Health Effects Monitoring Program in Ndilo, Dettah and Yellowknife

Progress Report: Results from the Phase I Baseline Study (2017-2018)

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Executive Summary

The Giant Mine is an inactive gold mine located 4 km north of the city of Yellowknife where it was in operation from 1948 to 2004. The mine is considered as one of the most contaminated sites in Canada. To address concerns of contamination of arsenic and other metals from the site, a Giant Mine Remediation Project was established. In 2014, the Mackenzie Valley Environmental Impact Review Board completed its assessment of the Remediation Project. One of the issues identified was a public concern around the impact on the local populations' health from the Giant Mine clean-up activities. Thus, one of the requirements as stated by the Review Board was to design and implement a broad health effects monitoring program in Ndilo, Dettah and Yellowknife.

The purpose of the Health Effects Monitoring Program (YKHEMP) is to establish a baseline of contaminant exposure and possible health effects in Ndilo, Dettah, and Yellowknife to ensure the Giant Mine Remediation Project does not negatively impact the health of the community during its remediation activities. YKHEMP will focus on arsenic and other contaminants such as cadmium and lead, which might result from the remediation project. This report presents the descriptive results of Phase I or the baseline study that summarized the measured arsenic concentrations in the urine and toenail, and lead and cadmium in the urine samples collected from the participants in 2017-2018.

The principal investigator of this study is Dr. Laurie Chan, a professor and Canada Research Chair in Toxicology and Environmental Health from the University of Ottawa. In order to engage with a number of affected stakeholders, a Health Effects Monitoring Program Advisory Committee (HEMPAC) was created as a mechanism for member groups to contribute to the development and implementation of the Monitoring Program by utilizing their health expertise, and knowledge of regional and community level issues. HEMPAC meets once a month, and its membership consists of the following representatives: Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), GNWT Dept. of Environmental and Natural Resources, GNWT Dept. of Health and Social Services, Health Canada, City of Yellowknife, Yellowknives Dene First Nation (YKDFN), North Slave Métis Alliance (NSMA), Giant Mine Oversight Board (GMOB), and the University of Ottawa.

A total of 2037 individuals, ages 3 to 79 and Elders, residing in Dettah, Ndilo, and Yellowknife in the last 12 months participated in this baseline study. Recruitment and data collection of the baseline cohort was conducted in two waves: in the fall (September-December 2017) and spring (April-June 2018). This was done to account for the potential seasonal effect on exposure. In total, there were 890 (673 adults, 217 children), randomly selected participants with a participation rate of 64%. In addition, the YKHEMP also recruited a total of 876 (685 adults, 191 children) volunteer participants from the Yellowknife general population, excluding members of the YKDFN and NSMA. All members of the YKDFN and the members of NSMA were invited to participate. A total of 225 (138 adults, 87 children) YKDFN and 46 (35 adults, 11 children) NSMA members participated in the YKHEMP.

Research assistants were hired to conduct interviews at the homes of the randomly selected participants, the volunteers, and the members of NSMA. YKDFN members were invited to meet with a registered nurse to complete the interview. Each participant answered a lifestyle questionnaire as well as provided toenails and urine for contaminant testing, and saliva samples for testing of genetic polymorphisms associated with arsenic metabolism. They also provided consent to have their medical records reviewed by the research team for the past 5 years.

Six elements including arsenic, antimony, cadmium, lead, manganese and vanadium were selected as the chemicals of potential concern (COPC) based on the screening exercise conducted in the concurrent Human Health and Ecological Risk Assessment conducted for the Giant Mine. Since arsenic is the major contaminant at the Giant Mine site, this study primarily investigates the body burden of arsenic and its potential associations with possible health effects. The program also measured concentrations of cadmium and lead in the collected urine samples. Results were compared to the 95^{th} percentiles of the population data based on the Canadian Health Measures Survey (CHMS, 2013) as reference values. Combined data on urine arsenic, cadmium, and lead collected in CHMS cycle 1 (2007-2009) and 2 (2009-2011) and the combined data for urine inorganic arsenic collected from CHMS cycle 2 (2009-2011), 3 (2012-2013), and 4 (2014-2015) were used. Individual results were reported back to all the participants by mail. Concentrations of antimony, manganese, and vanadium were measured in urine samples, and the results will be stored in the database and serve as baseline levels for future reference.

This progress report presents the descriptive statistics of the concentrations of COPCs measured in urine and toenail samples of participants from both waves of sample collection. The key question addressed was whether the residents of Ndilo, Dettah, and Yellowknife have elevated exposure to arsenic in relation to the general Canadian population. Another progress report will be published in the spring of 2020 that will present the key findings of all the results based on the samples and information collected for the baseline study. All results for comparisons between different groups are reported to be different only when $p < 0.05$.

A total of 1966 participants in the study provided urine samples for chemical analysis. The total arsenic concentrations ranged from 0.18 μg/L to 960 μg/L, and the total inorganic arsenic concentration ranged from 0.1 μg/L to 152 μg/L. There was no difference between the urine total arsenic concentrations between adults and children in all four sampling groups. However, for the inorganic arsenic, children participants from the Yellowknife randomized sample group, the volunteer group and the YKDFN had higher urine concentrations than those measured in the adults within the group.

Comparing the arsenic concentrations between the four groups of participants, the adult YKDFN participants had lower urine total arsenic concentrations, and the adult volunteer groups had higher inorganic arsenic concentrations compared to the other groups. Among children participants, only the urine total arsenic concentrations of the NSMA participants were lower than the other population groups.

Results of the 870 randomly selected participants in this study represent the urine metal profile of a total of 17,949 people, or the total population of Yellowknife. Their results were compared to the results of the Canadian Health Measures Survey that represents the Canadian population of 30,412,291 people.

The geometric mean of total arsenic in urine for the total population in Yellowknife was 8.0 μg/L and is lower than the 10.1 μg/L reported for the CHMS (Cycle 1 and 2). Results for the participants of YKHEMP ages between 12 to 19, 20 to 39, 40 to 59, and 60 to 79 were all lower than the CHMS participants of the same age group.

A different trend was observed in the urine inorganic arsenic concentrations. There was no difference between the geometric mean of the two total populations (5.6 μg/L for YKHEMP vs 5.4 μg/L for CHMS). However, the children from Yellowknife (GM=6.6 ug/L), particularly in the age group between 6 and 11 years old (GM=7.3 μg/L) had higher concentrations than the general Canadian population of the same age group (5.4 μg/L).

For the other sampling groups, the total arsenic in the children of YKDFN (6.7 μg/L) and NSMA groups (4.1 μg/L) was lower than the children of CHMS (8.2 μg/L). However, the inorganic urine arsenic concentrations in children of the Yellowknife volunteer (7.2 μg/L) and YKDFN groups (6.4 μg/L) were also higher than the CHMS children (5.4 μg/L).

Among adults, the urine total arsenic concentrations in all groups of YKHEMP participants (ranged from 5.4 μg/L for YKDFN to 8.1 μg/L for YK random and volunteers) were lower than the CHMS adult participants (10.7 μg/L). Total inorganic arsenic of adult YKDFN (4.5 μg/L) and NSMA participants (4.2 μg/L) were lower than the CHMS participants (5.4 μg/L).

There was no difference between the urine total arsenic concentrations between adults and children in all four sampling groups. However, for the inorganic arsenic, children participants from the Yellowknife randomized sample group, the volunteer group and the YKDFN had higher concentrations than those measured in the adults within the group.

Cadmium was detected in 1917 urine samples; 49 of the urine samples were below the detection limit. The urine cadmium concentrations ranged from below 0.007 μg/L to 3.71 μg/L. Children of all the four studied groups had lower cadmium concentrations compared to the adults. The geometric mean was 0.16 μg/L for the total population in Yellowknife that was lower than the 0.37 μg/L reported for the CHMS. In fact, participants of YKHEMP including all four sampling groups and all age groups had lower urine cadmium concentrations than the participants of CHMS participants of the same age group. There was no difference between urine cadmium concentrations among the four sampling groups.

The urine lead concentrations ranged from 0.004 μg/L to 11.36 μg/L. Children of the randomly sampled group, the volunteers, and the YKDFN had lower lead concentrations compared to the

adults. The same trend was observed among NSMA members, but the statistical test result was not significant and is likely due to their relatively small sample size.

There was no difference between the geometric mean of urine lead concentrations (0.54 μg/L) for the total population in Yellowknife and the geometric mean concentration (0.51 μg/L) reported for the CHMS. However, there were some specific differences in certain gender and age groups. The Yellowknife participants who were 20 to 39 years old had higher urine lead (0.51 μg/L) concentrations than the same group in CHMS (0.44 μg/L). Yellowknife female participants had higher urine lead concentrations (0.52 μg/L) compared to the CHMS (0.46 μg/L), which were mainly attributed to adult female participants (20-79 years old). No difference was observed between Yellowknife male participants and the CHMS. The YKDFN adult participants also had higher urine lead concentrations (0.66 μg/L) than the CHMS adult participants (0.54 μg/L).

The HEMPAC decided to use the 95th percentile of inorganic arsenic, lead and cadmium concentrations of the CHMS population (combined data on urine arsenic, cadmium, and lead collected in CHMS cycle 1 (2007-2009) and 2 (2009-2011), and the combined data for urine inorganic arsenic collected from CHMS cycle 2 (2009-2011), 3 (2012-2013), and 4 (2014-2015) as the reference levels. They are 21 μg/L for inorganic arsenic, 1.9 μg/L for adults and 1.3 μg/L for children for lead, and 1.3 μg/L for adults and 0.68 μg/L for children for cadmium. There was a total of 225 participants whose urine sample had at least one of the metals exceeding existing reference levels. An exceedance indicates the participant had levels higher than 95 percent of the general population in Canada; however, this does not necessarily indicate that there are health implications for that individual. The YKHEMP team then followed up with those participants to re-test the urine samples to confirm the higher exposure to investigate the possible sources and provide advice on ways to lower their exposure.

A total of 1872 participants provided enough toenail sample for arsenic analysis. Arsenic was detected in all the collected toenail samples. The toenail arsenic concentrations ranged from below 0.01 mg/Kg to 7.34 mg/Kg. Children between 3-5 and 6-11 on average had higher toenail arsenic concentrations than the youth (12-19). Additionally, all the child and youth age groups on average were higher than the adults (20-79).

For both children and adults, the volunteer group had the highest toenail arsenic concentrations among the different participating groups, and there was no difference between the other population groups.

As CHMS did not measure arsenic in the toenail, there is no comparable data for reference levels as in the case for metals in urine samples. Therefore, the HEMPAC reviewed the results and made comparisons to the results reported in the literature. The levels found in this study are comparable to the results obtained from similar studies conducted in areas adjacent to former mine sites. For reporting results to the participants, the HEMPAC decided to use the 80th percentile for children (1.35 mg/Kg) and 95th percentile (0.54 mg/Kg) for adults as screening levels to identify participants who had elevated level of exposure for follow up. There were 86 children and 72 adults who had toenail arsenic higher than the screening levels. These individuals have been invited to see a nurse practitioner for a follow-up.

The toenail arsenic results showed that the Wave 2 participants had higher arsenic levels than those from Wave 1 suggesting that there might be higher arsenic exposure in spring than in the fall. The possible seasonal effect can be confirmed by the planned laser-ablation ICP-MS study on the exceedance participants scheduled to take place in summer 2019.

Each participant has been provided with their individual test results, including appropriate medical advice. Participants whose results exceeded the reference levels in urine or screening levels in toenail were invited to contact the research team and arranged to have a meeting with a nurse practitioner. Participants were provided counselling on the health implications of their results and advice on ways to lower their exposure. Results of the participants were put into their medical files. Urine samples, in the case of arsenic or cadmium exceedance or blood samples, in the case of lead exceedance were collected for re-testing to confirm exposure.

This report presents the descriptive results of the baseline study for the biomonitoring program. It is important to note that arsenic occurs naturally in the Yellowknife area because of the local geological formations. The YKHEMP study currently cannot distinguish arsenic exposures from natural sources, Giant or Con mine, or dietary sources. The next progress report is expected to be published in May 2020. It will present results on the relationships between the diet and lifestyle

variables, the genetic information, the concentrations of metals in urine and the speciated arsenic concentrations in the toenail, and results of the medical history and medical file analysis. As YKHEMP is designed as a prospective cohort study, the children participants will be invited to participate in the next round of study in 2022 and both adult and children participants in 2027. In the meantime, the research team and the HEMPAC will continue to communicate the results to the residents of Yellowknife and implement the follow-up plan to promote healthy living and a healthy community.

Key Findings

- The overall Yellowknife population had significantly lower urine total arsenic than the general Canadian population.

- There is no difference in urine inorganic arsenic concentrations between the overall Yellowknife population and the general Canadian population. However, the levels of inorganic arsenic in children aged 6 to 11 years old, are higher than that of the general Canadian population of the same age.

- There was no difference in total urine arsenic concentrations between adults and children in all four sampling groups.

- Urine inorganic arsenic and toenail arsenic levels were generally higher in children and decreased with age.

- The adult YKDFN participants had lower urine total arsenic concentrations, and the adult volunteer groups had higher inorganic concentrations compared to the other groups. Among children participants, only the urine total arsenic concentrations of the NSMA participants were lower than the other groups.

- Toenail arsenic concentrations were higher in Wave 2 participants than in Wave 1, which suggests that there may be higher arsenic exposure in the spring than in the fall.

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- Jane Amphlett, Crown-Indigenous Relations and Northern Affairs Canada – Co-Proponent
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Past HEMPAC members:

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- Tony Whitford- NSMA
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- Dennis Kefalas- City of Yellowknife
- Susan Chatwood- Institute for Circumpolar Health Research
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1. Introduction

Giant Mine is an inactive gold mine located within the boundary of the City of Yellowknife, where it operated from 1948 to 2004. The site reverted to the Crown when owner Royal Oaks Mine went into receivership in 1999. Gold was extracted from arsenopyrite ores through a roasting process that generated a toxic by-product called arsenic trioxide. Despite the mine's closure, there is currently 237,000 tonnes of arsenic trioxide dust stored in 15 underground chambers, along with 4 large tailings ponds. Waste water is treated onsite to ensure it is within approved limits prior to discharge into Baker Creek and eventually to Yellowknife Bay. For its first 10 years of operation from 1948 to 1958, an estimated 20,000 tonnes of arsenic trioxide dust was released every year without any filtration. Following reports of arsenic poisoning in the 1950s, a baghouse filtration system was installed in 1958 to filter and store the arsenic trioxide in underground chambers (Sandlos and Keeling, 2012).

At present, the mine is considered one of the most contaminated sites in Canada (Spring Report of the Commissioner of the Environment and Sustainable Development, 2012). Although Giant Mine is no longer in operation, there are concerns of contamination of a list of chemicals of potential concern (COPCs) including arsenic, antimony, cadmium, lead, manganese, and vanadium from the site via surface runoff and groundwater migration (Stantec, 2015).

To address concerns about arsenic and other chemicals of potential concern, the Giant Mine Remediation Project was established and approved by the Mackenzie Valley Environmental Impact Review Board. The Giant Mine Remediation Project's primary goal is to protect human health and safety and the environment. To do so, the project is focused on the long-term containment and management of the stored underground arsenic trioxide waste, demolition and removal of on-site buildings, water management and treatment, and the remediation of all surface areas including the tailings ponds at the Giant Mine site. As required by the review board, the Project is subject to 26 measures aimed at preventing significant adverse impacts on the environment and mitigating the public concern.

- Measure #9 Stated:

The Developer will work with other federal and territorial departments as necessary to design and implement a broad health effects monitoring program in Ndilo, Dettah and Yellowknife focusing on arsenic and any other contaminants in people which might result from this Project. This will include studies of baseline health effects of these contaminants and ongoing periodic monitoring. This will be designed with input from: Health Canada, GNWT Health and Social Services and the Yellowknife medical community; and The Yellowknives Dene and other potentially affected communities. The organization conducting the monitoring will provide regular plain language explanations of the monitoring results in terms that are understandable to lay people, and communicate this to potentially affected communities in a culturally appropriate manner.

Erika Nyyssonen, GNWT and Mark Palmer, CIRNAC Project Leads for the implementation of Measure #9 recruited Dr. Laurie Chan, a professor and Canada Research Chair in Toxicology and Environmental Health from the University of Ottawa to be the Principal Investigator of the study based on his academic merits and experience of working with northern and Indigenous communities. Dr. Chan is the lead researcher who plays the role of the executive director and is responsible for the scientific quality of the program. It is critical to ensure that the program is fully participatory in nature. Therefore, key stakeholders including representatives from the Federal and Territorial governments, Indigenous communities, and NGO representing residents of Yellowknife were consulted during the planning phase of the program. They were invited to be members of the Advisory Committee that oversees all aspects of the program, from planning to implementation to communications of the results. See the section below on governance of the program. Extensive consultations and discussions were conducted between November 2015 and March 2016 to determine the objectives and the scope of this study.

This research program titled “Health Effects Monitoring Program in Ndilo, Dettah and Yellowknife” is developed to address measure #9. The purpose of this program is to make sure the remediation activities that take place at Giant Mine will not have a negative impact on people’s health. This is achieved by investigating the impact and exposure of the COPCs, particularly arsenic, on the Ndilo, Dettah, and Yellowknife population. The Health Effects Monitoring

Program will be a long-term program which will monitor the level of COPCs within humans as the remediation at the Giant mine progresses.

The overall objective of this study is to implement a broad health effects biomonitoring program for the population of Yellowknife, Ndilo, and Dettah, focusing on arsenic and other COPCs such as antimony, cadmium, lead, manganese, and vanadium, complementing the Human Health and Ecological Risk Assessment study. Both studies are required by the Environmental Assessment Measure #9, and together provide a comprehensive overview of the levels of contaminants currently present in the human population as well as the environment. It is important to note that arsenic occurs naturally in the Yellowknife area because of the local geological formations. The YKHEMP study currently cannot distinguish arsenic exposures from natural sources, Giant or Con mine, or dietary sources. The results also represent recent exposure and cannot be interpreted as indicators of the participants' life-long exposure.

1.1 Specific Objectives

a) Collect biological samples of toenail clippings, urine, and saliva from consenting participants from representative Yellowknife residents, YKDFN, and the NSMA populations as baseline parameters for an on-going monitoring program for population reference arsenic levels.
b) Analyse collected samples to characterize COPC exposure (particularly arsenic) within the population and draw comparisons with the general Canadian population (CHMS, 2013).
c) Investigate any associations between COPC concentrations, particularly arsenic, within the population and observed or reported health outcomes within that same population.
d) Explore results sharing with other related studies to understand sources of contaminant exposure and health interactions (e.g. Human Health and Ecological Risk Assessment, GNWT ENR fish monitoring of Northern Pike and Lake Whitefish).
e) Coordinate with the communication team (uOttawa & CIRNAC, with additional input from HEMPAC) to develop and implement an effective communication plan.
f) Establish a biobank (a secure -80ºC freezer located at the uOttawa campus) to archive collected urine and toenail samples for future reference.
g) Establish a detailed protocol including a set of benchmarks for the future on-going monitoring program.

Public consultation meetings were held in spring 2017 with the Yellowknife general population, the YKDFN and the NSMA, to introduce the project and answer questions. Any suggestions brought up at these meetings were incorporated into the finalized research plan before any recruitment or sampling began.

1.2 Approaches

The YKHEMP is designed to be a prospective cohort study that will study the relationship between the exposure of arsenic and other metals and the health of the residents in Yellowknife. The project duration will be at least 10 years. The study plan is to invite representative samples of Yellowknife residents from 3 to 79 years to participate in a baseline study and to follow the exposure and health outcomes of the participants in 5 and 10 years. The participants are to be recruited from three populations including the Yellowknife general population, members of the Yellowknives Dene First Nation and members of the North Slave Métis Alliance.

The project started in 2017. Around 1000 Yellowknife residents were randomly selected, and any residents who volunteered to participate were accepted. All members of the YKDFN and NSMA were invited to participate in the study. Each participant answered a Lifestyle questionnaire and provided toenails, urine for contaminant testing and saliva samples for testing of genetic polymorphism associated with arsenic metabolism. They also provided consent to have their medical records reviewed by the research team for the past 5 years. Data collection was conducted over 2 years starting in September 2017. Each participant has been provided with their individual test results with appropriate medical advice. Medical record data will only be used to investigate possible associations between contaminant exposure and specific health outcomes at the population level. Participants (age 3 to 17) will be invited to participate in a follow-up study in 2022 and a follow-up study for all participants (Age 3+) is planned for 2027.

Six elements including arsenic, antimony, cadmium, lead, manganese and vanadium were selected as the chemicals of potential concern (COPC) based on the screening exercise done in the concurrent Human Health and Ecological Risk Assessment conducted for the Giant Mine by CanNorth (2018). Since arsenic is the major contaminant at the Giant Mine site, this study primarily investigates the body burden of arsenic and its potential associations with possible health effects. The program also measured concentrations of cadmium and lead in the collected urine

samples. Results were compared to the updated 95th percentiles of the population data based on the Canadian Health Measures Survey as reference values using a similar approach reported by Saravanabhavan et al. (2017). Combined data on urine arsenic, cadmium, and lead collected in CHMS cycle 1 (2007-2009) and 2 (2009-2011) and the combined data for urine inorganic arsenic collected from CHMS cycle 2 (2009-2011), 3 (2012-2013), and 4 (2014-2015) were used. Individual results were reported back to all the participants by mail. Concentrations of antimony, manganese, and vanadium were measured in urine samples, and the results will be stored in the database and serve as baseline levels for future reference.

Recruitment and data collection for the baseline of the cohort was conducted in two waves. The first wave started in September 2017 and finished in December 2017. The second wave was conducted between April 2018 to June 2018. This progress report presents the descriptive statistics of the concentration of COPCs measured in the urine and the toenail samples collected from the participants from both waves of sample collection. The key question addressed was whether the residents in Yellowknife had elevated exposure to arsenic and other COPCs in relation to the general Canadian population. Another progress report will be published in the spring of 2020 that will present the key findings of all the results based on the samples and information collected for the baseline study.

1.3 Governance

Dr. Laurie Chan, a toxicologist from the University of Ottawa, is the lead researcher on the monitoring program. In order to engage with a variety of affected stakeholders, a Health Effects Monitoring Program Advisory Committee (HEMPAC) was created as a mechanism for member groups to contribute to the development and implementation of the monitoring program by utilizing their health expertise and knowledge of regional and community level issues.

HEMPAC meets once a month and consists of the following representatives:

- Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)
- The government of the Northwest Territories Department of Environment and Natural Resources (GNWT ENR)
- The government of the Northwest Territories Department of Health and Social Services (GNWT HSS)

- Health Canada (HC)
- City of Yellowknife
- Yellowknives Dene First Nation (YKDFN)
- North Slave Métis Alliance (NSMA)
- Giant Mine Oversight Board (GMOB)
- University of Ottawa (uOttawa)

The HEMPAC oversees all aspects of the program and makes decisions by consensus. The terms of reference of the HEMPAC is presented in Appendix 1.

The YKHEMP also created a Technical Committee in April 2018. The Technical Committee is made up of experts across different fields and includes Dr. Laurie Chan, the Chief Public Health Officer Dr. Kami Kandola, Health Canada, Giant Mine Oversight Board and the Yellowknives Dene First Nation. The committee discusses the more technical details of YKHEMP results and follow-up protocols. The committee meets as needed.

All results were made available to the Technical Committee to discuss the context and decide on the most appropriate follow-up action. The Chief Public Health Office of the GNWT Health Department has the responsibility and authority to inform the public about the health significance of the results of the biomonitoring program and makes the final decision on the management/intervention plan if necessary.

2. Methodology

2.1 Ethical Considerations

The YKHEMP research was conducted following the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans and in particular Chapter 9, research involving the First Nations, Inuit and Métis Peoples of Canada (Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Social Sciences and Humanities Research Council of Canada 2010), and the document entitled: Indigenous Peoples & Participatory Health Research: Planning & Management, Preparing Research Agreements published by the World

Health Organization (2010). The protocol of the YKHEMP was accepted by the Ethical Review Boards at the University of Ottawa, Aurora Research Institute, and Aurora College Research Ethics Committee. The YKHEMP also follows the First Nations principles of Ownership, Control, Access and Possession (OCAP®) of data (Schnarch, 2004). Individual participation in the project was voluntary and based on informed written consent following an oral and written explanation of each project component. Project direction followed agreed-upon guiding principles (see www.ykhemp.ca), which were jointly established by the Health Effects Monitoring Program Advisory Committee (HEMPAC) and consultation with Statistics Canada for the sampling methodology and random sample selection. Each of the participating communities, the Yellowknife general population, Yellowknives Dene First Nation and the North Slave Métis Alliance, were offered opportunities to contribute to the methodology and refinement of the data collection tools as well as results communications and any follow-up required through public consultation meetings. All information collected is kept confidential throughout the study.

Ethics Approval was obtained from the Health Sciences and Science Research Ethics Board of the University of Ottawa (http://research.uottawa.ca/ethics/reb). A copy of the Ethics Approval Certificate is attached in Appendix 2.

All research in the Northwest Territories including work in Indigenous knowledge as well the physical, social and biological sciences are required to obtain a research license. The research license for this baseline study was obtained from the Scientific Services Office at the Aurora Research Institute after the review of their ethics review board. A copy of the NWT research license is attached in Appendix 3.

A sample of the consent forms for children and adults is attached in Appendix 4.

2.2 Data Collection

(i) Sampling strategy

For the Yellowknife general population, a methodology of random sampling was developed to obtain a representative sample based on residential addresses provided by the City of Yellowknife municipality, with assistance from Statistics Canada. The aim of the sampling strategy was to realistically recruit a minimum of approximately 1,000 residents of Yellowknife over two years starting in fall 2017. The target population was residents of Yellowknife between the ages of 3 to

79 that have lived in Yellowknife for at least one year on the day of the interview. Up to one adult (18+) and one child (3-17) from each selected address was randomly selected based on whose birth date was next.

Yellowknife has a population of roughly 21,183 residents including 1,540 Yellowknives Dene, in 10 districts, with 6,129 addresses and 757 multi-residential units (i.e. apartment buildings). Before sampling, a sampling frame was developed based on the stratum, district, street name, civic address, and unit number. On average, 1.5 persons were expected to be selected per household using the number of households from the 2011 Census. Thus, a final sampling size of 1,900 households was selected at random from the total of 6,886 addresses based on the following parameters: 20% desired level of precision, approximate variability of the variable to be measured per unit of 100%, 5% level of confidence, 50% expected response rate, and 90% occupancy rate.

In responding to the request of the Yellowknife residents during the consultation period, the study also welcomed any residents who volunteered to participate in this study. However, the results of this group of participants are analyzed separately from the results of the randomized samples.

For the Yellowknives Dene First Nation, a mixed approach sampling was adopted as suggested by the Yellowknives Dene leadership. All YKDFN members were invited to participate on a voluntary basis. The participants were checked off using local household maps of Ndilo and Dettah provided by the Yellowknives Dene. Secondly, if a certain demographic or household was lacking, in order to reflect a representative sample that demographic or household was contacted and invited to participate in the program. The study aimed to interview a total of about 200 to 400 Yellowknives Dene over the two sampling waves. At the request of the Yellowknives Dene leadership, each YKDFN participant would visit a nurse and fill in an additional questionnaire that included a medical history record and a brief dietary questionnaire including a food frequency of local traditional foods consumed. A copy of the questionnaire is attached in Appendix 5.

For the North Slave Métis Alliance, all members were invited to participate as recommended by the NSMA leadership. The study aimed to interview 50 to 100 Métis over the two sampling waves.

Participants from the Yellowknife general population who identified as YKDFN (with proof of membership) or self-identified as NSMA were separated from the general population pool and included in the YKDFN and NSMA pool, accordingly. If the participant self-identified as a First

Nation from a Band other than YKDFN or NSMA, that participant was included with the general Yellowknife population.

In addition, if a non-randomly selected individual from the Yellowknife general population approached the research team asking to participate in the program, that individual was allowed to participate as a volunteer. However, since these individuals were not randomly selected the data will be treated separately from the data collected from random participants as it can introduce sampling bias.

(ii) Staff and Training

A total of 31 part-time local research assistants and 5 part-time registered nurses were hired to collect the data and biological samples over two years. Workshops were conducted to provide training in interviewing and biological sample collection protocols to ensure data was collected consistently among the research assistants and nurses and between the wave 1 and wave 2 sample collection. In addition, a full-time Community Project Coordinator was hired in Yellowknife to coordinate all the YKHEMP activities and answer questions from the public.

(iii) Recruitment

Recruitment of all three populations (Yellowknife general population, members of the YKDFN, and members of the NSMA) was conducted in two waves; the first wave began in the fall of 2017 and the second wave began in the spring of 2018. The two-wave approach was designed to account for any potential seasonal effect on exposure. The study was advertised by radio, local TV, social media and flyers. In addition, a communications and engagement plan was finalized by the research team and approved by the HEMPAC.

Invitation letters (Appendix 6) were sent to a total of 1900 residences, 860 in fall 2017 and 1040 in spring 2018, informing the occupant that their residence has been randomly selected to participate in the YKHEMP. This was followed up by trained local research assistants contacting households to make an appointment for an on-site interview at their home. At each household, the research assistant explained the project (e.g. people will get their personal results in a letter, information may help guide future health advisories in the City of Yellowknife), and invited up to

one adult (18 to 79) and one child (3 to 17) if present, whose birthday was coming up next to participate in the program. If additional members of the family asked to participate, the study accommodated their request, but all the additional participants were treated as volunteers and were not included in the randomly selected sample.

For the YKDFN, letters of invitation were delivered in person to all the houses in Ndilo and Dettah by two local youth. The Yellowknives Dene Research Coordinator then followed-up with households, and scheduled appointments with one of the registered nurses hired to conduct the study. The appointments took place at the participant's home, at the Wellness Centre in Ndilo or at the Goyathiko Language Centre in Dettah. The nurse explained the project and asked for consent to participate. One of the registered nurses spoke Wiiliideh and conducted the interview in Wiiliideh when needed.

For the NSMA members, letters of invitation were sent through internal NSMA email informing all of their members about the study and welcoming them to participate. A research assistant then followed up with those members who contacted us back to schedule an appointment for an on-site interview at their home at their convenience.

All participants were informed about the details of the project by trained research assistants or registered nurses and signed a consent form before proceeding with the interview and biological sample collection. Due to the slight differences in the methodology between Yellowknife residents, YKDFN, and NSMA participants, a separate consent form was created for each population. In addition, a consent form was created for children ages 3 to 12 where consent was obtained from the parent or guardian on the child's behalf. For youth participants ages 13 to 17, they were provided with the adult consent form as they were deemed able to give their own consent. This practice was adopted from the protocol of the Canadian Health Measures Survey.

Each consent form contained questions related to specific components of the monitoring program to which participants had to consent before any information or samples were collected. The consent for the YKDFN participants included additional questions related to completing a medical history questionnaire and a brief medical examination by one of the registered nurses.

(iv) Interviews

All participants who provided consent were asked to complete a Lifestyle Questionnaire (Appendix 7). The lifestyle questionnaire contained two components: general information and exposure history (e.g. lifestyle, diet, water source, occupational history). Participants were also asked to complete a short Food Frequency Questionnaire (FFQ) on the types and amounts of fish consumed (Appendix 7). Information about serving sizes was collected using food models. The FFQ for the YKDFN included additional components including the types and amounts of local traditional foods including wild animals, wild birds, wild berries, and mushrooms consumed, as suggested by the YKDFN leadership.

Sample kits were distributed to all participants by trained research assistants working with the Yellowknife general population and members of the North Slave Métis Alliance, and by the registered nurses working with the YKDFN, to collect urine, toenail clippings, and saliva, at their own time. Participants were instructed to restrict from eating seafood 3 days before urine sampling and to provide the first-morning urine void. The instruction was provided on whom to contact for sample pick-up or drop off at any of the designated locations in Yellowknife, Ndilo, and/or Dettah. Samples were kept at each location under appropriate storage conditions: at room temperature for saliva and toenails, and in the refrigerator at 4ºC for urine, until ready for shipping to the University of Ottawa (urine and toenail) or Génome Quebec (saliva) for analysis.

(v) Medical Records

In fall 2018, the YKHEMP received permission from the Northwest Territories Health Authority to access medical records for the past 5 years of those individuals who provided their consent.

A part-time medical researcher who is familiar with the Wolf EMR electronic system was hired to extract the data on-site at the data centre in Yellowknife. No medical files were removed from the office. The data code for a list of symptoms, illnesses and diseases that have been reported to be associated with contaminant exposure was compiled (See Appendix 8). The medical researcher extracted the data and created a secure database on a laptop that had no access to the internet. The

medical record data was merged in the YKHEMP database that will be used to investigate possible associations between contaminant exposure and specific health outcomes at the population level. The data collected in 2017 and 2018 will form a baseline to follow-up with the individuals over time to study the relationship between contaminant exposure and health effects among the participants.

(vi) Medical examination and medical questionnaire

In addition to having their medical records reviewed for the past 5 years, the YKDFN were asked to complete a medical questionnaire (Appendix 5) and underwent a brief medical exam that included taking a person's height, weight, and blood pressure. This additional component was added after recommendations from the YKDFN leadership. Possible associations between the biomonitoring results and medical conditions will be investigated. The results from this part of the study will be available in 2020 and shared at community meetings.

(vii) Genetic Polymorphism

Genetic differences between individuals have been found to impact differences in biological responses to the metabolic process. Thus, some individuals are more susceptible or resilient to diseases due to their genetic makeup. Genetic polymorphisms may occur as sequences or even single nucleotides. The latter is referred to as single nucleotide polymorphism (SNP). Several SNPs have been identified to be associated with arsenic, most notably the metabolism of arsenic. There are approximately 50 identified SNPs of 30 genes associated with how the body handles arsenic. Analysis of polymorphisms will provide indications on how the genetic makeup of the study participants may affect their interaction with arsenic. Studies have shown that some ethnicities may metabolize arsenic more efficiently. Based on earlier research, 72 SNPs were selected that were hypothesized to underline inter-individual differences in arsenic metabolism including SNPs in genes of the following pathways and classes: sheath interacting, nucleotide excision repair, organic anion transporter, reduction activity in arsenic metabolism, DNA repair, efflux carrier, transporter (ZIP family metal transporter), one-carbon metabolism, and folate metabolism pathway (See Appendix 9).

In this study, buccal swabs were collected from participants using a DNA Genotek buccal swab kit (OCR-100). DNA was isolated from buccal swab with the QIA symphony instrument along with the DSP Midi kit (cat# 937255, QIAGEN) according to the manufacturer's protocol. Samples were sent to Genome Quebec for genotyping using the Sequenom iPLEX Gold platform (Gabriel et al., 2009). The results from this part of the study will be available in 2020 and shared at community meetings.

2.3 Laboratory Analysis

All chemical analyses were performed at the Laboratory for the Analysis of Natural and Synthetic Environmental Toxicants (LANSET), Centre for Advanced Research in Environmental Genomics (CAREG), and at the University of Ottawa. For quality control, certified reference materials, as well as in-house and external quality controls were used (e.g. field blanks and spiked samples).

2.4 Reagents and standards

All reagents were of analytical grade and were used without further purification. Multi-element standard and multi-internal standard were purchased from Agilent. Nitric acid for trace metal analysis was purchased from Sigma Aldrich (cat. # 84385-2.5l) and Trace Select Ultra for trace analysis. Hydrogen peroxide was purchased from Sigma (cat. #16911-250ml-F). Standards and reagents were prepared using Milli-Q (Millipore).

Arsenic standards and other reagents for arsenic speciation were purchased from Sigma-Aldrich and SpexCertiprep. Stock solution of 1000mg/l of arsenite (Spex Certiprep, Cat#SPEC AS3M), Arsenate (Spex Certiprep, Cat#SPEC-AS5M), and 10mg/L of dimethylarsonic acid (SpexCertiprep, cat# SPEC-AS-DMA) and Methylarsonate (SpexCertiprep, cat# SPEC-AS-MMA) with a certified value of arsenic value traceable to a NIST Standard Reference materials were purchased from SpexCertiprep. Arsenobetaine stock solution of 1000mg/l was prepared by accurately weighting and dissolving arsenobetaine salt. A 10mM of ammonium phosphate dibasic was prepared by dissolving ammonium phosphate dibasic (Sigma, cat#379980-100G) in Milli-Q water (Millipore) and pH adjusted to 8.25 with 28% Ammonium hydroxide solution (Sigma, Cat#: 338818-100ML). The mobile phase was filtered through a 0.45micron filter before use.

2.5 Sample processing

(i) Urine Samples

Urine samples were shipped from Yellowknife to the laboratory in Ottawa with ice packs in coolers by cargo. Upon arrival in the laboratory within 24 hours, they were sub-sampled for various analyses. Urine samples for total metals and As speciation analysis were stored at -20C until analysis. On the day of analysis urine samples were thawed then kept on ice. Part of the sample was diluted 10 times in 1% nitric acid before laboratory analysis for total metal analysis and another part was diluted in 10mM ammonium phosphate dibasic before As speciation.

(ii) Toenails samples

Toenail samples were washed according to the protocol adapted from Button et al. (2009). First, visible exogenous material (dirt, clothing fiber, etc.) was removed using forceps; then samples were placed in 15 mL centrifuge tubes and sonicated in 3ml acetone for 5 minutes. Following the sonication, the samples were rinsed again with 2ml ultrapure water followed by 3ml acetone and final sonication in 3ml ultra-pure water for 10min. For the final step, the samples were rinsed 2 times with mill-Q before drying at 60C for 1-2 days before being ground and weighed on an analytical balance before digestion in nitric acid for total metals analysis.

A block Digestion system comprised of 48-place, 50ml (SCP Science model DigiPrep MS, cat. # 01-500-205) with temperature control module (SCP Science, cat. # 010-500-225) and Digi Probe (SCP Science, Cat. #010-505-115) was used for sample digestion. Temperatures ranged from ambient to at least 95℃. Samples were digested following DigiPrep application note for tissue digestion adapted from USEPA methods 200.2 revision 2.8 and Kubachka et al. (2012). For QA/QC, blanks and certified reference material were used.

2.6 Chemical Analyses

The LANSET (Laboratory for the Analysis of Natural and Synthetic Environmental Toxicants) laboratory analyzed the concentration of arsenic and COPCs in the urine and digested toenail using inductively coupled plasma mass spectrometry (ICP-MS) (7700x ICP-MS, Agilent Technologies, Japan). The system is equipped with low flow borosilicate glass MicroMist concentric nebulizer and quartz, Scott-type double pass spray chamber. The interface consisted of 1mm diameter Ni-typed sampling and 0.4mm diameter Ni-typed skimmer cone. Octopole Reaction System (ORS) was used as interference removal in Helium mode. An Agilent ASX-500 was used as an ICP-MS autosampler.

Stock solutions were diluted in 1% nitric acid and used to provide a working calibration curve of at least five points. For analytical quality controls an element quality control standard stock (High-Purity Standards, Cat# QCS-19) and urine multi-element stock (High-Purity Standards, Healt3 solution A) were used as check standard after calibration and then every 10 to 20 samples. Also different reference materials (NIST reference materials: NIST 2669 level1 and level2 Arsenic species in toxic human urine, 2668 level1 and level 2 Toxic element s in frozen human urine, IAEA 407 and IAEA 085 references from the International Atomic Energy Agency and Dolt-4 and Dolt-4 from the National Research Council Canada), and pooled samples for a spike recovery test were included in the analysis. The results for both check standard, spike recovery and reference materials were within 10-20% of expected values.

The chromatographic separation of arsenite (As^{3+}), arsenate (As^{5+}), methylarsonate (MMA), dimethylarsonic acid (DMA) and arsenobetaine was performed using a 10mM ammonium phosphate dibasic buffer with pH adjusted to 8.25 on Agilent 1200 Infinity LC system consisting of a 1260 Isocratic pump and 1260 Autosampler. The LC system was connected to the Agilent 7700x ICP-MS via Peek tubing and equipped with a low flow Micro Mist Nebulizer and quartz, low-volume Scott-type double-pass spray chamber. The mobile phase was delivered at 1ml/min, and the injection volume was fixed at 100uL.

The detection limit in the urine samples was 0.012 ug/L for total arsenic, 0.005 ug/L for the arsenic species, 0.007 ug/L for cadmium and 0.02 ug/L for lead. The detection limit in the toenail samples was 0.05 ug/Kg for total arsenic. The detection limits are lower compared to those reported for

the CHMS; 0.5 ug/L for total arsenic, 0.8 ug/L for the arsenic species, and 0.1 ug/L for cadmium and lead (Health Canada 2013; 2017).

Urinary Creatinine

Urine samples were diluted 10 times in ultrapure water then creatinine was measured using creatinine urinary detection kits that based on the calorimetric endpoint Jaffe method (Thermo Fisher Scientific Cat#: EIACUN). The absorbance was read at 500 nm wavelength on a Biotek Cytation 3 imaging reader (BioTek Instrument, Inc.)

2.7 Inter-laboratory Comparison

As the aim of the project is to compare the data collected with those from the CHMS, it was decided that an inter-laboratory comparison study would need to be conducted to ensure that there is no difference between the results generated from the two different laboratories used in these two studies. Out of ~2000 urine samples, (874 in Wave 1 & 1117 in Wave 2), 50 (i.e., 2.5%) randomly selected urine samples (i.e., 25 from each wave) were sent to Institut National de Santé Publique du Québec (INSPQ) where urine samples were evaluated for arsenic speciation for biomonitoring during Canadian Health Measures Survey. We compared results of arsenic species from our lab at the University of Ottawa with that of INSPQ using Pearson correlation and a paired *t*-test to evaluate if results were statistically comparable. Results of the inter-laboratory comparison are shown in Appendix 10. There was a strong correlation between the two sets of results, and there was no statistical difference in both total and inorganic arsenic results. These results confirm that the data obtained for urine total arsenic and inorganic arsenic concentrations from this study can be used to compare to the data reported for CHMS.

2.8 Statistical Analysis

Descriptive statistics on the urine concentrations of total arsenic, total inorganic arsenic (As^{3+} + As^{5+} + MMA + DMA), cadmium, lead, and toenail concentrations of total arsenic were reported. The descriptive statistics include sample size (n), arithmetic mean (AM), geometric mean (GM), confidence intervals (CIs), median, percentiles, minimum, and maximum concentrations. Results of urine concentrations of total arsenic, total inorganic arsenic (As (III)+ As (V)+ MMA + DMA), cadmium and lead were compared to the data reported by the CHMS; urine concentrations of total arsenic, cadmium, and lead were based on the combined data collected in CHMS cycle 1 (2007-

2009) and 2 (2009-2011). Urine concentrations of inorganic arsenic were based on the combined data collected from CHMS cycle 2 (2009-2011), 3 (2012-2013), and 4 (2014-2015).

Both the YKHEMP and CHMS are sample surveys, meaning that the participants represent other people in the population who have the same sex and belong to the same age group but were not included in the survey. Sample weights generated by Statistics Canada based on the sampling frame (Appendix 11) were incorporated into estimates (e.g. geometric mean or GM) for YKHEMP random participants and all CHMS participants to take into account the unequal selection probability as well as non-response. Further, a set of 500 bootstrap weights were used to calculate the 95% confidence intervals (CIs) to account for the complex survey design.

The data tables comparing YKHEMP random sample with CHMS include the sample size (unweighted n); weighted population size, geometric mean and corresponding 95% CIs for YKHEMP and CHMS participants. The chemical concentrations in urine are presented as the weight of chemical per volume of urine (i.e. µg chemical/L urine). The arsenic concentrations in toenail are presented as the weight of arsenic per weight of toenail (i.e. mg arsenic/Kg toenail). Inorganic arsenic concentration is calculated as the total concentration of arsenite As(III), arsenate As(V), monomethylarsonic acid (MMA), and dimethylarsinic acid (DMA).

The GM and corresponding 95th percentiles were calculated in 3 steps. First, calculating the log of each variable; second, calculating the mean and 95% CIs for the log-transformed variables with bootstrap weights; finally, taking the antilog of the GM and corresponding 95% CIs calculated from the second step. Measurements that fell below the limit of detection (LOD) for the laboratory analytical method were substituted with a value equal to half the LOD. For each chemical, results are presented by sex- and age-groups. The age groups are defined as 3-5, 6-11, 12-19, 20-39, 40-59, and 60-79 to be consistent with the CHMS. All the geometric means, and 95% CIs are presented with two significant digits to be consistent with the CHMS reporting rule. A two-sample t-test was used to compare the chemical concentrations in urine between the YKHEMP random sample and CHMS participants, as well as inter-group comparisons for YKHEMP.

The results of the other three sampled populations including the volunteers, members of the YKDFN and NSMA were also compared with CHMS and each other. Because of their relatively

small sample size, the participants were grouped into two age groups, i.e. children (3-19) and adults (20-79), only. Please note that this definition for children and adults is slightly different than the one used in the rest of the report, i.e. 3-17 for children and 18+ for adults, that is based on ethics requirements. This definition is used only for direct comparison with CHMS results.

All the CHMS analysis were performed in accordance with Statistics Canada guidelines on confidentiality and stability. If an estimate in the CHMS was based on fewer than 10 observations, or if the coefficient of variation (CV) was larger than 33.3%, it was not reported.

All descriptive statistics and statistical tests reported were performed using Stata version 14.1 (StataCorp LP, College Station, TX, USA). Student *t*-test was used to test the geometric means of two groups. Bonferroni correction was applied for multiple group comparisons. All results for comparisons between different sampling groups are reported to be different only when $p < 0.05$. Statistical significance was set at $p < 0.05$, with Bonferroni adjustments for multiple comparisons.

3. Results

3.1 Participation Rate

A total of 2037 individuals who reported residing in Yellowknife in the last 12 months participated in this study (Table 1). There were 890 (673 adults, 217 children), randomly selected participants. In addition, the YKHEMP interviewed a total of 876 (685 adults, 191 children) volunteer participants from the Yellowknife general population, excluding members of YKDFN and the NSMA. In total, 225 (138 adults, 87 children) YKDFN and 46 (35 adults, 11 children) NSMA members participated in the YKHEMP.

Table 1. Number of participants participated in this study.

Sampled Groups		n
Random	Adult	673
	Child	217
	Total	**890**
Volunteer	Adult	685
	Child	191
	Total	**876**
YKDFN	Adult	138
	Child	87
	Total	**225**
NSMA	Adult	35
	Child	11
	Total	**46**
ALL	**Adult**	**1531**
	Child	**506**
	TOTAL	**2037**

Table 2 presents the results of the sampling effort. A list of 1900 households in Yellowknife was selected randomly by Statistics Canada. Twenty-five addresses were confirmed to be non-existing by physical visits. Therefore, 1875 households were contacted by the local research assistants. The local research assistants could not contact the residents of 619 addresses after three visits. Twenty-one of the households were self-identified as YKDFN or members of NSMA and therefore

not included in the randomized group in this study. A total of 76 houses were deemed to be ineligible as the residents did not live in Yellowknife for the past 12 months. There were 83 addresses that were either vacant or the building had no access. Therefore, the total number of eligible households was 1069. The participation rate for the Yellowknife random population was calculated using the following equation:

$$\text{Participation Rate} = \frac{\text{\# of participating HHs}}{\text{\# of eligible HHs}} \text{ x } 100$$

$$\text{Participation Rate} = \frac{691 \text{ participating HHs}}{1076 \text{ eligible HHs}} \text{x } 100 = \mathbf{64\%} \textbf{ Household Participation Rate}$$

Table 2. Summary of sampling effort for the randomized samples of the general population in Yellowknife.

Household Status	**# of Households**
No. of households that were selected to participate	1900
No. of households that were contacted 1900 - (25 did not exist)	1875
Contacted 3 times No Response	*619*
YKDFN/NSMA	*21*
Not Eligible (NE)	76
Vacant Homes (VH)	40
Buildings with NO ACCESS	43
No. of eligible households	**1076**
Refused	385
No. of participating households	**691**
Addresses with only Adults	423
Addresses with Adults and Children	268
Household Participation Rate (# of participating HHs /# of eligible HHs x 100= 691/1076 x100)	**64%**

3.2 Metals in Urine

Out of the 2037 participants, a total of 71 did not provide urine samples. Therefore, the following sections provide results for a total of 1966 participants in the study. Only results of total arsenic, inorganic arsenic, cadmium and lead concentrations in the urine samples are presented in this report. Results for manganese, vanadium and antimony are included in Appendix 12.

(i) Arsenic in Urine

Total arsenic and total inorganic arsenic were detected in all the urine samples collected. The descriptive statistics including arithmetic mean, geometric mean, median, minimum, maximum and the 95^{th} percentile of the total arsenic and inorganic arsenic are presented in Table 3 and Table 4 respectively. The results are grouped by the four study groups, the random sampled Yellowknife general population, the volunteer Yellowknife general population, the Yellowknives Dene First Nation and members of the North Slave Métis Alliance. They are further classified by gender and age groups (children between 3 to 17 years old and adults older than 18 years old). The total arsenic concentrations ranged from 0.18 μg/L to 960 μg/L, and the inorganic concentration ranged from 0.1 μg/L to 152 μg/L. There was no difference between the urine total arsenic concentrations between adults and children in all four sampling groups. However, for the inorganic arsenic, children participants from the Yellowknife randomized sample group, the volunteer group and the YKDFN had higher concentrations than those measured in the adults within the group.

Table 3. Descriptive statistics of total arsenic concentrations in the urine samples (μg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child.

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95% Percentile
YK Random Adult (18+)	**Total**	658	15.89	7.75	6.92	0.53	960.27	46.99
	M	289	13.72	7.61	6.88	0.71	255.72	41.59
	F	369	17.59	7.86	6.92	0.53	960.27	52.29
YK Random Child (3-17)	**Total**	212	14.82	7.62	7.31	0.18	706.77	35.93
	M	109	10.63	7.08	7.30	0.18	82.88	33.38
	F	103	19.25	8.24	7.32	0.31	706.77	46.04
YK Volunteer Adult (18+)	**Total**	673	15.60	8.06	7.45	0.34	571.25	47.35
	M	300	15.48	7.96	7.62	0.34	571.25	45.74
	F	373	15.69	8.14	7.34	0.50	353.43	52.57
YK Volunteer Child (3-17)*	**Total**	183	18.35	8.28	7.19	0.48	823.59	56.28
	M	90	22.65	9.01	8.02	1.62	823.59	64.76
	F	92	14.08	7.55	6.46	0.48	254.01	40.59
YKDFN Adult (18+)	**Total**	120	9.43	5.40	4.91	0.25	252.05	25.24
	M	44	13.21	6.33	6.35	1.08	252.05	34.99
	F	76	7.25	4.93	4.65	0.25	37.02	25.58
YKKDFN Child (3-17)	**Total**	74	8.20	6.64	6.69	0.53	30.77	22.39
	M	38	8.09	6.68	6.58	2.23	29.01	23.62
	F	36	8.31	6.59	6.69	0.53	30.77	18.86
NSMA Adult (18+)	**Total**	35	8.34	5.90	6.33	1.53	69.32	30.42
	M	16	7.06	5.76	6.36	1.53	20.69	NA
	F	19	9.43	6.02	6.31	1.73	69.32	NA
NSMA Child (3-17)	**Total**	11	4.50	3.77	3.48	1.67	10.98	NA
	M	6	6.36	5.90	6.02	3.33	10.98	NA
	F	5	2.28	2.20	2.14	1.67	3.48	NA
Total		**1966**	**15.02**	**7.60**	**7.00**	**0.176**	**960.27**	**42.92**

*One participant self-identified the gender as others was not included in the gender analysis.

Table 4. Descriptive statistics of inorganic arsenic concentrations in the urine samples (μg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child.

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95th Percentile
YK Random Adult (18+)	**Total**	658	6.83	5.14	4.85	0.63	69.94	18.61
	M	289	6.31	4.92	4.79	0.63	39.38	15.49
	F	369	7.24	5.32	4.89	0.69	69.94	19.17
YK Random Child (3-17)	**Total**	212	8.89	6.60	6.37	1.19	111.09	23.11
	M	109	8.68	6.60	6.43	1.19	36.33	23.21
	F	103	9.10	6.60	6.21	1.53	111.09	23.29
YK Volunteer Adult (18+)	**Total**	673	7.61	5.69	5.50	0.09	151.89	18.27
	M	300	7.07	5.58	5.38	0.91	39.71	18.14
	F	373	8.04	5.78	5.65	0.09	151.89	20.11
YK Volunteer Child (3-17)*	**Total**	183	10.57	7.23	6.38	1.01	124.08	33.16
	M	90	10.82	7.63	7.15	2.16	64.70	43.32
	F	92	10.26	6.78	5.99	1.01	124.08	26.80
YKDFN Adult (18+)	**Total**	120	5.41	4.56	4.42	1.15	20.09	11.10
	M	44	6.32	5.20	5.32	1.15	20.09	17.11
	F	76	4.89	4.23	3.99	1.22	16.67	10.19
YKDFN Child (3-17)	**Total**	74	7.46	6.41	6.03	1.07	26.56	17.37
	M	38	7.76	6.60	6.20	2.80	21.12	19.09
	F	36	7.15	6.21	6.03	1.07	26.56	16.35
NSMA Adult (18+)	**Total**	35	5.09	4.30	4.80	0.39	13.73	12.32
	M	16	4.38	3.65	4.32	0.39	9.16	NA
	F	19	5.68	4.93	5.17	1.57	13.73	NA
NSMA Child (3-17)	**Total**	11	5.17	4.40	5.09	1.35	13.28	NA
	M	6	6.84	6.32	5.38	4.32	13.28	NA
	F	5	3.16	2.85	3.23	1.35	5.52	NA
Total		**1966**	**7.56**	**5.63**	**5.30**	**0.09**	**151.89**	**19.58**

*One participant self-identified the gender as others was not included in the gender analysis.

ii) Comparison between arsenic results of the YKHEMP randomized selected sample to CHMS

There was a total of 870 urine samples (658 adults and 212 children) collected from the randomized selected sample from the Yellowknife general population. A total of 9 samples were removed as their bootstrap weights were not provided. Therefore, the total number of samples used for the comparison with CHMS data was 861 (650 adults between 20 to 79 years old and 211 children between 3 to 19 years old). After the adjustment of the weighting factors, results of the 861 randomized sample represent a total of 17, 949 people in the City of Yellowknife. The comparison was made between this weighed geometric mean to the weighed geometric mean of CHMS which represent a total population of 30,412,291. The comparison between the geometric mean of urine total arsenic concentrations in the YKHEMP randomized samples and the CHMS results are presented in Table 5. The geometric mean (8.0 μg/L) for the total sampled population in Yellowknife was lower than the (10.1 μg/L) reported for the CHMS. Results for the participants of YKHEMP age between 12 to 19, 20 to 39, 40 to 59, and 60-79 were all lower than the participants of CHMS participants of the same age group.

A different trend was observed in the urine total inorganic concentrations; results are presented in Table 6. There was no difference between the geometric of the two populations (5.6 μg/L for YKHEMP vs 5.4 μg/L for CHMS). However, the children from Yellowknife (GM=6.6 ug/L), particularly the age group between 6 years old and 11 years old (GM=7.3 μg/L) had higher concentrations than the general Canadian population (5.4 μg/L).

Table 5. Urine total arsenic concentrations (µg/L) – geometric means for Yellowknife population aged 3-79 from YKHEMP and Canadian population aged 3-79 from CHMS cycle 1 and 2.

		YKHEMP random sample			CHMS		
	age group	n	weighted N	GM (95% CI)	n	weighted N	GM (95% CI)
Total	3- 5	39	686	7.3 (5.6,9.5)	584	1081167	6.6 (5.3,8.2)
	6-11	91	1579	9.0 (7.0,11.6)	2104	2122370	8.1 (7.5,8.9)
	12-19	81	1529	6.4 (5.2,7.8)*	2021	3287580	9.1 (8.0,10.4)
	20-39	259	6777	8.4 (7.4,9.6)*	2478	8978147	10.7 (9.5,12.1)
	40-59	287	5538	7.9 (7.0,9.0)*	2455	9827356	10.7 (9.2,12.3)
	60-79	104	1841	7.4 (5.9,9.2)*	2161	5116239	11.2 (9.4,13.4)
	3-19	211	3794	7.5 (6.6,8.6)	4709	6491117	8.2 (7.5,9.1)
	20-79	650	14156	8.1 (7.4,8.8)*	7094	23921742	10.7 (9.5,12.1)
	3-79	861	17949	8.0 (7.4,8.6)*	11803	30412860	10.1 (9.1,11.3)
Female	3- 5	21	409	6.5 (4.5,9.6)	290	525890	6.8 (5.2,8.8)
	6-11	38	688	10.6 (7.3,15.5)	1038	1028650	8.1 (7.3,9.0)
	12-19	48	831	7.4 (5.9,9.3)	980	1589540	9.2 (7.8,11.0)
	20-39	156	3350	7.9 (6.9,9.2)*	1419	4465310	9.8 (8.7,11.0)
	40-59	151	2703	8.4 (6.8,10.4)	1260	4936466	9.0 (7.8,10.3)
	60-79	57	859	7.3 (5.0,10.5)	1118	2664412	10.4 (8.5,12.7)
	3-19	107	1928	8.2 (6.8,9.9)	2308	3144080	8.3 (7.3,9.4)
	20-79	364	6912	8.0 (7.1,9.1)*	3797	12066188	9.6 (8.5,10.7)
	3-79	471	8840	8.1 (7.2,9.0)*	6105	15210268	9.3 (8.4,10.3)
Male	3- 5	18	277	8.5 (6.1,12.0)	294	555277	6.4 (4.6,8.9)
	6-11	53	891	7.9 (5.7,11.0)	1066	1093720	8.2 (7.1,9.4)
	12-19	33	698	5.3 (3.7,7.6)*	1041	1698040	9.0 (7.8,10.4)
	20-39	103	3427	8.9 (7.1,11)*	1059	4512837	11.7 (10.0,13.8)
	40-59	136	2835	7.5 (6.5,8.7)*	1195	4890890	12.7 (10.8,15.0)
	60-79	47	982	7.5 (5.7,9.8)*	1043	2451827	12.2 (10.3,14.5)
	3-19	104	1866	6.9 (5.7,8.3)	2401	3347037	8.2 (7.4,9.0)
	20-79	286	7244	8.1 (7.2,9.2)*	3297	11855554	12.1 (10.5,13.8)
	3-79	390	9109	7.9 (7.0,8.8)*	5698	15202592	11.1 (9.9,12.5)

*Significantly different from CHMS

Table 6. Urine inorganic arsenic concentrations (µg/L) – geometric means for Yellowknife population aged 3-79 from YKHEMP and Canadian population aged 3-79 from CHMS cycle 2, 3 and 4.

		YKHEMP random sample			CHMS		
	age group	n	weighted N	GM (95% CI)	n	weighted N	GM (95% CI)
Total	3- 5	39	686	6.5 (5.1,8.2)	1544	1081166	5.1 (4.8,5.4)
	6-11	91	1579	7.3 (6.2,8.8)*	1533	2280323	5.5 (5.1,5.8)
	12-19	81	1529	6.0 (5.3,6.9)	1516	3321376	5.5 (5.0,5.9)
	20-39	259	6777	5.9 (5.3,6.5)	1067	7813029	5.7 (5.2,6.2)
	40-59	287	5538	4.9 (4.5,5.4)	980	9127731	5.1 (4.7,5.6)
	60-79	104	1841	4.4 (3.8,5.1)	1000	5757238	5.3 (4.9,5.8)
	3-19	211	3794	6.6 (6.0,7.3)*	4593	7111445	5.4 (5.1,5.7)
	20-79	650	14156	5.3 (5.0,5.6)	3047	21996414	5.4 (5.1,5.7)
	3-79	861	17949	5.6 (5.3,5.9)	7640	29809443	5.4 (5.1,5.7)
Female	3- 5	21	409	6.0 (4.2,8.6)	771	736825	5.0 (4.5,5.4)
	6-11	38	688	7.2 (5.7,9.2)*	765	1100049	5.4 (5.0,5.8)
	12-19	48	831	6.4 (5.5,7.6)*	764	1663892	5.4 (5.0,5.8)
	20-39	156	3350	6.3 (5.6,7.1)*	562	3749928	5.3 (4.5,6.1)
	40-59	151	2703	4.8 (4.2,5.4)	480	4682105	5.1 (4.4,5.8)
	60-79	57	859	4.5 (3.6,5.7)	501	3012872	5.0 (4.5,5.7)
	3-19	107	1928	6.6 (5.8,7.5)*	2300	3500766	5.3 (5.0,5.6)
	20-79	364	6912	5.4 (5.0,5.9)	1543	11195743	5.1 (4.7,5.6)
	3-79	471	8840	5.7 (5.3,6.1)	3843	14945671	5.2 (4.8,5.5)
Male	3- 5	18	277	7.2 (5.4,9.6)*	773	772921	5.2 (4.8,5.7)
	6-11	53	891	7.4 (5.8,9.5)*	768	1180274	5.5 (5.0,6.1)
	12-19	33	698	5.6 (4.4,7.0)	752	1657484	5.5 (5.0,6.1)
	20-39	103	3427	5.5 (4.7,6.4)	505	4063101	6.1 (5.1,7.2)
	40-59	136	2835	5.1 (4.5,5.7)	500	4445626	5.2 (4.6,5.7)
	60-79	47	982	4.4 (3.6,5.3)*	499	2744366	5.7 (5.1,6.5)
	3-19	104	1866	6.6 (5.7,7.7)*	2293	3610679	5.5 (5.1,5.9)
	20-79	286	7244	5.2 (4.7,5.6)	1504	10800671	5.6 (5.2,6.1)
	3-79	390	9109	5.4 (5.0,5.9)	3797	14863772	5.6 (5.2,6.0)

*Significantly different from CHMS

(iv) Cadmium in urine

Cadmium was detected in 1917 urine samples; 49 of the urine samples were below the detection limit. The descriptive statistics of cadmium concentrations in the urine samples collected from the four study groups, the random sampled Yellowknife general population, the volunteer Yellowknife general population, the YKDFN and members of NSMA are presented in Table 7.

They are further classified by gender and age groups (children 3 to 17 years old and adults older than 18 years old). The urine cadmium concentrations ranged from below 0.007 μg/L to 3.71 μg/L. Children of all the four studied groups had lower cadmium concentrations compared to the adults.

Table 7. Descriptive statistics of cadmium concentrations in the urine samples (μg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95th Percentile
YK Random Adult (18+)	**Total**	658	0.34	0.22	0.23	<LOD	2.95	1.02
	M	289	0.34	0.21	0.21	<LOD	2.95	1.18
	F	369	0.34	0.23	0.26	<LOD	2.04	0.94
YK Random Child (3-17)	**Total**	212	0.10	0.06	0.07	<LOD	1.50	0.25
	M	109	0.08	0.05	0.07	<LOD	1.50	0.18
	F	103	0.11	0.07	0.09	<LOD	0.72	0.32
YK Volunteer Adult (18+)	**Total**	673	0.33	0.22	0.22	<LOD	3.71	0.96
	M	300	0.30	0.19	0.20	<LOD	3.71	0.91
	F	373	0.35	0.24	0.24	<LOD	2.92	1.01
YK Volunteer Child (3-17)*	**Total**	183	0.08	0.06	0.06	<LOD	0.67	0.20
	M	90	0.08	0.06	0.07	<LOD	0.28	0.20
	F	92	0.09	0.06	0.07	<LOD	0.67	0.22
YKDFN Adult (18+)	**Total**	120	0.33	0.24	0.27	0.010	1.12	0.84
	M	44	0.31	0.22	0.22	0.020	0.91	0.85
	F	76	0.34	0.26	0.28	0.010	1.12	0.79
YKDFN Child (3-17)	**Total**	74	0.10	0.08	0.09	<LOD	0.36	0.25
	M	38	0.11	0.08	0.10	0.021	0.36	0.25
	F	36	0.09	0.07	0.08	<LOD	0.29	0.26
NSMA Adult (18+)	**Total**	35	0.40	0.22	0.20	0.018	1.78	1.51
	M	16	0.27	0.17	0.19	0.018	1.16	NA
	F	19	0.50	0.28	0.20	0.060	1.78	NA
NSMA Child (3-17)	**Total**	11	0.07	0.04	0.05	<LOD	0.20	NA
	M	6	0.07	0.04	0.07	<LOD	0.14	NA
	F	5	0.06	0.04	0.05	0.010	0.20	NA
Total		**1966**	**0.28**	**0.16**	**0.17**	**<LOD**	**3.71**	**0.89**

*One participant self-identified the gender as others was not included in the gender analysis.

(v) Comparison between cadmium results of the YKHEMP randomized selected sample to CHMS

The comparison between the geometric mean of urine cadmium concentrations in the YKHEMP randomized samples and the CHMS results is presented in Table 8. The geometric mean was 0.16 µg/L for the total population in Yellowknife that was lower than the 0.37 µg/L reported for the CHMS. Results for the participants of YKHEMP of all age groups had lower cadmium concentrations than the participants of CHMS participants of the same age group.

Table 8. Urine cadmium concentrations (µg/L) – geometric means for Yellowknife population aged 3-79 from YKHEMP and Canadian population aged 3-79 from CHMS cycle 1 and 2.

		YKHEMP random sample			**CHMS**		
	age group	n	weighted N	GM (95% CI)	n	weighted N	GM (95% CI)
Total	3- 5	39	686	0.04 (0.03,0.06)*	584	1081167	0.24 (0.20,0.28)
	6-11	91	1579	0.05 (0.04,0.07)*	2103	2121802	0.24 (0.22,0.27)
	12-19	81	1529	0.08 (0.06,0.10)*	2021	3287580	0.27 (0.25,0.30)
	20-39	259	6777	0.17 (0.15,0.19)*	2478	8978147	0.31 (0.29,0.34)
	40-59	287	5538	0.25 (0.22,0.29)*	2454	9827356	0.47 (0.43,0.50)
	60-79	104	1841	0.32 (0.26,0.39)*	2160	5116239	0.52 (0.49,0.56)
	3-19	211	3794	0.06 (0.05,0.07)*	4708	6490549	0.26 (0.23,0.28)
	20-79	650	14156	0.22 (0.20,0.23)*	7092	23921742	0.41 (0.39,0.44)
	3-79	861	17949	0.16 (0.15,0.18)*	11800	30412291	0.37 (0.35,0.40)
Female	3- 5	21	409	0.04 (0.02,0.07)*	290	525890	0.21 (0.17,0.26)
	6-11	38	688	0.06 (0.04,0.09)*	1038	1028651	0.22 (0.20,0.25)
	12-19	48	831	0.12 (0.09,0.15)*	980	1589540	0.26 (0.23,0.29)
	20-39	156	3350	0.21 (0.18,0.25)*	1419	4465310	0.32 (0.29,0.35)
	40-59	151	2703	0.25 (0.21,0.29)*	1260	4936466	0.47 (0.42,0.51)
	60-79	57	859	0.26 (0.20,0.34)*	1118	2664412	0.50 (0.46,0.54)
	3-19	107	1928	0.07 (0.06,0.09)*	2308	3144080	0.24 (0.22,0.27)
	20-79	364	6912	0.23 (0.21,0.26)*	3797	12066188	0.41 (0.39,0.43)
	3-79	471	8840	0.18 (0.16,0.20)*	6105	15210268	0.37 (0.35,0.39)
Male	3- 5	18	277	0.04 (0.03,0.07)*	294	555277	0.26 (0.20,0.33)
	6-11	53	891	0.05 (0.03,0.07)*	1065	1093151	0.26 (0.23,0.29)
	12-19	33	698	0.05 (0.03,0.07)*	1041	1698040	0.29 (0.26,0.32)
	20-39	103	3427	0.14 (0.12,0.17)*	1059	4512837	0.31 (0.28,0.35)
	40-59	136	2835	0.25 (0.21,0.31)*	1194	4890890	0.47 (0.42,0.51)
	60-79	47	982	0.39 (0.29,0.52)*	1042	2451827	0.55 (0.50,0.61)
	3-19	104	1866	0.05 (0.04,0.06)*	2400	3346469	0.27 (0.24,0.31)
	20-79	286	7244	0.20 (0.18,0.23)*	3295	11855554	0.41 (0.39,0.44)
	3-79	390	9109	0.15 (0.13,0.17)*	5695	15202023	0.38 (0.35,0.41)

*Significantly different from CHMS

(vi) Lead in urine

Lead was detected in all the urine samples collected. The descriptive statistics of lead concentrations in the urine samples collected from the four study groups, the random sampled Yellowknife general population, the volunteer Yellowknife general population, the YKDFN and members of NSMA are presented in Table 9. They are further classified by gender and age groups (children between 3 to 17 years old and adults older than 18 years old). The urine lead concentrations ranged from 0.004 μg/L to 11.36 μg/L. Children of the randomly sampled group, the volunteers, and the YKDFN had lower lead concentrations compared to the adults. The same trend was observed among NSMA members, but the statistical test result was not significant and is likely due to their relatively small sample size.

(vii) Comparison between lead results of the YKHEMP randomized selected sample to CHMS

The comparison between the geometric mean of urine lead concentrations in the YKHEMP randomized samples and the CHMS results is presented in Table 10. There was no difference between the geometric mean (0.54 μg/L) for the total population in Yellowknife and the geometric mean concentration (0.51 μg/L) reported for the CHMS. However, there were some specific differences in certain gender and age groups. The Yellowknife participants who were 20 to 39 years old had higher urine lead (0.51 μg/L) concentrations than the same group in CHMS (0.44 μg/L). Yellowknife female participants had higher urine lead concentrations (0.52 μg/L) compared to the CHMS (0.46 μg/L), which were mainly attributed to adult female participants (20-79 years old). No difference was observed between Yellowknife male participants and the CHMS.

Table 9. Descriptive statistics of lead concentrations in the urine samples (μg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child.

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95th Percentile
YK Random Adult (18+)	**Total**	658	0.80	0.56	0.54	0.020	7.74	2.19
	M	289	0.82	0.58	0.55	0.020	6.56	2.42
	F	369	0.78	0.55	0.53	0.030	7.74	2.03
YK Random Child (3-17)	**Total**	212	0.58	0.43	0.45	0.004	4.33	1.56
	M	109	0.55	0.40	0.45	0.004	2.45	1.56
	F	103	0.62	0.46	0.45	0.032	4.33	1.70
YK Volunteer Adult (18+)	**Total**	673	0.78	0.58	0.54	0.030	11.36	2.12
	M	300	0.81	0.62	0.59	0.090	5.04	2.16
	F	373	0.75	0.54	0.50	0.030	11.36	2.12
YK Volunteer Child (3-17)*	**Total**	183	0.55	0.43	0.42	0.090	3.24	1.37
	M	90	0.56	0.44	0.43	0.110	3.11	1.38
	F	92	0.53	0.42	0.39	0.090	3.24	1.40
YKDFN Adult (18+)	**Total**	120	0.84	0.66	0.66	0.030	3.84	1.86
	M	44	0.96	0.76	0.67	0.180	3.84	2.86
	F	76	0.77	0.61	0.64	0.030	3.50	1.59
YKDFN Child (3-17)	**Total**	74	0.67	0.52	0.48	0.020	4.48	1.68
	M	38	0.65	0.56	0.57	0.160	2.23	1.43
	F	36	0.69	0.48	0.44	0.020	4.48	3.16
NSMA Adult (18+)	**Total**	35	0.63	0.51	0.52	0.090	1.60	1.48
	M	16	0.61	0.47	0.46	0.090	1.45	NA
	F	19	0.66	0.55	0.59	0.150	1.60	NA
NSMA Child (3-17)	**Total**	11	0.45	0.36	0.39	0.120	0.96	NA
	M	6	0.44	0.36	0.41	0.120	0.96	NA
	F	5	0.45	0.37	0.39	0.160	0.88	NA
Total		**1966**	**0.74**	**0.54**	**0.52**	**0.004**	**11.36**	**1.90**

*One participant self-identified the gender as others was not included in the gender analysis.

Table 10. Urine lead concentrations (µg/L) – geometric means for Yellowknife population aged 3-79 from YKHEMP and Canadian population aged 3-79 from CHMS cycle 1 and 2.

		YKHEMP random sample			CHMS		
	age group	n	weighted N	GM (95% CI)	n	weighted N	GM (95% CI)
Total	3- 5	39	686	0.45 (0.35,0.58)	584	1081167	0.48 (0.43,0.53)
	6-11	91	1579	0.43 (0.36,0.51)	2104	2122370	0.4 (0.37,0.43)
	12-19	81	1529	0.44 (0.35,0.56)	2021	3287580	0.42 (0.40,0.44)
	20-39	259	6777	0.51 (0.46,0.57)*	2478	8978147	0.44 (0.41,0.47)
	40-59	287	5538	0.61 (0.55,0.69)	2455	9827356	0.59 (0.55,0.64)
	60-79	104	1841	0.67 (0.56,0.80)	2161	5116239	0.67 (0.64,0.70)
	3-19	211	3794	0.44 (0.38,0.50)	3583	6491117	0.42 (0.41,0.44)
	20-79	650	14156	0.57 (0.53,0.61)	4469	23921742	0.54 (0.52,0.57)
	3-79	861	17949	0.54 (0.50,0.58)	11803	30412860	0.51 (0.49,0.54)
Female	3- 5	21	409	0.51 (0.36,0.73)	290	525890	0.46 (0.37,0.56)
	6-11	38	688	0.42 (0.33,0.52)	1038	1028650	0.41 (0.37,0.44)
	12-19	48	831	0.51 (0.36,0.73)	980	1589540	0.41 (0.37,0.45)
	20-39	156	3350	0.49 (0.43,0.55)*	1419	4465310	0.39 (0.36,0.42)
	40-59	151	2703	0.60 (0.51,0.70)	1260	4936466	0.51 (0.47,0.56)
	60-79	57	859	0.55 (0.44,0.69)	1118	2664412	0.58 (0.53,0.63)
	3-19	107	1928	0.48 (0.39,0.58)	2308	3144080	0.41 (0.39,0.44)
	20-79	364	6912	0.54 (0.49,0.59)*	3797	12066188	0.48 (0.45,0.51)
	3-79	471	8840	0.52 (0.48,0.57)*	6105	15210268	0.46 (0.44,0.49)
Male	3- 5	18	277	0.38 (0.27,0.55)	294	555277	0.50 (0.44,0.58)
	6-11	53	891	0.43 (0.33,0.57)	1066	1093720	0.40 (0.37,0.44)
	12-19	33	698	0.37 (0.27,0.51)	1041	1698040	0.43 (0.40,0.46)
	20-39	103	3427	0.53 (0.44,0.64)	1059	4512837	0.50 (0.46,0.54)
	40-59	136	2835	0.63 (0.54,0.73)	1195	4890890	0.67 (0.62,0.72)
	60-79	47	982	0.79 (0.60,1.04)	1043	2451827	0.79 (0.74,0.84)
	3-19	104	1866	0.40 (0.33,0.48)	1275	3347037	0.43 (0.41,0.45)
	20-79	286	7244	0.60 (0.53,0.67)	672	11855554	0.62 (0.59,0.65)
	3-79	390	9109	0.55 (0.50,0.61)	5698	15202592	0.57 (0.54,0.60)

*Significantly different from CHMS

(viii) Comparison of all urine metal concentrations among different groups of YKHEMP participants and to CHMS

The geometric mean of total arsenic, inorganic arsenic, cadmium and lead concentrations in the four groups of participants; random sample, volunteers, YKDFN and members of NSMA are presented in Table 11. Both children (N=491) and adults (N=1466) results are presented.

The total arsenic in the children of YKDFN and NSMA groups were lower than the children of CHMS. In contrast, the total inorganic arsenic concentrations in the urine of the children of the Yellowknife random samples and the volunteers and also the YKDFN were higher than the CHMS children.

Among adults, the urine total arsenic and cadmium concentrations in all groups of YKHEMP participants were lower than the CHMS adult participants. Total inorganic arsenic of adult YKDFN and NSMA participants were lower than the CHMS participants. For urine lead, the YKDFN participants had higher concentrations than the CHMS participants.

For the comparison between the four groups of participants, the adult YKDFN participants had lower urine total arsenic concentrations, and the adult volunteer groups had higher inorganic concentrations compared to the other groups. Among children participants, only the urine total arsenic concentrations of the NSMA participants were lower than the other groups.

Table 11. Urine total arsenic, inorganic arsenic, cadmium, and lead concentrations (µg/L) – geometric means for Yellowknife population aged 3-79, by participation group from YKHEMP and Canadian population aged 3-79 from CHMS.

	YK random sample		YK volunteers		YKDFN		NSMA		CHMS	
	n	GM (95% CI)	n	GM (95% CI)	n	GM (95% CI)	n	GM (95% CI)	n	GM (95% CI)
Total, 3-19 years old										
Total arsenic	211	7.5 (6.6,8.6)	192	8.2 (7.1,9.5)	75	6.7* (5.7,7.8)	13	4.1* (2.8,6.0)	4709	8.2 (7.5,9.1)
Inorganic arsenic	211	6.6* (6.0,7.3)	192	7.2* (6.4,8.1)	75	6.4* (5.7,7.3)	13	4.7 (3.3,6.7)	4593	5.4 (5.1,5.7)
Cadmium	211	0.06* (0.05,0.07)	192	0.06* (0.05,0.07)	75	0.08* (0.06,0.09)	13	0.05* (0.02,0.09)	4708	0.26 (0.23,0.28)
Lead	211	0.44 (0.38,0.50)	192	0.44 (0.40,0.48)	75	0.52 (0.44,0.62)	13	0.37 (0.25,0.55)	4709	0.42 (0.41,0.44)
Total, 20-79 years old										
Total arsenic	650	8.1* (7.4,8.8)	664	8.1* (7.5,8.7)	119	5.4* (4.6,6.4)	33	5.9* (4.5,7.7)	7094	10.7 (9.5,12.1)
Inorganic arsenic	650	5.3 (5.0,5.6)	664	5.7 (5.4,6.0)	119	4.5* (4.1,5.0)	33	4.2* (3.3,5.3)	3047	5.4 (5.1,5.7)
Cadmium	650	0.22* (0.20,0.23)	664	0.22* (0.20,0.24)	119	0.24* (0.21,0.28)	33	0.24* (0.16,0.35)	7092	0.41 (0.39,0.44)
Lead	650	0.57 (0.53,0.61)	664	0.58 (0.54,0.61)	119	0.66* (0.58,0.75)	33	0.52 (0.40,0.67)	7094	0.54 (0.52,0.57)

*Significantly different from CHMS

(ix) Screening of urine concentrations using reference levels from the CHMS

In the letters reporting individual results to the participants, the HEMPAC decided that the results of the individual would be compared to an existing reference level to provide a proper context and for the screening of participants that had relatively high concentrations for a follow-up. See Appendix 13 for an example of the letters. Section 6.4.1 describes in detail the follow-up plan for the participants who had urine metal concentrations exceeding existing reference levels.

The HEMPAC decided to use the 95th percentile of the inorganic arsenic, lead and cadmium concentrations of the CHMS population as the reference levels. They are 21 µg/L for inorganic arsenic, 1.9 µg/L for adults and 1.3 µg/L for children for lead, and 1.3 µg/L for adults and 0.68 µg/L for children for cadmium. The exceedance does not necessarily indicate that there are health implications for that individual; it only indicates that the participants had higher levels than 95 percent of the general populations in Canada and the YKHEMP team would follow up with them to re-test the urine samples to confirm the higher exposure, to investigate the possible sources and provide advice to lower their exposure.

Table 12 presents the number of participants who had urine metal concentrations exceeding the reference levels. There were a total of 245 exceedance for the three metals. Twenty participants had multiple metals in their urine exceeding the reference levels. Therefore, 225 participants were invited for follow-up.

Table 12. The number of participants and percentage of the YKHEMP participants exceeding the reference level or the 95th percentile of the CHMS population.

Population		**iAs**		**Pb**		**Cd**	
	Number of participants	Number of exceedances	%	Number of exceedances	%	Number of exceedances	%
YK Random Adult (18+)	658	23	3.5	41	6.2	19	2.9
YK Random Child (3-17)	212	15	7.1	14	6.6	4	1.9
YK Volunteer Adult (18+)	673	26	3.9	40	5.9	14	2.1
YK Volunteer Child (3-17)	183	21	11.5	11	6.0	0	0.0
YKDFN Adult (18+)	120	0	0.0	5	4.1	0	0.0
YKDFN Child (3-17)	74	2	2.7	6	8.1	0	0.0
NSMA Adult (18+)	35	0	0.0	0	0.0	4	11.4
NSMA Child (3-17)	11	0	0.0	0	0.0	0	0.0
Total	**1966**	**87**	**4.4**	**117**	**6.0**	**41**	**2.1**
Adult	1486	49	3.3	86	5.8	37	2.5
Child	480	38	7.9	31	6.5	4	0.8

3.3 Arsenic in Toenail

Of the total of 2037 participants, 87 did not provide toenail samples. In addition, there were 78 individuals who provided insufficient toenail samples, i.e. total weight less than 1 mg, for arsenic analysis. Therefore, we have toenail As results for a total of 1872 participants. The breakdown by participant group is presented in Table 13.

Arsenic was detected in all the collected toenail samples. The descriptive statistics of arsenic concentrations in the toenail samples collected from the four study groups, the random sampled Yellowknife general population, the volunteer Yellowknife general population, the YKDFN and members of NSMA are presented in Table 14. They are further classified by gender and age groups (children between 3 to 17 years old and adults older than 18 years old). The arsenic concentrations ranged from below 0.01 mg/Kg to 7.34 mg/Kg.

Table 15a and 15b show the results of toenail arsenic concentrations by age groups. There was a significant age effect. Children between 3-5 and 6-11 had higher concentrations than the youth (12-19), and both of them were higher than the adults (20-79). When comparing results obtained from participants in Wave 1 (Fall 2017) and Wave 2 (Spring 2018) collection, there was a significant difference for both children and adults (Table 15c). Wave 2 participants had higher arsenic levels than those from Wave 1 suggesting that there might be higher arsenic exposure in spring than in the fall. The possible seasonal effect will be confirmed by the planned laser-ablation ICP-MS study on the exceedance participants.

In the comparison of toenail arsenic between the participating groups, the volunteer group was higher than the randomized sampled group and members of the NSMA, and the YKDFN for both adults and children. There was no difference between the arsenic in toenail samples from the randomized sampled group, the NSMA members, and the YKDFN.

As CHMS did not measure arsenic in the toenail, there is no comparable data from the CHMS for reference levels as in the case for metals in urine samples. Therefore, the HEMPAC reviewed the results and compared these to the results reported in the literature (Table 16). Toenail arsenic concentrations of adult participants of YKHEMP was higher than those reported in Nova Scotia but

lower than the levels reported in known arsenic contaminated areas in India, Bangladesh, and England. The levels are comparable to the results obtained from 212 volunteer participants from a population in Cornwall, the UK where the drinking water had elevated arsenic concentrations. Moreover, the YKHEMP results are similar to those reported in studies conducted in children living in areas adjacent to former copper mine sites in Arizona and gold mine sites in Victoria, Australia. For reporting results to the participants, the HEMPAC decided to use 80th percentile for children (1.35 mg/Kg) and 95th percentile (0.54 mg/Kg) for adults as screening levels to identify participants who had elevated levels of exposure to follow up with (Table 15b). The rationale for choosing 80th percentile for children is to include a higher percentage of children in the follow-up study to identify the potential sources of arsenic among children.

Table 16 shows the number of exceedances and the percentage of the child (3-19) and adult (20-79) participants in each group. In total, there were 86 children and 72 adults who had toenail As higher than the screening levels and have been invited to see a nurse practitioner to follow up.

Table 13. Number of participants and number of toenail samples collected by groups.

Groups	Participants	Results for toenail As available
YK Random Adult (20-79)	673	643
YK Random Child (3-19)	217	192
YK Volunteer Adult (20-79)	685	647
YK Volunteer Child (3-19)	191	163
YKDFN Adult (20-79)	138	118
YKDFN Child (3-19)	87	69
NSMA Adult (20-79)	35	32
NSMA Child (3-19)	11	8
Total	**2037**	**1872**

Table 14. Descriptive statistics of arsenic concentrations in the toenail samples (mg/Kg) for YK Random, Volunteers, YKDFN, NSMA adult and child.

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95%percentile
YK Random Adult (18+)	Total	643	0.17	0.11	0.10	<0.01	4.11	0.50
	M	287	0.17	0.11	0.10	<0.01	2.27	0.49
	F	356	0.17	0.10	0.09	<0.01	4.11	0.51
YK Random Child (3-17)	Total	192	0.78	0.41	0.37	0.01	5.37	3.07
	M	98	0.98	0.54	0.58	0.01	5.37	3.14
	F	94	0.58	0.30	0.27	0.03	5.28	2.46
YK Volunteer Adult (18+)	Total	647	0.21	0.13	0.12	<0.01	4.16	0.58
	M	290	0.21	0.14	0.12	<0.01	4.05	0.60
	F	357	0.21	0.13	0.13	<0.01	4.16	0.55
YK Volunteer Child (3-17)*	Total	163	1.02	0.52	0.53	0.01	7.34	3.37
	M	83	1.02	0.55	0.55	0.02	5.19	3.36
	F	79	1.03	0.50	0.53	0.01	7.34	4.19
YKDFN Adult (18+)	Total	118	0.13	0.09	0.08	<0.01	1.16	0.49
	M	43	0.18	0.11	0.08	<0.01	1.16	0.66
	F	75	0.11	0.08	0.08	0.02	1.09	0.30
YKDFN Child (3-17)	Total	69	0.49	0.31	0.30	0.03	2.93	1.90
	M	37	0.52	0.35	0.35	0.05	2.72	1.83
	F	32	0.45	0.26	0.25	0.03	2.93	2.29
NSMA Adult (18+)	Total	32	0.17	0.13	0.11	<0.01	0.51	0.49
	M	15	0.17	0.13	0.11	0.05	0.44	NA
	F	17	0.18	0.12	0.15	<0.01	0.51	NA
NSMA Child (3-17)	Total	8	1.08	0.62	0.52	0.11	3.63	NA
	M	4	1.20	0.65	0.45	0.26	3.63	NA
	F	4	0.97	0.59	0.75	0.11	2.29	NA
Total All included		**1872**	**0.33**	**0.16**	**0.13**	**<0.01**	**7.34**	**1.43**

*One participant self-identified the gender as others was not included in the gender analysis.

Table 15a. Descriptive statistics of toenail arsenic (mg/Kg) of all participants by age group

Population	n	A.M.	G.M.	Median	Min	Max	95th Percentile
3 to 5 years	66	1.1	0.6	0.6	0.02	5.2	3.4
6 to 11 years	205	1.0	0.6	0.6	0.01	7.3	3.4
12 to 19 years	176	0.5	0.3	0.2	0.01	4.9	1.7
20 to 39 years	553	0.2	0.1	0.1	0.01	4.2	0.6
40 to 59 years	605	0.2	0.1	0.1	0.0003	2.4	0.5
60 to 79 years	267	0.1	0.1	0.1	0.003	1.3	0.4
Total (3 to 79 years)	**1872**	**0.3**	**0.2**	**0.1**	**0.0003**	**7.3**	**1.4**

Table 15b. Descriptive statistics of toenail arsenic (mg/Kg) for children (3-19) and adults (20-79).

Population	n	A.M.	G.M.	Median	Min	Max	80th Percentile	95th Percentile
3 to 19 years	432	0.8	0.4	0.4	0.0101	7.3	1.35	3.03
20 to 79 years	1440	0.2	0.1	0.1	0.0003	4.2	0.22	0.54

Table 15c. Comparison between results from Wave 1 (Fall 2017) and Wave 2 (Spring 2018) collection.

Groups	Wave	n	Mean (mg/Kg)	t	p-value
Child	1	161	0.51	-3.97	7.57E-05
	2	271	1.02		
Adult	1	698	0.15	-5.67	2.54E-08
	2	742	0.21		
Both	1	859	0.22	-7.62	4.14E-14
	2	1013	0.43		

Table 16. Comparison of arsenic concentrations in toenails in this study and those reported in the literature.

Reported Literature	As concentration (mg/Kg)		Reference
	Adult	**Child**	
This Study	**0.116**	**0.456**	
Nova Scotia, Canada	0.056	NA	Dummer et al. (2015) Yu et al. (2014)
Quebec, Canada	0.008-1.4	NA	Normandin et al. (2014)
Victoria, Australia	NA	0.49	Pearce et al (2010)
Arizona, USA	NA	0.543	Loh et al. (2016)
Cornwall, UK	0.151	NA	Middleton et al. (2015)
West Bengal, India	7.66 [a,b]	6.61 [a,b]	Mandal et al. (2003)
Pabna, Bangladesh	6.18 [a]	NA	Seow et al. (2012)
Devon, England	5.41	NA	Button et al (2009)

[a] Results are arithmetic mean.

[b] Results are from fingernails.

Table 17. Number of exceedance[1] of toenail As and the percentage by group and age (n=1872)

Population	**n**	**Number of exceedances**	**%**
YK Random Child (3-19)	192	34	18
YK Random Adult (20-79)	643	28	4
YK Volunteer Child (3-19)	163	44	27
YK Volunteer Adult (20-79)	647	40	6
YKKDFN Child (3-19)	69	6	9
YKDFN Adult (20-79)	118	4	3
NSMA Child (3-19)	8	2	25
NSMA Adult (20-79)	32	0	0
Total Children and youth (3-19)	432	86	20
Total Adult (20-79)	1440	72	5
Total	**1872**	**158**	**8**

[1]Total toenail As concentration higher than 1.35 mg/Kg (80th percentile for Child) & 0.54 mg/Kg (95th percentile for Adult).

3.4 Reporting results to the participants

Individual results of the metal in urine samples were sent to 877 participants of the first wave of the study between April and June 2018. All participants from wave 1 and wave 2 received their results on metals in urine and arsenic in toenail samples by email or mail in May 2019. Participants whose urine results exceeded existing reference levels or screening levels for toenail were invited to contact the research team and arranged to have a meeting with a nurse practitioner. Participants were provided counselling on the implications of their results and advice on ways to lower their exposure. Results of the participants were put into their medical files. Urine and/or blood samples were collected for re-testing to confirm exposure. See Appendix 14 for details of the Action Plan.

The research team has planned a series of community meetings in Yellowknife to present results of this report in May 2019.

3.5 Genotyping

Out of 2037 participants, 2007 provided swab samples (221 YKDFN, 46 NSMA and 1740 YK) for genotyping. DNA was successfully extracted from 1925 samples (214 YKDFN, 43 NSMA and 1668 YK). For YK population, 23 SNPs did not meet the screening criteria, i.e., 3 SNPs had minor allele frequency (MAF) <0.05, 1 SNP was a duplicate, 7 SNP reported a single allele, and 12 additional SNPs did not achieve Hardy-Weinberg Equilibrium, HWE. Hence, 46 SNPs will be considered for further analysis. For YKDFN population, 13 SNPs did not meet screening criteria, i.e., 5 SNPs had minor allele frequency (MAF) <0.05, 1 SNP was as duplicate, and 7 SNP reported a single allele. Hence, 56 SNPs will be considered for further analysis. The results from this part of the study will be available in 2020 and shared at community meetings.

Arsenic species levels or ratios between wild genotype (genotype with the highest prevalence) vs. genotype with at least one variant allele will be compared. We will perform ANOVA to examine overall group differences of the arsenic species levels or ratios by 3 genotypes (major homozygous, heterozygous, and minor homozygous) for 56 SNPs for YKDFN population and 46 SNPs for YK population. It is expected results of this analysis will be available by the end of 2019 and will be used to interpret the results for the concentrations of arsenic species measured in the urine samples of the participants at the population level.

4. Next Steps

This report presents the descriptive results of Phase I or the baseline study for the biomonitoring program. The next progress report is expected to be published in May 2020. Arsenic species of the toenail will be measured and presented. It will also present results on the relationships between the diet and lifestyle variables, the genetic information, the concentrations of metals in urine and the arsenic concentrations in the toenail, and results of the medical history and medical file analysis. As YKHEMP is designed as a prospective cohort study, the children participants (3-17 years old in the current baseline study and additional participants at the age of 3-17 years old in 2022) will be invited to participate in the next round of study in 2022; both child and adult participants in 2027. In the meantime, the research team and the HEMPAC will continue to communicate the results to the residents of Yellowknife and implement the follow-up plan to promote healthy living and a healthy community.

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Appendix 1: Terms of Reference for HEMPAC

Giant Mine Remediation Project (GMRP)
Health Effects Monitoring Program Advisory Committee (HEMPAC)
Terms of Reference

FINAL
November 25, 2016

Background

The Giant Mine Remediation Project Team is currently conducting a long-term remediation project at the Giant Mine site in Yellowknife, NT. The project was approved by the Mackenzie Valley Environmental Impact Review Board subject to 26 measures aimed at preventing significant adverse impacts on the environment and to mitigate public concern.

Measure #9 states: *The Developer will work with other federal and territorial departments as necessary to design and implement a broad health effects monitoring program in Ndilo, Dettah and Yellowknife focusing on arsenic and any other contaminants in people which might result from this Project. This will include studies of baseline health effects of these contaminants and ongoing periodic monitoring.*

Dr. Laurie Chan of the University of Ottawa has been contracted to be the Principal Investigator (PI) of the Health Effects Monitoring Program and will work closely with the Advisory Committee. Dr. Chan was selected due to his experience carrying out a number of health studies in the North and working closely with northern and Aboriginal communities. The design, implementation and communications of the program is the sole responsibility of the PI.

The program will establish a baseline of health effects in Ndilo, Dettah, and Yellowknife to measure against during remediation, so the Giant Mine Remediation Project team can ensure the remediation work does not affect the health of the community. The program will ensure community members are well informed.

The current and future land use, and any limitations related to potential or actual impacts to human health, in the areas surrounding Giant Mine are of utmost concern to the Yellowknives Dene First Nation and others. As such, a number of groups, including but not limited to; Indigenous peoples of Canada in the vicinity of Yellowknife, other area residents, traditional, current and future users of the lands and waters in the vicinity of the Giant Mine site, the City of Yellowknife, the Co-Proponents, the communities on and downstream of Great Slave Lake, and potentially all Canadians share an interest in the success of the remediation project, and in the current and future state of the lands and waters affected by the project.

Mandate

To provide advice and make recommendations to the Principal Investigator in the development and implementation of the Monitoring Program by utilizing health expertise, and knowledge of regional and community level issues.

Membership

Membership of the HEMPAC will consist of representatives from:

1) Indigenous and Northern Affairs Canada (INAC)
2) Government of Northwest Territories (GNWT) – Department of Environment and Natural Resources (ENR)
3) Government of Northwest Territories (GNWT) - Department of Health and Social Services (HSS)
4) Health Canada (HC)
5) City of Yellowknife
6) Yellowknives Dene First Nation (YKDFN)
7) North Slave Metis Alliance (NSMA)
8) Giant Mine Oversight Board (GMOB)
9) University of Ottawa

Membership shall be represented by the organization rather than a particular individual. If replacement of a particular person is needed, their replacement will be the responsibility of the participating department or organization. The addition of new members to the Committee shall be made by consensus.

In an effort to reduce knowledge gaps as a result of staff turnover, temporary absences, and workload, each member is to identify a secondary contact/knowledge expert. In the event one member cannot attend a meeting where all others have confirmed, attendance by the secondary contact is the preferred option before rescheduling is considered.

Additional external expertise can be added to the group, as required, to address specific issues or concerns. For example, communication staff from the membership groups can also be invited to attend meetings when required.

Chair

The HEMPAC will be chaired by the INAC representative. The INAC rep will provide a communication link between the HEMPAC, the Principal Investigator and the GMRP Team. The INAC rep will plan meeting agendas, preside over the meetings, and coordinate activities of the HEMPAC. The Chair is a full member of the HEMPAC.

Statement of Purpose

Specific responsibilities of the Advisory Committee include but are not limited to:

- Provide technical expertise and advice in the development and implementation of the Monitoring Program.

- Provide community perspective, expertise, advice and traditional knowledge in the development and implementation of the Monitoring Program.
- Monitor the implementation of the Monitoring Program and provide input into refinement opportunities.
- Provide advice on proposed communications for the Monitoring Program.

Tenure

The Committee will exist until the work of the Committee is completed or may be dissolved sooner by consensus.

Recommendations

Recommendations from the various members will be provided to the Principal Investigator. It is recognized that participating agencies may have specific requirements or recommendations relating to their mandates or interests.

Meetings

Meetings shall be held monthly, on the second Friday of the month.
An attempt will be made to schedule at least two face-to-face meeting per year, at a time and place convenient for all members.

Members will have the responsibility for reporting HEMPAC activities and discussions back to their respective organizations.

Secretariat Support

The GMRP will provide secretariat support by coordinating meetings, drafting records of decisions, coordinating meeting agendas, etc.

Costs

Costs of implementing the Health Effects Monitoring Program are the responsibility of the GMRP.

Appendix 2: Ethics Approval Certificate from the Health Sciences and Science Research Ethics Board of the University of Ottawa

File Number: H05-17-07 **Date (mm/dd/yyyy):** 06/06/2018

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Ethics Approval Notice

Health Sciences and Science REB

Principal Investigator / Supervisor / Co-investigator(s) / Student(s)

First Name	Last Name	Affiliation	Role
Laurie	Chan	Science / Biology	Principal Investigator
Janet	Cheung		Research Assistant
Rajendra	Parajuli		Project Coordinator

File Number: H05-17-07

Type of Project: Professor

Title: Health Effects Monitoring Program

Renewal Date (mm/dd/yyyy)	Expiry Date (mm/dd/yyyy)	Approval Type
06/26/2018	06/25/2019	Renewal

Special Conditions / Comments:
N/A

550, rue Cumberland, pièce 154 550 Cumberland Street, room 154
Ottawa (Ontario) K1N 6N5 Canada Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

File Number: H05-17-07 **Date (mm/dd/yyyy):** 06/06/2018

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: http://research.uottawa.ca/ethics/submissions-and-reviews.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: http://research.uottawa.ca/ethics/submissions-and-reviews.

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5387 or by e-mail at: ethics@uOttawa.ca.

Signature:

Catherine Paquet

Catherine Paquet
Director
For Daniel Lagarec, Chair of the Health Sciences and Sciences REB

550, rue Cumberland, pièce 154 Ottawa (Ontario) K1N 6N5 Canada
550 Cumberland Street, room 154 Ottawa, Ontario K1N 6N5 Canada
(613) 562-5387 • Téléc./Fax (613) 562-5338
www.recherche.uottawa.ca/deontologie/ www.research.uottawa.ca/ethics/

Appendix 3: NWT research license from the Scientific Services Office at the Aurora Research Institute

Licence No. 16244
File No. 12 408 102
February 14, 2018

2018
Northwest Territories Scientific Research Licence

Issued by:	**Aurora Research Institute – Aurora College** Inuvik, Northwest Territories
Issued to:	Dr. Laurie Chan University of Ottawa 30 Marie Curie Gendron Bldg, Room 180 Ottawa, ON K1N 6N5 Canada Phone: (613) 562-5800 ext.7116 Fax: (613) 562-5486 Email: laurie.chan@uottawa.ca
Affiliation:	University of Ottawa
Funding:	Indigenous and Northern Affairs Canada
Team Members:	Renata Rosol; Janet Cheung; Claudia Tanamal
Title:	**Health Effects Monitoring Program**
Objectives:	To assess the exposure and health impact of arsenic and other contaminants on the human population of Yellowknife, Ndilo and Detah in the Northwest Territories.
Dates of data collection:	February 15, 2018 to December 31, 2018
Location:	Yellowknife, Ndilo, Detah

Licence No.16244 expires on December 31, 2018
Issued in the Town of Inuvik on February 14, 2018

Pippa Seccombe-Hett
Vice President, Research
Aurora Research Institute

AURORA COLLEGE

Research Ethics Committee
P.O. Box 600, Fort Smith, NT X0E 0P0
Tel: (867) 872-7080 Fax: (867) 872-5024

www.auroracollege.nt.ca

May 29, 2018

Dr. Laurie Chan
University of Ottawa
30 Marie Curie Gendron Bldg Room 180
Ottawa, ON K1N 6N5

This letter will inform you of the results of the Aurora College Research Ethics Committee (REC) review of your application for the *Health Effects Monitoring Program* project. The REC found the project to be acceptable in accordance with Aurora College Policy I.04 *Ethical Conduct for Research Involving Human Subjects* and the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.*

Please be informed that, following the receipt of this approval to proceed with the project, Principal Investigator(s) must:

- obtain an annual Certificate of Ethics Approval until the research is complete (**the approval is given for one year and will expire on May 29, 2019**);
- seek re-approval from the REC for any amendment or modification of the approved research protocol or consent form;
- report immediately to the REC, any adverse or unexpected events resulting from the research on human subjects; and
- notify the REC upon termination or completion of the project.

To access these forms and instructions for their completion, please contact the REC.

Kindly confirm that the research will be carried out in accordance with the approved protocol, by signing the enclosed Certificate of Ethics Approval and sending a copy by email to the REC.

Please direct all correspondence to Jessica Dutton, REC coordinator, at chairrec@auroracollege.nt.ca; or by phone at 867-872-7084

Sincerely,

Alexandra Hood

Chair, Aurora College Research Ethics Committee
chairrec@auroracollege.nt.ca

Appendix 4: Consent forms

uOttawa

Université d'Ottawa | University of Ottawa
Département de Biologie | **Department of Biology**
30 Marie Curie, Ottawa, ON K1N 6N5
ON Canada K1N 6N5
Tel: (613) 562-5800 x6349

Consent Form
YK residents (13 -79 years)

Title of study: Health Effects Monitoring Program

Invitation to Participate: You have been randomly selected to participate in the Health Effects Monitoring Program as part of the Giant Mine Remediation Project. This study is led by Dr. Laurie Chan of the University of Ottawa. Funding is provided through Indigenous and Northern Affairs Canada.

Purpose of the Study: The purpose of the Health Effects Monitoring Program is to establish current baseline levels of contaminants, and examine possible health effects among residents in Ndilo, Dettah, and Yellowknife in the Northwest Territories, before remediation work begins. Then, during remediation, new monitoring results will be compared to the baseline to ensure participants' arsenic levels are not increasing because of work being done at Giant Mine. The monitoring program will focus on arsenic, and other Contaminants of Potential Concern (COPC) such as cadmium, lead, manganese, antimony and vanadium which may be released as a result of the remediation project.

Participation: If you agree to participate, we will conduct a 30–minute interview to complete a short lifestyle questionnaire, and a food frequency questionnaire on a variety of wild fish consumed. We will ask you to provide some toenail samples, a urine sample collected in the morning, and a saliva sample taken with a buccal swab from the inside of your cheek. Toenail and urine samples will be sent to the laboratory to test for arsenic and other metals of concern. The buccal swab will be used to test whether you have or do not have 20 specific genes that can help you to get rid of arsenic more efficiently from your body.

You will also be asked for permission to access your medical file for the past 5 years. We will investigate whether you have experienced symptoms related to arsenic or other contaminant exposure. This information will be coded with our study ID number.

Risks: There is no physical harm anticipated for participating in the monitoring program. Some of the questions in the Lifestyle Questionnaire are sensitive and personal, and you may feel uncomfortable. You don't have to answer all questions. You may also feel anxious about the type and amount of contaminants we may find in your body. You will receive your results with interpretation in a personal letter within a few months of data collection. A nurse of the research team will also be available to meet with you to explain your result, in case you had elevated levels of contaminants, the nurse will work with you to lower your exposure, and conduct further testing if necessary (i.e. blood test to confirm high exceedance).

Benefits: You will have the opportunity to find out whether you have been exposed to arsenic and other metals of concern. At the same time your participation will contribute to the understanding of arsenic exposure and its health effects in Yellowknife, Ndilo and Dettah.

Confidentiality and anonymity: All information you provide will be kept strictly confidential and will never be publicly attached to your name. You will receive your results with interpretation in a personal letter.

Conservation of data: The data collected (questionnaires, toenails, urine and saliva) will be kept in a secure manner (in a computer in a secure room at the University of Ottawa) until completion of the program. The Principal Investigator, along with research students, Janet Cheung and Dr. Rajendra Parajuli, will have access to the data. The data will only be used for the purpose of this study. A copy of the master database shall be provided to the Institute for Circumpolar Health Research, and kept in a secure manner, once data collection is complete.

Gift: You will receive a grocery gift card in the amount of $50 to thank you for taking the time to participate in the study.

Voluntary Participation: Your participation is voluntary. You are under no obligation to participate. If you choose to participate, you can withdraw from the study at any time and/or refuse to answer any questions without suffering any negative consequences. If you choose to withdraw, all information and data you have provided will be destroyed or returned to you on request. No samples of toenails, urine or saliva will be collected without your permission.

Who can I talk to if I have questions or problems?
The local research assistant will answer any questions you may have about this program or you may contact the following project team members at any time in the future.

Collect calls will be accepted.

Research Supervisor:
Dr. Laurie Chan
Professor and Canada Research Chair in Toxicology and Environmental Health
University of Ottawa, Faculty of Biology
Tel: 613-562-5800 ext. 7116
Email: laurie.chan@uottawa.ca

Yellowknife Contact:
Elizabeth Liske
Community Project Coordinator
Cell: 867-445-1574
Work: 873-8951 ext. 1011
Email: elizabethl@ykdene.com

If you have any questions regarding the ethical conduct of this study, you may contact:

Protocol Officer for Ethics in Research,
University of Ottawa, Tabaret Hall,
550 Cumberland Street, Room 154,
Ottawa, ON K1N 6N5
Tel: (613) 562-5387
Email: ethics@uottawa.ca

There are two copies of the consent form of which one will be kept by Dr. Chan.

Your decision to participate in the Health Effects Monitoring Program is completely up to you. You are free to withdraw from the program at any time, and you can choose not to answer any questions you don't feel comfortable answering.

By signing this form, I agree that:

1.	I understand that I am being asked to participate in a Health Effects Monitoring Program that will focus on Arsenic and other contaminants of primary concern for the Giant Mine Remediation Project.	Yes	No
2.	I understand that I have the right to not participate, to refuse to answer a question and the right to stop at any time.	Yes	No
3.	I understand that I can ask any questions related to the study at any time.	Yes	No
4.	I understand that my personal information will be kept confidential.	Yes	No
5.	I agree to give urine sample and be informed of the result.	Yes	No
6.	I agree to give toenail sample and be informed of the result.	Yes	No
7.	I agree to give saliva sample and be informed of the result.	Yes	No
8.	I agree to have my medical file reviewed for the past 5 years.	Yes	No
9.	A follow-up study is planned in 5 to 10 years. I agree to be contacted again to be invited to participate in the follow up study.	Yes	No
10.	I agree to have my samples kept in a biobank until the end of the study.	Yes	No
11.	I hereby consent to participate in the study.	Yes	No

NAME OF PARTICIPANT _____

DATE OF BIRTH (day/month/year) _____

_____ _____

Signature of participant Date
(day/month/year)

TELEPHONE #: _____ EMAIL:
_____

PARTICIPANT'S MAILING ADDRESS (for returning results of sample analysis):

_____

_____

NAME OF RESEARCH ASSISTANT WHO OBTAINED CONSENT (print):

_____ _____

Signature Date (day/month/year)

YK (13-79) Consent – Interviewer to keep **NOID _____**

Your decision to participate in the Health Effects Monitoring Program is completely up to you. You are free to withdraw from the program at any time, and you can choose not to answer any questions you don't feel comfortable answering.

By signing this form, I agree that:

1.	I understand that I am being asked to participate in a Health Effects Monitoring Program that will focus on Arsenic and other contaminants of primary concern for the Giant Mine Remediation Project.	Yes	No
2.	I understand that I have the right to not participate, to refuse to answer a question and the right to stop at any time.	Yes	No
3.	I understand that I can ask any questions related to the study at any time.	Yes	No
4.	I understand that my personal information will be kept confidential.	Yes	No
5.	I agree to give urine sample and be informed of the result.	Yes	No
6.	I agree to give toenail sample and be informed of the result.	Yes	No
7.	I agree to give saliva sample and be informed of the result.	Yes	No
8.	I agree to have my medical file reviewed for the past 5 years.	Yes	No
9.	A follow-up study is planned in 5 to 10 years. I agree to be contacted again to be invited to participate in the follow up study.	Yes	No
10.	I agree to have my samples kept in a biobank until the end of the study.	Yes	No
11.	I hereby consent to participate in the study.	Yes	No

NAME OF PARTICIPANT _____

DATE OF BIRTH (day/month/year) _____

_____ _____

Signature of participant Date (day/month/year)

TELEPHONE #: _____ EMAIL: _____

PARTICIPANT'S MAILING ADDRESS (for returning results of sample analysis):

_____

_____

NAME OF RESEARCH ASSISTANT WHO OBTAINED CONSENT (print):

_____ _____

Signature Date (day/month/year)

Consent Form
YK, NSMA (Child 3-12)

Title of study: Health Effects Monitoring Program

Invitation to Participate: Your child is being asked to participate in the Health Effects Monitoring Program as part of the Giant Mine Remediation Project. This study is led by Dr. Laurie Chan of the University of Ottawa. Funding is provided through Indigenous and Northern Affairs Canada.

Purpose of the Study: The purpose of the Health Effects Monitoring Program is to establish current baseline levels of contaminants, and examine possible health effects among residents in Ndilo, Dettah, and Yellowknife in the Northwest Territories, before remediation work begins. Then, during remediation, new monitoring results will be compared to the baseline to ensure participants' arsenic levels are not increasing because of work being done at Giant Mine. The monitoring program will focus on arsenic, and other Contaminants of Potential Concern (COPC) such as cadmium, lead, manganese, antimony and vanadium which may be released as a result of the remediation project.

Participation: If you agree to have your child participate, we will conduct a 30–minute interview to ask you to complete a short lifestyle questionnaire, and a food frequency questionnaire on a variety of wild fish your child consumed. We will ask your child to provide some toenail samples, a urine sample collected in the morning, and a saliva sample taken with a buccal swab from the inside of your child's cheek. Toenail and urine samples will be sent to the laboratory to test for arsenic and other metals of concern. The buccal swab will be used to test whether your child has or does not have 20 specific genes that can help them to get rid of arsenic more efficiently from their body.

We will also ask for your permission to access your child's medical files for the past 5 years. We will investigate whether your child has experienced symptoms related to arsenic or other contaminant exposure. This information will be coded with our study ID number.

Risks: There is no physical harm anticipated for your child to participate in the monitoring program. Some of the questions in the Lifestyle Questionnaire are sensitive and personal, and you may feel uncomfortable. You don't have to answer all questions. You may also feel anxious about the type and amount of contaminants we may find in your body. You will receive your results with interpretation in a personal letter within a few months of data collection. A nurse of the research team will also be available to meet with you to explain your result, in case you had elevated levels of contaminants, the nurse will work with you to lower your exposure, and conduct further testing if necessary (i.e. blood test to confirm high exceedance).

Benefits: You will have the opportunity to find out whether your child has been exposed to arsenic and other metals of concern. At the same time your child's participation will contribute to the understanding of arsenic exposure and its health effects in Yellowknife, Ndilo and Dettah.

Confidentiality and anonymity: All information you provide on behalf of your child will be kept strictly confidential and will never be publicly attached to his or her name. You will receive your child's results with interpretation in a personal letter.

Conservation of data: The data collected (questionnaires, toenails, urine and saliva) will be kept in a secure manner (in a computer in a secure room at the University of Ottawa) until completion of the program. The Principal Investigator, along with research students, Janet Cheung and Dr. Rajendra Parajuli, will have access to the data. The data will only be used for the purpose of this study. A copy of the master database

shall be provided to the Institute for Circumpolar Health Research, and kept in a secure manner, once data collection is complete.

Gift: You will receive a grocery gift card in the amount of $50 to thank you for taking the time to answer questions on your child's behalf. In addition, your child will receive a little toy to thank them for taking the time to participate in the study.

Voluntary Participation: Your participation is voluntary. You are under no obligation to have your child participate. If you choose to have your child participate, you can withdraw your child from the study at any time and/or refuse to answer any questions without suffering any negative consequences. If you choose to withdraw your child, all information and data you have provided will be destroyed or returned to you on request. No samples of toenails, urine or saliva will be collected from your child without a permission from you and your child.

Who can I talk to if I have questions or problems?
The local research assistant will answer any questions you may have about this program or you may contact the following project team member at any time in the future.

Collect calls will be accepted.

Research Supervisor:
Dr. Laurie Chan
Professor and Canada Research Chair in Toxicology and Environmental Health
University of Ottawa, Faculty of Biology
Tel: 613-562-5800 ext. 7116
Email: laurie.chan@uottawa.ca

Yellowknife Contact:
Elizabeth Liske
Community Project Coordinator
Cell: 867-445-1574
Work: 873-8951 ext. 1011
Email: elizabethl@ykdene.com

If you have any questions regarding the ethical conduct of this study, you may contact:

Protocol Officer for Ethics in Research,
University of Ottawa, Tabaret Hall,
550 Cumberland Street, Room 154,
Ottawa, ON K1N 6N5
Tel: (613) 562-5387
Email: ethics@uottawa.ca

There are two copies of the consent form of which one will be kept by Dr. Chan.

Your decision to have your child participate in the Health Effects Monitoring Program is completely up to you. You are free to withdraw your child from the program at any time, and you can choose not to answer any questions you don't feel comfortable answering.

By signing this form, I agree that:

1.	I understand that my child is being asked to participate in a Health Effects Monitoring Program that will focus on Arsenic and other contaminants of primary concern for the Giant Mine Remediation Project.	Yes	No
2.	I understand that I have the right to have my child not participate, to refuse to answer a question and the right to stop at any time.	Yes	No
3.	I understand that I can ask any questions related to the study at any time.	Yes	No
4.	I understand that my child's personal information will be kept confidential.	Yes	No
5.	I agree for my child to give urine sample and be informed of the result.	Yes	No
6.	I agree for my child to give toenail sample and be informed of the result.	Yes	No
7.	I agree for my child to give saliva sample and be informed of the result.	Yes	No
8.	I agree to have my child's medical file reviewed for the past 5 years.	Yes	No
9.	A follow-up study is planned in 5 to 10 years. I agree to be contacted again to have my child participate in the follow up study.	Yes	No
10.	I agree to have my child's samples kept in a biobank until the end of the study.	Yes	No
11.	I hereby consent for my child to participate in the study.	Yes	No

My signature means that I have the legal authority to sign for the child.

Name of child _____ Date of Birth (day/month/year) _____

_____ _____

Name of parent or legal guardian Signature of parent or legal guardian

_____

Date (day/month/year)

Telephone number _____

Participant's mailing address (for returning results of sample analysis):

_____

NAME OF RESEARCH ASSISTANT WHO OBTAINED CONSENT (print):

_____ _____

Signature Date (day/month/year)

YK, NSMA Child (3-12) Consent – Interviewer to keep NOID

_____

Your decision to have your child participate in the Health Effects Monitoring Program is completely up to you. You are free to withdraw your child from the program at any time, and you can choose not to answer any questions you don't feel comfortable answering.

By signing this form, I agree that:

1.	I understand that my child is being asked to participate in a Health Effects Monitoring Program that will focus on Arsenic and other contaminants of primary concern for the Giant Mine Remediation Project.	Yes	No
2.	I understand that I have the right to have my child not participate, to refuse to answer a question and the right to stop at any time.	Yes	No
3.	I understand that I can ask any questions related to the study at any time.	Yes	No
4.	I understand that my child's personal information will be kept confidential.	Yes	No
5.	I agree for my child to give urine sample and be informed of the result.	Yes	No
6.	I agree for my child to give toenail sample and be informed of the result.	Yes	No
7.	I agree for my child to give saliva sample and be informed of the result.	Yes	No
8.	I agree to have my child's medical file reviewed for the past 5 years.	Yes	No
9.	A follow-up study is planned in 5 to 10 years. I agree to be contacted again to have my child participate in the follow up study.	Yes	No
10.	I agree to have my child's samples kept in a biobank until the end of the study.	Yes	No
11.	I hereby consent for my child to participate in the study.	Yes	No

My signature means that I have the legal authority to sign for the child.

Name of child _____ Date of Birth (day/month/year) _____

_____ _____

Name of parent or legal guardian Signature of parent or legal guardian

_____

Date (day/month/year)

Telephone number _____

Participant's mailing address (for returning results of sample analysis):

_____

NAME OF RESEARCH ASSISTANT WHO OBTAINED CONSENT (print):

_____ _____

Signature Date (day/month/year)

Appendix 5: Questionnaire for YKDFN participants (Lifestyle Questionnaire, extended Food Frequency Questionnaire, and Medical History Questionnaire)

HEALTH EFFECTS MONITORING PROGRAM

ADULT QUESTIONNAIRE (YKDFN)

INTERVIEWER, PLEASE KEEP THIS FORM ATTACHED TO THE QUESTIONNAIRE AND USE IT TO CHECK THE RECORD FOR COMPLETENESS. THE PROJECT COORDINATOR WILL CHECK AGAIN.

		CHECK WHEN COMPLETED
I.	Consent Form	_____
II.	Lifestyle Questionnaire (Screening Questions, Personal Information, Exposure History)	_____
III.	Food Frequency Questionnaire	_____
IV.	Medical History Questionnaire	_____

Participant ID (NOID) _____

YKDFN QUESTIONNAIRE

Date of Interview (mm/dd/yyyy) _____/_____/_____

Completed by (name of nurse) _____

SCREENING QUESTIONS

A. YKDFN member **O** Yes

B. Consent: Please confirm that participant gave consent **O** Yes **O** No

---

Participant information:

First Name _____

Last Name _____

Address _____

_____

Postal Code _____

Any Additional comments (i.e. twin?): _____

District in which participants home is located:

O Range Lake
O Frame Lake South
O Frame Lake North
O Kam Lake
O Grace Lake
O Con Mine
O Downtown
O School Draw
O Old Town
O Niven
O Ndilo
O Dettah

PERSONAL INFORMATION

1. a) What is your date of birth? (DD/MM/YYYY) _____/_____/_____

b) How old are you? _____ *Ask only if the person can't remember year of birth. Answer to the closest year.*

2. How many years have you lived in Yellowknife? _____
Answer in years to the nearest whole number.

3. Gender: **O** M**ale** **O** Female **O** Other, specify: _____

For Female and Other participants

b. Are you pregnant? **O** Yes **O** No
c. Are you breastfeeding? **O** Yes **O** No

EXPOSURE HISTORY

4. Do you currently smoke cigarettes or other tobacco products? **O** Yes **O** No

*IF **Yes**:*

b) How many cigarettes do you smoke per day? _____
c) How many pipes, cigars or chewing tobacco cans do you smoke per day? _____
d) For how many years have you been smoking? _____

*IF **No**:*

e) Did you previously smoke cigarettes or other tobacco products? **O** Yes **O** No

IF Yes to e)

f) How many cigarettes did you smoke per day? _____
g) How many pipes, cigars or chewing tobacco cans did you smoke per day? ____
h) For how many years did you smoke? _____
i) When did you last smoke? _____ (*i.e. last week, month etc*)

5. What is your main water source for drinking and cooking?

O Public water supply (municipal/truck water) **O** Private well or spring
O Bottled Water **O** Surface water (river, lake, etc.)

6. How many cups of water do you drink per day on average? _____
(Including water used to make coffee/tea, homemade juice, soups, etc., do not include water in prepared food).

7. Do you filter your water, for example with a Brita, or have a filtration system in your home? **O** Yes **O** No

8. Do you drink water directly from lakes or rivers (water or ice)? **O** Yes

O No

b) Which lakes and rivers do you drink from? (Check all that apply)

☐ Yellowknife Bay (Great Slave Lake)
☐ Yellowknife River
☐ Hidden Lake
☐ Pontoon Lake
☐ Tibbitt Lake
☐ South of Yellowknife Bay (Great Slave Lake)
☐ Walsh Lake
☐ Prelude Lake
☐ Prosperous Lake
☐ Reid Lake
☐ Other, please specify _____

9. Do you use the nearby waters for other activities such as swimming, playing, bathing, etc.? **O** Yes **O** No

b) How often do you use the nearby waters for other activities (during swimming season)?

O More than once a week (12 times or more per year)
O Weekly (4 to 11 times per year)
O Monthly (2 to 3 times per year)
O Once a year

c) Which waters do you use for other activities?

☐ Back Bay (Great Slave)
☐ South of Yellowknife Bay (Great slave)
☐ Long Lake
☐ Prelude Lake
☐ Reid Lake
☐ Cameron river
☐ Frame Lake
☐ Yellowknife Bay (Great Slave)
☐ Yellowknife River
☐ Walsh Lake
☐ Prosperous Lake
☐ Pontoon Lake
☐ Tibbitt Lake
☐ Vee Lake
☐ Other: _____

10. Do you hunt? **O** Yes **O** No

If yes, what do you hunt?

☐ Big Game (e.g. Moose, caribou, bear, etc.)
☐ Small Game (e.g. Rabbit, beaver, muskrat, etc.)
☐ Birds (e.g. spruce hens, ducks, mallards, geese, etc.)
☐ Other, please specify _____

11. Do you eat locally harvested meat? **O** Yes **O** No

If yes, what kind of meat?

☐ Big Game (e.g. Moose, caribou, bear, etc.)
☐ Small Game (e.g. Rabbit, beaver, muskrat, etc.)
☐ Birds (e.g. spruce hens, ducks, mallards, geese, etc.)
☐ Other, please specify _____

12. Do you fish? O Yes O No

Where do you fish?

- ☐ Yellowknife Bay (Great Slave Lake)
- ☐ Back Bay (Great Slave Lake)
- ☐ Vee Lake
- ☐ Prelude Lake
- ☐ Pontoon Lake
- ☐ Reid Lake
- ☐ Yellowknife River
- ☐ South of Yellowknife Bay (Great Slave Lake)
- ☐ East Arm (Great Slave Lake)
- ☐ Walsh Lake
- ☐ Prosperous Lake
- ☐ Hidden Lake
- ☐ Tibbitt Lake
- ☐ Long Lake
- ☐ Other: _____

13. Do you eat locally harvested fish? **O** Yes **O** No

When was your last locally harvested fish meal?

- ☐ Past 3 days
- ☐ Past week
- ☐ Past month
- ☐ Past 6 months
- ☐ Past year
- ☐ More than a year ago

14. Do you consume locally grown vegetables and herbs (e.g. from a local community or home garden)? **O** Yes **O** No

IF yes, where does your soil come from in which the vegetables are grown?

- ☐ Local
- ☐ Imported
- ☐ Don't know
- ☐Both

15. Do you eat locally collected berries? **O** Yes **O** No

16. Do you eat locally collected mushrooms or wild fungus? **O** Yes **O** No

17. In the last year have you eaten any other wild harvest plants? **O** Yes **O** No

(example: fireweed, spruce tips, birch syrup, etc.)

Specify : _____

18. How often do you consume the following foods?

Type of product	At least once per day	At least once per week	At least once per month	Less than once per month	None
a. Fish from store (not local)	O	O	O	O	O
b. Shellfish from store (ex: shrimp, lobster, scallops)	O	O	O	O	O
c. Seaweed (including sushi)	O	O	O	O	O
d. Rice and rice products from store	O	O	O	O	O

19. a) Do you currently work on the Giant Mine site? **O** Yes **O** No
b) Do you work as part of the remediation operations? **O** Yes **O** No
c) Do you work in the office? **O** Yes **O** No
d) How long have you been working on the Giant Mine site? _____
(enter in whole years)

20. a) If no to 24a), have you previously worked at the Giant Mine? **O** Yes **O** No
b) Did you work as part of the mining operations? **O** Yes **O** No
c) Did you work in the office? **O** Yes **O** No
d) How many years did you work at Giant Mine? _____ *(enter in whole years)*

21. a) Did you previously work for Con Mine? **O** Yes **O** No
b) Did you work as part of the mining operations? **O** Yes **O** No
c) Did you work in the office? **O** Yes **O** No
d) How long did you work at Con Mine? _____ *(enter in whole years)*

22. Do you or have you worked in the any of the following industries or occupations? *(Check all that apply)*

Industry Type	Never	Currently	Formerly
a. Mining/Smelting (e.g. copper, lead, cobalt, gold, zinc, silver)	O	O	O
b. Coal Mine/Refinery	O	O	O
c. Saw Mill	O	O	O
d. Diamond Mine	O	O	O
e. Mine remediation other than Giant Mine	O	O	O
f. Armed Forces	O	O	O
g. Glass Manufacturing Industry	O	O	O
h. Cotton fields/orchards	O	O	O
i. Electronics Manufacturing	O	O	O
j. Carpentry	O	O	O
k. Firefighting	O	O	O
l. Heavy Construction (e.g. earthmoving, demolition, paving, sewer & water work.)	O	O	O
m. Auto Mechanic	O	O	O

23. Do you or have you worked with the following (occupationally and recreationally)?

	Yes	No	Unknown/Can't Recall
a. Wood preservatives	O	O	O
b. Chemical fertilizers	O	O	O
c. Lab/Chemical reagents	O	O	O
d. Pesticides	O	O	O
e. Paints/Thinners, Solvents	O	O	O
f. Rat poison	O	O	O

24. a) Were you tested for arsenic in the past in Yellowknife? **O** Yes **O** No

b) *If yes*, do you still have your result? **O** Yes **O** No

IF Yes to 27 b) Ask: May I take a picture of your previous result to share with Dr. Laurie Chan?

IF No to 27 b) Say: We would like your consent to search the Northwest Territories archives for these results. We are not sure if we will be able to find the results, but your consent will give us permission to look for them, and if we find them, we will share them with you. Can you sign the NWT Archive Consent Form so that we can search the archives for your results?

END of Lifestyle Questionnaire, proceed to Food Frequency Questionnaire.

Food Frequency Questionnaire

I would now like to ask you about how much fish, game, birds, and plants you have consumed in the past year.

WILD FISH CONSUMPTION

1. a) In the past 12 months, have you eaten any **Dry Fish**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Dry Fish? _____
In the Fall (Sept-Oct), how many days did you eat Dry Fish? _____
In the Summer (June-Aug), how many days did you eat Dry Fish? _____
In the Spring (Apr-May), how many days did you eat Dry Fish? _____

c) On the days when you ate Dry fish, how much did you usually eat?
O Less than one quarter fish **O** One-quarter fish **O** One-half fish
O 1 Fish **O** 2 Fish **O** 3 Fish
O More than 3 fish **O** Don't know

2. a) In the past 12 months, have you eaten any **Whitefish**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Whitefish? _____
In the Fall (Sept-Oct), how many days did you eat Whitefish? _____
In the Summer (June-Aug), how many days did you eat Whitefish? _____
In the Spring (Apr-May), how many days did you eat Whitefish? _____

c) On the days when you ate Whitefish, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

3. a) In the past 12 months, have you eaten any **Lake Trout**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Lake Trout? _____
In the Fall (Sept-Oct), how many days did you eat Lake Trout? _____
In the Summer (June-Aug), how many days did you eat Lake Trout? _____
In the Spring (Apr-May), how many days did you eat Lake Trout? _____

c) On the days when you ate Lake Trout, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

4. a) In the past 12 months, have you eaten any **Northern Pike (Jackfish)**?

O Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Northern Pike? _____
In the Fall (Sept-Oct), how many days did you eat Northern Pike? _____
In the Summer (June-Aug), how many days did you eat Northern Pike? _____
In the Spring (Apr-May), how many days did you eat Northern Pike? _____

c) On the days when you ate Northern Pike, how much did you usually eat? (*See visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

5. a) In the past 12 months, have you eaten any **Burbot (Louche or Lingcod) liver**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Burbot liver? _____
In the Fall (Sept-Oct), how many days did you eat Burbot liver? _____
In the Summer (June-Aug), how many days did you eat Burbot liver? _____
In the Spring (Apr-May), how many days did you eat Burbot liver? _____

c) On the days when you ate Burbot liver, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

6. a) In the past 12 months, have you eaten any **Burbot (Louche or Lingcod) other than liver**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Burbot? _____
In the Fall (Sept-Oct), how many days did you eat Burbot? _____
In the Summer (June-Aug), how many days did you eat Burbot? _____
In the Spring (Apr-May), how many days did you eat Burbot? _____

c) On the days when you ate Burbot, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

7. a) In the past 12 months, have you eaten any **Inconnu (Connie)**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Connie? _____
In the Fall (Sept-Oct), how many days did you eat Connie? _____
In the Summer (June-Aug), how many days did you eat Connie? _____
In the Spring (Apr-May), how many days did you eat Connie? _____

c) On the days when you ate Connie, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

8. a) In the past 12 months, have you eaten any **Pickerel (Walleye)**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Pickerel? _____
In the Fall (Sept-Oct), how many days did you eat Pickerel? _____
In the Summer (June-Aug), how many days did you eat Pickerel? _____
In the Spring (Apr-May), how many days did you eat Pickerel? _____

c) On the days when you ate Pickerel, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

9. a) In the past 12 months, have you eaten any **Grayling (Bluefish)**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Grayling? _____
In the Fall (Sept-Oct), how many days did you eat Grayling? _____
In the Summer (June-Aug), how many days did you eat Grayling? _____
In the Spring (Apr-May), how many days did you eat Grayling? _____

c) On the days when you ate Grayling, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

10. a) In the past 12 months, have you eaten any **Longnose Sucker**? **O**Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Longnose? _____
In the Fall (Sept-Oct), how many days did you eat Longnose? _____
In the Summer (June-Aug), how many days did you eat Longnose? _____
In the Spring (Apr-May), how many days did you eat Longnose? _____

c) On the days when you ate Longnose, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

11. In the past 12 months, have you eaten **any other fresh water food**?
(e.g. clams, other fish, etc)

Specify: _____

LAND ANIMAL CONSUMPTION

12. In the past 12 months, have you eaten any **Woodland Caribou**? **O** Yes **O** No

13.a) In the past 12 months, have you eaten any **Woodland Caribou MEAT**?
O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Woodland Caribou meat? _____
In the Fall (Sept-Oct), how many days did you eat Woodland Caribou meat? _____
In the Summer (June-Aug), how many days did you eat Woodland Caribou meat? _____
In the Spring (Apr-May), how many days did you eat Woodland Caribou meat?
_____

c. On the days when you ate Woodland Caribou meat, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

14.a) In the past 12 months, have you eaten any **Woodland Caribou LIVER**?

O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Woodland Caribou liver? _____
In the Fall (Sept-Oct), how many days did you eat Woodland Caribou liver? _____
In the Summer (June-Aug), how many days did you eat Woodland Caribou liver? _____
In the Spring (Apr-May), how many days did you eat Woodland Caribou liver? _____

c. On the days when you ate Woodland Caribou liver, how much did you usually eat?

(i) Flat size: □OV-XS □OV-S □OV-M □OV-L □OV-XL □OV-J

(ii) Thickness: □T01 □T02 □T03 □T04 □T05 □T06 □T07 □T08 □T09 □T10
□T11 □T12 □T13 □T14 □T15 □T16

15.a) In the past 12 months, have you eaten any **Woodland Caribou KIDNEY**?

O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Woodland Caribou kidney? _____
In the Fall (Sept-Oct), how many days did you eat Woodland Caribou kidney? _____
In the Summer (June-Aug), how many days did you eat Woodland Caribou kidney? _____
In the Spring (Apr-May), how many days did you eat Woodland Caribou kidney? _ _____

c. On the days when you ate Woodland Caribou kidney, how much did you usually eat?

(i) Flat size: □OV-XS □OV-S □OV-M □OV-L □OV-XL □OV-J

(ii) Thickness: □T01 □T02 □T03 □T04 □T05 □T06 □T07 □T08 □T09 □T10
□T11 □T12 □T13 □T14 □T15 □T16

16. In the past 12 months, have you eaten any **Barrenland Caribou**?

O Yes **O** No

17. a) In the past 12 months, have you eaten any **Barrenland Caribou MEAT**?

O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Barrenland Caribou meat? _____
In the Fall (Sept-Oct), how many days did you eat Barrenland Caribou meat? _____
In the Summer (June-Aug), how many days did you eat Barrenland Caribou meat? _____
In the Spring (Apr-May), how many days did you eat Barrenland Caribou meat? _____

c. On the days when you ate Barrenland Caribou meat, how much did you usually eat?

(i) Flat size: □OV-XS □OV-S □OV-M □OV-L □OV-XL □OV-J

(ii) Thickness: □T01 □T02 □T03 □T04 □T05 □T06 □T07 □T08 □T09 □T10

☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

18. a) In the past 12 months, have you eaten any **Barrenland Caribou LIVER**?
O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Barrenland Caribou liver? _____
In the Fall (Sept-Oct), how many days did you eat Barrenland Caribou liver? _____
In the Summer (June-Aug), how many days did you eat Barrenland Caribou liver? _____
In the Spring (Apr-May), how many days did you eat Barrenland Caribou liver? _____

c. On the days when you ate Woodland Caribou liver, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

19. a) In the past 12 months, have you eaten any **Barrenland Caribou KIDNEY**?
O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Woodland Caribou kidney? _____
In the Fall (Sept-Oct), how many days did you eat Woodland Caribou kidney? _____
In the Summer (June-Aug), how many days did you eat Woodland Caribou kidney? _____
In the Spring (Apr-May), how many days did you eat Woodland Caribou kidney? _____

c. On the days when you ate Woodland Caribou kidney, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

20. In the past 12 months have you eaten any **Moose**? **O** Yes **O** No

21. a) In the past 12 months, have you eaten any **Moose MEAT**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Moose meat? _____
In the Fall (Sept-Oct), how many days did you eat Moose meat? _____
In the Summer (June-Aug), how many days did you eat Moose meat? _____
In the Spring (Apr-May), how many days did you eat Moose meat? _____

c. On the days when you ate Moose meat, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10

☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

22. a) In the past 12 months, have you eaten any Moose LIVER? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Moose liver? _____
In the Fall (Sept-Oct), how many days did you eat Moose liver? _____
In the Summer (June-Aug), how many days did you eat Moose liver? _____
In the Spring (Apr-May), how many days did you eat Moose liver? _____

c. On the days when you ate Moose liver, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

23. a) In the past 12 months, have you eaten any Moose KIDNEY? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat Moose kidney? _____
In the Fall (Sept-Oct), how many days did you eat Moose kidney? _____
In the Summer (June-Aug), how many days did you eat Moose kidney? _____
In the Spring (Apr-May), how many days did you eat Moose kidney? _____

c. On the days when you ate Moose kidney, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

24. a) In the past 12 months, have you eaten any **NWT Rabbit meat**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat NWT rabbit meat? _____
In the Fall (Sept-Oct), how many days did you eat NWT rabbit meat? _____
In the Summer (June-Aug), how many days did you eat NWT rabbit meat? _____
In the Spring (Apr-May), how many days did you eat NWT rabbit meat? _____

c. On the days when you ate NWT rabbit meat, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

25.a) In the past 12 months, have you eaten any **Beaver meat**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat beaver meat? _____
In the Fall (Sept-Oct), how many days did you eat beaver meat? _____
In the Summer (June-Aug), how many days did you eat beaver meat? _____
In the Spring (Apr-May), how many days did you eat beaver meat? _____

c. On the days when you ate beaver meat, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

26. a) In the past 12 months, have you eaten any **Muskrat meat**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat muskrat meat? _____
In the Fall (Sept-Oct), how many days did you eat muskrat meat? _____
In the Summer (June-Aug), how many days did you eat muskrat meat? _____
In the Spring (Apr-May), how many days did you eat muskrat meat? _____

c. On the days when you ate muskrat meat, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

27.a) In the past 12 months, have you eaten any **Porcupine meat**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat porcupine meat? _____
In the Fall (Sept-Oct), how many days did you eat porcupine meat? _____
In the Summer (June-Aug), how many days did you eat porcupine meat? _____
In the Spring (Apr-May), how many days did you eat porcupine meat? _____

c. On the days when you ate procupine meat, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

28. a) In the past 12 months, have you eaten any **Bear meat**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat bear meat? _____
In the Fall (Sept-Oct), how many days did you eat bear meat? _____
In the Summer (June-Aug), how many days did you eat bear meat? _____
In the Spring (Apr-May), how many days did you eat bear meat? _____

c. On the days when you ate bear meat, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

29. In the past 12 months, **what other land animal** have you eaten?

Specify: _____

BIRD CONSUMPTION

30. a) In the past 12 months, have you eaten any **Spruce Hen/Grouse**?

O Yes

O No

b. In the Winter (Nov-Mar), how many days did you eat hen/grouse? _____
In the Fall (Sept-Oct), how many days did you eat hen/grouse? _____
In the Summer (June-Aug), how many days did you eat hen/grouse? _____
In the Spring (Apr-May), how many days did you eat hen/grouse? _____

c. On the days when you ate hen/grouse, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

31. a) In the past 12 months, have you eaten any **Ptarmigan?** O Yes

O No

b. In the Winter (Nov-Mar), how many days did you eat ptarmigan? _____
In the Fall (Sept-Oct), how many days did you eat ptarmigan? _____
In the Summer (June-Aug), how many days did you eat ptarmigan? _____
In the Spring (Apr-May), how many days did you eat ptarmigan? _____

c. On the days when you ate ptarmigan, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

32. a) In the past 12 months, have you eaten any **Ducks**? O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat ducks? _____
In the Fall (Sept-Oct), how many days did you eat ducks? _____
In the Summer (June-Aug), how many days did you eat ducks? _____
In the Spring (Apr-May), how many days did you eat ducks? _____

c. On the days when you ate ducks, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

33. a) In the past 12 months, have you eaten any **Common Loon**? O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat common loon? _____
In the Fall (Sept-Oct), how many days did you eat common loon? _____
In the Summer (June-Aug), how many days did you eat common loon? _____
In the Spring (Apr-May), how many days did you eat common loon? _____

c. On the days when you ate common loon, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

34.a) In the past 12 months, have you eaten any **Canada Goose**? O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat Canada goose? _____
In the Fall (Sept-Oct), how many days did you eat Canada goose? _____
In the Summer (June-Aug), how many days did you eat Canada goose? _____
In the Spring (Apr-May), how many days did you eat Canada goose? _____

c. On the days when you ate Canada goose, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

35.a) In the past 12 months, have you eaten any **Snow Goose**? O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat Snow goose? _____
In the Fall (Sept-Oct), how many days did you eat Snow goose? _____
In the Summer (June-Aug), how many days did you eat Snow goose? _____
In the Spring (Apr-May), how many days did you eat Snow goose? _____

c. On the days when you ate Snow goose, how much did you usually eat?

(i) Flat size: ☐OV-XS ☐OV-S ☐OV-M ☐OV-L ☐OV-XL ☐OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

36. In the past 12 months, **what other wild birds** have you eaten?

Specify: _____

PLANTS

37. a) In the past 12 months, have you drunk any **Labrador Tea**? O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat Labrador Tea? _____
In the Fall (Sept-Oct), how many days did you eat Labrador Tea? _____
In the Summer (June-Aug), how many days did you eat Labrador Tea? _____
In the Spring (Apr-May), how many days did you eat Labrador Tea? _____

c. On the days when you drank Labrador Tea, how much did you usually drink?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

38. a) In the past 12 months, have you eaten any **Low bush (Grey) Blueberries**?

O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat grey blueberries? _____
In the Fall (Sept-Oct), how many days did you eat grey blueberries? _____
In the Summer (June-Aug), how many days did you eat grey blueberries? _____
In the Spring (Apr-May), how many days did you eat grey blueberries? _____

c. On the days when you ate grey blueberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

39.a) In the past 12 months, have you eaten any **High bush (Black) Blueberries**?

O Yes O No

b. In the Winter (Nov-Mar), how many days did you eat black blueberries? _____
In the Fall (Sept-Oct), how many days did you eat black blueberries? _____
In the Summer (June-Aug), how many days did you eat black blueberries? _____
In the Spring (Apr-May), how many days did you eat black blueberries? _____

c. On the days when you ate black blueberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

40. a) In the past 12 months, have you eaten any **Cranberries**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat cranberries? _____

In the Fall (Sept-Oct), how many days did you eat cranberries? _____
In the Summer (June-Aug), how many days did you eat cranberries? _____
In the Spring (Apr-May), how many days did you eat cranberries? _____

c. On the days when you ate cranberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

41. a) In the past 12 months, have you eaten any **Gooseberries (Green)**?

O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat green gooseberries? _____
In the Fall (Sept-Oct), how many days did you eat green gooseberries? _____
In the Summer (June-Aug), how many days did you eat green gooseberries? _____
In the Spring (Apr-May), how many days did you eat green gooseberries? _____

c. On the days when you ate Green Gooseberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

42.a) In the past 12 months, have you eaten any **Gooseberries (Purple)**?

O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat purple gooseberries? _____
In the Fall (Sept-Oct), how many days did you eat purple gooseberries? _____
In the Summer (June-Aug), how many days did you eat purple gooseberries? _____
In the Spring (Apr-May), how many days did you eat purple gooseberries? _____

c. On the days when you ate Purple Gooseberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

43. a) In the past 12 months, have you eaten any **Blackberries**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat blackberries? _____
In the Fall (Sept-Oct), how many days did you eat blackberries? _____
In the Summer (June-Aug), how many days did you eat blackberries? _____
In the Spring (Apr-May), how many days did you eat blackberries? _____

c. On the days when you ate blackberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

44.a) In the past 12 months, have you eaten any **Wild Raspberries**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat raspberries? _____
In the Fall (Sept-Oct), how many days did you eat raspberries? _____
In the Summer (June-Aug), how many days did you eat raspberries? _____
In the Spring (Apr-May), how many days did you eat raspberries? _____

c. On the days when you ate raspberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

45. a) In the past 12 months, have you eaten any **Wild Strawberries**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat stawberries? _____
In the Fall (Sept-Oct), how many days did you eat stawberries? _____
In the Summer (June-Aug), how many days did you eat stawberries? _____
In the Spring (Apr-May), how many days did you eat stawberries? _____

c. On the days when you ate stawberries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

46.a) In the past 12 months, have you eaten any **Cloud Berries (Knuckleberries)**?
O Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat cloud berries? _____
In the Fall (Sept-Oct), how many days did you eat cloud berries? _____
In the Summer (June-Aug), how many days did you eat cloud berries? _____
In the Spring (Apr-May), how many days did you eat cloud berries? _____

c. On the days when you ate cloud berries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

47. a) In the past 12 months, have you eaten any **Red Currants**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat red currants? _____
In the Fall (Sept-Oct), how many days did you eat red currants? _____
In the Summer (June-Aug), how many days did you eat red currants? _____
In the Spring (Apr-May), how many days did you eat red currants? _____

c. On the days when you ate red currants, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

48. a) In the past 12 months, have you eaten any **Black Currants**? **O** Yes **O** No

b. In the Winter (Nov-Mar), how many days did you eat black currants? _____
In the Fall (Sept-Oct), how many days did you eat black currants? _____
In the Summer (June-Aug), how many days did you eat black currants? _____
In the Spring (Apr-May), how many days did you eat black currants? _____

c. On the days when you ate black currants, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

49. a) In the past 12 months, have you eaten any **Saskatoon Berries**? **O** Yes **O** No

In the Winter (Nov-Mar), how many days did you eat saskatoon berries? _____
In the Fall (Sept-Oct), how many days did you eat saskatoon berries? _____
In the Summer (June-Aug), how many days did you eat saskatoon berries? _____
In the Spring (Apr-May), how many days did you eat saskatoon berries? _____

b. On the days when you ate saskatoon berries, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

50. a) In the past 12 months, have you had any **Rosehip tea** or other preparation of Rosehips? **O** Yes **O** No

b. In the Summer (June-Aug), how many days did you eat or drink Rosehips? _____
In the Spring (Apr-May), how many days did you eat or drink Rosehips? _____
In the Winter (Nov-Mar), how many days did you eat or drink Rosehips? _____
In the Fall (Sept-Oct), how many days did you eat or drink Rosehips? _____

c. On the days when you ate Rosehips, how much did you usually eat or drink?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

51. a) In the past 12 months, have you had any **Wild Peppermint** tea or any other preparation with Wild Peppermint? **O** Yes **O** No

b. In the Summer (June-Aug), how many days did you eat or drink Peppermint? _____
In the Spring (Apr-May), how many days did you eat or drink Peppermint? _____
In the Winter (Nov-Mar), how many days did you eat or drink Peppermint? _____
In the Fall (Sept-Oct), how many days did you eat or drink Peppermint? _____

c. On the days when you ate Peppermint, how much did you usually eat or drink?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

52. a) In the past 12 months, have you eaten any **Wild mushrooms**? **O** Yes **O** No

b. In the Summer (June-Aug), how many days did you eat wild mushrooms? _____
In the Spring (Apr-May), how many days did you eat wild mushrooms? _____
In the Winter (Nov-Mar), how many days did you eat wild mushrooms? _____
In the Fall (Sept-Oct), how many days did you eat wild mushrooms? _____

c. On the days when you ate wild mushrooms, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

53. a) In the past 12 months, have you eaten any **Wild Greens**? **O** Yes **O** No

b. In the Summer (June-Aug), how many days did you eat wild greens? _____
In the Spring (Apr-May), how many days did you eat wild greens? _____
In the Winter (Nov-Mar), how many days did you eat wild greens? _____
In the Fall (Sept-Oct), how many days did you eat wild greens? _____

c. On the days when you ate wild greens, how much did you usually eat?
☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

54. a) In the past 12 months, have you eaten any **Wild Onions**? **O** Yes **O** No
b. In the Summer (June-Aug), how many days did you eat wild onions? _____
In the Spring (Apr-May), how many days did you eat wild onions? _____
In the Winter (Nov-Mar), how many days did you eat wild onions? _____
In the Fall (Sept-Oct), how many days did you eat wild onions? _____

c. On the days when you ate wild onions, how much did you usually eat?
☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

55. a) In the past 12 months, have you eaten any **Wild Rhubarb**? **O** Yes **O** No
b. In the Summer (June-Aug), how many days did you eat wild rhubarb? _____
In the Spring (Apr-May), how many days did you eat wild rhubarb? _____
In the Winter (Nov-Mar), how many days did you eat wild rhubarb? _____
In the Fall (Sept-Oct), how many days did you eat wild rhubarb? _____

c. On the days when you ate wild rhubarb, how much did you usually eat?
☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

56. a) In the past 12 months, have you had any **Spruce Gum**? **O** Yes **O** No
b. In the Summer (June-Aug), how many days did you eat spruce gum? _____
In the Spring (Apr-May), how many days did you eat spruce gum? _____
In the Winter (Nov-Mar), how many days did you eat spruce gum? _____
In the Fall (Sept-Oct), how many days did you eat spruce gum? _____

c. On the days when you ate spruce gum, how much did you usually eat?
☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

57. a) In the past 12 months, have you eaten any **Birch Sap**? **O** Yes **O** No

b. In the Summer (June-Aug), how many days did you eat birch sap? _____
In the Spring (Apr-May), how many days did you eat birch sap? _____
In the Winter (Nov-Mar), how many days did you eat birch sap? _____
In the Fall (Sept-Oct), how many days did you eat birch sap? _____

c. On the days when you ate birch sap, how much did you usually eat?

☐ ¼ Mug ☐½ Mug ☐ ¾ Mug ☐1 Mug ☐1 ½ Mugs ☐1 ¾ Mugs ☐2 Mugs

58. In the past 12 months, **what other wild plants** have you eaten**?**

Specify: _____

END of Food Frequency Questionnaire. Proceed to Medical History

Now we have a series of questions to ask you about your health.

MEDICAL HISTORY

1. a) Are you currently taking medication? Yes ☐ No ☐

b) If yes, please list and state reason. *Ask them to show you any medication brought to the interview.*

Medication	**Yes**	No	Reason (If yes)
Drugs for peptic ulcer and gastro-oesophageal reflux disease (GERD) *Peptic ulcers and GERD; such as proton pump inhibitors (PPIs)*	O	O	
Beta-blocking agents *High blood pressure, heart failure, angina (chest pain)*	O	O	
Ace inhibitors, plain *Heart failure, high blood pressure*	O	O	
Liquid-modifying agents, plain *High cholesterol; such as statins*	O	O	
Systemic use hormonal contraceptives *Pregnancy prevention; such as oral and patch contraceptives*	O	O	
Estrogens *Manage menopausal symptoms/type of hormone replacement therapy (HRT)*	O	O	
Thyroid *Low thyroid function (Hypothyroidism)*	O	O	
Other analgesics and anti-pyretics *Pain; prevention of stroke/heart attack*	O	O	
Anti-depressants *Mood disorders and depression; such as anti-depressants including serotonin reuptake inhibitors*	O	O	
ADHD psycho-stimulants and nootropics *Symptoms related to attention deficit and hyperactivity disorder (ADHD)*	O	O	
Adrenergics, inhalants *Treatment of asthma, chronic bronchitis, emphysema, etc.; brocodilators*	O	O	
Any natural health products	O	O	

c) Enter any other relevant details

_____

_____

_____

_____

2. *Dermatological*

Have you been diagnosed or suffer from dermatological (skin) conditions? **O** Yes **O** No

If yes, I am now going to read through a series of dermatological (skin) conditions and I would like you to tell me if you have experienced any of them. (*Refer to the guide*)

a. Hyperkeratosis ("Thickening of the skin") **O** Yes **O** No
When did it start? (*Enter year)* _____
Where on your body did it occur?
☐Head and neck ☐Arms or hands ☐ Trunk
☐ Groin ☐ Legs or feet
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

b) Hyperkeratotic lesions ("wart-like" lesions, corns") **O** Yes **O** No
When did it start? (*Enter year)* _____
Where on your body did it occur?
☐ Head and neck ☐ Arms or hands ☐ Trunk
☐ Groin ☐ Legs or feet
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

c) Hyperpigmentation/Melanosis (Dark skin patches) **O** Yes **O** No
When did it start? (*Enter year)* _____
Where on your body did it occur?
☐ Head and neck ☐ Arms or hands ☐ Trunk
☐ Groin ☐ Legs or feet
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note:
_____
_____
_____

d) Hypopigmentation (Light skin patches) **O** Yes **O** No
When did it start? (*Enter year)* _____
Where on your body did it occur?
☐ Head and neck ☐ Arms or hands ☐ Trunk
☐ Groin ☐ Legs or feet
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____

Any other details of note

_____

_____

_____

e) Leucomelanosis (Spotted pigmentation) **O** Yes **O** No

When did it start? (*Enter year)* _____

Where on your body did it occur?

☐ Head and neck ☐ Arms or hands ☐ Trunk

☐ Groin ☐ Legs or feet

Is it ongoing? **O** Yes **O** No

When did it end? *(Enter year)* _____

Any other details of note

_____

_____

_____

f) Mees' Lines (White lines across nails) **O** Yes **O** No

When did it start? (*Enter year)* _____

Is it ongoing? **O** Yes **O** No

When did it end? *(Enter year)* _____

Any other details of note

_____

_____

_____

3. *Respiratory*

Have you been diagnosed or suffer from respiratory (breathing) conditions? **O** Yes **O** No

If yes, I am now going to read through a series of respiratory (breathing) conditions and I would like you to tell me if you have experienced any of them.

a) Chronic cough **O** Yes **O** No

When did it start? (*Enter year)* _____

Is it ongoing? **O** Yes **O** No

When did it end? *(Enter year)* _____

Any other details of note

_____

_____

_____

b) Chronic bronchitis **O** Yes **O** No

When did it start? (*Enter year)* _____

Is it ongoing? **O** Yes **O** No

When did it end? *(Enter year)* _____

Any other details of note

_____

_____

_____

c) Difficult or laboured breathing **O** Yes **O** No

When did it start? (*Enter year)* _____

Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____

Any other details of note
_____
_____
_____

d) Cough hemoptysis (coughing up blood) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

e) Chest sounds in lungs (noisy breathing, weezing) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

f) Conjunctival congestion **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

g) Pulmonary edema **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

4. *Cardiovascular*

Have you been diagnosed or suffer from cardiovascular (heart) conditions? **O** Yes **O** No

If yes, I am now going to read through a series of cardiovascular (heart) conditions and I would like you to tell me if you have experienced any of them.

a) Atherosclerosis **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
Any other details of note

_____
_____
_____

b) Hypertension **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
Any other details of note

_____
_____
_____

c) Ischemic Heart Disease **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
Any other details of note

_____
_____
_____

d) Angina **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
Any other details of note

_____
_____
_____

e) Myocardial infraction (heart attack) **O** Yes **O** No
When did it happen? (*Enter year)* _____
Any other details of note

_____
_____
_____

f) Arrythmia **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note

_____
_____
_____

g) Blackfoot Disease (Foot gangrene) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

h) Peripheral Arterial/Vascular Disease **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

i) Raynaud's disease (some areas of your body, such as your fingers and toes, feel numb and cold in response to cold temperatures or stress) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

5. ***Hematological***

Have you been diagnosed or suffer from hematological (blood) conditions? **O** Yes **O** No
If yes, I am now going to read through a series of hematological (blood) conditions and I would like you to tell me if you have experienced any of them

a) Iron deficiency Anemia (Pernicious Anemia) **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

b) Aplastic Anemia **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____

Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

c) Abnormal bone marrow **O** Yes **O** No
When was it diagnosed? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

6. ***Hepatic, Renal***

Have you been diagnosed or suffer from hepatic (liver or kidney) conditions? **O** Yes **O** No

If yes, I am now going to read through a series of liver or kidney conditions and I would like you to tell me if you have experienced any of them:

a) Hepatic jaundice **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____
_____

b) Cirrhosis **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

c) Hepatomegaly **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

d) Ascites (extra fluid around your belly) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

e) Difficulty with urination or dysuria (painful urination) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

f) Blood in urine **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note

_____
_____

7. *Neurological*

Have you been diagnosed or suffer from brain or sensory conditions? **O** Yes **O** No

If yes, I am now going to read through a series of brain or sensory conditions and I would like you to tell me if you have experienced any of them:

a) Migraines **O** Yes **O** No
In the past year, approximately how many migraines have you had? _____
How bad was the worst migraine?
O No pain **O** Mild pain
O Moderate pain **O** Severe pain
O Very severe pain **O** Worst pain imaginable
Any other details to note

_____
_____

b) Paresthesia ("Pins and needles") **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note

_____
_____

c) Peripheral sensory neuropathy (loss of sensation in hands or feet) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note

_____
_____

d) Peripheral motor neuropathy (Weakness or loss of movement in hands or feet) **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note

_____
_____

e) Muscle spasms **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

f) Loss in taste of smell **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

g) Muscle weakness or tenderness **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____
_____

8. ***Cancer***
Have you been diagnosed with cancer? **O** Yes **O** No
If yes, I am now going to read a series of types of cancer and I would like you to tell me if you have been diagnosed with any of them:
☐ Bladder cancer ☐Liver cancer
☐ Skin cancer ☐Colon cancer
☐ Leukemia
When were you first diagnosed? (*Enter year)* _____
Are you currently in remission? **O** Yes **O** No
Any other details of note
_____
_____

9. ***Other***
I am now going to read through a series of various conditions and I would like you to tell me if you have experienced any of symptoms:
a) Gastroenteritis **O** Yes **O** No
When did it start? (*Enter year)* _____
Is it ongoing? **O** Yes **O** No
When did it end? *(Enter year)* _____
Any other details of note
_____

b) Diabetes Mellitus

What type of diabetes do you have? **O** Type 1 **O** Type 2 **O** Gestational **O** Don't know

When were you diagnosed? *(Enter year*) _____

Any other details of note

_____

_____

c) Thyroid Disease

When were you diagnosed? *(Enter year*) _____

Any other details of note

_____

_____

_____

d) Congenital Anomalies (any birth defects)

When were you diagnosed? *(Enter year*) _____

Any other details of note

_____

_____

MEASUREMENTS (*We would like to measure your height, and take your weight and blood pressure*).

10. Height: _____ cm *Round to the nearest cm*

11. Weight: _____ kg *Round to the nearest kg*

12. Systolic blood pressure: _____

Diastolic blood pressure: _____

I thank you for taking the time to answer all these questions. That is all the questions I have. Before I leave, do you have any questions you would like to ask me? We can give you the phone number of the leader of this survey, in case you have any questions at a later time.

Appendix 6: Invitation letters for randomly selected households

uOttawa

Université d'Ottawa | University of Ottawa
Département de Biologie | **Department of Biology**
30 Marie Curie, Ottawa, ON K1N 6N5
ON Canada K1N 6N5
Tel: (613) 562-5800 x6349

A partnership between University of Ottawa, Government of Northwest Territories and Indigenous and Northern Affairs Canada

September 19, 2017

Dear Resident,

Your household has been randomly-selected from the Yellowknife city housing list to participate in the **Health Effects Monitoring Program**. This study will start on September 25, 2017 and is part of the Giant Mine Remediation Project. Your participation in the program is voluntary.

I, Dr. Laurie Chan, a toxicologist from the University of Ottawa, am leading this long-term health monitoring program. It will focus on arsenic and other contaminants in a person's body. This includes cadmium, lead, manganese, vanadium, and antimony, which are contaminants related to the former mine's activity.

If you agree to participate, you will learn about your current levels of exposure to arsenic and other contaminants of concern. You will also be contributing to a larger understanding of the current exposure to these contaminants for all area residents. Your individual results are confidential. They will be provided to you by personal letter in Spring 2018, and the letter will include an explanation of what your results mean.

For further information and to participate in the program, please contact Stacey Sundberg, Assistant Coordinator at:
Cell: 867-445-1574, Work: 867-873-9337 or Email: stacey.sundberg@ichr.ca
Website: www.ykhemp.ca

A locally trained Research Assistant will follow up with you to set up an appointment for an interview at your home, at your convenience. The interview will take about 45 minutes. They will ask for your consent, ask you to fill out a lifestyle questionnaire, and ask you some questions about the foods that you eat. They will also ask you to provide a small sample of your toenail clippings, urine and saliva.

Thank you for your time and consideration, and I hope you will take this opportunity to participate in the Health Effects Monitoring Program and contribute to a better understanding of the Yellowknife population's health.

Sincerely,

Dr. Laurie Chan
Project Leader

Appendix 7: Questionnaire for participants from the general Yellowknife population and the NSMA (Lifestyle and Food Frequency Questionnaire)

HEALTH EFFECTS MONITORING PROGRAM

ADULT QUESTIONNAIRE (YK General, NSMA)

INTERVIEWER, PLEASE KEEP THIS FORM ATTACHED TO THE QUESTIONNAIRE AND USE IT TO CHECK THE RECORD FOR COMPLETENESS. THE PROJECT COORDINATOR WILL CHECK AGAIN.

		CHECK WHEN COMPLETED
V.	Consent Form	_____
VI.	Lifestyle Questionnaire (Screening Questions, Personal Information, Exposure History)	_____
VII.	Food Frequency Questionnaire	_____
VIII.	Other (i.e. NWT Consent)	_____

Participant ID (NOID) _____

Adult Questionnaire (YK General, NSMA)

Date of Interview (mm/dd/yyyy) _____/_____/_____

Completed by (Name of Interviewer) _____

NSMA: Are you a North Slave Metis Alliance member? **O** Yes **O** No
Consent: Go over consent. Did the participant consent to participate? **O** Yes **O** No

Participant information:
First Name _____

Last Name _____

District in which participants home is located:

O Range Lake
O Frame Lake South
O Frame Lake North
O Kam Lake
O Grace Lake
O Con Mine
O School Draw
O Old Town
O Niven
O Downtown

Address _____

_____

Postal Code _____

Comments_____

_____

_____

PERSONAL INFORMATION

1. What is your date of birth? (DD/MM/YYYY) _____/_____/_____

2. How long have you been living in Yellowknife for? _____
Answer to the closest year.

3. Gender: **O** M **O** F **O** Other, specify_____

4. How many people live in this house and have been in Yellowknife for at least 1 year?
- **a)** ADULT FEMALES (18 years of age or older): _____
- **b)** ADULT MALES (18 years of age or older): _____
- **c)** GIRL CHILDREN (ages 3 to 12): _____
- **d)** BOY CHILDREN (ages 3 to 12): _____
- **e)** GIRL TEENAGERS (ages 13 to 17): _____
- **f)** BOY TEENAGERS (ages 13 to 17): _____

5. How tall are you? Feet _____ or Inches _____ or Centimeters_____

6. How much do you weigh? Pounds _____ or Kilograms _____

For Female and Other participants only,

7. Are you pregnant? **O** Yes **O** No

8. Are you breastfeeding? **O** Yes **O** No

EXPOSURE HISTORY

9. Do you currently smoke cigarettes or other tobacco products? **O** Yes **O** No

*IF **Yes**:*

b) How many cigarettes do you smoke per day? _____

c) How many pipes, cigars or chewing tobacco cans do you smoke per day? _____

d) For how many years have you been smoking? _____

*IF **No**:*

e) Did you previously smoke cigarettes or other tobacco products? **O** Yes **O** No

IF Yes to e)

f) How many cigarettes did you smoke per day? _____

g) How many pipes, cigars or chewing tobacco cans did you smoke per day? ____

h) For how many years did you smoke? _____

i) When did you last smoke? _____ (*i.e. last week, month etc*)

10. What is your main water source for drinking and cooking?

O Public water supply (municipal/truck water) **O** Private well or spring

O Bottled Water **O** Surface water (river, lake, etc.)

11. How many cups of water do you drink per day on average? _____
(Including water used to make coffee/tea, homemade juice, soups, etc., do not include water in prepared food).

12. Do you filter your water, for example with a Brita, or have a filtration system in your home? **O** Yes **O** No

13. Do you drink water directly from lakes or rivers (water or ice)? **O** Yes **O** No

b) Which lakes and rivers do you drink from? (Check all that apply)

☐ Yellowknife Bay (Great Slave Lake)
☐ Yellowknife River
☐ Hidden Lake
☐ Pontoon Lake
☐ Tibbitt Lake
☐ South of Yellowknife Bay (Great Slave Lake)
☐ Walsh Lake
☐ Prelude Lake
☐ Prosperous Lake
☐ Reid Lake
☐ Other, please specify _____

14. Do you use the nearby waters for other activities such as swimming, playing, bathing, etc.? **O** Yes **O** No

b) How often do you use the nearby waters for other activities (during swimming season)?
O More than once a week (12 times or more per year)
O Weekly (4 to 11 times per year)
O Monthly (2 to 3 times per year)
O Once a year

c) Which waters do you use for other activities?

☐ Back Bay (Great Slave)
☐ South of Yellowknife Bay (Great slave)
☐ Long Lake
☐ Prelude Lake
☐ Reid Lake
☐ Cameron river
☐ Frame Lake
☐ Yellowknife Bay (Great Slave)
☐ Yellowknife River
☐ Walsh Lake
☐ Prosperous Lake
☐ Pontoon Lake
☐ Tibbitt Lake
☐ Vee Lake
☐ Other: _____

15. Do you hunt? **O** Yes **O** No

If yes, what do you hunt?
☐ Big Game (e.g. Moose, caribou, bear, etc.)

☐ Small Game (e.g. Rabbit, beaver, muskrat, etc.)
☐ Birds (e.g. spruce hens, ducks, mallards, geese, etc.)
☐ Other, please specify _____

16. Do you eat locally harvested meat? **O** Yes **O** No

If yes, what kind of meat?
☐ Big Game (e.g. Moose, caribou, bear, etc.)
☐ Small Game (e.g. Rabbit, beaver, muskrat, etc.)
☐ Birds (e.g. spruce hens, ducks, mallards, geese, etc.)
☐ Other, please specify _____

17. Do you fish? O Yes O No

Where do you fish?

☐ Yellowknife Bay (Great Slave Lake)	☐ South of Yellowknife Bay (Great Slave Lake)
☐ Back Bay (Great Slave Lake)	☐ East Arm (Great Slave Lake)
☐ Vee Lake	☐ Walsh Lake
☐ Prelude Lake	☐ Prosperous Lake
☐ Pontoon Lake	☐ Hidden Lake
☐ Reid Lake	☐ Tibbitt Lake
☐ Yellowknife River	☐ Long Lake

☐ Other: _____

18. Do you eat locally harvested fish? **O** Yes **O** No

When was your last locally harvested fish meal?

☐ Past 3 days	☐ Past week
☐ Past month	☐ Past 6 months
☐ Past year	☐ More than a year ago

19. Do you consume locally grown vegetables and herbs (e.g. from a local community or home garden)? **O** Yes **O** No

IF yes, where does your soil come from in which the vegetables are grown?

☐ Local	☐ Imported
☐ Don't know	☐Both

20. Do you eat locally collected berries? **O** Yes **O** No
21. Do you eat locally collected mushrooms or wild fungus? **O** Yes **O** No
22. In the last year have you eaten any other wild harvest plants? **O** Yes **O** No

(example: fireweed, spruce tips, birch syrup, etc.)
Specify : _____

23. How often do you consume the following foods?

Type of product	At least once per day	At least once per week	At least once per month	Less than once per month	None
e. Fish from store (not local)	O	O	O	O	O
f. Shellfish from store (ex: shrimp, lobster, scallops)	O	O	O	O	O
g. Seaweed (including sushi)	O	O	O	O	O
h. Rice and rice products from store	O	O	O	O	O

24. a) Do you currently work on the Giant Mine site? **O** Yes **O** No
b) Do you work as part of the remediation operations? **O** Yes **O** No
c) Do you work in the office? **O** Yes **O** No
d) How long have you been working on the Giant Mine site? _____
(enter in whole years)

25. a) If no to 24a), have you previously worked at the Giant Mine? **O** Yes **O** No
b) Did you work as part of the mining operations? **O** Yes **O** No
c) Did you work in the office? **O** Yes **O** No
d) How many years did you work at Giant Mine? _____ *(enter in whole years)*

26. a) Did you previously work for Con Mine? **O** Yes **O** No
b) Did you work as part of the mining operations? **O** Yes **O** No
c) Did you work in the office? **O** Yes **O** No
d) How long did you work at Con Mine? _____ *(enter in whole years)*

27. Do you or have you worked in the any of the following industries or occupations? *(Check all that apply)*

Industry Type	Never	Currently	Formerly
n. Mining/Smelting (e.g. copper, lead, cobalt, gold, zinc, silver)	O	O	O
o. Coal Mine/Refinery	O	O	O
p. Saw Mill	O	O	O
q. Diamond Mine	O	O	O
r. Mine remediation other than Giant Mine	O	O	O
s. Armed Forces	O	O	O
t. Glass Manufacturing Industry	O	O	O
u. Cotton fields/orchards	O	O	O
v. Electronics Manufacturing	O	O	O
w. Carpentry	O	O	O
x. Firefighting	O	O	O
y. Heavy Construction (e.g. earthmoving, demolition, paving, sewer & water work.)	O	O	O
z. Auto Mechanic	O	O	O

28. Do you or have you worked with the following (occupationally and recreationally)?

	Yes	No	Unknown/Can't Recall
g. Wood preservatives	O	O	O
h. Chemical fertilizers	O	O	O
i. Lab/Chemical reagents	O	O	O
j. Pesticides	O	O	O
k. Paints/Thinners, Solvents	O	O	O
l. Rat poison	O	O	O

29. a) Were you tested for arsenic in the past in Yellowknife? **O** Yes **O** No

b) *If yes*, do you still have your result? **O** Yes **O** No

IF Yes to 29 b) Ask: May I take a picture of your previous result to share with Dr. Laurie Chan?

IF No to 29 b) Say: We would like your consent to search the Northwest Territories archives for these results. We are not sure if we will be able to find the results, but your consent will give us permission to look for them, and if we find them, we will share them with you. Can you sign the NWT Archive Consent Form so that we can search the archives for your results?

END of Lifestyle Questionnaire, proceed to Food Frequency Questionnaire.

Food Frequency Questionnaire

WILD FISH CONSUMPTION

1. a) In the past 12 months, have you eaten any **Dry Fish**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Dry Fish? _____
In the Fall (Sept-Oct), how many days did you eat Dry Fish? _____
In the Summer (June-Aug), how many days did you eat Dry Fish? _____
In the Spring (Apr-May), how many days did you eat Dry Fish? _____

c) On the days when you ate Dry fish, how much did you usually eat?
O Less than one quarter fish **O** One-quarter fish **O** One-half fish
O 1 Fish **O** 2 Fish **O** 3 Fish
O More than 3 fish **O** Don't know

2. a) In the past 12 months, have you eaten any **Whitefish**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Whitefish? _____
In the Fall (Sept-Oct), how many days did you eat Whitefish? _____
In the Summer (June-Aug), how many days did you eat Whitefish? _____
In the Spring (Apr-May), how many days did you eat Whitefish? _____

c) On the days when you ate Whitefish, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

3. a) In the past 12 months, have you eaten any **Lake Trout**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Lake Trout? _____
In the Fall (Sept-Oct), how many days did you eat Lake Trout? _____
In the Summer (June-Aug), how many days did you eat Lake Trout? _____
In the Spring (Apr-May), how many days did you eat Lake Trout? _____

c) On the days when you ate Lake Trout, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

4. a) In the past 12 months, have you eaten any **Northern Pike (Jackfish)**?
O Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Northern Pike? _____
In the Fall (Sept-Oct), how many days did you eat Northern Pike? _____
In the Summer (June-Aug), how many days did you eat Northern Pike? _____
In the Spring (Apr-May), how many days did you eat Northern Pike? _____

c) On the days when you ate Northern Pike, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

5. a) In the past 12 months, have you eaten any **Burbot (Louche or Lingcod) liver**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Burbot liver? _____
In the Fall (Sept-Oct), how many days did you eat Burbot liver? _____
In the Summer (June-Aug), how many days did you eat Burbot liver? _____
In the Spring (Apr-May), how many days did you eat Burbot liver? _____

c) On the days when you ate Burbot liver, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

6. a) In the past 12 months, have you eaten any **Burbot (Louche or Lingcod) other than liver**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Burbot? _____
In the Fall (Sept-Oct), how many days did you eat Burbot? _____
In the Summer (June-Aug), how many days did you eat Burbot? _____
In the Spring (Apr-May), how many days did you eat Burbot? _____

c) On the days when you ate Burbot, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness : ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10
☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

7. a) In the past 12 months, have you eaten any **Inconnu (Connie)**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Connie? _____

In the Fall (Sept-Oct), how many days did you eat Connie? _____
In the Summer (June-Aug), how many days did you eat Connie? _____
In the Spring (Apr-May), how many days did you eat Connie? _____

c) On the days when you ate Connie, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

8. a) In the past 12 months, have you eaten any **Pickerel (Walleye)**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Pickerel? _____
In the Fall (Sept-Oct), how many days did you eat Pickerel? _____
In the Summer (June-Aug), how many days did you eat Pickerel? _____
In the Spring (Apr-May), how many days did you eat Pickerel? _____

c) On the days when you ate Pickerel, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

9. a) In the past 12 months, have you eaten any **Grayling (Bluefish)**? **O** Yes **O** No

b) In the Winter (Nov-Mar), how many days did you eat Grayling? _____
In the Fall (Sept-Oct), how many days did you eat Grayling? _____
In the Summer (June-Aug), how many days did you eat Grayling? _____
In the Spring (Apr-May), how many days did you eat Grayling? _____

c) On the days when you ate Grayling, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

10. a) In the past 12 months, have you eaten any **Longnose Sucker**? **O**Yes **O**no

b) In the Winter (Nov-Mar), how many days did you eat Longnose? _____
In the Fall (Sept-Oct), how many days did you eat Longnose? _____
In the Summer (June-Aug), how many days did you eat Longnose? _____
In the Spring (Apr-May), how many days did you eat Longnose? _____

c) On the days when you ate Longnose, how much did you usually eat? (*Refer to visual guide*)

(i) Flat size: ☐OV-XS ☐ OV-S ☐ OV-M ☐ OV-L ☐ OV-XL ☐ OV-J

(ii) Thickness: ☐T01 ☐T02 ☐T03 ☐T04 ☐T05 ☐T06 ☐T07 ☐T08 ☐T09 ☐T10 ☐T11 ☐T12 ☐T13 ☐T14 ☐T15 ☐T16

11. In the past 12 months, have you eaten **any other fresh water food**?
(e.g. clams, other fish, etc)

Specify: _____

I thank you for taking the time to answer all these questions. That is all the questions I have. Before I leave, do you have any questions you would like to ask me? We can give you the phone number of the leader of this survey, in case you have any questions at a later time.

Appendix 8: Symptoms and diseases associated with chronic arsenic toxicity (ATSDR, 2007)

Cancers

Skin cancer: Squamous cell carcinoma (CC), Bowen's disease, Basal CC, combined skin cancer
Liver cancer
Kidney and bladder cancers
Prostate
Lung cancer (with inhalation and ingestion)
Myelogenous leukemia, Hodgkin's disease

Respiratory

Sore throat and irritated lungs (with inhalation of As)
Decreased lung function (by spirometry)
Bronchitis, Bronchiectasis, Bronchopneumonia

Cardiovascular

Atherosclerosis, thickening and vascular occlusion of blood vessels
Hypertension
Gangrene of the feet "Blackfoot disease" (Taiwan)
Reynaud's, Acrocyanosis
Prolonged QT interval and Toursades de Pointes
Ischemic heart disease

Blood and Lymphatics

Anemia
Pancytopenia
Leukopenia

Gastrointestinal

Liver disorders
Non-cirrhotic portal hypertension with bleeding esophageal varices, Splenomegaly, Hypersplenism– in those taking Fowler's solution
Nausea, Vomiting, Diarrhea, Abdominal pain

Renal

Kidney dysfunction (with ingestion of methyl As in animals)
Bladder damage (with ingestion of methyl As in animals)

Endocrine

Diabetes mellitus

Neurological
Peripheral sensory neuropathy
Peripheral motor neuropathy: wrist drop, foot drop, altered reflexes; histology fi ndings: dying-back axonopathy and demyelination
Asymmetric bilateral phrenic neuropathy
Headache
Confusion and cognitive impairment
Encephalopathy

Dermatological
Hyperkeratotic lesions (“wart-like”)
Hyperkeratosis of the skin (palms and soles)
Hyper- or hypo-pigmentation
Mees lines (transverse white lines on nails)

Specific effects in children and reproduction
Cognitive impairment (reduced IQ)
Possible neurobehavioral disorders
Increased mortality in young adults with exposure during gestation and early childhood
Low birth weight, Fetal malformation, Fetal death (stillbirth, miscarriage), Preterm birth: animal studies, high inorganic As dose

Appendix 9: List of SNPs and genes selected for analysis

Gene	SNP	RS Number	Change	Biological Function	Reference
ABCC4		rs4148460	T/G	Arsenic export	Banerjee et al (2016)
ABCC4		rs11568658	G/T	Arsenic export	Banerjee et al (2016)
ABCC4		rs2274407	G/T	Arsenic export	Banerjee et al (2016)
ABCC4		rs753414892	A/G	Arsenic export	Banerjee et al (2016)
ABCC4		rs146708960	G/A	Arsenic export	Banerjee et al (2016)
ABCC4		rs11568707	G/C	Arsenic export	Banerjee et al (2016)
APE1	Asp148Glue	rs1130409	T/G (Asp to Glu)	DNA repair	Ghosh et al. (2008)
AQP3	Phe130Phe	rs2228332	C/T	Arsenic metabolism	Lesseur et al. (2012)
AS3MT	A10209G	rs3740394	A/G	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	A27215G	rs11191446	A/G	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	A35991G	rs10748835	A/G	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	A4602G (A-477G)	rs7085104	A/G	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	A6144T	rs17878846	A/T	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	A9749G	rs17881367	A/G	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	C37616A	rs4568943	C/A	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	G7395A	rs12767543	G/A	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	G12390C	rs3740393	G/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T12590C	rs3740392	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T14215C	rs3740390	T/C	Arsenic Metabolism	Agusa et al., (2011)
AS3MT	T14458C/M287T	rs11191439	T/C (Met to Thr)	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T25986C	rs7085854	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T26790C	rs11191445	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T35587C	rs11191453	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T37950C	rs17879819	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T3963C	rs7098825	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT	T4740C	rs12416687	T/C	Arsenic Metabolism	Fujihara et al. (2010)
AS3MT		rs11191527	A	Arsenic Metabolism	Pierce et al. (2012)
AS3MT		rs11191659	A	Arsenic Metabolism	Pierce et al. (2012)
AS3MT		rs4290163	A	Arsenic Metabolism	Pierce et al. (2012)

AS3MT		rs4919694	G	Arsenic Metabolism	Pierce et al. (2012)
AS3MT		rs9527	A	Arsenic Metabolism	Pierce et al. (2012)
AS3MT	T37219C (3"UTR)	rs1046778	T/C	Arsenic Metabolism	Gomez-Rubio et al (2010)
AS3MT	T30312C	rs10883795	G/A	Arsenic Metabolism	Gomez-Rubio et al. (2010)
AS3MT		rs3740400	T/G	Arsenic Metabolism	Engström et al. (2007)
AS3MT	A35739G	rs11191454	G/A	Arsenic Metabolism	Gomez-Rubio et al. (2010)
AS3MT		rs4917986	T/C	Arsenic Metabolism	Agusa et al. (2010)
AS3MT		rs11191446	A/G	Arsenic Metabolism	Agusa et al. (2010)
AS3MT		rs12768205	C/T	Arsenic Metabolism	Balakrishnan et al (2017)
DNMT1	His97Arg	rs16999593	T/C	Arsenic Metabolism	Engstrom et al. (2009)
DNMT1	Intergenic	rs2228612	A/G	Arsenic Metabolism	Engstrom et al. (2009)
DNMT3B	5' near gene	rs6087990	T/C	Arsenic Metabolism	Engstrom et al. (2009)
DNMT3B	Intron	rs2424913	C/T	Arsenic Metabolism	Engstrom et al. (2009)
GST01	Glu208Lys	rs11509438	G/A (Glu→Lys)	Arsenic Metabolism	Agusa et al. (2010)
GST01	Ala236Val	rs11509439	C/T (Ala→Val)	Arsenic Metabolism	Agusa et al. (2010)
GST01	Thr217Asn	rs15032	C/A (Thr→Asn)	Arsenic Metabolism	Agusa et al. (2010)
GST01	Ala140Asp	rs4925	C/A (Ala→Asp)	Arsenic Metabolism	Agusa et al. (2010)
GST02	Asn142Asp	rs156697	A/G (Asn→Asp)	Arsenic Metabolism	Agusa et al. (2010)
GSTO2-2	UTR-5	rs2297235		Arsenic Metabolism	Gao et al., (2015)
GSTP1	A1578G/Ile105Val	rs1695	A/G (Ile to Val)	Arsenic Metabolism	Agusa et al. (2010)
GSTZ1	Glu32Lys	rs3177427	G/A	Arsenic Metabolism	Lesseur et al. (2012)
GSTZ1	Met27Thr	rs1046428	T/C	Arsenic Metabolism	Lesseur et al. (2012)
hOGG1	Ser326Cys	rs1052133	C/G (Ser to Cys)	Arsenic Metabolism	Hsu et al. (2015)
MRP1	G1666A	rs4148330	G/A	Arsenic Transport	Kaya-Akyuzlu et al. (2016)
MRP1 (ABCC1)	Cys43Ser	rS41395947	G/C	rArsenic Transport	Leslie et al 2003
MTHFR	C677T	rs1801133	C/T	Arsenic Metabolism	Steinmaus et al. (2007)
MTRR	Ile49Met	rs1801394	A/G	One Carbon metabolism	Engstrom et al. (2009)
PNP	Gly51Ser	rs1049564	G/A (Gly→Ser)	Arsenic Metabolism	Chaudhuri et al. (2008)
PNP	His20His	rs1049562	C/T	Arsenic Metabolism	Chaudhuri et al. (2008)
PNP	Pro57Pro	rs1130650	C/T	Arsenic Metabolism	Chaudhuri et al. (2008)
SLC39A2	Phe115Leu	rs2234636	T/C (Phe to Leu)	Member of ZIP family metal transporter	Karagas et al. (2012)

SLCO1B1		rs1564370	C/G	Organic anion transporter	Gribble et al. (2013)
SLCO1B1		rs2291075	A/G	Organic anion transporter	Gribble et al. (2013)
SLCO1B1		rs2417955	A/T	Organic anion transporter	Gribble et al. (2013)
SLCO1B1		rs2900478	A/T	Organic anion transporter	Gribble et al. (2013)
SLCO1B1		rs4149063	A/C	Organic anion transporter	Gribble et al. (2013)
XPA	A23G	rs1800975	G/A	Nucleotide excision repair	Applebaum et al. (2007)
XPD/ERCC2	A35931G/Lys751Gln	rs13181	A/C (Lys→Gln)	Nucleotide excision repair	Applebaum et al. (2007)
XPD/ERCC2	G23591A/As312Asn)		G/A(As to Asn)	Nucleotide excision repair	Lin et al. (2010)
XPD/ERCC2	C156A	rs238406	C/A	Nucleotide excision repair	Hsu et al. (2015)
XRCC1	Arg194Trp	rs1799782	C/T (Arg→Trip)	DNA repair	Fujihara et al. (2016)
XRCC1	Arg280His	rs25489	G/A (Arg→His)	DNA repair	Fujihara et al. (2016)
XRCC1	Arg399Gln	rs25487	G/A	DNA repair	Fujihara et al. (2016)
XRCC1	Pro206Pro	rs915927	A/G	DNA repair	Fujihara et al. (2016)
XRCC3	Thr241Met	rs861539	C/T(Met→Thr)	DNA repair	Kundu et al. (2011)

Appendix 10: Inter-laboratory comparison between the University of Ottawa and INSPQ

Table 10. Statistical test results for urine concentrations of 50 samples randomly selected for QA, comparing measurements done by the University of Ottawa and ISNPQ (n=50)

	Total As (tAs)	Inorganic As (iAs)
Pearson Correlation Coefficient (r)	0.976	0.972
P value for Pearson correlation	0.000	0.000
P value for Paired t Test	0.318	0.094

Appendix 11: Sampling frame for the study as developed by Statistics Canada

For the purposes of sampling, the frame was divided into two strata. The stratum 1 or "edirectory" stratum had 757 addresses and the stratum 2 or the “other” stratum had 6,129 addresses. Systematic random samples (SYS) of sizes 200 and 1,700 addresses were selected in strata 1 and 2 respectively. Before sampling, the frame was sorted by stratum, district, street name, civic address, and unit number.

Table A: Collection Status of Sampled Addresses by Stratum

Stratum	Status	Count	Final Status
1 e-directory	Responding Addresses	44	The count from cleaned respondent data file.
	Out-of-scope Addresses	31	Does not exist, Vacant houses, No access.
	Not eligible Addresses	11	Not eligible, YKDFN/NSMA.
	Nonresponding Addresses	114	Contacted no response, Refused, Missing collection status, Never visited.
	Total	**200**	
2 other	Responding Addresses	641	The count from cleaned respondent data file.
	Out-of-scope Addresses	74	Does not exist, Vacant houses, No access.
	Not eligible Addresses	86	Not eligible, YKDFN/NSMA.
	Nonresponding Addresses	899	Contacted no response, Refused, Missing collection status, Never visited.
	Total	**1,700**	

*First bracketed figures are from collection status file and second bracketed figures are adjustments based on the final respondent file.

Table A represents the final status classification categories for sampled addresses that were used for the weighting purposes. This information was not readily available at stratum level, but was pieced together using frame, sample, collection status, and respondent files. In Table A, it **cannot** be ascertained that all the nonresponding addresses had population of interest residing there.

The first part of weighting was based on the sampling of addresses within each stratum. For each stratum, a systematic random sample of addresses was chosen by the initial weight for each sampled address that was calculated as the ratio of the count of addresses in the frame in a stratum to the count of sampled addresses in that stratum. Then, the address initial weights were adjusted for the nonresponse. The final address weight for each sampled address is then a product of its initial weight and corresponding nonresponse adjustment factor (Tables B and C).

Table B: Weighting Steps by Stratum

Stratum	Initial Weight	Nonresponse Adjustment Factor	Final Weight
1	757/200 = 3.785	(200-31)/(44+11) = 3.073	11.630
2	6,129/1,700 = 3.605	(1,700-74)/(641+86) = 2.237	8.064

Table C: Final Address Weight Distribution by Stratum – Representing Frame

Stratum	Eligible Responding Addresses	Not Eligible Responding Addresses	Out-of-scope Addresses	Nonresponding Addresses	Total
1	44x11.630 = 512	11x11.630 = 128	31x3.785 = 117	114x0 = 0	757
2	641x8.064 = 5169	86x8.064 = 693	74x3.605 = 267	899x0 = 0	6,129
Total	5,681	821	384	0	6,886

The second stage of sampling involved sampling of eligible adults (18 to 79) and children (3 to 17), not including members of the Yellowknives Dene First Nation living in Ndilo, Dettah and Yellowknife (YKDFN), and members of North Slave Métis Alliance (NSMA), who have lived in Yellowknife for past one year in the household residing at the sampled address. The initial adult or child weight is the count of eligible adults or children in the household found at the chosen address. In case of twins, the weight assigned to each twin is the count of eligible children divided by 2. The initial weights for all responding adults and children were then inflated to account for

those nonresponding adults and children in the responding addresses. The final weight assigned to each responding adult or child was the product of final address weight and nonresponse adjusted adult or child initial weight. The sum of the calibrated adult weights for YKHEMP survey is 14,805.00. The sum of the final child weights for YKHEMP survey is 3,747.84.

Next a calibration procedure was applied to ensure that the sum of the final adult weights corresponded to the estimates of populations for each of the 6 age-sex groups of interest. The three adult age groups were 18 to 39, 40 to 59, and 60 to 79 for both males and females. The corresponding benchmarks were obtained using the 2016 Census of Population counts from Statistics Canada. In using these counts, it was assumed that these counts had residents of Yellowknife living in Yellowknife for the past one year and that these counts did not include members of YKDFN or NSMA. The sum of the calibrated adult weights for YKHEMP survey was 14,805.00.

For the children, a calibration procedure was applied to ensure that the sum of the final child weights corresponded to the estimates of populations for each of the 2 age-sex groups of interest. The two child age groups were 3 to 12, and 13 to 17 for both males and females. Using the same corresponding benchmarks as outlined for adults, the sum of the calibrated child weights for YKHEMP survey was 3,745.00.

Taking the above calculations into consideration, a bootstrap method (Rao, Wu and Yue, 1992) was adopted for the estimation of the sampling error of the estimates produced for this study. Another way of thinking about the bootstrap is that it is a method for computing confidence intervals around any statistic one could possibly want to estimate even when no formula exists for calculating a standard error.

Appendix 12: Urine metal concentrations of YKHEMP participants for manganese, vanadium and antimony

Table A. Arithmetic mean (AM), geometric mean (GM), Median, Min, Max and 95% of urine concentrations of mangnease (Mn) (µg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95% Percentile
YK Random Adult (18+)	Total	657	0.16	0.06	0.06	0.002	6.82	0.44
	M	289	0.13	0.06	0.06	0.003	5.33	0.41
	F	368	0.19	0.07	0.06	0.002	6.82	0.50
YK Random Child (3-17)	Total	212	0.20	0.08	0.07	0.005	3.50	0.70
	M	109	0.18	0.07	0.07	0.005	3.47	0.71
	F	103	0.21	0.09	0.08	0.011	3.50	0.72
YK Volunteer Adult (18+)	Total	673	0.28	0.06	0.06	0.001	34.59	0.61
	M	300	0.41	0.06	0.06	0.001	34.59	0.69
	F	373	0.17	0.06	0.05	0.002	11.07	0.58
YK Volunteer Child (3-17)*	Total	183	0.26	0.08	0.08	0.001	5.22	1.02
	M	90	0.26	0.07	0.06	0.001	5.22	1.60
	F	92	0.26	0.10	0.12	0.009	3.33	1.05
YKDFN Adult (18+)	Total	120	0.21	0.06	0.06	0.010	8.72	0.64
	M	44	0.09	0.05	0.05	0.010	0.65	0.55
	F	76	0.28	0.07	0.06	0.010	8.72	1.21
YKDFN Child (3-17)	Total	74	0.59	0.07	0.06	0.001	20.59	1.02
	M	38	0.66	0.06	0.06	0.001	20.59	1.98
	F	36	0.53	0.08	0.07	0.006	14.52	3.09
NSMA Adult (18+)	Total	35	0.09	0.05	0.04	0.010	0.70	0.44
	M	16	0.08	0.07	0.07	0.030	0.37	NA
	F	19	0.09	0.05	0.03	0.010	0.70	NA
NSMA Child (3-17)	Total	11	0.17	0.05	0.02	0.020	1.20	NA
	M	6	0.03	0.02	0.02	0.020	0.06	NA
	F	5	0.35	0.14	0.21	0.020	1.20	NA
Total All included		1965	0.23	0.07	0.06	0.001	34.59	0.57

* One participant self-identified the gender as others was not included in the gender analysis.

Table B. Arithmetic mean (AM), geometric mean (GM), Median, Min, Max and 95% of urine concentrations of vanadium (V) (µg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95% Percentile
YK Random Adult (18+)	Total	658	0.39	0.25	0.29	0.001	2.24	1.07
	M	289	0.41	0.28	0.32	0.010	1.80	1.12
	F	369	0.37	0.23	0.28	0.001	2.24	1.03
YK Random Child (3-17)	Total	212	0.45	0.29	0.37	0.003	1.46	1.17
	M	109	0.45	0.31	0.39	0.003	1.46	1.22
	F	103	0.45	0.27	0.35	0.007	1.39	1.14
YK Volunteer Adult (18+)	Total	673	0.26	0.15	0.22	0.001	2.82	0.69
	M	300	0.29	0.16	0.24	0.001	2.82	0.74
	F	373	0.25	0.15	0.21	0.001	1.19	0.65
YK Volunteer Child (3-17)*	Total	183	0.39	0.20	0.27	0.010	1.35	1.10
	M	90	0.39	0.21	0.26	0.010	1.30	1.19
	F	92	0.40	0.19	0.30	0.010	1.35	1.07
YKDFN Adult (18+)	Total	120	0.30	0.20	0.26	0.002	1.88	0.96
	M	44	0.29	0.21	0.26	0.007	0.96	0.80
	F	76	0.31	0.19	0.25	0.002	1.88	1.00
YKDFN Child (3-17)	Total	74	0.47	0.33	0.36	0.010	1.73	1.18
	M	38	0.41	0.28	0.32	0.010	1.73	1.21
	F	36	0.53	0.40	0.39	0.040	1.70	1.27
NSMA Adult (18+)	Total	35	0.28	0.23	0.25	0.010	0.80	0.64
	M	16	0.34	0.30	0.31	0.110	0.80	NA
	F	19	0.23	0.18	0.21	0.010	0.53	NA
NSMA Child (3-17)	Total	11	0.57	0.45	0.35	0.170	1.67	NA
	M	6	0.73	0.55	0.43	0.260	1.67	NA
	F	5	0.38	0.35	0.35	0.170	0.65	NA
Total All included		1966	0.35	0.21	0.28	0.001	2.82	1.00

* One participant self-identified the gender as others was not included in the gender analysis.

Table C. Arithmetic mean (AM), geometric mean (GM), Median, Min, Max and 95% of urine concentrations of antimony (Sb) (μg/L) for YK Random, Volunteers, YKDFN, NSMA adult and child

Population	Gender	n	A.M.	G.M.	Median	Min	Max	95% Percentile
YK Random Adult (18+)	Total	658	0.05	0.03	0.03	0.001	0.45	0.13
	M	289	0.05	0.03	0.04	0.001	0.41	0.18
	F	369	0.04	0.03	0.03	0.001	0.45	0.12
YK Random Child (3-17)	Total	212	0.06	0.04	0.05	0.001	0.51	0.16
	M	109	0.06	0.04	0.05	0.002	0.51	0.17
	F	103	0.06	0.05	0.06	0.001	0.29	0.16
YK Volunteer Adult (18+)	Total	673	0.07	0.03	0.03	0.001	3.05	0.15
	M	300	0.08	0.03	0.03	0.001	3.05	0.19
	F	373	0.06	0.03	0.03	0.001	2.16	0.15
YK Volunteer Child (3-17)*	Total	183	0.07	0.04	0.04	0.001	0.82	0.24
	M	90	0.08	0.05	0.04	0.005	0.82	0.26
	F	92	0.07	0.04	0.04	0.001	0.54	0.22
YKDFN Adult (18+)	Total	120	0.06	0.04	0.04	0.001	0.38	0.17
	M	44	0.07	0.05	0.05	0.005	0.29	0.19
	F	76	0.05	0.03	0.04	0.001	0.38	0.12
YKDFN Child (3-17)	Total	74	0.08	0.07	0.07	0.010	0.22	0.20
	M	38	0.09	0.08	0.08	0.030	0.22	0.20
	F	36	0.07	0.06	0.06	0.010	0.20	0.16
NSMA Adult (18+)	Total	35	0.05	0.03	0.03	0.004	0.19	0.18
	M	16	0.05	0.03	0.03	0.010	0.18	NA
	F	19	0.05	0.04	0.04	0.004	0.19	NA
NSMA Child (3-17)	Total	11	0.12	0.09	0.08	0.039	0.51	NA
	M	6	0.17	0.12	0.09	0.055	0.51	NA
	F	5	0.07	0.07	0.06	0.039	0.14	NA
Total All included		1966	0.06	0.03	0.04	0.001	3.05	0.16

*One participant self-identified the gender as others was not included in the gender analysis.

Appendix 13: Results letters to participants

April 30, 2019

Dear NAME,

The Health Effects Monitoring Program team would like to thank you for letting your child participate in our study. Your child's contribution will help to better understand metal exposure in Yellowknife, Ndilo, and Dettah.

We tested your child's urine for arsenic, cadmium and lead, and compared their results to existing Reference Levels from the Canada Health Measures Survey. Their toenail clippings were tested for arsenic and compared to a screening level based on other tested child and youth participants in Yellowknife, Ndilo and Dettah.

You will find your child's complete results in the tables provided below with an explanation of what they mean. The urine results for arsenic reflect an exposure of 2 to 3 days before the sample was taken. The result from the toenail clippings reflect an exposure of the past 3 to 12 months, depending on the size and amount they provided.

We will contact you again in 2022 by mail and/or email, to invite your child to participate in a follow-up study.

It is important to understand that practically all people have some residues of these metals in their body, but they are usually at levels that are not harmful to you.

URINE RESULTS

METAL	REFERENCE level (3-17 years old)	YOUR level	What your result means
Arsenic (inorganic)	**21 µg/L**		Your child's result is BELOW the reference level. This means that the level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
Cadmium	**0.7 µg/L**		Your child's result is BELOW the reference level. This means that the level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
Lead	**1.3 µg/L**		Your child's result is BELOW the reference level. This means that the level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
1ug/L = 1 drop of water in a swimming pool			

TOENAIL RESULTS

METAL	SCREENING Level (3-17 years old)	YOUR level	What your result means
Arsenic	**1.3 mg/Kg**		Your child's result is WITHIN the level found in 80% of our tested child and youth participants and there is no need for a follow-up.

mg/Kg = milligram of metal per kilogram of body weight

1.3 mg/Kg for Children/Youth is the screening level below which we found 80% of our child participants (3-17 years). Using this screening level allows us to follow-up with more children and youth with elevated arsenic toenail levels.

For your information, we included Frequently Asked Questions sheets on arsenic, cadmium and lead. To learn more, please visit the resource section of our website at **www.ykhemp.ca.**

Please note that we plan to hold community meetings the week of May 13th, 2019 to share general study results with the public. We will communicate the details of the meetings in early May through radio and newspaper.

If you have any questions about your child's results, please do not hesitate to contact us at ykhemp@uottawa.ca or call at 613-325-9080 or 867-445-1574. Thank you again for participating in the Health Effects Monitoring Program.

Sincerely,

Laurie H.M. Chan, PhD
Principal Investigator
University of Ottawa
Tel: 613-325-9080
Email: ykhmemp@uottawa.ca

April 30, 2019

Dear NAME,

The Health Effects Monitoring Program team would like to thank you for participating in our study. Your contribution will help to better understand metal exposure in Yellowknife, Ndilo, and Dettah.

We tested your urine for arsenic, cadmium and lead, and compared the results to existing Reference Levels from the Canada Health Measures Survey. Your toenail clippings were tested for arsenic and the results were compared to a screening level based on other tested adult participants in Yellowknife, Ndilo and Dettah.

Your urine sample showed that your arsenic levels were ABOVE the Reference Level. **Your higher result does not necessarily mean that your health is at risk.** However, we believe it is important to retest metal levels to confirm the results, discuss with you what they mean, and take measures to identify the causes.

Please contact us to make a follow-up appointment.
Call 867-445-1574 or Email ykhemp@uottawa.ca

At the follow-up appointment you will meet with our nurse practitioner, Anna Bergen, at 5112 52nd Street, to discuss your results in more detail, and to provide another sample of urine to confirm your exposure.

You will find your complete results in the table below. The urine results for arsenic reflect an exposure of 2 to 3 days before the sample was taken. The result from your toenail clippings reflect an exposure of the past 3 to 12 months, depending on the size and amount you provided.

It is important to understand that practically all people have some residues of these metals in their body, but they are usually at levels that are not harmful to you.

TOENAIL RESULTS

METAL	SCREENING Level (18+ years old)	YOUR Level	What your result means
Arsenic	**0.5 mg/Kg**		Your result is WITHIN the level found in 95% of our tested participants, and there is no need for a follow-up.

mg/Kg = milligram of metal per kilogram of body weight

0.5 mg/Kg for Adults is the screening level below which we found 95% of adult participants (18+ years).

URINE RESULTS

METAL	REFERENCE Level (18+ years old)	YOUR Level	What your result means
Arsenic (inorganic)	**21 µg/L**		Your result is ABOVE the reference level. This means your level is higher than what is found in 95% of Canadians. The higher level may be due to eating any type of fish or seafood shortly before providing a urine sample. Please contact us to make an appointment with our nurse and to provide a follow-up urine sample to confirm your exposure.
Cadmium	**1.3 µg/L**		Your result is BELOW the reference level. This means that your level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
Lead	**1.9 µg/L**		Your result is BELOW the reference level. This means that your level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
1ug/L = 1 drop of water in a swimming pool.			

For your information, we included Frequently Asked Questions sheets on arsenic, cadmium and lead. To learn more, please visit the resource section of our website at **www.ykhemp.ca**.

Please note that we plan to hold community meetings the week of May 13th, 2019 to share general study results with the public. We will communicate the details of the meetings in early May through radio and newspaper.

Thank you again for participating in the Health Effects Monitoring Program, and we hope to hear from you.

Sincerely,

Laurie H.M. Chan, PhD
Principal Investigator
University of Ottawa
Tel: 613-325-9080
Email: ykhmemp@uottawa.ca

April 30, 2019

Dear NAME

The Health Effects Monitoring Program team would like to thank you for participating in our study. Your contribution will help to better understand metal exposure in Yellowknife, Ndilo, and Dettah.

We tested your urine for arsenic, cadmium and lead, and compared the results to existing Reference Levels from the Canada Health Measures Survey. Your toenail clippings were tested for arsenic and the results were compared to a screening level based on other tested adult participants in Yellowknife, Ndilo and Dettah.

Your toenail sample showed that your arsenic level was among the top 5% of our tested participants. **Your higher result does not necessarily mean that your health is at risk.** However, we believe it is important to retest metal levels to confirm the results, discuss with you what they mean, and take measures to identify the causes.

Please contact us to make a follow-up appointment.
Call 867-445-1574 or Email ykhemp@uottawa.ca

At the follow-up appointment you will meet with our nurse practitioner, Anna Bergen, at 5112 52nd Street, to discuss your results in more detail, and ask you to provide another sample of toenail for a more detailed analysis.

You will find your complete results in the table below. The urine results for arsenic reflect an exposure of 2 to 3 days before the sample was taken. The result from your toenail clippings reflect an exposure of the past 3 to 12 months, depending on the size and amount you provided.

It is important to understand that practically all people have some residues of these metals in their body, but they are usually at levels that are not harmful to you.

TOENAIL RESULTS

METAL	SCREENING Level (18+ years old)	YOUR Level	What your result means
Arsenic	**0.5 mg/Kg**		Your result is AMONG THE TOP 5% of our tested participants. Please contact us to make an appointment with our nurse to discuss your result in more detail and provide another toenail sample for a more detailed analysis.
mg/Kg = milligram of metal per kilogram of body weight 0.5 mg/Kg for Adults is the screening level below which we found 95% of adult participants (18+ years).			

URINE RESULTS

METAL	REFERENCE Level (18+ years old)	YOUR level	What your result means
Arsenic (inorganic)	**21 µg/L**		Your result is BELOW the reference level. This means that your level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
Cadmium	**1.3 µg/L**		Your result is BELOW the reference level. This means that your level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
Lead	**1.9 µg/L**		Your result is BELOW the reference level. This means that your level is similar to that found in 95% of Canadians, and there is no need for a follow-up.
1ug/L = 1 drop of water in a swimming pool			

For your information, we included Frequently Asked Questions sheets on arsenic, cadmium and lead. To learn more, please visit the resource section of our website at **www.ykhemp.ca**.

Please note that we plan to hold community meetings the week of May 13th, 2019 to share general study results with the public. We will communicate the details of the meetings in early May through radio and newspaper.

Thank you again for participating in the Health Effects Monitoring Program, and we hope to hear from you.

Sincerely,

Laurie H.M. Chan, PhD
Principal Investigator
University of Ottawa
Tel: 613-325-9080
Email: ykhmemp@uottawa.ca

Appendix 14: COPC Action Plan

(i) Proposed plan for interpretation of results

1. Population distribution of urine concentrations of arsenic (As), cadmium (Cd), lead (Pb) will be presented by age group similar to Canadian Health Measures Survey (CHMS (2010).
2. No interpretation or action for antimony (Sb), manganese (Mn) and vanadium (V). Only use the data for baseline reference.
3. For As, Cd, Pb, we will compare the data to the Canadian populations, i.e. the 95th percentile of the combined data obtained from the latest CHMS results (CHMS (2010). Risk of population exposure will also be discussed according to the population reference values from the CHMS (95th percentile) presented in the table below.
4. For toenail concentration of As, we will compare the results to the data from Yellowknife and from other comparable populations in Canada and elsewhere in the world.

(ii) Action for elevated level of exposure to As, Cd, and Pb

All participants will receive their own data in a letter. It is expected most participants will show levels lower than the population reference levels (table below), and be informed that the risk of their current exposure to As, Cd, and Pb is low.

1. Participants with **urine inorganic Arsenic (As) exceeding the reference level of 21 ug/L** will be referred to see a nurse practitioner. They will be asked to fill out a short follow-up questionnaire. They will be provided with medical counselling and a fact sheet as suggested by the ATSDR[1a] and will have urine samples collected for re-testing. Their record will be kept with their medical file by default.

2. Participants with **urine Cadmium (Cd) exceeding the reference level of 0.68 ug/L (3-17 years old) or 1.3 ug/L (18+ years old)** will be referred to see a nurse practitioner. They will be asked to fill out a short follow-up questionnaire. They will be provided with medical counselling and a fact sheet as suggested by the ATSDR[1b] and will have urine samples collected for re-testing. Their record will be kept with their medical file by default.

3. Participants with **urine Lead (Pb) exceeding the population reference value of 1.3 ug/L (3-17 years old) or 1.9 ug/L (18+ years old)**, will be asked to see a nurse practitioner to provide a blood sample to confirm their exposure. They will also be asked to fill out a short follow-up questionnaire. Urine is not a reliable biomarker for lead exposure.

4. Blood is the most reliable biomarker for lead exposure. Participants with **blood Pb exceeding 1.5 ug/dL (3-17 years old) or 3.3 ug/dL (18+ years old)**, will be asked to see a nurse practitioner. They will be provided with medical counselling and a fact sheet as suggested by the ATSDR[1c]. Their record will be kept with their medical file by default.

5. Participants with **toenail Arsenic (As) exceeding the 80th percentile for children (3-17 years old) at 1.3 mg/Kg, and 95th percentile for adults (18+ years old)** at **0.5 mg/Kg,** will be asked to see a nurse practitioner to provide another toenail sample. The toenail sample will be sent to a

laboratory in British Columbia, to conduct a more detailed analysis using a procedure called laser ablation ICP-MS. Laser ablation will show: 1. If arsenic in toenail comes from the surface of the nail or from inside the body; and 2. peak(s) of exposure in the last 3-12 months, depending on the length of toenail clipping provided. They will also be asked to fill out a follow-up questionnaire related to exposure to soil or dust and health outcomes.

6. All participants will be asked whether they would like us to share their personal results with their health care provider.

Table. Reference levels for the proposed metal biomonitoring study

Metal	Biomarker	Population Reference (95th percentile)	Reference
Arsenic, *inorganic*	Urine	21 ug/L	CHMS (2013, 2017)
Cadmium	Urine	0.68 µg/L (6-19 years old) 1.3 ug/L (20-79 years old)	CHMS (2013, 2017)
Lead	Urine[a]	1.3 µg/L (6-19 years old) 1.9 ug/L (20-79 years old)	CHMS (2013, 2017)
Lead	Blood[b]	1.5 ug/dL (6-19 years old) 3.3 ug/dL (20-79 years old)	CHMS (2013, 2017)

[a] Urine, a less intrusive biomarker, allows us to see if the person is potentially exposed to Lead.
[b] Blood helps us to confirm a person's exposure as it is the most reliable biomarker for Lead.

[1]**Physician Information**

a. *Arsenic*
Clinical Assessment
Patient Treatment
Fact Sheet
Additional Resources

b. *Cadmium*
Clinical Assessment
Patient Treatment
Fact Sheet
Additional Resources

c. *Lead*
Clinical Assessment
Patient Information
Fact Sheet
Additional Resources