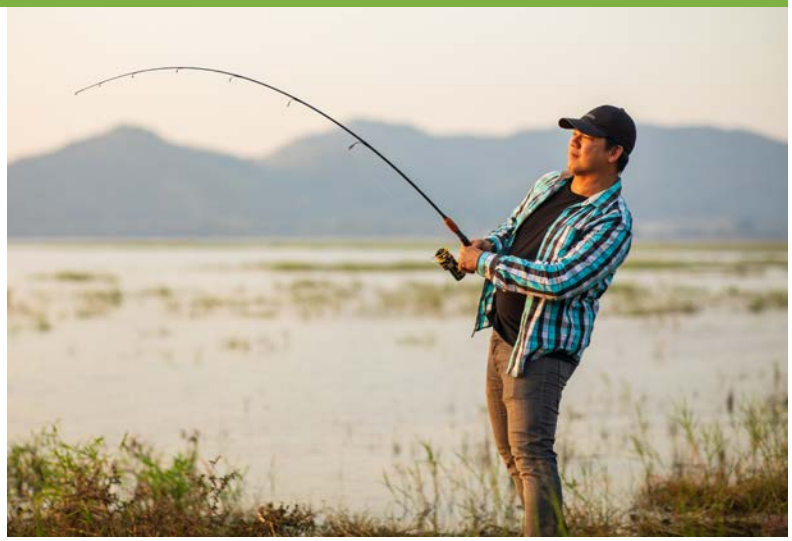
Guidance for Evaluating Human Health Effects in Impact Assessment:

COUNTRY FOODS



Health Canada Santé Canada

Canada

Health Canada is the federal department responsible for helping the people of Canada maintain and improve their health. Health Canada is committed to improving the lives of all of Canada's people and to making this country's population among the healthiest in the world as measured by longevity, lifestyle and effective use of the public health care system.

Également disponible en français sous le titre :

Conseils pour l'évaluation des effets sur la santé humaine dans le cadre d'une évaluation d'impact : LES ALIMENTS TRADITIONNELS

To obtain additional information, please contact:

Health Canada
Address Locator 0900C2
Ottawa, ON K1A 0K9
Tel.: 613-957-2991
Toll free: 1-866-225-0709
Fax: 613-941-5366
TTY: 1-800-465-7735
Email: publications-publications@hc-sc.gc.ca

Publication date: December 2023

Cat.: H129-54/5-2023E-PDF
ISBN: 978-0-660-68832-9
Pub.: 230593

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

Acknowledgement:
Health Canada's Impact Assessment Division would like to thank Dr. Laurie Chan, Professor and holder of the Canada Research Chair in Toxicology and Environmental Health, University of Ottawa, for his past contribution to the technical contents of this document.

This document may be cited as follows:

Health Canada. 2023. *Guidance for Evaluating Human Health Effects in Impact Assessment: COUNTRY FOODS*. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Any questions or comments on this document may be directed to:
Impact Assessment Program, Ottawa, Ontario K1A 0K9
Email: ia-ei@hc-sc.gc.ca

1 ACRONYMS

ACRONYM	MEANING
Agency	Impact Assessment Agency of Canada (also known as IAAC)
AMAP	Arctic Monitoring and Assessment Programme
CCME	Canadian Council of Ministers of the Environment
CFIA	Canadian Food Inspection Agency
CHHAD	Chemical Health Hazard Assessment Division
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
COPC	contaminant of potential concern
FEHNCY	Food, Environment Health and Nutrition of First Nations Children and Youth
FNFNES	First Nations Food, Nutrition and Environment Study
GBA Plus	gender-based analysis plus
HHRA	human health risk assessment
HIA	health impact assessment
HQ	hazard quotient
IA	impact assessment
IAA	*Impact Assessment Act*
IAAC	Impact Assessment Agency of Canada (also known as “the Agency”)
ILCR	incremental lifetime cancer risk
INAC	Indigenous and Northern Affairs Canada
IS	impact statement
ISC	Indigenous Services Canada
NCP	Northern Contaminants Program

ACRONYM	MEANING
PAH	polycyclic aromatic hydrocarbon
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
PHC	petroleum hydrocarbon
TISG	tailored impact statement guidelines
TRV	toxicological reference value

2 PURPOSE OF THIS DOCUMENT

This document provides generic guidance on assessing potential human health risks associated with contaminants affecting country foods (also known as traditional foods) in federal impact assessments (IAs) of proposed major resource and infrastructure projects in Canada. It presents the principles, current practices and basic information Health Canada looks for when reviewing the impact statement (IS) or other documentation submitted by project proponents as part of the IA process.

This document was prepared to support an efficient and transparent project review process. The foundational information described here should be supplemented appropriately with additional information relevant to proposed projects. The guidance was prepared for the Impact Assessment Agency of Canada (the Agency) and stakeholders involved in the IA process to communicate Health Canada's standard areas of engagement and priorities to help ensure that sufficient evidence is available to support sound decisions. As part of its review, Health Canada may suggest that the Agency, review panels or others collect information not specifically described in this document to assess the health effects of proposed projects. As the guidance provided here is generic and designed to support the IA process, the scope of Health Canada's review may also be amended to reflect project-specific circumstances.

Country foods are often linked to culture and identity, and are generally consumed more frequently in Indigenous communities. Consumption of country foods leads to significantly improved nutrient intake; however, when country foods are impacted by contaminants, risks of consuming contaminated foods may outweigh the benefits. While the primary consumers of country foods are members of Indigenous populations, some types of country foods are consumed by the general population.

Health Canada updates guidance documents periodically, and in the interest of continuous improvement, accepts comments and suggestions at the following address: ia-ei@hc-sc.gc.ca.

In the same series, the following guidance documents are available:

- *Guidance for Evaluating Human Health Effects in Impact Assessment: AIR QUALITY*
- *Guidance for Evaluating Human Health Effects in Impact Assessment: DRINKING AND RECREATIONAL WATER QUALITY*
- *Guidance for Evaluating Human Health Effects in Impact Assessment: HUMAN HEALTH RISK ASSESSMENT*
- *Guidance for Evaluating Human Health Effects in Impact Assessment: NOISE*
- *Guidance for Evaluating Human Health Effects in Impact Assessment: RADIOLOGICAL IMPACTS*

Please verify that you are reading the most recent version available by consulting the Government of Canada Publications: https://www.publications.gc.ca/site/eng/home.html.

3 INTRODUCTION AND CONTEXT

The key objectives of Health Canada's IA program are to inform and improve understanding of the potential risks to human health associated with proposed projects, to help prevent, reduce, and mitigate negative impacts and foster positive impacts. Health Canada's expert information and knowledge are available to assist the Agency, review panels and others in assessing the potential project-related health effects.

As a federal authority, Health Canada provides specialist or expert information or knowledge in the Department's possession (expertise) to support the assessment of impacts on human health from projects considered individually and cumulatively under the *Impact Assessment Act* (IAA). This complement of expertise may change or evolve over time. The Department provides scientific expertise; it does not play a regulatory role. The use of expertise provided by Health Canada in the IA process will ultimately be determined by the reviewing body(ies).

In comparison to the *Canadian Environmental Assessment Act 2012*, the IAA expands the assessment of health to promote a broader understanding of the biophysical environment and supports assessment of the social and economic effects of projects. Among other things, the IAA includes specific requirements to consider positive and negative effects on the health, social and economic conditions of the public, including Indigenous peoples. In addition, the IAA includes the requirement for potentially affected Indigenous groups to be consulted during the planning phase of the project and incorporate Indigenous traditional knowledge, if provided, alongside other evidence. The IAA also requires consideration of the intersection of sex and gender with other identity factors.

Gender-based analysis plus

Gender-based analysis plus (GBA Plus) identifies and analyses the differential impacts of designated projects on diverse population groups. The "plus" in GBA Plus acknowledges that GBA goes beyond biological (sex[1]) and socio-cultural (gender[2]) differences. It highlights the pathways on which those differences develop and how they intersect with other determinants to shape health and well-being. It guides how we consider sex and gender when we frame, plan for, and implement the impact assessment of designated projects. Gender-based analysis plus includes other individual and social identity factors such as race, religion, social position, income, age, ability, and education; this is called intersectionality[3]. The basic steps to applying GBA Plus include gathering appropriate data, understanding context, and asking analytical questions to determine whether the project is expected to have disproportionate effects on diverse populations. By working through a GBA Plus analysis, experts can better understand the possible differential effects of a project on distinct groups of people, including on disproportionately affected or impacted populations and populations identified by sex and gender. Considering how a program, policy, plan, or product might impact groups differently provides an opportunity for all those involved to help address potential pitfalls before they become a problem or to identify opportunities that would not have been otherwise considered.

1 Sex refers to physical and physiological features including chromosomes, gene expression, hormone levels and function, and reproductive/sexual anatomy. https://cihr-irsc.gc.ca/e/48642.html

2 Gender refers to the socially constructed roles, behaviors, expressions and identities of girls, women, boys, men, and gender diverse people. https://cihr-irsc.gc.ca/e/48642.html

3 Government of Canada's Approach Gender Based Analysis Plus. https://women-gender-equality.canada.ca/en/gender-based-analysis-plus/government-approach.html

Key GBA Plus considerations in IA of designated projects:

- Does the proposal identify the diverse communities of women, men and children who will be directly and indirectly affected by the proposed project's activities?
- Are the data about potential impacts disaggregated by sex, age, language and other social identities relevant to the local communities?
- Have the views of the affected women, men, Indigenous peoples and other disproportionately impacted groups been included in the proposed project's design?
- What are the implications of the proposed project's health and socio-economic effects on the well-being of women, men, Indigenous peoples and disproportionately affected populations?
- What types of measures are needed to ensure equitable representation during consultation processes and subsequent stages of the IA?
- What measures are needed to enhance the positive effects or mitigate any adverse effects of the designated project on women, men, children and other disproportionately affected groups?

Identifying the range of concerns and interests of, and impacts on, diverse groups based on social characteristics like gender, age, ethnicity, occupation, and length of residency, for example, can help foster the development of more comprehensive mitigation and enhancement strategies.

A health impact assessment (HIA) is a systematic, objective and yet flexible and practical way of assessing the potential positive and negative impacts of a proposal on health and well-being. In the context of designated projects under the IAA, an HIA aims to characterize the anticipated health effects, both adverse and positive, and the distribution of those effects within the population. The Agency determines the scope of the factors taken into account, including their relevance to the IA, as outlined in the tailored impact statement guidelines (TISG). The steps of an HIA include screening, scoping, assessment, recommendations, reporting, monitoring and evaluation of the effectiveness of the HIA process, and the impact on decision-making.

Health Canada has been working with key partners and rights holders, including Indigenous organizations, federal partners, provinces/territories, and other key stakeholders, to develop HIA guidance and tools for a more comprehensive assessment of potential health effects of proposed projects. The document provides guidance to scope and address the broader social and economic conditions underlying the health of potentially affected communities and Indigenous peoples. Health Canada has developed an interim HIA Guidance Document to bridge the gap between the IAA coming into force on August 28, 2019, and the planned publication by the Department of the guidance document and complementary material on HIA. The interim guidance document is available upon request at the following address: ia-ei@hc-sc.gc.ca.

Health Canada provides its expertise in human health risks associated with air quality, drinking and recreational water quality, ionizing radiation, electromagnetic fields, noise and country foods when it reviews and provides comments on information submitted by proponents in support of proposed projects. Health Canada also provides general information on the subject of health assessments in relation to proposed projects subject to the federal IA process.

This document concerns the assessment of human health risks associated with the consumption of potentially contaminated country foods. It contains information on the division of roles and responsibilities for issues related to country foods at various levels of government in Canada; health effects associated with contamination of country foods; indicators of these effects; and steps in Health Canada's preferred approach to assessing health effects related to consumption of contaminated country foods.

This publication provides technical guidance on defining country foods on a project basis, and assessing baseline conditions and the longer term anticipated impacts should the project proceed. As with all IA work, cumulative effects are a core element of country food assessment, as are mitigation and follow-up monitoring. While this guidance does not address possible changes in country foods abundance, it is nevertheless recognized that projects may damage habitat and disperse wildlife, altering abundance and availability; therefore, this aspect should also be considered when assessing impacts of proposed projects, in accordance with current federal and provincial legislation.

APPENDIX A provides a checklist for verifying that the key elements of a country food risk assessment have been completed and where this information appears in the assessment document.

APPENDIX B provides a list of references prepared by Health Canada or prepared under contract for Health Canada that contains material which may be relevant to a risk assessment for country foods.

APPENDIX C presents publications/resources where toxicological reference values (TRVs) can be found.

APPENDIX D identifies publications that are not cited in this document but may be useful in preparing documentation for country food issues addressed in IAs, by the following themes:

- Overall Country Foods and Human Health Risk Assessment
- Dietary Surveys and Methodologies
- Canadian Council of Ministers of the Environment (CCME) Guidelines
- Information about Canadian Dietary Intake, Including Indigenous
- Risk Communication and Risk Management
- Northern Contaminants Program and Arctic Monitoring and Assessment Programme (AMAP)
- Country Food Contamination Monitoring Programs
- Canadian Data Sources of Contaminant Levels in Country Foods
- Other

4 ROLES AND RESPONSIBILITIES

In Canada, different levels of government play a role related to food safety. Federal departments and agencies with roles concerning country foods include Health Canada, Indigenous Services Canada, and, if the foods are sold commercially, the Canadian Food Inspection Agency (CFIA). Certain aspects of country food safety and availability may be also covered by provincial and territorial regulators. In the context of project assessments, the depth and breadth of the analysis of food safety will vary; as territories and parts of provinces operate under different environmental assessment regimes (e.g., "North of the 60th parallel"), verifying appropriate legislation is encouraged.

4.1 HEALTH CANADA

Health Canada is typically asked to undertake reviews of IS or other documentation for a proposed project, subject to federal IA legislation. For example, under the IAA, Health Canada's primary role is to make available project-related specialist or expert information and knowledge in its possession.

Among other things, Health Canada sets standards for the safety and nutritional value of all foods sold in Canada. It exercises this mandate under the authority of the *Food and Drugs Act* and the *Food and Drug Regulations*. The department can provide expertise about the potential impacts of projects on country food quality and safety through choice and use of appropriate TRVs, and review risk assessment methodology. Health Canada can also provide expertise about the design and administration of dietary surveys, sampling of country foods for analysis, and the development and delivery method of consumption advisories.

4.2 INDIGENOUS SERVICES CANADA

From 2008 to 2018, the First Nations and Inuit Health Branch (formerly part of Health Canada) of Indigenous Services Canada (ISC) supported and funded the *First Nations Food, Nutrition and Environment Study* (FNFNES), which collected baseline data on the dietary intake, food security status, and environmental contaminant exposure of adult First Nations living on reserve in 92 randomly selected First Nations communities south of 60th parallel across Canada. The regional reports and final study are posted at www.fnfnes.ca/download. These publications provide the first comprehensive and statistically representative (at the regional level) information about diets, including average and range of daily intakes of traditional/country foods, and baseline levels of selected chemical contaminants in country foods. The study also conducted human biomonitoring for mercury, assessed metals in household's drinking water and pharmaceutical levels in surface waters around First Nations reserves. The study is finished; however, academically-led analyses of results is expected to continue over the next few years and will be published in peer reviewed journals. A new study, funded by ISC, called the *Food, Environment Health and Nutrition of First Nations Children and Youth* (FEHNCY) will look at the nutrition, health and environment of First Nations children and youth aged 3–19 years across Canada and is intended to last for 10 years.

4.3 CROWN-INDIGENOUS RELATIONS AND NORTHERN AFFAIRS CANADA

In 2017, Indigenous and Northern Affairs Canada (INAC) was dissolved and replaced by two departments: Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) and ISC. The Northern Contaminants Program (NCP), now led by CIRNAC, was initiated by INAC in 1991. The NCP works to reduce and, wherever possible, eliminate contaminants in traditionally harvested foods, while providing information that assists informed decision making by individuals and communities in their food use. It addresses concerns about human exposure to elevated levels of contaminants in wildlife species that are important to the traditional diets of northern Indigenous peoples of the Yukon, Northwest Territories, Inuvialuit, Nunavut, Nunavik, and Nunatsiavut. Information on this program can be found at www.science.gc.ca/eic/site/063.nsf/eng/h_7A463DBA.html.

4.4 CANADIAN FOOD INSPECTION AGENCY

While Canada's food safety standards for commercial foods are established by Health Canada, the CFIA provides all federal food inspection services related to commercial foods and enforces the standards established by Health Canada. Its authority is provided through both Canada's *Food and Drugs Act* and the *Canada Agricultural Products Act.* Commercial foods available to the public that could be contaminated by a project's activities are subject to these acts.

4.5 PROVINCIAL AND TERRITORIAL GOVERNMENTS

Various provincial and territorial departments and agencies have a role in, among other things, monitoring foods that may be contaminated and issuing consumption advisories.

5 EVALUATING THE POTENTIAL CONTAMINATION OF COUNTRY FOODS IN IMPACT ASSESSMENTS

5.1 COUNTRY FOODS

The term “country foods” will be used in this document, although some stakeholders prefer the expression “traditional foods.” Country foods are defined as all foods sourced outside of commercial food systems.

These include any food that is trapped, fished, hunted, harvested or grown for subsistence or medicinal purposes, outside of the commercial food chain. This definition encompasses the following food items:

- Aquatic and terrestrial fauna fished, trapped, hunted, and/or harvested (e.g., game animals and birds, fish, and seafood) for domestic consumption;
- Produce harvested from naturally occurring sources (e.g., berries, seeds, leaves, roots, and lichen);
- Plant tissues (e.g., roots, bark, leaves, and seeds) ingested for medicinal or other uses (e.g., teas);
- Produce (e.g., fruits, vegetables, and fungi) grown in gardens, and/or home orchards;
- Aquatic and terrestrial fauna (and its by-products) produced for domestic consumption but not for market (e.g., ducks, chickens or other fowls, eggs, and dairy products).

It is also possible that foods sold commercially are contaminated by a project’s activities. More information on this issue can be found at https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety.html.

5.2 COUNTRY FOODS AS A PATHWAY IN A HUMAN HEALTH RISK ASSESSMENT

Within the risk assessment of a proposed project, ingestion of contaminants via food can be a significant pathway of exposure, particularly when chemicals that may increase as a result of project activities possess the ability to bioaccumulate or biomagnify in the food chain, and/or when the consumption of country food may constitute a significant portion of an exposed person’s diet.

The potential human health risks associated with elevated levels of chemicals in country foods can be examined in an IA through a human health risk assessment (HHRA) for country foods. The HHRA is a process used to estimate the exposure that individuals may receive from consumption of country foods and to identify whether there may be potential risks associated with that exposure, accounting for the cumulative effects of current and proposed projects.

An HHRA provides increased defensibility for human health-related conclusions of an IA. It can also be used to provide a quantitative estimate of the potential risks in an exposed population, and highlight the need for and guide the development of appropriate mitigation measures, follow-up, monitoring plans, remediation, and/or risk management approaches to reduce or eliminate the potential human health risks associated with the project activities.

Guidance offered in this document is not designed nor intended as a substitute for the sound professional judgment of a qualified and experienced risk assessment practitioner. Many risk assessments for country foods conducted to support IAs will present unique situations not specifically addressed here. Risk assessors are encouraged to ensure that their assessments address all relevant potential risks. The methods described in this document do not negate the need for sound professional judgment. If alternative or unique approaches are considered appropriate, these should be sufficiently documented and described to enable peer review, and they should also be evaluated for their impact on risk estimates relative to the application of the standard methods prescribed.

The TISG prepared by the Agency outline the need to conduct an HHRA when elevated concentrations of contaminants of potential concern (COPCs) are predicted in one or more environmental media for a proposed project. The level of detail required to evaluate potential human health impacts may vary from project to project, and where there are no predicted pathways that may result in exposure to the population, a qualitative/screening approach may be sufficient. For projects with operable pathways and a potential for human exposure to contaminants, a quantitative risk assessment can provide an estimate of potential human health risks associated with chemicals released from various stages of the proposed project. Detailed information on HHRA methodologies in the context of IA can be found in the *Guidance for Evaluating Human Health Effects in Impact Assessment: HUMAN HEALTH RISK ASSESSMENT* (Health Canada, 2023).

The information that is part of an HHRA is discussed under the following headings:

Stage 1: Problem Formulation
Stage 2: Exposure Assessment
Stage 3: Effects/Toxicity Assessment
Stage 4: Risk Characterization

Figure 5.1 illustrates the sequencing of these stages according to Health Canada's suggested approach to assessing the potential risk associated with consumption of impacted country foods using an HHRA.

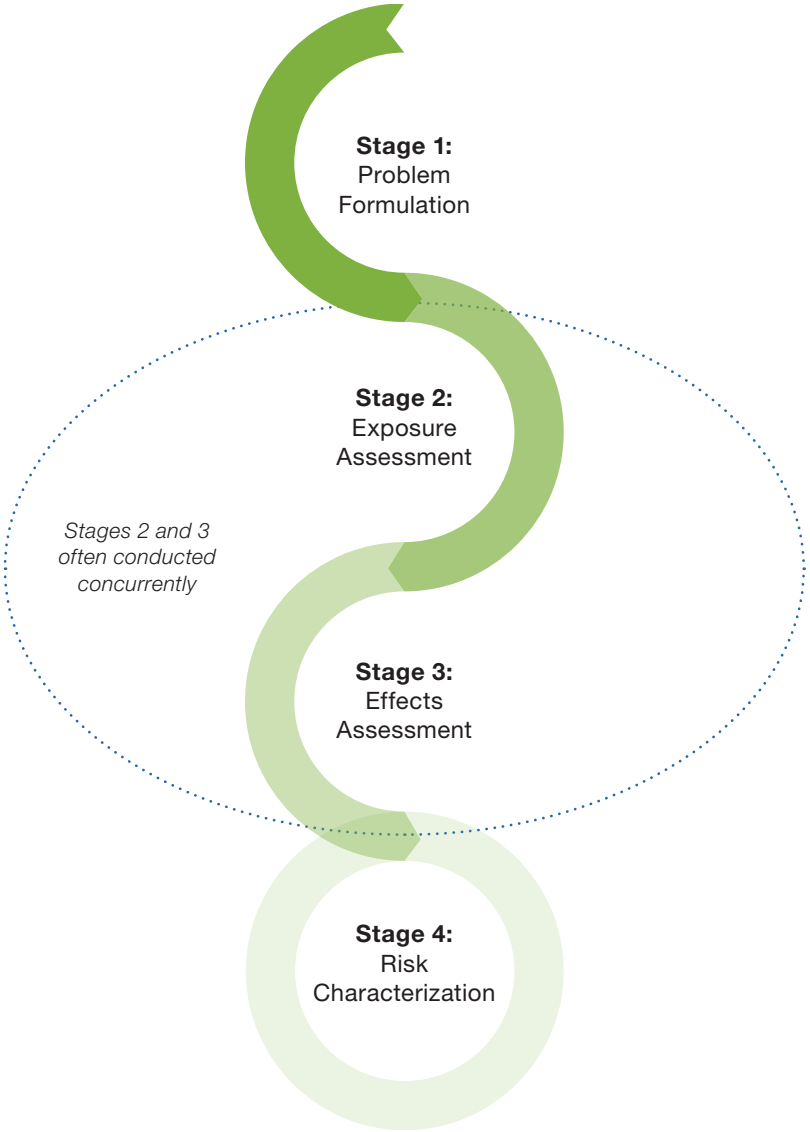


Figure 5.1: Human Health Risk Assessment Process

5.2.1 Stage 1: Problem formulation

The purpose of problem formulation is to determine:

1. if the proposed project can release chemicals that may impact environmental media; and
2. if there are operable exposure pathways present through which elevated levels of chemicals associated with the proposed project may affect individuals.

In this stage of the project, the appropriate type of HHRA is also determined. The key tasks in problem formulation (US EPA, 2014) are as follows:

a) Develop a conceptual model

b) Develop an analysis plan

A. CONCEPTUAL MODEL

A conceptual model is a visual representation that identifies:

- the sources of potential hazards (e.g., COPCs associated with the project);
- the exposure pathways via the environmental media that may be impacted (e.g., air, water, soil, sediment, and ultimately foods); and
- the individuals (receptors) who may consume the foods.

The key components of the conceptual model are described in Figure 5.2, which illustrates that all of these components must be present in order for there to be a potential risk.

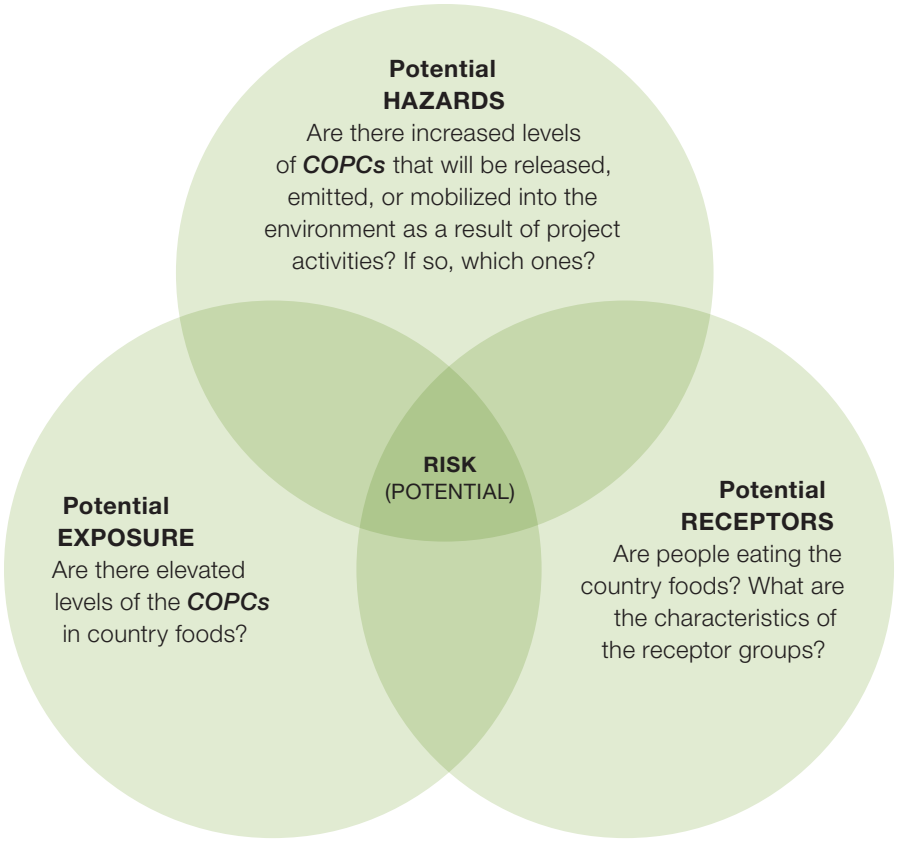
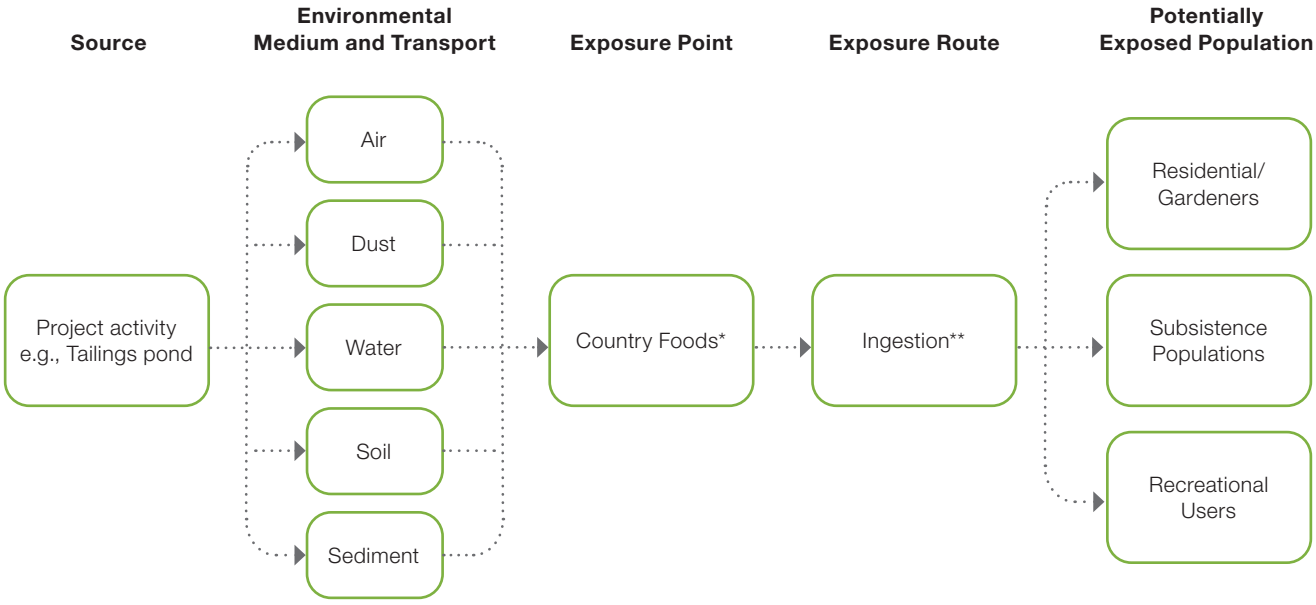


Figure 5.2: Risk Components Relationship for Country Foods

All substances that may be elevated in environmental media as a result of project activities may be initially considered as COPCs. However, if the predicted concentration plus the baseline concentration is calculated to be below guidelines/standards/criteria for the impacted medium, the problem formulation phase of the risk assessment may conclude that the particular substance does not need to be carried forward as a COPC in a quantitative risk assessment. However, in the case of country foods, where there are usually no guidelines/standards/criteria available for screening that environmental medium, the COPCs would be carried forward into a quantitative risk assessment to identify whether there may be human health risks associated with the predicted concentrations.

Figure 5.3 provides an example of a project-specific conceptual model associated with a specific activity/component of the project.



* Country Foods, or traditional foods, include any food that is trapped, fished, hunted, harvested or grown for subsistence or medicinal purposes, outside of commercial food chain, and that is not regulated under the Food and Drugs Act.

** Inhalation or dermal expose may occur if contaminated plants used for medicinal purposes are burned and inhaled, used on the skin (i.e., to heal wounds), or if contaminated soil comes into contact with the skin.

Figure 5.3: Example of a Human Health Site Conceptual Model

Making the decision about the need for an HHRA

If the conceptual model determines that individuals are likely to consume foods that may be impacted by project activities, then it is recommended the HHRA includes the country food exposure pathway. For those IAs where country foods are not considered to be an operable exposure pathway, the HHRA should provide a clear rationale for not including country foods as a medium in the HHRA (e.g., no increase of COPCs in any foods that may be consumed by individuals currently or in the future).

i. Hazard Identification—Increased Levels of COPCs in Country Foods

The first step in the development of a conceptual model is to determine whether project activities may result in increased levels of COPCs in country foods through impacts to other media (e.g., release of chemicals to air, water, soil, sediment).

Does the project involve the release, the emission, the mobilization or the modification of one or more COPCs in the environment, which may result in increased concentrations of COPCs in country foods?

The main elements of hazard identification that should be documented are the following:

- Factors that may determine the likelihood of contaminant release, emission, mobilization, and/or modification in the environment, such as:
  - the nature of the project to be undertaken
  - the release of contaminants from stack emissions
  - atmospheric emissions from other sources
  - the materials and chemicals present
  - excavation and construction
  - the transportation of materials
  - potential flooding
  - the rerouting of waterways
  - waste management
  - releases of contaminated water due to leaking and leaching
- The baseline concentrations of each COPC in each media (e.g., air, water, soil, sediment, food).
- A summary of the modelling conducted for each COPC, identifying predicted concentrations in environmental media (the identification of the COPCs should reference where any supporting information is found in the IA documentation).
- Identification of all potential COPCs selected in each IA, which may be elevated in the environment for each stage of project activities.
- Identification of the parameters used to model concentrations in country foods (e.g., estimated concentrations of COPCs in various environmental media that will then result in increased concentrations in country foods).
- Summary of the predicted values of COPCs in all edible tissues of plants/animals that are consumed.

Table 5.1 lists typical COPCs that may be released from common project types. Project-specific HHRA requires a site-specific identification of possible COPCs.

Table 5.1: Typical COPCs Possibly Contaminating Country Foods by Activity Type/Industrial Sector

Main Sector/Activity	Sub-Sector	COPC/General Country Food Contamination
Construction and Transportation		Dependent on types of construction vehicle or mode of transportation. For vehicles burning fossil fuels, associated contaminants may include polycyclic aromatic hydrocarbons (PAHs), metals, and trace elements (e.g., arsenic, copper, lead, manganese, sulphur, zinc).
Electric power generation and transmission	*Hydro-electric*	Methylmercury (methylation process occurring during the inundation of reservoirs)
	Nuclear	Radionuclides
Mining, extraction and smelting	*Aluminum*	Metals, particularly aluminum; fluorides; PAHs and polychlorinated dibenzo-p-dioxins (PCDDs)/polychlorinated dibenzofurans (PCDFs) in smelting
	Gold	Chromium, arsenic, mercury, cadmium, cyanide, PAHs and PCDDs/PCDFs (smelting)
	Mixed metals	Metal and trace elements (depending on the content of ore and the natural environment), PAHs, PCDDs/PCDFs (smelting)
	Nickel	Metals including nickel, aluminum, cadmium; PAHs; PCDDs/ PCDFs (smelting)
	Ferrous/steel	Metals including manganese, tin, zinc; PAHs and PCDDs/PCDFs (smelting)
	Uranium	Metals and trace elements (e.g., arsenic, cadmium); radionuclides including uranium, radium (^{226}Ra), lead (^{210}Pb),and polonium (^{210}Po)
Petroleum production, distribution, processing and storage	*Bitumen (oil sands) extraction*	PAHs, petroleum hydrocarbons (PHCs), heavy metals, and trace elements (e.g., aluminum, arsenic, cadmium, chromium, iron, lead, mercury, molybdenum, nickel, selenium, sulphur, vanadium, zinc)
	General (transportation, etc.)	Metals, PHCs, benzene, toluene, ethylbenzene, xylenes, PAHs, lead, and methyl tertiary butyl ether
	Coal gasification	Metals, PAHs, and PHCs

ii. Exposure—Transport Pathways into Country Foods

The purpose of this step is to identify all potential ways by which country foods can be exposed to COPCs—these are referred to as transport or exposure pathways. An exposure pathway includes consideration of the contaminant source, transfer mechanism(s), release mechanism(s), environmental transport or residency media, and exposure routes. The exposure route refers to how a country food comes into contact with a COPC (e.g., water or soil ingestion; inhalation of particulates or volatile compounds; dermal contact).

The conceptual model should identify, for each COPC, all operable transport pathways for the COPCs to migrate from potential project contaminant sources to country foods. Several common examples are provided in Table 5.2.

Table 5.2: Identification of Possible Contaminant Transfer Pathways into Country Foods

		PATHWAY COMPONENTS		
	Sources and Contaminants	**Transfer Mechanism**	**Release Mechanism**	**Environmental Transport or Residency Media**
EXAMPLES	Slurry discharge (e.g., metals, volatile organic compounds)	Contact of slurries with soil, surface water or groundwater used for irrigation	Uptake into plant tissues, incidental ingestion by herbivores, adsorption on plant material, entrainment into dust, inundation leading to methylation of mercury resulting in uptake by country food species	Produce, fish and other aquatic organisms, wild game, poultry, eggs and dairy, juice or wine, plant materials used for tea
	Stack emissions (release of COPCs to air)	Aerial deposition onto plants, soils, sediments, surface water	Uptake into plant tissues, incidental ingestion by herbivores, and adsorption on plant material resulting in uptake by country food species	Produce, fish and other aquatic organisms, wild game, poultry, eggs and dairy, juice or wine, plant materials used for tea

iii. Receptors

The problem formulation stage identifies all individuals that may be impacted by the proposed project currently and in the future. In the case of the country food component, these would be human receptors that do or will consume potentially contaminated country foods. Such human receptors include individuals that are present or expected to be present in the future within the spatial boundaries of the project and/or could be impacted by country foods as well as individuals with permanent residences or temporary use areas (e.g., cabins, recreational use, seasonal occupancy, transient use for country food collection). When identifying potential receptors, consideration should be given to potentially sensitive and/or unique receptors that may be exposed to increased levels of risk due to physiology, health status, behaviour, and/or lifestyle. Examples include seniors, pregnant or nursing mothers and infants (particularly where COPCs are known to biomagnify or exhibit potential neurotoxic or fetotoxic effects), and consumers of higher quantities of local country foods that may receive greater exposure to COPCs. The HHRA should also identify individuals that may be exposed outside of the spatial boundary. For example, an adult hunter in the area may bring food back to a non-impacted area where others (family members, community members, elders, etc.) may consume the foods with elevated levels of COPCs; in this case, while the adult may be the only receptor at the site, all age groups that consume the foods would need to be addressed in the HHRA.

Are human receptors consuming (currently or likely in the future) country foods in the potentially affected areas?

The third element of the site conceptual model is to adequately determine current or future possible transport pathways to human receptors. The HHRA should clearly identify what country food species and tissues may be consumed, and their seasonal consumption amounts, from the impacted areas. References should be provided for all receptor characteristics along with rationale for assumptions made. For instance, it is not sufficient to simply assume that 10% of foods may be consumed from the local area without rationale for that assumption. Engaging potentially affected communities and integrating traditional knowledge into the IA are important for obtaining data representative of the project area. In the absence of such information, assumptions made in the HHRA should be of a precautionary nature.

When creating a list of locally consumed country foods, it is helpful to consult the FNFNES data (see section 4.1) as well as conduct local surveys and engage Indigenous communities that may have an interest in or be affected by the project. More information on this subject can be found at www.sciencedirect.com/science/article/pii/S0195925509000845 and www.ontario.ca/page/ environmental-assessments-consulting-aboriginal-communities.

Some receptor characteristics are provided in Health Canada guidance (Health Canada, 2023). Table 5.3 provides a suggested format for capturing receptor details that will support the site conceptual model and the HHRA.

Table 5.3: Identification of Possible Receptors

	RECEPTOR AND CHARACTERISTICS	SPECIES CONSUMED	TISSUE(S) CONSUMED	COPC(S)
EXAMPLES	Subsistence fisher	Northern pike (*Esox lucius*); Whitefish (*Coregonus* sp.)	Skin, muscle tissue, organs (e.g., liver) Skin, muscle tissue, organs (e.g., liver), roe	Methylmercury
	Indigenous population 1 (specify), 10 km from project boundary	Dungeness crab (*Metacarcinus magister*)	Muscle tissue, hepatopancreas	Dioxins and furans, PAHs, PCBs
	Indigenous population 2 (specify)	Bearberry (*Arcto-staphylos* spp.); black, gold and red currant, and gooseberry (*Ribes* spp.); blueberry/ bilberry, black huckleberry (*Vaccinium* spp.)	Berries, leaves for tea	Metals
	Backyard fruit growers in the city, 30 km from the project	Apple (*Malus* spp.), pear (*Pyrus* spp.), raspberry, strawberry	Fruit	

B. ANALYSIS PLAN

Not all IAs will require the completion of a quantitative HHRA—a qualitative approach may be sufficient (e.g., if there are no active or potential exposure pathways). However, for projects with an identified potential exposure to elevated levels of contaminants, a quantitative assessment would be required as there are no applicable regulatory guidelines against which concentrations of COPCs in foods can be screened. Also, it is recommended that a quantitative HHRA be conducted in the following cases:

- The project is proposed for a region that is already experiencing high background levels of certain contaminants (e.g., methylmercury, cadmium, selenium).
- The project contribution, in conjunction with cumulative effects from existing developments or foreseeable projects, leads to substantive increase of one or more COPCs.

Existing guidelines and standards for commercial foods are developed with consideration of commercial food consumption patterns, which have relatively limited variability in Canada, in particular with respect to staple foods. Country foods can present a substantial level of variability in the types and amounts of country foods consumed, thus the need for a project-specific quantitative characterization of all COPCs that may impact country foods.

If country foods are identified as a pathway, the usual approach is a multi-media HHRA including all environmental media (air, dust, sediment, water or soil) and exposure pathways (ingestion including country foods, other foods and water; inhalation and dermal absorption). Generally, if country foods is an operable pathway for COPCs, it is very likely there is another active pathway (e.g., air, soil and water) of exposure. The analysis plan should specify what kind of HHRA will be carried out, and should provide justification for the approach.

5.2.2 Stage 2: Exposure assessment

The objective of the exposure assessment is to estimate the concentration of each COPC to which individuals may be exposed. Exposure to COPCs is predicted using various models to estimate the concentrations of COPCs in the applicable environmental media and in different assessment scenarios. A quantitative exposure assessment is conducted for the country food component of the HHRA by using estimated exposure for each COPC in all foods. Such analysis should be conducted for each phase of the project (e.g., construction, operation, decommissioning), unless it can be justified that one phase is representative of all other phases and presents a major source of contamination. It is preferable that baseline data be measured in foods from the area and estimated for future stages of the project. An exposure assessment should be completed for all relevant age groups (e.g., even if only the adults hunt in the impacted areas, all other members of the population may consume the foods).

In order to collect and use appropriate site-specific information, Health Canada recommends obtaining consumption patterns for different foods for the specific population/communities of interest and/or similar populations that consume foods from the impacted area. For example, British Columbia's coastal communities may have different consumption patterns compared to British Columbia's inland communities. The HHRA report should provide referenced data for the consumption frequency of each type of food (i.e., seasonal consumption) as well as the daily amount consumed (i.e., serving size or g/day). This information is required to estimate exposure to each COPC associated with consumption of country foods. Published literature may be used, where available, if data refer to similar populations with similar consumption patterns.

A country food consumption survey specific to the local population would yield the most representative consumption rates for use in the assessment. Another source of consumption information are the FNFNES summary reports, which contain information on types, amounts and frequency of foods consumed by adults in First Nations communities across Canada (South of the 60th parallel) (Chan et al., 2014, 2012, 2011). The FNFNES methodology also includes samples of two types of dietary intake questionnaires, a food frequency questionnaire and a 24-hour recall, which could be used in the development of a site-specific country food consumption survey. The *Compendium of Canadian Human Exposure Factors for Risk Assessment* (Richardson, 1997) also provides standard consumption rates for fish and wildlife by First Nations. These, or other published sources of country food consumption information, are considered to be acceptable provided that they are representative of the consumption habits of local population in question.

If a published literature source was used, the report should provide a rationale for its use (i.e., timing, geographical and population scope) and discuss any data gaps or extrapolations. The key steps in determining country food consumption are outlined below.

A. CHARACTERISING RECEPTORS

In the problem formulation section of the HHRA, individuals that may be exposed to the COPCs through consumption of country foods were identified (e.g., the receptors). The exposure assessment part of the risk assessment summarizes the specifics of each of the receptor groups, such as age, estimated body weight, and consumption rates of each food type. All receptor groups should be included, and a quantitative risk assessment completed for each. For instance, toddlers may consume more food than adults on a body weight basis, therefore receiving greater exposure to COPCs, which is why all age groups need to be considered.

If a survey is conducted to identify local consumption rates of foods, it is recommended that the country food consumption survey include the following information:

- receptor characteristics (i.e., age, gender, cultural affiliation, etc.), including receptors with atypical consumption patterns due to occupational, recreational, and cultural activities relevant to country food consumption (e.g., hunters, trappers, fishers)
- a list of the country foods consumed, including common and scientific names of species
- the source of country foods (i.e., where the food is typically harvested and how it is obtained—hunted, fished, gathered, etc.)
- specific tissues (skin, fatty tissue, muscle tissue or organs) or parts of plants (roots, leaves, flowers, berries, seeds, etc.) that are consumed
- the typical portion size for each tissue or plant part consumed, using standard measures of weight or volume
- the frequency of consumption (i.e., the number of servings per week or month or season, and if there are any seasonal patterns and variations due to special events such as celebrations or holidays)
- the typical method of preparation: skin on/off, washing, peeling, cooking (raw, fried, baked, etc.), drying, fermenting, and any other preparation methods that may affect the COPC concentration of the foods consumed
- traditional knowledge (i.e., species consumed, when the foods are consumed, their residence times, and times of increased consumption of specific foods such as, seasonal patterns or migration periods)

B. ESTIMATING RECEPTOR EXPOSURE TO BASELINE LEVELS OF COPCs

The baseline scenario represents the current levels of potential contaminants in an area, including those from existing sources, and describes the existing conditions for the proposed project area. The baseline levels of contaminants should be documented in order to evaluate the extent of possible environmental changes related to future project activities (and thus the subsequent potential impacts on human health). Comparing predicted COPC concentrations for the proposed project activities to the baseline concentrations provides information on the potential impact of the proposed project.

The baseline concentrations of the COPCs in country foods that are assessed in the HHRA should be measured or estimated. The analysis should address the following:

- Sampling design—identify locations where each sample was obtained; for vegetation samples, it is recommended that co-located soil samples in the root zone also be collected and analyzed to assess uptake rates.
- Sample size—sufficient to allow the testing laboratory to meet detection limits that are applicable in an HHRA, without compositing of samples (or minimizing compositing of samples).
- Species and tissue sampling—identify which species (plant and animal) and tissues are most representative of country food consumption (accounting for the fact that some species and tissues may have higher concentrations of COPCs due to bioaccumulation and biomagnification, and some plants are known hyperaccumulators).
- Field collection—provide a summary of the methods used to collect the foods, including the procedures to limit potential cross-contamination and sampling biases.
- Contaminant speciation—where toxicity differs based on COPC speciation, speciation should be taken into consideration as part of the HHRA or rationale provided if it is not considered.
- Bioavailability—it is commonly assumed that 100% of COPC present in animal and plant tissues is bioavailable and absorbed by humans in the gastrointestinal tract.
- Laboratory selection—confirm that the laboratory selected is able to obtain data for each COPC in tissue with a detection limit that is sufficiently adequate to confidently conclude on the potential risks to human health. Where guidelines are available, the detection limits should be less than such guidelines for the contaminant and species of interest, and/or less than risk-based or background concentrations for the species and tissues of interest based on a review of published literature.
- Quality assurance—provide a summary of the quality control/quality assurance plan implemented for the sampling program, including data for duplicate samples, etc.
- Laboratory analytical reporting—the analytical report for the COPCs will include information for the concentrations of COPCs in both dry weight and wet weight (e.g., conversion of wet [as consumed] versus dry [preparation for sampling] units). For lipophilic organic compounds (i.e., PCDDs), results may be reported on a lipid basis (modified from Health Canada 2010b, section 3.0).
- Optional—determination of exposure to COPCs through market food ingestion, as certain contaminants of concern associated with the proposed project may be present in commercially available foods, are naturally occurring (e.g., metals) or are associated with other anthropogenic processes unrelated to the proposed project. Combining these values in the risk characterization for the ingestion pathways may be appropriate in order to adequately characterize risk.

It is important to include all relevant data related to baseline samples, including the number of samples collected, the number of non-detectable samples, the minimum and maximum concentrations, and any statistical evaluation undertaken (e.g., mean, median, upper 95% confidence limit of the mean).

Information about exposure to COPCs through market food ingestion can be found in published literature, including the following sources:

- Health Canada's *Canadian Total Diet Study (*https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/canadian-total-diet-study.html) provides information about market food contamination levels. The above website also includes a hyperlink to the average dietary intakes of various chemical contaminants that have been estimated using food residue data collected through the Total Diet Study and Canadian food consumption data.
- The *Canadian Community Health Survey (*https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs.html) provides some information on market food ingestion rates in Canada.
- The CFIA collects surveillance data for chemical contaminants in market foods and these are available through its published chemical residue reports (https://inspection.canada.ca/food-safety-for-industry/food-chemistry-and-microbiology/eng/1331960432334/1331962151945) or by contacting the CFIA via e-mail (information@inspection.gc.ca).

If exposure to COPCs through market foods is not included in the HHRA, then a referenced, scientific rationale for exclusion should be included (e.g., retail foods have a low contribution to COPC exposure).

For further information on sampling methodology for country foods, refer to Health Canada's supplemental guidance on risk assessment for country foods (Health Canada, 2010b).

C. PREDICTED EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the levels of COPCs to which individuals may be exposed from the consumption of country foods using information on the amount of each COPC in the consumed foods, the amount of foods consumed and their frequency of consumption.

For the country food pathway, the exposure assessment section will provide an estimate of predicted COPC concentrations in each of the country foods consumed over the life of the project, including the post-project phase (project decommissioning or abandonment, if applicable). The exposure assessment will also account for cumulative effects of approved but not yet operating, and/or other proposed or likely developments within the potentially impacted area, if applicable. The risk assessor should ensure that the values used are appropriate for the exposed population and the report should provide sufficient rationale to justify the use of the values identified, noting whether the value is conservative or whether the value may result in an underestimate of exposure.

Consumption surveys are a good way to obtain site-specific information to use in an assessment. Results of such consumption surveys should be presented in terms of wet weight tissues to replicate the "as consumed" conditions. Also, it is good practice to evaluate potential risks associated with the most impacted areas where foods are likely to be obtained (e.g., backyard garden, specific lake or river), rather than adopting averages over larger areas.

Where a preliminary analysis suggests a potential for unacceptable human health risks, further assessment may be necessary to resolve conservatism and uncertainty in the HHRA process before the actual extent of the human health risk can be fully quantified and defined.

5.2.3 Stage 3: Effects/toxicity assessment

In the context of an HHRA, the effects assessment component is typically referred to as the toxicity assessment stage. This stage of the risk assessment involves identifying the potential toxic effects of each COPC and summarizing TRVs published by regulatory agencies, which will then be used to characterize potential risks in Stage 4 of the HHRA. A brief summary of the key health concerns associated with exposure to each COPC should be provided in the HHRA report or appendix. The summary should discuss both cancer and non-cancer endpoints, where appropriate.

The toxicity assessment is conducted for all identified COPCs and considers all receptor groups, including sensitive receptors. Depending on the mechanism of toxicity, the toxicity assessment either provides an estimate of how much exposure to a chemical can occur without any anticipated adverse health effects (threshold effect chemical) or establishes a relationship between the exposure dose of a chemical and the probability of developing an adverse health effect such as cancer (non-threshold effect chemical).

Although it is a separate step, the effects assessment should be conducted in conjunction with the exposure assessment. Information obtained during the exposure assessment, such as exposure duration (short-term versus long-term), can influence the effects assessment, and the mechanisms of toxic action (e.g., local versus systemic) can affect how the exposure assessment is performed. The effects assessment considers the site conceptual model developed during the problem formulation because TRVs are often exposure route-specific and are occasionally specific to certain sensitive receptors. The TRVs and exposure doses must be compatible with each other (i.e., if the exposure is expressed as a daily dose per unit body weight, the TRV should also be expressed in the same form).

For threshold-acting contaminants, TRVs are expressed as tolerable daily intakes or reference doses for the oral pathway; for non-threshold contaminants, TRVs are expressed as slope factors for the same pathway. Further information on toxicity assessment is found in Health Canada's detailed quantitative risk assessment guidance (Health Canada, 2010a) and risk assessment for short-term exposure guidance (Health Canada, 2013).

It is recommended that TRVs be obtained from reputable regulatory agencies—ideally from Health Canada sources where available—and that the most current values are applied in an HHRA as older TRVs may no longer be scientifically defensible or relevant. *Appendix C* identifies possible sources of TRVs for IAs.

If no published TRVs are available, or if there is compelling evidence that the published TRVs are inappropriate (e.g., outdated or based on a different exposure route or chemical form), then new TRVs may be required. *De novo* development of TRVs should only be undertaken by individuals qualified and experienced in toxicology. Further information on toxicity assessment is found in *Appendix B* of Health Canada's detailed quantitative risk assessment guidance (Health Canada, 2010a). If a TRV for a specific COPC is not available from any regulatory sources and cannot be derived from published literature, an alternative TRV may be substituted that is based on a structurally similar compound with similar mechanisms of action and fully supported with referenced scientific rationale.

5.2.4 Stage 4: Risk characterization

The purpose of risk characterization is to provide an estimate of potential risks to human health via consumption of country foods considering the potential exposure. The approaches described below are most commonly used, but are not an exhaustive list of methods that could be employed to characterize human health risks.

The risk estimates are typically separated into cancer and non-cancer endpoints.

Carcinogens (genotoxic) are generally assessed as non-threshold (i.e., any exposure may lead to a theoretical increase in the incidence of cancer). The increase in risk is calculated as an incremental lifetime cancer risk (ILCR). The estimated lifetime average daily dose will be multiplied by the appropriate slope factor to derive a conservative estimate of the potential ILCR associated with that exposure. Cancer risks will be deemed to be "essentially negligible" (*de minimis)* where the estimated ILCR is ≤ 1 in 100,000 (≤ 1 x 10^{-5}). The rationale for this essentially negligible risk level is presented in *Appendix C* of Health Canada's preliminary quantitative risk assessment guidance (Health Canada, 2012).

ILCR = Lifetime Average Daily Dose (µg/kg/d) x Cancer Slope Factor (µg/kg/d)$^{-1}$
OR in the case of airborne contaminants with a unit risk value in units of (µg/m^3)$^{-1}$
ILCR = Air Concentration (µg/m^3) x Fraction of Time Exposed x Cancer Unit Risk (µg/m^3)$^{-1}$

Most non-carcinogens are generally assessed as threshold contaminants (i.e., there is a level known as a no observed adverse effect level (NOAEL) below which exposure is not associated with adverse human health outcomes). The risk associated with a certain level of exposure to these contaminants is calculated as a hazard quotient (HQ), which is calculated by dividing the estimated exposure to the contaminant in question by the TRV for that contaminant. Where an HHRA evaluates only project-related exposures (excluding background estimated daily intake for sources not related to the project, including consumer products, food, air, and water), risks associated with an HQ ≤ 0.2 will be deemed negligible. Where risks associated with the project and the estimated intake from background sources are combined, the resulting HQ would be compared to a target value of 1.0. A target HQ of 1 basically means that the exposure from the project plus background does not exceed the TRV. If the HQ of 1 is exceeded, it may indicate a situation of non-negligible risk and the assessment may require further refinement. An HQ benchmark of 1 is generally used if levels of COPCs from background sources (in addition to exposure from the project, such as market foods, air, water, soil) have been included in the risk calculations. If exposure to COPCs from background sources is not included in the exposure calculations prior to comparing to a target HQ of 1, the risk may be underestimated. If a target value other than 1.0 is used, a detailed rationale should be provided to clearly justify the choice of this value. This is consistent with the CCME (2006) and has become accepted common practice in Canada.

With regard to mixtures of chemicals, for concomitant exposures to multiple COPCs determined to have similar target tissues and mechanisms of action, non-cancer HQs should be assumed to be additive and summed for those contaminants. All exposures from the project (country foods plus other exposures from media that may be impacted by the project) need to be added to obtain a final HQ associated with the project. All information used to derive final conclusions should be clearly documented to allow for peer review.

For concomitant exposures to multiple carcinogens determined to have similar target tissues and mechanisms of action, the risks, represented by ILCRs, should be assumed to be additive and thus summed. Health Canada may be consulted as needed regarding similarity of mechanisms of action and the need to aggregate risks. All other carcinogens with unique mechanisms of action, target organs, and/or forms of cancer should be assessed individually. Health Canada (2012) suggests using the same methodologies for summing toxic equivalence factors and potency equivalence factors.

A risk characterization summary (i.e., HQs for non-carcinogens, and ILCRs for carcinogens) should be provided for every COPC and receptor for each of the following scenarios:

- Baseline levels (current levels);
- Predicted levels from the project alone;
- Predicted levels resulting from baseline and project combined;
- Cumulative effects of this project and all other known proposed projects, if applicable;
- Predicted levels for project decommissioning or abandonment, if applicable.

If there are exceedances of either the target HQ or ILCR, additional mitigation measures should be considered in the conclusion/discussion section of the HHRA as well as a review of the assumptions made in the risk assessment and determining if further work is needed to refine the level of risk.

5.2.5 Uncertainty analysis

Data gaps and/or assumptions made when conducting the assessment may lead to an underestimation or an overestimation of potential human health risks, which may result in the development of inappropriate risk management strategies, monitoring, and/or follow-up programs. For example, if standard rates of consumption for the general public are used instead of dietary exposure data related to the regional study area outlined in the project, then the risks due to COPC exposure for certain groups with higher than average consumption of the country foods (e.g., hunters, fishers) may be underestimated.

In order to account for these data gaps/assumptions, it is good practice to include a discussion in the HHRA on uncertainties in a risk assessment for country foods. Some of the contributors to uncertainties related to exposure assessment for country foods result from the following:

- Adequacy of data collected to assess baseline levels of COPCs in foods;
- Variability in the contaminant levels in foods;
- Use of surrogate data for one type of country food to apply to other types of country foods for which there are no data;
- Use of mathematical models to predict COPC exposure from country foods that results from project activities;
- Availability of local data regarding dietary exposure to COPCs;
- Use of food consumption amounts that are not specific to the subject population;

- Use of short-term dietary intake (e.g., 24-hour recall, 1-week food frequency questionnaire) data alone to make projections about lifelong intakes, particularly in the case of foods infrequently consumed;
- Uncertainties in TRVs;
- Potential for synergistic/antagonistic effects of multiple COPCs.

5.2.6 Conclusion/recommendations

This section of the analysis contains the information concerning potential human health effects, including the uncertainties identified in the assessment, and the accompanying rationale or justification of the final conclusion. The need for monitoring and/or follow-up programs, risk mitigation strategies, and risk management approaches should also be described. Including a well-structured HHRA in the IS clearly articulates potential impacts on human health as a result of the project and increases the defensibility of the conclusions.

Conclusions presented in the report should be sufficiently detailed and appropriate for the proposed project; for example, they should be based on quantitative estimates of the potential risks in an exposed population, discuss the need for mitigation measures, and outline how the follow-up monitoring plans and/or risk management approaches were developed.

5.3 MITIGATION

The IS should identify whether mitigation may be appropriate to address potential human health risks associated with contamination of country foods where the HHRA has identified that exposure to one or more COPCs may exceed the target HQ or ILCR.

Mitigation measures generally reduce the anticipated impact of sources rather than constraining pathways or receptors. Mitigation measures may include the following:

- Reducing airborne emissions (e.g., closed-loop processes or emissions scrubbers for industrial projects);
- Containing contaminated water and/or soils to prevent access by species that are consumed as country foods;
- Where necessary, developing consumption advisories when increases in COPC levels in foods are unavoidable and ensure appropriate education/communication to the affected population;
- Providing and/or facilitating access to reasonable substitutions for contaminated country foods item(s);
- Consulting with local populations on the appropriateness and acceptability of proposed mitigation measures.

5.4 MONITORING

In the context of an IA, monitoring is generally conducted to determine the accuracy of predicted COPC levels in country foods obtained by modelling, thus ensuring that people are not exposed to unacceptable levels of COPCs in country foods. The questions below can be used as a starting point to assist in determining if a monitoring plan is appropriate:

- Is there significant public concern about the possibility of country food contamination?
- Is there uncertainty about one or more predicted COPC levels in country foods?
- Based on predicted COPC levels in country foods, are there likely exceedances of HQ/ILCR targets (or are the estimates close to target levels)?
- Are there any available results of human biomonitoring suggesting elevated COPC levels in the population?
- Is there a history of country food contamination in areas close to the proposed project area?
- Is there potential for novel COPCs—substances not on the *Domestic Substance List*[4] or substances with limited data on uptake into country food species and/or human health effects—to be released, emitted or mobilized as a result of project activities?
- Are new technologies and/or substances being used during the project activities?

Key considerations in developing a monitoring plan are the following:

1. When to start monitoring
2. Where to monitor
3. Frequency and duration of monitoring
4. What species and tissues to sample
5. The need for human biomonitoring
6. Which contaminants to monitor
7. Sample collection that reflects when country foods are typically harvested, collected, fished, and/or hunted (e.g., when foods are ripe/in season)
8. Communication plan

In cases where monitoring results demonstrate COPC levels significantly beyond modelled results, a revision of the HHRA may be warranted, using the updated information. The outcome of such assessments may indicate the need for different or additional mitigation measures.

4 The Domestic Substance List, published in the Canada Gazette Part II on May 4, 1994, is an inventory of approximately 23 000 substances manufactured in, or imported into Canada on a commercial scale. https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/substances-list/domestic.html

5.4.1 When to start monitoring

Baseline levels of COPCs in country foods should be measured as part of the IA prior to the project start. If those levels were neither measured nor comprehensive, then it is recommended that they be identified prior to project start. Baseline levels of COPCs in different foods will be variable, and there is a lack of data on tissue concentrations for many COPCs in foods. Baseline levels can also be established using a reference site (i.e., nearby site with similar environmental conditions, but outside the zone of influence of the project).

A. MONITORING DURING CONSTRUCTION

To have the most robust and accurate data, it is advisable to start country food monitoring during the construction phase of a project if:

- vehicles and/or other diesel-powered equipment will be used;
- start-up activities (e.g., vegetation clearing, excavation, damming, blasting) may mobilize contaminants; and/or,
- waste management options include incineration.

B. MONITORING DURING OPERATIONS

Country food monitoring begins after project operation commences and continues for a defined period during this phase.

C. MONITORING DURING DECOMMISSIONING

If decommissioning is a foreseeable part of the project, it may be appropriate to continue country food monitoring during the decommissioning phase, especially if there is the possibility of COPC emission, release, mobilization, and/or modification in the environment (e.g., tailing ponds).

5.4.2 Where to monitor

Monitoring should be conducted in the areas where potential effects are most likely to occur and where country foods are being harvested. The report usually describes the local study area and a larger regional study area, which ideally should be delineated for each environmental medium that may be impacted. Delineation should also be performed for country foods.

5.4.3 Frequency and duration of monitoring

The scheduling of country food monitoring should reflect:

- emissions during initial operation of a project until contaminant levels peak and a pattern of declining contaminant levels is determined;
- when modelling indicates likely increases in contaminant concentration in relevant media;
- growth and migratory patterns of the species being monitored.

In addition to scheduled monitoring, additional monitoring may also be conducted to reflect specific incidents. For instance, increased monitoring may be appropriate in cases of spills/accidental releases, or if monitoring of other media (e.g., air, water, soil) indicates elevated levels of contaminants (above that modelled for the purpose of the IA).

5.4.4 What species and tissues to sample

An appropriate choice of species for monitoring is contingent on the following:

- Actual species and tissues consumed;
- Feasibility of collecting enough samples to estimate exposure;
- Representation of different growth rates and trophic levels for foods consumed;
- Ability to obtain enough tissue from different edible tissue types (i.e., organs, muscle, fat) to complete an analysis.

In some cases, the sampling of species, which are not actually consumed but are widely available and representative of consumed species in terms of contaminant exposure and metabolism, may be appropriate as a supplemental data source, but not as the only data source. Also, when sampling migratory wildlife (e.g., caribou), it is important to consider sampling other consumed species (e.g., deer) that may be more reflective of year round COPC exposure as a result of the project.

Consider the following when choosing tissues to sample:

- Actual consumption of the tissue (frequency and amount of consumption). Some tissues, normally organs, are only consumed irregularly at particular times of the year, but may be consumed in large amounts by specific populations which may be of a concern from both acute and chronic toxicity perspectives.
- How representative the level of contaminant in the analyzed tissue is of the level in other tissues of the same species also consumed by humans.

5.4.5 The need for human biomonitoring

In some cases, human biomonitoring can be an appropriate tool to follow the migration of contaminants through the food chain, up to human consumers. Such monitoring may be particularly considered when background levels of COPCs in country foods are already raising concerns or may pose risks when certain foods are consumed without limitations. Biomonitoring may consist of sampling body fluids, human hair or other tissues; however, given the more invasive nature of this procedure, it should be adequately planned and carried out in consultation with affected communities and in collaboration with representatives of Indigenous peoples.

5.4.6 Which contaminants to monitor

If a contaminant is identified as a COPC for the proposed project, it should be included in the monitoring plan. If a COPC is excluded from the monitoring plan, an appropriate rationale (e.g., monitored through regional monitoring programs) should also be included.

If any novel contaminants are identified during project activities, it is good practice to monitor them and complete a risk assessment. Also, it should be decided what detection limits will be used for each COPC and if the same detection limits will be used for all tissues sampled.

5.4.7 Sample collection

There are generally two approaches to choosing a sample appropriate for country food monitoring:

1. A sufficient number of samples for each tissue of interest should be collected during each sampling period in order to obtain a statistically significant sample size (a predefined number of samples from species representative of a range of age, gender, and size characteristics). Care should be taken to consider population size in a sampling program in order that it does not inappropriately deplete the existing population. Additionally, the size of each sample submitted for analysis should be sufficient to obtain the required analytical detection limit (the analytical laboratory should be consulted prior to sampling to identify the size requirements for each sample).
2. Paralleling actual hunting or harvesting patterns by collecting specimens donated by community members who hunt, gather or harvest country foods. This method reduces costs, tends to be more reflective of the actual species and tissues that are consumed, and makes use of traditional knowledge. However, when this method is used, it may be difficult to obtain a statistically significant sample size, and there are inter-sample reliability issues and bias to consider (variability in preference for species, size, gender, etc.) Additionally, it is important to document how the samples are collected and whether any contaminants are introduced during collection. It is often, however, the only practical method of collecting samples. If this method is used, the uncertainty section of the report should identify potential uncertainties associated with the samples.

5.4.8 Communication plan

Including a communication plan, if appropriate, related to the distribution of monitoring reports to local, provincial, territorial, federal, and First Nations and Inuit health authorities and communities is a key part of monitoring. The communication plan would include the steps that will be taken if there are any exceedances of established benchmarks or if there are no exceedances.

6 ASSESSMENT OF CUMULATIVE EFFECTS

Under subsection 22(1)(a)(ii) of the IAA, an IA must take into account "any cumulative effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out."

Assessing the cumulative effects of projects is a central element of the IA. The cumulative effects scenario represents the potential environmental effects of the existing baseline plus project scenario in combination with effects from reasonably foreseeable future projects within the same area of influence. Reasonably foreseeable future projects include those that are approved but not yet operating, and/or other proposed or likely developments within the potentially impacted area. The cumulative effects scenario provides an estimate of human health risks in the future when other facilities are also in operation.

In the case of country foods, an assessment of cumulative effects should include the following:

- Changes in levels of contaminants in country foods resulting from all past, present, and known future projects.
- Whether all past, present, and/or known future projects could result in possible changes in contaminant exposure due to access to new sources of country foods (e.g., access to country food sources that were previously inaccessible such as the creation of a new road, which could result in fishing and hunting in areas where there was previously no fishing or hunting, and fish repopulation of a rehabilitated tailings pond) and/or changes in levels of country food consumption amount.
- Where COPCs have similar endpoints, it may be necessary to not only address cumulative effects, but also the additive effects.

For guidance on assessing cumulative effects, consult the Agency's website for up-to-date guidance materials at Canada.ca/iaac.

7 FOLLOW-UP PROGRAMS

Under Section 2 of the IAA, a follow-up program is defined as a program for:

a) Verifying the accuracy of the IA of a designated project; and

b) Determining the effectiveness of any mitigation measures.

It may be appropriate to consider a follow-up program for country foods if one of the following applies (note that this is not a comprehensive list and is not a substitute for professional judgment):

- There is uncertainty about the modelling of COPC emissions, release, mobilization or deposition in the environment and uptake in country food sources;
- There is potential for novel COPCs to be introduced into country foods;
- It is uncertain whether proposed mitigation measures will be effective (e.g., the use of novel technology or complex systems);
- The unexpected contamination of country foods or operational changes alter the levels or nature of the contaminants released.

Health Canada may make available expert health-related information or knowledge regarding a follow-up program upon request by the Agency, a review panel or others conducting the IA.

For further and up-to-date information on the need for and requirements of follow-up programs, contact the Agency.

8 REFERENCES

Canadian Council of Ministers of the Environment. (2006). *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines [Revised]*. Report CCME PN 1332, CCME, Winnipeg, MB. ISBN 13-978-1-896997-45-2.

Chan L., Receveur O., Batal M., David W., Schwartz H., Ing A., Fediuk K., Black A., and Tikhonov C. (2014) and (2016). *First Nations Food, Nutrition & Environment Study: Results from Ontario (2011/2012)* and *First Nations Food, Nutrition & Environment Study: Results from Alberta (2013)*. Ottawa: University of Ottawa from www.fnfnes.ca/docs/FNFNES_Ontario_Regional_Report_2014_final.pdf www.fnfnes.ca/docs/Alberta_Reports/FNFNES_Alberta_Regional_Report_.pdf

Chan L., Receveur, O., Sharp, D., Schwartz H., Ing, A., Fediuk, K., Black, A., and Tikhonov, C. (2012). *First Nations Food, Nutrition & Environment Study: Results from Manitoba (2010).* Prince George: University of Northern British Columbia from www.fnfnes.ca/docs/MB%20Reports/FNFNES%20Report-MB_WEB_rev.pdf

Chan L., Receveur, O., Sharp, D., Schwartz H. Ing, A., and Tikhonov , C. (2011). *First Nations Food, Nutrition & Environment Study: Results from British Columbia (2008/2009).* Prince George: University of Northern British Columbia from www.fnfnes.ca/docs/FNFNES_Report_BC_FINAL_PRINT_v2-lo.pdf

Federal/Provincial/Territorial Committee on Environmental and Occupational Health. (2004). *Canadian Handbook on Health Impact Assessment—Volume 3: The Multidisciplinary Team*. Ottawa, Ontario: Health Canada. Available at: http://publications.gc.ca/collections/Collection/H46-2-04-362E.pdf

Health Canada. (2023). *Guidance for Evaluating Human Health Effects in Impact Assessment: HUMAN HEALTH RISK ASSESSMENT*. Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Health Canada. (2021). *Federal Contaminated Site Risk Assessment in Canada: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0*. Ottawa, Ontario: Environmental Health Assessment Services, Safe Environments Program. https://publications.gc.ca/collections/collection_2021/sc-hc/H129-114-2021-eng.pdf

Health Canada. (2013). *Federal Contaminated Site Risk Assessment in Canada, Interim Guidance on Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites.* Contaminated Sites Division, Safe Environments Directorate, Ottawa. Available at: http://publications.gc.ca/collections/collection_2013/sc-hc/H144-11-2013-eng.pdf

Health Canada. (2010a). *Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals ($DQRA_{CHEM}$).* Ottawa, Ontario: Environmental Health Assessment Services, Safe Environments Program. Available at: http://publications.gc.ca/collections/collection_2011/sc-hc/H128-1-11-639-eng.pdf

Health Canada. (2010b). *Federal Contaminated Site Risk Assessment in Canada: Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRA$_{FOODS}$)*. Contaminated Sites Division, Safe Environments Directorate, Ottawa. Available at: https://publications.gc.ca/collections/collection_2012/sc-hc/H128-1-11-641-eng.pdf

Impact Assessment Act. S.C. 2019, c. 28, s.1. (2019). Available online at: https://laws-lois.justice.gc.ca/PDF/I-2.75.pdf

Richardson, G.M. (1997). *Compendium of Canadian Human Exposure Factors for Risk Assessment.* O'Connor Associates Environmental Inc.

United States Environmental Protection Agency (US EPA). (2014). *Framework for Human Health Risk Assessment to Inform Decision Making.* https://www.epa.gov/sites/production/files/2014-12/documents/hhra-framework-final-2014.pdf

APPENDIX A | COUNTRY FOODS ASSESSMENT CHECKLIST

This checklist can be used to verify that the main components of a country food assessment have been completed. It is helpful to include this checklist with the IS (or equivalent document), and to show where the components of the country food assessment are located in the document. This is especially helpful if the components are located in more than one section of the document.

OVERALL		
✓	**Item**	
	1. Worked examples are included for calculations in a quantitative risk assessment.	
	2. Units are clearly stated and consistent (or conversion calculations are included as appropriate).	
	3. Assumptions are clearly stated and justified.	

HHRA—PROBLEM FORMULATION		
✓	**Item**	**Section in IA**
	4. All COPCs as result of project activities are identified.	
	5. Possible impacted media (air, dust, sediment, water or soil) which could result in increased COPC concentrations in foods that may be consumed are identified.	
	6. All plant/animal/fish/fowl species that may be consumed as country foods are identified and carried forward in the risk assessment.	
	7. All current and likely future consumer groups are identified.	
	8. A detailed rationale is included for not completing a country food assessment if the conclusion is that this assessment is not necessary.	
	9. A discussion is included about whether or not a multi-media HHRA was considered and conducted for any COPC with an identified risk and multiple pathways.	

HHRA—EXPOSURE ASSESSMENT, EFFECTS ASSESSMENT, AND RISK CHARACTERIZATION		
✓	Item	Section in IA
	10. The amount and frequency of consumption of each food are provided for eaters only, and/or a justification is provided for assumed consumption levels if dietary intake is not available.	
	11. Current (baseline) COPC levels are documented in edible tissues for each of the country foods consumed by the population. If pre-existing data were used, a rationale for their use is included, making reference to timing and to geographical and population scope, and discussing any data gaps or extrapolations.	
	12. Likely exposure to contaminants from market food consumption is identified (optional).	
	13. A summary of the sampling program, locations of samples, and analytical data is included.	
	14. A summary of the TRVs is provided, with rationale for each TRV.	
	15. A risk characterization (HQs for non-carcinogens, and ILCRs for carcinogens) is included for each COPC and receptor: i. Baseline levels (current levels) ii. Predicted levels from the project alone iii. Predicted levels resulting from baseline and project combined iv. Cumulative effects of this project and all other known proposed projects, if applicable v. Predicted levels for project decommissioning or abandonment, if applicable	
	16. The report identifies and explains whether or not any HQs exceed benchmark levels for acceptability for non-carcinogens, and whether or not any ILCRs exceed targets for carcinogens; and a rationale for benchmark selection is included.	
	17. A discussion of uncertainties associated with assumptions in the assessment is included.	

MITIGATION		
✓	Item	Section in IA
	18. Scenarios and rationales for the inclusion or exclusion of mitigation are included.	
	19. A discussion regarding mitigation approaches and a rationale for the chosen approach(es) are included.	

MONITORING		
✓	Item	Section in IA
	20. Rationales for the inclusion or exclusion of monitoring are included.	
	21. A discussion about monitoring approaches and a rationale for the chosen approach(es) are included.	
	22. A communication plan is included, if appropriate.	

CUMULATIVE EFFECTS AND FOLLOW-UP PROGRAM		
✓	Item	Section in IA
	23. Cumulative scenarios and effects are considered.	
	24. Additional mitigation and/or monitoring are considered if cumulative effects on country foods exceed the project-only scenario.	
	25. The country food section (as required) of the follow-up program is described.	

APPENDIX B | ADDITIONAL INFORMATION ON HEALTH CANADA HUMAN HEALTH RISK ASSESSMENT DOCUMENTS

The documents listed below provide HHRA guidance for federal contaminated sites in Canada. Risk assessments of contaminated sites are based on known existing levels of COPCs and are not universally applicable to HHRAs intending to support IAs, where concentrations of contaminants are modelled for various media over the lifetime of a project. However, these documents contain valuable guidance applicable to IAs—relevant information and document locations are identified below. Please note that these documents can be accessed directly from Archives Canada publications web page (links to PDF format provided); however, these links will not lead to Health Canada's Contaminated Sites program, where multiple documents can be requested.

Health Canada. (2021). *Federal Contaminated Site Risk Assessment in Canada: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0*. Ottawa, Ontario: Environmental Health Assessment Services, Safe Environments Program.

- Prescribes, to the degree possible, standard exposure pathways, receptor characteristics, TRVs, and other parameters required to quantitatively and consistently assess potential chemical exposures and human health risks.

Health Canada. (2010a). *Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRA$_{CHEM}$)*. Ottawa, Ontario: Environmental Health Assessment Services, Safe Environments Program. http://publications.gc.ca/collections/collection_2011/sc-hc/H128-1-11-639-eng.pdf and errata http://publications.gc.ca/collections/collection_2015/sc-hc/H128-1-11-639-1-eng.pdf

- Most risk assessments conducted to support environmental assessments will have similar considerations of those described in the DQRA guidance.

Health Canada (2010b). *Federal Contaminated Site Risk Assessment in Canada: Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRA$_{FOODS}$)*. http://publications.gc.ca/collections/collection_2012/sc-hc/H128-1-11-641-eng.pdf

- Listing of some country foods that may be consumed
- Sampling methodology for country foods, including considerations for the number of samples that may be required
- Resources for Indigenous dietary consumption of traditional foods
- Limited discussion on modelling tissue concentrations and the use of uptake models for a HHRA incorporating country foods

APPENDIX C | SOURCES OF TOXICOLOGICAL REFERENCE VALUES

Source	Description	Availability
Health Canada. Chemical Health Hazard Assessment Division (CHHAD)	TRVs used by CHHAD in health risk assessments for chemicals in foods	Unpublished. For questions related to TRVs, contact CHHAD at chhad.inquiries-requetes.dedpcs@hc-sc.gc.ca
Health Canada. *Federal Contaminated Site Risk Assessment in Canada, Toxicological Reference Values (TRVs) Version 3.0*	TRVs for a number of substances found at contaminated sites	https://publications.gc.ca/collections/collection_2021/sc-hc/H129-108-2021-eng.pdf
United States Environmental Protection Agency. *Integrated Risk Information System (IRIS)*	TRVs provided for hundreds of substances	https://www.epa.gov/iris
Joint Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives. *Summary of Evaluations Performed by the Joint FAO/WHO Expert Committee on Food Additives*	Details on tolerable intakes for many substances	https://www.who.int/foodsafety/publications/chem/summary72.pdf
Agency for Toxic Substances and Disease Registry. *Minimal Risk Levels for Hazardous Substances*	List of minimal risk levels for oral (and inhalation) routes for many substances	www.atsdr.cdc.gov/mrls/index.html

APPENDIX D | THEMATIC REFERENCE LIST

D.1 OVERALL COUNTRY FOODS AND HUMAN HEALTH RISK ASSESSMENT

Federal/Provincial/Territorial Committee on Environmental and Occupational Health. (2004). *Canadian handbook on health impact assessment—Volume 3: The multidisciplinary team*. Ottawa, Ontario: Health Canada. Available at: http://dsp-psd.pwgsc.gc.ca/Collection/H46-2-04-362E.pdf

Federal/Provincial/Territorial Committee on Environmental and Occupational Health. (2004). *Canadian handbook on health impact assessment—Volume 4: Health Impacts by Industry Sector*. Ottawa, Ontario: Health Canada. Available at: http://dsp-psd.pwgsc.gc.ca/Collection/H46-2-04-363E.pdf

Golder Associates Ltd. (2005). *Guidance on conducting surveys of country food contamination.* Ottawa, Ontario. Prepared under contract to the Environmental Assessment Division, Health Canada.

Hatfield Consultants for the World Bank. (2008). *Persistent organic pollutants toolkit*. Available at: www.popstoolkit.com

Health Canada. (2009). *Concentration of Contaminants & Other Chemicals in Food Composites.* Available at: www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/canadian-total-diet-study/concentration-contaminants-other-chemicals-food-composites.html

Meridian Environmental Inc. (2011). *Sampling and Laboratory Analysis of Country Foods*. Prepared under contract to the Contaminated Sites Division, Health Canada.

Richardson, G.M. (1997). *Compendium of Canadian Human Exposure Factors for Risk Assessment.* O'Connor Associates Environmental Inc.

United States Environmental Protection Agency (US EPA). (2012). *Human Health Risk Assessment.* From www.epa.gov/risk_assessment/health-risk.htm

D.2 DIETARY SURVEYS AND METHODOLOGIES

Carrington, C.D. and Bolger, P.M. (2001). Methods for projecting long-term dietary exposure from short-term survey data for environmental contaminants. *Toxicology and Industrial Health, 17* (5–10), 176–179.

First Nations Food, Nutrition and Environment Study. (2012). FNFNES Questionnaire 2012. www.fnfnes.ca/docs/Forms/FNFNES%20Ontario%202012%20Questionnaire.pdf

Gibson, R.S. (2005). *Principles of Nutritional Assessment*. Oxford University Press.

D.3 CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT GUIDELINES

Canadian Council of Ministers of the Environment (CCME). *Canadian Tissue Residue Guidelines for the Protection of Wildlife Consumers of Aquatic Biota.* Available at: https://ccme.ca/en/resources/tissue-residue

D.4 INFORMATION ABOUT CANADIAN DIETARY INTAKE, INCLUDING INDIGENOUS PEOPLES

Batal, M., Gray-Donald, K., Kuhnlein, H. V., and Receveur, O. (2005). Estimation of traditional food intake in indigenous communities in Denendeh and the Yukon. *International Journal of Circumpolar Health, 64* (1), 46–54.

Bergeron, O, Richer, F., Bruneau S., and Laberge Gaudin, V. (2015). *The Diet of Québec First Nations and Inuit Peoples*. Institut national de santé publique. Available at: https://www.inspq.qc.ca/sites/default/files/publications/2065_diet_first_nations_inuits.pdf

Berti, P. R., Soueida, R. and Kuhnlein, H. V. (2008). Dietary assessment of indigenous Canadian Arctic women with a focus on pregnancy and lactation. *International Journal of Circumpolar Health 67* (4), 349–362.

Blanchet, C., Dewailly, E., Ayotte, P., Bruneau, S., Receveur, O., and Holub, B. J. (2000). Contribution of selected traditional and market foods to the diet of Nunavik Inuit Women. *Canadian Journal of Dietetic Practice and Research 61* (2), 50–59.

Blanchet, C., Dewailly E., Chaumette, P. N. , Nobmann, E. D., Bjerregaard. P., Pars,T. , Lawn, J., Furgal, C., and Proulx, J.F. (2002). Diet profile of circumpolar Inuit. In G. Duhaime (Ed.), *Sustainable food security in the Arctic*. Vol 1 (p. 47–60). Quebec: Canadian Circumpolar Institute Press. Available at: https://www.chaireconditionautochtone.fss.ulaval.ca/doc/Publication/Chapitre-2-01.pdf

Blanchet, C. and Rochette, L. (2008). *Nutrition and food consumption among the Inuit of Nunavik. Qanuippitaa? How are we?* Québec, Québec: Institut national de santé publique: Nunavik Regional Board of Health and Social Services. Available at: https://www.inspq.qc.ca/pdf/publications/762_ESI_Nutrition_Report_MA.pdf

Chan L., Receveur O., Batal M., David W., Schwartz H., Ing A., Fediuk K., Black A., and Tikhonov C. (2014). *First Nations Food, Nutrition & Environment Study: Results from Ontario (2011/2012)*. Ottawa: University of Ottawa from www.fnfnes.ca/docs/FNFNES_Ontario_Regional_Report_2014_final.pdf

Chan L., Receveur, O., Sharp, D., Schwartz H., Ing, A., Fediuk, K., Black, A.,and Tikhonov, C. (2012). *First Nations Food, Nutrition & Environment Study: Results from Manitoba (2010).* Prince George: University of Northern British Columbia from www.fnfnes.ca/docs/MB%20Reports/FNFNES%20Report-MB_WEB_rev.pdf

Chan L., Receveur, O., Sharp, D., Schwartz H. Ing, A., and Tikhonov, C. (2011). *First Nations Food, Nutrition & Environment Study: Results from British Columbia (2008/2009).* Prince George: University of Northern British Columbia from www.fnfnes.ca/docs/FNFNES_Report_BC_FINAL_PRINT_v2-lo.pdf

Deutch, B. (2003). Recent Dietary Studies in the Arctic. In *AMAP Assessment 2002: Human Health in the Arctic* (p. 74–87). Oslo, Norway: AMAP.

Dewailly, E., Blanchet, C., Gingras, S., Lemieux, S., and Holub, B.J. (2003). Fish consumption and blood lipids in three ethnic groups of Québec (Canada). *Lipids, 38* (4), 359–365.

Duhaime, G., Chabot, M. and Gaudreault, M. (2002). Food consumption patterns and socioeconomic factors among the Inuit of Nunavik. *Ecology of Food and Nutrition, 41,* 91–118.

Gagne, D., Blanchet, R., Lauzière, J., Vaissière, E., Vézina, C., Ayotte, P., Serge Déry, S., and Turgeon O'Brien, H. (2012). Traditional food consumption is associated with higher nutrient intakes in Inuit children attending childcare centres in Nunavik. *Int J Circumpolar Health*, 71: 18401. http://dx.doi.org/10.3402/ijch.v71i0.18401

Health Canada. *Canadian Total Diet Study.* Available at: https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/canadian-total-diet-study.html

Indian and Northern Affairs Canada. (2005). *Highlights of the Canadian Arctic Contaminants Assessment Report II, Appendix A: A partial listing of traditional/country foods consumed by northern Aboriginal peoples*. pp.107–111.

Intrinsik Environmental Sciences Inc. (2011). *Literature Review of Country and Traditional Food Consumption Rates and Patterns in Alberta*. Prepared under contract to the Contaminated Sites Division of Health Canada.

Kuhnlein, H. V., Receveur, O., Soueida, R., and Berti, P. R. (2008). Unique patterns of dietary adequacy in three cultures of Canadian Arctic indigenous peoples. *Public Health Nutrition, 11* (4), 349–360.

Lawn, J. and Harvey, D. (2001). *Change in Nutrition and Food Security in Two Inuit Communities, 1992 to 1997.* Ottawa, Ontario: Indian and Northern Affairs Canada. Available at: http://epe.lac-bac.gc.ca/100/200/301/inac-ainc/change_nutrition-e/nutfoosec_e.pdf

Lawn, J. and Harvey, D. (2003). *Nutrition and Food Security in Kugaaruk, Nunavut—Baseline Survey for the Food Mail Pilot Project.* Ottawa, Ontario: Indian and Northern Affairs Canada. Available at: https://epub.sub.uni-hamburg.de/epub/volltexte/2009/1059/pdf/KugaRep03_e.pdf

Lawn, J. and Harvey, D. (2004). *Nutrition and Food Security in Kangiqsujuaq, Nunavik—Baseline Survey for the Food Mail Pilot Project.* Ottawa, Ontario: Indian and Northern Affairs Canada. http://epub.sub.uni-hamburg.de/epub/volltexte/2009/1058/pdf/kangrep04_e.pdf

Lawn, J. and Harvey, D. (2004). *Nutrition and Food Security in Fort Severn, Ontario—Baseline Survey for the Food Mail Pilot Project.* Ottawa, Ontario. Indian and Northern Affairs Canada. Available at: http://dsp-psd.pwgsc.gc.ca/Collection/R2-350-2004E.pdf

Lawn, J., Harvey, D., Hill, F., and Brule, D. (2002). *An Update on Nutrition Surveys in Isolated Northern Communities*: *Revised 24-hour diet recall data from the Food Mail Nutrition Surveys (1992 and 1993) and the Santé Québec Health Survey among the Inuit of Nunavik, 1992 and original data from the 1997 Food Mail Nutrition Surveys.* Ottawa, Ontario: Indian and Northern Affairs Canada. Available at: http://dsp-psd.pwgsc.gc.ca/Collection/R2-188-2001E.pdf

Mos, L., Jack, J., Cullon, D., Montour, L., Alleyne, C., and Ross, P. S. (2003). The Importance of Marine Foods to a Near-Urban First Nation Community in Coastal British Columbia, Canada: Toward a Risk-Benefit Assessment. *Journal of Toxicology and Environmental Health, Part A 67*, 791–808.

Nakano, T., Fediuk, K., Kassi, N., Egeland, G. M., and Kuhnlein, H. V. (2005). Food use of Dene/Métis and Yukon children. *International Journal of Circumpolar Health, 64* (2), 137–46.

Pacey, A., Weiler, H., and Egeland, G. M. (2011). Low prevalence of iron-deficiency anaemia among Inuit preschool children: Nunavut Inuit Child Health Survey, 2007–2008. *Public health nutrition*, *14* (8), 1415–23.

Sheikh, N., Egeland, G. M., Johnson-Down, L., and Kuhnlein, H. V. (2011). Changing dietary patterns and body mass index over time in Canadian Inuit communities. *International journal of circumpolar health*, *70* (5), 511–9.

Statistics Canada. (2001). *Harvesting and Community Well-being Among Inuit in the Canadian Arctic: Preliminary Findings from the 2001 Aboriginal Peoples Survey—Survey of Living Conditions in the Arctic.* Ottawa, Ontario. https://www150.statcan.gc.ca/n1/en/catalogue/89-619-X

D.5 RISK COMMUNICATION AND RISK MANAGEMENT

Archibald, C.P. and Kostasky, T. (1991). Public health response to an identified environmental toxin: Managing risks to the James Bay Cree related to cadmium in caribou and moose. *Canadian Journal of Public Health, 82*, 22–26.

Furgal, C. M., Powell, S. and Myers, H. (2005). Digesting the Message about Contaminants and Country Foods in the Canadian North: A Review and Recommendations for Future Research and Action. *Arctic, 58* (2), 103–114. Accessed in August 2009 from http://pubs.aina.ucalgary.ca/arctic/Arctic58-2-103.pdf

Receveur, O., Kassi, N., Chan, H. M., Berti, P.R., and Kuhnlein, H. V. (1998). *Yukon First Nations assessment of dietary benefit: risk*. Montreal, Quebec. Centre for Indigenous Peoples' Nutrition and Environment, McGill University.

D.6 NORTHERN CONTAMINANTS PROGRAM AND ARCTIC MONITORING AND ASSESSMENT PROGRAMME

AMAP. (2003). *AMAP Assessment 2002: Human health in the Arctic*. Oslo, Norway. Available at: www.amap.no/documents/doc/amap-assessment-2002-human-health-in-the-arctic/95

AMAP. (2004). *AMAP Assessment 2002: Heavy metals in the Arctic*. Oslo, Norway. Available at: www.amap.no/documents/doc/amap-assessment-2002-heavy-metals-in-the-arctic/97

AMAP. (2004). A*MAP Assessment 2002: Persistent organic pollutants in the Arctic*. Oslo, Norway. Available at: www.amap.no/documents/doc/amap-assessment-2002-persistent-organic-pollutants-in-the-artic/96

AMAP. (2004). AMAP *Assessment 2002: Radioactivity in the Arctic*. Oslo, Norway. Available at: www.amap.no/documents/doc/amap-assessment-2002-radioactivity-in-the-arctic/93

AMAP. (2015). *AMAP Assessment 2015: Human Health in the Arctic*. Oslo, Norway. Available at: www.amap.no/documents/doc/AMAP-Assessment-2015-Human-Health-in-the-Arctic/1346

Northern Contaminants Program. (2017). *Canadian Arctic Contaminants Assessment Report—Human Health Assessment 2017* is available at: https://publications.gc.ca/collections/collection_2018/rcaanc-cirnac/R74-2-4-2017-eng.pdf

D.7 COUNTRY FOOD CONTAMINATION MONITORING PROGRAMS

CanNorth. Athabasca Environmental Monitoring. Multiple reports available at https://www.cameconorth.com/environment/monitoring

Golder Associates Ltd. (2001). *Oil Sands Regional Aquatics Monitoring Program (RAMP) 2000 Volume 1: Chemical and Biological Monitoring*. Calgary, Alberta. www.ramp-alberta.org/UserFiles/File/AnnualReports/2001/2001%20RAMP%20Vol%201.pdf

Therrien, J. (2006). *Environmental monitoring at Robertson reservoir [1990–2005]. Evolution of mercury levels in the flesh of fish.* Report submitted to Hydro-Québec by GENIVAR. https://inis.iaea.org/search/searchsinglerecord.aspx?recordsFor=SingleRecord&RN=38094913

D.8 CANADIAN DATA SOURCES OF CONTAMINANT LEVELS IN COUNTRY FOODS

Programs

Canadian Wildlife Service, Environment Canada. https://www.canada.ca/en/services/environment/wildlife-plants-species.html

The Canadian Wildlife Service has a wildlife contaminants monitoring program that provides some information on baseline levels of contaminants in country foods.

Documents

Chan, L. H. M. and Receveur, O. (2000). Mercury in the traditional diet of indigenous peoples in Canada. *Environmental Pollution*, 110 (1), 1–2.

Chan, L. H.M., Solomon, P., and Kinghorn, A. (2008). *Our waters, our fish, our people—Mercury contamination in fish resources of two Treaty #3 Communities: Final Report.* Ste-Anne-de-Bellevue, Quebec: Centre for Indigenous Peoples' Nutrition and Environment, McGill University. https://vdocuments.mx/our-waters-our-fish-our-people-mercury-contamination-in-fish-resources.html

Chapman, P. M. (2004). *Selenium from coal mining in the Elk River Valley.* North Vancouver, B.C., EVS Environment Consultants. https://circle.ubc.ca/handle/2429/8879

Downie, D. L. and Fenge, T. (Eds). (2003). *Northern Lights Against POPs: Combatting Toxic Threats in the Arctic.* Montreal & Kingston: McGill-Queen's University Press.

Fisk, A. T., Hobbs, K. E. and Muir, D.C.G. (2003). *Contaminant levels, trends and effects in the biological environment, Canadian Arctic Contaminants Assessment Report II.* Indian and Northern Affairs Canada. http://caid.ca/CanArtCon4.2003.pdf

Gamberg, M., Braune, B., Davey, E., Elkin, B., Hoekstra, P. F., Kennedy, D., Zeeb B. (2005). Spatial and temporal trends of contaminants in terrestrial biota from the Canadian Arctic. *Science of the Total Environment, 230*, 148–164. www.sciencedirect.com/science/article/pii/S0048969705004419

Golder Associates Ltd. (2003). *Trace metals in traditional foods within the Athabasca oil sands area.* www.barbau.ca/content/trace-metals-traditional-foods-within-athabasca-oil-sands-area-1

Health Canada. (2007). *Human Health Risk Assessment of Mercury in Fish and Health Benefits of Fish Consumption*. Available from: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/fn-an/alt_formats/hpfb-dgpsa/pdf/nutrition/merc_fish_poisson-eng.pdf

Houwers, C. (2004). *Petroleum Contaminants Community Research Project: Final Report.* Fort St. John, B.C.: Wildland Resources.

Indian and Northern Affairs Canada. (2003). *Human health: Canadian arctic contaminants assessment report II.* http://caid.ca/CanArtCon2.2003.pdf

Indian and Northern Affairs Canada. (2003). *Knowledge in action: Canadian arctic contaminants assessment report II.* http://caid.ca/CanArtCon3.2003.pdf

Indian and Northern Affairs Canada. (2003). *Sources, occurrence, trends and pathways in the physical environment: Canadian arctic contaminants assessment report II*. http://caid.ca/CanArtCon5.2003.pdf

Kinghorn, A., Solomon, P., and Chan, H. M. (2007). Temporal and spatial trends of mercury in fish collected in the English-Wabigoon River System in Ontario, Canada. *The Science of the Total Environment, 372* (2–3), 615–23.

Kuhnlein, H.V. and Chan, H. M. (2000). Environment and contaminants in traditional food systems of northern indigenous peoples. *Annual Review of Nutrition 20*: 595–626.

Kwan, M.K.H. (2006). *Assessment of the spatial trend of mercury in lake trout in Nunavik: Final report, 2006.* Kuujjuaq, Quebec: Makivik Corporation, Resource Development Department.

Larter, N. C. and Nagy, J. A. (2000). A comparison of heavy metal levels in the kidneys of High Arctic and mainland caribou populations in the Northwest Territories of Canada. *The Science of the Total Environment, 246* (2–3), 109–119.

Macdonald, C. (2000). *The Status of Contaminants in Fish and Marine Mammals in the Inuvialuit Settlement Region.* Inuvik, Northwest Territories: Prepared by Northern Environmental Consulting for the Fisheries Joint Management Committee. Available at: http://fishfp.sasktelwebhosting.com/publications/fjmccontam2000.PDF

Macdonald, R. W., Barrie, L. A., Bidleman, T. F., Diamond, M. L., Gregor, D. J., Semkin, R. G. and Stern, J. A. (2000). Contaminants in the Canadian Arctic: 5 years of progress in understanding sources, occurrence and pathways. *The Science of the Total Environment 254* (2–3), 93–234.

Macdonald, C. R., Elkin, B. T. and Tracy, B. L. (2007). Radiocesium in Caribou and Reindeer in Northern Canada, Alaska and Greenland from 1958 to 2000. *Journal of Environmental Radioactivity, 93* (1), 1–25.

Muir, D., Wang, X., Bright, D., Lockhart, L. and Köck, G. (2005). Spatial and temporal trends of mercury and other metals in landlocked char from lakes in the Canadian Arctic archipelago. *Science of the Total Environment, 351–352*, 464–478.

Pier, M. D., Zeeb, B.A. and Reimer, K. J. (2002). Patterns of contamination among vascular plants exposed to local sources of polychlorinated biphenyls in the Canadian Arctic and Subarctic. *The Science of The Total Environment, 297* (1–3), 215–227.

Robillard, S., Beauchamp, G., Paillard, G. and Bélanger, D. (2002). Levels of Cadmium, Lead, Mercury and 137 Cesium in Caribou (Rangifer tarandus) Tissues from Northern Québec. *Arctic 55* (1): 1–9. Available at: http://pubs.aina.ucalgary.ca/arctic/Arctic55-1-1.pdf

Schetagne, R., Therrien, J. and LaLumiere, R. (2013). *Environmental monitoring at the La Grande Complex. Evolution of fish mercury levels. Summary report 1978–2012.* Direction Barrages et Environnement, Hydro-Québec Production and Groupe conseil GENIVAR inc. Available at: https://www.hydroquebec.com/data/developpement-durable/pdf/evolution-fish-mercury-levels.pdf

Thomas, P. et al. (2005). Radionuclides and trace metals in Canadian moose near uranium mines: Comparison of radiation doses and food chain transfer with cattle and caribou. *Health Physics, 88* (5), 423–38.

Van Oostdam, J. et al. (2005). Human health implications of environmental contaminants in Arctic Canada: A review. *The Science of the Total Environment, 351–352*, 165–246.

Canadian Biomonitoring Data

Butler Walker, J., Seddon, L., McMullen, E., Houseman, J., Tofflemire, K., Corriveau, A., Weber, J.,Mills, C., Smith, S., and Van Oostdam, J. (2003). Organochlorine levels in maternal and umbilical cord blood plasma in arctic Canada. *Science of the Total Environment*, *302*: 27–52. https://www.sciencedirect.com/science/article/pii/S0048969702003194

Health Canada. (2010). *Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 1 (2007–2009)*. Available at: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/contaminants/chms-ecms/report-rapport-eng.pdf

Health Canada. (2013). *Second Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 2 (2009–2011)*. Available at: www.occupationalcancer.ca/wp-content/uploads/2013/05/2ndHumanBiomonitoringReport.pdf

Health Canada. (2015). *Third Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 3 (2012–2013)*. Available at: https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/pdf/pubs/contaminants/chms-ecms-cycle3/chms-ecms-cycle3-eng.pdf

Health Canada. (2017). *Forth Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 4 (2014–2015)*. Available at: https://www.canada.ca/content/dam/hc-sc/documents/services/environmental-workplace-health/reports-publications/environmental-contaminants/fourth-report-human-biomonitoring-environmental-chemicals-canada/fourth-report-human-biomonitoring-environmental-chemicals-canada-eng.pdf

Health Canada. (2019). *Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 5 (2016–2017)*. Available at: https://www.canada.ca/content/dam/hc-sc/documents/services/environmental-workplace-health/reports-publications/environmental-contaminants/fifth-report-human-biomonitoring/pub1-eng.pdf

Health Canada. (2021). *Sixth Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 6 (2018–2019)*. Available at: https://www.canada.ca/content/dam/hc-sc/documents/services/environmental-workplace-health/reports-publications/environmental-contaminants/sixth-report-human-biomonitoring/pub1-eng.pdf

Sandanger, T.M., Sinotte, M., Dumas, P., Marchan, M., Sandau, C.D., Pereg, D., Berubé, S., Brisson, J., and Ayotte, P. (2007). Plasma concentrations of selected organobromine compounds and polychlorinated biphenyls in post-menopausal women of Québec, Canada. *Environmental Health Perspectives, 115* (10), 1429–34. Available at: www.ncbi.nlm.nih.gov/pubmed/17938731

Tian, W., Egeland, G.M., Sobol, I., and Chan, H.M. (2011). Mercury hair concentrations and dietary exposure among Inuit preschool children in Nunavut, Canada. *Environment International 37* (1), 42–48.

D.9 Other

World Health Organization. *Global Environment Monitoring System (GEMS/Food)—Food Contamination Monitoring and Assessment Programme.* Available at: https://www.who.int/teams/nutrition-food-safety/databases/global-environment-monitoring-system-food-contamination