ENVIRONMENTAL POLLUTANTS - MONITORING

In this section:

1. AIR QUALITY - OUTDOOR

Both the federal and provincial governments measure air quality in Manitoba. The federal National Air Pollution Surveillance (NAPS) program run by Environment Canada currently operates five monitors, located at:

Monitor Location		Known or suspected carcinogens measured
Winnipeg	299 Scotia Street	Fine particulates ($PM_{2.5}$), VOCs, and TCDD
Winnipeg	65 Ellen Street	Fine particulates ($PM_{2.5}$)
Thompson	Westwood	
Brandon	Community College	Lead, arsenic, and cadmium content of total suspended particulate, fine particulates ($PM_{2.5}$)
Flin Flon	143 Main Street	

Additional monitoring has been done in the Flin Flon area:

Monitor Location		Known or suspected carcinogens measured
Creighton (SK)	Fire Hall/School	Lead, arsenic, and cadmium content of total suspended particulate
Flin Flon	Ruth Betts	
Flin Flon	Sewage Plant	

Other outdoor air quality monitoring may be done by industries as part of their emissions permits, but these data are not publicly available. The Manitoba Conservation and Water Stewardship branch may have more data for specific emitters:

Stack Sampling Information

Manitoba Conservation has established guidelines and protocols to assist those Manitoba entities that are required to undertake stack sampling as part of their Environment Act Licence or those who are proposing to submit stack sampling data for Manitoba Conservation's consideration:

- Guideline for Stack Sampling Facilities *(290 Kb PDF file)*
- Manitoba Stack Sampling Protocol *(169 Kb PDF file)*

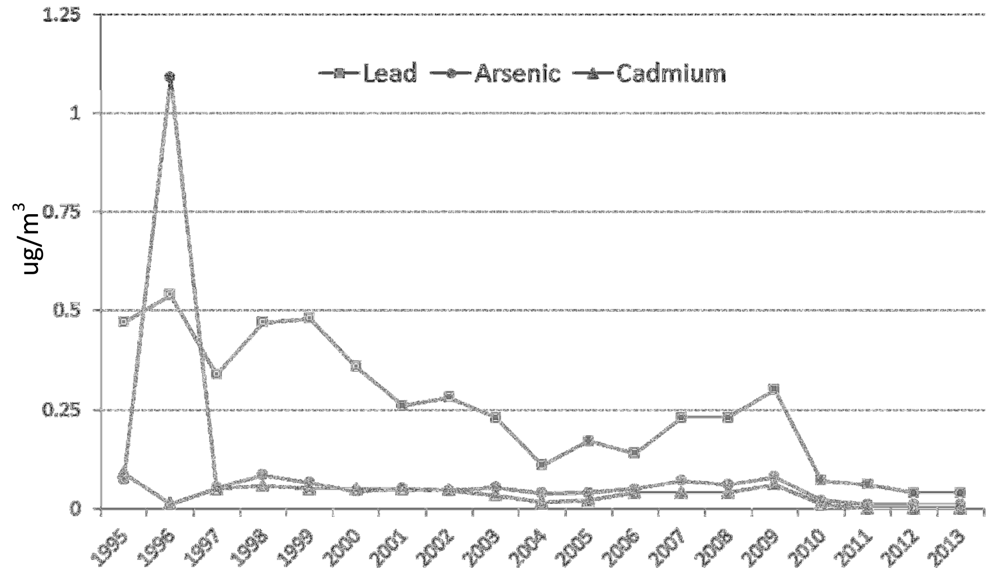
Manitoba Conservation Air Quality Section

https://www.gov.mb.ca/conservation/envprograms/airquality/stack-sampling/index.html

The monitoring conducted around the Flin Flon area shows the influence of the Hudson Bay Mining and Smelting Co. activities in the region. Over time, levels of metals measured in the total suspended particulate have decreased to levels of 0.04 ug/m^3 for lead, and from 0.01 ug/m^3 to 0 ug/m^3 for arsenic and cadmium respectively (Figure 1.1). In other cities, levels of lead are much lower – in 2010, the average lead level based on 15 NAPS stations across Canada was 0.0012 ug/m^3; the average arsenic level was 0.00043 ug/m^3; and the average cadmium level was 0.00011 ug/m^3.[1]

[1] CAREX Canada summary of NAPS data for 2010

Figure 1.1. Annual average levels of airborne metals in Flin Flon 1995 - 2013



CAREX Canada's eRISK tool can be used to calculate the excess lifetime cancer risk of current levels of airborne lead, arsenic and cadmium in the Flin Flon area. Health Canada considers lifetime excess cancer risks between 1 and 10 per million as negligible, indicating no cause for concern, and excess risk levels above this as an indication that more detailed studies of people's actual exposure maybe useful and ways to reduce exposure should be considered. Even though the average measured levels of these metals are higher compared to other cities in Canada, the lifetime excess cancer risk for current levels in the Flin Flon area are very low (Table 1.1). Individually, the excess risk for each metal is below 10 per million. Cumulatively, the lifetime excess cancer risk is ~16 per million, which is still very low.

Table 1.1. Lifetime excess cancer risk – airborne lead, arsenic and cadmium in Flin Flon 2013

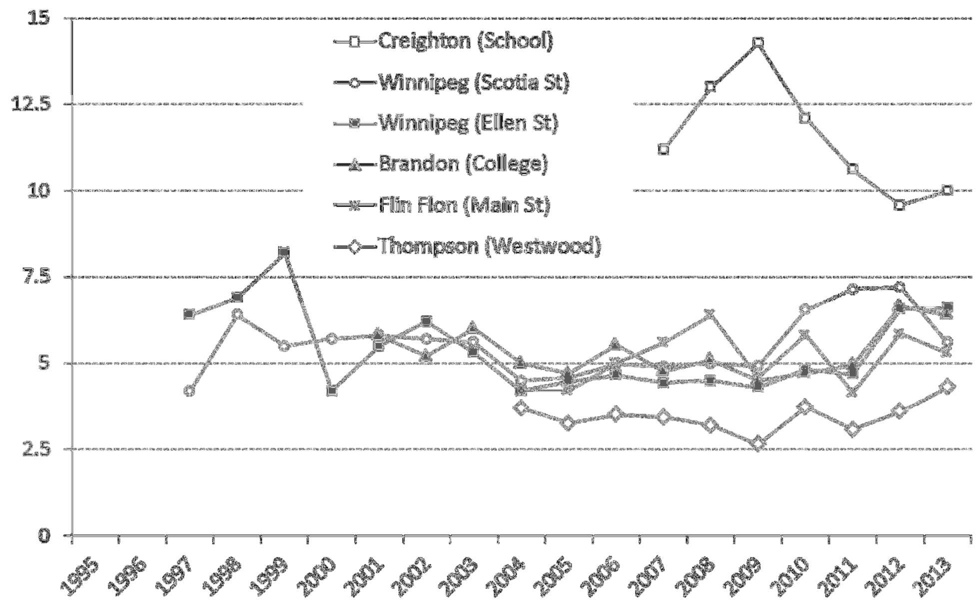
Substance	2013 Average Annual Level (ug/m^3)	Lifetime Excess Cancer Risk (per million)
Lead	0.04	0.04
Arsenic	0.01	**6.3**
Cadmium	0.01	**9.7**

Annual average fine particulate ($PM_{2.5}$) levels range between 2.5ug/m^3 and 7.5ug/m^3 at most locations monitored (Figure 1.2). These levels are similar to annual average $PM_{2.5}$ levels nationally: the annual average across 204 Canadian NAPS stations in 2011 was 6.9ug/m^3. [2] However, a station in Creighton, Saskatchewan measured higher than average levels between 2007 and 2013.

[2] http://www.carexcanada.ca/en/particulate_air_pollution/environmental_estimate/#data

As of this year, the Canadian guideline for annual $PM_{2.5}$ is 10ug/m^3, based on the average of the three most recent years, and is proposed to be lowered to 8.8ug/m^3 in 2020.[3] $PM_{2.5}$ levels most monitored locations in Manitoba meet the current guideline and would also meet the proposed 2020 guideline if levels remain similar. The station at Creighton would just meet the current standard, as the average of the annual levels measured there in 2011, 2012 and 2013 is 10ug/m^3, but would not meet the proposed 2020 guideline if levels do not decrease.

Figure 1.2. Annual average levels of fine particulates 1995 - 2013



A lifetime excess cancer risk calculation cannot be done for $PM_{2.5}$ because there is no accepted cancer potency factor. $PM_{2.5}$ refers to particle size only, and any airborne substance or chemical compound that is small enough is included in the measure of $PM_{2.5}$. The amount of each substance or chemical in $PM_{2.5}$ may vary from place to place, and over time, because of different sources, and each substance or chemical compound may have different cancer potency factors.

The most comprehensive air quality measurements are collected at the NAPS station located on Ellen Street in Winnipeg. Table 1.2 shows the most recent annual average levels of 18 known and suspected carcinogens, along with the lifetime excess cancer risk associated for those with available cancer potency factors, calculated using the CAREX Canada eRISK tool. In all cases, the lifetime excess cancer risk is well below 10, suggesting these substances are not of concern in terms of air pollutants and increased cancer risk.

[3] http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=A4B2C28A-2DFB-4BF4-8777-ADF29B4360BD

Table 1.2. Known and suspected carcinogens in air – Ellen St. station, Winnipeg[4]

Substance	IARC*	Year	Annual Average (ug/m3)	Lifetime Excess Cancer Risk (per million)
Formaldehyde	1	2014	1.53	1.6
Acetaldehyde	2b	2014	0.8	0.2
1,3-Butadiene	2b	2013	0.06	0.8
Benzene	1	2013	0.6	1.4
Ethylbenzene	2b	2013	0.17	0.03
Styrene	2b	2013	0.04	Not available
Naphthalene	2b	2013	0.08	0.2
Dichloromethane	2a	2013	0.44	0.04
Chloroform	2b	2013	0.1	0.2
Trichloroethylene	1	2013	0.04	0.1
Tetrachloroethylene	2a	2013	0.135	0.07
PAH- Benzo[a]pyrene	1	2011	0.0001	0.009
PAH - Dibenz[a,h]anthracene**	2a	2011	0.00002	Not available
PAH - Benz[a]anthracene	2b	2011	0.00011	0.001
PAH - Benzo[b]fluoranthene	2b	2011	0.00015	0.001
PAH - Benzo[k]fluoranthene	2b	2011	0.00006	0.0005
PAH - Benzo[a]phenathrene (Chrysene)	2b	2011	0.00015	0.0001
PAH - Indeno[1,2,3-cd]pyrene	2b	2011	0.00009	0.0008

* International Agency for Research on Cancer (IARC) category 1 = known carcinogen, 2a = probable carcinogen, 2b = possible carcinogen.
** includes Dibenz[a,h]anthracence and dibenzo[a,c]anthracene

[4] Data from the National Air Pollution Surveillance (NAPS) program at http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx

2. AIR QUALITY – INDOOR

Indoor air quality is not monitored widely or regularly anywhere in Canada. There are no studies published in the academic literature for any chemical substances in indoor air in Manitoba. There are, however, several studies that have measured radon and some information is available about asbestos contaminated insulation.

Radon. These naturally occurring radioactive particles are emitted by soils and rocks in varying amounts, depending on the local geology. Holes or cracks in the foundations of a house can let radon particles inside where they can build up to harmful levels, especially in areas with low ventilation over the winter. Radon is known to cause lung cancer and the risks are much higher for smokers. The current Health Canada guideline for annual average radon is 200 becquerel per cubic meter (Bq/m^3).

Beginning in 2009, Health Canada gathered radon measurements from homes across Canada, including 1,180 homes in Manitoba[5]. Approximately 77 percent of the homes had levels below the guideline (Table 2.1). Of the remaining homes, 21 percent had levels between 200 and 600 Bq/m^3, and 2.5 percent had levels higher than 600 Bq/m^3. Levels of radon in Manitoba appear to be higher compared to most other provinces and territories – there were more homes above the guideline in Manitoba than any other area, except New Brunswick. Higher levels are more often seen in the southwest (Figure 2.1). Table 2.2 lists the First Nations communities according to the percentage of homes testing above the current guideline, and suggest monitoring priority.

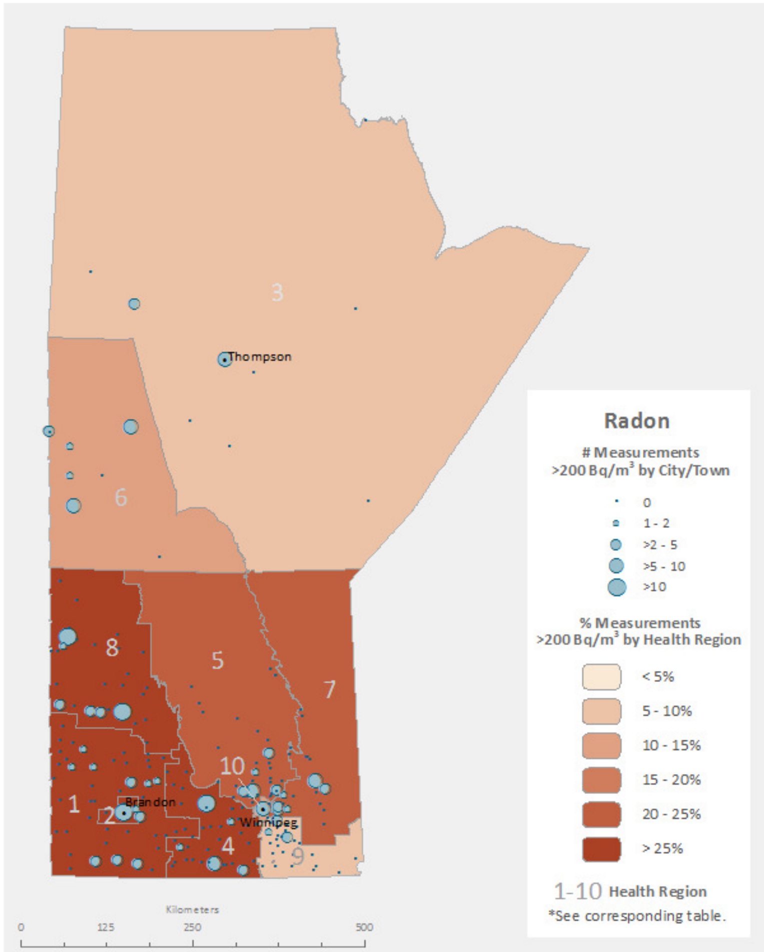
Table 2.1. Radon Measurements in Canada – 2009 to 2011

		PERCENT OF HOMES			
Province/ Territory	Homes	≤ 100 Bq/m³	>100 - 200 Bq/m³	>200 – 600 Bq/m³	>600 Bq/m³
BC	1812	82.2%	9.8%	6.6%	1.4%
AB	1124	67.6%	25.8%	6.0%	0.6%
SK	1200	51.9%	32.3%	14.8%	1.0%
MB	1180	49.9%	26.7%	20.9%	2.5%
ON	3930	75.0%	16.9%	7.2%	1.0%
QC	1779	77.4%	12.8%	8.7%	1.1%
NB	825	54.9%	20.5%	18.4%	6.2%
NS	591	79.2%	12.2%	6.1%	2.5%
PE	111	87.4%	9.0%	3.6%	0.0%
NL	712	83.6%	10.4%	4.8%	1.2%
NU	80	100.0%	0.0%	0.0%	0.0%
NT	186	78.0%	16.7%	4.8%	0.5%
YT	225	56.4%	24.5%	13.3%	5.8%
CANADA	13,755	70.9%	18.0%	9.5%	1.6%

Source: Cross Canada Radon Survey Year 1 (2009-2010) & Year 2 (2010-2011)

5 http://www.carexcanada.ca/en/radon/environmental_estimate/#provincial_tables_and_maps+maps

Figure 2.1. Radon Measurement in Manitoba by Health Region[6]



(Percent >100, >200, >600 Bq/m³ by Health Region and City Measurements)

	Health Region	Homes	≤ 100 Bq/m³	>100 - 200 Bq/m³	>200 - 600 Bq/m³	>600 Bq/m³
1	Assiniboine	110	33.7%	32.7%	31.8%	1.8%
2	Brandon	79	25.3%	30.4%	40.5%	3.8%
3	Burntwood/Churchill	152	77.6%	14.5%	7.2%	0.7%
4	Central	108	29.6%	27.8%	35.2%	7.4%
5	Interlake	119	47.0%	28.6%	24.4%	0.0%
6	Norman	214	60.7%	27.1%	11.7%	0.5%
7	North Eastman	101	52.5%	26.7%	19.8%	1.0%
8	Parkland	119	37.0%	19.3%	31.9%	11.8%
9	South Eastman	112	58.9%	32.2%	8.9%	0.0%
10	Winnipeg	66	50.0%	37.9%	12.1%	0.0%

[6] http://www.carexcanada.ca/en/radon/environmental_estimate/#provincial_tables_and_maps+maps

Table 2.2. First Nations Reserves by Health Region and Radon Testing Priority

Priority	First Nation	Health Region
High Priority for Testing. Health Regions with > 25% of Homes Above Guideline		
	Birdtail Sioux	Assiniboine Health Region
	Canupawakpa Dakota First Nation	Assiniboine Health Region
	Gamblers	Assiniboine Health Region
	Keeseekoowenin	Assiniboine Health Region
	Rolling River	Assiniboine Health Region
	Sioux Valley Dakota Nation	Assiniboine Health Region
	Waywayseecappo FNT4 - 1874	Assiniboine Health Region
	Dakota Plains	Central Health Region
	Dakota Tipi	Central Health Region
	Long Plain	Central Health Region
	Roseau River Anishinabe FNG	Central Health Region
	Sandy Bay	Central Health Region
	Swan Lake	Central Health Region
	Ebb and Flow	Parkland Health Region
	O-Chi-Chak-Ko-Sipi First Nation	Parkland Health Region
	Pine Creek	Parkland Health Region
	Sapotaweyak Cree Nation	Parkland Health Region
	Skownan First Nation	Parkland Health Region
	Tootinaowaziibeeng Treaty Reserve	Parkland Health Region
	Wuskwi Sipihk First Nation	Parkland Health Region
Moderate Priority for Testing. Health Regions with 15% to 25% of Homes Above Guideline		
	Brokenhead Ojibway Nation	Interlake Health Region
	Dauphin River	Interlake Health Region
	Fisher River	Interlake Health Region
	Kinonjeoshtegon First Nation	Interlake Health Region
	Lake Manitoba	Interlake Health Region
	Lake St. Martin	Interlake Health Region
	Little Saskatchewan	Interlake Health Region
	Peguis	Interlake Health Region
	Pinaymootang First Nation	Interlake Health Region
	Berens River	North Eastman Health Region
	Bloodvein	North Eastman Health Region
	Fort Alexander	North Eastman Health Region
	Hollow Water	North Eastman Health Region
	Little Black River	North Eastman Health Region
	Little Grand Rapids	North Eastman Health Region
	Pauingassi First Nation	North Eastman Health Region
	Poplar River First Nation	North Eastman Health Region
Low Priority for Testing. Health Regions with 10% to 15% of Homes Above Guideline		
	Chemawawin Cree Nation	Norman Health Region
	Grand Rapids First Nation	Norman Health Region
	Mathias Colomb	Norman Health Region
	Mosakahiken Cree Nation	Norman Health Region
	Opaskwayak Cree Nation	Norman Health Region
Very Low Priority for Testing. Health Regions with less than 10% of Homes Above Guideline		
	Barren Lands	Burntwood/Churchill Health Region
	Bunibonibee Cree Nation	Burntwood/Churchill Health Region
	Cross Lake First Nation	Burntwood/Churchill Health Region
	Fox Lake	Burntwood/Churchill Health Region
	Garden Hill First Nations	Burntwood/Churchill Health Region
	God's Lake First Nation	Burntwood/Churchill Health Region
	Manto Sipi Cree Nation	Burntwood/Churchill Health Region
	Marcel Colomb First Nation	Burntwood/Churchill Health Region
	Nisichawayasihk Cree Nation	Burntwood/Churchill Health Region
	Northlands	Burntwood/Churchill Health Region
	Norway House Cree Nation	Burntwood/Churchill Health Region
	Red Sucker Lake	Burntwood/Churchill Health Region
	Sayisi Dene First Nation	Burntwood/Churchill Health Region
	Shamattawa First Nation	Burntwood/Churchill Health Region
	St. Theresa Point	Burntwood/Churchill Health Region
	Tataskweyak Cree Nation	Burntwood/Churchill Health Region
	War Lake First Nation	Burntwood/Churchill Health Region
	Wasagamack First Nation	Burntwood/Churchill Health Region
	York Factory First Nation	Burntwood/Churchill Health Region
	Buffalo Point First Nation	South Eastman Health Region

NOTE: Radon levels can vary widely from one home to the next. A home with a well-sealed foundation may have very low levels of radon indoors, even in regions with naturally higher levels of radon. A home with cracks in the foundation may have elevated levels of radon indoors, even in an area with little natural radon.

Health Canada recommends every home be tested, as this is the only way to confirm the indoor radon level.

Asbestos contaminated insulation. Asbestos fibres are known to cause mesothelioma, a rare type of cancer. Most people who get this kind of cancer have been exposed to asbestos fibres at some point in their lives. Usually this exposure occurred at work, especially in places where insulating materials that contain asbestos are used to control heat from machines and engines in industrial locations and shipyards. Brake pads used in the automotive and heavy duty vehicle industry also contained asbestos, so mechanics may have higher exposures. In the past, people working in asbestos processing facilities were most at risk of developing mesothelioma.

Beginning in the 1920s, a substance called vermiculite was mined in Libby, Montana. Vermiculite can be puffed up through a heating process and is an excellent insulator. The vermiculate mined at Libby was used to make building insulation sold under the name Zonolite throughout the US and Canada. It was known that the vermiculite deposit in Libby also contained asbestos, but the connection between asbestos and mesothelioma was not widely recognized until the late 1970s.

Zonolite was used in Canada up until 1990 by homeowners across Canada, and by the federal government building military and First Nations housing. It is not known exactly how many homes used Zonolite, but it was present in 215 (6.6 percent) of 3,184 homes evaluated in Manitoba.[7] Houses built after 1990 are very unlikely to have Zonolite insulation.

There is at least one documented case in Manitoba of First Nations people with mesothelioma due to Zonolite insulation. Six family members of Raven ThunderSky (Berens River) have died from mesothelioma due to the asbestos contained in the Zonolite insulation used in their home.

Indian and Northern Affairs Canada (INAC) has reviewed their records to attempt to identify where this insulation may have been used in the construction of houses on reserves[8]. Of houses built between 1960 and 1990, INAC found 234 references to houses that may have been built using Zonolite® Loose-Fill Vermiculite Insulation in Manitoba.

Records for the specific homes on reserve with Zonolite may be available on request to INAC, if this information not already known by individual First Nation communities.

In general, as long as the insulation is not disturbed, there is a very low risk of getting mesothelioma. That means no one should go into attic spaces where Zonolite insulation is present without proper precaution. Renovation or demolition of buildings with Zonolite insulation (and any other asbestos containing products) can cause asbestos fibres to become airborne and thus present a serious health risk.

[7] http://www.gov.mb.ca/health/publichealth/environmentalhealth/vermiculite.html
[8] Aboriginal Affairs and Northern Development Canada. 2010. Information on Vermiculite Insulation Containing Asbestos. http://www.aadnc-aandc.gc.ca/eng/1100100016218/1100100016219

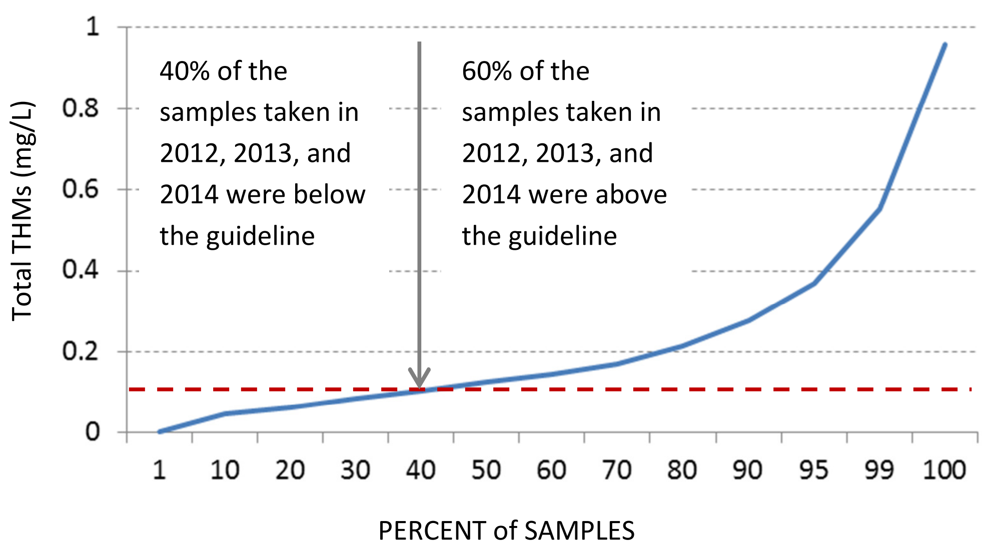
3. DRINKING WATER

Public Drinking Water Systems. Chlorination by-products, particularly trihalomethanes, as well as lead and arsenic in drinking water are noted as being issues of concern on the Manitoba Environmental Health website. Data on trihalomethanes in drinking water on First Nations reserves is not publicly available. However, data from drinking water systems serving non-reserve areas in Manitoba do indicate the levels commonly found in the province.

Trihalomethanes are formed when chlorine-based disinfectants are added to drinking water. The chlorine reacts with naturally occurring organic matter in the untreated water and a wide range of chemical by-products can be formed. Some trihalomethanes are suspected to cause cancer: the International Agency for Research on Cancer (IARC) has classified chloroform and bromodichloromethane as possible carcinogens. Both are commonly occurring by-products.

The available files for public drinking water systems in Manitoba only report levels of total trihalomethanes. It is not possible to identify levels of the specific chemicals within this category that may increase lifetime excess cancer risk. However, the Canadian drinking water guideline for total trihalomethanes is 0.1 milligram per liter (0.1 mg/L). Data for 2012, 2013 and 2014[9] show that more than half the time, the guideline for total THMs was exceeded (Figure 3.1).

Figure 3.1 Average Trihalomethanes in Public Drinking Water Systems in Manitoba

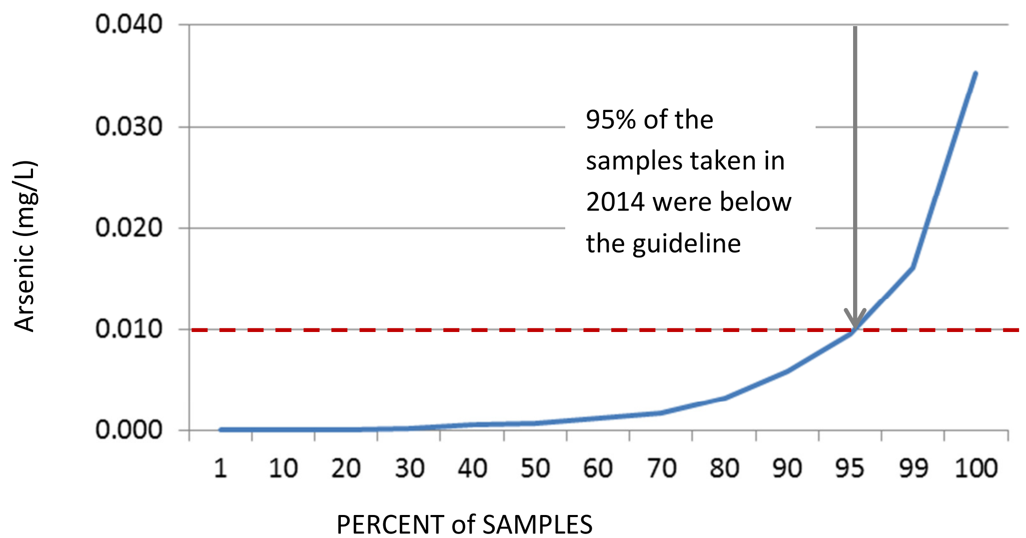


Lead may also be present due to natural source or industrial contamination, but may also be due to the presence of lead plumbing pipes in homes built prior to the 1950, or the use of lead solder for plumbing up to 1990. No available measurements of lead in public drinking water systems were identified for this report.

[9] http://www.gov.mb.ca/waterstewardship/odw/public-info/general-info/water_system_data.html

Arsenic in drinking water is often due to natural deposits in the local rocks and soils. It can also be present due to contamination from industrial emissions and runoff from poorly controlled tailing ponds. Arsenic levels in public drinking water systems in Manitoba were below the Canadian drinking water guideline (0.01 mg/L) most of the time (Figure 3.2).

Figure 3.2 Average Arsenic in Public Drinking Water Systems in Manitoba[10]



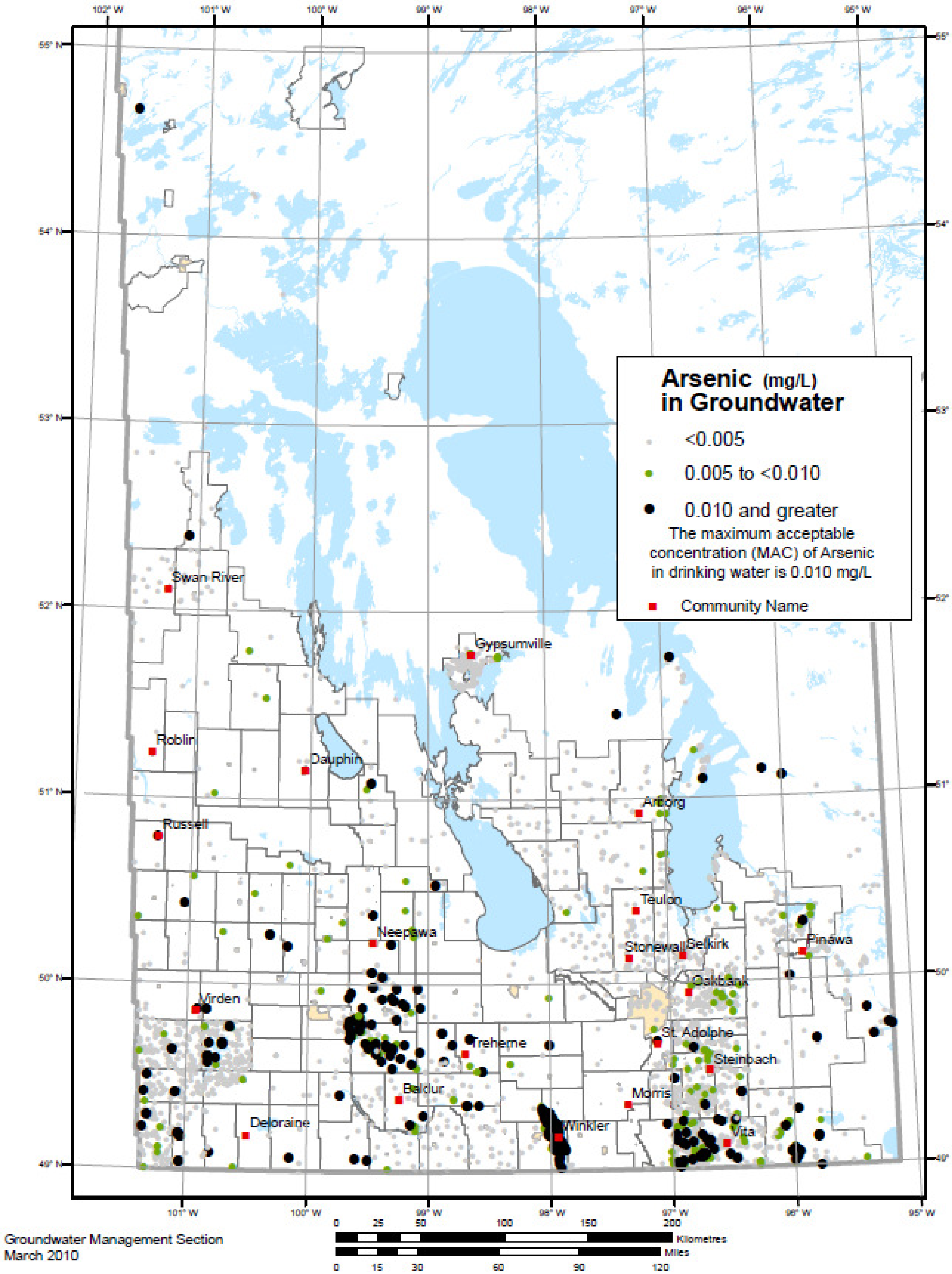
The eRISK tool available from CAREX Canada can be used to calculate the excess lifetime cancer risk associated with these levels of arsenic. Typically, Health Canada considers excess lifetime cancer risks between 1 and 10 per million as negligible, indicating no cause for concern, and excess risk levels above this as an indication that more detailed studies of people's actual exposure maybe useful and ways to reduce exposure should be considered.

The current guideline level of 0.01 mg/L is in fact above this threshold. Over a 70 year lifetime, drinking normal amounts of water with 0.01 mg/L of arsenic is associated with an lifetime excess cancer risk of 470 per million. The Health Canada website explains the guideline is set at what can be generally achieved at municipal- and residential-scale treatment, but also states that technology is available to reduce arsenic levels to much lower levels[11]. The level of arsenic in drinking water associated with a 10 per million lifetime excess cancer risk is 0.00025 mg/L.

A map of locations where arsenic in ground water tested above the guideline of 0.01 mg/L is provided in Figure 3.3. In general, anyone using water from private wells should test for arsenic. People using water from private wells in the areas known to have higher levels of arsenic should be aware of the risks and seek ways to reduce their exposure.

[10] http://www.gov.mb.ca/waterstewardship/odw/public-info/general-info/compliance_data/year_rnd_pws_may_29_2015.pdf
[11] http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/arsenic/index-eng.php#a1

Figure 3.3. Arsenic in Groundwater



Arsenic and Lead in Tap Water on Selected Reserves. In the fall of 2010, tap water was sampled in nine on-reserve First Nations communities in Manitoba[12]:

- Chemawawin Cree Nation
- Cross Lake Band of Indians
- Hollow Water First Nation
- Northlands Denesuline First Nation
- Pine Creek First Nation
- Sagkeeng First Nation
- Sandy Bay Ojibway First Nation
- Sayisi Dene First Nation
- Swan Lake First Nation

All of the communities in the study had water treatment plants and reported using filtration systems in combination with chlorination. A total of 706 households participated: 92 percent received water from a treatment system; 7 percent used trucked-in water, and 1 percent got water from other sources (private wells or bottled water).

The maximum level of **arsenic** detected was 0.0024 mg/L, similar to arsenic levels in drinking water from treatment plants not on reserves, and lower than the current guideline level of 0.01 mg/L. The lifetime excess cancer risk associated with the maximum level of arsenic detected in these communities is about 100 per million. This means that for an individual drinking normal amounts of water with this level of arsenic for 70 years, the chance is 100 in a million that they will develop cancer from it, compared to someone not drinking that water. Put another way, if 1 million people drank this water all their lives, no more than 100 of them would be expected to get cancer from it when compared to 1 million people who drank water without arsenic.

Given that the maximum level measured was used for this calculation, most of the households sampled likely have less arsenic in their drinking water. Still, for those people who have the maximum amount, the lifetime excess risk of 100 per million is above the level for concern (1 to 10 per million) used by Health Canada. This suggests that ways to reduce arsenic levels in drinking water should be explored, and a more comprehensive analysis of arsenic levels across all communities with treatment plants could be useful to confirm the range of arsenic levels.

Lead was also measured in the drinking water. The maximum level detected was 0.051 mg/L, higher than the current guideline of 0.01 mg/L. In total, thirteen samples tested above the guideline, but these were all taken as soon as the tap was turned on, after water had been sitting in the pipes. When new samples were taken after letting the taps run for a few minutes, lead levels were all below the guideline. The maximum level (0.051 mg/L) is associated with a lifetime excess cancer risk of 11 per million, generally within the threshold Health Canada considers to be negligible.

NOTE: Cadmium was measured in this study as well, but cadmium is not known to be carcinogenic when ingested via food or water. It is carcinogenic when inhaled.

[12] University of Northern British Columbia (2010). First Nations Food, Nutrition and Environment Study (FNFNES), results from Manitoba (2010).

4. FOOD

Domestic and Imported Foods for Purchase. Food purchased from grocery stores is tested for contaminants under two key federal agencies – the Canadian Food Inspection Agency, and Health Canada.

The Canadian Food Inspection Agency runs the National Contaminant Residue Monitoring Program (NCRMP); conducts spot testing if a contamination issue is suspected; and conducts spot testing for compliance with current guidelines. Contaminants tested for include:

- agricultural chemical – pesticides, wood preservatives
- veterinary drugs – antibiotics, hormones and growth promoters
- metals – naturally present, or due to environmental contamination through use of fertilizers, pesticides, or industrial emissions

In 2010-2012, test results indicated a very high rate of compliance, with between 98 and 100 percent of samples meeting the current guidelines.[13] These results are not specific to Manitoba, but represent a wide range of domestic and imported foods available in Canada.

The Canadian Total Diet Studies, conducted by Health Canada[14], test a standard set of foods, referred to as a 'market basket', purchased in major cities. Typically one or two cities are sampled per year during the studies. Since 1992, market baskets from the following cities have been tested:

Toronto	July 1992 and January 1996
Montreal	July 1993
Halifax and **Winnipeg**	January and **July 1994**, respectively
Vancouver and Ottawa	January and July 1995, respectively
Whitehorse	January 1998
Calgary	January 1999
Ottawa	October 2000
St. John's	June 2001
Vancouver	April 2002
Montreal	May 2003
Winnipeg	**April 2004**
Toronto	September 2005
Halifax	September 2006
Vancouver	September 2007

As per this list, market baskets from Winnipeg have been analyzed only in 1994 (for pesticides, PCBs and dioxin/furans), and in 2004 (trace elements, including arsenic and lead). These data are relatively old and they are unlikely to represent contaminant levels encountered today, or by First Nations people living on reserve.

[13] Canadian Food Inspection Agency (2013). National Chemical Residue Monitoring Program 2010-2012 Report.
[14] http://www.hc-sc.gc.ca/fn-an/surveill/total-diet/index-eng.php

Traditional Foods. As part of the First Nations Food, Nutrition and the Environment Study (FNFNES) in Manitoba, 651 samples representing 83 different types of traditional foods were analysed for a variety of contaminants, including:

Arsenic	Arsenic is a heavy metal that remains in the environment for a long time and can be transported long distances when emitted to the air. Sources to air include burning fossil fuels and industrial processes like metal mining and refining. It is commonly found in drinking water when local geological deposits contain arsenic. It can also be present in areas where gold mining occurred.	Inorganic arsenic is a known carcinogen. The arsenic in food is often in the form of arsenobetaine which does not increase cancer risk.
Cadmium	Cadmium is a heavy metal that remains in the environment for a long time and can be transported long distances when emitted to the air. It occurs naturally, but most of the cadmium pollution comes from burning fossil fuels and metal mining and refinery processes. It can also be present in leachate from landfills and waste storage sites containing metals and batteries.	Cadmium is a known carcinogen when inhaled.
Chlordane	Chlordane is an insecticide used widely in Canada from the 1940s to the 1980s. It was de-registered for use in 1991. It is persistent in the environment and accumulates in fatty tissues of fish and animals.	Chlordane is a possible carcinogen.
DDE (DDT)	DDE is an indicator of DDT exposure. DDT was a commonly used insecticide. It is very long-lasting once released. Its use was severely restricted in Canada in the early 1970s due to observed harmful environmental effects and its ability to bioaccumulate in fish and animals.	DDT is a probable carcinogen
Dioxin/Furan	Dioxins and furans belong to a group of chemicals that are very similar. Most are not made on purpose, but are byproducts of other processes, especially herbicide manufacturing, pulp and paper manufacturing, and incinerating waste. Burning wood or garbage at home can also produce dioxins and furans. Dioxins and furans can accumulate in the fat of animals and eating food is the most likely way of being exposed. The FNFNES study reports total dioxin/furans in toxic equivalents to TCDD.	The most toxic is 2,3,7,8-tetrachloro-p-dibenzo-dioxin (TCDD), a known carcinogen.
Hexachloro-benzene	Hexachlorobenzene (HCB) is a long lasting fungicide that was used to control fungus on plant seeds, especially wheat. It has not been used in Canada since 1972, but it is still present in some agricultural soils and can become airborne when those soils are tilled. Small amounts are also produced unintentionally, as byproducts when manufacturing chlorinated solvents and pesticides.	HCB is a possible carcinogen.
Lead	Lead is a heavy metal that remains in the environment for a long time and can be transported long distances when emitted to the air. It can occur naturally, but most of the lead pollution comes from burning fossil fuels and metal mining and refinery processes. Lead can also be present in leachate from landfills and waste storage sites containing metals and batteries.	Inorganic forms of lead are probable carcinogens; organic forms of lead are possible carcinogens.

Mercury	Mercury is a heavy metal that remains in the environment for a long time and can be transported long distances. It is released to the air by burning fossil fuels (especially coal) and also through some industrial processes. Mercury is not known to increase cancer risk, but it can cause severe nerve damage, especially in growing babies before they are born.	When mercury gets into lakes and streams, it is easily converted to **methylmercury**, which is a possible carcinogen and can accumulate in fish and seafood to harmful levels.
PAHs	Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals. The main source of PAHs is burning organic matter, such as fossil fuels (coal, gas, oil), wood, tobacco, garbage and even grilling meat. They can be produced naturally from forest fires and even evaporate from oil seeps. The FNFNES study reports total PAHs, in toxic equivalents to benzo[a]pyrene.	Benzo[a]pyrene is a known carcinogen
PCBs	Polychlorinated Biphenyls (PCBs) are industrial chemicals used in electrical equipment, heat exchangers and hydraulic systems from the 1930s to the late 1970s in Canada. They are very persistent in the environment and build up in the fatty tissues of fish and animals. It has been illegal to release PCBs to the environment in Canada since 1985, although some equipment still contains PCBs and must be treated as hazardous waste when disposed of.	PCBs as group are a known carcinogen.
PDBEs	Polybrominated Diphenyl Ethers (PBDEs) are chemicals used as flame retardants in a wide variety of consumer products. They are long lasting and tend to accumulate in fatty tissues. PBDEs have been detected in most people tested in North America and Europe, although at low levels.	PBDEs are on the moderate priority list for evaluation by IARC.
PFOS	Perfluorooctane sulfonate (PFOS) is created when the chemicals used to stain guard fabrics (i.e., ‘Scotchguard’) breaks down over time. It is long lasting in the environment and can accumulate in fatty tissues. It belongs to a group of chemicals call perfluorinated compounds (PFCs).	PFCs are on the high priority list for evaluation by IARC, due to observed increases of liver and pancreatic tumours on rodents.
Toxaphene	Toxaphene was commonly used as an insecticide, but due to its persistence in the environment and known environmental and health impacts, it was widely phased out of use in 1982. It is still being used on other countries, and since it can be transported long distances when emitted to air, it is still a concern in North America.	Toxaphene is a possible carcinogen.

* International Agency for Research on Cancer (IARC) classifies known carcinogens as 1, probable carcinogens as 2A, and possible carcinogens as 2B.

The authors of the FNFNES report conducted a health risk analysis, using the ratio of estimated daily intake to acceptable daily intake thresholds. This approach is commonly used for non-cancer health effects. They asked study participants about how much they normally ate of each kind of food, and calculated how much contaminant a person would eat, given the measured levels found in the samples provided.

Ratios larger than one (the estimated intake is higher than the acceptable daily intake) indicate a health hazard exists. Ratios less than one indicate no health hazard exists. The FNFNES authors found no health hazards from any of the contaminants, with the exception of lead (Table 4.1). The health hazard ratio for lead was 1.64 for maximum concentrations measured for those people who consumed the highest amounts of traditional meats.

Table 4.1. Health hazard assessment from the First Nations Food, Nutrition and Environment Study

Contaminant	Acceptable Daily Intake	Average Daily Intake	Health Hazard ratio	High Daily Intake	Health Hazard Ratio
Arsenic	1.0	0.02	0.02	0.07*	0.07
Cadmium	1.0	0.04	0.04	0.17*	0.17
Chlordane	0.05	0.00001	0.00024	--	0.00007
DDE	20.0	0.00019	0.00001	0.00085	0.00004
Dioxin/Furan	0.0000023	0.00000000001	0.00001	0.00000000005	0.00002
HCB	0.27	0.00003	0.0001	0.0001	0.00038
Lead	3.6	1.35	0.38	5.39*	**1.64**
Mercury	0.5	0.02	0.04	0.09*	0.18
PAHs	40.0	0.00022	0.00001	0.0012	0.00003
PBDE	0.1	0.00065	0.00654	0.00364	0.03644
PCBs	1.0	0.00011	0.00011	0.00055	0.00055
PFOS	0.08	0.00045	0.00566	0.00204	0.02554
Toxaphene	0.2	0.00002	0.00009	--	0.00002

* calculated using high consumption and high concentration, all others calculated using average concentration.

An assessment of cancer risk combines the estimated daily intake of a contaminant (based on the measured levels and amounts eaten) with a cancer potency factor, as is done in the CAREX Canada eRISK tool. Table 4.2 shows the lifetime excess cancer risk for those substances with cancer potency factors, using the FNFNES data for the intake of contaminants for people who eat average or high amounts of traditional foods.

Table 4.2. Lifetime excess cancer risk assessment using the CAREX Canada eRISK tool

Substance	Average intake (ug/kg bw/day)	Lifetime Excess Cancer Risk per million	Substance	High intake (ug/kg bw/day)	Lifetime Excess Cancer Risk per million
Arsenic	0.02	**36**	Arsenic	0.05	**90**
Lead	1.4	**11.5**	Lead	5.4	**46**
HCB	0.00003	0.06	HCB	0.0001	0.2
PCBs	0.00011	0.2	PCBs	0.00055	1.0
Toxaphene	0.00002	0.024	Toxaphene		
PAHs	0.00022	0.51	PAHs	0.0012	2.8
Dioxins/furans	1E-11	0.0013	Dioxins/furans	5E-11	0.0065

Health Canada considers lifetime excess cancer risks between 1 and 10 per million as negligible and no cause for concern. Based on the data collected by the FNFNES study, lifetime excess cancer risks are above this threshold for arsenic and lead, for people who eat even average amounts of traditional foods. Still, the largest excess risk calculated is still relatively low, amounting to an additional 90 cancers in 1 million people, if they all ate high amounts of traditional foods for 70 years containing the arsenic levels measured in the FNFNES study. Most people would likely consider this an acceptable risk, given the nutritional benefits of eating traditional foods.

The FNFNES did not analyse food or water samples for three commonly used pesticides in Manitoba that are linked to increased risks for cancer over the long term: glyphosate (probable carcinogen), 2,4-D (possible carcinogen) and chlorothalonil (possible carcinogen). More information about these pesticides is presented in the Environmental Pollutants – Sources report.

Mercury in Traditional Foods. Mercury is not currently classified as a known or suspected carcinogen, but it can have serious health impacts, especially on the brain development of babies in the womb. Adults can also have brain and nerve damage if exposed to very high levels of mercury. However, once mercury enters the environment, it can be converted to methylmercury by microorganisms in the soil or aquatic systems and bio-magnify up the food chain. The International Agency for Research on Cancer (IARC) classifies methylmercury as a possible carcinogen.[15]

Methylmercury is most commonly higher in fish compared to mammals. Levels are typically highest in predatory fish at higher levels in the aquatic food chain, and get higher as the fish ages. The government of Manitoba puts out consumption guidelines for fish caught in lakes and streams based on amounts of total mercury measured in samples. The amount of methylmercury may be less than the total mercury measured, but assuming that all of it is methylmercury provide better protection for human health.

The FNFNES measured mercury in hair samples from 236 people living in the communities that participated in the study, and an indicator of potential methylmercury exposure. The current Health Canada guideline for mercury in hair is 6 ug/g for the general population, and 2 ug/g for women of childbearing age. It is lower for women to provide extra protection for a baby in case of pregnancy.

The results showed that 229 out of 236 people sampled had hair mercury levels below 2 ug/g. The remaining 7 people were women who had levels above the 2 ug/g guideline, indicating they should take steps to reduce their exposure to mercury. All of these women lived in communities in Northwest Manitoba. The FNFNES reports that consumption of caribou kidney contributes the most to mercury intake in this region (50%), followed by trout and walleye (35% together).

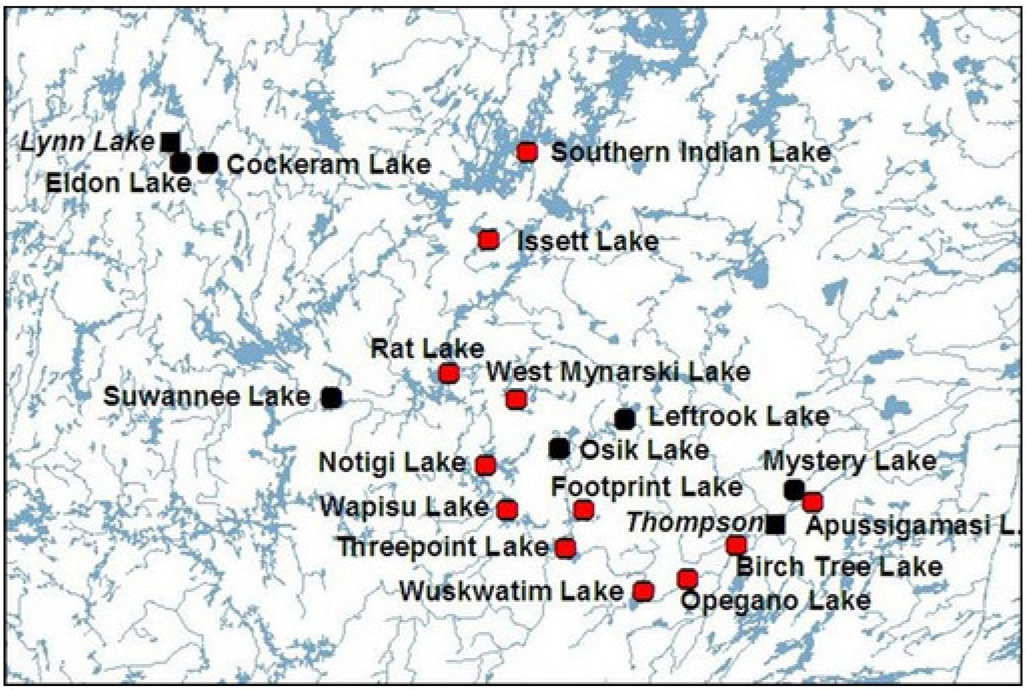
Fish consumption advisories are available for 52 lakes and rivers in Manitoba on the Water Stewardship Division website.[16] For each water body, common fish are assigned to one of five categories based on typical mercury concentrations. The size of fish is also taken into account – smaller fish of the same species may be in a different consumption category, they may have accumulated less mercury.

[15] IARC Summary of Monograph 58: http://www.inchem.org/documents/iarc/vol58/mono58-3.html
[16] http://www.gov.mb.ca/waterstewardship/fish/mercury/manitobamap.html

Fish with less than 0.2 ug/g of mercury are included in Category 1 and can be eaten 8 times a month by women of child-bearing age and children under 12, and 19 times per month by other adults. The number of recommended meals goes down as the mercury content increases. For example, women of child-bearing age and children under 12 should not eat any fish with 0.5 ug/g of mercury or more.

In Northwest Manitoba, recommendations are available for the waterbodies shown in Figure 4.1. Detailed information on each site is available by using the interactive map at http://www.gov.mb.ca/waterstewardship/fish/mercury/northwest.html

Figure 4.1. Northwest Manitoba – Waterbodies with Fish Consumption Guidelines



NOTE: red symbols indicate waterbodies that have been flooded due to reservoir development and diversion flows, and so methylmercury content in fish may be higher.[17] Black symbols indicate waterbodies that have not been impacted.

[17] Bodaly et al (2007). Post-impoundment Time Course in Increased Mercury Concentrations in Fish in Hydroelectric Reservoirs of Northern Manitoba, Canada. Archives of Environmental Contaminant Toxicology 53 pp 379-389.