Environment and Climate Change Canada
Environnement et Changement climatique Canada

Annex II

BISPHENOL A IN WATER AND SEDIMENT

CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

Canada

Suggested citation for this document: Environment and Climate Change Canada (2020) Canadian Environmental Sustainability Indicators: Bisphenol A in water and sediment. Consulted on *Month day, year*. Available at: www.canada.ca/en/environment-climate-change/services/environmental-indicators/bisphenol-a-water-sediment.html.

Cat. No.: En4-144/90-2020E-PDF
ISBN: 978-0-660-34160-6

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CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

BISPHENOL A IN WATER AND SEDIMENT

July 2020

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Bisphenol A in water and sediment

Bisphenol A (BPA) is a synthetic substance used in epoxy resins and to make hard and clear plastics. It can enter the environment through municipal and industrial wastewaters, washing residues and leachate from landfills. BPA poses health and environmental concerns for humans as well as aquatic and terrestrial organisms as it can adversely affect reproduction, growth and development. These indicators assess BPA concentrations in surface water and sediment against the Federal Environmental Quality Guidelines.[1]

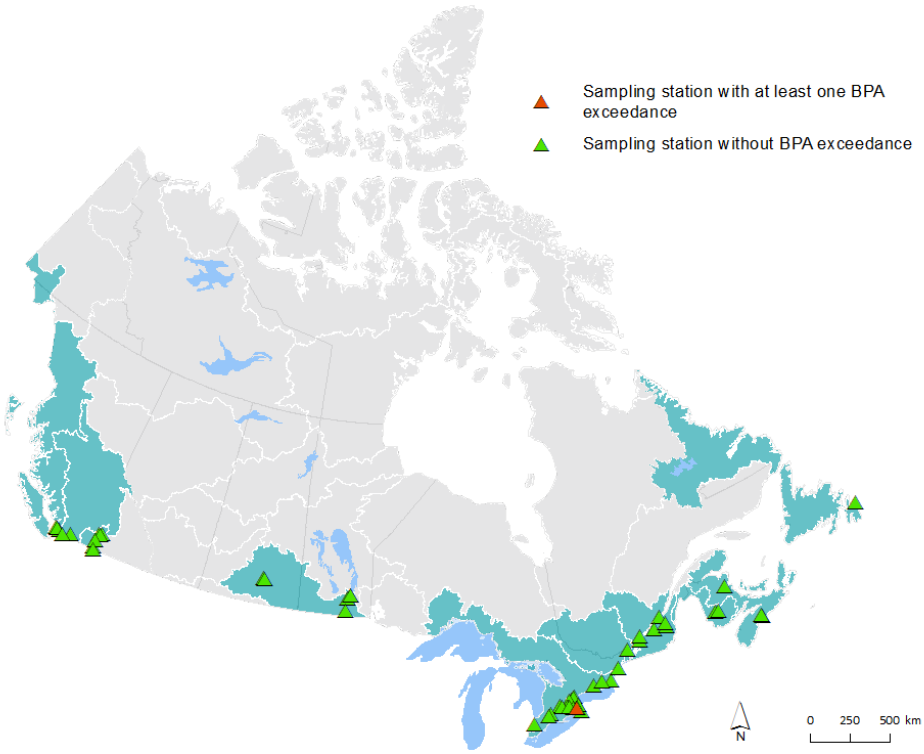
Bisphenol A in surface water

Key results

From 2008 to 2018

- one (1) out of the 1 931 surface water samples analyzed in 10 drainage regions presented a concentration above the guideline
- the only sample showing a concentration above the guideline was collected in the Great Lakes drainage region

Figure 1. Location of sampling stations with and without at least 1 sample exceeding the surface water guideline for BPA by drainage regions, Canada, 2008 to 2018



Data for Figure 1

Note: The Federal Environmental Quality Guideline in surface water for BPA is 3 500 nanograms per litre (ng/L). Samples with BPA concentrations above the guideline are defined as an exceedance. See Figure 3 for the drainage region map. Measurements were made in 1 931 surface water samples collected in 51 sites from 10 drainage regions between 2008 and 2018.
Source: Environment and Climate Change Canada (2019) Chemicals Management Plan Monitoring and Surveillance.

[1] The Federal Environmental Quality Guidelines are numerical limits established under the Chemicals Management Plan to protect aquatic life. Concentrations below the guidelines are not of concern, while concentrations above guidelines indicate that further evaluation may be required.

The exceedance recorded in the Great Lakes drainage region occurred in the Beaverdams Creek sampling station. This sample was collected in February 2011. Since December 2014, the 22 samples collected at this sampling station showed concentrations below the detection limit.

Even though most samples (99.9%) showed BPA concentrations below the guideline, BPA levels were higher in water bodies in urban areas. Also, samples collected downstream of 3 municipal wastewater treatment plants showed higher BPA concentrations than the ones collected upstream. It is important to note that BPA is not produced by the wastewater treatment plants, but this chemical may persist in wastewater after treatment.[2]

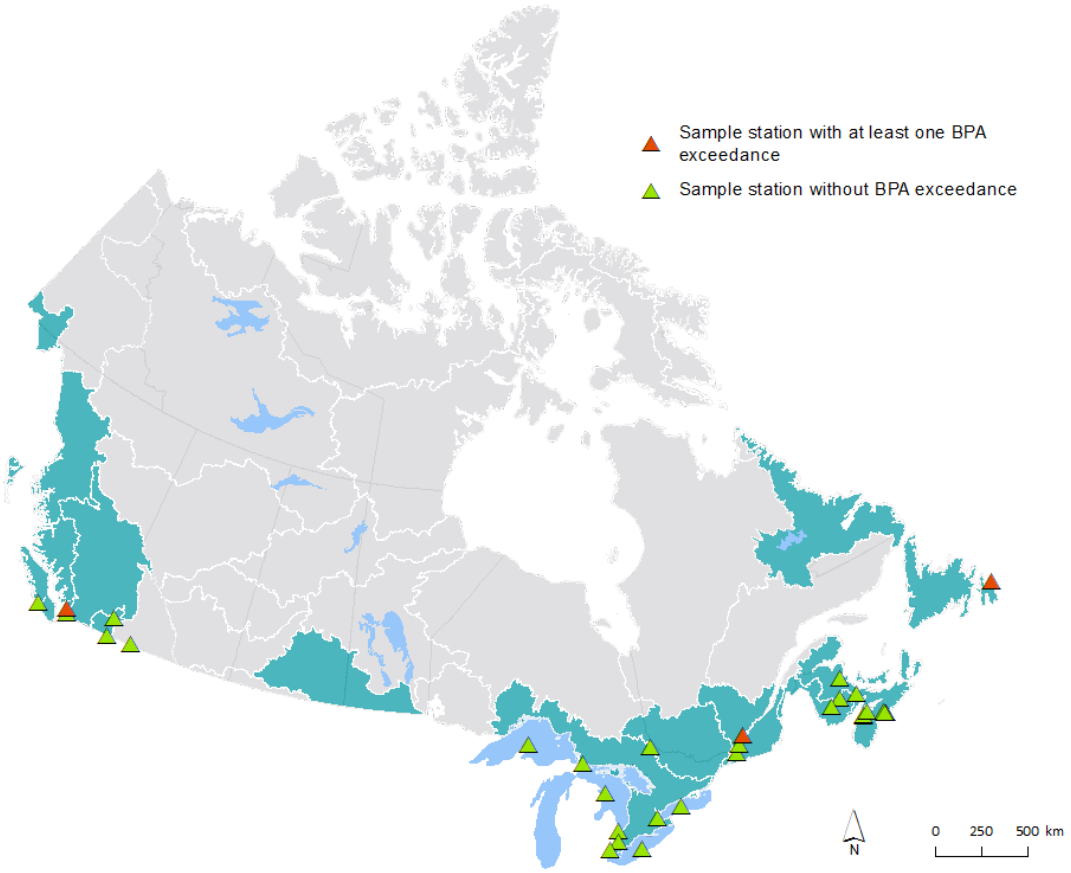
Bisphenol A in sediment

Key results

From 2011 to 2018

- three (3) out of the 272 samples analyzed in 9 drainage region had a concentration above the guideline
- three (3) drainage regions presented at least 1 sample with a concentration above the guideline

Figure 2. Location of sampling stations with and without at least 1 sample exceeding the sediment guideline for BPA by drainage regions, Canada, 2011 to 2018



Data for Figure 2

Note: The Federal Environmental Quality Guideline in sediment for BPA is 25 nanograms per gram (ng/g) of dry weight normalized to 1% total organic carbon. Samples with BPA concentrations above the guideline are defined as an exceedance. See Figure 3 for the drainage region map. Measurements were made in 272 surface sediment samples collected in 31 sites from 9 drainage regions between 2011 and 2018.
Source: Environment and Climate Change Canada (2019) Chemicals Management Plan Monitoring and Surveillance.

[2] Environment and Climate Change Canada (2020). Bisphenol A in the Canadian Environment. Retrieved in March 2020.

The analysis revealed that exceedances were observed for sediment samples collected in Still Creek, Waterford River and Lake Saint-Pierre. These sampling stations are located, respectively, in the Fraser-Lower Mainland, Newfoundland-Labrador, and St. Lawrence drainage regions.

For 99% of the analyzed samples, the concentration in BPA was below the guideline. 68% of the analyzed samples had concentrations in BPA below the detection limit.

About the indicators

What the indicators measure

The Bisphenol A in water and sediment indicators provide an overview of the status of drainage regions against the Federal Environmental Quality Guidelines (the guidelines) for bisphenol A (BPA) concentration in surface water and sediment. The guidelines were developed under the Chemicals Management Plan and are used in this report to evaluate whether, and the degree to which, concentrations in the environment exceed the guidelines.

Why these indicators are important

These indicators provide information on the presence of BPA in the environment.

BPA is an industrial chemical used to make hard, clear plastic known as polycarbonate, which is used in many consumer products, including bottles, pitchers, water carboys, tableware and storage containers. It is also found in epoxy resins, which act as a protective lining on the inside of metal-based food and beverage cans. BPA is produced in high volumes worldwide. In 2015, global consumption was of approximately 7.7 million metric tonnes and was predicted to reach 10.6 million tonnes by 2022. Based on a survey conducted under section 71 of the *Canadian Environmental Protection Act*, no BPA was manufactured in Canada in 2006 at quantities greater than or equal to 100 kg.

There are no known natural sources of BPA and potential releases to the environment are restricted to those associated with human activities. Releases of BPA may occur during production, processing, and use or disposal of the substance or products containing it. Degradation of the flame retardant tetrabromobisphenol A (TBBPA) is also a source of BPA to the environment under oxygen-poor conditions, such as those found in buried sediment (Arbeli et al., 2006; Environment and Climate Change Canada and Health Canada, 2013; Voordeckers et al., 2002).

BPA is entering the environment through wastewaters and washing residues and has been found in wastewater treatment plant effluents and some leachate from landfills. It also breaks down slowly in the environment when there is a lack of oxygen. The combination of the slow break down of BPA and its wide use in Canada means that over time, this chemical could build up in our waters and harm fish and other organisms. It poses a health and environmental concern for humans and both aquatic and terrestrial organisms because it can adversely affect reproduction, growth and development.

In 2008, BPA was declared a "toxic substance" as defined by the *Canadian Environmental Protection Act* and is being addressed under the Chemicals Management Plan. The Government of Canada has undertaken a number of risk management actions to reduce releases to the environment, including a Pollution Prevention Planning Notice for industrial and commercial users of BPA and an Environmental Performance Agreement with paper recycling mills (the latter was effective from 2013 to 2017). In both cases, the effluent release target concentration for industrial effluents and paper recycling mill effluents was set at 1.75 micrograms per litre (µg/L).

The success of these risk management actions in reducing the concentration of BPA in the environment are evaluated in the report Evaluation of the Effectiveness of Risk Management Measures for Bisphenol A (BPA) - Ecological Component. In order to protect human health, the Government of Canada also prohibited the importation and sale of polycarbonate baby bottles that contain BPA in 2010.

Safe and healthy communities

These indicators support the measurement of progress towards the following 2019 to 2022 Federal Sustainable Development Strategy long-term goal: All Canadians live in clean, sustainable communities that contribute to their health and well-being.

Related indicators

The Perfluorooctane sulfonate (PFOS) in fish and water indicators identify the drainage regions where concentrations of PFOS in fish and water are above the Federal Environmental Quality Guidelines.

The Polybrominated diphenyl ethers in fish and sediment indicators identify the drainage regions where concentrations of polybrominated diphenyl ethers in fish and sediment are above the Federal Environmental Quality Guidelines.

The Water quality in Canadian rivers indicators provide a measure of the ability of river water across Canada to support plants and animals.

The Releases of harmful substances to water indicators track human-related releases to water of 3 toxic substances, namely mercury, lead and cadmium, and their compounds. For each substance, data are provided at the national, regional (provincial and territorial) and facility level and by source.

Data sources and methods

Data sources

The bisphenol A (BPA) environmental concentration data were obtained from Environment and Climate Change Canada's Chemicals Management Plan (CMP) Monitoring and Surveillance program. More specifically, concentrations of BPA in water came from the national water sampling program and the Great Lakes sampling program.

More information

BPA concentrations samplings were conducted at monitoring sites that are part of the CMP Monitoring and Surveillance network. The monitoring sites were selected to be representative of major river systems across Canada and to incorporate existing locations of long-term monitoring.

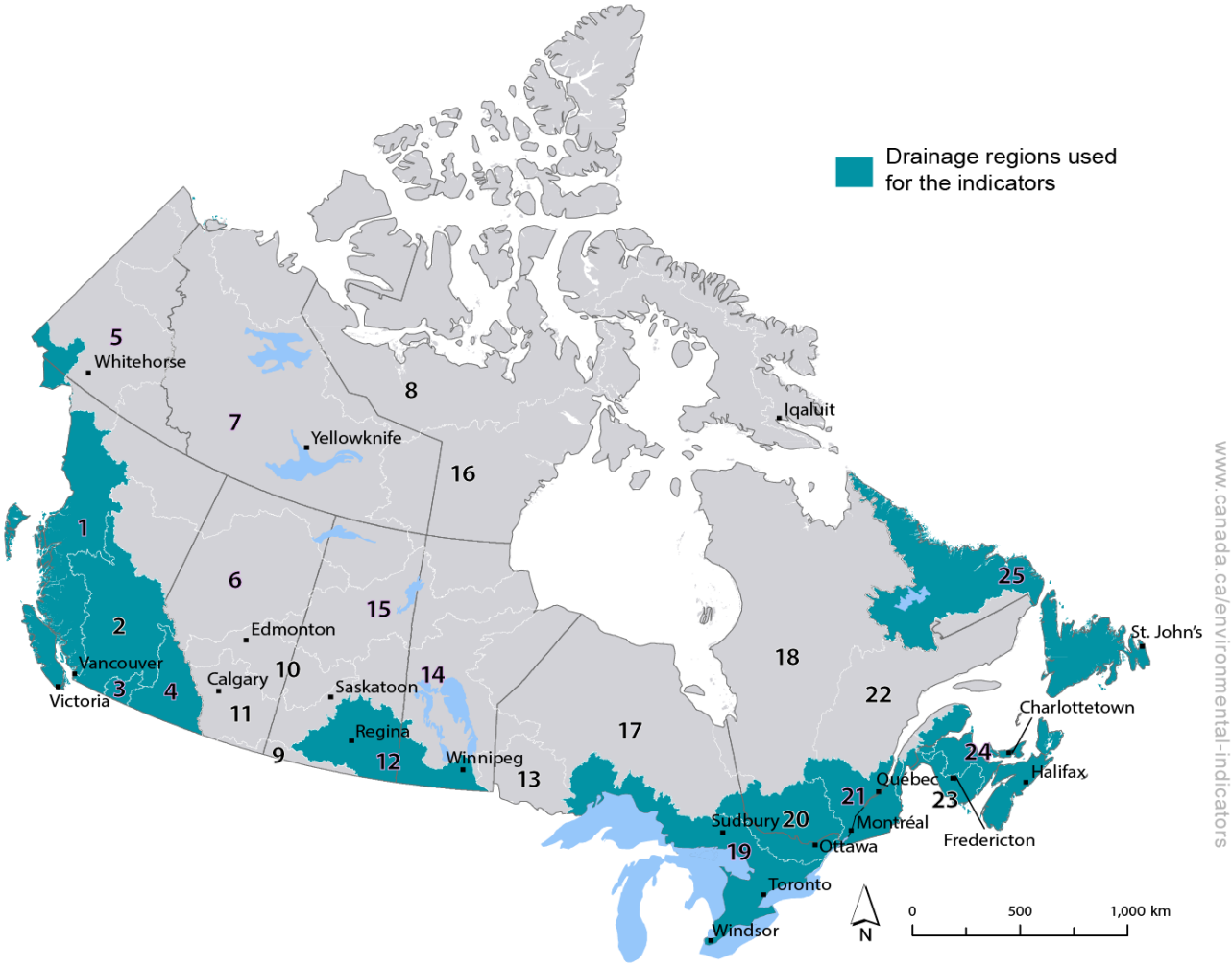
The sampling locations for water and sediment varied throughout the reporting years. Data for water and sediments were gathered in as many drainage regions as permitted by program capacity in any year. To provide a better representation of each drainage region, all the samples for all the recent available years, namely 2008 to 2018 for surface water and 2011 to 2018 for sediment, were used to calculate the indicators.

Spatial coverage

The Bisphenol A in water and sediment indicators use water drainage regions as the geographical unit for the calculation of the national indicators. These drainage regions correspond to those defined in Statistics Canada's Standard Drainage Area Classification. Figure 3 outlines the drainage regions where samplings for BPA were conducted.

Monitoring for BPA in surface water was conducted in 10 drainage regions at 51 sites within streams, rivers, and lakes across the country between 2008 and 2018. Monitoring for BPA in sediments was conducted in 9 drainage regions at 31 sites between 2011 and 2018.

Figure 3. Geographic extent of the drainage regions used for the indicators



1. Pacific Coastal
2. Fraser–Lower Mainland
3. Okanagan–Similkameen
4. Columbia
5. Yukon
6. Peace–Athabasca
7. Lower Mackenzie
8. Arctic Coast–Islands
9. Missouri
10. North Saskatchewan
11. South Saskatchewan
12. Assiniboine–Red
13. Winnipeg
14. Lower Saskatchewan–Nelson
15. Churchill
16. Keewatin–Southern Baffin
17. Northern Ontario
18. Northern Quebec
19. Great Lakes
20. Ottawa
21. St. Lawrence
22. North Shore–Gaspé
23. Saint John–St. Croix
24. Maritime Coastal
25. Newfoundland–Labrador

Methods

The Bisphenol A in water and sediment indicators are showing whether BPA concentrations in surface water and sediment have exceeded the Federal Environmental Quality Guidelines (the guidelines). Samples with BPA concentrations above the guidelines are defined as an exceedance.

More information

The indicator is obtained by comparing the BPA concentrations with the value of the guideline (see Table 1 for the BPA guidelines). For each sampling site, the maximum BPA concentration value was used

to compare with the guideline. If that maximum concentration exceeded the guideline, the drainage region is considered to be exceeding the guideline over the time period studied.

For the sediment samples, concentrations were adjusted to 1% total organic carbon to enable comparison with the guidelines. When no organic carbon data was available for a specific sample, the median value of the total organic carbon measurements from samples collected in the same water body was used. Hamilton Harbour was an exception because only 2 total organic carbon measurements were available. Therefore the minimum measured total organic carbon value was conservatively assumed for Hamilton Harbour for samples where no total organic carbon data were available. For water bodies without any total organic carbon data, a conservative assumption of 1% organic carbon content was used.

Federal Environmental Quality Guidelines

The Federal Environmental Quality Guidelines (the guidelines) provide benchmarks for the quality of the ambient environment. Where the guideline is met, there is low likelihood of adverse effects on aquatic life exposed via the water or sediment. The guidelines can serve 3 functions:

- they can aid in preventing pollution by providing targets for acceptable environmental quality
- they can assist in evaluating the significance of concentrations of chemical substances currently found in the environment (monitoring of water and sediment)
- they can serve as performance measures of the success of risk management activities

The guidelines were developed under the Chemicals Management Plan. Measured concentrations exceeding the guideline levels indicate the potential for aquatic organisms to be affected by BPA in those locations.

Table 1. Federal Environmental Quality Guidelines for bisphenol A

Water (nanograms of BPA per litre)	Sediment [A] (nanograms of BPA per gram of dry weight)
3 500	25

Note: [A] Value normalized to 1% total organic carbon.

Caveats and limitations

Monitoring and surveillance of BPA in lakes and rivers under the Chemicals Management Plan began in 2008. Monitoring is not necessarily performed at the same location each year because of challenges in obtaining water or sediment samples. These challenges include remoteness, shipping logistics and resource constraints. Because of this, a comparison from one year to the next at the national level is not yet possible. Therefore the Bisphenol A in water and sediment indicators are estimated by grouping the samples for all available years by sampling site (2008 to 2018 for BPA in water and 2011 to 2018 for BPA in sediment).

Resources

References

Arbeli et al. (2006) Reductive dehalogenation of tetrabromobisphenol-A by sediment from a contaminated ephemeral streambed and an enrichment culture. Chemosphere 64: 1472-1478. Retrieved on January 28, 2020.

Environment and Climate Change Canada and Health Canada (2008) Screening Assessment for the Challenge Phenol, 4,4' -(1-methylethylidene) bis- (Bisphenol A). Retrieved on January 28, 2020.

Environment and Climate Change Canada (2008) Proposed Risk Management Approach for Phenol, 4,4'-(1-methylethylidene) bis (Bisphenol A). Retrieved on January 28, 2020.

Environment and Climate Change Canada (2011) Environmental Monitoring and Surveillance in Support of the Chemicals Management Plan. Retrieved on January 28, 2020.

Environment and Climate Change Canada (2018) Federal Environmental Quality Guidelines Bisphenol A. Retrieved on January 28, 2020.

Environment and Climate Change Canada (2019) Federal Environmental Quality Guidelines (FEQGs). Retrieved on January 28, 2020.

Environment and Climate Change Canada (2020) Bisphenol A in the Canadian Environment. Retrieved on March 31, 2020.

Environment and Climate Change Canada (2020) Evaluation of the Effectiveness of Risk Management Measures for Bisphenol A (BPA) - Ecological Component. Retrieved on March 31, 2020.

Environment Canada and Health Canada (2013) Screening assessment report Phenol, 4,4'-(1-methylethylidene) bis[2,6-dibromo-, Ethanol, 2,2'-[(1-methylethylidene)bis[(2,6-dibromo-4,1-phenylene)oxy]]bis, Benzene, 1,1'-(1-methylethylidene)bis[3,5-dibromo-4-(2-propenyloxy)-. Retrieved on January 28, 2020.

Health Canada (2008) Bisphenol A fact sheet. Retrieved on January 28, 2020.

Health Canada (2008) Home garden safety - Bisphenol A. Retrieved on January 28, 2020.

Lehmler H-J, Liu B, Gadogbe M and Bao W (2018) Exposure to Bisphenol A, Bisphenol F, and Bisphenol S in U.S. Adults and Children: The National Health and Nutrition Examination Survey 2013–2014. ACS Omega, 3, 6523-6532. Retrieved on January 28, 2020.

Voordeckers et al. (2002) Anaerobic biotransformation of tetrabromobisphenol A, tetrachlorobisphenol A, and bisphenol A in estuarine sediments. Environ. Sci. Technol., 36 (2002), pp. 696-701. Retrieved on January 28, 2020.

Annex

Annex A. Data tables for the figures presented in this document

Table A.1. Data for Figure 1. Location of sampling stations with and without at least 1 sample exceeding the surface water guideline for BPA by drainage regions, Canada, 2008 to 2018

Drainage region	Sampling site	Number of samples	BPA exceedances (number of samples)	BPA exceedances (percentage)	Highest BPA concentration (nanograms per litre)
Pacific Coastal (1)	Serpentine River	32	0	0	61
Fraser-Lower Mainland (2)	Still Creek	72	0	0	229
Fraser-Lower Mainland (2)	Upper Fraser River	1	0	0	Below the detection limit
Fraser-Lower Mainland (2)	Fishtrap Creek	17	0	0	8
Fraser-Lower Mainland (2)	Main Arm of Fraser River	2	0	0	Below the detection limit
Fraser-Lower Mainland (2)	North Arm of Fraser River	2	0	0	Below the detection limit
Okanagan-Similkameen (3)	Mill Creek	18	0	0	39
Okanagan-Similkameen (3)	Lower Mill Creek	42	0	0	49
Okanagan-Similkameen (3)	Upper Mill Creek	39	0	0	Below the detection limit
Okanagan-Similkameen (3)	Okanagan River (Penticton)	15	0	0	11
Okanagan-Similkameen (3)	Okanagan River (Oliver)	30	0	0	8
Okanagan-Similkameen (3)	Osoyoos Lake	31	0	0	188
Assiniboine-Red (12)	Emerson	17	0	0	44
Assiniboine-Red (12)	Downstream of Winnipeg's wastewater treatment plant	17	0	0	40
Assiniboine-Red (12)	Downstream of Selkirk's wastewater treatment plant	34	0	0	271
Assiniboine-Red (12)	Upstream of Lake Winnipeg	13	0	0	125
Assiniboine-Red (12)	Wascana Creek (upstream of Regina)	42	0	0	131
Assiniboine-Red (12)	Wascana Creek (downstream of Regina)	83	0	0	603

Drainage region	Sampling site	Number of samples	BPA exceedances (number of samples)	BPA exceedances (percentage)	Highest BPA concentration (nanograms per litre)
Great Lakes (19)	Beaverdams Creek	74	1	1.3	6 370
Great Lakes (19)	Credit River	28	0	0	Below the detection limit
Great Lakes (19)	Dicks Creek	46	0	0	266
Great Lakes (19)	Fort Erie	23	0	0	Below the detection limit
Great Lakes (19)	Downstream of Galt wastewater treatment plant	12	0	0	173
Great Lakes (19)	Grand River (downstream of Waterloo/Kitchener)	79	0	0	67
Great Lakes (19)	Grand River (upstream of Waterloo/Kitchener)	71	0	0	54
Great Lakes (19)	Hamilton Harbour - Site 1001	30	0	0	86
Great Lakes (19)	Hamilton Harbour - Site 909	60	0	0	106
Great Lakes (19)	Hamilton Harbour - Site 914	83	0	0	2 897
Great Lakes (19)	Hamilton Harbour - Site 926	55	0	0	101
Great Lakes (19)	Highland Creek	86	0	0	1 941
Great Lakes (19)	Mimico Creek	60	0	0	179
Great Lakes (19)	Niagara-on-the-Lake	44	0	0	Below the detection limit
Great Lakes (19)	Taylor Creek	83	0	0	239
Great Lakes (19)	Thames River (downstream of London)	78	0	0	199
Great Lakes (19)	Thames River (upstream of London)	72	0	0	Below the detection limit
Great Lakes (19)	Trent River	3	0	0	Below the detection limit
Ottawa (20)	Ottawa River	31	0	0	11
St. Lawrence (21)	Bras Saint-Victor	8	0	0	Below the detection limit

Drainage region	Sampling site	Number of samples	BPA exceedances (number of samples)	BPA exceedances (percentage)	Highest BPA concentration (nanograms per litre)
St. Lawrence (21)	Chaudiere River (downstream of St Joseph de Beauce wastewater treatment plant)	9	0	0	Below the detection limit
St. Lawrence (21)	Prescott	3	0	0	Below the detection limit
St. Lawrence (21)	Princeville Brook	8	0	0	Below the detection limit
St. Lawrence (21)	St. Lawrence River at Berthierville	11	0	0	140
St. Lawrence (21)	St. Lawrence River at Lavaltrie	82	0	0	180
St. Lawrence (21)	St. Lawrence River at Quebec	55	0	0	Below the detection limit
St. Lawrence (21)	Wolfe Island	47	0	0	40
St. John - St. Croix (23)	St. John River (downstream)	22	0	0	106
St. John - St. Croix (23)	St. John River (upstream)	24	0	0	77
Maritime Coastal (24)	Lower Little Sackville River	36	0	0	23
Maritime Coastal (24)	Upper Little Sackville River	12	0	0	10
Maritime Coastal (24)	Napan River	35	0	0	450
Newfoundland and Labrador (25)	Waterford River	54	0	0	42

Note: The number in parentheses beside the drainage region name represents the identifier number of the drainage region. The Federal Environmental Quality Guideline in surface water for Bisphenol A is 3 500 nanograms per litre. Samples with BPA concentrations above the guideline are defined as an exceedance. See Figure 3 for the drainage region map. Measurements were made in 1 931 surface water samples collected in 51 sites from 10 drainage regions between 2008 and 2018.

Source: Environment and Climate Change Canada (2019) Chemicals Management Plan Monitoring and Surveillance.

Table A.2. Data for Figure 2. Location of sampling stations with and without at least 1 sample exceeding the sediment guideline for BPA by drainage regions, Canada, 2011 to 2018

Drainage region	Sampling site	Number of samples	BPA exceedances (number of samples)	BPA exceedances (percentage)	Highest BPA concentration [A] (nanograms per gram of dry weight)
Pacific Coastal (1)	Frederick Lake	1	0	0	Below the detection limit

Drainage region	Sampling site	Number of samples	BPA exceedances (number of samples)	BPA exceedances (percentage)	Highest BPA concentration [A] (nanograms per gram of dry weight)
Pacific Coastal (1)	Serpentine River	1	0	0	Below the detection limit
Fraser-Lower Mainland (2)	Still Creek	3	1	33.3	26
Okanagan-Similkameen (3)	Mill Creek	2	0	0	4
Okanagan-Similkameen (3)	Osoyoos Lake	1	0	0	Below the detection limit
Columbia (4)	Beaver Creek	1	0	0	6
Great Lakes (19)	Lake Superior	31	0	0	8
Great Lakes (19)	St. Mary River	4	0	0	Below the detection limit
Great Lakes (19)	Lake Huron	6	0	0	Below the detection limit
Great Lakes (19)	St. Clair River	15	0	0	5
Great Lakes (19)	Lake St. Clair	9	0	0	Below the detection limit
Great Lakes (19)	Detroit River	15	0	0	8
Great Lakes (19)	Lake Erie	45	0	0	1
Great Lakes (19)	Lake Ontario	4	0	0	3
Great Lakes (19)	Hamilton Harbour	5	0	0	19
Great Lakes (19)	Toronto Harbour	5	0	0	7
St. Lawrence (21)	Lake Saint-Louis	21	0	0	6
St. Lawrence (21)	St. Lawrence River	16	0	0	7
St. Lawrence (21)	Lake Saint-Pierre	69	1	1.4	42
Saint John-St. Croix (23)	Grand Lake	1	0	0	Below the detection limit
Saint John-St. Croix (23)	St. John River	4	0	0	11
Maritime Coastal (24)	Lake Morris	1	0	0	Below the detection limit
Maritime Coastal (24)	Bissett Lake	1	0	0	2
Maritime Coastal (24)	Banook Lake	2	0	0	6
Maritime Coastal (24)	Lake William	1	0	0	Below the detection limit
Maritime Coastal (24)	Fales River	1	0	0	4
Maritime Coastal (24)	Zekes Brook	1	0	0	10
Maritime Coastal (24)	Cornwallis River	1	0	0	Below the detection limit

Drainage region	Sampling site	Number of samples	BPA exceedances (number of samples)	BPA exceedances (percentage)	Highest BPA concentration [A] (nanograms per gram of dry weight)
Maritime Coastal (24)	Petitcodiac	1	0	0	Below the detection limit
Maritime Coastal (24)	Napan River	2	0	0	Below the detection limit
Newfoundland-Labrador (25)	Waterford River	2	1	50	48

Note: [A] Values normalized to 1% total organic carbon. The number in parentheses beside the drainage region name represents the identifier number of the drainage region. The Federal Environmental Quality Guideline in sediment for Bisphenol A is 25 nanograms per gram (ng/g) of dry weight. Samples with BPA concentrations above the guideline are defined as an exceedance. See Figure 3 for the drainage region map. Measurements were made in 272 surface sediment samples collected in 31 sites from 9 drainage regions between 2011 and 2018.
Source: Environment and Climate Change Canada (2019) Chemicals Management Plan Monitoring and Surveillance.

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