HC 03 ATTACHMENT 1: FULL RESPONSE

Health Canada HC-TIR-03 – Country Foods

Review Comment Number	HC-TIR-3
Subject/Topic	Country Foods
Reference	• Advance Technical Comment Responses Phase 2 Proposal – Mary River Project
Summary	Health Canada notes multiple uncertainties and data gaps associated with the presented HHRA country foods documents. In some cases, a limited number of samples were available for certain country foods considered in the HHRA, thus COPC concentrations may not be accurately represented. In other cases data is non-existent or might not be representative of what is found in the region.
Importance of issue to impact assessment process	Health Canada is unable to adequately assess the information presented on the potential risk to human health from the project through consumption of country foods because of the lack of information and uncertainty of estimates
Detailed Review Comment • Gap / Issue • Disagreement with FEIS • Reasons for Disagreement with FEIS	Baseline occurrence data for COPCs were only measured in Arctic char (landlocked/lake) (n=30) and the leaves of blueberry plants (n=8) from the project area. Baseline data for the remaining country foods were obtained from the literature. Health Canada notes multiple uncertainties and data gaps associated with the presented documents described below: A limited number of samples were available for certain country foods considered in the HHRA, thus COPC concentrations may not be accurately represented. It is unclear if the occurrence data (IE: being found in a place or under a particular set of conditions) from the literature are representative of the baseline scenario for the project area. Some of the references cited in the HHRA appear to include data specific to Nunavut, although it is not entirely clear which region of Nunavut and whether the information adequately represents the project area in question. It is unclear which geographic areas other data used to represent the baseline scenario were from. With respect to ptarmigan, Health Canada could not locate the study cited in Table HC-03-5 (page 17) of the HHRA in the list of references. Baseline data are not available for all of the COPCs in each of the country foods considered in the HHRA. Purple mountain saxifrage was identified as being consumed by local populations;

however, Health Canada could not locate baseline data for this country food in the HHRA.
As well, a rationale was not provided for why another plant (e.g., yellow crazy weed (airaq) root) may be appropriate to use as a surrogate for vegetation. Table HC-03-4 on page 16 of the HHRA refers to a "mid-point value" for yellow crazy weed (airaq) root and it is unclear what this value refers to (e.g., median, mean?).

Recommendation/Request	a) Provide clarification and a rationale on whether the occurrence data from literature are representative of the baseline scenario for the project area. b) Provide supporting details and a rationale on the geographic locations of the data sources employed and why these are considered to be representative of the baseline scenario for the project area. c) Provide a rationale for not collecting baseline data for each of the country foods that were noted to be consumed. d) Provide a rationale on the appropriateness of using one plant as a surrogate for vegetation. e) Clarify what is meant by "mid-point value" for yellow crazy weed (airaq) root (e.g., median, mean?).

Request:

HC-TIR-3a: Provide clarification and a rationale on whether the occurrence data from literature are representative of the baseline scenario for the project area.

Response:

The majority of baseline data used in the assessment were obtained from studies completed in the vicinity of Baffin Island Nunavut and are therefore considered to be representative of the Project area. In order to provide clarity to address whether the occurrence data (IE: being found in a place or under a particular set of conditions) from the literature are representative of the baseline scenario for the project area Table 3-1 is provided to identify the collection locations for the sample data. Specific regions and locations are provided as detailed in the studies reviewed. With the exception of snow goose and ptarmigan, regionally specific baseline tissue metals concentration data were available.

Baseline metal concentrations in tissue were not available for snow goose from the Nunavut region. Tissue concentrations data for Canada goose were used as a surrogate; however, a regionally derived tissue concentration data set was not identified. Rather, concentrations from geese harvested in the northeast US were included in the assessment. Baseline regionally specific tissue concentration data were not identified for ptarmigan; rather rock ptarmigan tissue concentrations from Northern Canada were included in the assessment.

Table 3-1 Occurrence Data used in the Baseline Assessment

Species	***N***	***Source***	***Geographical reference for Mary River***	***Appropriate***	***Reference used in the Assessment for COPC concentration***
yellow crazyweed	6	Mary River	North Baffin Island extending approximately 250 km from Milne Inlet south to Steensby Inlet	yes	Baffinland Mary River Project EIS Dec 2010 Appendix C6 Vegetation Baseline Report
Arctic hare	2	Cape Searle, Baffin Island NU	located southeast of project area on Baffin Island	yes	Mallory et al 2004
Arctic hare	9	Dubawnt River, NU	located south east of project area in Keewatin Region	Applicable based on comparison to samples from Mallory et al. (2004)	Pedersen and Lierhagen 2006
Caribou muscle	78	Qamanirjuaq caribou herd	Regional data from NU caribou	yes	Gamberg et al 2016
Caribou kidney	78	Qamanirjuaq caribou herd	Regional data from NU caribou	yes	Gamberg et al 2016
Ptarmigan	46	Northern Canada	Birds collected from Sanikiluaq, Belcher Islands (southeastern Hudson Bay), Nunavut; Kangiqsualujjuaq (George River), Que´bec; Salluit, Que´bec; Baker Lake, Nunavut; Grise Fjord (southern Ellesmere Island), Nunavut; Richardson River, Nunavut; Yellowknife area, Northwest Territories; Fort Good Hope area, Northwest Territories; Old Crow, Yukon; Watson Lake, Yukon; Dawson area, Yukon	applicable based on comparisons to one sample from Kuhnlein et al. 2000	Braune and Malone 2006
Snow goose	194	Minnesota, Wisconsin, Washington, DC, Maryland, New Jersey, South Carolina, Virginia, New York, Pennsylvania, Massachusetts, and Rhode Island	Not regionally specific however may account for concentrations in birds in fall and spring migrations	applicable based on comparisons to one sample from Kuhnlein et al. 2000	Horak et al 2014
Narwhal	60	Pond Inlet, NU	located NE of project area close to Milne Inlet	yes	Wagemann 1983
Ringed seal liver	2	Qikiqtarjuaq, NU	located southeast of project area on Baffin Island, proximal to Cape Searle	yes	Mallory et al 2004
Ringed seal liver	13	Admiralty Inlet and Nanasivik NU	Located NW of project area (proximal to project)	yes	Wagemann et al 1989
Ringed seal muscle	2	Qaqulluit and Padloping Islands, Baffin, NU	located southeast of project area on Baffin Island, proximal to Cape Searle	yes	Mallory et al 2004
Ringed seal muscle	13	Admiralty Inlet and Nanasivik NU	Located NW of project area (proximal to project)	yes	Wagemann et al 1989

For Arctic hare, two datasets were used to characterize the baseline tissue metal concentrations. Pedersen and Lierhagen (2006) completed a study of nine adult and seven juvenile Arctic hare from the Dubawnt River area in the Keewatin Region of Nunavut and Mallory et al. (2004) characterized tissues concentrations in two Arctic hare from Cape Searle, Baffin Island, Nunavut. Pedersen and Lierhagen (2006) provide concentration data for cadmium, copper, lead and mercury and Mallory et al. (2004) provide concentration data for aluminum, arsenic, cadmium, cobalt, copper, iron, lead, mercury, magnesium, manganese, selenium and zinc. Comparison of the metal concentrations from the two studies are included in Table 3-2. Cadmium, copper and lead concentrations were higher in the Mallory et al. (2004) dataset. The use of the larger dataset, more distant from the Project location, may introduce uncertainty into the sample set as Arctic hare are small herbivores with small home ranges and therefore their food sources may be influenced by differences in local or regional geology.

Table 3-2 Measured Exposure Point Concentrations of Arctic Hare Used in the Baseline Assessment [mg/kg-DW]

COPC	*Arctic Hare*			*Arctic Hare*			*Selection Decision*
	EPC used	*n*	*Reference*	*EPC*	*n*	*Reference*	
Cadmium	0.082	9	geomean; Pedersen and Lierhagen 2006	0.2	2	geomean; Mallory et al 2004 Baffin NU	sample size larger in Pederson and Lierhagen study
Copper	10	9	geomean; Pedersen and Lierhagen 2006	16.8	2	geomean; Mallory et al 2004 Baffin NU	sample size larger in Pederson and Lierhagen study
Lead	0.001	9	geomean; Pedersen and Lierhagen 2006	9.1	2	geomean; Mallory et al 2004 Baffin NU	potenital contamination by leaded ammunition
Mercury	0.002	9	geomean; Pedersen and Lierhagen 2006	<0.1	2	geomean; Mallory et al 2004 Baffin NU	detection level lower in Pederson and Lierhagen study

For both the rock ptarmigan and the Canada goose, metal concentration data from single samples obtained from the CINE diet study (Kuhnlein et al. 2000) were compared to the baseline dataset. The comparisons are provided in Table 3-3 and Table 3-4 for the ptarmigan and the Canada goose, respectively. Cadmium concentrations in the single samples of ptarmigan and Canada goose from the CINE diet study were higher than in the baseline dataset selected. Canada goose tissue concentration data were obtained from birds harvested in the northeastern US collected by wildlife agencies as part of urban wildlife damage management programs during June and July, 2006 and 2007. While the use of surrogate data from animals harvested distant from the Project site introduces uncertainty into the assessment, the assessment team weighed this issue with datasets that had larger sample sizes (which would account for variability) and used professional judgement when selecting baseline EPCs.

Table 3-3 Measured Exposure Point Concentrations of Ptarmigan Used in the Baseline Assessment [mg/kg-DW]

COPC	Ptarmigan			Ptarmigan			Selection Decision
	EPC used	n	Reference	EPC	n	Reference	
Arsenic	0.0678	46	median; Braune and Malone 2006	<DL	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Braune and Malone study, Region not specified in Kuhnlein study
Cadmium	0.203	46	median; Braune and Malone 2006	0.79	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Braune and Malone study, Region not specified in Kuhnlein study
Lead	NV	--	--	0.04	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Braune and Malone study, Region not specified in Kuhnlein study
Mercury	0.169	46	1/2 DL; Braune and Malone 2006	0.01	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Braune and Malone study, Region not specified in Kuhnlein study

Table 3-4 Measured Exposure Point Concentrations of Canada Goose (surrogate for Snow Goose) Used in the Baseline Assessment [mg/kg-DW]

COPC	Canada Goose (surrogate for Snow Goose)			Canada Goose (surrogate for Snow Goose)			Selection Decision
	EPC	n	Reference	EPC	n	Reference	
Arsenic	0.05	194	mean; Horak et al 2014	0.05	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Horak et al study, Region not specified in Kuhnlein study
Cadmium	0.016	194	mean; Horak et al 2014	0.5	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Horak et al study, Region not specified in Kuhnlein study
Lead	0.191	194	mean; Horak et al 2014	2.54	1	Kuhnlein et al. 2000 (Inuit - No region specified)	potential contamination by leaded ammunition
Mercury	0.154	194	mean; Horak et al 2014	0.27	1	Kuhnlein et al. 2000 (Inuit - No region specified)	sample size larger in Horak et al study, Region not specified in Kuhnlein study

References:

Baffinland Mary River Project EIS Dec 2010 Appendix C6 Vegetation Baseline Report

Braune, B. M., & Malone, B. J. (2006). Organochlorines and trace elements in upland game birds harvested in Canada. Science of the total environment, 363(1-3), 60-69.

Gamberg, M., Cuyler, C., & Wang, X. (2016). Contaminants in two West Greenland caribou populations. Science of the Total Environment, 554, 329-336.

Horak, K., Chipman, R., Murphy, L. and Johnston, J., 2014. Environmental Contaminant Concentrations in Canada Goose (Branta canadensis) Muscle: Probabilistic Risk Assessment for Human Consumers. Journal of food protection, 77(9), pp.1634-1641.

Kuhnlein, H.V., Loring, E., Receveur, O. and Chan, H.M., 2000. Assessment of dietary benefit/risk in Inuit communities. Centre for Indigenious Peoples' Nutrition and Environment.

Mallory ML, Wayland M, Braune BM, Drouillard KG.2004. Trace elements in marine birds, arctic hare and ringed seals breeding near Qikiqtarjuaq, Nunavut, Canada. Mar Pollut Bull. 004;49:119–41

Pedersen, Simen, and Syverin Lierhagen. "Heavy metal accumulation in arctic hares (Lepus arcticus) in Nunavut, Canada." Science of the total environment 368, no. 2-3 (2006): 951-955.

Wagemann, R., 1989. Comparison of heavy metals in two groups of ringed seals (Phoca hispida) from the Canadian Arctic. Canadian Journal of Fisheries and Aquatic Sciences, 46(9), pp.1558-1563.

HC-TIR-3b: Provide supporting details and a rationale on the geographic locations of the data sources employed and why these are considered to be representative of the baseline scenario for the project area.

Response:

As outlined in the response to HC TIR-3a, the majority of baseline data used in the assessment were obtained from studies completed in the vicinity of Baffin Island Nunavut and are therefore considered to be representative of the Project area. Exceptions to the local specificity include data for the Arctic hare from the Keewatin Region, rock ptarmigan from Northern Canada and Canada goose from the NE US. The uncertainties associated with the use of the Arctic hare and Canada goose data are explained in the response to HC TIR-3a.

The five-year mean harvest estimate for ptarmigan as presented in the Nunavut Wildlife Harvest Survey (2014) for Pond Inlet the years 1996 and 2001 was 926 animals (range 645 -1269). The survey provided the Inuit translation of Akilgik as ptarmigan; Ulukhaktok (2008) further refined the species to rock ptarmigan. Rock ptarmigan tissue metal concentrations were obtained from a study of upland game birds harvested across Canada (Braune and Malone 2006). Nine “pools” of rock ptarmigan were collected between 1991 and 1994 from areas in northern Canada, including Sanikiluaq, Belcher Islands (southeastern Hudson Bay), Nunavut; Kangiqsualujjuaq (George River), Que´bec; Salluit, Que´bec; Baker Lake, Nunavut; Grise Fjord (southern Ellesmere Island), Nunavut; Richardson River, Nunavut; Yellowknife area, Northwest Territories; Fort Good Hope area, Northwest Territories; Old Crow, Yukon; Watson Lake, Yukon; and Dawson area, Yukon. Median concentrations and ranges of arsenic, cadmium, mercury and selenium concentrations were provided. While birds collected from Grise Fjord, NU would be most proximal to the Project site, no location specific data were provided in the study. The use of a regional dataset introduces uncertainty into the assessment.

References:

Braune, B. M., & Malone, B. J. (2006). Organochlorines and trace elements in upland game birds harvested in Canada. Science of the total environment, 363(1-3), 60-69.

Priest H, Usher PJ. (2004). Nunavut Wildlife Harvest Study. Final Report. Prepared for Nunavut Wildlife Management Board (NWMB), February 2004.

The Community of Ulukhaktok, The Wildlife Management Advisory Council (NWT), and the Joint Secretariat (Ulukhaktok). 2008. Olokhaktomiut Community Conservation Plan. http://www.screeningcommittee.ca/pdf/ccp/Ulukhaktok_CCP.pdf

HC-TIR-3c: Provide a rationale for not collecting baseline data for each of the country foods that were noted to be consumed.

Response:

Baseline data were not collected for each of the country foods that were noted to be consumed as appropriate and applicable data or surrogate data were identified in the literature. Samples of Arctic Char and blueberry leaves were collected at the Project site. These samples were analyzed and the metal data used in the assessment. In order to have representative data, sufficient to establish a measure of central tendency, Health Canada (2010) recommends the collection of at least five to ten samples in order to establish baseline tissue concentrations. The harvesting and collection of this number of each of the species included in the assessment was not feasible therefore literature values, selected using professional judgement, were used to inform the baseline tissue concentrations for the mammalian and avian species.

References:

Health Canada. 2010. Federal Contaminated Site Risk Assessment in Canada: Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{Foods}$).

HC-TIR-3d: Provide a rationale on the appropriateness of using one plant as a surrogate for vegetation.

Response:

Black et al. (2008) completed a quantitative ethnobotanical assessment of the medicinal plants used by the Inuit of the Qikiqtaaluk Region. Through interviews with volunteer informants in 2004 and a review of historical interview transcripts (obtained between 1976 and 1999), 13 different medicinal plant species and their uses were identified. Four (4) of the medicinal species identified by Black et al. (2008) were also included in the traditional knowledge component of the Baseline Vegetation Assessment (Burt 2010). These four plants are willow leaves or uqaujat (*Salix arctica*), purple mountain saxifrage or aupilattunnguat (*Saxifraga oppositifolia*), prickly saxifrage or kakillaqnait (*Saxifraga tricuspidata*), and yellow crazyweed (airaq) root (*Oxytropis maydelliana*). Two of the four plants purple mountain saxifrage and prickly saxifrage were identified as being used to make tea rather than being consumed (Burt 2010). The leaves of the willow and the root of the crazyweed were identified as being consumed however given the inclusion of blueberry leaves collected from the Project site the metal concentration data in the willow leaves were not included in the assessment. Four samples of yellow crazyweed root were harvested and analyzed for metal constituents while only one sample of purple saxifrage root was analyzed. Therefore, the root data from the crazyweed were included in the assessment as a surrogate for all medicinal root plants.

For information purposes the concentration data from the purple saxifrage root (N=1) are included as Table 3-5.

Table 3-5 Metal Concentrations in the Purple saxifrage root (Burt 2010)

COPC	*Concentration (mg/kg dw)*
Cadmium	0.1
Chromium	28.7
Cobalt	2.3
Copper	9.3
Iron	1970
Lead	3.78
Nickel	18.4
Zinc	29.3

References:

Black, P.L., Arnason, J.T. and Cuerrier, A., (2008). Medicinal plants used by the Inuit of Qikiqtaaluk (Baffin Island, Nunavut). Botany, 86(2), pp.157-163.

Burt P. (2010). Vegetation Baseline Study Report. Appendix C6 - Baffinland Iron Mines Corporation - Mary River Project

HC-TIR-3e: Clarify what is meant by “mid-point value” for yellow crazy weed (airaq) root (e.g., median, mean?).

Response:

The concentration data for the yellow crazyweed (airaq) root was obtained from Table 1 in the Baseline Vegetation Study – Appendix C6 (Burt 2010). The data provided were limited to ranges for the metals analysed in the six samples included in the baseline vegetation study. The midpoint was calculated as an average of the minimum and maximum values in the range. Table 3-6 provides the ranges and identifies the midpoint for each of the metals.

Table 3-6 Metal Concentrations - Yellow crazyweed (Burt 2010)

COPC	*Range (mg/kg dw)*	*EPC (midpoint) (mg/kg dw)*
Cadmium	<0.05 – 0.15	0.1
Chromium	1.0 – 26.8	13.9
Cobalt	0.3 – 1.2	0.75
Copper	2.6 – 4.9	3.75
Iron	85 – 3310	1696.5
Lead	0.08 – 3.30	1.69
Nickel	1.5 – 15.5	8.5
Zinc	15.5 – 22.7	19.1

References:

Burt P. (2010). Vegetation Baseline Study Report. Appendix C6 - Baffinland Iron Mines Corporation - Mary River Project

HC 04 ATTACHMENT 1: FULL RESPONSE

Health Canada HC-TIR-04 – Country Foods

Review Comment Number	HC-TIR-4
Subject/Topic	Country Foods
Reference	• Advance Technical Comment Responses Phase 2 Proposal – Mary River Project
Summary	The assessment of risk to human health from country foods to address some of the uncertainties such as COPC concentrations needs refining, particularly in the context of arsenic. The absence of certain food sources in estimating project impacts, and the lack of community-specific food consumption data such as a dietary survey leave uncertainties and the inability to fully assess risks to human health.
Importance of issue to impact assessment process	Currently the Country Foods HHRA documentation is not refined enough to adequately assess the potential risk to human health from project related activities.
Detailed Review Comment • Gap / Issue • Disagreement with FEIS • Reasons for Disagreement with FEIS	Arsenic was taken into consideration as part of the HHRA. Inorganic arsenic concentrations were estimated based on reported percentages of inorganic arsenic relative to total arsenic concentrations in various foods. The values were obtained from studies published in the scientific literature as well as from a 2001 US EPA assessment. Health Canada does not have any concerns with the relative percentage used to estimate inorganic arsenic concentrations from total arsenic concentrations measured in Arctic char. The available data suggests that, in the absence of any point source of arsenic contamination, the proportion of inorganic arsenic concentration relative to total arsenic in fish and shellfish is generally less than 10%. If necessary, exposure to inorganic arsenic could be further refined by attributing more specific inorganic arsenic ratios to each type of seafood. With respect to the percentages of inorganic arsenic assumed for other food sources, these values were obtained from Schoof et al. (1999); it is unclear if surrogate animal species were assumed for these country foods, and if so which ones, as this was not indicated in the HHRA. Health Canada notes that in the European Food Safety Authority's (EFSA) 2014 dietary exposure assessment for inorganic arsenic, inorganic arsenic was estimated as 70% of the total arsenic reported for most of the foods other than fish and shellfish. In the absence of any empirical data for

	inorganic arsenic in country foods other than fish and shellfish, which may be harvested from the impact area in question, Health Canada recommends applying a precautionary approach similar to that of the EFSA and assuming that inorganic arsenic represents 70% of the total arsenic concentration in these foods.
Recommendation/Request	a) Further information is needed to confirm if surrogate animal species were assumed for any country foods obtained from Schoof et al. (1999), and if so which ones, as this was not indicated in the HHRA. b) If there is a source of arsenic contamination at the site, empirical data for inorganic arsenic in food should be collected in order to accurately assess potential health risks. c) Given the exceedances of the HQ benchmark for cadmium, methylmercury and inorganic mercury, Health Canada supports refining the assessment of risk to human health from country foods to address some of the uncertainties such as COPC concentrations, the absence of certain food sources in estimating project impacts, and the lack of community-specific food consumption data. d) Monitor cadmium and methylmercury levels in country foods identified as major contributors to total exposure for these COPCs and present in the annual reports to the NIRB. e) The HHRA indicates that seal blubber is consumed by local Inuit populations and it is further acknowledged that organic contaminants tend to accumulate in such fatty tissues. Considering that there is a need for mitigation measures to control organic contaminant concentrations from project activities and that local populations consume foods that may accumulate organic contaminants, f) Monitor environmental media for organic contaminants to verify the effectiveness of the mitigation measures and confirm that there is no impact to seal blubber and to human health.

Request:

HC-TIR-4a: Further information is needed to confirm if surrogate animal species were assumed for any country foods obtained from Schoof et al. (1999), and if so which ones, as this was not indicated in the HHRA

Response:

Table HC-TIR-4-1 presents a summary of the inorganic arsenic content that was assumed in the country foods assessment (this information was previously presented in Table HC-03-9). The inorganic arsenic content was based on a study by Schoof et al. (1999) that conducted a market basket survey of 40 store bought food commodities and four samples of each commodity were analyzed. The inorganic arsenic content of 78% applied to berries in the current assessment was based on a variety of vegetables in the Schoof et al. (1999) study. Table HC-TIR-4-2 presents the total and inorganic arsenic concentrations in vegetables and the calculated percent inorganic arsenic content. The value of 78% applied to berries in the current assessment is the calculated 95%UCLM. The mammalian and avian inorganic arsenic content of meat applied in the current assessment (i.e., 5%) was based on a variety of meats and proteins (i.e., beef, chicken, pork and eggs) analyzed in the Schoof et al. (1999) study, Table HC-TIR-4-3 presents the total and inorganic arsenic concentrations in meats and proteins and the calculated percent inorganic arsenic content. The value of 5% was selected as it was the highest value measured in the variety of proteins. The same study (Schoof et al. 1999) also presented the inorganic arsenic content of a variety of fish and seafood (Table HC-TIR-4-4) as less than 1%, which was lower than the assumed value of 2% used in the assessment. The assumed arctic char value of 2% was the highest value measured in a variety of freshwater fish that are typically found in North America (see Table HC-TIR-4-5).

Table HC-TIR-4-1 Inorganic Arsenic Content of Foods Assumed in the Assessment

Food	Value	Reference / Comment
Arctic char	2%	Schoof et al 1999
Arctic hare	5%	Schoof et al 1999
Berries	78%	Schoof et al 1999
Caribou MUSCLE	5%	Schoof et al 1999
Caribou ORGAN	5%	Schoof et al 1999
Medicinal plants	78%	Schoof et al 1999
Narwhal	5%	Schoof et al 1999
Ptarmigan	5%	Schoof et al 1999
Ringed seal liver	5%	Schoof et al 1999
Ringed seal muscle	5%	Schoof et al 1999
Snow goose	5%	Schoof et al 1999

HC-TIR-4-2 Total and Inorganic Arsenic Content of Vegetables (Schoof et al, 1999)

Food	Total Arsenic [ng/g-WW]	Inorganic Arsenic [ng/g-WW]	Percent Inorganic
Beans(green)	2.1	1.2	57%
Carrots	7.3	3.9	53%
Corn(kernal)	1.6	1.1	69%
Cucumber	9.6	4.1	43%
Lettuce	1.4	1.5	100%
Onions	9.6	3.3	34%
Peas	4.3	4.5	100%
Potatoes	2.8	0.8	29%
Spinach	5.1	6.1	100%
Tomato	9.9	0.9	9%
Average	5.4	2.7	59%
95UCLM	7.4	3.8	78%

HC-TIR-4-3 Total and Inorganic Arsenic Content of Meats (Schoof et al, 1999)

Food	Total Arsenic [ng/g-WW]	Inorganic Arsenic [ng/g-WW]	Percent Inorganic
Beef	51.4	0.4	1%
Chicken	86.4	0.9	1%
Pork	13.5	0.6	4%
Eggs	19.9	1	5%
Average	42.8	0.73	3%

HC-TIR-4-4 Total and Inorganic Arsenic Content of Fish and Seafood (Schoof et al, 1999)

Food	Total Arsenic [ng/g-WW]	Inorganic Arsenic [ng/g-WW]	Percent Inorganic
Saltwater finfish	2360	0.5	0.0%
Tuna	512	1	0.2%
Freshwater finfish	160	1	0.6%
Shrimp	1890	1.9	0.1%
Average	1231	1.3	0.3%

HC-TIR-4-5 Total and Inorganic Arsenic Content of Freshwater Fish (Schoof et al, 1999)

Food	Total Arsenic [ng/g-WW]	Inorganic Arsenic [ng/g-WW]	Percent Inorganic
Catfish(#1)	25	0.5	2%
Catfish(#2)	31	0.5	2%
Catfish(#3)	29	0.5	2%
Rainbow trout	555	0.5	0.1%
Tuna	512	1	0.2%
Freshwater	160	1	1%
Average	219	0.67	1.0%

In the Detailed Comments above, Health Canada notes that in the European Food Safety Authority's (EFSA) 2014 dietary exposure assessment for inorganic arsenic, inorganic arsenic was estimated as 70% of the total arsenic reported for most of the foods other than fish and shellfish. Health Canada suggests that in the absence of any empirical data for inorganic arsenic in country foods other than fish and shellfish, which may be harvested from the impact area in question, they recommend applying a precautionary approach similar to that of the EFSA and assuming that inorganic arsenic represents 70% of the total arsenic concentration in these foods. In response to this, a review of the EFSA (2014) was undertaken. Although the EFSA (2014) report indicated that there were 2753 food samples for which inorganic arsenic concentrations were available, this data was not used to derive the factor of 70% which was applied to the reported total arsenic concentrations to estimate inorganic arsenic content in foods of terrestrial origin. The 70% factor was taken from the previous EFSA (2009) report in which it was acknowledged that representative speciation data are scarce, and as a result, the EFSA Panel was not able to assess the typical ratios between inorganic and organic arsenic in different food categories. They indicated that the Panel "had to make a number of assumptions for the estimation of the contribution of inorganic arsenic to total arsenic in the exposure assessment based on the few data on inorganic arsenic submitted by the reporting European countries, as well as on key literature data. Thus, the proportion of inorganic arsenic was assumed to vary from 50 to 100 % of the total arsenic reported in food commodities other than fish and seafood, with 70 % considered as best reflecting an overall average". The derivation of the 70% factor is not further described in the report; however, it is reported that inorganic arsenic analysis was carried out on less than 20 samples from the "meat and meat products and substitutes" category. Therefore, although EFSA has indicated that a 70% adjustment may be appropriate for all foods of terrestrial origin, the majority of the samples considered in the selection of this value are from categories other than meat and meat products (e.g., grains, vegetables, fruits, etc.). Inclusion of speciation data for meats in the derivation of an overall adjustment factor is further complicated by the fact that total arsenic concentrations are typically very low in these food items. Of a total of 19,024 samples from the "Meat, meat products and offal category" in EFSA (2009), total arsenic was below the limit of detection in 75% of samples.

Overall, although a limited number of samples were reported in Schoof et al. (1999), the fraction of inorganic arsenic utilized in the HHRA is specific to meat products and is considered to be more appropriate to estimate inorganic arsenic content in game meat relative to the use of the 70% adjustment factor recommended by EFSA (2009; 2014) for foods of all terrestrial origin. If this assumed inorganic arsenic factor were to be used in the model for the Project case, increment cancer risks would still be within the acceptable level of incremental risk at both the Port and Mine.

HC-TIR-4b: If there is a source of arsenic contamination at the site, empirical data for inorganic arsenic in food should be collected in order to accurately assess potential health risks.

Response: As presented in Appendix A of TSD-11, arsenic is generally not detected in dustfall samples collected as part of the existing environmental monitoring program near the Mine, Tote Road and Milne Port. The dustfall monitoring data summarized in Appendix A of TSD-11 indicate that arsenic was detected in 39 of 216 dustfall samples (18% of samples) at the dustfall monitoring stations closest to the Mine, Milne Port, and Tote Road. Hence, the vast majority of samples are below detection, and based on these data, the ore is not considered to be a significant source of arsenic that merits site specific speciation in food.

The application of literature based arsenic speciation values for prediction of human health risks associated with arsenic is common practice in human health risk assessment. The predicted incremental risk outcomes associated with the Project presented in Technical response HC-03 are not above a 1:100,000 risk level, and hence, are not indicative of an exposure situation of concern, despite using assumptions that half of one's total annual berry and fish consumption would come from areas near these remote areas (HTO cabins). Therefore, it is not considered necessary to speciate arsenic in local traditional foods, based on the outcomes of the assessment. In addition, due to existing monitoring programs of soils, lichen, surface waters, sediment, fish, effluent and dustfall, any significant changes in these compartments relative to arsenic concentrations will be identified.

HC-TIR-4c: Given the exceedances of the HQ benchmark for cadmium, methylmercury and inorganic mercury, Health Canada supports refining the assessment of risk to human health from country foods to address some of the uncertainties such as COPC concentrations, the absence of certain food sources in estimating project impacts, and the lack of community-specific food consumption data.

Response:

The findings of elevated risk levels in the Baseline scenario of HC-03 for cadmium and mercury are consistent with those identified in the Inuit Health Survey (Chan, 2011). We support the possible refinement of the risk estimates but given that these occur in baseline assessment and that the Project risk estimated for these contaminants are negligible (see response to next comment), we do not see these refinements as being Project-related. It is our understanding that funding has been provided to a community researcher under the Northern Contaminants Program (2018-2019) in Pond Inlet, and the data resulting from that study would assist in possible future refinement. The title of that study is "Expanding community-based monitoring of contaminants concentrations in Marine Country food used by Mittimatalingmui: Science and local knowledge assessing the risks to human health in Pond Inlet". This study is specifically examining Ringed Seal, Arctic Char and Narwhal. The caribou data used in the baseline assessment are recent and include a reasonable sample size (see response to HC-TIR-3a).

Reference:

Chan HM. 2011. Inuit Health Survey 2007-2008. Contaminant Assessment in Nunavut. Nunavut Steering Committee Member Organizations.

HC-TIR-4d: Monitor cadmium and methylmercury levels in country foods identified as major contributors to total exposure for these COPCs and present in the annual reports to the NIRB.

Response:

As discussed in Technical Response HC-03, and TSD-11, cadmium and mercury are largely at deposition rates below detection levels in the ore. Using analytical detection levels of 4E-05 to 7E-07 mg/dm^2-day for mercury and 6.2E-5 to 9.7E-7 mg/dm^2-day for cadmium, mercury was not detected in any of the selected 216 dustfall samples taken near the Mine (Stations DF-M-02 and -03), Milne Port (Stations DF-P-01; -05 and -07), and Tote Road (Stations DF-RN-04; -05; DF-RS-4 and -05). Cadmium was detected in only 3.2% of dustfall samples (7 samples had detectable cadmium levels of 216 samples taken) concentrations ranged from 1.4E-06 to 8.1E-07 mg/dm^2-day.

The foods modelled in Technical Response HC-03 which were identified as major contributors to cadmium were caribou organ meats, and to a lesser extent, seal liver (See Table HC-03-10). Inorganic mercury exposures were highest from seal liver (adult only), followed by narwhal (Table HC-03-11), whereas methyl mercury exposures were highest from narwhal (Table HC-03-12). The risks associated with the consumption of these traditional foods were elevated in Baseline, but the Project contributions to risk were all negligible at incremental RQ values of 0.25%, 0.17% and 0.07% for cadmium, mercury and methyl mercury respectively, even with the inclusion of soil ingestion and dust inhalation.

The amount of time these three species spend in areas near the Project are likely limited, relative to species with smaller home ranges. As discussed in HC-03, based on the collar data collected, only 3 collared caribou were found within the PDA, or 100 m of the PDA between 2008 – 2010. The data are presented below, as absolute time, and proportion of year. The number of hours in a given year within 100 m of the PDA ranged from 0:51 hours to 4:05 hours, with a total percentage of time in the PDA/Year ranging from 0.009% to 0.0047% of time (based on 8760 hours in a year). Based on this, and the large home range of this species, the potential for the project to influence either caribou meat or organ meats is extremely low. Narwhal are transient and only reside in the Milne Port area for a limited period of time, and hence, would experience limited exposure to Project releases related to dust deposition. For ringed seal, this species is resident in Milne Port, but has a reasonably large home range. An assessment of the impacts of dust deposition on marine sediments and surface waters in Milne Port area was conducted (See TSD-17), and the conclusions of this assessment were that dust deposition is not expected to result in detectable changes in concentrations of metals in sediment in Milne Inlet (see Section 2.6.5, TSD-17). TSD-17 concluded that concentrations of metals, particularly iron, in water may measurably increase in the same areas due to introduction of dust, even though marine water quality guidelines for these metals do not exist. The magnitude of effects were classified to range from negligible (i.e., not detectable) to moderate (low-level exceedances) in the LSA. Based on this assessment, and the length of time that either Narwhal or ringed seal may spend in the area adjacent to Milne Port facilities was considered to be reasonably limited.

There are existing monitoring programs for soils, vegetation (lichen -a major component of the diet for caribou), freshwater and marine surface waters, freshwater and marine sediments, freshwater fish, and dustfall, and all of these monitoring programs include metals analysis (including cadmium and mercury). These existing monitoring programs will enable identification of noticeable trends in cadmium or mercury concentrations in abiotic environmental media and would be expected to detect change sooner than that which might occur in tissues of animals which have large home ranges and move around in their environments.

Therefore, in light of the existing monitoring programs for multiple types of media, as well as the lack of detection of mercury in dustfall, and the limited detection of cadmium in dustfall, the limited time that these species may be present in areas associated with Project emissions, it is not considered necessary to monitor levels of cadmium and methylmercury in these country foods identified as major contributors to total exposure in the Baseline assessment (i.e., Narwhal, seal, caribou).

HC-TIR-4e; f: The HHRA indicates that seal blubber is consumed by local Inuit populations and it is further acknowledged that organic contaminants tend to accumulate in such fatty tissues. Considering that there is a need for mitigation measures to control organic contaminant concentrations from project activities and that local populations consume foods that may accumulate organic contaminants, Monitor environmental media for organic contaminants to verify the effectiveness of the mitigation measures and confirm that there is no impact to seal blubber and to human health.

Response: The reference to organic contaminants accumulating in seal blubber was related to contaminants such as chlorinated organic compounds. There is an existing marine monitoring program, which is currently in place for the Project, at Milne Port. This program includes monitoring of sediments and surface waters. Organic compounds related to the Project could include petroleum hydrocarbons, and polycyclic aromatic hydrocarbons, and these types of compounds are already included in the marine sediment monitoring program. These compounds do not tend to accumulate in tissues, such as blubber, and hence would not be expected to represent a concern from a traditional food consumption perspective. Chlorinated organics can be released from the incinerator units present at Milne Port, and the Mine site, but the anticipated levels are low, due to efficiency of these units, the waste management plan which is in place during all Phases of the Project in order to minimize emissions from incineration activities, and the testing for PCDD/F emissions to confirm compliance with the Canada Wide Standard (CWS) for PCDD/F, which is 0.080 I-TEQ ng/Rm^3 @ 11 % 0_2.

References:

Golder, 2018. 2018 Milne Inlet Marine Environmental Effects Monitoring Program (MEEMP) and Aquatic Invasive Species (AIS) Monitoring Program. Submitted to Baffinland Iron Mines Corporation, Oakville, ON. Golder Associates, 2018.