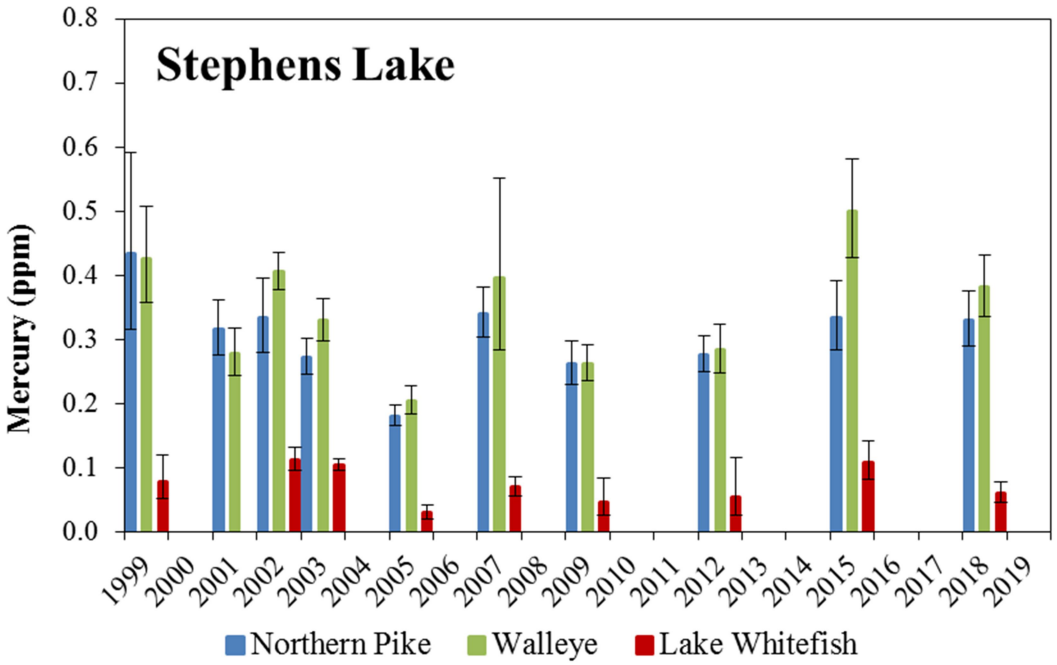

Figure 2. Standard mean mercury concentrations (± 95% confidence limits) measured in fish from Stephens Lake from 1999–2018.

3.0 ESTIMATES OF PEAK MERCURY CONCENTRATIONS FOR OTHER SIZE CLASSES OF FISH IN GULL AND STEPHENS LAKE

Both the Johnston et al. (1991) model and Stephens Lake proxy model use standard mean mercury concentrations based on a specific length for each fish species to predict peak mercury values post-Project. In contrast, the values used to inform the consumption recommendations are based on arithmetic means for a species-specific range of lengths. It is not possible to use the Johnston et al. (1991) model to generate a peak value for any other fish length since it requires regression constants (b_0, b_1) that were generated by the authors specifically for a 550 mm Northern Pike, a 400 mm Walleye, and a 350 mm Lake Whitefish.

It is possible to provide estimates for peak mean mercury concentrations for different length classes using the predicted increases for the standard length of fish provided in the EIS. The EIS predicted that there would be an increase of about 3 fold for a 350 mm Lake Whitefish and 5 fold for a 400 mm Walleye and a 550 mm Northern Pike from the reservoir, and about a 2 fold increase for all three species from Stephens Lake. However, it should be noted that this approach makes the assumption that fish of different lengths accumulate mercury at the same rate. As noted in the EIS: "*within species, mercury concentrations of younger individuals tend to increase faster than those of older fish (Schetagne and Verdon 1999; Harris and Hutchinson 2009)*" (p. 7-18 of KHLP 2012). Therefore, there is some

uncertainty associated with using the predicted increases for the standard lengths of fish, particularly for the concentrations in smaller fish. Annual monitoring of mercury concentrations of the three species from the reservoir and Stephens Lake and timely reporting of results will ensure the validity of these predictions (described in Section 5.0).

The first step is to generate arithmetic mean concentrations for the three size classes for Lake Whitefish, Northern Pike, and Walleye using the "baseline" data (Table 2). Data from 2001 to 2016 was used to generate the baseline mean concentrations for Gull Lake and data from 2001-2018 was used to generate the means for Stephens Lake. Including data collected since 2001 to calculate the baseline conditions increases the sample size (particularly for the largest length class, which generally has the fewest samples), includes more recent data than available at the time the EIS was written, and better reflects the natural variation in mercury concentrations that exists over time. Mercury concentrations from fish sampled from Gull Lake in 2019 were not included in the calculation of the "baseline" concentrations for the length classes because of potential effects of Project construction on mercury levels.

The "baseline" mean concentration of each length class was then multiplied by the predicted increase of mercury concentrations for the standard lengths of each species (i.e., multiplied by a factor of 2 for all three species in Stephens Lake, and for the reservoir were multiplied by 3 for Whitefish and by 5 for Northern Pike and Walleye) to generate the predicted peak mean concentration for each length class (Table 2).

The best estimates for the most likely fish mercury concentrations at peak for three size classes of Lake Whitefish, Northern Pike, and Walleye from the Keeyask reservoir and Stephens Lake are summarized in Table 2. It is understood that these values may be utilized as part of the HHRA and communication products.

Table 2. Estimates of peak mean mercury concentration ([Hg]; ppm) for three length classes of Lake Whitefish, Northern Pike, and Walleye from the Keeyask reservoir and Stephens Lake.

	Baseline Mean [Hg][1]			Predicted Peak Mean [Hg][2]		
Lake Whitefish	<300 mm	300-450 mm	>450 mm	<300 mm	300-450 mm	>450 mm
Keeyask Reservoir	0.042	0.072	0.178	0.126	0.216	0.534
Stephens Lake	0.061	0.092	0.159	0.122	0.184	0.318
Northern Pike	<500 mm	500-750 mm	>750 mm	<500 mm	500-750 mm	>750 mm
Keeyask Reservoir	0.152	0.308	0.709	0.760	1.54	3.55
Stephens Lake	0.171	0.352	0.924	0.342	0.704	1.85
Walleye	<400 mm	400-550 mm	>550 mm	<400 mm	400-550 mm	>550 mm
Keeyask Reservoir	0.155	0.476	0.676	0.777	2.38	3.38
Stephens Lake	0.222	0.461	0.741	0.444	0.922	1.48

[1] Calculated by averaging mercury concentrations of fish sampled between 2001-2016 from Gull Lake and between 2001-2018 from Stephens Lake.
[2] Calculated by multiplying the current mean mercury concentrations by the predicted increases in the EIS (i.e., 3 times for Lake Whitefish and 5 times for Walleye and Northern Pike from the reservoir and 2 times for all three species from Stephens Lake).

4.0 UPDATED FISH MERCURY CONCENTRATIONS IN SPLIT LAKE

An update of length-class specific fish mercury data from Split Lake with recently collected data (2019) was provided in the memorandum "Updated Fish Mercury Information for Gull, Stephens, and Split Lakes for Mercury and Human Health Implementation Group Purposes" (Holm 2020b). The mean mercury concentration of the length classes was consistent (i.e., less than a 20% difference) among sampling periods (i.e., 2002-2016 versus 2016-2019) for Walleye and Lake Whitefish. In the case of Northern Pike, there was a greater than 20% difference for only the largest size class. However, due to the small sample size (4 samples), a lack of significant difference among periods, and the difference for the combined lengths being less than the 20% threshold, this difference is likely an artifact of sampling variation rather than an actual increase in mercury concentrations over time (Holm 2020b).

Since so few Northern Pike greater than 750 mm have been analysed for mercury since 2001 (n = 21 samples), it is recommended that the range of data used to calculate the length-class specific means for the largest size class of Northern Pike include all available data in order to increase the sample size. Likewise, since no Lake Whitefish in the smallest length class have been analyzed for mercury since 2010, it is recommended all of the Lake Whitefish of the smallest size class analyzed since 2001 be included in the calculation of the mean (n = 18). The updated length-class specific mean mercury concentrations for Split Lake are summarized in Table 3 alongside the values applied to the consumption recommendations provided in 2017.

Table 3. Mean mercury concentration ([Hg]; ppm) for three length classes of Lake Whitefish, Northern Pike, and Walleye from Split Lake for two sampling periods. The top row represents the data used for the updated Keeyask MHHWG Fish Mercury and Human Health communication products in 2017 (source: Jansen 2017) and the bottom row represents current concentrations that could be used to update of these products, if required.

Species/Period	Sampling Years	Mean [Hg] by Length-Class		
Lake Whitefish		<300 mm	300-450 mm	>450 mm
2017 Concentrations	2002-2016	0.033	0.082	0.126
Current Concentrations	2013-2019*	0.031	0.094	0.134
Northern Pike		<500 mm	500-750 mm	>750 mm
2017 Concentrations	2007-2016	0.171	0.421	0.641
Current Concentrations	2013-2019*	0.183	0.398	0.729
Walleye		<400 mm	400-550 mm	>550 mm
2017 Concentrations	2007-2016	0.255	0.352	0.692
Current Concentrations	2013-2019	0.225	0.398	0.736

* Values in red include fish sampled since 2001 because of the small number of individuals captured in the length class.

In response to request for fish mercury concentrations for species specific standard length (for input into Split Lake communication materials), an updated standard mean mercury concentration for Split Lake was calculated by averaging the annual standard means calculated over the 2001-2019 period (Figure 3). As discussed in Section 3.0, using several years of mercury data to estimate mercury concentrations better reflects the natural variation in mercury concentrations that exists over time. The updated length-standardized mercury concentrations for Split Lake are summarized in Table 4.

Table 4. Average and range of annual length-standardized mercury concentration (ppm) of three fish species from Split Lake between 2001-2019.

Species	Lake Whitefish	Northern Pike	Walleye
Fork Length	350 mm	550 mm	400 mm
Mean	0.06	0.28	0.26
Range	0.03 - 0.10	0.18 – 038	0.12 – 0.41

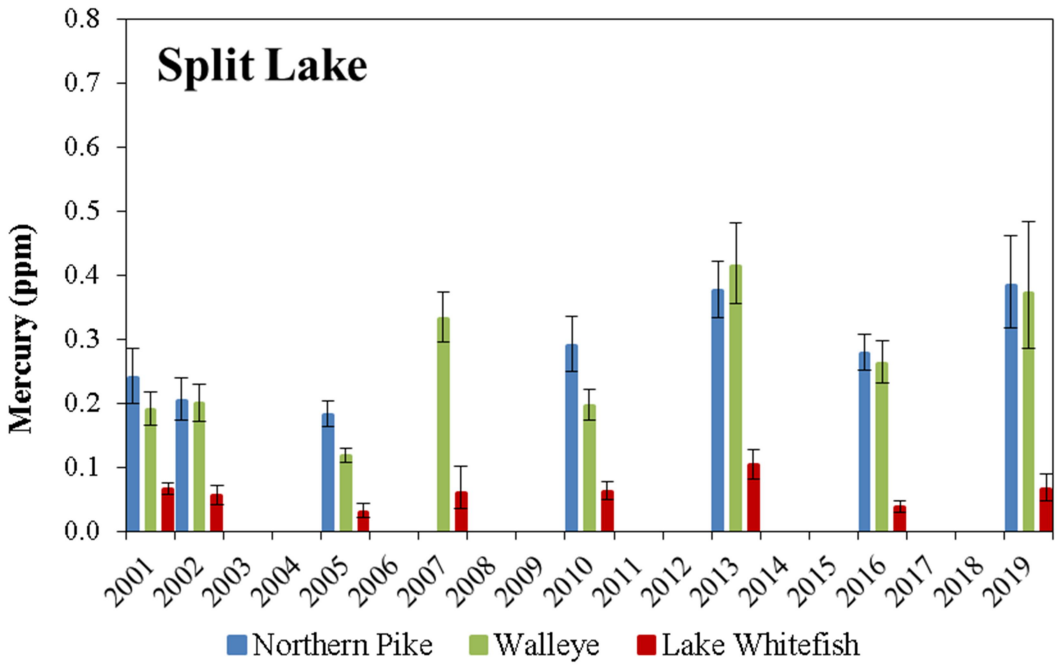

Figure 3. Standard mean mercury concentrations (± 95% confidence limits) measured in fish from Split Lake from 2001–2019.

5.0 ANNUAL POST-IMPOUNDMENT MONITORING OF FISH MERCURY

The validity of predictions about the magnitude and timing of peak mercury concentrations in fish due to the Keeyask Project will be assessed as part of the Keeyask Aquatic Effects Monitoring Program (KHLP 2015). The periodicity of post-impoundment fish mercury monitoring is outlined in the AEMP:

"*During the operation phase, monitoring will proceed yearly in the directly affected waterbodies (i.e., Keeyask reservoir, Stephens Lake) until maximum fish mercury concentrations are reached .... Thereafter, monitoring of mercury levels will be conducted every three years until concentrations have reached pre-Project levels or are considered stable at a new background level. ... For those waterbodies not hydrologically affected by the Project (i.e., Split Lake…), monitoring will proceed at a 3-yearly interval throughout the operation phase until fish mercury concentrations have reached pre-Project concentrations or are considered stable at a new background level in the Keeyask reservoir* " (p. 7-7 of KHLP 2015).

The AEMP defines how it will be determined when peak levels of fish mercury have been reached post-impoundment as:

"Maximum post-Project mercury concentrations will be considered attained for a species if standardized means (or arithmetic means if the relationship between fish length and mercury content is not significant) are not statistically different for three consecutive sampling periods (i.e., 1 year for fish from the Keeyask reservoir and Stephens Lake; every 3 years for other waterbodies) or are significantly lower in the sampling period following two sampling periods of similar concentrations. Stable post-Project concentrations at the end of the declining phase will be considered attained for a species if standardized (or arithmetic) means are not statistically different for three consecutive sampling periods" (p. 7-6 of KHLP 2015).

AEMP mercury monitoring occurs in the late-summer/early fall. To provide resource users that harvest fish from Stephens Lake information on mercury concentrations in fish earlier in the year, additional annual mercury sampling will be conducted starting in the spring 2021 concurrent with the AEMP fish community monitoring programs.

The AEMP (KHLP 2015) includes a "Management Response Framework" for fish mercury monitoring. This framework outlines the steps and events (e.g., an exceedance in a predicted benchmark) that could prompt adaptive management (e.g., adjustments in mitigation and monitoring). "*A review of the monitoring program will be undertaken throughout the implementation of the AEMP with the intent to provide a mechanism for modification(s) as data are acquired over time*" (p. 7-9 of KHLP 2015).

The results of the annual monitoring of fish mercury will be analyzed and communicated to decision makers in a timely fashion to ensure the accuracy of data used to inform the Human Health Risk Assessment. As stated in the AEMP:

"*The sharing of data and information from the different monitoring components is an integral part of the AEMP. Because of the linkages between fish mercury concentrations and human health, the timely dissemination of information between disciplines is critical. To this end, confirmed results from fish mercury monitoring will be provided, as soon as they are available, to the KHLP's Monitoring Advisory Committee and* [Mercury and Human Health Implementation Group]. *As noted in the Socio-Economic Monitoring Plan, the timely provision of the most current fish mercury concentrations will provide the basis for updates to the "Human Health Risk Assessment" and safe consumption recommendations, both of which are components of the "Mercury and Human Health Risk Management Plan" for the Keeyask Generation Project*" (p. 7-9 KHLP 2015).

6.0 LITERATURE CITED

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Johnston, T.A., Bodaly, R.A., and Mathias, J.A. 1991. Predicting fish mercury levels from physical characteristics of boreal reservoirs. Canadian Journal of Fisheries and Aquatic Sciences 48: 1468-1475.

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APPENDIX 5: NORTHERN ROAD TRAFFIC MONITORING QUARTERLY DATA COLLECTION SUMMARY APRIL 2021

NORTHERN ROAD TRAFFIC MONITORING QUARTERLY DATA COLLECTION SUMMARY MARCH 2021

Traffic Monitoring Site 10

Manitoba Hydro

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Summary

Background

Construction-related activities associated with the development of the Keeyask Project, Keewatinohk Converter Station Project and Bipole III Transmission Project (BPIII) generated additional traffic on various segments of the Provincial Road (PR) network, in particular, on PR 280 and PR 290. Three types of traffic are being realized - local traffic, workforce traffic, and traffic generated from shipping materials and equipment for both local and site specific needs.

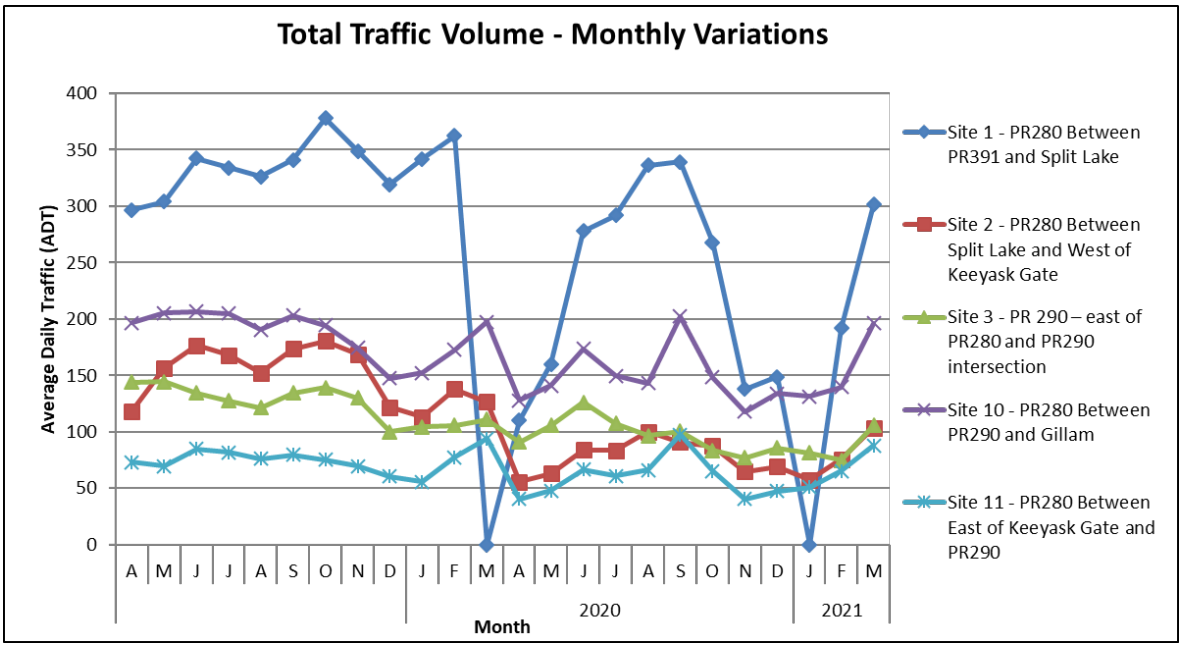
The Environmental Impact Statements (EIS) for both the Keeyask Project and the Bipole III Transmission Project (BPIII) contain requirements for continual traffic monitoring throughout the lifespan of these Projects. While the Environmental Impact Statements (EIS) for both the Keeyask and BPIII Projects predicted that existing transportation networks and plans for PR 280 upgrades would be able to accommodate the changes associated with Project construction, communities in the area expressed concerns regarding traffic safety and road conditions. Manitoba Infrastructure (MI) is responsible for the existing provincial highway system, including maintenance and upgrades to PR 280 and PR 290. Monitoring has been ongoing and continues with information from MI, Manitoba Public Insurance (MPI), and the Keeyask site access gates to assess EIS predictions and respond to community concerns.

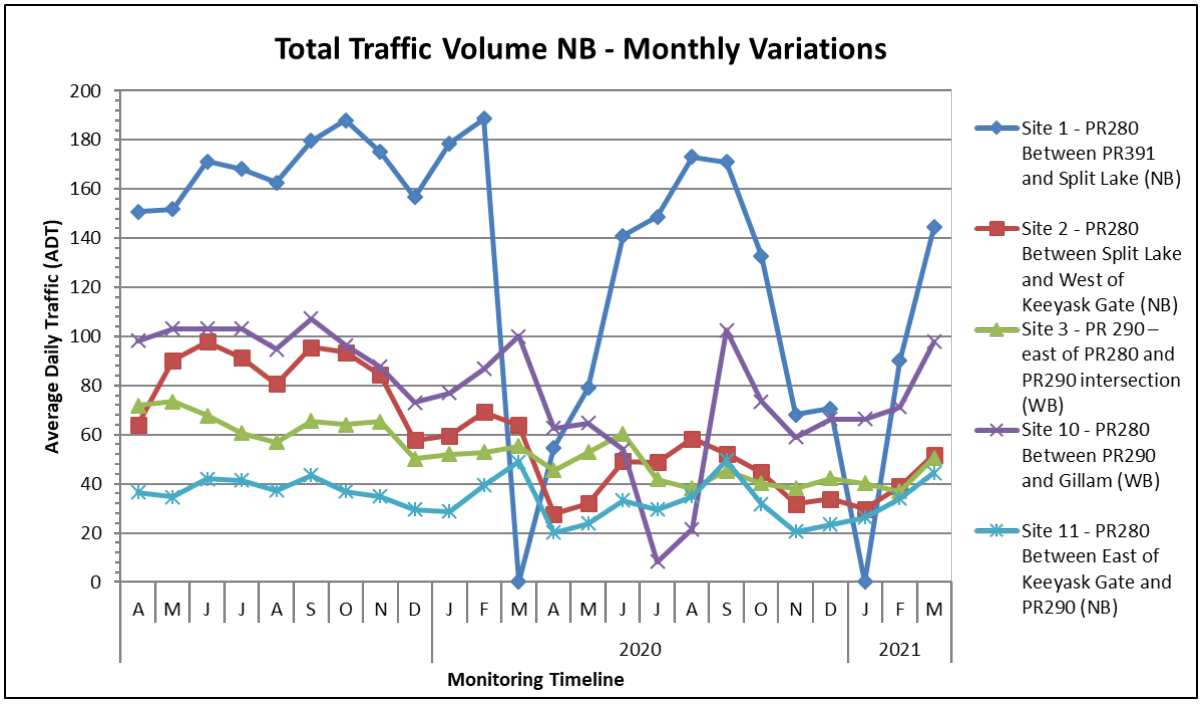
Traffic monitoring stations have been installed at five locations on PR 280 and PR 290 – Site 1, 2, 3, 10 and 11. Refer to **Appendix A** for a map of the traffic monitoring station locations and monitoring station failures. MI installed the stations in 2015 with funding provided by Manitoba Hydro (MH) and MI provides ongoing maintenance of the equipment. MI collects data from the stations and submits the information on a monthly basis to MH. Induction loops are able to differentiate various vehicle types based upon axle count and spacing. Vehicle classifications have been grouped into small, medium and large vehicles as shown in **Appendix B**.

Notable Quarterly Results:
Measures have been implemented to address the Covid-19 global pandemic since March 2020. These measures include the restriction of access on and off the site resulting in a sizable reduction of traffic and gate counts during the January – March quarterly reporting period.

Data Collection Results

Total Traffic Volume – Monthly

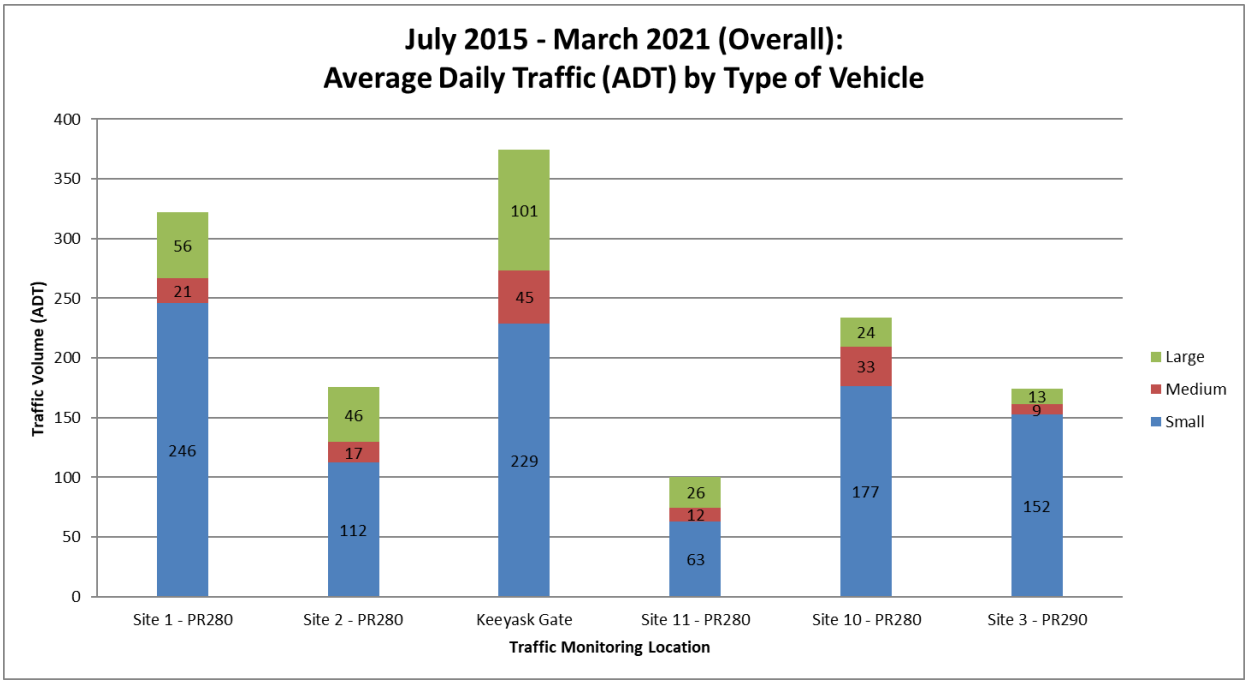


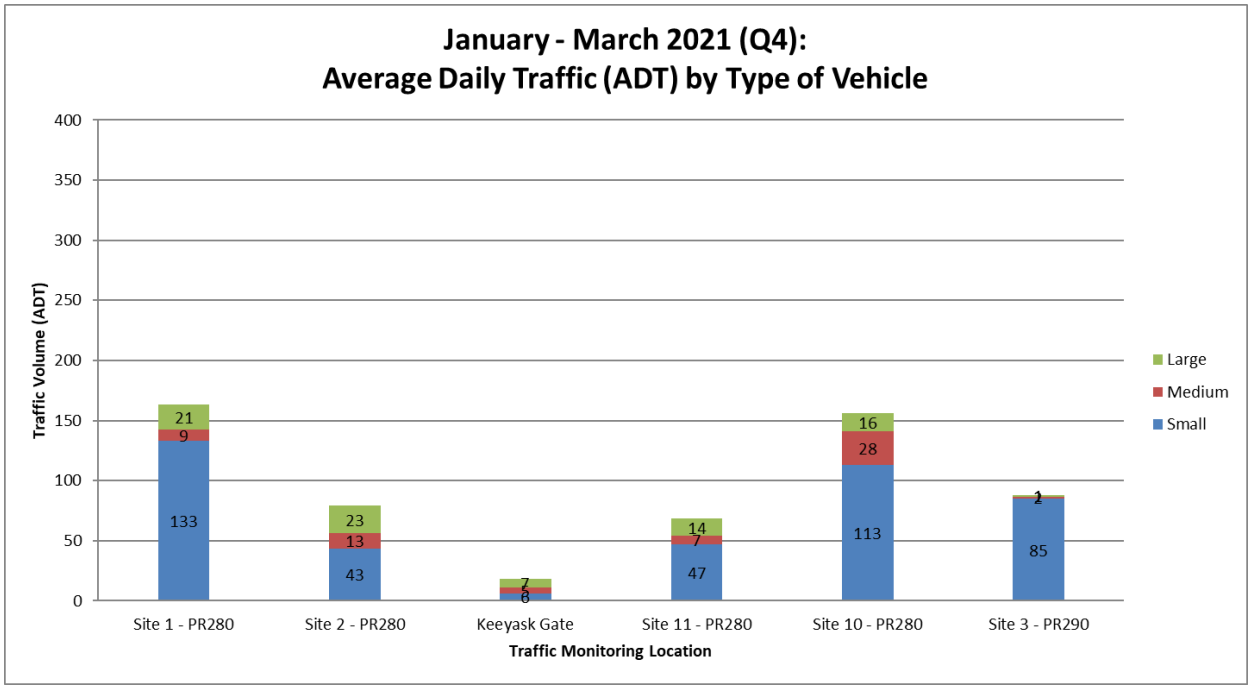


Summary

- Traffic at all sites has reduced year over year however; the split between the reduction of project traffic and traffic as a result of COVID-19 cannot be deterimined.
- Site 1 lost data between December 19, 2020 and January 31,2021.

Average Daily Traffic (ADT) – by type of vehicle

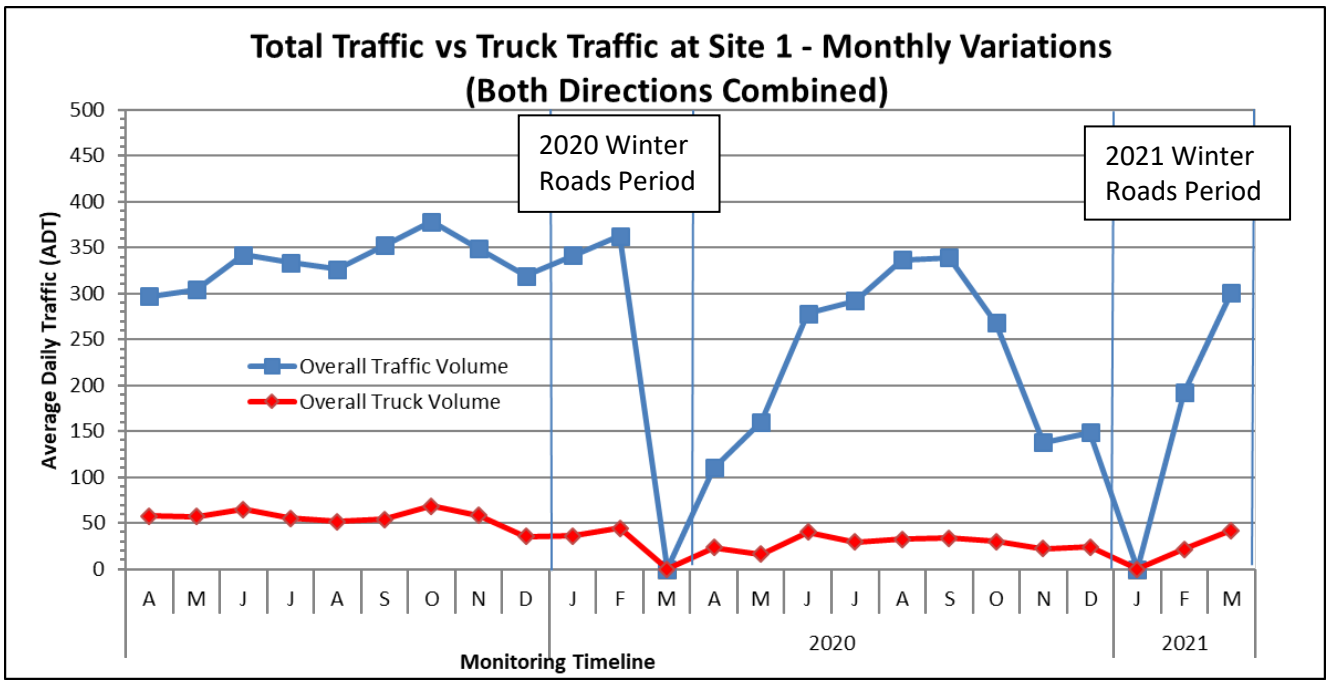




Summary

- Small vehicles result in the highest percentage of vehicle type.
- ADT vs traffic type graphs by site location are given in **Appendix C.**

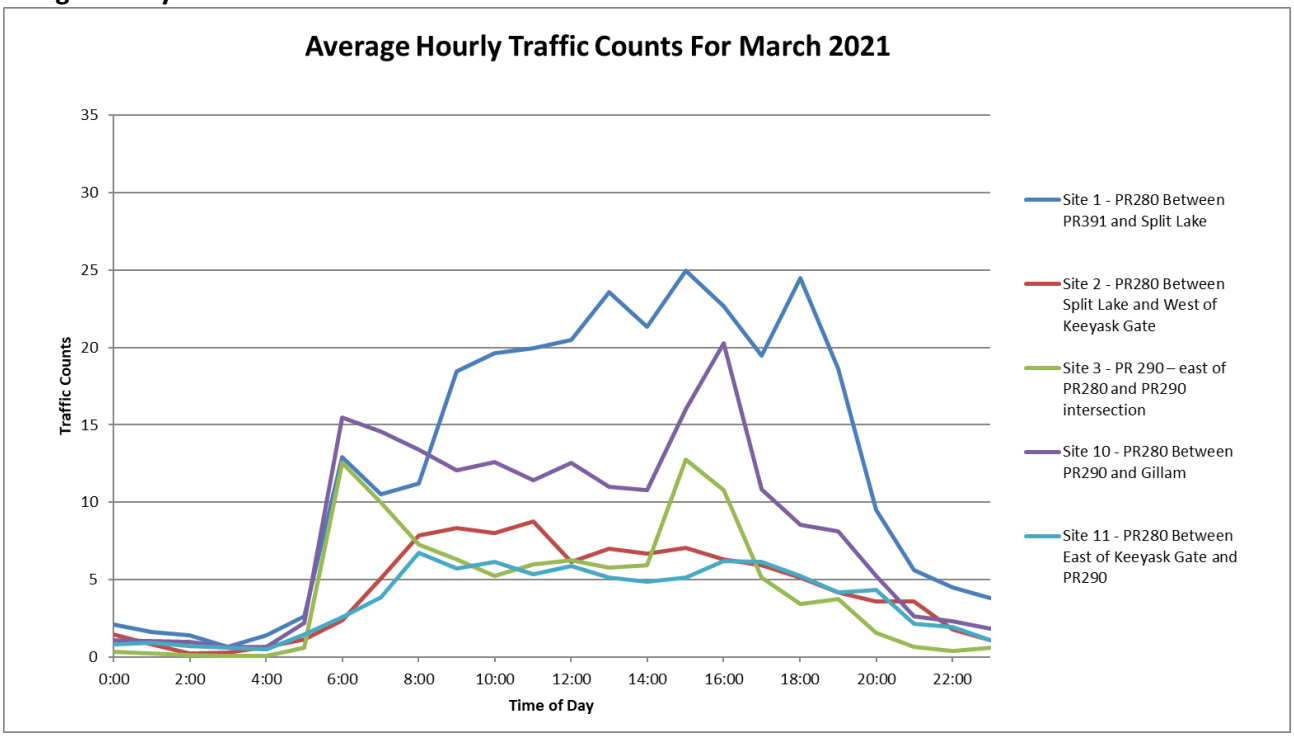
Total Traffic vs Truck Traffic



Summary

- Truck traffic (i.e. large vehicles) graphed against overall traffic does not indicate a correlation to increased volume.
- Truck traffic vs overall traffic graphs for other sites are given in **Appendix D.**

Average Hourly Traffic Count



Summary

- Peak travel time between 12 and 6 pm.

Keeyask Security Gate Records

The security gates on the North Access Road and South Access Road into Keeyask collect data on vehicles entering the site. Security personnel located at the gate tracks the type and number of vehicles that enter and leave the site.

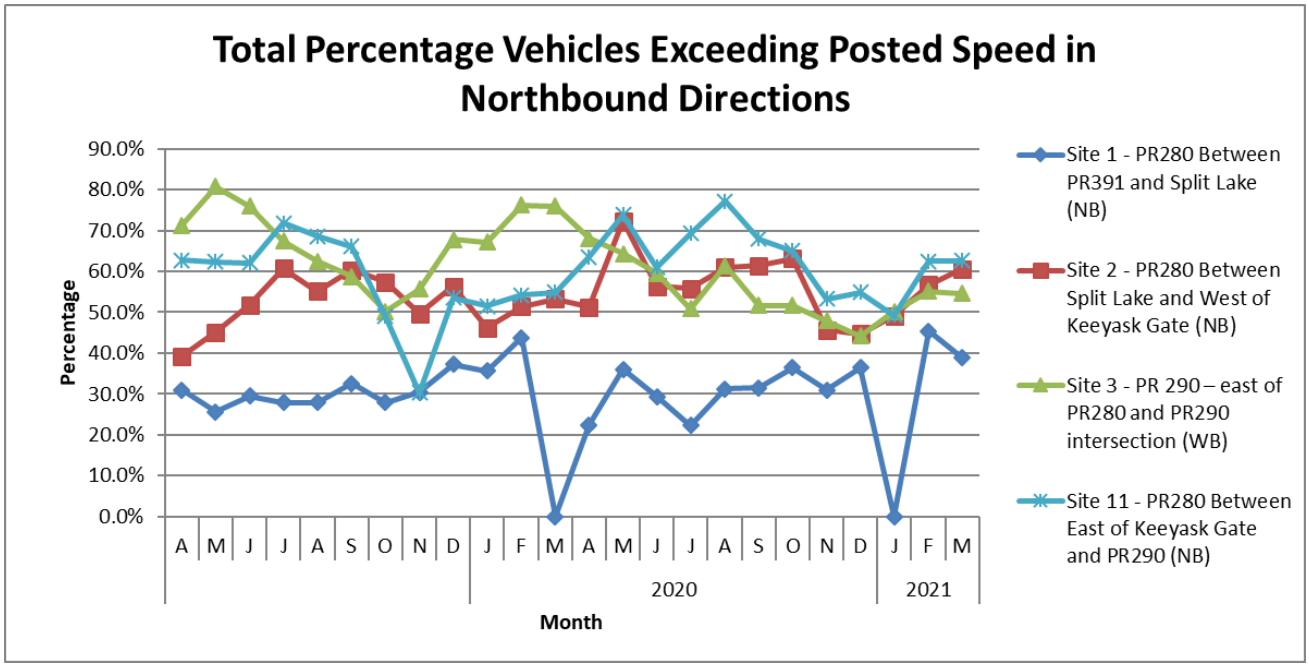
KEEYASK NORTH ACCESS ROAD SECURITY GATE			
Period		Gate Count Total	Daily Average
2019	April	3,380	113
	May	3,363	108
	June	3,566	119
	July	3,242	105
	August	2,948	95
	September	3,431	114
	October	3,302	107
	November	2,915	97
	December	1,737	56
2020	January	1,699	55
	February	1,753	60
	March	1,460	47
	April	552	18
	May	398	13
	June	768	26
	July	977	32
	August	1,479	48
	September	2,411	80
	October	2,299	74
	November	744	25
	December	488	16
2021	January	351	11
	February	615	22
	March	698	23

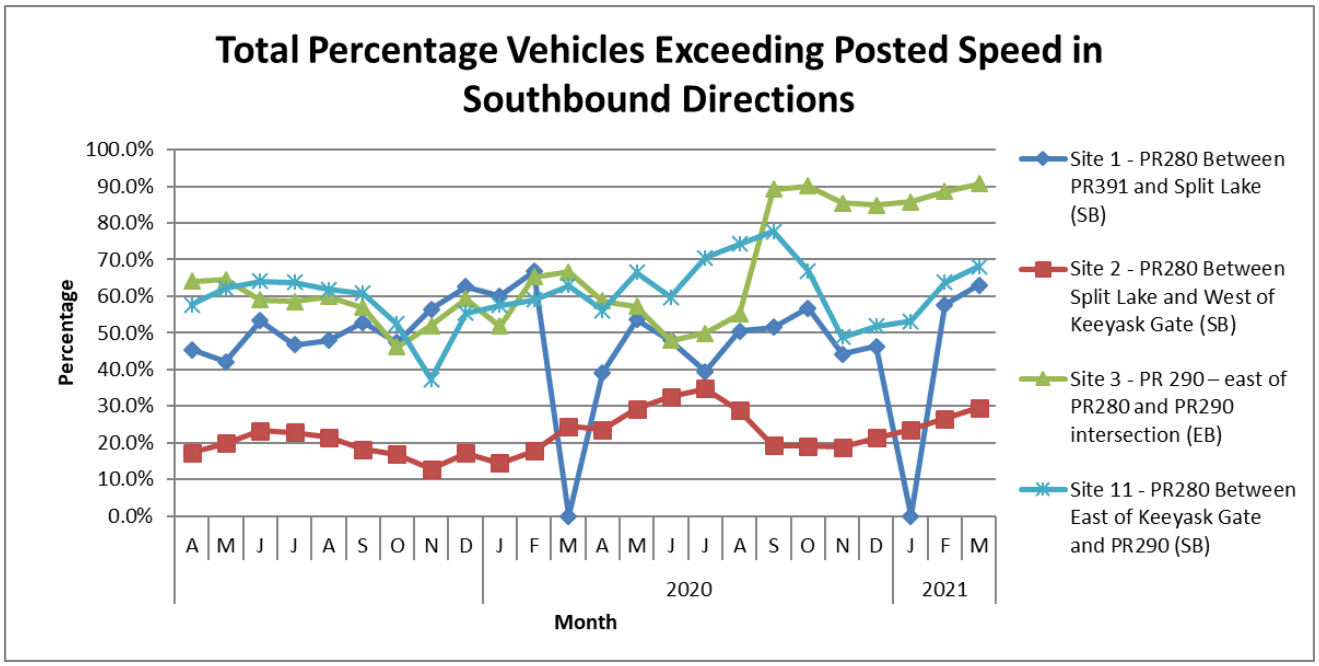
KEEYASK SOUTH ACCESS ROAD SECURITY GATE			
Period		Gate Count Total	Daily Average
2019	April	1,232	41
	May	884	29
	June	1,073	36
	July	995	32
	August	876	28
	September	857	29
	October	1,699	55
	November	1,902	63
	December	1,605	52
2020	January	1,045	34
	February	1,246	43
	March	873	28
	April	43	1
	May	113	4
	June	318	11
	July	447	14
	August	287	9
	September	463	15
	October	470	15
	November	256	9
	December	212	7
2021	January	210	7
	February	250	9
	March	871	28

Summary

- Gate data shows a significant decrease through the North and South Access Gates due to reduced Keeyask construction activity as well as Covid-19 traffic reductions.
- Increase in the Gate Count in February and March 2021 can be related to the return of site workers.

Speeding Analysis





Summary

- Graphs are representative of vehicles exceeding the posted speed limit (>90 km/hr.) as recorded by monitoring stations.
- Site 1 lost data from December 19, 2020 – January 31, 2021.

Average Vehicle Speed

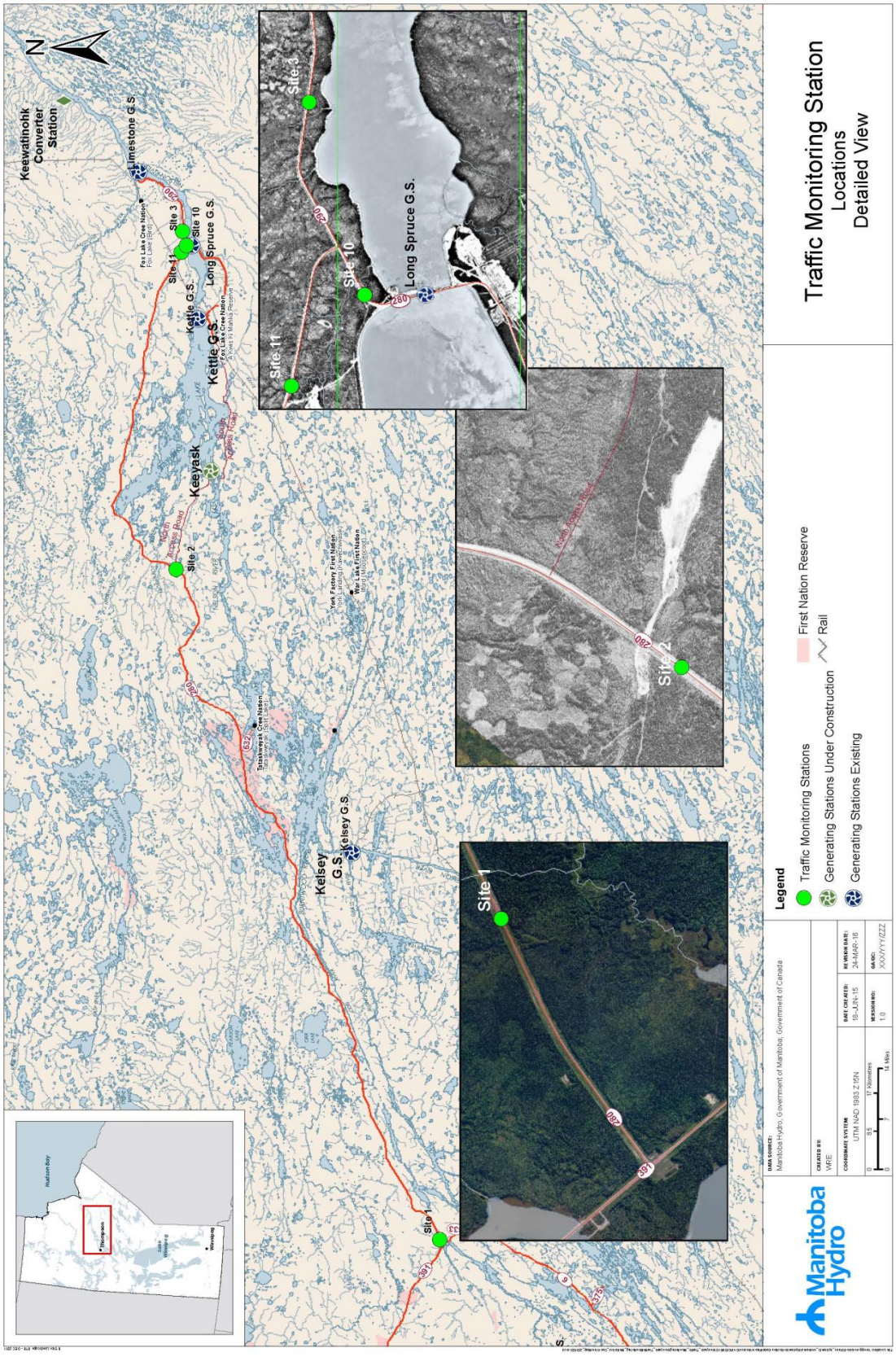
Average Vehicle Speed

Station	Posted Speed	Avg Speed (April to June 2020)			Avg Speed (July to Sept 2020)			Avg Speed (Oct to Dec 2020)			Avg Speed (Jan to Mar 2021)		
		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Site 1 – PR280 between PR391 and Split Lake	90 - NB	82	81	75	83	77	75	84	80	78	88	83	77
	90 - SB	88	81	78	89	80	76	88	82	81	93	90	87
Site 2 – PR280 between Split Lake and Keeyask	90 - NB	94	97	83	90	98	84	93	92	80	92	94	81
	90 - SB	80	73	68	76	74	71	77	68	66	82	74	69
Site 3 – PR290 east of PR280/290 intersection	90 - WB	95	85	83	91	92	88	88	82	78	90	87	79
	90 - EB	92	88	75	84	103	91	102	103	107	103	107	105
Site 11 – PR280 north of the PR280/290 intersection	90 - NB	95	90	83	100	88	89	92	83	82	91	91	81
	90 - SB	93	87	83	100	89	91	93	81	84	96	90	84

Summary

- Average Vehicle Speed data results in the small vehicle category averaging the highest speeds.
- Average speed is higher in winter months which can be attributed to frozen road conditions that tend to be smoother and free of dust.
- Speeding has varied throughout the years with a decrease in spring and fall due an increased likelihood of poor road conditions related to weather, road reconstruction, or even to driver awareness initiatives being implemented by MH and MI.
- Monitoring locations give data related to that specific location only.
    - Site 1 station shows higher speeding rates for SB traffic compared to NB traffic due to the monitoring station being in close proximity to the PR 391 intersection.
    - Site 10 located at curve on north side of Long Spruce Generating Station. Vehicles are slowing down to navigate the curve or have just come out of the curve and are still speeding up; therefore speed data for Site 10 was not included in this analysis.
- Speeding information by vehicle type by Station is given in **Appendix E.**

Appendix A – Traffic Monitoring Locations and List of Failures



Monitoring Station Failures:

- Station 1: November 2015 approximately two weeks.
    - Average daily traffic was extrapolated based on the partial month's data collection.
- Station 1: June 2016 approximately three days.
    - Results have been based on a 27 day period rather than 30 days.
- Station 1: July 2016 approximately three weeks.
    - Results are skewed.
- Station 1: July 31, 2017.
    - Loss of data.
- Station 2: September 2017approximately 2 weeks.
    - Loss of data.
- Station 11: September 2017 approximately 1 week.
    - Loss of data.
- Station 11: June and July 2018 for Station 11.
    - Loss of data due to a recording device error.
- Station 2: March 12 2019 approximately 2 weeks.
    - Loss of data due to recording device error.
- Station 1: March 2020
    - Loss of data due to recording device error.
- Station 1: December 2020 – January 2021
    - Loss of data from December 19- January 31 due to recording device error.

Appendix B - Vehicle Classifications

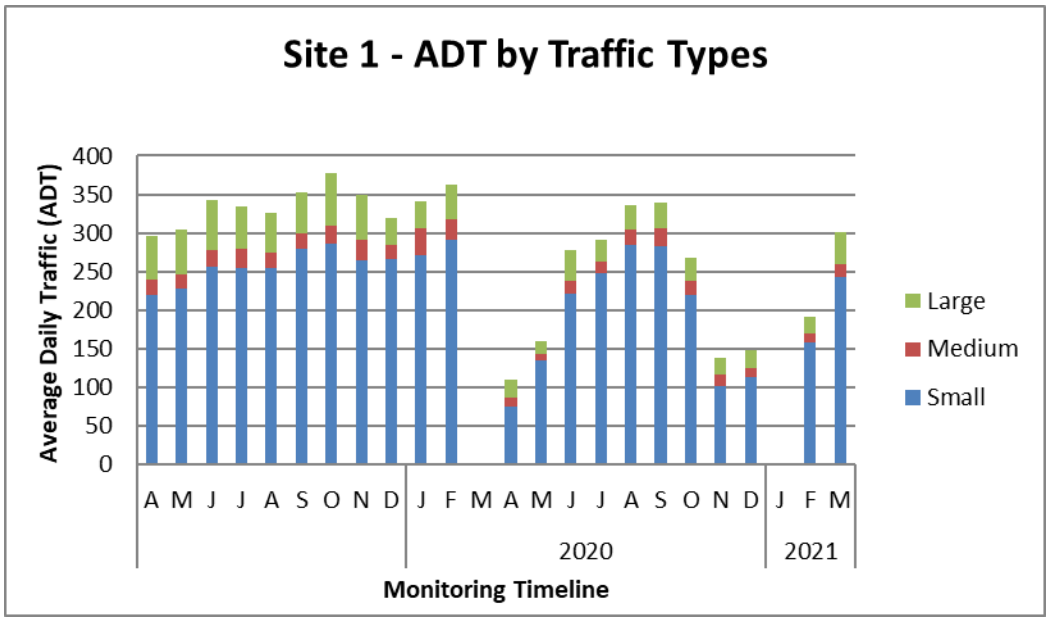
The induction loops that are buried within the roadway are spaced at a given interval. The time it takes for the front axle and rear axle to cross the loops gives an indication of the speed of the vehicle within an accuracy range of +/- 5 km/h. This information is reflective of vehicle speed tendencies at the traffic monitoring station location. The specific location of the traffic monitoring station may impact the speed tendencies dependent upon road geometry in each direction.

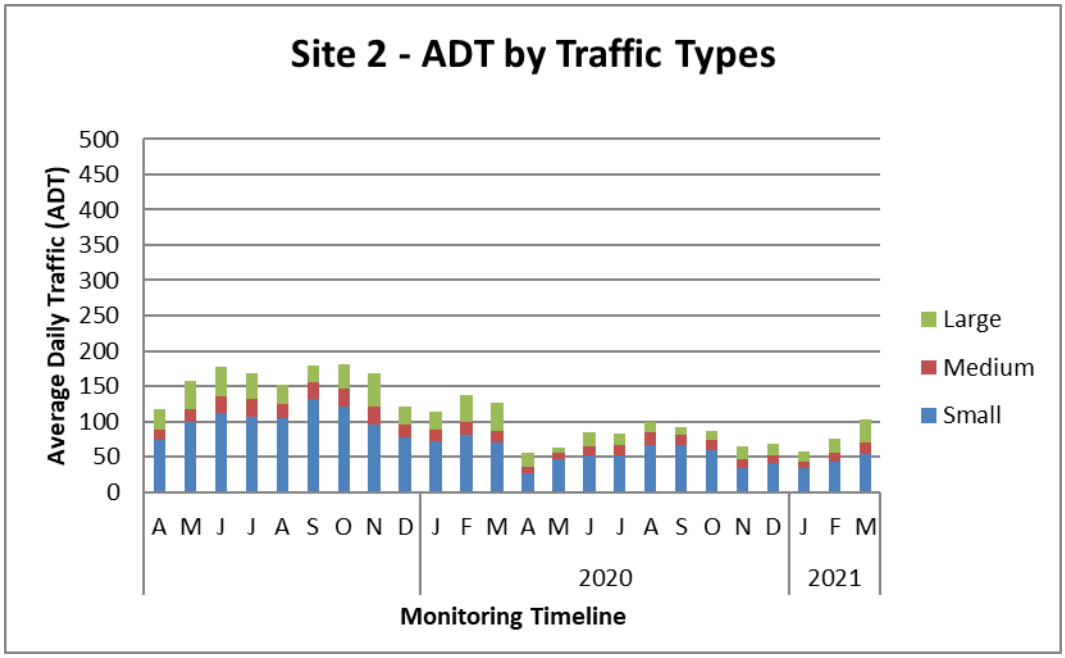
Vehicle Category	Vehicle Description
Small	
Medium	
Large	

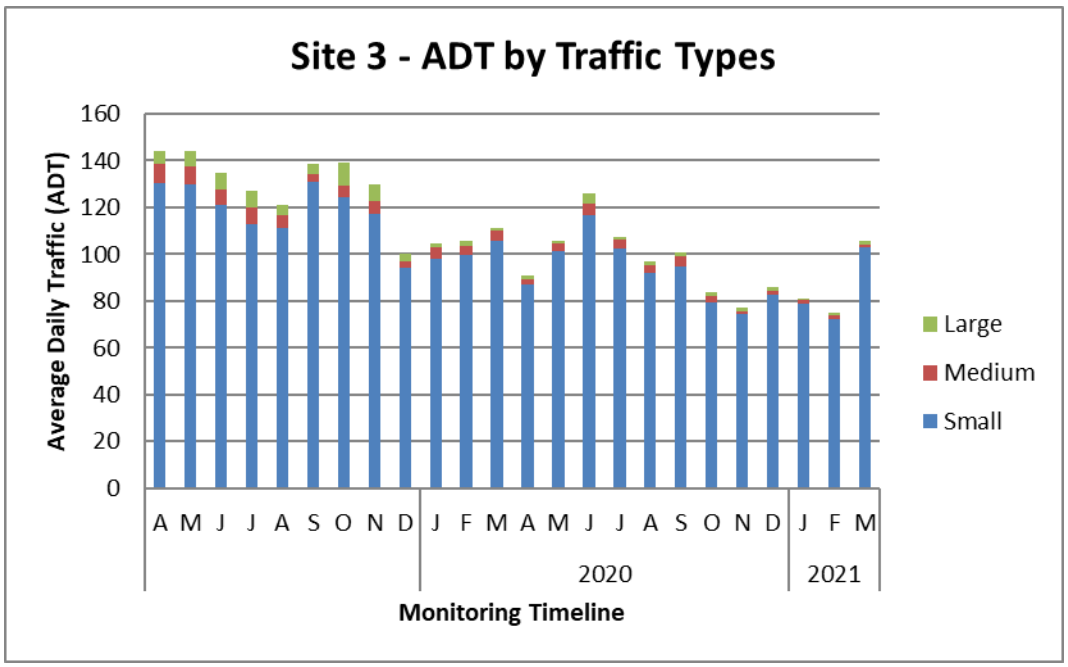
Bin 1	Class 1	Small	Cars, truck and vans
Bin 2	Class 2, 3, 4	Medium	Buses, single dual & tandem dual trucks, dual steering with tandem drive
Bin 3	Class 5 and 6	Large	Trucks 5 axles and up

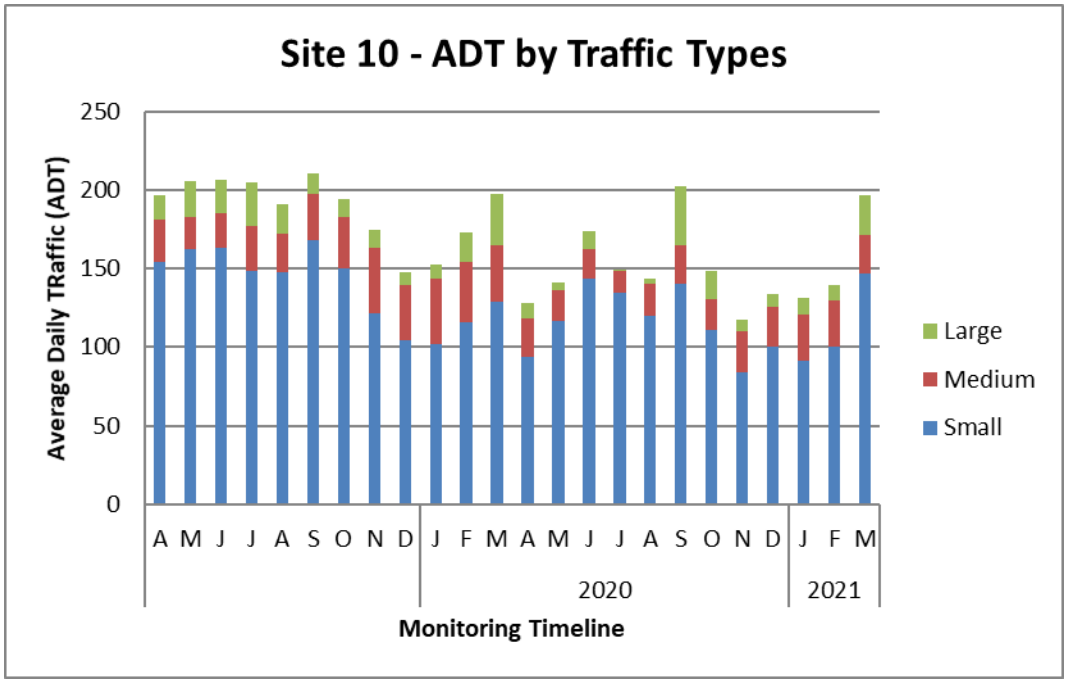
- Small vehicles are categorized as all passenger cars, trucks and vans.
- Medium vehicles are categorized as all buses and dual or tandem axle trucks.
- Large vehicles are categorized as all vehicles with five axles and more.

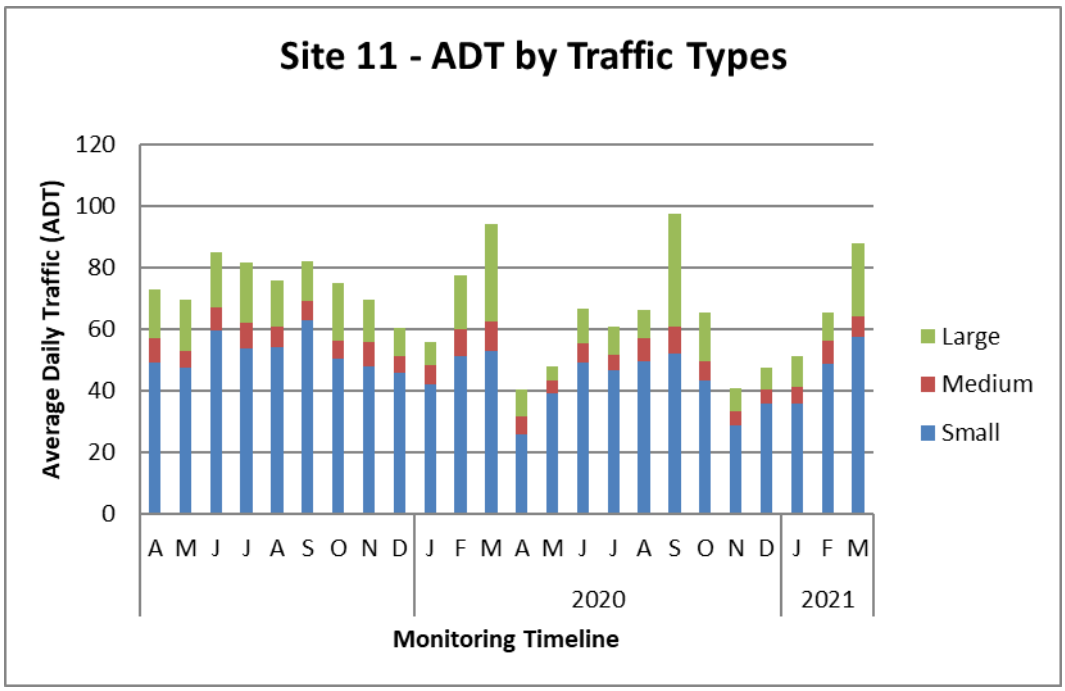
Appendix C – Monthly Traffic Counts



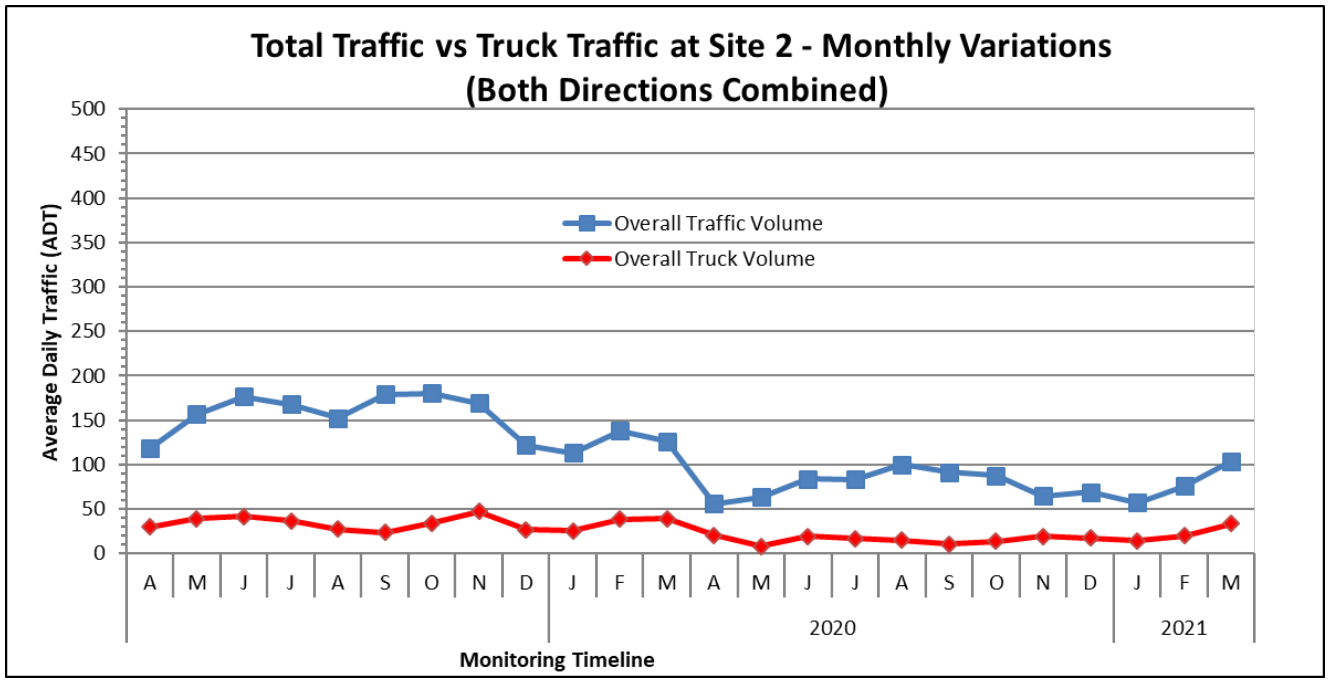


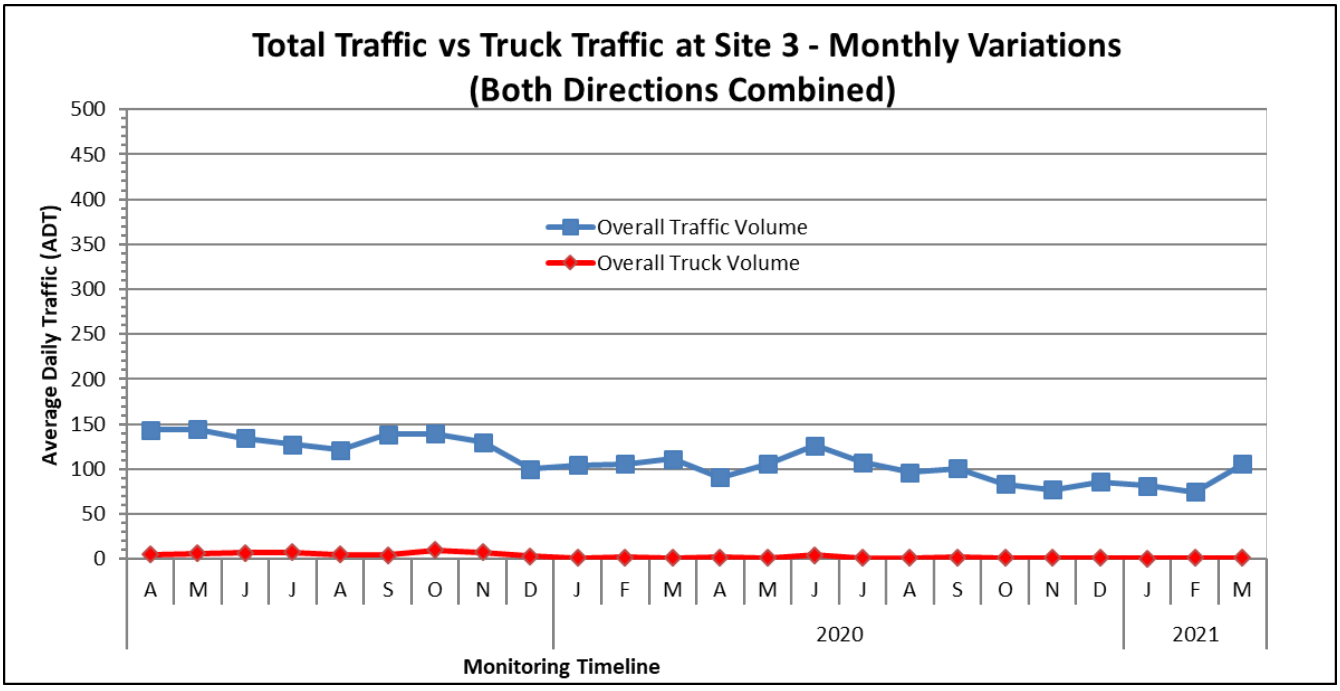


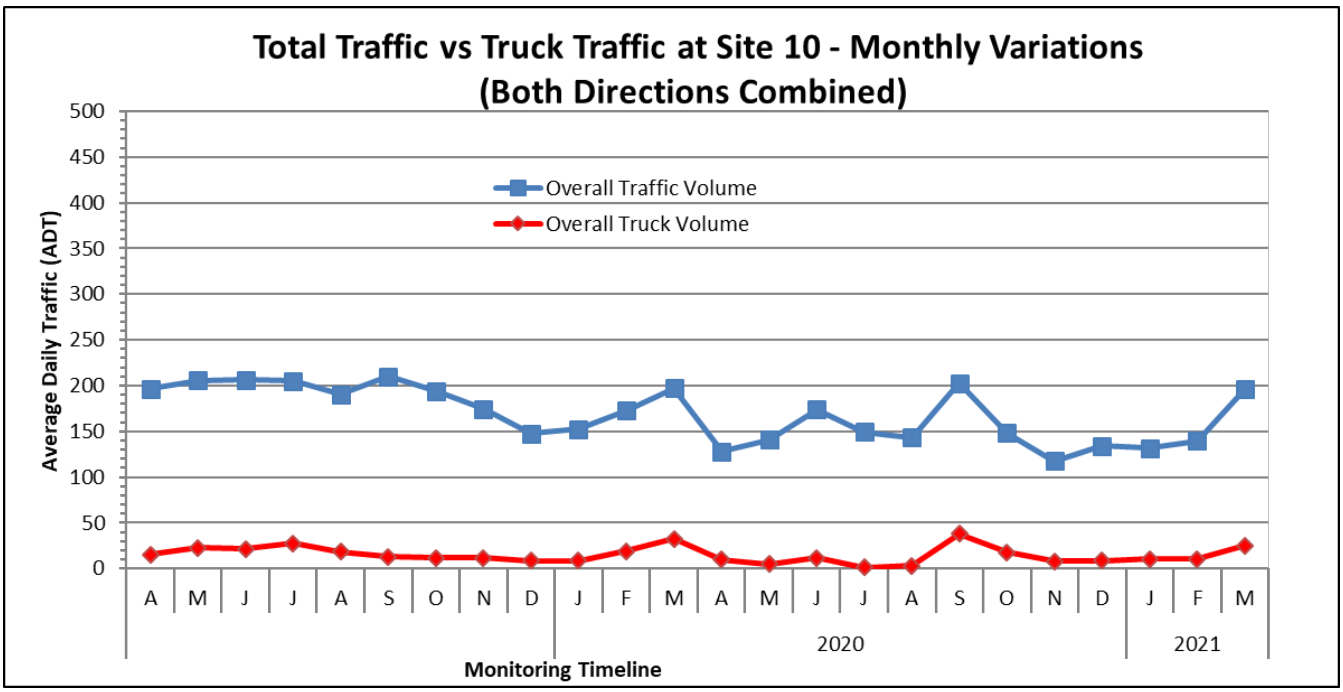


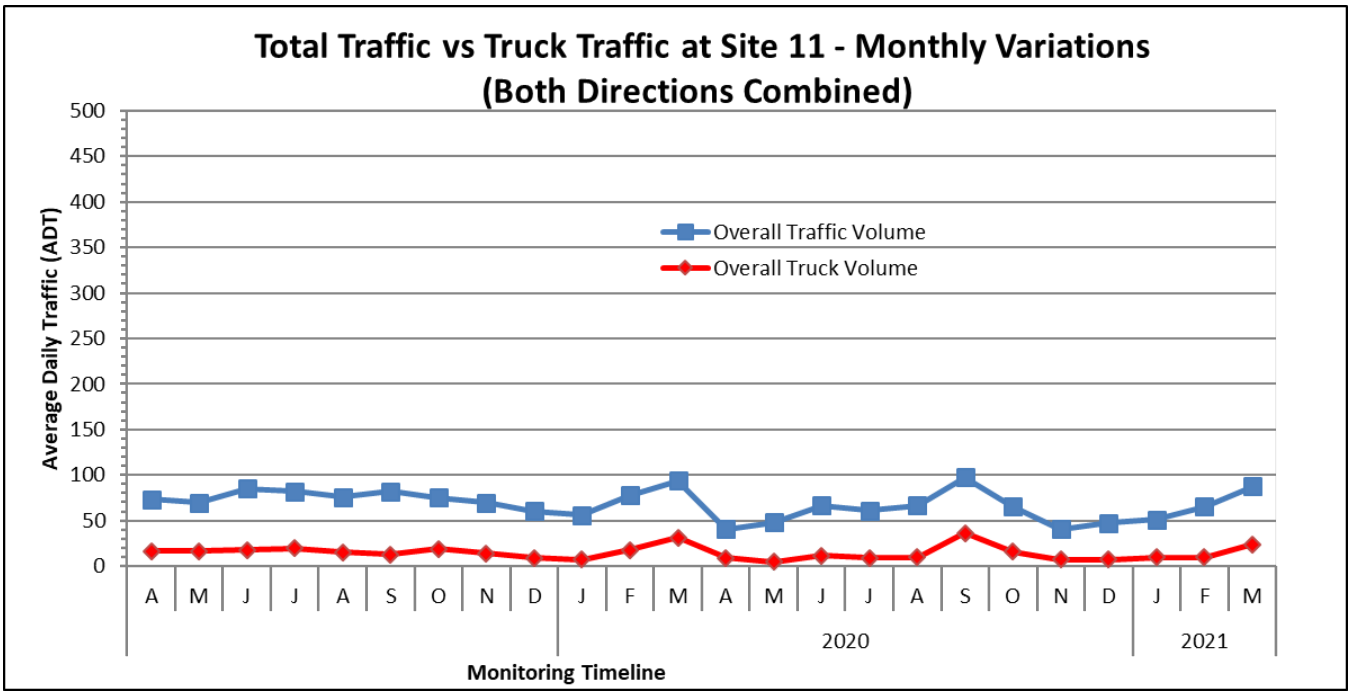


Appendix D – Truck Traffic vs Total Traffic

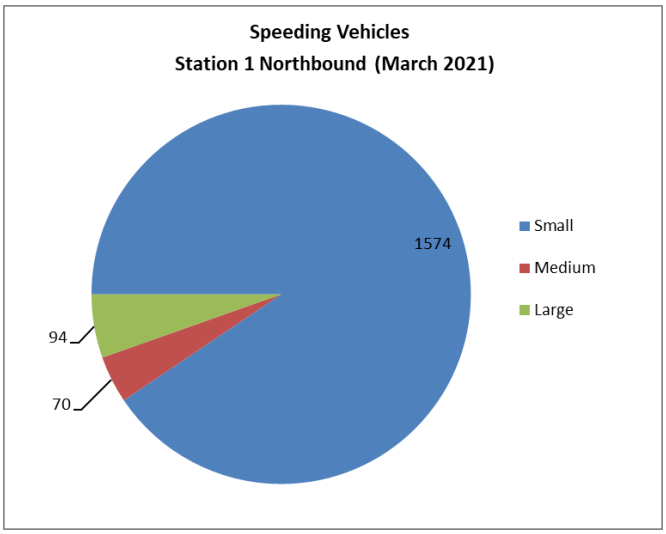






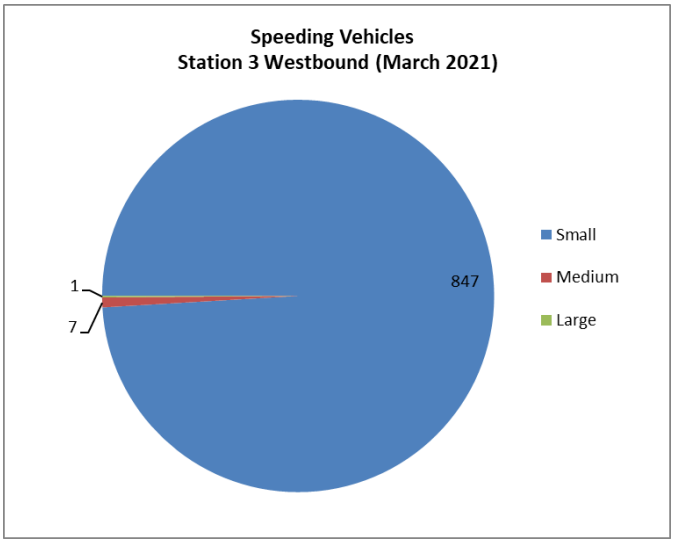


Appendix E – Speed Data by Vehicle Type



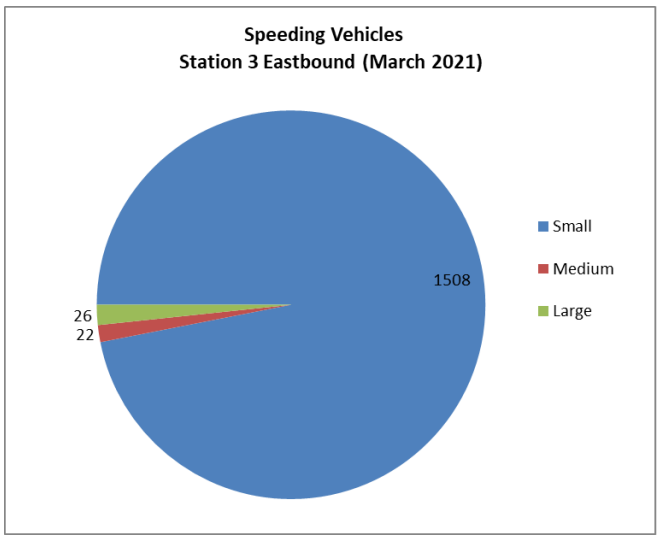
Speed Data				
Northbound - Station 1 March 2021				
	Vehicle Length (cm)			
	Bin #1	Bin #2	Bin #3	
	0-702	703-1202	1203-3500	Total
<= 90 kph	2063	153	524	2740
	56.7%	68.6%	84.8%	61.2%
> 90 kph	1574	70	94	1738
	43.3%	31.4%	15.2%	38.8%
> 100 kph	578	21	13	612
	15.9%	9.4%	2.1%	13.7%
> 110 kph	173	6	1	180
	4.8%	2.7%	0.2%	4.0%
Total	3637	223	618	4478

Station 1 – PR 280 between PR 391 and Split Lake (Southbound)



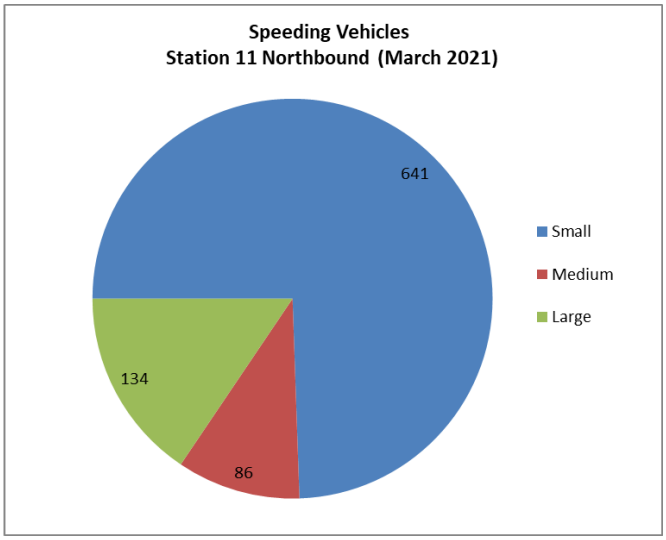
Speed Data				
Westbound - Station 3 March 2021				
	Vehicle Length (cm)			
	Small	Medium	Large	
	0-702	703-1202	1203-3500	Total
<= 90 kph	681	12	19	712
	44.6%	63.2%	95.0%	45.4%
> 90 kph	847	7	1	855
	55.4%	36.8%	5.0%	54.6%
> 100 kph	353	2	0	355
	23.1%	10.5%	0.0%	22.7%
> 110 kph	125	0	0	125
	8.2%	0.0%	0.0%	8.0%
Total	1528	19	20	1567

Station 3 – PR 290 East of PR 280 and PR290 Intersection (Westbound)



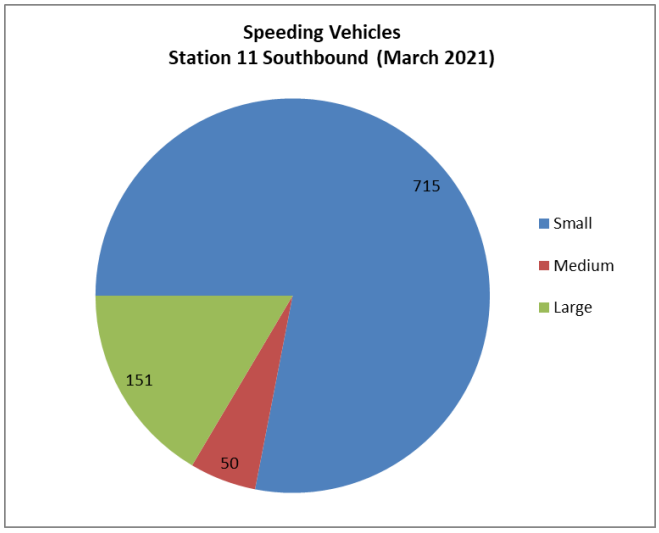
Speed Data Eastbound - Station 3 March 2021				
	Vehicle Length (cm)			
	Small	Medium	Large	
	0-702	703-1202	1203-3500	Total
<= 90 kph	150	6	4	160
	9.0%	21.4%	13.3%	9.3%
> 90 kph	1508	22	26	1556
	91.0%	78.6%	86.7%	90.7%
> 100 kph	1092	19	20	1131
	65.9%	67.9%	66.7%	65.9%
> 110 kph	523	10	11	544
	31.5%	35.7%	36.7%	31.7%
Total	1658	28	30	1716

Station 3 – PR 290 East of PR 280 and PR290 Intersection (Eastbound)



Speed Data Northbound - Station 11 March 2021				
	Vehicle Length (cm)			
	Small	Medium	Large	
	0-702	703-1202	1203-3500	Total
<= 90 kph	254	33	227	514
	28.4%	27.7%	62.9%	37.4%
> 90 kph	641	86	134	861
	71.6%	72.3%	37.1%	62.6%
> 100 kph	420	52	29	501
	46.9%	43.7%	8.0%	36.4%
> 110 kph	203	13	4	220
	22.7%	10.9%	1.1%	16.0%
Total	895	119	361	1375

Station 11 – PR 280 between East of Keeyask Gate and PR 290 (Northbound)



Speed Data Southbound - Station 11 March 2021				
	Vehicle Length (cm)			
	Small	Medium	Large	
	0-702	703-1202	1203-3500	Total
<= 90 kph	169	41	219	429
	19.1%	45.1%	59.2%	31.9%
> 90 kph	715	50	151	916
	80.9%	54.9%	40.8%	68.1%
> 100 kph	503	35	67	605
	56.9%	38.5%	18.1%	45.0%
> 110 kph	239	7	11	257
	27.0%	7.7%	3.0%	19.1%
Total	884	91	370	1345

Station 11 – PR 280 between East of Keeyask Gate and PR 290 (Southbound)

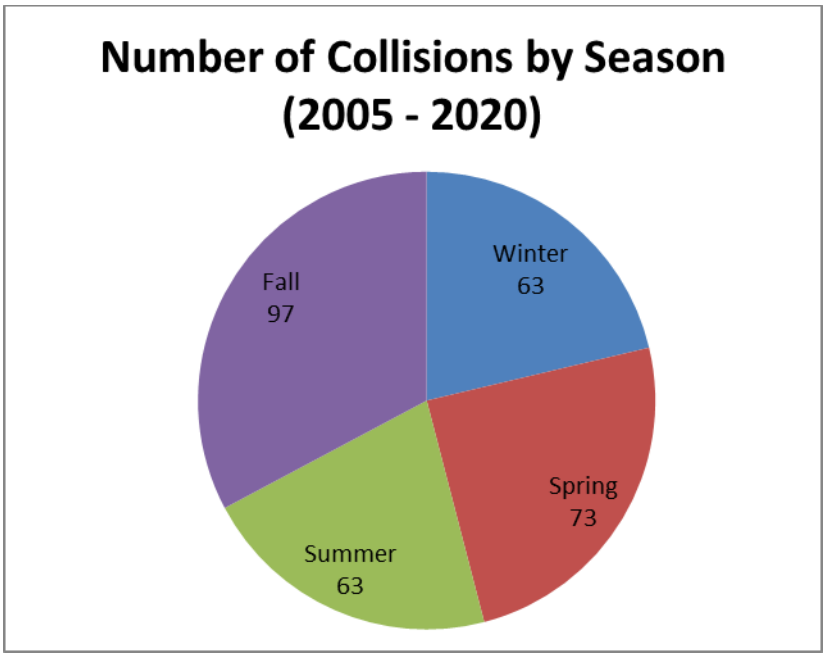
Appendix F – Annual Collision Summary

Reported collision data has been tracked by MPI up to the end of 2020. MPI is only able to log collisions that are reported and the details are limited to what is provided. In addition, the local RCMP detachment provides information on reported collisions.

Collision data is provided by MPI annually in January for PR 280. Collision data for PR 290 is very low and ranges from 0 collisions to a high of 2 collisions per year. For this reason, this data is not included in the following tables and graphs.

A collision is defined as any reported incident involving a personal injury or property damage to a vehicle. Property damage can be attributed to collisions with wildlife, running off the road into a fixed object, head on or side swipe collisions with other vehicles, overturned vehicles, and damage to vehicles as a result of hitting potholes/ruts. It does not include cracked or broken windshields from rocks kicked up by passing vehicles as this would not constitute a reportable collision.

PR 280 Number of Collisions by Season (2005-2020)



Summary

- There were a total of 296 collisions on PR 280 between 2005 and 2020.
- Average of 20 collisions per year.
- 25% of collisions occurred during the spring - March, April and May.
- 33% of collisions occurred during the fall - September, October and November.
- Single vehicle collisions accounted for approximately 93% percent of all collisions during the analysis period.

PR 280 Collision Severity and Contributing Factors

Year	Severity			Contributing Factor		
	Property Damage	Non-Fatal Injury	Fatality	Wildlife	Ran-off Road	Other/Unknown
2005	12	4	0	2	8	6
2006	11	6	0	3	13	1
2007	9	3	1	0	4	9
2008	6	2	0	1	4	3
2009	10	4	1	0	9	6
2010	8	1	0	1	3	5
2011	2	2	0	0	1	3
2012	2	0	0	0	1	1
2013	3	0	1	0	1	3
2014	26	4	0	6	3	21
2015	23	1	0	6	6	12
2016	34	3	0	7	8	22
2017	46	0	0	15	9	22
2018	28	1	0	8	6	14
2019	29	1	0	7	6	16
2020	13	3	0	5	1	7
Total	**262**	**35**	**3**	**61**	**83**	**151**

**Data available annually.*

Summary

- Approximately 89% of collisions along PR 280 were property damage.
- Running off the road was the contributing factor in 28% of collisions.
- Other factors, including collisions with other vehicles and overturning in the roadway accounted for approximately 51% of all reported collisions.
    - Typical causes are considered to be: loss of control, fatigue, speeding along curved sections or attempting to avoid another vehicle or wildlife.

PR 280 Collision Rate

Year	Collision Rate (incidents per MVKT)
2005	0.98
2007	0.79
2009	0.82
2011	0.19
2013	0.14
2015	0.66
2016	0.97
2017	1.14
2018	0.71
2019	0.80
Average	**0.72**
MI Threshold	**1.5**

**2016 collision rate revised to correct previous reporting error.*

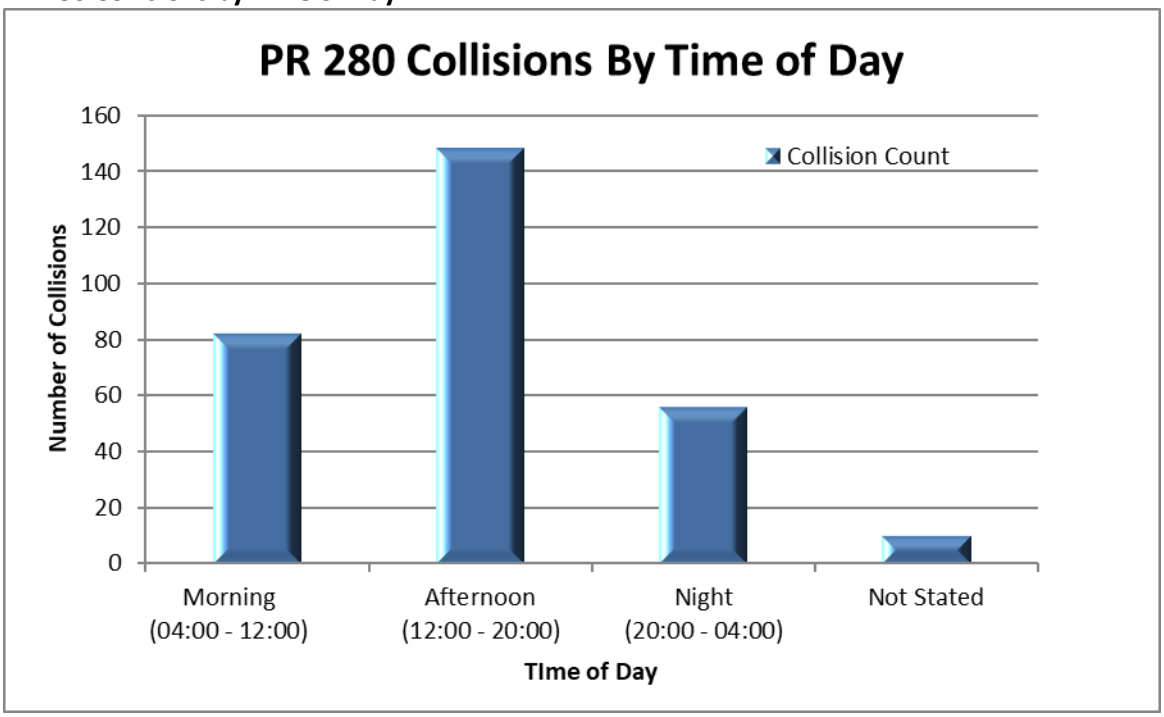
Calculation Notes:

- Collision rate (CR) is based on the number of collisions that occurred and the volume of traffic on a section of roadway during a specified period.
- CR is measured as the number of collisions per million vehicle-kilometres of travel (MVKT) on a section of roadway during the analysis period.
- Traffic volumes used in calculating the collision rate are the average of the annual average daily traffic (AADT) volume recorded each year over the eleven year period.
- Many agencies consider road sections with collision rates exceeding 1.5 incidents per MVKT as warranting further review.
- AADT counts used to calculate collision rate are based on a collection period of two weeks. Counts are extrapolated from two week count.

Summary:

- Based on the AADT and the number of collisions for 2005, 2007, 2009, 2011, 2013, 2015, 2016, 2017, 2018 and 2019 PR 280 has an average collision rate of approximately 0.72 incidents per MVKT over the study period.
- The collision rate of 0.72 remains below the industry standard threshold of 1.50 incidents per MVKT.
- The annual collision rate increased slightly from .71 in 2018 to .80 in 2019 due to one additional collision and lower traffic volumes year over year.
- 2020 data will be received in June 2021.

PR 280 Collisions by Time of Day



January 1, 2005 – December 31, 2020
Data available annually.

Summary:

- Approximately 50% of collisions occur in the afternoon.
- Approximately 28% of collisions occur in the morning.
- Daytime collisions are predominant.

