January 24, 2022

DELIVERED VIA EMAIL

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Re: Guidelines for Canadian Recreational Water Quality: Indicators of Fecal Contamination

Thank you for the opportunity to provide comments on the draft *Guidelines for Canadian Recreational Water Quality: Indicators of Fecal Contamination* ("*Draft Guidelines*"). Impaired recreational water quality is a significant public health and environmental issue across the country. The Canadian Environmental Law Association and Swim Drink Fish Canada support a scientific, risk-assessment standard for fecal contamination and a renewed focus on identifying and addressing the sources of pollution of our waterways.

We recommend revising the *Draft Guidelines* to avoid leaving significant discretion to public health authorities to determine what steps to take after the new Beach Action Value is exceeded. We would also support a stronger recommendation that only monitoring techniques that provide timely results be used.

A. Background on Canadian Environmental Law Association and Swim Drink Fish Canada

The Canadian Environmental Law Association ("CELA") is a specialty legal aid clinic that works toward protecting public health and the environment by seeking justice for those harmed by pollution or poor decision-making and by changing policies to prevent problems in the first place. Our primary focus is on assisting and empowering low-income people and disadvantaged communities. Since 1970, CELA has used legal tools, conducted public legal education, undertaken ground-breaking research, and advocated for increased environmental protection and to safeguard communities.

Swim Drink Fish Canada ("SDF") is a Canadian charity focused on building a movement of people working for swimmable, drinkable, fishable water for everyone.

B. Analysis of New Guidelines for Recreational Water Quality

(i) Background on Bacteriological Contamination at Beaches

CELA and SDF have long raised concerns about the significant public health issue across the country caused by chronic bacteriological contamination at Canadian beaches. The health impacts of

contamination at public beaches are significant. Every year, an estimated 3.5 million Americans and 400,000 Canadians get sick from swimming in contaminated water.[1] The risk to health is elevated for children because they are more likely to ingest water, play in areas with the highest contamination, and spend extended time in the water.[2] Other vulnerable members of the population include those with a compromised immune system, the elderly, pregnant women, and tourists.[3]

Recreational water illnesses may occur whenever you come into contact with contaminated water. Enteric illness is the most frequent outcome of recreating in contaminated water. There are also rare, but serious, outcomes that may result from contact with heavily polluted waters including typhoid fever, hepatitis, gastroenteritis, and dysentery.[4]

In Ontario, SDF identified that 15-20% of public beaches have chronic bacterial contamination issues.[5] The *Action Plan to Protect the Great Lakes and St. Lawrence 2020-2030* ("*Action Plan*") report similarly identified that up to 20% of all beaches in the Great Lakes region post a public health advisory repeatedly during the swimming season, including because of untreated wastewater following heavy rainfall.[6]

There are significant economic gains that would result from addressing recreational water quality contamination. In Ontario, the *Action Plan* found that the benefits of improved beach and shoreline quality would include avoidance of the costs of beach closures in the range of $96 million to $162 million per year.[7]

The Great Lakes and St. Lawrence Collaborative identified three key recommendations to improve monitoring of recreational waters:

1. Adopt a risk-based, science-based approach to beach management that would target beaches with chronic bacteriological contamination issues and require action by beach owners to track and address the persistent sources of bacteriological contamination, with funding support;

2. Both the Governments of Canada and Ontario need to modernize their guidelines on the use of new techniques and technologies that allow for more time-sensitive monitoring, assessment and reporting of beach quality.

3. Ontario would create a centralized portal to communicate beach quality information, making beach quality categorization, testing and survey results easily accessible to the public.[8]

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[1] Swim Drink Fish, "5 Things to Know About Recreational Water Illness", March 29, 2021. ("5 Things to Know") <https://www.theswimguide.org/2021/03/29/5-things-to-know-about-recreational-water-illness/>
[2] Swim Drink Fish Canada, *Canada Beach Report 2017, First Edition,* ("Beach Report"), p 14. Attached as **Appendix A.**
[3] *Beach Report,* p. 14
[4] "5 Things to Know"
[5] The Great Lakes and St. Lawrence Collaborative, *Protecting the Great Lakes and St. Lawrence: Part 1 Great Lakes Action Plan 2030,* June 2019, p. 34. ("*Protecting the Great Lakes*"). Attached as **Appendix B**.
[6] The Great Lakes and St. Lawrence Collaborative, *Action Plan to Protect the Great Lakes and St. Lawrence 2020-2030,* Implementing Innovations in Science and Technology, June 2020, s. 2.2, p. 10. ("*Action Plan"*). Attached as **Appendix C.**
[7] *Action Plan,* p. 31
[8] *Action Plan,* p. 25; *Protecting the Great Lakes,* p. 4

We support the renewed focus in the *Draft Guidelines* on identifying the sources of contamination. However, for the reasons outlined below, the *Draft Guidelines* should be improved to ensure there is consistency in how the minimum recreational water quality standard is applied across the country, and that monitoring is only done using technologies that will provide timely results.

(ii) The Beach Action Value Approach to Minimum Water Quality Standards

Recreational water quality standards are the minimum protective standard water must meet to be considered acceptable for human contact. The goal is to protect people from getting sick from fecal pollution and other contaminants in the water. The minimum standard is determined based on a risk factor and assumes some people will still get sick from recreational water use. It is important to pair minimum water quality standards with immediate action to address contamination in our waterways.

The *Draft Guidelines* contemplate a minimum standard which would be equivalent to 36 people becoming sick per 1000 exposed people.[9] CELA and SDF recognize that it is difficult to compare the proposed standard to the previous standard based on an evolving definition of gastrointestinal illness. We note that the current approach calculated the guideline values based on a seasonal gastrointestinal illness rate of approximately 1-2%, or 10-20 illnesses per 1000 swimmers.[10] CELA and SDF encourage Health Canada to ensure that current risk levels are maintained by the new standard, and urge Health Canada to adopt a standard equivalent to the Ontario Provincial Water Quality Objective ("PWQO") of 100 cfu/ 100 ml (geometric mean from at least 5 samples).[11]

The overall approach to measuring E.coli contamination has been significantly revised in the *Draft Guidelines*. It focuses on single sample Beach Action Values, as opposed to geometric means calculated by taking several samples at the same beach, with a single sample maximum.

The Beach Action Value guideline is 235 cfu/ 100 ml, which corresponds to a geometric mean of 126 cfu/ 100 ml.[12] This guideline is ostensibly more stringent than the previous Canadian guideline, which recommended a geometric mean from a minimum of five samples of 200 cfu/ 100 mL and a single sample maximum guideline of 400 cfu/ 100 ml. It is not more stringent than the PWQO standard of a geometric mean of 100 cfu/ 100 ml.

We are also concerned about the recommendation to use only one sample for the Beach Action Value, as this will provide a less fulsome picture of water quality.

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[9] Health Canada, Draft Guidelines for Canadian Recreational Water Quality: Indicators of Fecal Contamination, ("*Draft Guidelines*"), pp. 14, 18

[10] Health Canada, *Guidelines for Recreational Water Quality: Third Edition,* 2012, p. 27. <https://www.canada.ca/content/dam/canada/health-canada/migration/healthy-canadians/publications/healthy-living-vie-saine/water-recreational-recreative-eau/alt/pdf/water-recreational-recreative-eau-eng.pdf>

[11] Ministry of Environment and Energy, Water Management: Policies, Guidelines, Provincial Water Quality Objectives, Table 2 – Table of PWQOs and Interim PWQOs. < https://www.ontario.ca/page/water-management-policies-guidelines-provincial-water-quality-objectives#section-2>

[12] *Draft Guidelines*, pp. 3, 18

CELA and SDF support a consistent standard for action across the country. Currently, consistency between provinces and territories, and even between watersheds in the same province or territory, is lacking.[13] We are concerned that the new monitoring approach would exacerbate these inconsistencies because they allow individual public health units to decide what actions to take if the Beach Action Value level is exceeded. The Guideline suggests that the Beach Action Value is not to be used as a maximum threshold or "never to exceed" value, unlike the previous single sample maximum.[14]

(iii) Timeliness of Results

CELA and SDF supports the *Draft Guidelines* recommendation to use quantitative and digital PCR-based monitoring methods, which may provide same-day results.[15] The Great Lakes and St. Lawrence Collaborative identified the timeliness of beach monitoring results as a significant concern. For instance, in Ontario, beach monitoring results are not reported in a timely manner. Public Health Ontario's 'Public Beach Water guidance on test methods for E. coli' requires and pays for membrane filtration testing as per the Ontario Ministry of Environment's drinking water testing methods E3371. The results take 24-48 hours, resulting in information being posted at beaches which often no longer reflects the quality of the water. It is critical that only more timely sampling methodologies are used.[16]

Other technologies which would provide more timely results should also be supported in the *Draft Guidelines.* The Great Lakes and St. Lawrence Collaborative's recommendation was to allow for other testing approaches, including in-house testing of samples by public health units. Approval should be granted for any methods that have received US Environmental Protection Agency approval or a method which is reasonably validated by CSA or NSF.[17] The *Draft Guidelines* should be strengthened to recommend only testing methodologies which would provide timely results.

(iv) Sources of Contamination

We support the increased focus on identifying the sources of contamination in recreational waters, and urge mandatory follow up by beach owners to ensure that the sources of contamination are remediated, with funding support from the Government of Canada. This recommendation reflects the Great Lakes and St. Lawrence Collaborative recommendation to track the sources of contamination in beaches deemed impaired or which have chronic contamination issues, and to subsequently take action to address the sources of contamination.[18] The problem is significant; action to address impaired beaches would affect approximately 120 beaches in Ontario.[19]

Bacteriological contamination at beaches may be caused by different sources, including sewage, waterfowl feces, leaking septic tanks, domestic animals, and urban and agricultural run-off. All sources

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[13] *Beach Report,* pp. 10-11
[14] *Draft Guidelines,* p. 18
[15] *Draft Guidelines,* pp. 4, 18
[16] *Protecting the Great Lakes,* pp. 34, 39
[17] *Protecting the Great Lakes,* p. 39
[18] *Action Plan,* p. 11
[19] *Protecting the Great Lakes,* p. 34

of contamination should be tracked and assessed. Untreated sewage should be top priority because of its high concentration of pathogens and link to serious health effects.[20]

CELA and SDF are concerned that the *Draft Guidelines* also allow public health authorities to make individual decisions about posting advisories based on the sources of contamination. This is most worrisome when the sources of contamination cannot be identified. This recommendation raises serious concerns about inconsistency across the country and inappropriate uses of discretion.[21]

(v) Secondary Contact Standards

The overarching goal of strong recreational water quality guidelines is to protect public health. Along with the guidelines recommended for beaches with swimming, public health may be impacted by secondary uses like boating and fishing.[22] In particular, where the source of contamination is determined and fecal contamination is found in a waterway, both primary and secondary contact activities should be restricted. We recommend clear, consistent standards with triggers for action to address potential illness from secondary uses of recreational waters.[23]

Thank you for the opportunity to comment on the *Draft Guidelines.* We would be pleased to discuss these submissions further.

Yours sincerely,

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Swim Drink Fish Canada

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[20] *Protecting the Great Lakes,* p. 34
[21] *Draft Guidelines,* pp. 4-5
[22] "5 Things to Know"
[23] *Draft Guidelines,* p 22-23

SWIM Guide

Canada Beach Report 2017

First Edition

Swim Drink Fish Canada

Published by Swim Drink Fish Canada.

Swim Drink Fish Canada is a Canadian charity, founded in 2001 under the name “Lake Ontario Waterkeeper”. The organization represents a network for 1.5-million people working for swimmable, drinkable, fishable water. Swim Drink Fish Canada’s mission is to create a nation of water leaders, people who are connected to their waterbodies, connected to each other, and active in community life. By protecting water, we believe we can protect the things that are most important in life: family, culture, health, and prosperity.

Swim Guide is a beach information service created by Swim Drink Fish Canada. Swim Guide started on Lake Ontario and has since expanded to describe beach information, water quality history, and water quality monitoring practices in every province in Canada. Since 2011, “Swim Guide” beach information website and app have been the most comprehensive beach water quality service in Canada.
With over 1 million all-time users, Swim Guide offers water quality alerts, beach descriptions, photos, and directions for 7,000 beaches in Canada, the U.S.A., as well as Baja Mexico, and New Zealand. In 2017 Swim Guide launched in the Bahamas. Swim Guide is available in English, French. The Swim Guide iOS app is available in English, French, and Spanish.

The Canada Beach Report is available on Swim Guide at the following address:
http://www.theswimguide.org/

This publication can be made available on request in a variety of alternative formats.

For further information or to obtain additional copies or a hard copy, please contact:

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Acronyms and Abbreviations

Acute febrile respiratory illness	AFRI
Alberta Health Services	AHS
American National Technical Advisory Committee's	NTAC
Canada-Newfoundland and Labrador Water Quality Monitoring Agreement	WQMA
Canadian Environmental Assessment Act	CEAA
Centres for Disease Control and Prevention	CDC
Combined sewer overflow	CSO
Department of Environment and Local Government	DELG
Environmental Health Officer	EHO
Environmental Protection Agency	EPA
Federal-Provincial-Territorial Working Group on Recreational Water Quality	FPT Working Group / Working Group
First Nations and Inuit Health Branch	FNIHB
First Nations Health Authority	FNHA
Gastrointestinal Illnesses	GI
Guidelines for Canadian Recreational Water Quality	Guidelines
Halifax Regional Municipality	HRM
Health Protection and Promotion Act	HPPA
Institut National de Santé Publique du Québec	INSPQ
Ministry of the Environment and Climate Change	MOECC
Ministry of Health and Social Services / Ministère de la Santé et des services sociaux	MSSS
Ministry of Natural Resources	MNR
New Brunswick Department of Environment and Local Government	DELG
Nova Scotia Lifeguard Society	NSLS
Ontario Public Health Standards	OPHS
Provincial Water Quality Objectives	PWQO

The Ministry of Sustainable Development, Environment, and Action Against Climate Change / Ministère du développement durable, de l'environnement, et de la lutte contre les changements climatiques	MDDELCC
World Health Organization	WHO

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Thank you.

Executive Summary

> *Canadians everywhere understand the importance of clean, safe recreational bathing waters. Whether they are used for sport or relaxation, health or pleasure, there is something about the enjoyment and sense of well-being derived from the experience that cannot easily be matched.*[1]

The Canada Beach Report is the first report of its kind. It provides Swim Guide, and others in our field, with an understanding of the landscape of beach water quality rules, monitoring practices, and reporting across Canada.

The Canada Beach Report will answer these questions for Canadians: Does recreational water quality information exist for the beaches where I swim? Is this information reliable? Is it easily accessible? Is my water swimmable? Is there sufficient information and effective communication about the quality of the water to allow me to protect myself from contact with contaminated recreational water?

We believe 100% of Canadian households should have access to basic data about the swimmability of their watersheds. Access to clean, swimmable beaches and the exercise, enjoyment, and relaxation these recreational water environments provide is integral to health, well–being, and the quality of life people in Canada value.

People living in Canada have an undeniable connection to water. Bordered by three oceans and dotted with tens of thousands of lakes, rivers, and streams, some of the most unique and beautiful coastal and inland beaches on the planet are found here.

Water is part of us and has made us who we are. Water is our heritage, our culture. Canadians overwhelmingly value fresh water as our most precious resource.[2] Over half of Canadians feel very strongly that water is part of our national identity, according to the 2017 Royal Bank of Canada Canadian Water Attitudes Study.[3] Canada has more coastline than any other country in the world.

People are increasingly engaging in recreational water activities, more frequently, and for longer

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[1] Canada, "Environmental & Workplace Health, Water Quality: Recreational Water," Health Canada, http://www.hc-sc.gc.ca/ewh-semt/water-eau/recreat/index-eng.php (accessed 30 May 2017).

[2] Royal Bank of Canada, *2017 RBC Canadian Water Attitudes Study*. RBC Community & Sustainability, Toronto, March 2017, Accessed 9 April 2017. 4.

[3] Royal Bank of Canada, *2017 RBC Canadian Water Attitudes Study*. RBC Community & Sustainability, Toronto, March 2017, Accessed 9 April 2017. 4. http://www.rbc.com/community-sustainability/_assets-custom/pdf/CWAS-2017-report.pdf.

periods of time.[4] More and more people are enjoying the country's waterways year round, outside of Canada's short summer months.

Along with the substantial benefits of Canada's rich water resources come potential health hazards. Various sources of contamination expose recreational water users to waterborne pathogens and recreational water illnesses. In Canada, sewage and stormwater are the leading contributors to water pollution.[5] Over 200 billion litres of untreated sewage are dumped in our waterways every year.[6] Sources of sewage pollution include sewage discharges from waste treatment plants, combined sewer overflows (CSOs), septic malfunctions, and stormwater.

With climate change, health risks are on the rise for recreational water users; increased precipitation, stormwater outflow, and runoff lead to increased concentrations of contaminants and pathogens in surface water. Drought can have the same effect, concentrating contaminants and pathogens. From a recreational water user's perspective, effective and frequent water quality monitoring and public notification of water contamination and test results are more important than ever.

Beach water quality assessment and monitoring practices differ widely across the country. Communication There are no federal standards for recreational water quality. Rather, Health Canada recommends guidelines for the management of recreational water. Recreational water management falls to the jurisdiction of provinces and territories.

Recreational water quality standards vary across provinces and territories, and even within provinces and territories, according to the practices of the monitoring agencies assigned. While many provinces use a variation of the federal guidelines as their standards, some provinces do not have regular monitoring or sampling programs for recreational water quality. Within certain provinces, different agencies use different monitoring guidelines and practices—even in the same watershed. Vast areas of certain provinces are completely unmonitored for recreational water

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[4] Kathy Pond, *Water recreation and disease. Plausibility of Associated Infections: Acute Effects, Sequelae and Mortality* (Geneva, World Health Organization, 2005), viii.

[5] Municipal wastewater is one of the largest sources of pollution, by volume, to surface water in Canada. Treated wastewater may contain grit, debris, disease-causing bacteria, biological wastes, nutrients, and chemicals with the potential to damage human and environmental health. The higher the level of treatment provided by a wastewater management system, the cleaner the effluent and the less the impact on the environment. Canada. "Data Sources and Methods for the Municipal Wastewater Treatment Indicators," Environment & Climate Change Canada, http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=48190375-1&offset=2&toc=show (accessed February 2017).

[6] Elizabeth Tompson, "Billions of litres of raw sewage, untreated waste water pouring into Canadian waterways." *CBC*, December 23 2016, (Accessed January 2017), http://www.cbc.ca/news/politics/sewage-pollution-wastewater-cities-1.3889072

quality.

The Canada Beach Report focuses exclusively on monitoring of Canada's natural, untreated water bodies; marine beaches, lakes, and rivers. This report provides a comparison of different recreational water quality monitoring programs and practices across Canada, province by province, territory by territory. Recreational water monitoring and management on indigenous reserves is also explored. The report also presents the number of beaches monitored in each province and territory and the provincial or local recreational water monitoring bodies, their programs, and the monitoring frequencies within each jurisdiction. The report identifies the standards or guidelines used in the province, water quality indicators, and method of calculation used to determine whether beach water quality is suitable for recreational use. Finally—and with particular relevance to public health—the report discusses when and how swimming advisories are issued and communicated to the public.

Key Findings

- All provinces monitor recreational water. However, only 6 of the 10 provinces have established recreational water quality monitoring guidelines: British Columbia, Alberta, Manitoba, Ontario, Québec, and Nova Scotia.
- Saskatchewan and New Brunswick are currently developing protocols for recreational water quality monitoring.
- Recreational water quality guidelines are not established in the Territories.
- Existing monitoring programs only cover a fraction of the marine beaches, lakes, and rivers where Canadians and visitors swim. Most Canadians swim at unmonitored or under-monitored locations.
- Recreational waters are monitored on-reserve in Canada.
- Every province with the exception of Newfoundland and Labrador monitor cyanobacteria (Blue-Green Algae) and cyanotoxins. Monitoring of cyanobacteria is increasing in frequency, and monitoring practices are become more standardized.
- Monitoring recreational water quality at marine, lake, and river beaches is not uniform across the country. Nor are monitoring practices, including reporting of test results to the public, uniform across municipalities within provinces and territories.
- Factors influencing recreational water quality monitoring practices include geography, climate, funding, as well as local priorities.
- Most provinces and territories do not issues rain advisories to recreational water users to help them avoid contact with contaminated water.
- With few exceptions, provinces and territories do not notify the public in the event of a sewage

bypass that could increase contamination a recreational water location.

- With few exceptions, provinces and territories do not notify the public when combined sewers overflow, contaminating recreational waters and increasing the risk of illness.

Recreational Water Illnesses in Canada

The impact of poor water quality and the importance of recreational water quality monitoring of natural bodies of water

> *Recreational waters can be considered as any natural fresh, marine or estuarine bodies of water where a significant number of people use the water for recreation.*[7]

Most cases of reported recreational water illnesses are contracted from treated water, such as swimming pools, water parks, and water play areas.[8] The Centres for Disease Control (CDC) found outbreaks at untreated, natural swimming locations accounted for approximately 23% of total recreational water outbreaks.[9] The CDC reports that recreational water illnesses and outbreaks are under reported due to barriers in detection, investigation, and reporting. Further, the CDC found that "variation in public health capacity and reporting requirements across jurisdictions, those reporting outbreaks most frequently might not be those in which outbreaks most frequently occur."

There are three primary types of hazards that may be present when residents and visitors engage in recreational water activities in Canada's natural, untreated water bodies: microbiological, chemical, and physical.

Harmful microorganisms or germs (bacteria, viruses, fungi, and protozoa) cause recreational water illnesses in untreated water (marine and freshwater beaches, lakes, rivers, and swimming holes). Sewage and polluted stormwater runoff are the main sources of water contamination that put the health of recreational water users at risk.

Swimming in contaminated water can lead to a number of illnesses and infections. Enteric illness

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[7] Health Canada, *Guidelines for Canadian Recreational Water Quality, Third Edition*, (Ottawa, Health Canada, 2012), 14.

[8] Centers for Disease Control, "Recreational Water Illnesses." http://www.cdc.gov/healthywater/swimming/swimmers/rwi.html (accessed January 2017).; Michele C. Hlavsa; Virginia A. Roberts; Amy M. Kahler, Elizabeth D. Hilborn, Taryn R. Mecher, Michael J. Beach, Timothy J. Wade, Jonathan S. Yoder, Centers for Disease Control, *Outbreaks of Illness Associated with Recreational Water — United States, 2011–2012,* June 26, 2015 / 64(24);668-672 https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6424a4.htm?s_cid=mm6424a4_w.

[9] Centres for Disease Control, Outbreaks of Illness Associated with Recreational Water.

(intestinal), diarrhea, and vomiting are the most frequent adverse health outcomes from contact with contaminated water.[10] Acute febrile respiratory illness (AFRI) along with skin rashes, eye and ear infections, and respiratory problems are also common recreational water illnesses. More serious diseases, such as human adenovirus, are also possible health outcomes from contact with contaminated water. Though less frequent, there is evidence that recreational water users can contract serious and potentially fatal diseases.11 Waterborne pathogens can cause acute illnesses in swimmers and other recreational water users, including Campylobacter spp., Cryptosporidium parvum, *E. coli* O157, HAV, Leptospira icterohaemorrhagiae, Salmonella typhi, and Shigella spp. The World Health Organization's (WHO), outlines life-threatening diseases recreational water can contract:

> Bacteria may cause life-threatening diseases such as typhoid, cholera and leptospirosis. Viruses can cause serious diseases such as aseptic meningitis, encephalitis, poliomyelitis, hepatitis, myocarditis and diabetes. Protozoa may cause primary amoebic meningoencephalitis (PAM) and schistosomiasis is caused by a flatworm (trematode).[12]

Further, sequelae, which are after-effects or conditions caused by a previous disease or condition, can also result from recreational water illnesses.

Recreational water illnesses are most commonly contracted by swallowing water—the faecal-oral route. Diseases can also be contracted by inhaling spray from, and physical contact with contaminated water.[13]

One of the first significant studies on the correlation between recreational water quality and illness among swimmers in Canada was a study conducted over the summer of 1980 at 10 Ontario beaches.[14]

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[10] United States Environmental Protection Agency, *Recreational Water Quality Criteria*, (Office of Water, 2012), 50; Health Canada, *Guidelines, Third Edition,* 38; Centers for Disease Control & Prevention, "Recreational Water Illnesses."

[11] Pond, *Water Recreation and Disease,* xvii.

[12] Pond, Water Recreation and Disease, 3.

[13] Centers for Disease Control, "Recreational Water Illnesses."; Michele C. Hlavsa; Virginia A. Roberts; Amy M. Kahler, Elizabeth D. Hilborn, Taryn R. Mecher, Michael J. Beach, Timothy J. Wade, Jonathan S. Yoder, Centers for Disease Control, *Outbreaks of Illness Associated with Recreational Water — United States, 2011–2012,* June 26, 2015 / 64(24);668-672 https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6424a4.htm?s_cid=mm6424a4_w

[14] P.L. Seyfried, Tobin RS, Brown NE, Ness PF, "A prospective study of swimming-related illness.I. Swimming-associated health risk," *American Journal of Public Health*. 75(9) (1985):1068-1070.

The results obtained from the water quality assessments of the beaches, and interviews with over 6,000 beach goers, indicated that "the overall crude symptom rates for swimmers were significantly higher than for nonswimmers, possibly due to the swimmer being exposed to the microflora in the water."[15]

Dr. Margaret Sanborn and Dr. Tim Takaro (2013) wrote one of the most important studies on recreational water related illnesses in Canada.[16]

Their study found that, on average, swimmers have a 3% to 8% chance of becoming ill after water contact.[17] Children are at higher risk of gastrointestinal illness from swimming as they are much more likely to ingest water, play in the areas with the highest concentration of contamination (sand and nearshore), and spend extended time in the water. Athletes participating in sports with significant and prolonged contact with the water, such as surfing, open water swimming, and kitesurfing, are also at higher risk. Even secondary contact activities like boating and fishing increase recreational water users' risk of acute gastrointestinal illness by 40% to 50% compared to non-water activities.[18]

Most significantly, Sanborn and Tamako found that, "The greatest risk of bacterial, protozoal, and viral gastroenteritis [among children] during the swimming season is likely not from exposure through food consumption, drinking water, or at day care, but rather from exposure to recreational water."[19]

Other vulnerable members of the population include those with a compromised immune system, the elderly, pregnant women, and tourists.

Outbreaks of waterborne diseases related to recreational water use occur most frequently during the summer months when people are more likely to be swimming or in direct contact with recreational water. The incidence of recreational water illnesses is forecasted to increase with climate change (higher temperatures and severe weather events). This is due to a number of factors: longer swimming seasons and increased recreational activity, more favourable conditions for pathogens in water, and increased volumes of sewage and other contamination caused by wet

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[15] Seyfried et al., "A prospective study of swimming-related illness," 1070.

[16] Margaret Sanborn and Tim Takaro, "Recreational water-related illness: Office management and prevention," *Canadian Family Physician,* 59(5) (May 2013): 491-495. Accessed October 2016. http://www.cfp.ca/content/59/5/491.full

[17] Sanborn and Tamako, "Recreational water-related illness,"491.

[18] Ibid.,491.

[19] Ibid., 492.

weather events.[20] Studies show that over the last 50 years, over 50% of waterborne disease outbreaks in the U.S. were associated with heavy rain events.[21] In the Great Lakes this number is even higher, at 66%.[22]

Municipal wastewater effluents are the largest single effluent discharges, by volume, in the country.[23] Canada releases over 200 billion litres of raw sewage and untreated wastewater into the country's waterways every year.[24] About 30% of Canadian communities have inefficient wastewater treatment, according to Environment and Climate Change Canada's last national survey.[25] The latest survey from 2009 indicated that 3% of Canadians receive no treatment for their sewage, 16% receive only primary treatment, and 13% were on septic or haulage systems.[26]

The impact of sewage on fresh, marine, and estuarine recreational waters across the country is significant.

In addition to pathogens, sewage and stormwater put recreational water users at risk from contact with chemicals, heavy metals, and biocides, pharmaceuticals, and other contaminants that are washed or dumped into the water.

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[20] Ibid., 492; Natural Resource Defense Council, Rising Tide of Illness: How Global Warming Could Increase the Threat of Waterborne Diseases. Natural Resource Defense Council, Washington, D.C., July 2010. Accessed September 2016. https://www.nrdc.org/sites/default/files/GWillness4pgr_08.pdf.

[21] Ibid.,2.

[22] Krystyn Tully, "Global Sustainable Cities: Water, Floods, Extreme Weather Presentation." Lake Ontario Waterkeeper Blog, June 21, 2016, http://www.waterkeeper.ca/blog/2016/6/20/global-sustainable-cities-presentation-water-floods-extreme-weather

[23] Canada. Environment and Climate Change Canada. Water Pollution. Wastewater. Wastewater Pollution. https://www.ec.gc.ca/eu-ww/default.asp?lang=En&n=6296BDB0-1, (accessed April 2017)

[24] Tompson, "Billions of litres of raw sewage."

[25] Canada, "2011 Municipal Water Use Report- Municipal Water Use 2009 Statistics" Environement Canada, 2011. https://ec.gc.ca/Publications/B77CE4D0-80D4-4FEB-AFFA-0201BE6FB37B/2011-Municipal-Water-Use-Report-2009-Stats_Eng.pdf ; Canada. "Municipal Wastewater Treatment Indicator," Environment & Climate Change Canada, http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=2647AF7D-1 (accessed April 2017).

[26] Canada. "Environmental Indicators, Municipal Wastewater Treatment Indicator," Environment & Climate Change Canada,http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=2647AF7D-1 (accessed April 2017).

Fast Facts About Canadians and their Recreational Waters

- Swimming is the most-mentioned activity that Canadians like to do that involves water, followed by spending time on the beach and fishing. Nearly two-thirds of Canadians swim in lakes or rivers at least once per year. [27]
- In Canada, sewage and stormwater are the leading contributors to water pollution.[28] Human sources account for most recreational water illnesses.[29]
- Swimmers have a 3% to 8% chance of becoming ill after swimming.[30]
- Swimming is a substantial source of illness, especially in children, the elderly, and people with compromised immune systems.
- The risk of illness increases in more contaminated water.[31]
- Two-thirds of Canadians express concern about the quality of the water in rivers and lakes used for swimming.[32]
- Four in ten people in Québec, the Prairies, and Atlantic Canada do not swim in lakes and rivers. In Alberta it is 5 in 10.[33]
- Each summer, 6.5 million people visit Ontario beaches. Ontarians account for 89% of visits to the province's 300 beaches.[34] In other words, nearly half of Ontarians visit a beach each summer.[35]
- When people visit beaches, locals and visitors stimulate the local economy by spending on average $170 per person. In 2014, there were 139.5 million visits in Ontario and visitors spent

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[27] Royal Bank of Canada, 2016 RBC Canadian Water Attitudes Study, 6.

[28] Canada. "Data Sources and Methods for the Municipal Wastewater Treatment Indicators."

[29] Sanborn and Tamako, "Recreational water-related illness," 492.

[30] Ibid, 491.

[31] Ibid.

[32] Royal Bank of Canada, 2016, 6

[33] Ibid., 77-78

[34] Ontario Ministry of Tourism, Culture, and Sport, Tourism Research Unit, *Ontario Beach Tourism Statistics 2014*, Toronto, 3, Accessed March 2017. http://rto7.ca/Documents/Public/Reports-Ministry-of-Tourism-Culture-and-Sport/Ontario-Beach-Tourism-2014

[35] 5,785,000-million visits (89% of 6.5 million people) averaged over Ontario's current population of 13.6 million people.

$23.9 billion.[36]

[36] Ontario Ministry of Tourism, Culture, and Sport, Tourism Research Unit, Ontario Beach Tourism Statistics 2014, Toronto, Winter 2017, Accessed March 2017. http://rto7.ca/Documents/Public/Reports-Ministry-of-Tourism-Culture-and-Sport/Ontario-Beach-Tourism-2014.

Understanding Recreational Water Quality Monitoring in Canada: Federal Guidelines and Provincial and Territorial Jurisdiction

Health Canada's *Guidelines for Canadian Recreational Water Quality* were established in 1983 with the primary goal of protecting public health and safety. The 1983 Guidelines were based on the American National Technical Advisory Committee's (NTAC) recommendations to the Federal Water Pollution Control Administration on bacterial indicators of sewage contamination in recreational water from the 1960s. The NTAC recommended that a maximum of 200 faecal coliforms per 100 mL was the human health standard for recreational waters.[37] The *Guidelines* have been revised twice: in 1992 and, most recently, in 2012.

The *Guidelines for Canadian Recreational Water Quality* are prepared by the Federal-Provincial-Territorial (FPT) Working Group on Recreational Water Quality, established by the Federal-Provincial-Territorial Committee on Health and the Environment. The FPT Working Group on Recreational Water Quality was established in 1988, mandated to revise the 1983 Guidelines.[38] In preparing the Guidelines the Working Group worked together "to review and evaluate current scientific information on recreational water quality and develop up-to-date guidance."[39] Most recently the Working Group prepared the Third Edition (2012) of the Guidelines.

The provincial members of the FPT Working Group on Recreational Water Quality included representatives from 8 of the ten provinces. Federal members include Environment Canada and the US Environmental Protection Agency. Health Canada is the Secretariat of the Guidelines. There are no members, corresponding members, or invited members from Canada's territories in the Working Group. There are also no members, corresponding members, or invited members specifically representing recreational water quality monitoring on indigenous reserves.

Comparable to other national and international approaches, the Guidelines developed by the FPT Working Group provide a framework for provincial and local bodies responsible for the management of recreational waters.

Of note, these federal guidelines are just that: guidelines. The Guidelines are not legally enforceable standards. The health programs and services related to recreational water are only legally

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[37] Ontario Ministry of the Environment. Microorganisms in Recreational Waters: Scientific Criteria Document for Standard Development No. 1-84, Toronto, 1985, 3.

[38] Health and Welfare Canada, *Guidelines for Canadian Recreational Water Quality*, (Ottawa, Health and Welfare Canada, 1992), 5.

[39] Ibid, 8.

enforceable at the provincial and territorial level, or if adopted by a federal agency, such as the Public Health Agency of Canada. In other words, a federal agency can adopt the criteria as a "standard" and thereby make it legally enforceable. Authorities in provinces and territories can and often do share the responsibility of beach management with beach managers or local service providers, such as municipalities.

> Recreational water quality generally falls under provincial and territorial jurisdiction. Responsibility for the safe management of recreational waters can be shared between the provincial or territorial authorities and the beach managers or service providers.[40]

Health Canada's Guidelines for *Canadian Recreational Water Quality* serve a similar purpose as the U.S. Environmental Protection Agency's (EPA) Recreational Water Criteria: to set forth the best recreational water quality guidelines to protect human health, based on scientific knowledge, for provinces and territories.

In the USA, the Clean Water Act requires the EPA to develop recreational water quality criteria.

> Under §304(a)(l) of the Clean Water Act (CWA) of 1977 (P.L. 95-217) the Administrator of the EPA is directed to develop and publish water quality criteria (WQC) that accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare that might be expected from the presence of pollutants in any body of water, including groundwater.[41]

Note: In Canada, the basis for Health Canada's legislated role as a federal authority on environmental assessments (EA) of Drinking and Recreational Water Quality and Human Health Risk Assessment (HHRA) comes from the *Canadian Environmental Assessment Act, 2012 (CEAA 2012)*.[42] Health Canada provides expertise as a federal authority on Drinking and Recreational Water Quality and HHRA to responsible authorities.

Monitoring and Management of Recreational Water Quality in Indigenous Communities

We've established that provinces and territories have primary jurisdiction over recreational water

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[40] Health Canada. *Guidelines, Third Edition*, 8.

[41] United States Environmental Protection Agency, *Recreational Water Quality Criteria*, 1.

[42] Canada. "Health Canada's Participation in Environmental Assessments," Health Canada, http://healthycanadians.gc.ca/publications/department-ministere/hc-sc/environmental-assessment-evaluation-environnementale/index-eng.php (accessed December 8, 2016).

quality in Canada.

Recreational water quality monitoring in indigenous communities differs widely across the country. The federal government's role is ambivalent, as there is no regulatory body specifically working on recreational water quality in indigenous communities. Typically, management of recreational water quality and recreational water quality monitoring programs is a collaborative effort involving First Nations Chiefs and Environmental Health Officers and can include provincial and municipal health authorities.

Understanding the responsibility for recreational water quality monitoring on indigenous reserves in Canada

While provinces have a general responsibility to indigenous peoples living off reserve, under the Constitution Act of 1867 the federal government of Canada has a responsibility to indigenous people living on reserve. Indigenous communities on reserve fall under the jurisdiction of the Ministry of Indigenous and Northern Affairs. The federal government has a special responsibility for protecting the health of indigenous people living on reserve, and the health impacts of drinking and recreational water quality on the health of indigenous people is part of this federal responsibility.

Health Canada is responsible for providing health services to First Nations and Inuit people. The government of Canada established the First Nations and Inuit Health Branch (FNIHB) as a department within Health Canada. FNIHB is responsible for public health and delivering health services on reserves.

Monitoring water quality is part of FNIHB's programs and services.[43]

FNIHB's Environmental Public Health Program works in First Nations communities to "identify and prevent environmental public health risks that could adversely impact the health of community residents."[44] The Environmental Public Health Program provides services to indigenous communities south of the 60th parallel. Some indigenous communities have chosen to deliver their own health services (transferred communities), whereby the community or Tribal Council employs the Environmental Health Officer directly. (Responsibility for environmental public health programming north of the 60th parallel was transferred to territorial governments or First Nations and Inuit control as part of land claims settlements in the 1980s.)

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[43] Canada. "First Nations and Inuit Health Branch," Health Canada, http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/fnihb-dgspni/fact-fiche-eng.php (accessed January 2017).

[44] Canada, "First Nations and Inuit Health, Environmental Public Health," Health Canada, http://www.hc-sc.gc.ca/fniah-spnia/promotion/public-publique/index-eng.php (accessed January 2017).

The First Nations Environmental Public Health Program's public health assessment activities include seasonal recreational water quality monitoring in the following recreational facilities:

> Arenas, beaches, billiard halls, bingo halls, bowling alleys, campgrounds, casinos, community centres, curling rinks, golf courses, parks, playgrounds and swimming facilities. In addition, seasonal monitoring of recreational water may be provided.[45]

In certain indigenous territories in Canada, recreational waters are more at risk from significant development projects, such as oil and gas and mining. In such cases, under the *Canadian Environmental Assessment Act (CEAA), 2012*, Health Canada participates in environmental assessments as a federal authority.[46] The key objective of Health Canada's EA program is to prevent, reduce and mitigate the potential effects of any change to the environment (such as exposure to contaminants through air, water or country foods) on the health of Aboriginal peoples."[47]

The environmental effects taken into account in the CEAA, with respect to recreational water in indigenous communities, are related to development projects on federal lands. Federal lands are defined as "reserves, surrendered lands and any other lands that are set apart for the use and benefit of a band and that are subject to the Indian Act, and all waters on and airspace above those reserves or lands."[48]

Section 5 c (i) of CEAA 2012 defines federal responsibility for protecting the health of indigenous people on reserve:

> (c) with respect to aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on
>
> (i) health and socio-economic conditions,
> (ii) physical and cultural heritage,
> (iii) the current use of lands and resources for traditional purposes, or
> (iv) any structure, site or thing that is of historical, archaeological, paleontological or

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[45] Health Canada, First Nations and Inuit Health Branch, *First Nations Environmental Public Health Program*, 2008, 14, Accessed January 2017. http://www.hc-sc.gc.ca/fniah-spnia/alt_formats/fnihb-dgspni/pdf/pubs/promotion/2009_env_prog-eng.pdf.

[46] *Canadian Environmental Assessment Act*, 2012, c. 19, s. 52.

[47] Canada. "Health Canada's Participation in Environmental Assessments."

[48] *Canadian Environmental Assessment Act*, c. 19, s. 52.

architectural significance.[49]

Note that CEAA requirements and processes are only applicable for the review of significant development projects that would require federal ministry review under that Act, for example, mines, pipelines, and oil and gas extraction. Recreational water quality monitoring on indigenous reserves in this capacity is very limited. Typically, monitoring would only cover pre-development proposals. Post-development monitoring would rest with the proponent, such as the company responsible for the project.[50] "Post development monitoring would typically only be done by the proponent if specifically outlined as a condition of approval and/or during a spill/release event."[51]

Recreational water quality management and monitoring on indigenous reserves across Canada is further explored in the provinces and territories section of the report.

Canada: 2012 Guidelines for Canadian Recreational Water Quality, 3rd Edition

The stated primary purpose of the Health Canada's *Guidelines for Canadian Recreational Water Quality* is "the protection of public health and safety."[52] The Guidelines for Canadian Recreational Water were developed to guide decisions of provincial and local authorities, since recreational water quality falls generally under provincial and territorial jurisdiction.[53]

The document does not set forth legally enforceable federal recreational water quality standards and protocols. Rather, the recommendations outlined in the Guidelines are only legally enforceable "where adopted by the appropriate provincial/territorial or federal agency."[54]

The Guidelines provide a framework to help prevent illness among people in contact with water polluted with faeces.

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[49] Ibid.

[50] Linda Pillsworth, personal communication, email, December 13, 2016.

[51] Simon Sihota, personal communication, phone interview and email, February 13, 2017.

[52] Health Canada. *Guidelines, Third Edition*,3..

[53] Ibid.,9.

[54] Ibid., 15

Federal Recreational Water Quality Guidelines

Both fresh and marine water quality guidelines in Canada tolerate a gastrointestinal illness rate of 1% to 2%. In other words, the minimum protective standard recommended in Canada is: for every 1000 swimmers, 10 to 20 people will contract a gastrointestinal issue (or worse) following their swim.[55] More than that is considered unacceptable.

About 80% of Canadians live in a population centre, which is considered a community of 1000 people or more and with more than 400 people per square kilometre.[56] In Canada, recreational water quality monitoring is largely limited to official beaches and swim spots that are part of the country's small, medium, and large population centres.

One of the main reasons recreational water quality monitoring is limited to official beaches in population centres is that higher swimmer populations increase the health risks for bathers and leave more people at risk of contracting a recreational illness. These beaches are also more likely at risk of contamination from stormwater, sewage and other sources of urban and agricultural pollution generated by these population centres.

Few regions, provinces, and territories have routine water quality testing or monitoring. Although the vast majority of the population in Canada lives in areas where beaches are monitored, "most swimming in Canada occurs in unmonitored water."[57] Further, in Canada, "owing to geography and climate," a much larger percentage of the population engages in recreational water activities in freshwater rather than marine water.[58]

Parameters

Indicator Bacteria

Sewage and stormwater contain many contaminants that can make recreational water users sick, including disease-causing pathogens, pharmaceuticals, heavy metals, chemicals, and plastics. However, it is very expensive to test and difficult to analyze everything that can be found in sewage

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[55] Health Canada. Guidelines, Third Edition, 27.

[56] Canada. "From Urban Areas to Population Centres," Statistics Canada, http://www.statcan.gc.ca/eng/subjects/standard/sgc/notice/sgc-06 (December 2017).

[57] Sanborn and Tamako, "Recreational water-related illness," 491.

[58] Health Canada. Guidelines, Third Edition, 34.

and stormwater. Frequent and rapid testing is required for efficiency in identifying a problem and warning people about the risk.

The solution, worldwide, has been to test for indicator bacteria. All indicator bacteria are faecal, and they are meant to serve as surrogates to the bigger, badder contaminants found in sewage. E.coli is considered the best indicator of faecal pollution in freshwater. Intestinal *enterococci* is the best indicator of contamination in marine water. When levels of indicator bacteria are higher than the minimum protective standard, this translates to an increase in the number of people who will get sick.

The *Guidelines for Canadian Recreational Water Quality* advocate the use of both a geometric mean and a single sample limit for measuring indicator bacteria.

The use of dual limits allows recreational water operators to better evaluate the water quality both in the short term and over the duration of the swimming season. The single-sample limit will alert management to any immediate water quality issues, whereas the geometric mean limit will alert management to chronic contamination problems. This dual approach represents good monitoring practice as part of an overall commitment to a strategy of risk management for recreational waters.

The 2012 edition of the Guidelines reaffirms existing federal *E. coli* guidelines for primary contact recreation:

- 200 *E. coli* / 100 mL – geometric mean at least 5 samples
- 400 *E. coli* / 100 mL – single sample maximum

In marine recreational waters, *enterococci* is the most appropriate indicator of faecal contamination, with guidelines values as follows:

- 35 *Enterococci* / 100 mL – geometric mean at least 5 samples
- 70 *Enterococci* / 100 mL – single sample maximum

In addition, the 2012 Guidelines added new secondary contact guidelines, which should not exceed five times the value for primary contact:

- 1000 *E. coli* / 100 mL – geometric mean of at least 5 samples

The guideline values were developed “based on epidemiological evidence relating to *E. coli* concentrations in fresh recreational waters to the incidence of swimming-associated gastrointestinal illness observed among swimmers.”[59]

[59] Ibid, 27.

Health Canada has based its rationale on the US EPA's analysis of epidemiological data, determining that using guideline values for both *E. coli* and *enterococci* will correspond to a GI illness rate of 10 to 20 illnesses per 1000 swimmers - between 1% and 2%.[60] Note that the most recent EPA Recreational Water Quality Criteria values for both ***E. coli*** and *enterococci* correspond to a GI illness rate of 32 and 36 illnesses per 1000 swimmers.[61]

Cyanobacteria and toxic algae

Blue-green algae is a form of bacteria called cyanobacteria. These prehistoric bacteria grow in slow moving or still water. Blue-green algae can survive in all kinds of conditions and tolerate incredible environmental stresses.

While 30% to 50% of cyanobacteria are not harmful, there are several species of cyanobacteria that can produce toxins (known collectively as cyanotoxins) as the cells die or get eaten by other organisms. Cyanotoxins can cause all kinds of adverse health effects to humans and animals. If a person has contact with toxic algae, they can develop skin irritations and/or allergic reactions in their eyes, ears, nose, throat; ingesting the toxins, by eating contaminated fish or accidentally swallowing water while swimming, kayaking, or falling off a stand up paddle board can cause a number of side effects, including headaches, diarrhea, vomiting, fever, abdominal pain, and general malaise.

In Canada, the Guidelines include recommendations for monitoring and managing cyanobacteria. The guidelines for blue-green algae were determined to specifically protect children in contrast to other water quality limits that are designed to protect adults. Children are likely to ingest water while swimming, and they suffer more intense adverse health problems when exposed to cyanobacteria and toxic algae.[62]

The Guidelines recommend recreational water quality criteria for cyanobacteria:

- 100,000 cells of cyanobacteria /mL
- 20 µg/L total microcystin (a toxin of cyanobacteria)

Canada's cyanobacteria and toxic algae guidelines are based on the WHO's criteria; however, the EPA's new criteria is stricter. Published as a draft on 12 December 2016 under the working title Human Health Recreational Ambient Water Quality Criteria and/or Swimming Advisories for

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[60] Ibid, 27.

[61] United States Environmental Protection Agency, *Recreational Water Quality Criteria*, 43.

[62] Ibid., 83.

Microcystins and Cylindrospermopsin,[63] the recommended criteria for cyanobacterial toxins in the USA are:

- Microcystins: 4 µg/L
- Cylindrospermopsin: 8 µg/L

The new EPA cyanobacteria criteria will be finalized once public comments have been reviewed.

Canada does not have recreational water quality guidelines for cyanobacterial toxins other than microcystin. In fact, with the exception of the EPA's 2016 draft for cyanotoxins, criteria for cyanotoxins other than microcystin have not yet been developed anywhere.

Other Parameters

The Guidelines also provide considerations for other parameters such as pH, temperature, chemical hazards, and aesthetics objectives such as turbidity, clarity and colour, oil and grease, and litter. However, Health Canada has not developed guidelines and objectives for most of these additional parameters.[64]

Monitoring Frequency

Water quality, like the weather, can change quickly and often. The frequency at which recreational water quality is monitored, therefore, impacts how well health risks are communicated to the public.

According to Canada's Guidelines for Recreational Water Quality, section 3.1.1, Frequency of Microbiological Sampling, "Decisions regarding the frequency of water samples collected for microbiological analysis should be made by the appropriate local or regional authority."[65]

Health Canada's *Guidelines for Canadian Recreational Water Quality* officially recommends a

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[63] United States. "Human Health Recreational Ambient Water Quality Criteria and/or Swimming Advisories for Microcystins and Cylindrospermopsin," Environmental Protection Agency, https://www.epa.gov/wqc/microbial-pathogenrecreational-water-quality-criteria#swimming (accessed April 2017).; United States. "Human Health Recreational Ambient Water Quality Criteria and/or Swimming Advisories for Microcystins and Cylindrospermopsin - Drafrt," Environmental Protection Agency, 822-P-16-002 December 2016, https://www.epa.gov/sites/production/files/2016-12/documents/draft-hh-rec-ambient-water-swimming-document.pdf

[64] Health Canada, Guidelines, Third Edition,,4.

[65] Ibid., 16.

minimum recreational water quality sampling frequency of once per week during the swimming season. However, the Guidelines support more frequent water quality monitoring (daily as opposed to weekly) to allow monitoring bodies to more reliably observe water quality trends, make more informed decisions regarding the suitability for swimming of recreational water bodies, react more quickly to water quality problems, and track chronic water quality issues.

The Guidelines also recommend collecting samples when events that are known to negatively impact water quality occur, for example, following heavy rain or on weekends when there are more swimmers in the water.

Reduced monitoring

The *Guidelines* also offer recommendations for reduced monitoring. These reduced monitoring recommendations are intended for water bodies with either long-term good water quality or chronically poor water quality. Swim sites in remote locations or with few recreational water users can also be considered for a reduced monitoring schedule.

Communication of Health Risk and Beach Water Quality Results

> *The primary reason for monitoring bathing water quality and for informing the public is to protect public health.*[66]

There is great value in informing the public about the current recreational water quality at their recreational water sites. First and foremost, communicating recreational water information to the public helps to prevent illness. Informing people about the quality of their recreational water helps to protect their health, which is the core of recreational water quality monitoring.

The Guidelines state:

> In order to participate in safe, enjoyable recreational water activities, the public requires access to information on the quality of the area and its facilities, as well as notification of any existing water quality hazards. Beach operators, service providers and responsible authorities have a responsibility to inform and educate the public and provide adequate warnings about any hazards relevant to their recreational water areas.[67]

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[66] Jamie Bartram and Gareth Rees (Eds)., *Monitoring Bathing Waters: A Practical Guide to the Design and Implementation of Assessments and Monitoring Programmes* World Health Organization, London, 2000, Accessed February 2017. http://www.who.int/water_sanitation_health/bathing/monbathwat.pdf.

[67] Health Canada, *Guidelines, Third Edition*,,20.

The benefits of public awareness and communication of recreational water quality information can: reduce the potential risk of swimmer illness or injury; improve the quality of the water; correct public misconceptions regarding water quality; improve public confidence; and increase beach attendance.[68]

In areas of Canada where beach water quality is monitored, signage or advisory posts let the public know whether the water met, or failed to meet, recreational water quality criteria. If the most recent test results fail to meet the local water quality criteria, be they a standard, model, or guidelines, additional signage or warnings at the site are recommended. Such signs or warnings should include details about the health risk, the monitoring body, and next steps.

In addition, water quality results and advisories are communicated through various platforms, such as government and/or health authority websites, local news sources, beach hotlines, and on the radio. Social media sites such as Facebook and Twitter have also become popular channels through which recreational water quality information is shared. When asked "How much do you trust each of the following to provide you with information about water quality and safety in Canada?" Canadians placed most trust in Regional Watershed/Conservation Authorities and non-governmental organizations such as environmental and social advocacy groups, followed by third party water quality monitors and municipal governments.[69] Most people look for recreational water quality information on municipal websites, followed by on-site information at the beach, lake, or river.[70]

The best way to reduce recreational water illnesses is by preventing people from being exposed to contaminants. The Guidelines suggest that reducing monitoring and discouraging recreational water use in areas with chronic water quality programs is an option.

> It may also be good to reduce monitoring frequencies for recreational water areas that consistently demonstrate poor water quality results, but only where appropriate management actions are taken to discourage recreational use, and provided that the risks are clearly communicated to the public.[71]

However, putting up "no swimming signs" is never a true solution. Rather than keeping people out of the water permanently, the best practice is to address water contamination by taking steps to

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[68] Health Canada, *Guidelines, Third Edition*,20.

[69] Royal Bank of Canada, *2017 RBC Canadian Water Attitudes Study*, 88.

[70] Ibid.

[71] Health and Welfare Canada, *Guidelines* 16.

return water to a swimmable state.

Preventive Multi-Barrier Approach

> *A preventive multi-barrier approach to management that focuses on the identification and control of water quality hazards and their associated risks before the point of contact with the recreational water user represents the best strategy for the protection of public health from risks associated with recreational waters. Reactive management strategies relying on compliance monitoring alone will not be sufficient in protecting the health of the recreational water user.*[72]

Health Canada recommends a multi-barrier approach as the best strategy to protect public health from recreational water illnesses. A multi-barrier approach identifies all impediments to water suitable for swimming and creates barriers, such as "source protection, monitoring, hazard control, communication, consultation"[73] to both eliminate the hazards and minimize their impact on human health. The multi-barrier approach for recreational water quality is based on the "source-to-tap" approach used in protecting the integrity of drinking water in Canada.[74] It is a best practice approach recommended by the WHO in the "Annapolis Protocol" and detailed in WHO's 2013 *Guidelines for Safe Recreational Water Environments*.

The *Guidelines for Canadian Recreational Water Quality* strongly recommend as a best practice that beach managers employ a multi-barrier approach to assessing and managing water quality problems.

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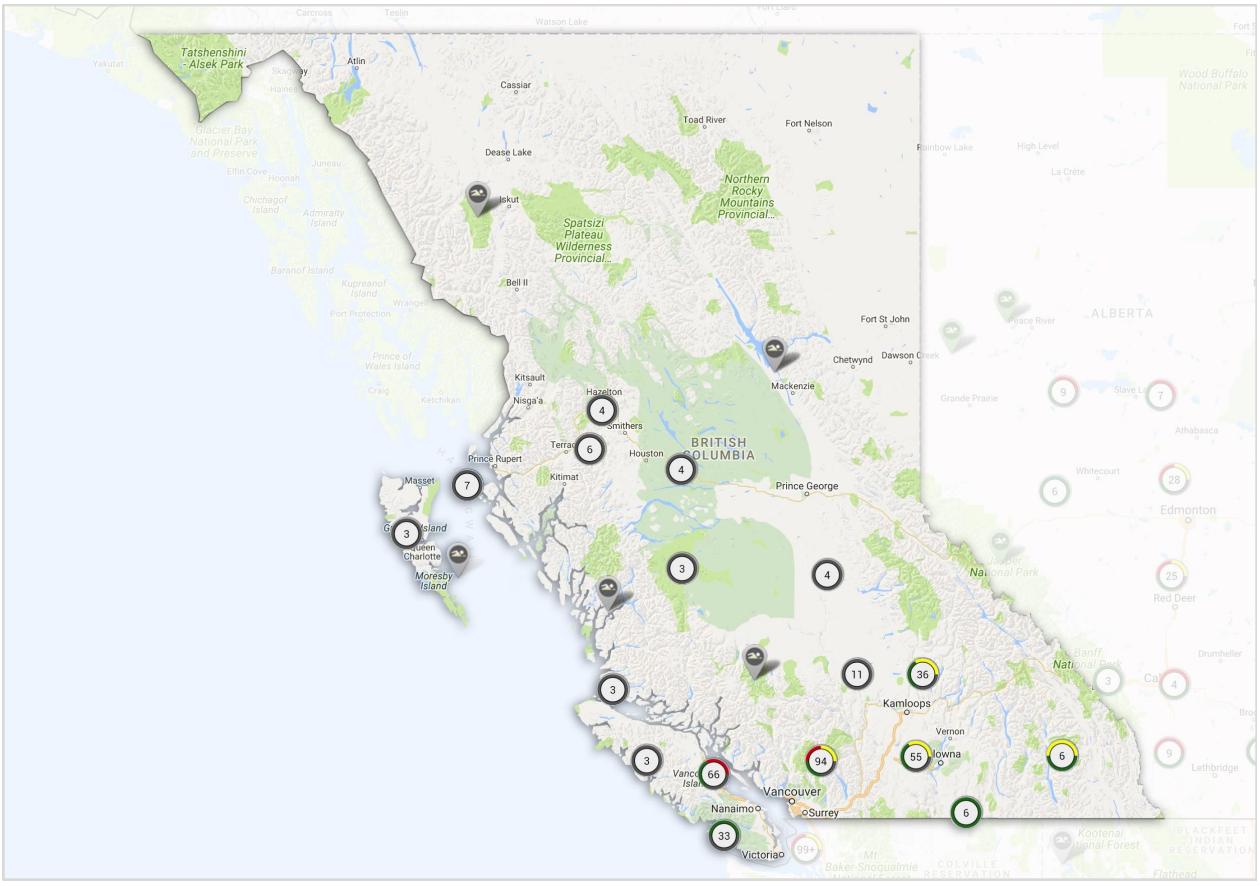
[72] Health Canada, *Guidelines, Third Edition*,,10.

[73] Ibid., 6.

[74] Ibid., 11.

Provinces and Territories: Recreational water quality standards and protocols

British Columbia



There are approximately 450 designated freshwater, estuarine, and marine water recreational water locations in British Columbia.

The British Columbia Ministry of Environment sets water quality guidelines for the protection of designated water uses, including recreation, drinking, support of aquatic life, wildlife, and agriculture. British Columbia's water quality guidelines represent safe levels of substances to protect designated water uses. Recreational water quality is assessed using the British Columbia Ministry of the Environment's Recreational Water Quality Guidelines for ambient water.

The Ministry of Environment may also set water quality objectives for specific water bodies. The objectives are set to protect the most sensitive designated use for a water body, thereby protecting

all other designated uses. The Ministry conducts water quality objectives attainment monitoring on a water body-specific basis, and water quality for recreational use is assessed where recreation is a designated use. The British Columbia Provincial Lake Sampling Program also monitors water quality in lakes across the province, many of which are used for recreational purposes.[75]

There is no specific provincial legislation for the regulation of recreational waters, beaches, or water access points in British Columbia.[76] The legislative mandate regarding recreational water comes from the province's Public Health Act. Health authorities are mandated under sections 77 and 83 to "reduce health hazards and promote healthy living in British Columbia."[77] Specifically, Environmental Health Officers (EHOs) are mandated under Section 77, Division 4: Environmental Health Officers, Role of environmental health officers, and local governments are mandated under Section 83, Division 6: Local Governments, Role of local government to monitor recreational water quality if required or take actions to reduce health hazards and protect the public from health risks associated with recreational water.[78]

The implementation and management of recreational water quality at beaches in British Columbia is the responsibility of the province's Health Authorities. Beach owners and operators oversee the operations of the beaches and work in coordination with Health Authorities and Environmental Health Officers.

In general, the federal *Guidelines for Canadian Recreational Water Quality* are followed throughout the province of British Columbia. In April 2016, the government of British Columbia published a set of recommendations for recreational water quality monitoring in the province called *Model Recreational Water Quality Program: British Columbia Health Authorities Implementation of the Guidelines for Canadian Recreational Water Quality, 3rd Edition*. The model recommends that health authorities follow the federal guidelines for Canadian Recreational Water Quality for faecal coliform and cyanobacteria and cyanotoxin monitoring. The document "provides recommendations for application of a provincially consistent model for recreational water program for beaches," and "is intended to support a clear and consistent approach to delivery of recreational water programs

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[75] Heather Granger, personal communication, British Columbia Ministry of Environment, Water Protection, and Sustainability Branch, April 12, 2016.

[76],British Columbia, *Model Recreational Water Quality Program: BC Health Authorities Implementation of the Guidelines for Canadian Recreational Water Quality, 3rd Edition* (British Columbia Health Authorities, April 2016), 1,4.

[77] Ibid.*, 2*.

[78] Canada. British Columbia. *Public Health Act,* 2008, c. 4, s. 77;Canada. British Columbia. *Public Health Act,* 2008, c. 6, s. 83.

across BC."[79]

Six provincial health authorities monitor freshwater and marine beaches in British Columbia80 It is up to these health authorities to create and implement recreational water quality monitoring at beaches in their regions. This is often carried out in coordination and collaboration with municipal governments, beach owners and operators, and the public. Municipalities also monitor recreational waters and take action to reduce health hazards and protect the public from health risks associated with recreational water.

Protocols specific to cyanobacterial toxins in British Columbia recreational water exist at the provincial level under the *Decision Protocols for Cyanobacterial Toxins in British Columbia Drinking Water and Recreational Water.* These cyanobacteria-related protocols are designed to standardize the monitoring, action processes, and communication strategies for blue-green blooms and toxic algae.[81]

Parameters for monitoring recreational water quality

Indicator Bacteria

In addition to freshwater swimming sites, most recreational water environments in British Columbia feature marine or brackish water. Recreational water quality is measured by testing levels of faecal coliform bacteria: *E. coli* (usually in freshwater) and *enterococci* (in marine or brackish water). However, *E. coli* is considered acceptable for marine waters if there are studies to back up testing for this indicator. [82]

The *Model Recreational Water Quality Program* underlines that "sample results only correlate to the next 2 days' water quality therefore a dual approach of using single sample maximums and

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[79] British Columbia Health Authorities, *Model Recreational Water Quality Program*, 1.

[80] British Columbia. "Regional Health Authorities." http://www2.gov.bc.ca/gov/content/health/about-bc-s-health-care-system/partners/health-authorities/regional-health-authorities (accessed August 17, 2016).

[81] British Columbia, Environmental Protection and Sustainability, *Decision Protocols for Cyanobacterial Toxins in British Columbia Drinking Water and Recreational Water,* 3 September 2015, Accessed November 22, 2016. http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/documents/cyanobacteria-sampling-protocols-sept3-2015.pdf.

[82] "*E. coli* (Section 4.1.1) is also recognized as a useful predictor of the risk of gastrointestinal illness in marine recreational waters (Wade et al., 2003). If it can be shown that *E. coli* can adequately demonstrate the presence of faecal contamination in marine waters, then the *E. coli* maximum limit for fresh waters may be adopted. If there is any doubt, samples should be examined for both sets of indicators for extended periods to determine whether a positive relationship exists." Health Canada, *Guidelines, Third Edition*, 34.

geometric mean limits is recommended."[83]

The following are microbiological water quality guidelines from X.

Primary contact guidelines

E. Coli

- 200 *E. coli* / 100 mL – geometric mean at least 5 samples
- 400 *E. coli* / 100 mL – single sample maximum

Enterococci

- 35 *enterococci* / 100 mL – geometric mean at least 5 samples
- 70 *enterococci* / 100 mL – single sample maximum

Immediate resampling is recommended following a single sample exceedance.

Secondary contact guidelines

Indicator bacteria should not exceed five times the value for primary contact.

- *E. coli*: (5 × 200/100 mL) = 1000 *E. coli*/100 mL (geometric mean of at least 5 samples)
- *Enterococci*: (5 × 35/100 mL) = 175 *enterococci*/100 mL (geometric mean of at least 5 samples)

Cyanobacteria

Water bodies suspected to have cyanobacterial blooms are monitored according to the Health Canada Guidelines. The guidelines' recommendations serve as British Columbia's standardized, province-wide protocol under *Decision Protocols for Cyanobacterial Toxins in British Columbia Drinking Water and Recreational Water.*[84]

- Microcystin-LR not exceed 1.5 µg/L (drinking water)
- Total cyanobacteria not exceed 100,000 cells/mL and total microcystins not exceed 20 ug/L (expressed as microcystin-LR) (recreational water)

Locations and sources of cyanobacteria blooms and toxic algae vary throughout the province, and therefore monitoring and management varies from region to region. While the province has a recommended protocol, there are a number of variations of how cyanobacteria and cyanotoxins are monitored and managed by the province's six health authorities.

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[83] British Columbia Health Authorities, *Model Recreational Water Quality Program*, 3.

[84] British Columbia, *Decision Protocols for Cyanobacterial Toxins in British Columbia Drinking Water and Recreational Water*, 2015.

Communication, beach postings, and advisories

The province emphasizes that communication between the Environmental Health Officers, administration, Medical Health Officers, stakeholders, and the public is key to achieving the goals of recreational water quality monitoring programs, which aim to:

- Reduce risk of swimmer illness or injury
- Improve water quality
- Correct public misconceptions regarding water quality
- Improve public confidence
- Increase beach attendance[85]

The British Columbia model recommends public awareness through a combination of communication channels, including visual and written cues on beach signs, websites, and use of media outlets.

British Columbia Health Authorities

The implementation and management of recreational water quality at beaches in British Columbia is the responsibility of the province's Health Authorities.[86] Health authorities are mandated under the Public Health Act (section 77 and 83) to "reduce health hazards and promote healthy living in British Columbia."[87]

Local health authorities monitor water quality at recreational swimming spots in British Columbia, and municipalities also monitor recreational water quality.

> Health authorities may sample the water quality of recreational beaches or create reports on recreational water quality concerns to help inform them of any public health risks. At their discretion, they may decide to close beaches, issue public advisories or post warning signs based on these sampling results, until the water samples indicate that it is safe to resume swimming in these waters.[88]

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[85] British Columbia Health Authorities, *Model Recreational Water Quality Program*, 13,14.

[86] Ibid., 1,4.

[87] Ibid, 2.

[88] British Columbia, "Recreational Water Quality", Environmental Protection & Sustainability, http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/recreational-water-quality (accessed November 22, 2016).

The Health Authorities in British Columbia are:

Regional Health Authorities

- Fraser Health
- Interior Health
- Northern Health
- Vancouver Coastal Health
- Island Health

First Nations

- First Nations Health Authority

Under British Columbia's *Public Health Act*, health authorities have legislative power to close beaches for primary recreational activities and take other actions to protect public health from risks associated with recreational water. [89]

In general, health authorities and municipalities monitor beach water quality from April to September. Samples are usually collected weekly, with a monthly minimum of 5 samples. However, there are wide variations within the province when it comes to how and when water quality is monitored for recreational quality.

Vancouver Coastal Health (+80 beaches)

Coast Garibaldi: 50 designated public beach sites along the Sea to Sky corridor (Squamish, Whistler, and Pemberton) and the Sunshine Coast (Gibsons, Sechelt, and Powell River)90; Vancouver, Richmond, and North Shore: 25 beaches (2016 sampling)[91]

; Bowen Island: 6 Beaches

With the exception of Trout Lake, Vancouver Coastal Health does not sample or test beach water directly. Metro Vancouver conducts sampling and analysis of beach water quality at designated sites. Municipalities in Coast Garibaldi and Bowen Island manage their own monitoring programs.

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[89] Canada. British Columbia. *Public Health Act,* 2008, c. 4, s. 77;Canada. British Columbia. *Public Health Act,* 2008, c. 6, s. 83.

[90] Vancouver Coastal Health. "Environmental Health Services – Coast Garibaldi Area," http://healthspace.ca/vch

[91] Vancouver Coastal Health, *Beach Water Quality*, September 29, 2016 http://www.vch.ca/media/Beach_Water_Quality_Report_September_29_2016.pdf; Vancouver Coastal Health, *Beach Water Quality*, September 1, 2016, Accessed December 2016 .http://www.vch.ca/Documents/Beach-water-quality-report-metro-Vancouver.pdf

Metro Vancouver area beaches are monitored throughout the swimming season, which officially runs from end of May to early September. Testing is conducted to determine compliance with the national *Guidelines for Canadian Recreational Water Quality* for primary contact recreational activities.[92]

As mentioned, *E. coli* is typically the indicator bacteria for freshwater beaches. It is sometimes monitored as the indicator bacteria in brackish or estuarine beaches. For example, in the Metro Vancouver area and Coast Garibaldi, *E. coli* is used as the indicator bacteria in fresh, marine, and brackish water (a mixture of Fraser River water and ocean water).[93]

An in-depth Metro Vancouver study confirmed that *E. coli* was a more useful predictor of the risk of gastrointestinal illness in those waters.[94] The *Guidelines for Canadian Recreational Water Quality* support the use of *E. coli* as the water quality indicator in certain cases:

> "If it can be shown that *E. coli* can adequately demonstrate the presence of faecal contamination in marine waters, then the *E. coli* maximum limit for fresh waters may be adopted."[95]

The decision to use *E. coli* as the indicator for Metro Vancouver's waters is consistent with recreational water quality data collected for over 20 years, allowing for comparison with historical data.[96]

Vancouver Coastal Health tests recreational water weekly at monitored sites, and the levels of E. coli are expressed as a running average: a geometric mean over the most recent 30 days.

Beach Postings and Advisories

When the geometric mean of 200 *E. coli* / 100 mL of water is exceeded, or in the case of a known hazard or spill, an assessment of the risk level and best approach to protect the health of

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[92] Vancouver Coastal Health, *Beach Water Quality*; Heather Granger, personal communication.

[93] Jessica Ip, personal communication, Vancouver Coastal Health Vancouver Office, August 17, 2016; Cindy Watson, personal communication, Vancouver Coastal Health, Squamish Office, November 22, 2016; Steve Chong, personal communication, Vancouver Coastal Health, Richmond Office, November 22, 2016.

[94] Jessica Ip, personal communication.

[95] Health Canada, *Guidelines, Third Edition,* 34.

[96] Jessica Ip, personal communication.

recreational water users will be made.[97]

The Medical Health Officer may then require the local government to post an advisory sign warning the public that the water is contaminated and unsafe for swimming.[98] As Vancouver Coastal Health follows the best practices and procedures outlined in the federal guidelines, re-sampling is often carried out.[99]

Interior Health (54 beaches)

Like the other British Columbia health authorities, Interior Health monitors beaches on a weekly basis throughout the summer. Interior Health samples designated beaches from June to September. The indicator bacteria used is E. Coli, as the beaches within this area are inland (freshwater). One sample is collected per beach per week. The geometric mean for each beach is calculated from the 5 most recent samples.[100]

E. Coli Guidelines

- 200 *E. coli* / 100 mL – geometric mean at least 5 samples
- 400 *E. coli* / 100 mL – single sample maximum

Beach Postings and Advisories

An exceedance of the geometric mean triggers an advisory, and the beach is physically posted with a sign to alert swimmers of water quality concerns. A high single sample may also trigger an advisory; often, re-sampling is conducted to verify a high single sample value; if confirmed, a beach advisory is posted.

In addition to physically posting a beach when levels are found to be in exceedance of Health Canada guidelines, the local government (community or regional districts) may issue alerts or reports online to advise the public of water quality concerns.

While Interior Health does not track individual cases of waterborne infections such as swimmers' itch, a grouping of reports may warrant further investigation by the health unit.

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[97] Vancouver Coastal Health, *Pools and Beaches*, http://www.vch.ca/public-health/environmental-health-inspections/pools-beaches.

[98]Vancouver Coastal Health, *Beach Water Quality*,.http://www.vch.ca/Documents/Beach-water-quality-report-metro-Vancouver.pdf

[99] Jessica Ip, personal communication.

[100] British Columbia, Interior Health Authority, Sample History: Sample Parameter Report, September 2016.https://www.interiorhealth.ca/YourEnvironment/RecreationalWater/Documents/Beach-sample-results.pdf

Northern Health (no officially monitored beaches)

Northern Health does not routinely monitor recreational water sites or sample beaches for water quality.

Routine recreational monitoring is limited in Northern Health due to a variety of factors such as climate, resource limitations for staff, vast geography and majority of recreational sites tend to be lakes and rivers.[101]

Northern Health is divided into three territories: Northern Interior, North West, and North East. Recreational waters are monitored on a case-by-case basis when there is evidence to suspect that the beach water poses a risk to public health. For example, if there has been a sewage spill, or if a waterborne illness is reported following bathing at a beach, Northern Health will investigate. This evidence could include (but is not limited to):

a. reports of a disease outbreak or illnesses of specific aetiology
b. reports of a specific event such as a sewage spill or discharge

Interpretation of sample results follows the *Guidelines for Canadian Recreational Water Quality.*

When sampling at recreational locations occurs, Northern Health follows the federal guidelines.

E. Coli **Guidelines**

- 200 *E. coli* / 100 mL – geometric mean at least 5 samples
- 400 *E. coli* / 100 mL – single sample maximum

Cyanobacteria

Water bodies suspected to have cyanobacteria blooms are monitored according to the Health Canada Guidelines. Monitoring occurs on a case-by-case basis, and action is taken when a bloom is reported. However, few laboratories in British Columbia process blue-green algae samples. There is currently no lab in Northern Health's jurisdiction that processes cyanobacteria tests. Therefore, when Northern Health investigates blue-green algae blooms, inspections are done visually.

Like the rest of the province's health authorities, Northern Health works with other health authorities to standardize cyanobacteria monitoring and management across the province based on the federal recommendations.

- microcystin-LR not exceed 1.5 ug/L (drinking water)
- Total cyanobacteria not exceed 100,000 cells/mL and total microcystins not exceed 20 ug/

[101] Neelam Hayer, personal communication, email, December 6, 2016.

L (expressed as microcystin-LR). (recreational water)

Communications

Northern Health uses multiple communication channels to alert the public to recreational water quality issues. Northern Health has posted advisories during a blue-green algal bloom at the affected water body. Media outreach, such as radio announcements and interviews on local news stations, has also been used as a means to communicate information on an advisory.

Local community groups are also called upon to get the word out. For example, during the summer of 2016, in addition to posting advisories for several blue-green algae blooms, Northern Health contacted the community associations for several local lakes with residents residing around the lakes. The community groups shared advisories on Facebook groups or via community mailboxes.[102]

Fraser Health (45 beaches)

Fraser Health monitors approximately 45 beach sites.[103] In Fraser Health's jurisdiction, water samples are collected at approximately 45 recreational water sites on a weekly basis during the spring and summer to determine compliance with the federal *Guidelines for Canadian Recreational Water Quality*.[104] There are both freshwater and marine beach under Fraser Health's jurisdiction.

Fraser Health uses *E. coli* as the indicator for both marine and freshwater beaches.[105]

***E. Coli* Guidelines**

- 200 *E. coli* / 100 mL – geometric mean (usually 5 samples)
- 400 *E. coli* / 100 mL – single sample maximum

Cyanobacteria

In the case of cyanobacteria, Fraser Health follows the protocol for monitoring algae blooms laid out by the provincial Decision Protocols for Cyanobacterial Toxins in British Columbia Drinking Water and Recreational Water. However, the occurrence of cyanobacteria and toxic algae in the

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[102] Ibid.

[103] Fraser Health, *Recreational Water Quality Current Conditions for Beaches in Fraser Health*, 2016, Accessed December 6, 2016, http://www.fraserhealth.ca/media/20160923_beachsamples.pdf; British Columbia Ministry of Health. *Core Public Health Functions for BC: Evidence Review - Water Quality: Recreation Water*. 2007, Accessed December 6, 2016, http://www.health.gov.bc.ca/library/publications/year/2007/recreational-water-quality-evidence-review.pdf

[104] Fraser Health, "Beach Conditions," http://www.fraserhealth.ca/health-info/health-topics/recreational-water/beach-conditions/ (accessed March 2017).

[105] Ibid.

region is very low.

Beach Postings and Advisories

An "unsatisfactory" condition is given when a geometric mean exceeds 200 *E. coli* bacteria / 100 mL of water and/or when a series of single sample results exceed 400 *E. coli* bacteria / 100 mL and an assessment of the beach conditions is completed by Fraser Health. Under these circumstances, swimming and primary contact activities such as surfing, water skiing, diving, and whitewater canoeing/rafting/kayaking are not recommended.[106]

Fraser Health recommends that beach operators post advisory signs to warn swimmers of unsatisfactory physical, chemical, or biological conditions.[107]

Island Health (Vancouver Island Health Authority) (100 beaches)

Island Health monitors nearly 100 beaches. Island Health is split into three service delivery areas: North (20 beaches), Central (39 beaches), and South (40 beaches).

Island Health conducts sampling at beaches that are "formally recognized public recreational water bathing areas, with lands controlled by a federal, provincial, regional or municipal body/agency, which provide access to ocean, lake or river water."[108] Sampling is not conducted at private beaches or "unofficial bathing areas" on public lands.[109]

The sampling program generally runs from May until Labour Day. The Environmental Health Officer (EHO) conducts a beach assessment for each beach.[110] Sampling frequency is determined once the beach is assessed based on use, historical sample results, and possible sources of contamination.[111] The frequencies are:

High:	Sampled weekly
Moderate:	Sampled every 2 weeks
Low:	Sampled monthly
Very Low:	Not sampled unless EHO deems necessary

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[106] Ibid.

[107] Ibid.

[108] Island Health, "Beach Reports," http://www.viha.ca/mho/recreation/beach_reports.htm (accessed February 2017).

[109] Ibid.

[110] Ibid.

[111] Ibid.

***E. Coli* Guidelines**

- 200 *E. coli* / 100 mL – geometric mean (usually 5 samples)
- 400 *E. coli* / 100 mL – single sample maximum

Beaches are automatically posted when a sample result exceeds 1000 *E. coli* / 100 mL.

Island Health states that consideration is given to posting a beach advisory when the geometric mean exceeds 200 *E. coli* / 100 mL or when a single results exceeds 400 *E. coli* / 100 mL.112 However, posting a beach advisory when samples exceed the geometric mean and/or single sample maximums are not automatic and depend on the circumstances.[113]

***Enterococci* Guidelines**

- 35 *enterococci* / 100 mL – geometric mean at least 5 samples
- 70 *enterococci* / 100 mL – single sample maximum

Beaches are automatically posted when a sample result exceeds 175 *Enterococci* / 100 mL.

Consideration is given to posting a beach advisory when the geometric mean exceeds 35 *Enterococci* / 100 mL or a single results exceeds 70 *Enterococci* / 100 mL.[114]

First Nations Health Authority

The First Nations Health Authority (FNHA) provides health services to First Nations in British Columbia In 2013, FNIHB transferred responsibility of health related programs, services, and responsibilities to FNHA to allow for greater First Nations' control.[115]

The FNHA follows the Canadian Recreational Water Quality Guidelines for marine and freshwater recreational sites. In all cases of recreational water quality monitoring, FNHA provides investigation, advice, and recommendations to First Nations governments (Chiefs and Councils). FNHA works collaboratively with First Nations governments to address water quality issues. Related activities may include assisting with communication of contamination to the public/residents.

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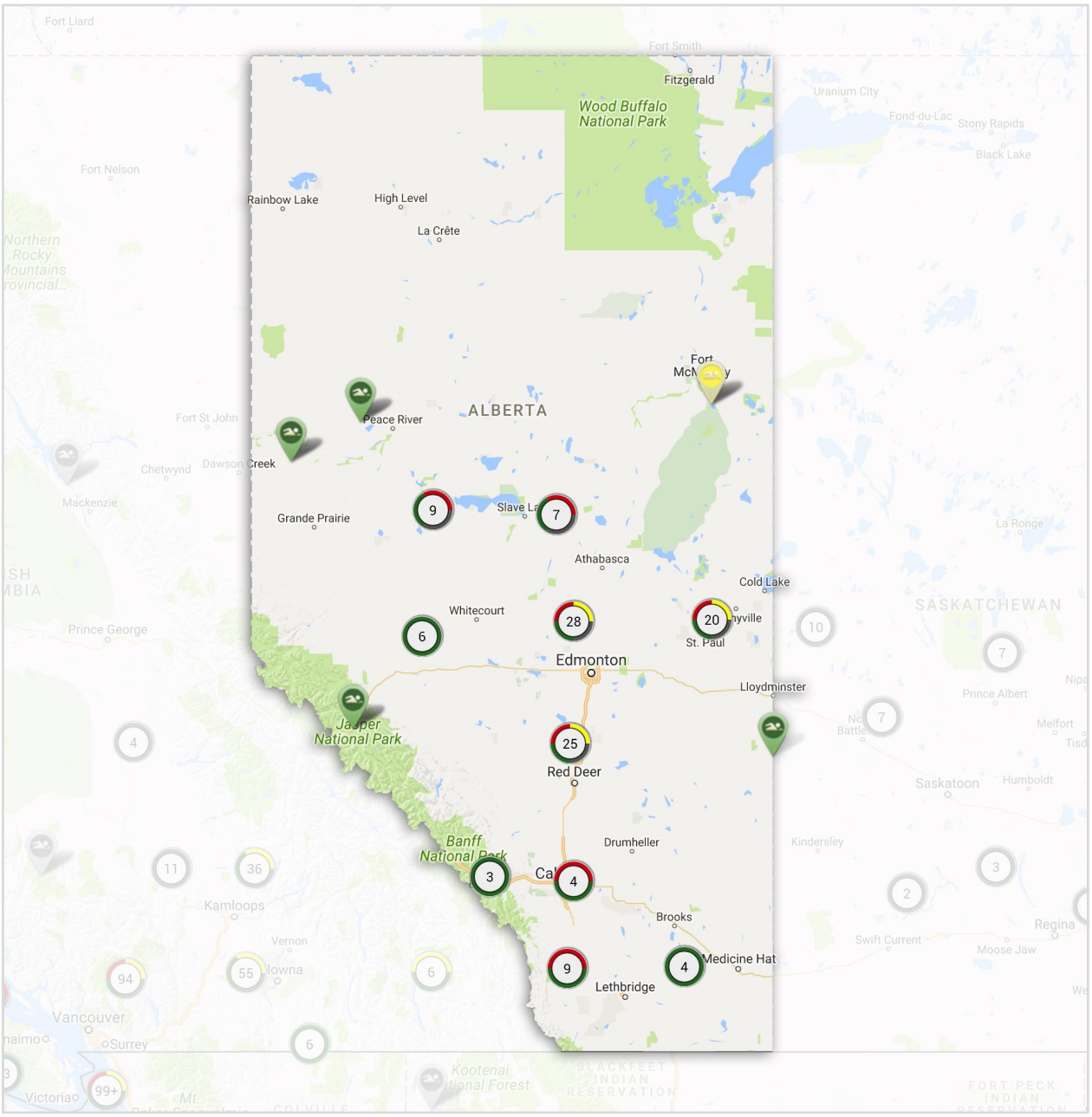
[112] Ibid.

[113] Ibid.

[114] Ibid.

[115] First Nations Health Authority, "BC First Nations Health Authority Marks Historic Transfer of Services from Health Canada," http://www.fnha.ca/about/news-and-events/news/bc-first-nations-health-authority-marks-historic-transfer-of-services-from-health-canada (accessed January 2017).

Alberta



All of Alberta's recreational water sites are inland and are therefore all freshwater. In 2016, Alberta Health Services (AHS), the agency that delivers health services in Alberta, monitored a total of 56 freshwater beaches across the province's five zones—Calgary, Central, Edmonton, North, and South—for microbiological and/or cyanobacteria parameters. Sites are monitored during the open water season, typically June to September. Monitoring is typically conducted on a weekly basis. Blue-Green algae advisories typically remain in effect until November. In addition to AHS monitoring,

approximately 200 beaches had varying levels of sampling for faecal coliforms completed by their own operators.

Alberta follows the federal *Guidelines for Canadian Recreational Water Quality* for cyanobacteria, but follows the historical set of standards for faecal coliforms, which were originally outlined in General Nuisance and General Sanitation Regulation, Part 3: Public Beaches under the provincial Public Health Act. Faecal coliforms are used as the indicator bacteria when testing bathing beaches for suitability for swimming.

Alberta is currently developing the Alberta Recreational Water Management Protocol. The purpose of the non-regulatory protocol is to establish recreational water quality standards to protect the public from all health risks (bacterial, chemical, and physical). The protocol also aims to provide "clear and comprehensive guidelines to proactively assess and manage the public health risks associated with recreational waters throughout Alberta."[116]

The current Nuisance and General Sanitation Regulations were revised in 2014, and Section 3 Public Beaches was rescinded as it was "outdated and no longer reflective of the current management practices or water quality guidelines recognized to be protective of public health." Once published, the new protocol will clarify how recreational waters are managed in Alberta, set water quality standards, and describe the roles of the provincial agencies and operators in overseeing monitored swimming sites. In the meantime, the province and AHS are continuing to use the faecal coliform standards. The Protocol is expected to be completed in 2017.

Parameters for monitoring recreational water quality

Indicator Bacteria

Alberta continues to apply Section 16 of the previous regulation. In order to be considered safe for swimming, a beach must meet the following criteria:

- Two consecutive values below 400 faecal coliform CFU / 100 mL; and
- Geometric mean below 200 faecal coliform CFU / 100 mL taken over a 30-day period

Part of the investigation after receiving unsatisfactory results includes a site assessment, if warranted, to determine potential exposures or causes. This will also allow for a risk assessment, including necessity for additional sampling.

Typically, when water fails to meet the criteria, signs are posted at the recreational site and an

[116] Joan Yee, personal communication, email, August 29, 2016.

advisory is posted on the AHS website (http://www.albertahealthservices.ca/1926.asp). AHS always notifies Alberta Health, which distributes the information to a variety of organizations, including to Alberta's First Nations and Inuit Health Branch.

Cyanobacteria

Alberta Health Services has a blue-green algae/cyanobacteria monitoring program in place. Approximately 50 beaches in Alberta are proactively monitored on a scheduled basis over the course of the swim season for cyanobacteria and microcystin. This surveillance includes visual observations and cell count and microcystin monitoring. Beaches and other recreational water spots that are not part of the regular monitoring program are investigated and responded to on a demand/complaint basis.

Water bodies suspected to have cyanobacterial blooms are monitored according to the Guidelines for *Canadian Recreational Water Quality.*[117]

- Total cyanobacteria not exceed 100,000 cells/mL and total microcystins not exceed 20 ug/L (expressed as microcystin-LR). (recreational water)

In the case of cyanobacteria and/or microcystin exceedance, AHS posts an advisory on its website[118] and social media accounts and posts physical signage with educational messaging at affected swim sites.[119] AHS notifies Alberta Health, which distributes the information to a variety of organizations, including to Alberta's First Nations and Inuit Health Branch and Alberta Environment and Parks. Where indicated, follow-up with potential affected drinking water systems from the blue-green algae advisory is completed, including any indigenous communities through FNIHB's EHOs.

Recreational Water Quality in Indigenous Communities in Alberta

As in the rest of Canada, First Nations reserves in Alberta fall under federal jurisdiction. There are over 140 First Nations reserves in Alberta. The First Nations and Inuit Health Branch (FNIHB) is responsible for public health on reserves. Of the water bodies that AHS monitored in 2016, 7 border or are within 1km of a First Nation reserve.[120] There may be several beaches or swim spots tested on a single lake.

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[117] Ibid.

[118] Alberta, "Health Advisories," Alberta Health Services, https://myhealth.alberta.ca/alerts/Pages/Alberta-Health-Advisories.aspx (accessed December 2016).

[119] Jessica Popadynetz, personal communication, email, June 19, 2015.

[120] Joan Yee, personal communication, phone, December 14, 2016.

In the case of an advisory at a recreational water site monitored by AHS for a bacterial exceedance or for blue-green algae, AHS alerts Alberta Health and notifies the public on its website. Alberta Health distributes the information about the advisory as well. First Nations and Inuit Health Branch Alberta Region (FNIHB) also receive the alert and provide additional notices to affected First Nations communities.[121]

Some popular recreational water sites, such as Pigeon Lake, are on or near reserves. In these cases, there is increased collaboration and dialogue between the respective health agencies. Based on the limited number of beaches and current program mandates and priorities, recreational water quality monitoring on reserves is on an as-needed basis. Drinking water is sampled regularly on reserves, and action is taken if there is a concern that contaminants could affect recreational waters.

Monitoring cyanobacteria on reserve in Alberta follows the provincial process. In fact, FNIHB contributed to the development of the provincial cyanobacteria program. FNIHB Alberta follows the provincial cyanobacteria investigation and notification process.[122]

As is the case in other provinces, there is no formal routine recreational water quality program for indigenous communities in Alberta. Often, First Nations in Alberta hire their own staff to monitor recreational water quality on reserve. There are few on-reserve beaches in Alberta. The number of bathing beaches and recreational water areas on reserve in Alberta is unknown.

There is a lot of cooperation and coordination between FNIHB and AHS when it comes to recreational water quality. Just as AHS alerts FNIHB to recreational water quality issues affecting water bodies near First Nations communities, FNIHB includes AHS in all communications and recreational water alerts for on-reserve issues.[123] As much as possible, activities between AHS and FNIHB are coordinated.

Other scenarios for monitoring recreational water quality on reserve in Alberta include the monitoring of waters that are at risk due to development. For example, Environment Canada monitors water in the Athabasca sub-basin in north-eastern Alberta. The Athabasca sub-basin is the site of major oil and gas development projects and forestry projects. Monitoring of water quality is the federal government's responsibility, as outlined in the CEAA. "There is also a responsibility for

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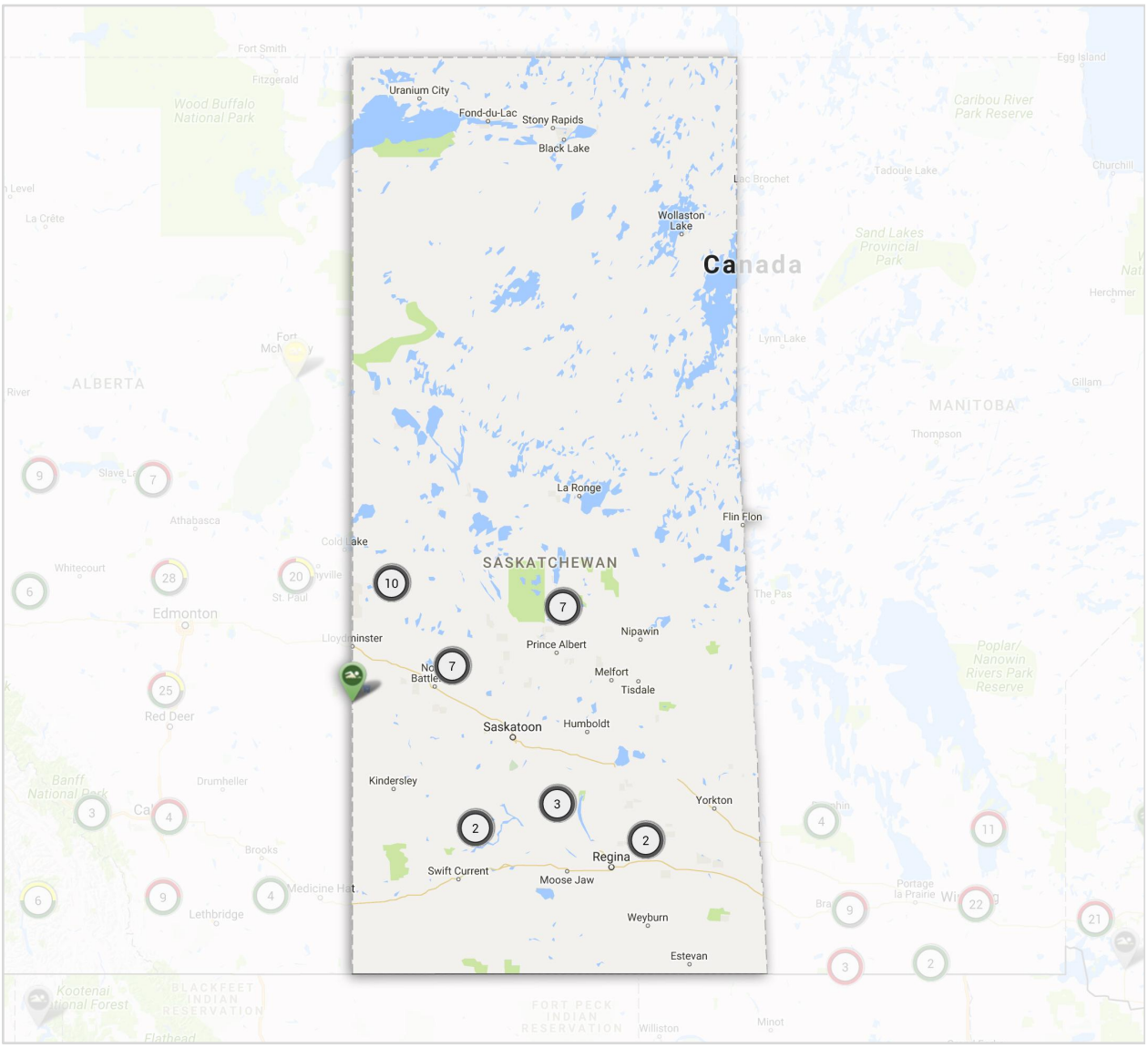
[121] Ibid.

[122] Simon Sihota, personal communication, phone, December 21, 2016.

[123] Ibid.

monitoring of waters from provincial regulators such as the Alberta Energy Regulator (AER). This may include monitoring on or near the indigenous community."[124]

Saskatchewan



Currently, Saskatchewan does not have an official beach water quality monitoring program for its

[124] Simon Sihota, personal communication,email, February 13, 2017.

public beaches.[125] The province carries out some monitoring of beach sites. There are approximately 70 beaches monitored; however, the public does not have access to test results. Beach monitoring results are published when sampling reveals that there are water quality concerns.[126]

Healthy Beach Program

In recent years, the Saskatchewan Ministry of Health has been working with Regional Health Authorities and non-governmental organizations to implement a beach monitoring program.127 To date, a registry of approximately 70 public beaches in the province has been created and work is ongoing to determine which beaches will have weekly, monthly, or seasonal monitoring.128 Once the program is underway, online recreational water quality information (e.g., a public website that lists all monitored beaches and water quality indicators and results) may be available.[129]

Parameters for monitoring recreational water quality

The Ministry of Health will sometimes issue advisories when monitoring information indicates water quality concerns.[130] When sampling of recreational (beach) water areas shows levels of microcystin or *E. coli* that exceed the *Guidelines for Canadian Recreational Water Quality*, the regional health authority will use a risk-based approach to determine if an advisory will be issued.[131] (Risk considerations include, but are not limited to, wind direction, wave action, and ambient temperature.[132])

Health officials notify those responsible for the recreational water area and signage is posted along the beach area. Additionally, if the advisory impacts a large watershed area or a popular beach, a news release may be issued.[133]

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[125] Saskatchewan, "Swimming Pools and Recreational Water," Environment, Public Health, & Safety, https://www.saskatchewan.ca/residents/environment-public-health-and-safety/environmental-health/swimming-pools-and-recreational-water (accessed July 2016); Tim Macaulay, personal communication, phone, July 8, 2016.

[126] Tim Macaulay, personal communication.

[127] Ibid.

[128] Ibid.

[129] Ibid.

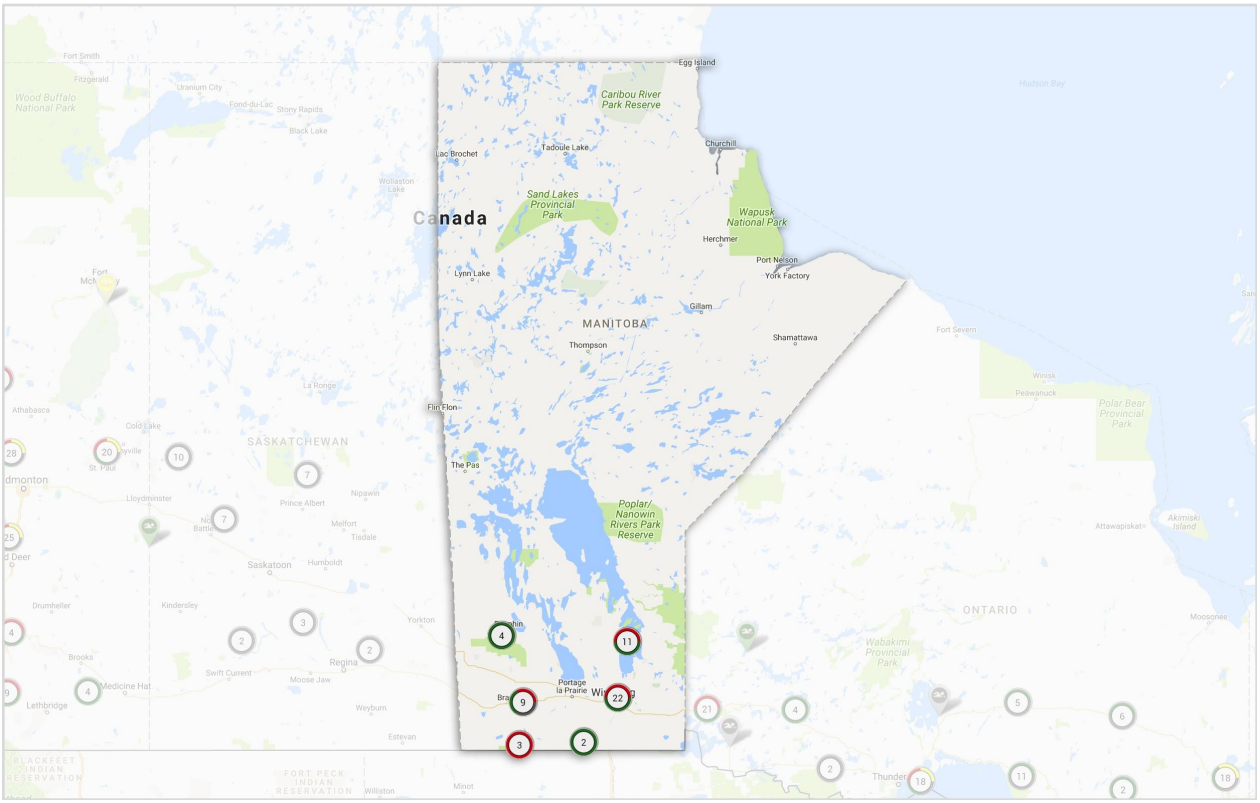
[130] Ibid.

[131] Tyler McMurchy, personal communication, August 30, 2016.

[132] Ibid.

[133] Ibid.

Manitoba



Clean Beaches Program

Manitoba Sustainable Development and Manitoba Health, Seniors, and Active Living collaboratively developed the Provincial Clean Beaches Program. They work in cooperation to monitor over 60 beaches across the province during the swimming season (June to August) to assess the risk of illness to recreational water users.[134]

Beach monitoring frequency varies based on recreational intensity and historical bacteria data, and can be twice a week, weekly, bi-weekly, or monthly.[135]

About half of the monitored beaches in the province are tested monthly. Another 8 are monitored bi-weekly. Typically, the approximately 20 beaches on Lake Winnipeg are monitored once a week.

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[134] Manitoba, "Manitoba Beaches," Manitoba Sustainable Development, http://www.gov.mb.ca/sd/waterstewardship/quality/beaches.html (accessed January 2017); Cassie McLean, personal communication, phone, August 24, 2016.

[135] Manitoba, "Clean Beaches Program," Water Stewardship Division, https://www.gov.mb.ca/waterstewardship/water_quality/lake_winnipeg/clean_beaches.html (accessed January 2017)

Gimli Beach and West Grand Beach on Lake Winnipeg are monitored more frequently at twice a week.[136]

The *Manitoba Water Quality Standards, Objectives and Guidelines* set the primary recreation surface water objectives for *E. coli*, cyanobacteria, and microcystin during the swimming season.

Parameters for monitoring recreational water quality

E. coli

- 200 *E. coli* / 100 mL – geometric mean
- 400 *E. coli* / 100 mL – single sample maximum

These objectives are similar to the federal *Guidelines for Canadian Recreational Water Quality*. The geometric mean for each beach is calculated from multiple samples collected across the swimming area on a single day.[137] The number of samples collected per beach varies. Five samples are collected at larger beaches, while three samples are collected at smaller beaches.[138]

Any exceedance of the recreational objective for either the geometric mean (maximum 200 *E. coli* / 100 mL) or a single sample (maximum 400 *E. coli* / 100 mL) triggers re-sampling. During re-sampling, the number of replicated samples is doubled to 6 or 10 samples per beach.[139] If the beach continues to exceed the recreation objective, re-sample replicates may be doubled again to assist in determining the source of contamination. Meanwhile, the beach will be posted with a yellow beach advisory sign, and the website will display the advisory both on the advisory page and on the map under the individual beach.[140]

Due to extensive studies conducted on Lake Winnipeg, the advisory signs for the Lake include an additional bullet point advising bathers to "minimize water contact if lake levels are high and strong winds are blowing from the north," since large numbers of *E. coli* are present in the wet sand of beaches. During some periods of high winds, when water levels are rising in the south basin, these bacteria can be washed out of the sand and into the swimming area of the lake. These advisory

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[136] Cassie McLean, personal communication.

[137] Ibid.

[138] Ibid.

[139] Ibid.

[140] Ibid.

signs remain posted for the duration of the season.[141]

Cyanobacteria

Manitoba monitors the 60 beaches in the Clean Beaches Program for cyanobacteria and toxic algae. Algae samples are collected when an algal bloom is present. Manitoba also monitors blooms reported at locations that are not part of the program. If the cyanobacterial cell count exceeds 100,000 cells/mL, a first level algae advisory sign is posted at the beach to warn bathers to avoid swimming or contact with water.[142] The first level algae advisory sign remains posted at a beach for the remainder of the season.[143,144]

If the microcystin concentrations exceed 20 µg/L, a second level algae toxin advisory sign is posted at the beach indicating that drinking, swimming, or other contact with the water is not recommended. The second level algae advisory sign remains posted at the beach until concentrations return to acceptable levels, below 20 µg/L, at which point the sign is replaced with a first level algae advisory sign that remains posted for the remainder of the season.[145]

Additional Parameters

Manitoba monitors for swimmer's itch each season, with confirmed water bodies and dates posted on the Manitoba Sustainable Development website.[146] This program relies on reporting from the public through a swimmer's itch reporting form, which is circulated to health care professionals and beach operators at the beginning of each season.[147] Bathers can also report swimmer's itch directly to Manitoba Sustainable Development at manitoba.ca/beaches.

Communication, beach postings, and advisories

Samples are processed and analyzed at an analytical lab contracted by the Manitoba Government. Sample analysis results are received 24 hours from the time of sample submission to the analytical

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[141] Dwight Williamson et al. *Principal Factors Affecting Escherichia Coli at Lake Winnipeg Beaches, Manitoba, Canada Interim Report*, Manitoba Water Stewardship Report No. 2004-01, City, January 29, 2004, Accessed November 2016. https://www.gov.mb.ca/waterstewardship/water_quality/lkwpg_beach_report_interim-040129.pdf; C. McLean, personal communication, 4 January 2017.

[142] Manitoba, "Clean Beaches Program."

[143] Ibid.

[144] Ibid.

[145] Ibid.

[146] Cassie McLean, personal communication.

[147] Ibid.

laboratory.[148]

In addition to physically posting a beach when levels are found exceed the provincial guidelines, the Manitoba Sustainable Development website maps the beaches in the province and allows beachgoers to access the latest sample results.[149] During the bathing season, a weekly beach conditions summary is issued and is made available on the beach website, and the Manitoba Government Twitter feed provides weekly updates and advises the public to check for advisory signs at beaches and to review the online report.

Recreational Water Quality in Indigenous Communities in Manitoba

As in other provinces, the FNIHB is responsible for delivering health services to indigenous reserves in Manitoba. Recreational water quality monitoring does take place on some indigenous reserves in Manitoba. As in other provinces, typically First Nations Chiefs and Councils indicate an interest or a need for recreational water quality monitoring at on-reserve beaches or recreational water sites. EHOs from FNIHB's Environmental Public Health program support this initiative with equipment and training. Certain indigenous communities use their own on-reserve drinking water labs to test recreational water for indicator bacteria. On-reserve recreational water quality monitoring programs are funded federally.

According to Tim Ness, Senior EHO for Health Canada, EHOs may be consulted for information and advice on issues of safe recreational water use. EHOs may consult Manitoba's Clean Beaches Program for recreational water quality monitoring data when applicable. EHOs will conduct site inspections of designated beaches upon request.[150]

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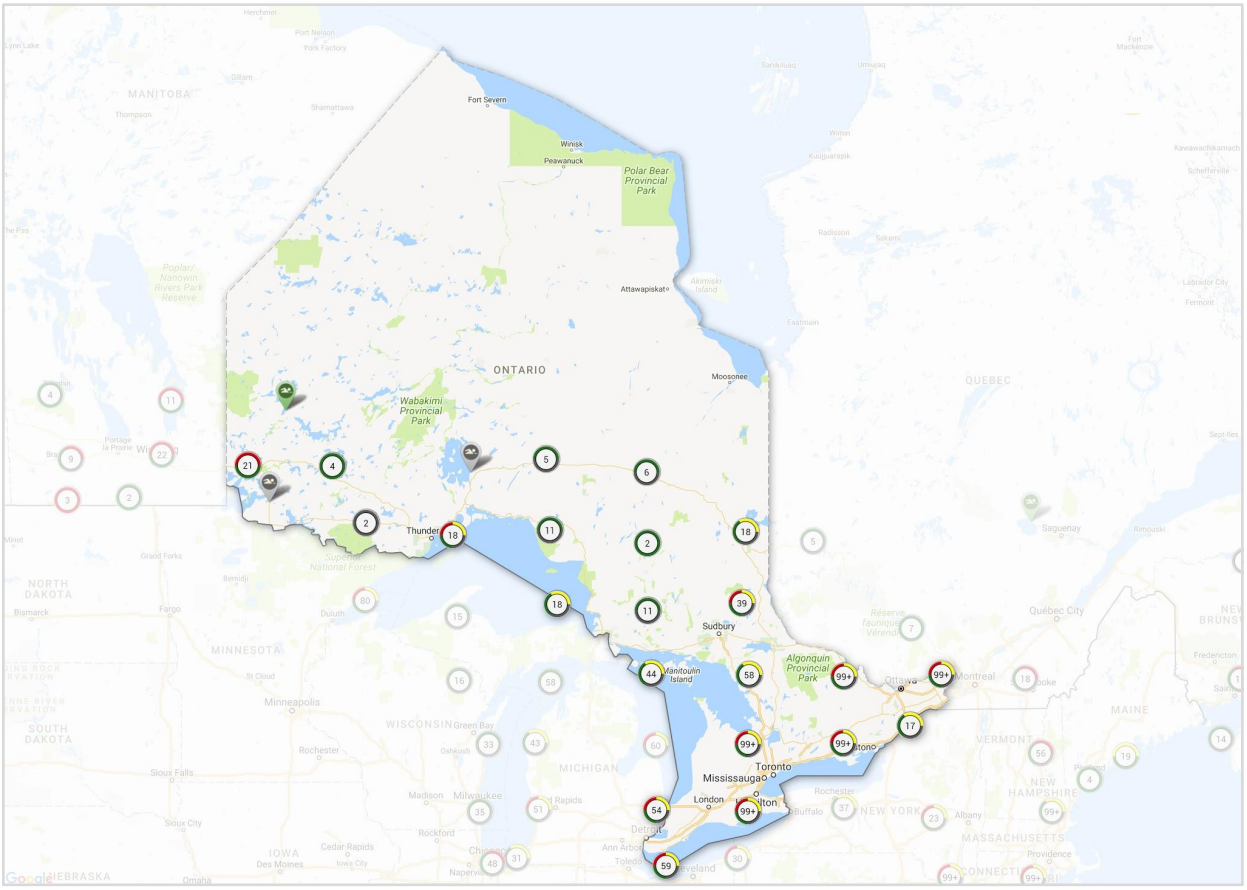
[148] Ibid. email, 8 June 2017.

[149] Ibid.

[150] Tim Ness, personal communication, phone and email, January 3, 2017

Ontario



Ontario has around 300 Great Lakes beaches and an additional 550 inland beaches.[151] Beaches are monitored according to the Ontario Recreational Water Protocol (2016). Municipalities and public health units monitor most of the province's beaches, while Ontario Parks monitors provincial park beaches. Beaches are generally sampled weekly from June to Labour Day.

In Ontario, recreational water quality requirements are established by the Ontario Public Health Standards (OPHS).[152]

The Ministry of Health and Long Term Care, under the Health Protection and Promotion Act (HPPA), publishes the OPHS protocols and standards. The Recreational Water Protocol (2016) is one of 27

[151] Albert Simhon, "Health Canada, Ontario, USEPA Recreational Water Guidelines" (GLBA Conference, International Beach 101 Workshop, Ontario Ministry of the Environment, Toronto, November 12, 2014).

[152] Ontario, "Ontario Public Health Standards", Ministry of Health & Long-term Care, http://health.gov.on.ca/en/pro/programs/publichealth/oph_standards/default.aspx (accessed November 1, 2016).

mandatory health programs and services in Ontario, and it provides direction to boards of health on how to deliver "local, comprehensive recreational water programs."[153]

The overarching purpose of the Recreational Water Protocol is to "assist in the prevention and reduction of waterborne illness and injury related to recreational water use at public beaches."[154] It specifies the minimum and mandatory public health programs and services related to its purpose.

Requirements in the Protocol are related to recreational water facilities, camp waterfront, and public beaches. In the latest version of the Recreational Water Protocol (2016) public beaches are defined as:

> Any public bathing area owned/operated by a municipality to which the general public has access, and where there is reason to believe that there is recreational use of the water (e.g., beach signage, sectioned off swimming area, water safety/rescue equipment, lifeguard chairs, etc.), which may result in waterborne illness or injury as determined by the local medical officer of health.[155]

The Standards related to the Recreational Water Protocol is named "Safe Water" standard.

Safe Water requirements are as follows:

Requirement #1: The board of health shall report Safe Water Program data elements in accordance with the Drinking Water Protocol, 2008 (or as current); and the Recreational Water Protocol, 2008 (or as current).

Requirement #3: The board of health shall conduct surveillance of public beaches and public beach water illnesses of public health importance, their associated risk factors, and emerging trends in accordance with the Recreational Water Protocol, 2008 (or as current).

Requirement #5: The board of health shall conduct surveillance of recreational water facilities in accordance with the Recreational Water Protocol, 2008 (or as current).

Requirement #9: The board of health shall provide education and training for owner/operators of

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[153] Ontario, *Recreational Water Protocol, 2016,* Ministry of Health and Long-Term Care, Toronto, May 2016, Accessed August 8, 2016. http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/recreational_water.pdf

[154] Ibid.

[155] Ontario, *Recreational Water Protocol, 2016*, Ministry of Health and Long-Term Care, Toronto, May 2016, Accessed November 15, 2016. http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/recreational_water.pdf, 3.

recreational water facilities in accordance with the Recreational Water Protocol, 2008 (or as current).

Requirement #10: The board of health shall ensure that the medical officer of health or designate is available on a 24/7 basis to receive reports of and respond to:

- Adverse events related to safe water, such as reports of adverse drinking water on drinking-water systems governed under the Health Protection and Promotion Act or the Safe Drinking Water Act;
- Reports of water-borne illnesses or outbreaks;
- Safe water issues arising from floods, fires, power outages, or other situations that may affect water safety; and
- Safe water issues relating to recreational water use including public beaches in accordance with the Health Protection and Promotion Act; the Drinking Water Protocol, 2008 (or as current); the Infectious Diseases Protocol, 2008 (or as current); the Public Health Emergency Preparedness Protocol, 2008 (or as current); and the Recreational Water Protocol, 2008 (or as current).

Requirement #13: The board of health shall reduce risks of public beach use by implementing a beach management program in accordance with the Recreational Water Protocol, 2008 (or as current).

Requirement #14: The board of health shall reduce the risks of recreational water facility use by implementing a management program in accordance with the Recreational Water Protocol, 2008 (or as current).

Investigation and response to adverse events and complaints at public beaches, communication strategies for the public, promoting safe use and operation of beaches, implementation of beach management programs, and response to safe water issues are outlined in the Protocol.[156]

Implementation of the standards and protocols that the Recreational Water Protocol (2016) requires in relation to public beaches are supported by an additional document: Beach Management Guidance Document (2014).[157]

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[156] Leeds, Grenville & Lanark District Health Unit, *Beach Management Protocol - Orientation Manual*, October 2008. Accessed August 8, 2016. http://www.healthunit.org/aboutus/boh/orientation/beach_management.pdf.

[157] Ontario, *Beach Management Guidance Document, 2014.* Ministry of Health and Long-Term Care, Toronto, Accessed November 1, 2016. http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/guidance/guide_beach.pdf

The stated goal of surface water quality management in Ontario's Provincial Water Quality Objectives (1994) is "to ensure that the surface waters of the Province are of a quality which is satisfactory for aquatic life and recreation."[158] The PWQO are science-based, but are not regulatory instruments (i.e., they do not have the force of law).[159]

The rationale for recreational PWQOs is that "the use of water for swimming, bathing, and other recreational activities requiring immersion of the user should not cause disease in the human user … or irritation or to loss of enjoyment of the water."[160]

Parameters for monitoring recreational water quality

Indicator Bacteria

Ontario observes a more stringent geometric mean for *E. coli* bacteria in recreational waters than the federal recommendations, though there is no single sample maximum in the Ontario standards. Beaches are generally posted when the geometric mean of 5 samples within a 30-day period exceeds 100 *E. coli* / 100 mL of water. Several health units also re-sample after posting a beach (for example Ontario Provincial Parks, Peel, Sudbury, Kingston, and Ottawa).

With these standards, it is estimated that about 7 swimmers per 1000 (0.7%) are at risk of gastrointestinal illness.[161]

Since 1994, *E. coli* has been recommended as the indicator bacteria for all compliance and monitoring of recreational waters in Canada. However, some health units in Ontario continue to monitor faecal and/or total coliform in order to stay consistent with historical data and certain former objectives of Ontario (PWQO):

> As a benchmark for the long term monitoring results, the former objectives for fecal coliforms and total coliforms are referenced for your information. For fecal coliforms the objective was a 100 counts per 100 ml (based on a geometric mean density for a series of water samples). For total coliforms the objective was 1000 counts per 100 ml (based

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[158] Ontario, "Water Management: Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy," Ministry of Environment and Energy, July 1994, https://www.ontario.ca/page/water-management-policies-guidelines-provincial-water-quality-objectives (accessed January 2017).

[159] Albert Simhon, "Health Canada, Ontario, USEPA Recreational Water Guidelines."

[160] Ontario. "Water Management.".

[161] Ontario, *Scientific Criteria for Microbiological Standards for Recreational Waters.* Ministry of the Environment, Hazardous Contaminants and Standards Branch, (city, February 1984), 17..

on a geometric mean density for a series of water samples).[162]

Cyanobacteria

Ontario has a very comprehensive plan for blue-green algae in drinking water. There is, however, no cyanobacteria monitoring plan at the provincial level in Ontario for recreational water quality. Some municipalities have a formal monitoring plan. In the case of reported blooms in Ontario, the Ministry of the Environment and Climate Change (MOECC), the Ministry of Natural Resources (MNR), the Conservation Authority, and the local municipality work together to investigate and manage the cyanobacteria. The province recommends issuing an advisory to the public after a visual confirmation. Beach closures are recommended when toxins are present and confirmed by laboratory tests.[163] Action is taken when levels reach those recommended in the *Guidelines for Canadian Recreational Water Quality*.

Cyanobacteria

- 100,000 cyanobacteria cells / mL

Microcystin

- 20 µg/L

Recreational Water Quality in Indigenous Communities in Ontario

As in other provinces, the FNIHB is responsible for delivering health services to indigenous reserves in Ontario.

There is recreational water quality monitoring on some First Nations reserves in Ontario. However, it is not managed the same way in each community.

Typically, a First Nations Chief and Council indicate an interest or a need for recreational water quality monitoring at an on-reserve beach or an untreated swim spot. EHOs from FNIHB's Environmental Public Health program support this initiative with equipment and training.[164] On-reserve recreational water quality monitoring programs are funded federally.[165]

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[162] Ontario. "Water Management.".

[163] Ontario, "Blue-Green Algae," Ministry of the Environment and Climate Change, https://www.ontario.ca/page/blue-green-algae (accessed December 12, 2016); Ontario, *Beach Management Guidance*.

[164] Shaun Mackie, personal communication, location, December 21, 2016..

[165] Canada, "First Nations and Inuit Health, Environmental Public Health."

Certain indigenous communities use their own on-reserve drinking water labs to test recreational water for indicator bacteria. Samples are also sometimes sent to provincial labs for processing. Most reserves that do not have access to provincial or contracted labs have an on-site drinking water lab.

On-reserve monitoring programs usually follow the federal guidelines rather than Ontario's standards for recreational water quality.

Recreational Water Quality monitoring in Ontario: Case studies

Kingston

Kingston, Ontario, like Toronto, Ottawa, Vancouver, Victoria and other older cities in Canada, relies on a combined sewer system. Stormwater and sewage combine during wet weather and raw sewage flows into nearby water. When this happens, bacteria levels soar and water does not meet government guidelines for public health or environmental protection. Water quality remains poor for about 48 hours after an overflow. However, few municipalities alert the public when a combined sewer overflow is happening, or happened recently, even though the quality of their recreational waters have been compromised with untreated sewage.

Utilities Kingston unveiled a new real-time sewer monitoring system: "Know Before You Go". This is a first in Canada. The system was made live in spring of 2017. The system alerts residents when untreated sewage overflows from waterfront pipes into Lake Ontario. It uses technology developed by Utilities Kingston to meet the needs of people who swim or boat in the city. The system lets the public know when a CSO is happening, as well as provides a warming is a CSO happened within the past 48 hours.

Toronto

Toronto's 11 official beaches are tested on a daily basis during the summer months. Beach advisories are issued when the previous day's test results exceed the provincial guideline of 100 *E. coli* / 100 mL of water.

The public can access test results on the Toronto Beaches website, and an open data feed is also available. Beaches are posted with water quality information.

Ontario Parks Beaches

Swimming areas at Ontario's Provincial Parks are monitored and managed by the Ministry of Natural resources. There are over 150 monitored Ontario Parks beaches. The beaches are monitored on either a weekly or monthly basis, or they are unmonitored. Monitoring frequency at

Ontario Parks beaches is determined based on their popularity and remoteness.

Sudbury and District Health Unit - Sewage Alerts and Blue-Green Algae

In 2014, the city of Greater Sudbury began issuing public alerts in the case of sewage bypasses and wastewater overflows.166 The move is meant to help protect public health by letting residents know when their water bodies have been contaminated by sewage.

Sudbury and District Health Unit also works with the provincial Ministry of the Environment to monitor blue-green algae at beaches for public bathing. Upon receiving a report of algae in recreational water, a health inspector from the Ministry of the Environment or from the Sudbury and District Health Unit will conduct a site visit for visual confirmation.[167]

If the presence of cyanobacteria is confirmed, the beach will be posted immediately with a caution status advisory warning bathers that "Blue-green algal blooms have been observed." This information is also communicated online on the health unit's Beach Water Testing Results page.

Algal (cyanobacteria) blooms are often readily apparent from visual inspection; however, the Health Unit will often confirm by testing for cyanobacteria (100,000 cells/ mL) and the algal toxin microcystin (0.5 µg/L).

Beaches are not usually physically closed unless there is an identified health hazard, such as a chemical spill or a high exceedance of water quality standards (e.g., *E. coli* levels are high above the provincially prescribed standard of 100 *E. coli* / 100 mL of water).[168]

Although the Sudbury and District Health Unit does not have statistics pertaining to illnesses acquired from recreational water bodies, laboratories are required to report any confirmed case of reportable diseases, such as giardiasis, cryptosporidiosis, and *E. coli*. The Sudbury and District Health Unit will then follow up to determine potential causes of illness. Reports of illness are tracked locally and provincially to determine clusters or potential outbreaks, which would be investigated further.[169]

The health unit's role with swimmer's itch is solely educational, as they do not conduct routine

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[166] City of Greater Sudbury, "Sewer and Water, Release Alerts," http://www.greatersudbury.ca/living/sewer-and-water/release-alert/sewer-bypass-alert-notification/ (accessed March 2017).

[167] Ashley DeRocchis, personal communication, August 30, 2016.

[168] Sudbury and District Health Unit, "Beach Water Testing: Frequently Asked Questions," https://www.sdhu.com/health-topics-programs/water/beaches-splash-pads-pools-spas/beach-water-testing-frequently-asked-questions (accessed August 2016); Ashley DeRocchis, personal communication.

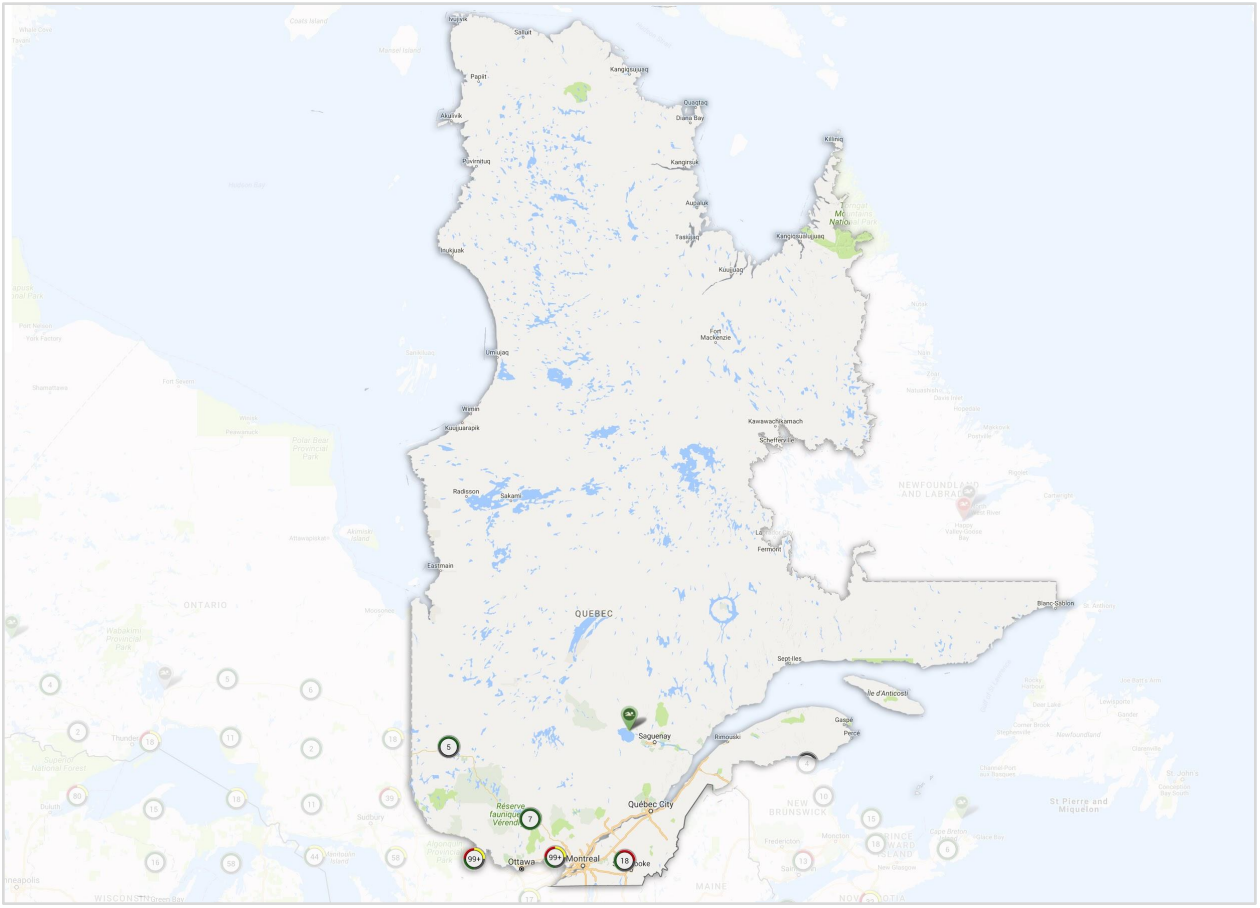
[169] Ashley DeRocchis, personal communication.

surveillance of swimmer's itch.[170]

The Sudbury and District Health Unit works closely with the City of Greater Sudbury to provide education on health matters related to recreational water use. Lifeguards are provided with education about beach water sampling and blue-green algae prior to the swimming season.

[170] Ibid.

Québec



There are about 400 public beaches in the province of Québec. The Ministry of Sustainable Development, Environment, and Action Against Climate Change (Ministère du développement durable, de l'environnement, et de la lutte contre les changements climatiques or MDDELCC) monitors approximately 345 of these beaches through its Environnement-Plage program.

The Québec beaches in the Environnement-Plage monitoring program are listed under 17 regions. Monitoring occurs from mid-June to the end of August. Certain municipalities and beach operators provide additional sampling data.[171]

Recreational water quality guidelines and beach supervision requirements in the province of Québec are legally defined in the Environmental Quality Act, Article 83 (*Loi sur la qualité de l'environnement*) and Regulation respecting safety in public baths (Règlement sur la sécurité dans

[171] Québec, Programme Environnement-Plage, accessed 19 October 2016, translated by Gabrielle Parent-Doliner, http://www.mddelcc.gouv.qc.ca/programmes/env-plage/index.htm

les bain publics).[172],[173]

In general, beaches are sampled at least 2 to 5 times during the swimming season, depending on their rating. Beaches are given a rating (A to D) depending on results from the previous year. Beaches with an A rating are sampled at least twice the following summer. Beaches with a B rating are sampled at least 3 times the following summer. The ministry will increase sampling and inspections at beaches that do not meet the A (excellent) or B (good) rating, and it will consult with the municipality to identify the source of contamination. These beaches will be sampled at least 5 times the following summer. New beaches will also be sampled at least 5 times when they first become part of the Environnement-Plage program.[174] A failing grade (D) means the beach will be temporarily closed until the samples show that the quality of the water is back to A,B, or C. [175] Many municipalities, such as Gatineau, carry out additional testing, often during alternating weeks, as part of the provincial Environnement-Plage program.[176]

Note that there are brackish waters in Québec. The St. Lawrence River, a grand river and estuary, empties into the Atlantic Ocean. Québec considers marine waters to have salinity equal to or greater than 10 parts per thousand. When water is of this salinity it is tested for *enterococci* rather than E.coli. This salinity level is found at the Saint Lawrence River at Jean-Port-Joli (MRC de l'Islet) and at Petite-Rivière-Saint-François (MRC de Charlevoix).[177]

Parameters for monitoring recreational water quality

Indicator Bacteria

Environnement-Plage uses a composite sampling technique to monitor beaches. This method entails collecting a large number of samples along a stretch of beach, then combining all the samples into a composite sample. The composite sample is then analyzed to provide an overview

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[172] Canada. Québec. *Loi sur la qualité de l'environnement*, c. ??, s. viii; Québec, "Fil D'information, Début du programme Environnement-Plage - Lanaudière," Portail Québec, http://www.fil-information.gouv.qc.ca/Pages/Article.aspx?idArticle=2406231706 (accessed February 13, 2017).

[173] Canada. Québec, *Règlement sur la sécurité dans les bains publics*, B- 1.1, r.11; Québec, "Programme Environnement-Plage," Portail Québec, http://www4.gouv.qc.ca/fr/Portail/citoyens/programme-service/Pages/Info.aspx?sqctype=sujet&sqcid=622 (February 2017).

[174] Québec, "Programme Environnement-Plage."

[175] Ibid.; Gille Delaunais, personal communication, email, 5 June 2017.

[176] Rachel Balderson, personal communication, email, August 29, 2016.

[177] Québec, "Communiqué de presse: Programme Environnement-Plage - Bilan régional, été 2016," MDDELCC, http://www.mddelcc.gouv.qc.ca/infuseur/communique.asp?no=3581(accessed October 19, 2016).

of the water quality at the stretch of beach where the samples were taken.

The length of the beach determines the number of samples to be taken and the number of composite samples that will be produced. A minimum of six samples is taken per beach. The analysis of the composite sample is used to determine whether a beach passes or fails water quality criteria. An arithmetic mean is used to calculate E.coli and *enterococci* counts (for example, the mean of 2 composite samples is the bacterial count).

In the event of an exceedance, resampling is to be carried out immediately, and the beach is closed until it passes water quality testing. If the beach fails a second test, the municipality shall, in accordance with Article 83 in the *Environmental Quality Act*, close the beach until the area has been remediated.[178]

> Lorsque, après enquête, une piscine, une plage ou tout autre lieu de baignade est considéré une menace pour la santé, la municipalité doit en interdire l'accès jusqu'à ce que ces lieux aient été assainis.[179]

The public is notified by signs at the beach, notices on the ministry's website, or by phoning the regional environmental control call centre.[180]

The monitoring frequency for each beach is determined based on its rating. Ratings are assigned at the end of a season using an arithmetic mean of the swim season test results.

Rating	**Quality**	**E. coli**	**Enterococci**	**Monitoring frequency /year**
A	Excellent (Pass)	up to 20 / 100 mL	up to 5 / 100 mL	2 times
B	Good (Pass)	20-100 / 100 mL	6 – 20 / 100 mL	3 times
C	Fair (Pass)	100-200 / 100 mL	21-35 / 100 mL	5 times
D	Polluted (Fail)	≧201 / 100 mL	≧ 36/ 100 mL	5 times

[178] Québec, *Vecteur La gestion des eaux de baignade : un monde de différences*, MDDELCC, Reseau Environnement.com, May 2010, 18-21,Accessed February 2017. http://www.mddelcc.gouv.qc.ca/eau/recreative/VECTEUR-mai2010-DBrouillette.pdf

[179] Canada. Québec. *Loi sur la qualité de l'environnement*, c. 49, d. viii, s.83.

[180] Québec, "Programme Environnement-Plage."

NEW BEACH				5 times

Cyanobacteria (fleurs d'eau d'algues bleu-vert et cyanotoxines)

Québec's protocol for cyanobacteria blue-green algae blooms is based on research by the Ministry of Sustainable Development, Environment, and Action Against Climate Change (Ministère du développement durable, de l'environnement et de la lutte contre les changements climatiques or MDDELCC) and the Ministry of Health and Social Services (Ministère de la Santé et des services sociaux or MSSS).[181]

Like most provinces, Québec follows the WHO's cyanobacteria criteria for recreational waters. A major difference is that the Institut National de Santé Publique du Québec (INSPQ) recommends that the WHO's low level of adverse health effects (20,000 cyanobacteria cells per mL), rather than at the levels that are considered moderate (100,000 cyanobacteria cells per mL), be followed.

MEEDLCC also considers a body of water impaired when cyanobacteria exceeds 20,000 cells per mL.

> Le ministère de l'environnement (MDDELCC) considère qu'un milieu aquatique est affecté par une fleur d'eau de cyanobactéries lorsque leur abondance est d'au moins 20 000 cellules par millilitre.[182]

MEEDLCC's Protocol for blue-green algae blooms:[183]

1. When a blue-green algae bloom is observed, the person or party who observed the bloom contacts the MDDELCC and makes a report. Individuals are invited to submit an online report to the MDDELCC. The bloom can also be reported to the local public health department.

2. After receiving a report, MDDELCC confirms the presence of blue-green algae. If field technicians suspect the presence of blue-green algae, a water sample is taken. If the

[181] Québec, "Algues bleu-vert," MSSS,,http://sante.gouv.qc.ca/conseils-et-prevention/algues-bleu-vert/ (accessed 23 January 2017); Québec, "Algues bleu-vert," MEEDLCC, http://www.mddelcc.gouv.qc.ca/eau/flrivlac/algues.htm (accessed 23 January 2017).

[182] Québec, "Cyanobactéries et cyanotoxines," Institute National de la Santé Publique, https://www.inspq.qc.ca/eau-potable/cyanobacteries (accessed February 13, 2017).

[183] Québec, "La gestion des épisodes de fleurs d'eau d'algues bleu-vert," MEEDLCC, http://www.mddelcc.gouv.qc.ca/eau/algues-bv/outil-gestion/gestion-episodes.pdf (accessed February 2017).

laboratory results of the test for cyanobacteria find there to be 20,000 cyanobacteria cells per mL or more, MDDELCC alerts the affected municipality that there is a bloom and informs them of test results. The person or party who originally observed the bloom is also notified.

3. When there is a confirmed blue-green algae bloom, MDDELCC follows general procedures for an affected water body. There are procedures for drinking water, recreational waters, and official public beaches. The department of public health can also take action if they are the first to be alerted by MDDELCC in case of risk to the health of the population.

4. In the case of a blue-green algae bloom at a public beach, the beach is either totally or partially closed, depending on the location of the bloom. All swimming, and contact with the affected area is prohibited. The public must be alerted to the potential dangers to their health, with signs or with other onsite barriers and information indicating what activities should be avoided until the bloom is no longer a threat. The regional tourist association or the municipality must also be notified of the bloom.

Cyanobacteria criteria prompting Québec to take action to protect public health[184]

Alert threshold for cyanobacteria:

- **Low adverse health effects:** 20 000 cyanobacteria cells per mL
- **Moderate low adverse health effects:** 100,000 cyanobacteria cells / mL

Alert threshold for cyanotoxins

Québec's alert threshold for cyanotoxins were put in place to protect those most at risk of subchronic toxicity in the case of ingestion or contact with a cyanotoxin. Children are particularly vulnerable to cyanotoxins, because they spend more time in the water. Studies have shown that children ingest twice the amount of water as adults. Children also have a lower body weight.[185]

Microcystin

16µg/L

Anatoxine -A

40 µg/L

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[184] Québec, "Cyanobactéries et cyanotoxines."

[185] Ibid.

Communication, beach postings, and advisories

The public is notified of water quality issues by signs at the beach. They can also access recreational water quality monitoring results for monitored beaches on the ministry's website. The website is updated daily at 11AM during monitoring season with any new water quality results. The public can also find out the water quality at monitored recreational water sites by phoning their regional the environmental control call centre.[186] In the case of cyanobacteria, the regional tourism association is also notified in order to spread information about the bloom.

Recreational Water Quality Monitoring on-reserve in Québec[187]

Health Canada's FNIHB is responsible for delivering environmental public health services to indigenous reserves in Québec (with the exception of communities under the Convention de la Baie-James et du Grand nord du Québec and transferred communities)

Seasonal monitoring of recreational Water is offered to communities. Each year a community action plan which could include a recreational water quality monitoring is developed with each First Nations Health Directions. EHOs from FNIHB's Environmental Public Health program support this initiative with equipment and provide training to community samplers.

In 2016, 40 swimming sites were sampled in 18 different communities. In the evaluation of the water-quality conditions, approximately 18-20 recreational water samples are taken. Samples are then sent to our accredited laboratory for anlaysis. Additional analyses are sometimes performed in certain indigenous communities by using their own on-reserve drinking water labs to test recreational water for indicator bacteria (E coli –Idexx Colilert Quantitray).

Interpretation of the results are done using recreational water quality guidelines which carry stricter criteria: the federal guidelines or provincial standards, models, or protocol. At the present time, the Québec provincial guidelines are used as reference to classify recreational waters.

When any samples exceeds recreational water quality guidelines,the Community Health Director is alerted and public notice on-reserve follows. Communication of poor water quality can include a sign erected at the beach and radio notice.

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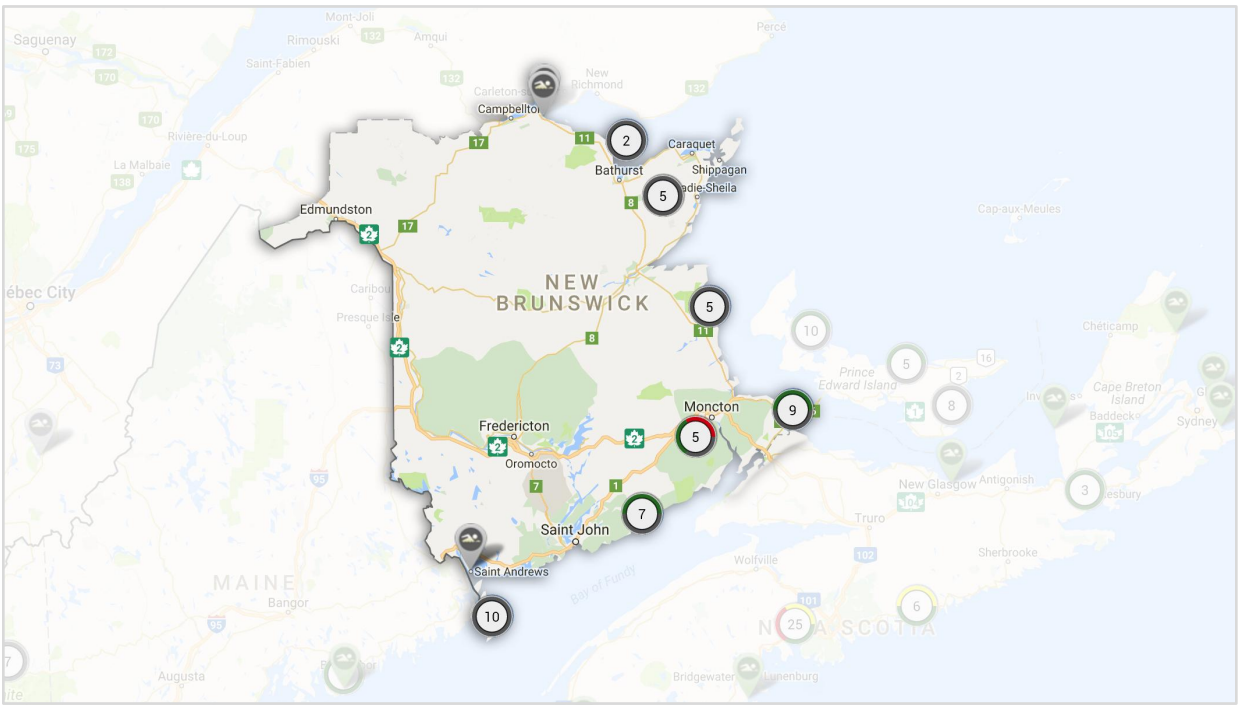
[186] Québec, "Programme Environnement-Plage."

187 Oumar Ba, personal communication, 8 June 2017.

New Brunswick



New Brunswick's Department of Tourism reports that there are approximately 60 official beaches for swimming and recreational water activities in the province. However, few of New Brunswick's beaches are monitored. New Brunswick had neither a standardized policy for recreational water quality monitoring at beaches and other untreated swim spots in the province188 nor a set of recommendations for monitoring recreational water quality at fresh and marine water beaches.

Several municipalities have their own monitoring programs for local beaches. The City of Moncton monitors Centennial Park Beach during the swimming season. This is a man-made pool/beach with sand and its own water system that is not influenced by sewer or stormwater outfalls.[189] Another example of a municipal beach water testing program is that of the Town of Sackville, which monitors Silver Lake in Lillas Fawcett Park. The lake is tested weekly from June to September for *E. coli* and coliform. Results are posted at the lake.[190] In addition, a municipal beach called Aboiteau is monitored and may in future participate in the Blue Flag program, in which samples are collected

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[188] Diane. Fury, personal communication, phone, July 18, 2016.

[189] Heather Fraser, personal communication, phone, August 25-26, 2016.

[190] New Brunswick, "Town of Sackville," Tourism New Brunswick, http://www.tourismnewbrunswick.ca/Products/L/Lillas-Fawcett-ParkandSilver-Lake.aspx (accessed November 2016); Diane Fury, personal communication.

weekly during the beach season. The village of Cap Pelé monitors Aboiteau beach.

The provincial Department of Health originally carried out the very limited beach testing at other monitored beaches in the province. The department monitored Parlee Beach and Murray Beach, both provincial park beaches. The Department of Tourism took on the responsibility for New Brunswick's other beaches, developing a rating system for the beaches it monitors.

There are a number of limitations to the Department of Tourism's recreational water quality monitoring. The recreational water quality criteria, monitoring protocol, and the communication and advisory system are not clearly defined. The rating system for these beaches ranges from excellent, good, fair, and poor, to closed.[191] The ratings are based on *E. coli* and *enterococci* levels and rain events. However, this rating system is not a standard or policy, and information about the beach monitoring program is not public facing. The Department of Tourism at Parlee Beach only requires a beach to be closed to swimming in the case of an industrial or chemical spill or a widespread communicable disease outbreak.

There was significant media coverage in 2016 spotlighting this poorly defined beach water quality monitoring, which impacted public health at two of the provinces most popular beaches : Parlee and Murray. Poor public notice surrounding water quality problems at two of the province's most popular beaches are a long term problem. Protection of human health from contaminated recreational water was compromised by this system.

Parameters for monitoring recreational water quality: Department of Tourism

Indicator Bacteria

- **Excellent:** Water quality based on bacteriological counts is categorised the same as good No limitations of activities.
- **Good:** No precipitation within the last 24 to 48 hours. Bacteriological data - between 0 & 99 E. Coli. / Faecal coliform or 0 to 14 *enterococci* within a 100 mL sample. Excellent weather conditions - absence of wind and waves. Light bather load. Clear water conditions.
- **Fair:** Low levels of precipitation in the last 24 to 48 hours: less than 10mm. Generally not less than 5mm in a 24-hour period. Bacteriological data - between 100 & 174 E. Coli. / Faecal coliform or 15 to 29 *enterococci* within a 100 mL sample. Absence of wind and waves. Moderate bather load. Absence of "undetermined matter" within the water. Absence of algae blooms. Moderately clear water conditions.
- **Poor:** Bacteriological data - between 175+ E. Coli. / Faecal coliform or 30 *enterococci* within a 100 mL sample. Windy/wavy conditions. Heavy bather load. Presence of

[191] Gabrielle Fahmy, "Parlee Beach Water Quality Bacteria." *CBC*, August 29, 2016, accessed January 2017, http://www.cbc.ca/news/canada/new-brunswick/parlee-beach-water-quality-bacteria-1.3740466

"undetermined matter" in the water. Presence of algae blooms. Particularly cloudy/turbid water conditions. Factors to consider in the surrounding environment: Municipal storm and sewage / adjacent farms; Natural drainage/upsets/spills; Presence of large flocks of birds; Malfunction of nearby septic systems.

- **Closed:** Chemicals: industrial/spills. Widespread communicable disease outbreak.

Cyanobacteria

In New Brunswick, the departments of Environment and Local Government (DELG) and Health (DH) work in partnership to respond to algal blooms.192 The DELG responds to blooms and carries out sampling and analyses. Both the DELG and DH issue public health notices regarding cyanobacteria and toxic algae.

The *DH's Guidance for Public Advisories on Cyanobacterial Blooms in Recreational Water* recommends how advisories about algae blooms are communicated with the public.

Communication, beach postings, and advisories

There is no provincial recommendation on how indicator bacteria exceedance and other recreational water quality information is to be communicated among monitoring bodies, stakeholders, and the public.

There are, however, clear guidelines on cyanobacteria advisories. When there is a blue-green algae bloom and/or toxic algae, the public is notified via the Government of New Brunswick's website, onsite signage, and in the media.[193]

Changes to New Brunswick recreational monitoring protocol: Spring 2017

In April 2017, the province released a notice to the press that a new recreational water quality monitoring protocol is being developed in accordance with the *Canadian Guidelines for Recreational Water Quality.*[194] At the time of this report's publication, the updated protocol was specific to Parlee Beach. This new protocol is called the Parlee Beach Water Monitoring Protocol.

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[192] New Brunswick, *Algal Bloom Action Plan*, Department of Environment and Local Government, Water, 7 October 2016, Accessed December 9, 2016. http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/Algae-Algues/AlgalBloomActionPlan.pdf

[193] New Brunswick, "Public Health Advisories and Alerts," Office of Chief Medical Officer, http://www2.gnb.ca/content/gnb/en/departments/ocmoh/health_advisories.html (accessed December 2016)

[194] New Brunswick, "New protocol for monitoring water quality at Parlee Beach," Department of Health, Department of Environment & Local Government, Department of Tourism, Heritage, & Culture, April 5, 2017,
http://www2.gnb.ca/content/gnb/en/news/news_release.2017.04.0435.html (accessed April 2017).

The provincial government indicated that a province-wide update is forthcoming, and it will include increases to the number of monitored locations and monitoring of recreational water quality at these locations in accordance with the federal guidelines.[195]

> A water quality monitoring protocol will be developed for Murray Beach and all other provincial parks based on the principles behind the protocol for Parlee Beach. The *Guidelines for Canadian Recreational Water Quality* require an assessment to be done for each provincial park in order to develop protocols for each of them. This assessment will be completed for all parks within the provincial park system before this summer.[196]

Due to the long term monitoring and reporting issues at Parlee beach we were not able to confirm the integrity of the new protocol and monitoring program in time for publication of the Canada Beach Report.

Watershed Organizations in New Brunswick: Case Study

Watershed organizations, such as the Petitcodiac Watershed Alliance (PWA) are funded through the Department of Environment and focus on monitoring the water quality of freshwater tributaries.[197]

The Petitcodiac Watershed Alliance operates primarily out of the Moncton area. When conducting water quality testing and monitoring, PWA is careful to avoid duplication of efforts with the City of Moncton, which also monitors a beach in the area. PWA uses the federal guidelines, tests for *E. coli* only, does not use a geometric mean, and collects one sample per beach on a monthly basis.

Other watershed organizations in New Brunswick include:

- Shediac Bay Watershed Alliance - provincial beaches
- Eastern Charlotte Waterways (southern New Brunswick) - marine waters

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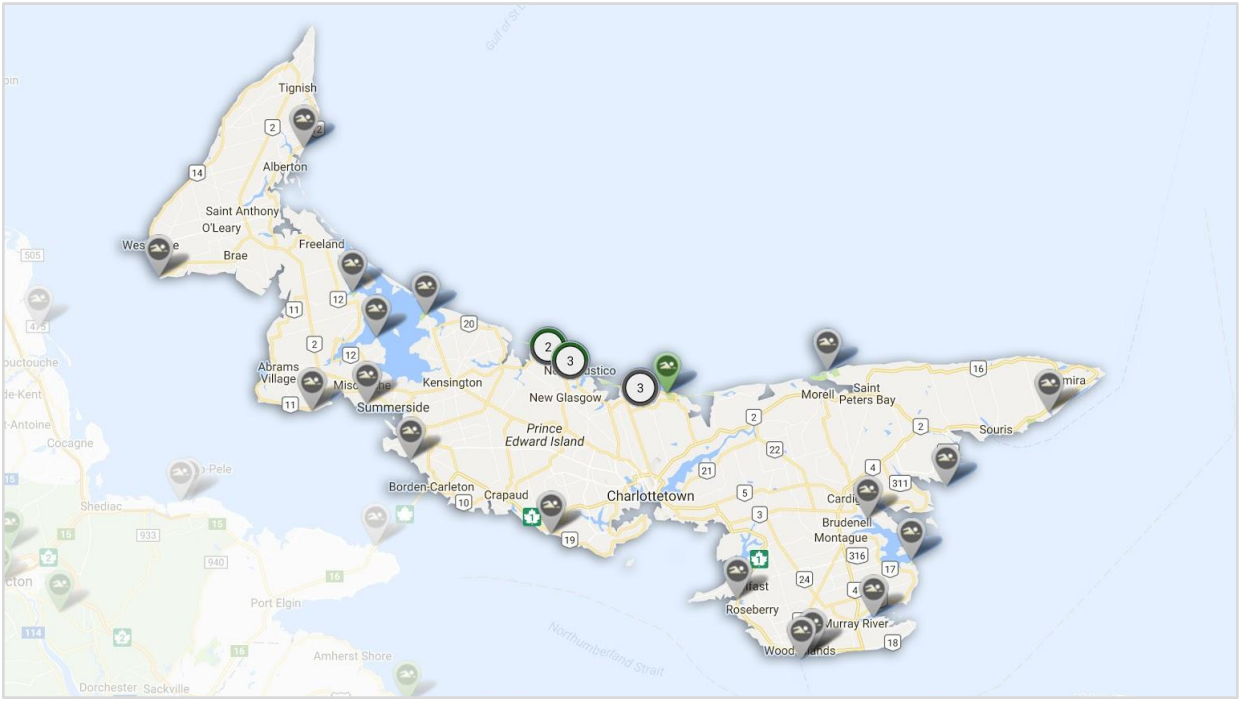
[195] New Brunswick, Department of Health, *Parlee Beach Water Monitoring Protocol,* Spring 2017, accessed June 2017

[196] Ibid.

[197] Diane Fury, personal communication.

Prince Edward Island



According to Tourism PEI, the island province has more than 800 kilometres of beaches and 90 official beaches. However, the province has neither instituted recreational water quality monitoring guidelines or standards, nor does it conduct monitoring of its marine or freshwater beaches.

The only recreational water quality monitoring on Prince Edward Island is conducted by Parks Canada. Parks Canada takes samples at four freshwater tributaries at three National Parks beaches: North Rustico, Stanhope, and Cavendish. The freshwater tributaries are sampled from the end of June to September on a weekly basis.

Parameters for monitoring recreational water quality

Indicator bacteria

Parks Canada samples for *E. coli*, and uses a single sample threshold of 200 *E. coli* / 100 mL for a single sample.[198]

Parks Canada posts an advisory at the outflow if the 30-day geometric mean at freshwater outflows rises above 200 *E. coli* / 100 mL of water. If a site exceeds recreational water quality criteria it is not resampled. There is no resampling in the instance of an exceedance as the samples

[198] Arja Page, personal communication, Phone interview, September 29, 2016.

take between 3 and 5 days to process.

Parks Canada threshold

200 *E. coli* / 100 mL of water - 30-day geometric mean

Cyanobacteria

Blue-green algae and toxic blooms are uncommon in PEI. There is no monitoring program in place for cyanobacteria. Rather, blooms are monitored and advisories are issued on a case-by-case basis. The Department of Communities, Land, and Environment, in coordination with Public Health, handle reports of blooms. PEI's chief medical officer issues a public advisory when a water body is affected with a "heavy growth" of blue-green algae.[199]

Communication, beach postings, and advisories

In the case of a water quality issue at a recreational site, onsite public notices are put up. Parks Canada also shares the information with stakeholders. In the case of blue-green algae, additional measures are taken to communicate the health risks with the public. Onsite signage is put up to inform recreational water users of the associated health risks. The government of PEI also has a website where cyanobacteria alerts are posted.[200]

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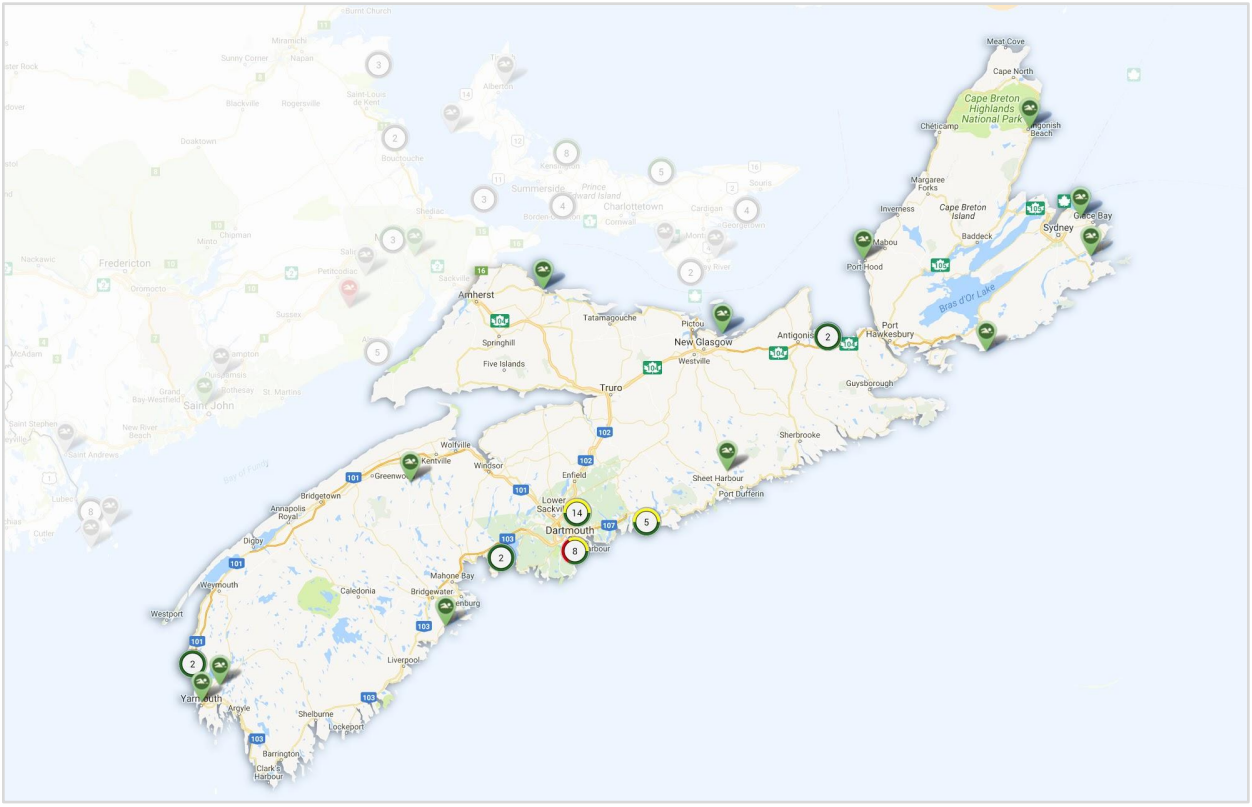
[199] Prince Edward Island, "Blue-Green Algae (Cyanobacteria)," Communities, Land, and Environment, https://www.princeedwardisland.ca/en/information/communities-land-and-environment/blue-green-algae-cyanobacteria (accessed October 2016).

[200] Ibid.

Nova Scotia



Nova Scotia does not have a provincial protocol or set of guidelines for monitoring recreational water in the province.

The Nova Scotia Lifeguard Society (NSLS) and the Halifax Regional Municipality (HRM) conduct regular monitoring of recreational waters. In addition to supervising beaches, the Department of Health and Wellness contracts the NSLS to conduct weekly testing of the water at all supervised beaches to ensure the water meets the criteria recommended in *Guidelines for Canadian Recreational Water Quality*. The province recommends the *Guidelines for Canadian Recreational Water Quality* to the authorities managing and monitoring beaches.

> The Environmental Health Division assists with the interpretation of sample results and takes action with the Regional Medical Officer of Health to ensure swimmers are protected from water that has bacteria levels higher than those indicated in the Canadian Guidelines for Recreational Water Quality.[201]

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[201] Nova Scotia, "Nova Scotia Beaches," Environmental Health, Recreational Water http://novascotia.ca/dhw/environmental/beaches.asp (accessed December 11, 2016).

On 1 July 2016 Nova Scotia Environment was formed, consolidating several departments: the Department of Natural Resources, the Department of Health and Wellness, the Department of Agriculture, Nova Scotia Environment, and the Department of Fisheries and Aquaculture. The Environmental Health and Food Safety Division of Nova Scotia Environment now coordinates the assessment of and response to reported or suspected health hazards at beaches in Nova Scotia.[202]

Halifax Regional Municipality

The Halifax Regional Municipality (HRM) monitors water quality at 23 supervised beaches in the Halifax region on a minimum weekly basis in July and August. While there are no official provincial standards in place for beach management, the municipality's beach monitoring program is based on the *Guidelines for Canadian Recreational Water Quality*.[203]

Beaches are managed (i.e., closure and re-opening of beaches) cooperatively between the HRM, Halifax Water, Nova Scotia Environment, and the local Medical Officer of Health through the Nova Scotia Department of Health and Wellness.[204]

Generally, water at inland beaches is tested for *E. coli*, and marine or estuarine beaches are tested for *Enterococci*. Currently, two samples are collected at each beach; openings and closures are determined based on the framework for single samples, which correspond to the federal recreational water quality maximum values for a single sample.[205]

Parameters for monitoring recreational water quality

Indicator bacteria

E. coli

- 400 *E. coli* / 100 mL – single sample maximum

E. coli is the indicator bacteria for water quality. In the event of a single sample exceedance of the maximum guideline value of 400 *E. coli* / 100 mL for a single sample, the beach will be posted and

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[202] Nova Scotia, " Highlights," http://novascotia.ca/nse/environmental-health/ (accessed December 2016).

[203] Cameron Deacoff, personal communication, email, August 30, 2016.

[204] Ibid.

[205] Ibid.

closed for swimming and re-sampling will take place.[206]

In addition, the HRM also re-samples if a single sample exceeds the federally-prescribed geometric mean guideline of 200 *E. coli* / 100 mL of water. In these circumstances the beach would not be closed unless the single sample maximum value is also exceeded.[207]

Enterococci

- 70 *Enterococci* / 100 mL – single sample maximum

Enterococci is the indicator bacteria for marine or estuarine (brackish water) beaches. In the event of a single sample exceedance of the maximum guideline value of 70 *enterococci* / 100 mL for a single sample, the beach is posted and closed for swimming and re-sampling takes place.[208]

In addition, the HRM also re-samples if a single sample exceeds the federally-prescribed geometric mean guideline of 35 *enterococci* / 100 mL of water. In these circumstances the beach would not be closed unless the single sample maximum value is also exceeded.[209]

Cyanobacteria

During the (rare) suspected presence of blue-green algae, samples will be collected to confirm that cyanobacteria is present. In such an event, the HRM follows the federal guidelines in posting or closing the beach.[210]

Communication, beach postings, and advisories

Beaches are physically posted when sample result values exceed the single sample maximum guidelines (mentioned above) for either *E. coli* or *enterococci*. Lifeguards on duty at these supervised beaches will also advise beachgoers to avoid swimming or contact with water.[211]

In addition, beach status is posted on the municipality's website at http://www.halifax.ca/rec/aquatics/beaches.php; on Twitter alerts (@HfxGov); via the media room at https://apps.halifax.ca/

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[206] Ibid.

[207] Ibid.

[208] Ibid.

[209] Ibid.

[210] Ibid.

[211] Ibid.

hfxnews; and on the municipality's Beach Hotline, 902.490.5458.[212]

Nova Scotia Lifeguard Service

The NSLS monitors water quality at 23 supervised beaches across Nova Scotia. The beach monitoring program is based on the *Guidelines for Canadian Recreational Water Quality*.[213]

Parameters for monitoring recreational water quality

Indicator Bacteria

The majority of the beaches are marine. Water is tested weekly with 5 samples collected from each beach.[214] *Enterococci* is the indicator bacteria for marine waters, while *E. coli* is used for freshwater.[215] Five samples are collected at each beach, and openings and closures are determined according to the federal recreational water quality maximum values for both single sample maximum and geometric mean:

E. coli

- 400 *E. coli* / 100 mL - single sample maximum
- 200 *E. coli* / 100 mL - geometric mean of 5 samples

Enterococci

- 70 *Enterococci* / 100 mL - single sample maximum
- 35 *Enterococci* / 100 mL - geometric mean of 5 samples

Cyanobacteria

During the (rare) suspected presence of blue-green algae, samples will be collected to confirm that cyanobacteria is present. In such an event, the NSLS follows the federal guidelines for posting or closing the beach.[216]

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[212] Ibid.

[213] Nova Scotia Lifeguard Services, "Supervised Beaches," http://www.nsls.ns.ca/supervised-beaches (accessed August 2016).

[214] Sara Jennex, personal communication, location, August 31, 2016.

[215] Ibid.

[216] Ibid.

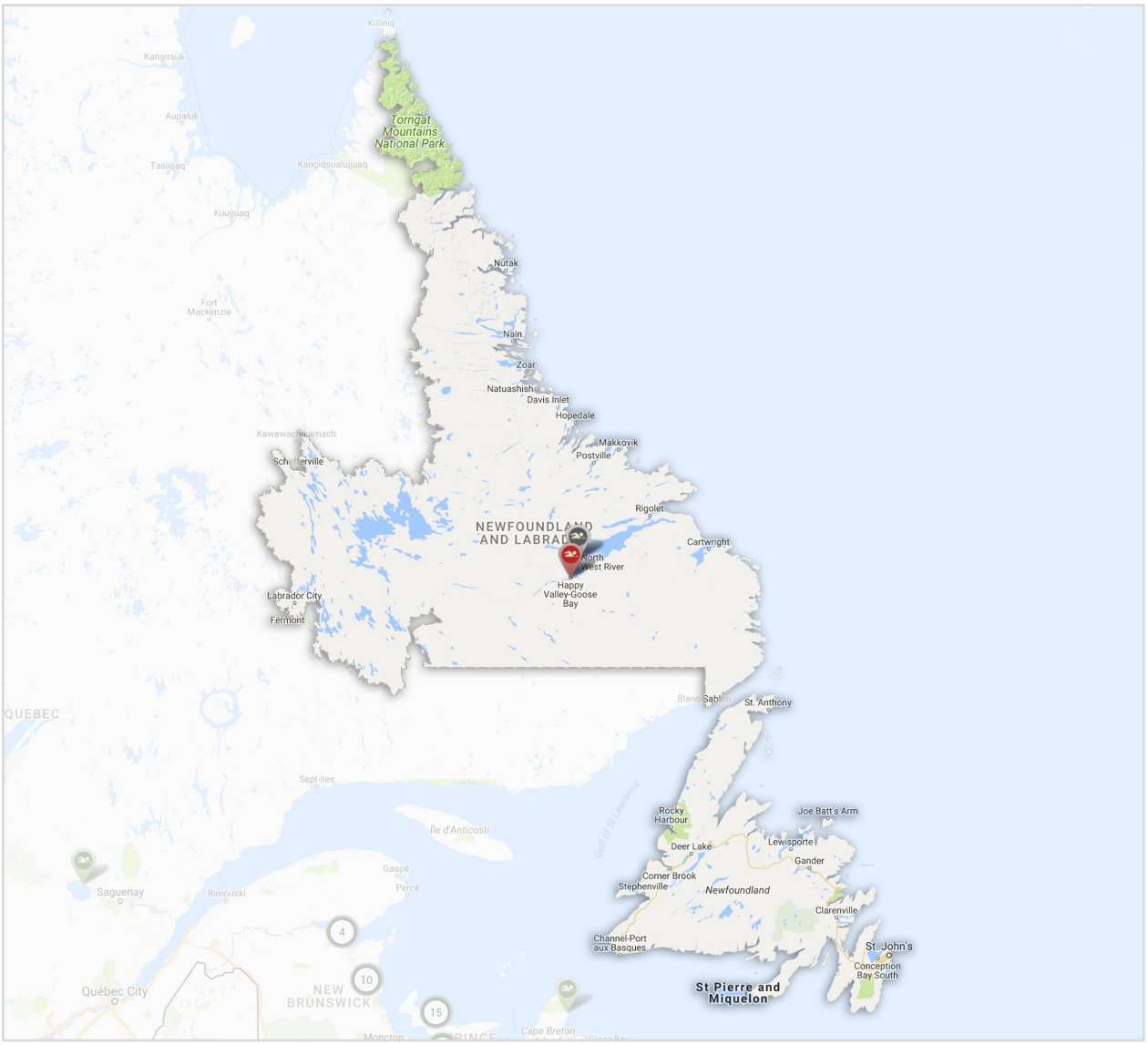
Communication, beach postings, and advisories

The Department of the Environment sends sample results to the province's Medical Officer of Health, who has the authority to close a beach. Officials will close a beach if the *Enterococci* level reaches 70 counts per 100 mL of water. Beaches may be retested when counts exceed 200 *E. coli* per 100 mL of water. When counts exceed 35 *Enterococci* per 100 mL, beaches are retested every 24 to 48 hours until levels drop below the accepted levels and closure is considered.

Lifeguards on duty at supervised beaches will advise beachgoers to avoid swimming or contact with water. The Department of Health and Wellness will issue public notices once a beach is reopened. Beach status is displayed on the NSLS website at http://www.nsls.ns.ca/?q=supervised-beaches.[217]

[217] Sueann Musick, "Lifeguard service: Beach closures are not common." New Glasgow News, August 14, 2015, accessed August 2016, http://www.ngnews.ca/News/Local/2015-08-14/article-4246618/Lifeguard-service-beach-closures-are-not-common/1

Newfoundland and Labrador



The public, recreational beaches/natural swimming areas of Newfoundland and Labrador are not routinely monitored, tested, or sampled for recreational water quality and exceedance. This includes both marine and freshwater swimming sites. However, indicator bacteriological monitoring and cyanobacteria monitoring are conducted on an as-needed basis.

Under the 1986 Canada-Newfoundland and Labrador Water Quality Monitoring Agreement (WQMA), Environment and Climate Change Canada and the provincial Department of Environment and Climate Change Conservation monitor ambient surface water quality at about 120 sampling locations and water bodies. The main management goal of this federal-provincial agreement is to

"ensure water quality is suitable for different beneficial water uses."[218] Chemical and physical parameters are collected under this monitoring program. Bacteriological monitoring is sometimes included in ambient surface water quality monitoring. However, bacteriaological monitoring is not undertaken to provide information regarding suitability for swimming and other recreational water activities.

Parameters for monitoring recreational water quality

Indicator bacteria

Service Newfoundland and Labrador conducts bacteriological monitoring of natural swimming areas in the province on an as-needed basis.[219]

Cyanobacteria

The Department of Environment and Climate Change monitors blue-green algae. This fairly new initiative commenced in 2007. Prior to August 2007, blue-green algae were not prevalent in Newfoundland and Labrador. [220]

The Department of Environment and Climate Change monitors cyanobacteria on a case-by-case basis. The Department investigates blooms as reports of their presence are received.

The Department follows Health Canada's *Guidelines for Canadian Drinking Water Quality* for microcystin-LR when a drinking water supply is at risk. However, to date no drinking water has been affected with toxic algae in Newfoundland and Labrador.[221] All other water bodies are monitored according to the *Guidelines for Canadian Recreational Water Quality.*[222]

- Microcystin-LR not exceeding 1.5 ug/L (drinking water)
- Total cyanobacteria not exceeding 100,000 cells/mL and total microcystins not exceeding 20 ug/L (expressed as microcystin-LR). (recreational water)

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[218] Newfoundland Labrador, "Water Quality Monitoring Agreement," Department of Environment and Conservation, http://www.env.gov.nl.ca/env/waterres/quality/background/agreement.html (accessed November 1, 2016).

[219] Renee Paterson, personal communication, location, December 5, 2016.

[220] Newfoundland Labrador, "Blue-Green Algae Cyanobacteria," Department of Environment and Conservation, http://www.env.gov.nl.ca/env/waterres/quality/background/bgalgae.html (accessed November 18, 2016).

[221] Newfoundland Labrador, *Blue-Green Algae Monitoring Summary Report 2007-2015*, Department of Environment and Conservation, March 2016, Accessed November 18, 2016. http://www.env.gov.nl.ca/env/waterres/quality/background/bga_reports/bga_rpt2016.pdf

[222] Ibid.

Communication, beach postings, and advisories

The following channels of communication are used to alert the public about a recreational water quality issue: onsite signage, website, media outlets like TV and radio, and social media. The channels used depend on the area that is affected by a recreational water quality issue.[223]

[223] Renee Paterson, personal communication.

Nunavut, Northwest Territories, and Yukon

The territories of Nunavut, Northwest Territories, and Yukon do not routinely monitor beaches.

Yukon

The Yukon government does not implement routine testing or monitoring at any of the beaches in

the territory.[224] Yukon beaches are not staffed by lifeguards. In the case of problems (e.g., algae blooms, which do not frequently occur) the Yukon government has a regulation it can follow; however, this situation is atypical.[225] In June and July, the lakes tend to be less suitable for swimming as they become even colder due to glacial melt. To avoid the physical risks of river swimming, families and children are encouraged to make use of community pools for swimming and recreation.[226]

Northwest Territories

The government of the Northwest Territories does not monitor beach or recreational water quality.[227]

Nunavut

Nunavut does not have a regular beach sample or monitoring program. Most recreational water activities in the territory involve boating, often for purposes of hunting.228 While some testing is conducted in relation to pollution or contamination at beaches, this work is neither territory wide, nor carried out at regular intervals.[229] The Department of Health monitors recreational water on a complaints-based basis.

In the case of a report of contamination of a fresh or marine water site, the Department of Health may work with the Department of Environment or Indigenous and Northern Affairs Canada (INAC). Public health issues related to water are communicated to affected communities via the Chief Medical Officer of Health. This is done in accordance with the standards mandate and responsibility under the Public Health Act.[230]

The presence of blue-green algae is not monitored in Nunavut.

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[224] Environment Yukon, personal communication, phone, August 22, 2016.

[225] Ibid.

[226] Ibid.

[227] Peter Workman, personal communication, phone, August 24, 2016.

[228] Michele Leblanc-Havard, personal communication, email, 9 January 2017.

[229] David Oberg, personal communication, email, 14 December 2016

[230] Michele Leblanc-Havard, personal communication.

National Highlights

Recreational water quality monitoring leaders

Alberta and Manitoba are leaders in blue-green algae monitoring. Alberta monitors cyanobacteria and cyanotoxins proactively.

Québec follows the strictest guidelines in Canada for monitoring cyanobacteria. The Institut National de Santé Publique du Québec (INSPQ) recommends that the WHO's low level of adverse health effects (20,000 cyanobacteria cells per mL), be followed.

Ontario stands out as a leader in recreational water quality monitoring and information reporting. In general, Ontario's municipal governments do a better job testing waters and sharing information than other provinces. Ontario applies one of the best recreational water quality guidelines for protecting public health and the environment. Kingston, Ontario also has the only real-time combined sewer overflow and sewage bypass alert system in the country.

Despite the province's short summer, cold water temperatures, and lack of sandy beaches Newfoundland and Labrador monitor recreational water quality on a case by case basis, following the federal guidelines.

New Brunswickers brought attention to the poor recreational water quality monitoring and public notice practices at Parlee and Murray Beach in 2016. As a result of public and media pressure, New Brunswick made significant improvements to recreational water quality monitoring and public notice practices at these beaches in 2017.

Recreational water quality monitoring programs on Indigenous reserves seem to have more community involvement when it comes to determining whether a water body should be monitored for recreational water quality.

Recommendations

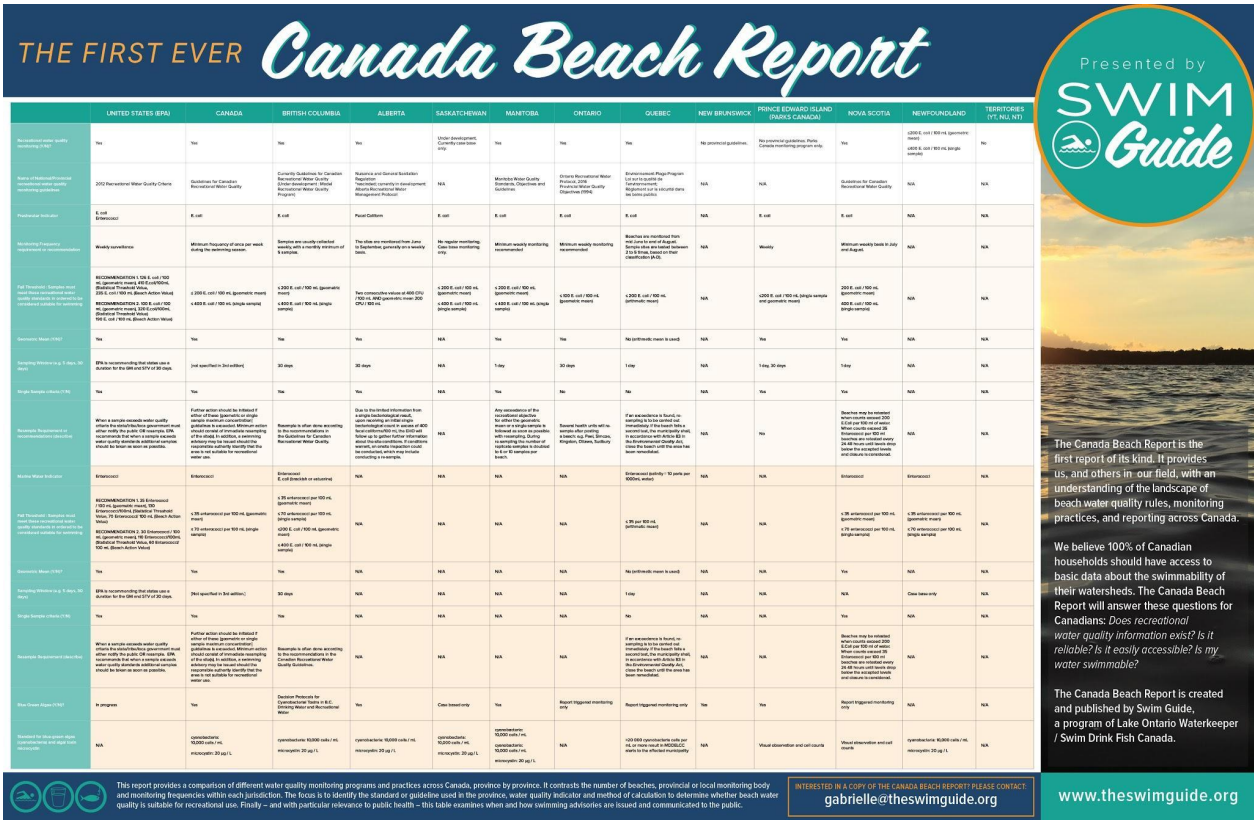
In order to protect public health and inspire people to restore and protect Canada's water bodies, recreational water quality monitoring in Canada needs to improve at the provincial and municipal level.

Most Canadians continue to swim and recreate in unmonitored and under-monitored waters. Canadians are not alerted to events that could contaminate their waters and impact their health.

Swim Guide offers the following ten recommendations to provinces and municipal monitoring authorities:

1. Provinces without standardized recreational water quality monitoring should develop and implement a recreational water quality monitoring model or protocol for their municipalities, EHOs, and beach operators, based on the federal guidelines for recreational water quality monitoring.
2. More water bodies and recreational water sites need to be monitored in all provinces, to better reflect the growing popularity of outdoor recreation activities.
3. Beaches should be tested more frequently in all provinces, to improve the accuracy of water quality information being communicated to the public.
4. Recreational water quality information should be released to the public faster and through more channels (e.g., social media, press releases). In addition to physical signs at beaches and swim spots, the public should be able to access results online, and through other media.
5. Current recreational water quality data from monitoring program, including information such as date of sample and bacteria counts, should be open and accessible to the public.
6. The public should be notified when wet weather events could impact the quality of their recreational waters and put their health at risk.
7. The public should be notified of combined sewer overflows that impact the quality of their waters with untreated sewage. Kingston's new real-time warning system is recommended as the gold standards for CSO notification.
8. The public should be notified when there are bypasses at sewage treatment plants.
9. Municipalities with old wastewater infrastructure, including combined sewers, should have a plan in place to separate their sewage from their stormwater.
10. Water literacy campaigns should be launched to help the public better understands the impact poor water quality may have on their health and waterways, the sources of pollution at their favourite beaches and swim spots, and actions they can take to protect their health and the health of the environment.

Appendix A



To download a copy of the Canada Beach Report graphic, visit www.theswimguide.org

Appendix B

Summary of number of monitored beaches per province/territory

Province/Territory	Public Beaches *	Monitored Public Beaches
British Columbia	450	280
Alberta	250	46**
Saskatchewan	70	0
Manitoba	60	60
Ontario	850	850
Quebec	400	350
New Brunswick	60	2
Nova Scotia	100	46
Prince Edward Island	>90	4
Newfoundland and Labrador	N/A	0
Nunavut	N/A	0
Northwest Territories	N/A	0
Yukon	N/A	0

*Public beaches are those recognized by local governments as official natural bathing locations. Beaches on Indigenous reservations are not included.
**This number reflect beaches monitored by AHS. Approximately 200 beaches had varying levels of sampling for faecal coliforms completed by their own operators.

Appendix C

Summary of Public Reporting Practices

Province/ Territory	Routine Reporting	Media Advisories	Phone Hotline	Website	Social Media Reporting	Mobile App	In Swim Guide
British Columbia	✓	✓*	✓*	✓*	✓*	X	✓
Alberta	✓	✓	X	✓	X	X	✓
Saskatchewan	X	N/A	N/A	N/A	N/A	N/A	N/A
Manitoba	✓	✓	✓	✓	✓	X	✓
Ontario	✓	✓*	✓*	✓*	✓*	✓*	✓
Québec	✓	✓	X	✓	X	X	✓
New Brunswick	X	X	X	✓ (BGA)	X	X	✓
Nova Scotia	✓	✓	X	✓	X	X	✓
PEI	✓	✓ (BGA)	X	✓ (BGA)	X	X	✓
Newfoundland and Labrador	X	✓	X	✓ (BGA)	✓	X	X
Nunavut	X	N/A	N/A	N/A	N/A	N/A	N/A

Northwest Territories	*X*	N/A	N/A	N/A	N/A	N/A	N/A
Yukon	*X*	N/A	N/A	N/A	N/A	N/A	N/A

✓="Yes" ✓*="Varies by health unit" ✓**(BGA)**="Yes, Blue Green Algae" *X*="No" **N/A** ="Not Applicable"

Appendix D

Other Automated or Routine Alerts for Recreational Water Users

Province/ Territory	Wet weather alerts	Sewage bypass	Combined Sewer Overflow (CSO)
British Columbia	X	X	X
Alberta	X	X	X
Saskatchewan	X	X	X
Manitoba	✓*	X	✓
Ontario	✓*	✓* (Sudbury, Kingston, Ottawa)	✓ (Kingston only)
Québec	X	X	X
New Brunswick	X	X	X
Nova Scotia	X	X	✓*
PEI	X	X	X
Newfoundland and Labrador	X	X	X
Nunavut	X	X	X
Northwest Territories	X	X	X
Yukon	X	X	X

✓="Yes" ✓*="Varies by region" X="No"

Links and Resources

British Columbia Links and Resources

Fraser Health: http://www.fraserhealth.ca/your_environment/recreational_water/beach_conditions/beach-condition-reports

Interior Health: http://www.interiorhealth.ca/YourEnvironment/RecreationalWater/Documents/Beach-sample-results.pdf and https://www.interiorhealth.ca/YourEnvironment/RecreationalWater/Pages/default.aspx

Island Health: http://www.viha.ca/mho/recreation/beach_reports.htm

Northern Health: http://www.healthspace.ca/Clients/NHA/NHA_Website.nsf

Vancouver Coastal Health: Metro Vancouver: http://www.vch.ca/public-health/environmental-health-inspections/pools-beaches/beach-water-quality-reports

Vancouver Coastal Health: Coast Garibaldi: http://healthspace.ca/vch

First Nations Health Authority: http://www.fnha.ca/

British Columbia Ministry of Environment Recreational water quality guidelines: http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines

Alberta

Alberta Health Services: https://myhealth.alberta.ca/alerts/Pages/Alberta-Health-Advisories.aspx

Saskatchewan

Environmental Health, Swimming Pools and Recreational Water: https://www.saskatchewan.ca/residents/environment-public-health-and-safety/environmental-health/swimming-pools-and-recreational-water

Manitoba

Manitoba Sustainable Development, Manitoba Beaches: http://www.manitoba.ca/beaches

Ontario

Recreational Water Protocol, 2016: http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/recreational_water.pdf

Kingston Utilities “Know Before You Go” Wastewater notification system: https://utilitieskingston.com/Wastewater/SewerOverflow/Map

Québec

Environnement-Plage home: http://www.mddelcc.gouv.qc.ca/programmes/env-plage/index.htm

Adresses du Ministère en région: http://www.mddelcc.gouv.qc.ca/ministere/rejoindr/adr_reg.htm

Cyanobacteria: https://www.inspq.qc.ca/eau-potable/cyanobacteries

New Brunswick

Public Health Advisories and Alerts: http://www2.gnb.ca/content/gnb/en/departments/ocmoh/health_advisories.html

Parlee Beach Water Monitoring Protocol (2017): http://www2.gnb.ca/content/dam/gnb/Departments/eco-bce/Promo/Parlee_Beach/parlee_beach_water_monitoring_protocol_document.pdf

Nova Scotia

Environmental Health, Recreational Water - Nova Scotia Beaches: http://novascotia.ca/dhw/

environmental/beaches.asp

Nova Scotia Lifeguard Services, Supervised Beaches: http://www.nsls.ns.ca/supervised-beaches

Prince Edward Island

Prince Edward Island, Communities, Land, and Environment, Blue-Green Algae (Cyanobacteria): https://www.princeedwardisland.ca/en/information/communities-land-and-environment/blue-green-algae-cyanobacteria

Newfoundland and Labrador

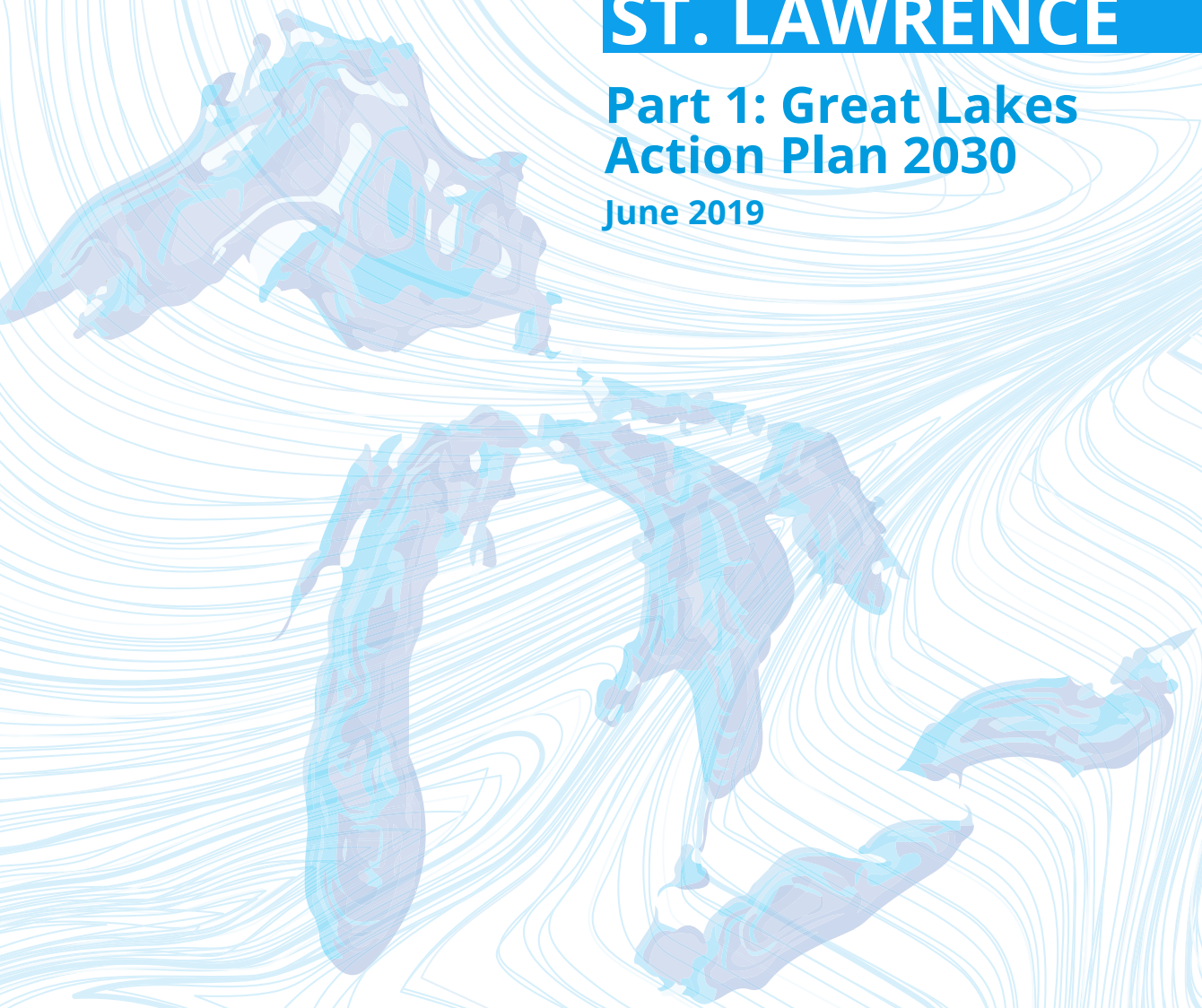
Newfoundland Labrador, Department of Environment and Conservation, Water Quality Monitoring Agreement: http://www.env.gov.nl.ca/env/waterres/quality/background/agreement.html

Newfoundland Labrador, Department of Environment and Conservation, Blue-Green Algae Monitoring Summary Report 2007-2015, March 2016: http://www.env.gov.nl.ca/env/waterres/quality/background/bga_reports/bga_rpt2016.pdf

PROTECTING THE GREAT LAKES AND ST. LAWRENCE

Part 1: Great Lakes Action Plan 2030

June 2019



The Great Lakes and St. Lawrence Collaborative

COUNCIL OF THE GREAT LAKES REGION
BUILDING OUR FUTURE TODAY
Discover. Connect. Influence.

STRATÉGIES Saint-Laurent

Great Lakes Fishery Commission

FRESHWATER FUTURE CANADA

Great Lakes and St. Lawrence Cities Initiative
Alliance des villes des Grands Lacs et du Saint-Laurent

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EXECUTIVE SUMMARY

Protecting a system of water and a region as vast and as valuable as the Great Lakes requires an ambitious plan, new and innovative approaches using new tools and data, mobilization of many individuals, businesses, communities, and organizations on the ground as well as significant sustained investment.

That is why five organizations - the Great Lakes and St. Lawrence Cities Initiative, the Council of the Great Lakes Region, the Great Lakes Fishery Commission, Freshwater Future Canada, and Stratégies Saint-Laurent - proposed to Environment and Climate Change Canada (ECCC) to undertake a stakeholder led process to find new and innovative ways to protect the Great Lakes and St. Lawrence in these changing times.

With funding support from ECCC, the Great Lakes and St. Lawrence Collaborative was established in October 2018. The 18-month process is delivering recommendations on new and innovative approaches to protect the Great Lakes and St. Lawrence. This report is focused on the first part, the Great Lakes. The second part, on the St Lawrence, will be completed by the end of 2019. ECCC asked that the Collaborative focus on four challenges:

1. How to adapt to climate change along the Great Lakes shoreline;
2. How to reduce our exposure to harmful pollutants;
3. How to reduce nutrients entering waterways;
4. How to make all of our beaches free from sources of chronic bacteriological contamination.

To develop these recommendations, an Expert Panel was established, led by Gord Miller, former Environmental Commissioner of Ontario, and Jean Cinq-Mars, Québec's former Sustainable Development Commissioner. The Expert Panel was supported by four issue tables who provided strategic advice on the four challenges above. Through political engagement and place-based technical advice, the Collaborative process and recommendations have benefited from Indigenous counsel and knowledge.

The following Action Plan proposes 15 key actions to protect the Great Lakes and those who live in the region.

When implemented, these actions will:

- protect Great Lakes shoreline communities that are most vulnerable to high water levels by making them more climate resilient;
- act more quickly to prevent and reduce environmental and human exposure to harmful chemicals in the Great Lakes region;
- accelerate actions to reduce agricultural and urban nutrient runoff in priority areas that cause harmful algal blooms, and to improve the health of our waters;
- ensure that all Great Lakes beaches are clean and protect public health.

Implementing these 15 key actions will require substantial, sustained investment. While not all the needed investments should be born by government, it is proposed that the federal government should lead the charge by providing $100 million per year, for ten years, leveraging contributions from other levels of government and other sources of financing.

Summary of Recommendations

It is recommended that:

Climate Change

1. The Governments of Canada and Ontario commit to establishing and funding shoreline resiliency priority zones to identify and address significant threats from climate change (high water levels, stronger wind/ wave energy, erosion, sudden spring thaws, ice jams) impacting natural and built infrastructure on Great Lakes shorelines, with an emphasis on naturalization and green infrastructure solutions, beginning with five shoreline priority zones:

i. Central Western Lake Erie (Chatham-Kent, Leamington)

ii. Central Lake Huron (Amberley to Grand Bend)

iii. Central Lake Ontario (Toronto to Prince Edward County)

iv. North Central Lake Superior (Fort William First Nation, Thunder Bay)

v. Southeastern Georgian Bay (Penetanguishene, Tiny Township)

2. The Government of Canada create a climate data sub-portal for Great Lakes priority zones be created within the Canadian Centre for Climate Services portal.

3. The Ontario Government, through the Ontario Ministry of Natural Resources and Forestry, and Conservation Authorities, invest further in the development of Light Detection and Ranging (LIDAR), flood plain mapping, and monitoring/modelling data to benefit shoreline communities.

4. The Governments of Canada and Ontario offer ongoing guidance and funding (on a competitive basis) to all shoreline municipalities and Indigenous communities to support actions to make their shorelines more climate resilient.

Toxics and Other Harmful Pollutants

5. The Federal Government, through Environment and Climate Change Canada (ECCC) and Health Canada, develop a targeted environmental and human health effects monitoring, human biomonitoring and surveillance program to provide early detection of unexpected effects in The Great Lakes Basin that feeds directly into a regulatory and non-regulatory response plan to reduce exposure.

6. ECCC and Health Canada develop guidelines to guide the generation and communication of data collected through the surveillance program and develop Guidance on the Appropriate Response to Exposure and Effects surveillance program data.

7. ECCC and Health Canada introduce a Strategy to Promote Substitution of Harmful Chemicals in Products, including a Centre for Chemical Substitution, and a Chemical Substitution Recognition Program.

Nutrients

8. The Governments of Canada and Ontario adopt a targeted, geographically specific approach to reducing nutrients entering the Great Lakes, employing precision conservation and stormwater optimization, to bridge the gap between farm scale conservation implementation and urban stormwater management with broader water quality impacts.

9. The Government of Ontario, with support from the Government of Canada, develop a data management strategy and tools be developed to support the precision conservation approach and to facilitate the collection and use of datasets (e.g. elevation, soil type, property boundaries, land use) needed to prioritize properties, and best practices, and to coordinate monitoring and modelling data at a watershed level.

10. The Governments of Canada and Ontario, together with partner universities, Indigenous communities, and relevant organizations, create a Centre for Water Quality and Nutrient Management to generate and coordinate information to support precision conservation and stormwater optimization approaches in the Great Lakes Basin.

11. Agriculture and Agri-food Canada and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) work with the Centre for Water Quality and Nutrient Management to designate a dedicated network of extension workers, through existing organizations or a new institution, that receive standardized training, and provide consistent technical advice to farmers.

12. Where subwatershed modelling and monitoring identifies urban areas as significant contributors of phosphorus loading, the Ontario Ministry of Environment, Conservation and Parks (MECP) require the relevant municipalities in consultation with conservation authorities to develop an urban stormwater optimization/ plan with steps to achieve measurable phosphorus reductions.

Beaches and Bacteriological Contamination

13. The Ontario Government introduce a new risk-based categorization system for Ontario beaches, and require actions of owners of 'impaired' beaches that have chronic bacteriological contamination issues.

14. The Ontario Ministry of Health and Long-Term Care (MOHLTC) create and maintain a central portal with beach quality information, including information on the 'status' of the beach (based on four categories: impaired, fair-good, good-excellent, under CSO advisory)

15. MOHLTC amend Public Health Ontario's Public Beach Water guidance on test methods for *E. coli* be amended to allow for alternate testing methods other than membrane filtration as per Ontario Ministry of Environment, Conservation and Parks (MECP) guidance on drinking water testing methods.

MESSAGE FROM EXPERT PANEL CO-CHAIRS

Nine months ago, we were tasked by the Federal Minister of Environment and Climate Change, the Honourable Catherine McKenna, to give her and her provincial counterparts advice on new and innovative approaches to tackle four of the most compelling and complex problems facing one of the largest systems of fresh water in the world, the Great Lakes and the St. Lawrence.

We would like to thank Minister McKenna and Environment and Climate Change Canada for the faith they put in us and in our stakeholder-led process to rise to this challenging task. This report, focused on the Great Lakes, is the first of a two-part series, which will also include recommendations on St. Lawrence protection, to be completed in the Spring of 2020.

We are very pleased to be delivering on the first part of our commitment. This report outlines recommendations that, if adopted by the Governments of Canada and Ontario and embraced by local authorities, Indigenous communities, the private sector and non-governmental stakeholders, and lake lovers across the basin, would have a transformative effect on the Great Lakes region and all of us who live in it and rely on its waters to sustain our quality of life.

This Great Lakes Action Plan charts a course to:

- protect the most vulnerable shoreline communities from damages caused by climate change and high water levels;
- proactively investigate our exposure to toxic chemicals in the environment and in products, and require immediate action where exposure to unhealthy levels of harmful pollutants is found;
- stop nutrient runoff from agricultural and urban areas that contribute the most, reducing the proliferation of harmful algal blooms in our waterways;
- make beaches and recreational waters on Great Lakes shorelines free from known sources of sewage and other sources of bacteriological contamination.

We strongly believe that this is an agenda worth embracing by all. Protecting our Great Lakes is a Canadian non-partisan issue. We have seen political adversaries set aside their differences and come together in common cause to protect the Great Lakes on the U.S. side of the border under the Great Lakes Restoration Initiative. We expect the same leadership from our Canadian political leaders.

We would like to take this opportunity to thank all those who contributed to this Action Plan, including the members of the Collaborative Expert Panel, Issue Table co-chairs and members, the Collaborative Steering Committee, Indigenous advisors, researchers, the Collaborative Secretariat, and all those who participated in our webinars and the Great Lakes Summit to provide critical feedback.

Finally, we would like to thank Environment and Climate Change Canada for its financial support of the Collaborative.

Gord Miller Jean Cinq-Mars

DEDICATION

Many Great Lakes advocates have been moved and inspired by the dedication of Anishinabek Water Walker Josephine Mandamin's campaign to bring attention to the Great Lakes and our responsibility to protect them.

Josephine Mandamin, head of the Anishinabek Women's Water Commission, who was from Wikwemikong First Nation, led Mother Earth Water Walks beginning in 2003, and eventually walked 17,000 km around all five of the Great Lakes.

Josephine passed away on February 22, 2019. She leaves behind her husband, eight children, 13 grandchildren and 16 great-grandchildren, as well as many people inspired by her, and a legacy for us to carry forward.

In her own words, "When we carry that water, we are telling people that we will go any lengths for the water. We'll probably even give our lives for the water if we have to."

This report is dedicated to Josephine's spirit and her contribution to our awareness and appreciation of the value of the Great Lakes.

ACKNOWLEDGEMENTS

The Great Lakes and St. Lawrence Steering Committee wishes to express its sincere gratitude to all the volunteers who devoted their time, energy and expertise to developing and fine tuning the recommendations in this report, including the Collaborative Expert Panel, co-chaired by Gord Miller and Jean Cinq-Mars, as well as four Issue Tables, co-chaired by Al Douglas and Ewa Jackson (climate change), Dale Cowan and Gayle Wood (nutrients), Dr. John Carey and Helen Doyle (toxics), and Sandra Cooper and Bernard Mayer (beaches), and supported by issue table members.

This report was written by the Collaborative Secretariat, Nicola Crawhall of Westbrook Public Affairs and Korice Moir. Background research was prepared by a research team led by Dr. Gail Krantzberg of McMaster University, including Ginni Dhaliwal, Danish Karmally, Bridget McGlynn, Mozafar Niroomand, and Dr. George Uzonwanne. Dave Thompson of PolicyLink prepared the economic analysis of the Action Plan and its recommendations.

INTRODUCTION

'The Great Lakes and St. Lawrence Region, stretching across Ontario and Quebec, is home to 14 million Canadians. The Great Lakes and St. Lawrence River are a globally significant resource and ecosystem. Holding 20% of the world's surface fresh water, the lakes provide drinking water to over 40 million Canadians and Americans living near the shoreline. The waters of the Great Lakes and St. Lawrence and the basin's many rivers and streams also play a critical role in sustaining the health of aquatic, riparian and terrestrial ecosystems, supporting more than 3,500 of plants and animals, including one-fifth of all fish species in North America.

The Great Lakes and St. Lawrence Region is also a critically important economic region to both countries, accounting for 30% of combined Canadian and U.S. economic activity and employment, or 51 million jobs across a diverse range of sectors that rely on, and/or have an impact on water quality and ecosystem health, notably manufacturing, agriculture, maritime transportation, energy generation, land use development, tourism, and recreational and commercial fishing. In fact, with economic output valued at US$5.8 trillion in 2015, if the region were a country, it would be the third largest economy in the world.

Protecting a system of water as vast as the Great Lakes is laborious work with slow progress measured over decades. To add to this complexity, we are confronted with new challenges, primarily driven by the effects of climate change, and population and development pressures. These changes drive so-called nonpoint sources of pollution that have proven to be difficult to mitigate effectively. Progress on reducing such diffuse sources of pollution has confounded authorities and communities alike.

That is why five organizations - the Great Lakes and St. Lawrence Cities Initiative, the Council of the Great Lakes Region, the Great Lakes Fishery Commission, Freshwater Future Canada, and Stratégies Saint-Laurent - came together to propose to Environment and Climate Change Canada (ECCC) to undertake a stakeholder led process to find new and innovative ways to protect the Great Lakes in these changing times. In response, ECCC asked that the Collaborative focus on four specific challenges:

1. How to adapt to climate change in the Great Lakes basin;
2. How to identify and act to reduce our exposure to harmful pollutants;
3. How to reduce nutrients entering waterways;
4. How to make all of our beaches free from sources of chronic bacteriological contamination.

Interestingly, the four issue tables tasked with developing recommendations in these four areas independently arrived at similar conclusions. Firstly, there was a consensus that with limited resources, a risk-based approach was required to focus on those sources that contribute the most to the problem and those people or parts of the environment most impacted. Secondly, there was a recognition that new tools and technologies at our disposal, from big data to more precise monitoring methodologies, fit perfectly with this risk-based approach, allowing for a surgical precision to

interventions that was not available to us 20 years ago. Finally, given the complexity of the issues, and the large geography involved, collaborative efforts are needed involving a range of parties, from senior governments and Indigenous communities, to municiaplities and conservation authorities, to private businesses, to non governmental and community groups, to those who live in and visit Great Lakes communities.

The result is a set of 15 recommendations presented in this report, that, if adopted, would make a great leap forward in Great Lakes protection, one that would provide more immediate, more precise, more measurable results for the benefit of those who live in this extraordinary region.

None of these recommendations will get off the ground without adequate investment. The economic case for increasing investment in the Great Lakes is compelling. A Brookings Institute cost benefit analysis showed a 2:1 return on Great Lakes investments. This helped convince U.S. legislators to approve the Great Lakes Restoration Initiative, which has delivered over $2 billion to projects on the U.S. side of the Great Lakes over the last decade. Now is the right time for Canada to step up and show a similar level of commitment.

What is the Collaborative?

The Great Lakes St. Lawrence Collaborative is a two-year, stakeholder-led process made possible through financial support from Environment and Climate Change Canada. From the outset, its objectives have been to influence and increase investment in Great Lakes and St. Lawrence protection, promote new and innovative approaches that can accelerate and make more precise interventions, and to engage a broad cross section of stakeholders in the development of the recommendations.

The Collaborative acknowledges and recognizes First Nation and Métis peoples as aboriginal and treaty rights holders in the Great Lakes region.

The Collaborative process has two phases, a nine-month Great Lakes phase beginning in November 2018, followed by a nine-month St. Lawrence phase beginning in May 2019, and a three-month period between January to March 2020 to integrate the findings and recommendations into one Great Lakes St. Lawrence Plan. This plan will be presented to the federal Minister of Environment and Climate Change, and her counterparts across relevant departments and at the provincial level.

The end result will be an Action Plan for the Great Lakes and St. Lawrence Basin that makes a great leap forward by modernizing the way we protect our health, communities, and the environment in four strategic areas: climate change, nutrients, and toxics and other harmful pollutants, and beaches and bacteriological contamination.

This report presents the recommendations of the first part of the Collaborative process, an Action Plan focused exclusively on the Great Lakes basin.

Engaging Interested Parties

The Collaborative has engaged interested parties in the Great Lakes region through direct representation on the Expert Panel, the Steering Committee, Indigenous advisors, and the four Issue Tables, involving about 75 people. The recommendations contained in this report are the product of their deliberations.

In order to solicit feedback from the broader community, the Collaborative held two webinars in March and April of 2019 to present draft recommendations at different stages of their development and to hear comments from those online. About 150 people were consulted through these webinars. A webinar was also held with staff from the Chiefs of Ontario and several Indigenous communities on the draft recommendations to solicit their feedback.

On May 1, 2019, a Great Lakes Summit was held in Toronto. With over 100 participants at the Summit and via livestream, the Collaborative received detailed written comments and feedback on the draft that were incorporated into the recommendations.

All feedback was considered carefully by the issue tables and the Expert Panel before the recommendations were finalized.

Interested parties were also kept informed of developments through a monthly newsletter and information posted on the Collaborative's website: https://westbrookpa.com/glslcollab/.

COLLABORATIVE PROCESS AND STRUCTURE

Part 1 of the Collaborative, focused on the Great Lakes, was launched on October 26, 2018. A structure was established that consisted of:

- an independent expert panel with representatives from Indigenous communities, business, academia, NGOs and municipalities, co-chaired by Gord Miller, former Environmental Commissioner of Ontario, and Jean Cinq-Mars, Québec's former Sustainable Development Commissioner.
- four issue tables for the Great Lakes Phase tasked with developing recommendations on climate change, nutrients, toxics and other harmful pollutants, and beaches and bacteriological contamination.
- a steering committee to oversee the administration and financing of the Collaborative process, consisting of representatives from the five founding partners: the Council of the Great Lakes Region, Freshwater Future Canada, the Great Lakes and St. Lawrence Cities Initiative, the Great Lakes Fishery Commission, and Stratégies Saint-Laurent.
- a secretariat to facilitate day-to-day operations, organize events and engagement of interested parties, and to prepare reports.

Indigenous Engagement

First Nations and Métis peoples have systems of government and aboriginal and treaty rights protected under the Canadian constitution in the Great Lakes region. In recognition of this status, the Collaborative invited Indigenous political representation to the Expert Panel. As a member of the Expert Panel, Regional Deputy Grand Council Chief Edward Wawia of the Anishinabek Nation provided advice to the Collaborative on respecting and acknowledging Indigenous peoples as rights holders and governments within the Great Lakes Basin.

In addition to recognizing Indigenous peoples as aboriginal and treaty rights holders, the Collaborative also sought out place-based advice and expertise from select Indigenous communities living within the Great Lakes basin that informed the recommendations of the issue tables.

The Collaborative reached out to Aamjiwnaang First Nation to understand the experience of a First Nation community exposed to industrial chemicals in Sarnia.

With respect to nutrients, the Collaborative welcomed advice from Six Nations on the Grand River about datasets and GIS-based platforms being used to track nutrient runoff from their territory.

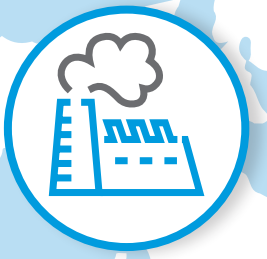
On climate change and priority shoreline zones, Fort William First Nation highlighted the vulnerability of properties along its shoreline, as well as the location of a contaminated soils containment berm in close proximity to the shoreline.

A briefing was held for staff from Chiefs of Ontario and several Indigenous communities on May 23rd to review and solicit feedback on the draft recommendations.

Through political engagement and place-based technical advice, the Collaborative process and recommendations have benefited from Indigenous counsel and knowledge.

KEY CHALLENGES FACING THE GREAT LAKES

Climate Change



Toxics and Other Harmful Pollutants

Nutrients

Beaches and Bacteriological Contamination

While the Great Lakes have been coping with climate change, polluted beaches and recreational waters, nutrients and harmful algal blooms and exposure to toxics for a number of years, their impact on those who work and live by and play in the Great Lakes and their tributaries has reached a level of disruption that demands new, modernized approaches.

A. Climate Change

The Collaborative recognizes unique shoreline risks in the Great Lakes Basin and proposes to provide direct assistance and funding to municipal and Indigenous communities in shoreline resiliency priority zones hardest hit by extreme flooding and erosion associated with climate change.

B. Toxics and Other Harmful Pollutants

The Collaborative proposes to actively investigate ways we are exposed to harmful toxic chemicals and require more immediate and dedicated action to reduce our exposure.

C. Nutrients and Harmful Algal Blooms

The Collaborative seeks to harness the power of big data to identify nutrient hotspots and work directly with landowners, municipalities, Indigenous communities, and others in priority areas to reduce nutrient runoff that causes harmful effects, such as algal blooms, and to improve the health of our water.

D. Bacteriological Contamination of Beaches

Using a risk-based approach, the Collaborative proposes to identify beaches with chronic bacteriological contamination problems, and require action to clean up the source of contamination, including untreated sewage.

A. CLIMATE CHANGE

Climate change continues to put significant pressure on communities, businesses, natural heritage and ecological integrity in the Great Lakes Basin. Changes in temperature and precipitation are adversely affecting the hydrology of the basin, altering water supplies, and causing fluctuations in lake levels. These changes, combined with growing infrastructure deficits, poor planning decisions, and disparate levels of adaptive capacity, will sustain levels of vulnerability and increase future risk for communities within the basin.

In the Great Lakes, shoreline communities face unique climate change impacts. Shoreline communities are particularly vulnerable to the effects of fluctuating water levels on natural and built infrastructure assets. Water levels determine the features of a shoreline such as beaches, bluffs, and wetlands. Many of these natural features have been altered by wetland drainage, shoreline hardening, and as well as recreation, shipping, and other land and water uses.

Climate change increases the probability of intense storms, the amount of snow melt precipitation and ice cover contributing to high water levels, as well as increased wind and wave energy. This has resulted in damaged property, washed out beaches and marshes, disrupted public works including shoreline roads and stormwater and sewage outfalls, and damage to recreational facilities like marinas and bike paths.

The issue table chose to focus its recommendations on high water levels, as experienced in 2017, given the level of damage and the lack of preparedness of shoreline areas most affected. It is recognized that there are other climate pathways for which shoreline communities must prepare, including low water levels, as experienced for a number of years in the early 2000s.

In some cases the impacts on shorelines have crossed critical tolerance thresholds leaving communities with high costs of recovering from damage caused by flooding and erosion. Great Lakes shoreline communities are in a unique position of having to adapt to the combination of high shoreline water levels, riverine and inland flooding. Unfortunately recent high water levels and flooding were not predicted.

In 2017, the Great Lakes and St. Lawrence River system experienced unanticipated high water levels with significant impacts including:

- extensive shoreline flooding,
- residential property damage,
- leaking septic systems,
- infiltration into shoreline wells,
- blocked access roads,
- debris causing damage to boats,
- shoreline erosion,
- vegetative damage due to high winds and waves.

In the spring of 2019, the Great Lakes basin has also seen water levels well above the seasonal average in Ontario and Québec. With climate change contributing to a greater likelihood of extreme weather and flooding events, we can anticipate future periods of extreme high water levels, and fluctuations over time.

Shoreline communities require a collaborative approach to assessing and managing the climate change risks by building shoreline resilience.

Building Shoreline Climate Resiliency - Who Does What

Shoreline climate risk assessments and adaptation measures involve multiple jurisdictions with roles and responsibilities for shoreline management and resiliency.

Municipalities are responsible for land use planning decisions, and water and wastewater infrastructure design along the shoreline, as well as emergency response in the event of flooding.

Shoreline decisions in Indigenous communities are made by First Nations councils.

Ontario Conservation Authorities are responsible for watershed and riverine flood protection and floodplain mapping that extends to shoreline risk mapping.

The Ontario Government recently committed to "improve understanding of how climate change will impact the province" and "help Ontarians prepare for impacts of climate change, such as extreme weather events" in its 'Made-in-Ontario Environment Plan'. As part of this effort, it will undertaking a province-wide climate impact assessment.

The Government of Canada's Pan-Canadian Framework on Clean Growth and Climate Change includes actions to move forward on climate change adaptation and build resilience to climate impacts, as well as Climate Lens for infrastructure funding to support a "risk management approach to anticipate, prevent, withstand, respond to, and recover from a climate change related disruption or impact."

The Canada-Ontario Agreement (COA) on Great Lakes Water Quality and Ecosystem Health is a federal-provincial agreement that supports the restoration and protection of the Great Lakes basin as committed to in the Canada-U.S. Great Lakes Water Quality Agreement. Binational efforts in Annex 9 Climate Change Impacts involve "coordinating efforts to identify, quantify, understand, and predict the climate change impacts on the quality of the waters of the Great Lakes, and sharing information that Great Lakes resource managers need to proactively address these impacts."

The International Joint Commission regulates water levels and flows in Lake Superior, through the Lake Superior Board of Control, and in Lake Ontario and the St. Lawrence River through Regulation Plan 2014.

Desired Outcome and Recommended Actions

The desired outcome of the following climate change recommendations is to support shoreline communities with special vulnerability to high water levels to become more climate resilient.

Four key actions are proposed:

1. Designate shoreline resiliency priority zones to identify and address significant threats from climate change associated with high water levels, with emphasis on naturalization and green infrastructure solutions.
2. To support the priority zone process, create a climate information sub portal for Great Lakes shoreline priority zones.
3. Invest further in the development of Light Detection and Ranging (LIDAR), flood plain mapping, and monitoring/modelling data to benefit shoreline communities.
4. Provide technical guidance and make funding available to support actions by municipalities and Indigenous communities to address shoreline hazards associated with climate change.

It Is Recommended That

1. The Governments of Canada and Ontario commit to establishing and funding shoreline resiliency priority zones to identify and address significant threats from climate change (high water levels, stronger wind/wave energy, erosion, sudden spring thaws, ice jams) impacting natural and built infrastructure on Great Lakes shorelines. Emphasis should be placed on naturalization and green infrastructure.

Begin with five shoreline priority zones with a focus on adapting and creating resiliency to high water levels along shorelines:

i. Central Western Lake Erie (Chatham-Kent, Leamington)

ii. Central Lake Huron (Amberley to Grand Bend)

iii. Central Lake Ontario (Toronto to Prince Edward County)

iv. North Central Lake Superior (Fort William First Nation, Thunder Bay)

v. Southeastern Georgian Bay (Penetanguishene, Tiny Township)

The list of priority zones may evolve or be expanded over time. While the initial focus is on high water levels, zones may explore different climate pathways (e.g. low water levels) or other climate risks/hazards and implementation measures.

Proposed Shoreline Resiliency Priority Zones

As this report was being finalized, it was reported that Lake Ontario water levels along the Toronto shoreline had reached their highest levels in recorded history, surpassing the high water levels of 2017.

With these looming circumstances setting the stage for another year of high water levels threatening shorelines, the following five shoreline resiliency priority zones are recommended based on: the severity of impacts they experienced during and following the 2017 high water levels; their geographic location across the Great Lakes region; their particular climate risk exposure or vulnerabilities; their unique assets and features at risk; and their varying levels of capacity to adapt.

Given the severity of impacts in 2017, these zones are proposed for immediate action and funding. Additional zones may be added in the future.

i. **Central Western Lake Erie** shoreline zone (Chatham-Kent, Leamington)

The Central Western Lake Erie shoreline zone includes the shorelines of Chatham-Kent and Leamington. These two communities represent some of the most productive agricultural and food processing areas in Ontario. Chatham-Kent alone generates several billion in agricultural produce annually and Leamington is known as the tomato capital of Canada.

This stretch of shoreline is a proposed priority zone due to the low lying land in relation to the shoreline around Rondeau Bay, and in the northwestern area closer to Lake St. Clair. These areas are currently being protected through a series of berms and dikes.

In 2017, a dike was breached, and again in early 2019, a state of emergency was declared when the Thames River dike failed in multiple locations around Poppe Road and Buchanan Line in Tilbury, flooding the downtown area as well as agricultural land. Thousands of acres of agricultural land are at risk of flooding due to high water levels and outdated dikes and berms that require rehabilitation, representing a significant economic risk in one of the most agriculturally productive areas in Ontario.

ii. **Central Lake Huron** shoreline zone (Amberley to Grand Bend)

The stretch of shoreline between Amberley and Grand Bend, including Central Huron, Bayfield and Goderich, is a prime tourist and seasonal cottage destination due to its beautiful beaches (Grand Bend, Bayfield) and high bluffs overlooking Lake Huron (Central Huron, Goderich).

This is a proposed priority zone because the shoreline is being battered by strong wave action, high winds, and occasionally tornados. The result is some of the worst shoreline erosion anywhere in Ontario, imperiling properties on the top of bluffs and compromising the quality of beaches that are significant tourist destinations.

iii. **Central Lake Ontario** shoreline zone (City of Toronto to Prince Edward County)

The most densely urbanized area in Ontario, the Central Lake Ontario stretch of shoreline between Toronto and Clarington, including communities like Whitby, Ajax and Bowmanville, has a mix of naturalized areas, including the Toronto Islands, recreational paths along much of the shoreline, residential properties, and industrial facilities, including the Pickering Nuclear plant and cement production facilities.

This shoreline is a priority zone given significant impacts experienced during record high water levels in 2017. Lake Ontario's daily level peaked at 75.88 m (248.95 ft) in late May, the highest recorded level since records began in 1918. Impacts included eroded bluffs, sunken docks, collapsed breakwalls, flooded basements and washed out roads.

In 2017, a local state of emergency was declared for a portion of the Clarington shoreline as well as all of Prince Edward County.

The Toronto Islands, a favoured recreational area for the city of 2.6 million, were closed to the public for an extended period due to extensive flooding impacting residents, infrastructure, and sensitive natural areas.

In the spring of 2019, water levels along Lake Ontario were notably high as well, increasing the risk and exposure to flooding and erosion.

iv. **North Central Lake Superior shoreline zone** (Fort William First Nation, Thunder Bay)

Lake Superior is known for its rugged, rocky shoreline. However, the soft shoreline just to the side of Chippewa Park in Fort William First Nation has been significantly impacted by high water levels and increased wind and wave action. Residences were built on the shoreline that is often flooded in the spring thaw and during the 'gales of November' when storms roll in from Lake Superior.

There is a 50-year-old containment berm that holds contaminated sediment from the Northern Harbour clean up in the Thunder Bay area of concern. It is located just outside of Chippewa Park, right beside a river that flows into Lake Superior. With rising water and stronger wave action, there is concern that the containment berm could be damaged, sending creosote contaminated sediment into Chippewa Park, into the river, and into Lake Superior.

Top priorities in this priority zone process are an evaluation of the berm system, additional evaluation of residences at risk, and improved resilience of 'riprap', that is, boulders that have been placed where the river meets the lake that serves as a barrier to protect a sawmill and a solar farm. This area flooded two years ago, and is at risk in the future.

v. **Southeastern Georgian Bay shoreline zone** (Penetanguishene, Tiny Township)

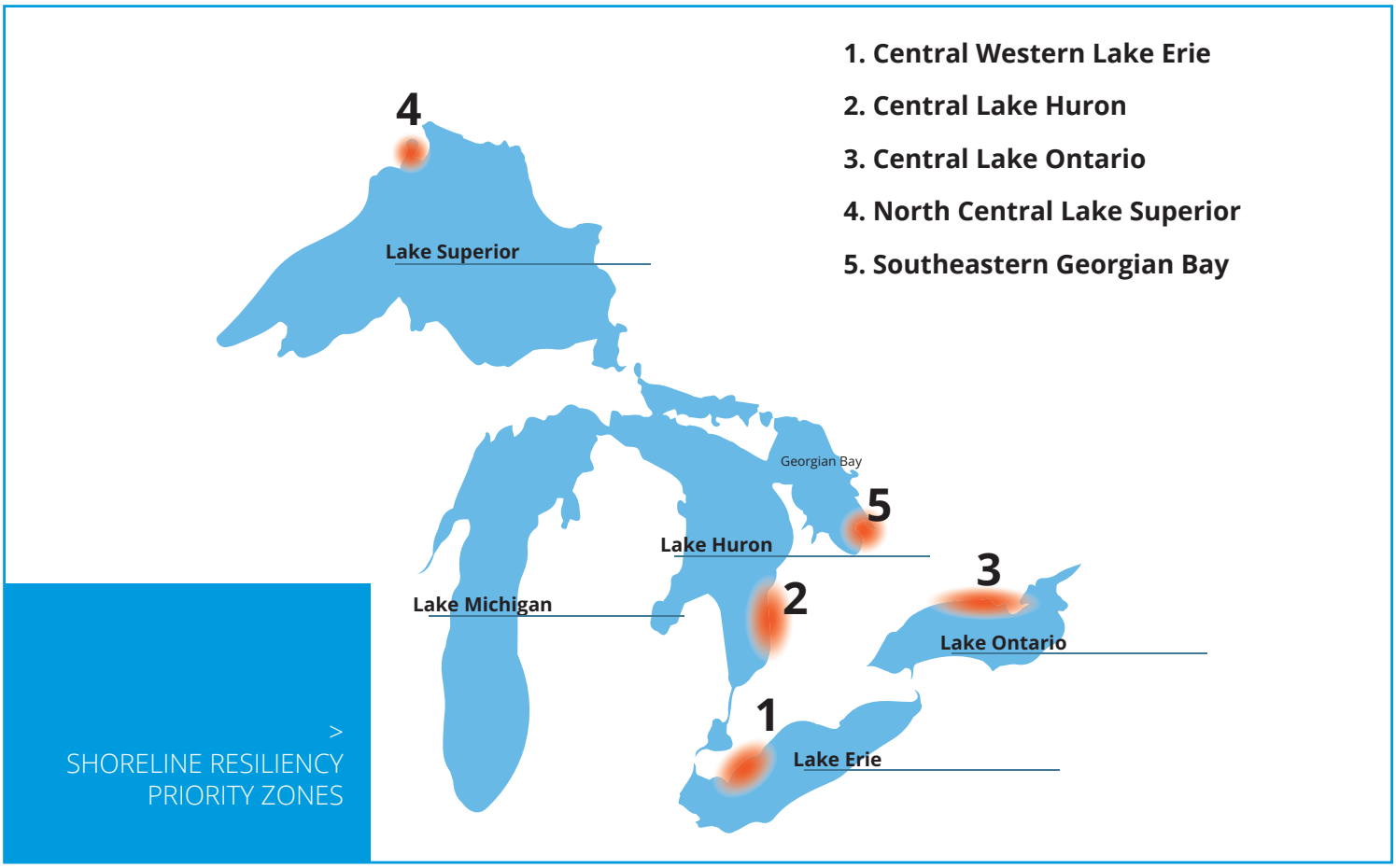
The southeastern tip of Georgian Bay, comprised of the Township of Tiny and the Town of Penetanguishene, jutting out into Georgian Bay, makes it a favoured destination in all seasons.

This shoreline has been identified as a priority zone due to the significant development and redevelopment projects in recent years, which are transforming the natural shoreline. Small seasonal cottages are being converted to larger permanent dwellings with accompanying requests for dredging, vegetation removal, fill placement, and hardscaping like paved driveways and manicured lawns. Additional commercialization pressure of marinas, recreational features, etc. has also been occurring. This trend of development shows no sign of abating.

Communities are struggling with hardened surfaces along the shoreline that reduce infiltration and cause drainage and flooding problems in their communities. In addition, engineered shorelines for development purposes have altered the natural landscape.

Watershed flooding is an increasing occurrence as well as the risk of sewage treatment plant bypasses which impacts shoreline water quality. There are also concerns about the unknown impacts of changing water levels on the introduction, spread and management of invasive species, like phragmites. Significant changes to water levels (both high and low) also impact commercial operations such as marinas and boat launches.

This area has experienced significant impacts from high/fluctuating water levels and expects continued development pressures.



1.1 It is further recommended that collaboratives of local communities, conservation organizations, businesses, and Indigenous communities, among others, be created. These would build on collaboration and work already under way.

Each zone collaborative would:

a) Establish partners and guiding process

- Identify zone partners, develop a partner map and/or conduct social network analysis, and identify a lead partner organization for each zone.

b) Conduct ongoing stakeholder and Indigenous engagement

- Communicate risks to infrastructure, industry, properties, and recreation, including risk of repeated flooding that may require changes in flood plain designation and building restrictions in these areas.

c) Complete risk assessments

- Assess specific shoreline hazards and risks based on local expertise and Indigenous knowledge
- Use modelling, mapping, and predictive tools
- Integrate assessments of shoreline, riverine and overland flooding
- Gather information on current vulnerabilities, future threats
- Evaluate historic trends and projections of climate change
- Update hazard/risk maps to visualize and communicate threats
- Take into consideration watershed influences and the importance of green infrastructure and low impact development to support shoreline resiliency.

d) Develop and implement shoreline resiliency plans

- Develop shoreline resiliency plans based on risk assessment
- Conduct cost benefit analysis
- Consider restrictions on new development along shoreline

- Secure necessary approvals, including environmental assessment where required
- Negotiate funding for adaptation measures with senior governments
- Invest in adaptation measures to address hazards based on risk assessments, with emphasis on naturalization and green infrastructure.
- Integrate measures into existing adaptation plans, watershed-based and/or regional decision-making.
- Evaluate the effectiveness of adaptation measures.
- Improve emergency response protocols.

1.2 It is further recommended that support be provided across zones by ECCC and MECP to:

- Assist with access to relevant climate information
- Document the work of the collaboratives and share lessons learned across zones and in other areas in the Great Lakes region.
- Assist with building and supporting the capacity of Indigenous communities to assess risk and implement shoreline resiliency, including the use of traditional knowledge.

2. It is recommended that the Government of Canada create a climate data sub-portal for Great Lakes priority zones within Canadian Centre for Climate Services portal.

The subportal would provide climate information to community members and partners to support a range of climate change shoreline risk management activities. This includes spatially appropriate historical trends and future projections of climate change, as well as information and resources accessible to community members and local partners to improve knowledge and provide frameworks for adaptive action.

3. It is recommended that the Ontario Government, through the Ontario Ministry of Natural Resources and Forestry, and Conservation Authorities, invest further in the development of Light Detection and Ranging (LIDAR), flood plain mapping, and monitoring/modelling data to benefit shoreline communities.

How long is Ontario's Great Lakes shoreline?

There are 7,606 km of shoreline around the Ontario portion of the Great Lakes. To put this in perspective, the longest highway in the world, the TransCanada highway, stretching from Victoria, British Columbia to St. John's, Newfoundland, is only slightly longer, at 7,821 km long. In other words, if you were to stretch out Ontario's Great Lakes shoreline, it would nearly reach from coast to coast. That is a tremendous amount of shoreline to protect.

Length of Great Lakes Shoreline in Ontario

Lake	Shoreline (km)
Lake Huron	3,888
Lake Superior	2,493
Lake Ontario	636
Lake Erie	589
TOTAL	**7,606**

4. To build shoreline resiliency right around the Ontario Great Lakes, it is recommended that the Governments of Canada and Ontario offer ongoing guidance and funding (on a competitive basis) to support individual projects to help municipalities and indigenous communities make their shorelines more climate resilient.

4.1 Ontario Ministry of Natural Resources and Forestry (MNRF), Infrastructure Canada, and Crown-Indigenous Relations and Northern Affairs Canada should prepare and circulate to interested municipalities and Indigenous communities a community-specific self-assessment survey of shoreline hazards (e.g. beach and shoreline recession, bluff failure).

4.2 Based on the shoreline hazard assessments, the Governments of Canada and Ontario should identify priority needs (e.g. improvements in the naturalization and design of beaches, protection of marshlands), that would be eligible for funding under Federal-Provincial infrastructure funding (Green Infrastructure stream, Culture and Recreational stream). Special emphasis should be placed on naturalization and green infrastructure.

4.3 Ontario MNRF and Crown-Indigenous Relations and Northern Affairs Canada should develop and provide guidance to participating municipalities and Indigenous communities on how to make shorelines more climate-resilient. This could be informed by the experience and lessons learned from shoreline priority zone collaboratives.

The State of Wisconsin's Coastal Management Program

The State of Wisconsin's Coastal Management program administers a grant program that provides a total of US$1.5 million for:

- Coastal wetland protection and habitat restoration
- Nonpoint source pollution control
- Coastal resource and community planning
- Great Lakes education
- Public access and historic preservation projects

A more regional specific project has been created called the South-East Wisconsin Coastal Resilience Project, which serves the counties of Ozaukee, Milwaukee, Racine, and Kenosha. Counties are encouraged to form communities of practice to inform and direct shoreline resilience work. The State of Wisconsin developed a self-assessment survey and resources that help communities on the South-East coast weigh the effects of coastal hazards associated with fluctuating water levels, and increased wave and wind action, and consider planning and mitigation actions to increase coastal resilience. The assessment contains a tool to prioritize coastal hazards issues, a series of yes/no questions related to common planning and mitigation actions and a summary to reflect on the top actions of interest to your community. Once the survey is completed, the communities can identify project ideas appropriate for funding. A particular emphasis is put on adapting to natural processes, restoring natural shoreline, moderating coastal erosion, stabilizing bluffs and banks, and building environmentally friendly shore protection structures.

Funding for SEWI is provided by the US National Oceanic and Atmospheric Administration's Coastal Resilience Grants program.

A guidance document for Wisconsin coastal communities and property owners, Living on the Coast, has been developed by the Army Corps of Engineers and Wisconsin Sea Grant.

B. TOXICS AND OTHER HARMFUL POLLUTANTS

The United States Environmental Protection Agency (U.S. EPA) estimates that there are approximately 7,700 chemicals widely used in large amounts in North America. Environment and Climate Change Canada will complete assessments of 4,300 chemicals by 2021. These assessments, undertaken under Section 64 of the Canadian Environmental Protection Act (CEPA), evaluate the toxicity of individual substances and require a response plan to limit further exposure.

The CEPA process regulates individual 'legacy' substances once they have been introduced into the environment. Unlike medication that must be approved by government following trials before being introduced to the market, chemicals are introduced to the market without any government scrutiny until evidence accumulates that suggests that they are having a harmful effect.

There are numerous examples of the effects of toxic substances that have gone undetected for years before prompting a response. For example, an investigation into the collapse of bee colonies was traced to neonicotinoides, the feminization or intersex effects in some aquatic species was traced to certain endocrine disrupting chemicals, a decline in salmon population in New Brunswick was traced to aerial spraying of DDT against spruce bud worm, microplastics that have accumulated in fish and other species in the Great Lake were linked to personal care products, to name a few.

While the CEPA process has laid a strong foundation for chemicals management in Canada, the next step is to take action in a more immediate and proactive way, to reduce human and environmental exposure to the chemicals and chemical mixtures that are in use but have not yet been identified as causing harm, and to prevent new harmful chemicals from being introduced in products and into the environment every year.

While existing environmental and human health monitoring data has been instrumental in efforts to reduce the discharge of toxic substances through the federal chemicals management plan under CEPA, there remain challenges with respect to communicating the meaning of the data to at-risk individuals and communities in a way that can inform their choices to reduce their exposure, particularly more vulnerable populations including pregnant women and children. Even when data is available that indicates adverse effects from exposure to chemicals, response from authorities can be slow and sporadic.

Finally, products are a leading source of exposure to harmful pollutants, particularly pharmaceuticals and personal care products that contain endocrine disrupting chemicals.

With the review of the federal Chemicals Management Plan in 2020 and the anticipated renewal of the Canada-Ontario Agreement Respecting the Great Lakes Water Quality and Ecosystem Health, this is an opportune time to consider how these challenges related to exposure to chemicals can be most effectively addressed.

Toxics Legislative and Regulatory Landscape - Who Does What

Legislation and regulation governing the management of toxic chemicals falls largely in the federal domain. The Canadian Environmental Protection Act 1999, administered jointly by Environment and Climate Change Canada and Health Canada, is the legislative framework for the program that identifies and conducts a risk assessment of chemicals deemed 'toxic'. In 2016, ECCC and HC committed to completing the assessment of the remaining 1550 of the 4300 substances identified under CEPA by 2020, through the Chemicals Management Plan (CMP). The CMP is undergoing a review in 2020.

Other relevant legislation includes the Pest Control Products Act, which regulates pesticides and their application, administered by Health Canada; the Food and Drugs Act, which regulates substances in food, including Great Lakes fish, as well and substances in drugs and cosmetics, administered by Health Canada; and the Consumer Products Safety Act, under Health Canada, governs consumer products that are imported, and requires that safety information and appropriate labelling be provided on imported products.

ECCC and Health Canada also have important roles in research and monitoring of toxics and harmful pollutants in the environment and in people. There is also an important enforcement role under the Federal Fisheries Act, administered by Fisheries, Oceans and the Coastguard and Environment Canada. Section 36 of the Act prohibits the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the Fisheries Act or other federal legislation.

Binational cooperation over chemicals management in the Great Lakes Region is largely directed by commitments under Annex 3, Chemicals of Mutual Concern, of the Canada-US Great Lakes Water Quality Agreement (2012). The Parties make commitments to address specific chemicals of mutual concern from all sources in the Great Lakes basin, including the management of mercury, PCBs, PFOA, PFCAs, PBDEs, HBCD and SCCPs.

Notable reports on toxics management in Canada

On March 22, 2016, the House of Commons passed a motion designating the Standing Committee on Environment and Sustainable Development to undertake a comprehensive review of CEPA. Environment and Climate Change Canada issued a discussion paper outlining some key issues that were relevant to the review.

In 2017, the Standing Committee released its report "Healthy Environment, Healthy Canadians, Healthy Economy: Strengthening the Canadian Environmental Protection Act, 1999". The federal government responded to the standing committee's report a year later.

The federal Commissioner of Environment and Sustainable Development plays an important role in evaluating the effectiveness of the Government of Canada's chemicals management plan and other aspects of chemical safety and exposure. In 2016, Commissioner Julie Gelfand released her audit on Chemicals in Consumer Products and Cosmetics, and in 2018, a report on toxics substances including aspects of CEPA. The report examined six toxic chemicals in detail and evaluated the progress of managing the chemical with the objectives. The results of the audit stated that ECCC still had significant work to do to achieve their objectives, and that many of the recommendations made by a previous audit had not yet been met.

Desired Outcome and Recommended Actions

The desired outcome is to act more quickly to prevent and reduce environmental and human exposure to harmful chemicals in the Great Lakes region. This will be done in three ways:

5. Establish a targeted 'exposure and effects' environmental and human health biomonitoring program in the Great Lakes region that will provide early detection of effects from harmful pollutants.
6. Use information from this targeted program to reduce exposure, through effective communication and involvement of at-risk individuals and communities, and to drive appropriate responses by enforcement officials, regulators, and those responsible for the release of the pollutant.
7. Create a Chemical Substitution Strategy that supports the substitution or elimination of toxic chemicals and harmful pollutants in products and processes in the Great Lakes region, based on a comprehensive review of function and use of a substance of concern and its likely alternatives.

It Is Recommended That

5. The Government of Canada develop a targeted environmental and human health effects monitoring, human biomonitoring and surveillance program to provide early detection of unexpected effects in the Great Lakes basin that feeds directly into a regulatory and non-regulatory response plan to reduce exposure.

EEM and Human Biomonitoring in Canada

Environmental effects monitoring and human biomonitoring are both well established in Canada. EEM is used by ECCC as a science-based performance measurement tool to evaluate the adequacy of effluent regulations in protecting fish and fish habitats. Both the pulp and paper and mining sectors are subject to requirements to conduct environmental effects monitoring.

There are a number of human biomonitoring initiatives, including the Canadian Health Measures Survey conducted by Statistics Canada in cooperation with Health Canada, involving over 5,000 Canadians, and includes a biomonitoring component; and the Maternal-Infant Research on Environmental Chemicals (MIREC), a five-year study evaluating the exposure to heavy metals of 2,000 pregnant women and their babies; and the First Nations Food, Nutrition and Environment Study, a study funded by Health Canada, led by researchers at the Universities of Ottawa and Montreal, involving over 6,000 individuals in 93 First Nation communities across the country.

5.1 It is further recommended that ECCC and Health Canada establish a taskforce that includes external expertise, to i) identify the priority areas and data sets that would determine the scope of the surveillance program; and ii) determine appropriate trigger in terms of what effects would instigate this process. Selection of the targeted areas would be guided by five criteria:

5.1.1 effects from toxic chemicals on aquatic ecosystems, building on the Canadian Aquatic Biomonitoring Network (CABIN) data & other water monitoring data.

5.1.2 human health response/effects/exposure to harmful pollutants in the environment, both in the air and water, building on ongoing National Biomonitoring Initiatives, including the Canadian Health Measures Survey, the Maternal-Infant Research on Environmental Chemicals, and the First Nations Biomonitoring Initiative, or where a community-driven environmental bio-monitoring program is already in place.

5.1.3 specific geographic hotspots, where people live in close proximity to areas where it can be reasonably assumed that chemical mixtures are found.

5.1.4 Indigenous participation in surveillance program essential, e.g. select 1 or more Indigenous communities as priority areas, incorporate community-based monitoring in Indigenous territory, and traditional knowledge.

5.1.5 effects at critical developmental life stages in humans and other organisms, e.g. exposure to endocrine disrupting chemicals at embryonic stage of development.

5.2 ECCC should establish a research program to identify causes, sources of effects identified, using Effects Detected Analysis.

5.3 Once Effects Detected Analysis is complete, ECCC and Health Canada should integrate above environment effects and human health monitoring and surveillance results into an enhanced pollutant assessment and response process (Chemical Management Plan).

5.3.1 The current assessment process must be updated to place high priority on multiple exposure, including analysis of cumulative effects or exposure to chemical mixtures.

5.3.2 ECCC and Health Canada should conduct a jurisdictional review on best practices in assessing impacts to chemical mixtures and cumulative effects, and share publicly and with interested parties, including Indigenous communities.

The European Union's Solutions Program

The Solutions program, under the EU"s Water Framework Directive, links chemical assessment with ecological assessment, using effects detection in monitoring followed by effects interpretation. The EU has adopted such an approach because it has concluded that relying on chemical status alone based on a small number of priority substances does not reflect the actual risk nor does it provide solutions to exposure. It is therefore complementing chemical status monitoring with monitoring of complex mixtures of contaminants. It then uses spatial effects and mixture risk modelling to consider the direct toxic pressure on aquatic organisms caused by a mixture of contaminants as well as human health exposure through drinking water and fish consumption.

As a final step to reduce exposure, guidance and accountability measures are needed for polluters, and regulatory and enforcement agencies to ensure that the data is used to direct their actions to stop the release of the pollutants and hold polluters accountable.

6. It is recommended that ECCC and Health Canada develop guidelines to guide the generation and communication of data collected through the surveillance program described in Recommendation 1, which outlines:

i. An integrated environmental health monitoring and knowledge translation approach to data generation;

ii. Adopts a collaborative approach which involves affected communities directly; and

iii. Ensures broad multidisciplinary collaboration throughout the process – from the development of monitoring program, through to dissemination of information for informed decision-making and response.

This recommendation underlines the importance of empowering those at risk to reduce their exposure to harmful pollutants. Rather than gather and analyze data internally within government agencies, this targeted surveillance program must involve at-risk individuals and communities in the collection, interpretation and communication of the data.

Those at-risk typically have little control or input into the type of monitoring and surveillance conducted in order to address their concerns and priorities. Furthermore, if they are given data without explaining its relevance, those at risk cannot make informed decisions to limit their exposure. It is not just data that should be communicated. Information could also include surveys, research studies, as well as information products like reports interpreting monitoring results, health protection messages and health promotion material explaining risks of exposure to toxic substances.

6.1 It is further recommended that ECCC and Health Canada, with their provincial counterparts, and with stakeholder input, develop Guidance on the Appropriate Response to Exposure and Effects surveillance program data, including guidance on steps to take, agencies to involve, how to engage the community or individuals-at-risk and appropriate timelines.

In some cases, even when those at-risk participate in the collection of data and they are made aware of what they are exposed to, they still lack the power to reduce their exposure, or to ensure that those responsible for the release of the pollutants are held accountable.

This guidance would be followed when developing case-by-case action plans and response, developed in consultation with the impacted community, relevant government agencies, including provincial enforcement agencies, and parties responsible for the source of the pollutant(s).

UN Rapporteur on Toxics asked to investigate combined exposure to air and water pollutants on Aamjiwnaang First Nation

Aamjiwnaang First Nation is located in Southwestern Ontario, near the city of Sarnia. It is home to 850 community members living on reserve – about one quarter of whom are children.

Sarnia's chemical industry has grown around Aamjiwnaang First Nation, with sixty-two chemical producing facilities within 25 kilometers of the community, surrounding it on three sides. With approximately 10 tons of pollutants discharged into the St. Clair River and an average of 100 spills a year, the River was declared an Area of Concern in 1985. Of particular concern is mercury contamination in the sediment of the St. Clair River. Progress has been made in remediating the sediment in some areas but three areas remain contaminated.

In addition to concerns over their water quality, residents are exposed to air emissions from chemical production, including benzene, a known carcinogen, and sulphur dioxide, which can contribute to respiratory and cardiovascular disease.

Community members who grew up swimming in the waters and harvesting fish and traditional medicines now report negative health effects from engaging in these traditional activities, which are constitutionally protected aboriginal and treaty rights under section 35 of the Constitution Act, 1982.

In response to these concerns, Aamjiwnaang First Nation invited the University of Michigan School of Public Health to conduct a 'Biomarkers of Chemical Exposure to Aamjiwnaang First Nation' study, involving 43 mother-child pairs. The study concluded that mothers and their children are exposed to multiple environmental pollutants, with higher trends than the Canadian average of cadmium, some perfluorinated chemicals (PFCs), some polychlorinated biphenyls (PCBs), Hexachlorohexane (HCH) and DDT.

In April 2019, Aamjiwnaang First Nation requested that the UN Special Rapporteur on Human Rights and Toxics, Mr. Baskut Tuncak, investigate the environmental contamination in and around Aamjiwnaang First Nation and 'seek clarification on what if any remediation efforts are being taken, and most importantly to remind the Government of its obligations under international law and request information, where relevant, on steps being taken by the authorities to redress the situation in question. The UN Rapporteur has also been asked by First Nations elders to investigate the connection between aerial spraying of forests with glyphosate and a decline in deer and moose populations.

The UN rapporteur undertook a fact finding mission to Canada in May and June of 2019. In his preliminary findings, Mr. Tuncak said that Canada showed a 'blatant disregard for Indigenous rights' in its handling of toxic chemicals and industrial discharges, and called on the federal government to improve the speed with which it responds to situations where indigenous Peoples are disproportionately exposed to pollutants.

6.2 A regular progress report on results of the Targeted Surveillance Program, communication and engagement with the at risk community, and any response taken by authorities as a result of the information generated by the Program, should be prepared jointly by ECCC and Health Canada in collaboration with community stakeholders and Indigenous partners, and meeting(s) with impacted community.

6.3 Progress reports should be posted on the Environmental Registry of Ontario and an equivalent federal registry.

6.4 To ensure accountability, it is recommended that the federal Commissioner of Environment and Sustainable Development be tasked with reviewing the progress reports and evaluating the effectiveness of the program in identifying effects of harmful pollutants, communicating information to reduce exposure, and addressing the source of pollutants in a timely manner.

7. It is recommended that ECCC and Health Canada introduce a Strategy to Promote Substitution of Harmful Chemicals in Products.

The Chemical Substitution Strategy should employ an alternatives assessment methodology that focuses on alternate ways to achieve the function of the harmful chemical rather than simply replacing a chemical with another chemical, to ensure that the replacement chemical does not share the same harmful characteristics of the one it has replaced. (regrettable substitution)

There should be public engagement in the development and implementation of the Chemical Substitution Strategy. Progress should be documented on an annual basis and made public.

Alternatives Assessment and Regrettable Substitution

By employing an alternative assessment methodology that considers the function of the chemical, it may be concluded that the chemical should be removed and not replaced, as its function was found to have little value. For example, producers of toothpaste have agreed to remove rather than replace plastic microbeads added to their products to 'whiten' our teeth.

A notable example of regrettable substitution occurred when ECCC undertook an assessment under the CEPA process of Nonyl phenol ethoxylates. As a result of the assessment, NPEs were found to be toxic, but manufacturers replace them with octophenol ethoxylates. Overtime, these were found to have the same toxic characteristics as NPEs.

7.1 It is further recommended that a Centre for chemical substitution be designated and appropriately resourced by ECCC to lead chemical substitution efforts in the Great Lakes basin, including:

- Assist ECCC in developing list of harmful pollutants detected in Great Lakes that should be prioritized for chemical substitution efforts.
- Bring together manufacturers, retailers, governments to support chemical substitution.
- Provide technical support to manufacturers to substitute harmful chemicals and assess alternatives.
- Develop consistent methods for evaluating alternatives to priority chemicals.
- Establish training programs for government and related stakeholders along supply chain on alternatives assessment, chemical substitution and green chemistry.
- Review available hazard data and identify information gaps that impede further progress with chemical substitution.

Making Hazard data available

To be effective, chemical substitution relies on full product hazard data. Under Section 70 of CEPA, manufacturers, importers, distributors or users of products that have information on the toxicity of the product are obligated to provide the information to ECCC. Section 71 further allows ECCC to request that further toxicological tests be conducted by manufacturers. These provisions are essential tools that must be employed by ECCC to support a successful chemical substitution strategy.

7.2 It is further recommended that ECCC create a voluntary chemical substitution recognition program to recognize industry leaders in chemical substitution, similar to U.S. EPA's Safer Choice program.

7.3 To ensure promotion of chemicals substitution in products on both sides of the border, it is recommended that the Parties to Great Lakes Water Quality Agreement (GLWQA) review and revise binational commitments on chemicals substitution in Chemicals of Mutual Concern Annex.

7.3.1 ECCC should make a request to the International Joint Commission to provide recommendations on a binational Great Lakes Coordination plan on chemical substitution that would inform changes to GLWQA annex.

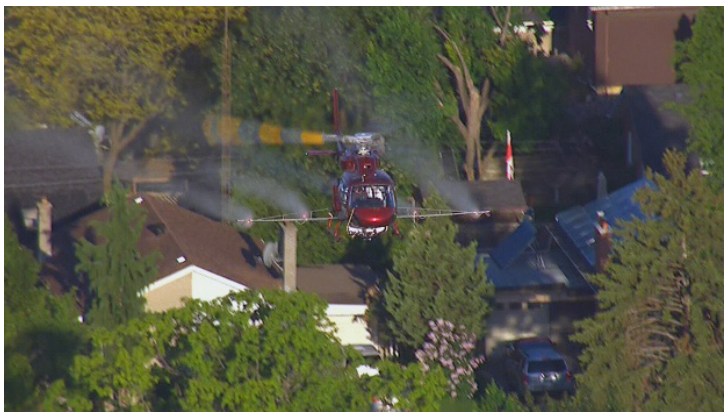
Impact of Chemicals in Products in Great Lakes Region

Chemicals that are used in products, particularly those in detergents, antibacterial products, pharmaceuticals and personal care products, are of growing concern to Great Lakes water quality because of the concentration of their discharge in the Region and the evidence of their accumulation in sediment and aquatic organisms. As these products are used, the chemicals in them are discharged through agricultural runoff, industrial effluent, and the bulk of sewage generated by the 40 million residents in the Great Lakes basin.

Hormone disrupting chemicals are of concern due to their potential to alter hormones in fish and other aquatic organisms at critical life stages, resulting in reproductive,

behavioural and developmental problems. Three separate studies have shown widespread distribution of alkylphenols, which are hormone disrupting chemicals used in detergents, cleaning products and adhesives, throughout the Great Lakes basin. There is added concern of the impact of exposure to multiple hormone disrupting chemicals, including estrogenic birth control.

The growing trend to add antibacterial and antimicrobial agents in cosmetics and personal care products has also become a serious concern. Triclosan, an antibacterial agent, also identified as an endocrine disrupting chemical that accumulates in the organs of fish, has been identified as a priority chemical to be assessed under the Canadian Environmental Protection Act (CEPA) process. A 2010 study showed widespread presence of Triclosan in the Great Lakes, in 89% of surface water samples and in a separate study, in 75% of people tested. In 2009, the Canadian Medical Association called on the Government of Canada to ban household antibacterial products due to the risk of bacteriological resistance.



C. NUTRIENTS

The frequency and severity of harmful algal blooms (HABs) are increasing within the Great Lakes Basin. Nonpoint sources of nutrients, including phosphorus (P), from agriculture and urban stormwater runoff are key contributors to the growth of HABs. A 2019 report by the Environmental Law and Policy Centre notes that HABs are further exacerbated by greater frequency of intense storms and precipitation as well as changes in water temperature associated with climate change. It should be noted that the need to reduce HABs across the Great Lakes must be balanced with maintaining nutrient inputs to sustain productive fisheries.

While some agricultural nonpoint contributions of nutrients, including individual farms, may be at very low concentrations, their cumulative impact is significant. It is therefore difficult to determine where to focus efforts for the greatest and most immediate impact given limited funding. The problem demands a different approach to what has been offered to date, in terms of broad-based agricultural education and incentive programs. We need to be more strategic in prioritizing areas in which to focus our efforts to reduce nutrients impacting our waterways.

There is also the added challenge of evolving nutrient management advice, and coordinating those providing advice and assistance to reduce nutrient loss, including extension workers, researchers, certified crop advisors, as well as drainage superintendents and Conservation Authority staff. Greater consistency in messaging will better assist farmers on making decisions affecting nutrient loss from their fields.

Urban stormwater presents a different set of challenges to agricultural runoff. Urban stormwater is often collected and discharged into waterways without treatment. While retention and collection infrastructure is in place, stormwater management facilities (such as wet ponds) must be maintained to remain effective at achieving required reduction in total suspended solids. Attention is being paid to improve planning and absorb more runoff with green infrastructure and low impact development, rather than it being discharged into waterways.

Targeted geographically-focused data and analysis are needed to identify which agricultural and urban

properties are likely to be contributing the most nutrients and to customize best management practices (BMPs) to reduce nutrient loss. Data privacy must also be respected. In Ontario, there are barriers to collecting farm data. Lessons on data management and protection of data confidentiality can be learned from the U.S. Geological Survey, and the U.S. Department of Agriculture. At the same time, we also need to improve how we coordinate, analyze and share monitoring and modelling to accelerate and implement more precise interventions in priority areas.

It is important to acknowledge and build on Ontario's progress to date in reducing nutrients entering waterways through the promotion of best management practices and low impact development for urban and agricultural sources, including existing programs like the 4R Nutrient Stewardship Program, Environmental Farm Plans, nutrient management plans, Sustainable Technology Evaluation Program (STEP), and wastewater treatment modifications. Periodic cost share programs such as the Great Lakes Agricultural Stewardship Initiative (GLASI), Lake Erie Agriculture Demonstrating Sustainability (LEADS) and the Canadian Agricultural Partnership have also advanced knowledge and understanding of best management practices in the Great Lakes region.

Wastewater is a point source of nutrients, and while important, these recommendations are focused on the challenge of nonpoint sources only, as these make up an estimated 87% of total phosphorus load in the Thames River basin.

Non Point sources contribute most to total phosphorus load

In the Thames River watershed, long term water quality and flow monitoring programs, and recent phosphorus load monitoring has provided information on the scale and timing of phosphorus loads at subwatersheds. Across the watershed, 87% of total phosphorus load comes from nonpoint sources, with 13% from wastewater treatment plant point sources. Although it is estimated the majority of nonpoint source total phosphorus loading comes from agriculture, urban nonpoint loads must also be addressed. Findings also show that phosphorus and sediment loads are highest in winter and spring runoff/highest flow conditions and that phosphorus loads come from individual properties and tributaries across the Thames watershed. As such, the focus to date has been on promoting the implementation of key strategic practices across the watershed.

Great Lakes Nutrient-Related Agreements and Plans

Great Lakes Water Quality Agreement

Under Annex 4 (Nutrients) of the binational Great Lakes Water Quality Agreement (GLWQA), Canada and the United States have committed to reducing nutrients entering the central and western basin of Lake Erie by 40% based on 2008 levels.

Lake Erie Action Plan

Canada and Ontario have agreed to a strategy to achieve Canada's share of this target, as outlined in the Canada-Ontario "Lake Erie Action Plan: Partnering on Achieving Phosphorus Loading Reductions to Lake Erie from Canadian Sources". Within the Lake Erie basin, the Thames River has been identified by Canada and Ontario as a priority watershed for phosphorus reduction with a target of 40% reduction from 2008 levels. The Thames watershed has highly productive farmland with about 80% of the land used in agriculture.

Canada-Ontario Agreement

The Canada-Ontario Agreement (COA) on Great Lakes Water Quality and Ecosystem Health is a federal-provincial agreement that supports the restoration and protection of the Great Lakes basin. COA's Annex 1 on Nutrients is designed to address the issue of excess nutrients and reduce harmful and nuisance algal blooms.

International Joint Commission's Lake Erie Ecosystem Priority

In 2014, the International Joint Commission (IJC) released a report entitled A Balanced Diet for Lake Erie with a series of recommendations on actions needed to reduce nutrients entering Lake Erie.

Thames River Shared Waters Approach

A water management plan (Thames River Shared Waters Approach to Water Quality and Quantity 2019 draft) has been developed by the partners of the Thames River Clear Water Revival which includes key issues on addressing phosphorus in the Thames watershed and recommendations for implementation by its various partners including Indigenous communities, the City of London, Environment and Climate Change Canada, Ontario MECP, Ontario MNRF, and MAFRA, and Upper Thames River and Lower Thames Valley Conservation Authorities.

Lake Simcoe Protection Act/Plan
Canada and Ontario have also coordinated funding and actions to monitor and reduce nutrients entering Lake Simcoe under the Lake Simcoe Protection Act, and the Lake Simcoe Protection Plan.

Nutrient Management Act
Ontario's Nutrient Management Act provides a framework for the management, application and storage of agricultural source materials (such as manure) and non-agricultural source materials (such as sewage biosolids) applied to agricultural land as nutrients.

Desired Outcome and Recommended Actions

The desired outcome is to reduce agricultural and urban nutrient runoff in priority areas contributing to harmful algal blooms, and to improve the health of our waters. The following actions are proposed:

8. Adopt precision conservation and urban stormwater optimization approaches.
9. Develop data management strategy and tools to identify priority properties and strategic best practices.
10. Create a 'Water Quality and Nutrient Management Centre' to support nutrient management through precision conservation and urban stormwater optimization.
11. Designate a 'network' of extension workers with standardized training to provide consistent technical advice on phosphorus loss reduction.
12. Where urban areas are identified as significant contributors of phosphorus loading, require municipalities to develop an urban stormwater optimization/prioritization plan.

It Is Recommended That

8. The Governments of Canada and Ontario adopt a targeted, geographically-specific approach to reducing nutrients entering the Great Lakes, employing precision conservation and stormwater optimization, to bridge the gap between farm scale conservation implementation and urban stormwater management with broader water quality impacts.

8.1 This requires embedding precision conservation and urban stormwater optimization approaches within agricultural and infrastructure investments and extension programs to support farmers, municipalities, First Nations, and others in their efforts to reduce phosphorus loss on a subwatershed basis and improve water quality within the Great Lakes Basin.

This targeted, geographically-specific approach does not preclude nor replace strategic practices that should be widely implemented across watersheds (for example, the timing of manure spreading to avoid spreading while land is frozen, planting cover crops, etc.).

8.2 Precision conservation is defined as a targeted, geographically-specific approach that identifies properties in priority subwatersheds and recommends a set of specialized practices, technologies and procedures at sufficient scale to enable landowners to make decisions yielding the greatest benefit from resources allocated to reduce nutrient loss.

Importance of Identifying Priority Subwatersheds

The Great Lakes Water Quality Agreement Annex 4 on Nutrients identified 14 large watersheds in both Canada and the United States as a priority in the Lake Erie Basin, including the Thames River basin and creeks in the Leamington area in Ontario. Areas were chosen based on their relatively high nutrient loads flowing into Lake Erie, and whether an algal bloom was appearing at the mouth of the tributary that drained into the watershed.

Loads coming out of tributaries at the mouths were documented. The Heidelberg approach, involving three samples per day at the mouth of tributaries for 365 days across 15 different parameters, is considered the most effective, but is data intensive. Annex 4 opted for 50 to 100 samples per year. However, this approach could miss large storm events that contribute to 70-90% of phosphorus loss.

On the U.S. side, in Ohio, an Annex 4 subcommittee on tributary loadings documented monitoring results from the mouths of tributaries in key priority watersheds. They also moved upstream to document loads in small tributaries. Ohio monitors total load and flow weighted mean concentration, which shows more consistent concentrations in both dry and wet years, avoiding the conclusion in dry years that phosphorus levels have dropped, or the reverse in wet years.

In 2018, Governor Kasich of Ohio issued an executive order designating eight Maumee subwatersheds as "impaired" based on three years of this type of monitoring. A strategy to identify priority subwatersheds, and eventually down to the property level, must be based on sampling stations at the mouth of tributaries at a frequency capturing the largest storms.

The Governments of Canada and Ontario have started to look at prioritizing subwatersheds in the Thames River basin. This exercise would help identify where to focus precision conservation and stormwater optimization activity.

Key steps in precision conservation

The Governments of Canada and Ontario identify priority subwatersheds where precision conservation should be focused. This should be based on contributions of higher levels of nutrients, or the sensitivity of the receiving water body.

a. Identify customized conservation practices that have the greatest impact on nutrient loss in specific circumstances.

b. Use GIS-based decision support platforms to identify specific properties contributing phosphorus.

c. Engage farmers directly to discuss options for conservation practices, customization and placement.

d. Best practice advice continues to evolve and remains unclear to many farmers. Customized best practice information and extension support is required.

e. Assist farmers applying conservation practices targeting location/timing.

f. While Ontario Conservation Authorities and agricultural extension programs exist, there is not enough capacity and coordination needed to make progress.

Building on Existing Agricultural Stewardship Programs and Initiatives

Precision conservation must be integrated into whole farm operations by 'stacking' a suite of best management practices, and build on progress achieved to date on reducing nutrient loss through a number of existing and past programs and initiatives:

The Canadian Agricultural Partnership is a federal-provincial cost share program continues to advance knowledge and understanding of best management practices as well as support customized edge-of-field conservation practices (restored wetlands, saturated buffers, bioreactors, drainage modifications, placement of ponds, etc.) and technologies (e.g. passive or active phosphorus removal systems).

The 4 R Ontario Nutrient Stewardship is an industry-led program that promotes the application of the right source of fertilizer at the right rate and time to the right

place. The 4R voluntary certification program trains crop advisors and agricultural retailers to explore and document strategies to improve nutrient management on farms. The 4R Nutrient Stewardship program also serves as a protocol for carbon reduction.

OMAFRA recently convened a Soil Health Working Group to gather advice on developing Ontario's Agricultural Soil Health and Conservation Strategy.

Environmental Farm Plans are planning tools to help farmers identify potential risks and implement good site-specific field practices, such as cover crops, limited tilling practices, among other stewardship actions. Farmers have also developed site-specific nutrient management plans for individual farms.

Farmland Health Check-Up facilitates on-farm risk assessments of soil health and water quality, with specific attention paid to erosion, compaction, organic matter, and soil chemistry.

Lake Erie Agriculture Demonstrating Sustainability (LEADS) was a cost share program that supported the implementation of best management practices on farms within the Lake Erie and Lake St Clair watersheds using risks identified through the Farmland Health Check-Up.

Other cost share programs such as the Great Lakes Agricultural Stewardship Initiative (GLASI) helped farmers improve soil health and stewardship practices through promotion and monitoring of best management practices, as well as providing long-term data and valuable information for farmers and decision makers.

The Thames River Phosphorus Reduction Collaborative (PRC) is a joint project of the Ontario Federation of Agriculture and the Great Lakes and St. Lawrence Cities Initiative, aimed at developing, testing and promoting a suite of effective land management and drainage solutions for agriculture, developed cooperatively with partners, for reducing or removing phosphorus from agricultural run-off and improving water quality in the Thames River.

Different Approaches to Precision Conservation

Chesapeake Bay

Lessons can be learned from thirty plus years of nutrient management in the Chesapeake Bay watershed. After sporadic adoption of best management practices, a targeted 'precision conservation' approach was adopted in the Chesapeake area focusing best practices at the lot level where they can have the greatest impact.

The availability of high resolution (one metre spatial resolution) land cover information has improved the potential for precision conservation. These efforts have been spearheaded by the Chesapeake Conservancy who worked partners to identify new cost-effective practices and technologies that can accurately determine high-functioning natural landscapes and help guide conservation targeting in the Chesapeake Bay watershed.

Spatially Referenced Regression on Watershed Attributes (SPARROW) is a modelling tool that utilizes in-stream water quality measurements and spatially referenced characteristics of watersheds to estimate the origin and fate of contaminants in rivers. Pennsylvania has embraced this watershed prioritization approach as integral to the development of their watershed clean-up plan to meet the Chesapeake Bay wide pollution caps for nitrogen, phosphorus and sediment.

The SPARROW model is intended to be used by water managers to plan watershed management and implement best management practices throughout the United States, including the Great Lakes region. Results of this prioritization effort are summarized in the Chesapeake Progress report by the U.S. Department of Agriculture's Natural Resource Conservation Service. This advanced targeting helps focus efforts on properties that will provide ecosystem services and deliver the greatest amount of benefits with limited funding.

Illinois and Kentucky
Precision conservation management (PCM) is a farmer-led effort developed to address natural resource concerns on a field-by-field basis by identifying conservation practices that effectively address environmental issues in a financially viable way. The mission of the PCM program in Illinois and Kentucky is to increase adoption of voluntary conservation practices by commodity crop farmers and animal producers in the Mississippi River Basin by assisting farmers with selection of financially-favourable best management practices for their unique farming enterprise.

9. It is recommended that the Government of Ontario, with support from the Government of Canada, develop a data management strategy and GIS-based tools to support the precision conservation approach and to facilitate the collection and use of datasets (e.g. elevation, soil type, property boundaries, land use) needed to prioritize properties and best practices.

9.1 As part of the data management strategy, establish confidentiality protocols to protect landowner data, e.g. in aggregated form.

9.2 Relevant layers of GIS-based data need to be made available to identify areas contributing high levels of phosphorus, such as field boundary data, soils data, land use data, and elevation data.

Using big data to support precision conservation

Examples of big data supporting precision conservation in other jurisdictions:

Agricultural Conservation Planning Framework
The Agricultural Conservation Planning Framework (ACPF) is a decision support model and set of tools for precision conservation employed in the U.S. midwest. ACPF takes a watershed approach to conservation planning and scenario building using layers of data such as digital elevation, field boundaries, soils, and crop cover. Maps are generated with this geographically specific data to identify priority subwatersheds and a decision support platform helps determine site-specific opportunities to implement agricultural conservation practices. ACPF can also evaluate the effectiveness of multiple practices in meeting nutrient reduction targets. According to the experience in Minnesota, it is easy to tailor to specific local needs. The decision support tool not only provides a framework for prioritization and implementation, but also offers lessons from the U.S. midwest in producer engagement and coordination of conservation efforts.

Nutrients Tracking Tool
Another example of using big data is the Nutrients Tracking Tool developed by Tarleton State University in Texas to estimate nutrient loss from crop and pasture land.

Building on existing decision support tools/data platforms in Ontario

Existing data platforms and tools in Ontario that could be integrated to support the adoption of a precision conservation approach:

OMAFRA's **Phosphorus Loss Assessment Tool for Ontario (PLATO)** is designed to assess the risk of P loss from agricultural fields. The tool considers soil texture, slope, and proximity to surface water, transport of nutrients, as well as phosphorus application techniques, timing and rates.

AAFC's **Indicator of Risk of Water Contamination by Phosphorus (IRWOC-P)** in an internal platform that assesses the risk associated with Canadian agricultural practices at a watershed scale.

Ontario's Watershed Flow Assessment Tool is an accessible open data and mapping portal used to visualize hydrology and water flow and data within Ontario.

Ontario's AgMaps Geographic Information Portal is an online application that allows users to search for agricultural data on soils and drainage, and create customized maps.

Water Information Systems KISTERS (WISKI) are being developed through Conservation Authority nodes across Ontario to incorporate water data from multiple sources and agencies.

9.3 It is recommended that a watershed-level nutrients data portal be created to ensure accessibility and coordination of Great Lakes nutrients monitoring/ modelling data and analysis (both agricultural and urban stormwater) at the watershed level to inform precision conservation and stormwater optimization.

The watershed-level nutrients data portal would include:

- A Great Lakes map of the greatest nutrient losses, pressures, and priority areas.
- A comprehensive list of monitoring stations and parameters.
- A list of agencies responsible for monitoring and modelling.
- Monitoring and modelling data, interpretation, and visualization.
- Tools and strategies for nutrient loss mitigation, including advice on best management practices, and expertise to apply at a site-specific property level.
- A list of ongoing partner initiatives and projects outlining who is doing what and identifying linkages in order to coordinate efforts.
- Required bandwidth for Indigenous communities to ensure accessibility
- Both agriculture and urban data to support precision conservation in agriculture, and stormwater optimization approach in urban environments.

10. It is recommended that the Governments of Canada and Ontario, together with partner universities, Indigenous communities, and relevant organizations, create a Centre for Water Quality and Nutrient Management to generate and coordinate information to support precision conservation and stormwater optimization approaches in the Great Lakes Basin.

10.1 The Centre would offer the following functions supporting both agricultural and urban nutrient management:

Overarching Process

- Coordinate overall prioritization process.
- Promote a sustainable cycle of nutrients, including the production, use, recovery, reuse and recycling of phosphorus.

Data Collection

- Support open data mapping and portal/inventory of watershed-level monitoring, modelling, data visualization, projects, and support commitment to open data.
- Promote community of practice that shares models (proprietary, costly modeling exercises).
- Develop a data confidentiality protocol.
- Implementation Advice and Training
- Communicate methods and practises in agriculture and stormwater to reduce phosphorus loss, and provide best management practice advice (e.g. managing non-growing season).
- Promote action on the ground for the adoption of best management practices, green infrastructure, low impact development, and restoration projects.
- Develop and train a dedicated network of extension workers/delivery nodes and training.

Policy and Finance

- Explore new policy tools, approaches, and guidelines.
- Conduct cost benefit analysis, incorporating externalities.
- Explore and support investment options, e.g. serve as an aggregator for green bonds, payments for ecosystem services, stormwater fees, and/or other financial mechanisms.

Evaluation

- Develop improved methods to measure and track progress through modelling, monitoring of water quality levels, and validation of practices on the landscape.
- Evaluate the effectiveness and cost-efficiency from water quality/nutrient loss perspective and other co-benefits, and aim for continuous improvement.

Opportunities to manage a sustainable phosphorus cycle from production and use to recovery

Many countries are now recognising the integrated nature of the phosphorus cycle and the need to improve many aspects of how we produce, distribute, use, recover, reuse and recycle phosphorus. The development of a Center focused on nutrient management would allow for 'new thinking' around a circular economy of phosphorus.

In the future, it is likely that phosphorus may be seen much more as a precious, increasingly scarce and expensive commodity that is too valuable to waste, and therefore efforts to recover phosphorus from agriculture and urban stormwater, as well as wastewater, will increase. This has the multiple benefits of reusing phosphorus, potentially saving farmers and municipalities money, creating jobs, reducing greenhouse gases, and improving water quality.

Examples of similar initiatives developed in other countries include the Sustainable Phosphorus Alliance, the Dutch Nutrient Platform, and the European Phosphorus Platform.

11. It is recommended that Agriculture and Agri-food Canada (AAFC) and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) work with the Centre for Water Quality and Nutrient Management to designate a dedicated network of extension workers, through existing organizations or a new institution, that receive standardized training, and provide consistent technical advice to farmers.

This extension network would support a range of partners including farmers and farm groups, Conservation Authorities, certified crop advisors, engineers, drainage superintendents, extension workers (e.g. Ontario Soil and Crop Improvement Association (OSCIA)), governments, and non-profit organizations such as Ducks Unlimited Canada (DUC) and Alternative Land Use Services (ALUS).

11.1 The network would receive training on providing advice to priority property owners in priority subwatersheds on the most effective practices that reduce P loss, especially during peak times during the year.

Agricultural stewardship extension and training

Agricultural Extension and Training Success Factors

- Bringing together a suite of agricultural extension workers to deliver consistent advice.
- Connecting trusted experts and farmers face-to-face, in addition to written materials and online tools.
- Support peer review approach with local farmers and experts making decisions.
- Providing ongoing training of trainers on the latest technology, innovative approaches, policies/regulations, and incentives
- Target training relevant to certain times of year for specific key actions, subwatersheds and/or properties (relevant to winter spring runoff).
- Ensuring the long-term sustainable funding of extension and training specialists.
- Supporting market-based opportunities for certified crop advisors to deliver services that provide public benefits, including extending the business service model to phosphorus loss reduction.
- Including accountability mechanisms such as monitoring, evaluation and reporting criteria.

What agricultural extension and training is required?

- Support soil BMP implementation and a feedback loop to researchers for continuous improvement.
- Foster expansion of known practices that improve water management and reduce overland flow (i.e. cover crops).
- Promote existing erosion assessment, prevention and mitigation tools.
- Expand on-farm soil health planning tools such as 4R Nutrient Stewardship certification, Environmental Farm Plan, Farmland Health Check-up, etc.
- Deliver consistent messaging on soil care practices.

Who needs training? Farmers, certified crop advisors in agriculture retail and agricultural consultants, equipment manufacturing, input supply companies, engineers, drainage contractors, Conservation Authority field staff, and financial service experts, among others.

Who would train? Ontario Ministry of Agriculture, Food and Rural Affairs field extension/environmental branch, Agricultural and Agri-food Canada, university extension groups at the universities of Guelph, Waterloo, Western University, Windsor. Also experienced contractors, engineers, drainage superintendents, and other partners.

12. It is recommended that, where subwatershed modelling and monitoring identifies urban areas as significant contributors of phosphorus loading, the Ontario Ministry of Environment, Conservation and Parks (MECP) require the relevant municipalities in consultation with Conservation Authorities to develop an urban stormwater optimization/prioritization plan with steps to achieve measurable phosphorus reductions.

12.1 Prioritization would be based on urban stormwater management optimization modelling, at a watershed scale where appropriate. Plans would need to consider the use of grey and green stormwater infrastructure and natural assets, and explore financial tools that municipalities and Conservation Authorities can use, such as stormwater management fees, offset programs, and green/blue bonds.

12.2 Education and training support needs to be provided as well. The Sustainable Technologies Evaluation Program (STEP) could be expanded to deliver professional training on the effective design, construction, inspection and maintenance of grey and green stormwater infrastructure. It is important to support the continued evolution of university and/or college curriculum so that new and innovative green infrastructure approaches are taught. It is also recommended that green infrastructure certification programs be explored as such as the U.S. National Green Infrastructure Certification program.

Lake Simcoe Urban Stormwater Optimization

The Lake Simcoe Region Conservation Authority, in partnership with the Government of Ontario, municipal and Indigenous communities, has completed subwatershed plans and implementation plans for a select number of urban stormwater priority projects.

"Urban stormwater optimization" is being explored as a pilot project within the Lake Simcoe watershed. This approach seeks to determine the potential of system-based, watershed-wide stormwater management planning to achieve optimal performance (in this case, phosphorus reduction) of stormwater infrastructure using both green and grey infrastructure as well as natural assets in the most cost-efficient way.

A continuous simulation model is coupled with a decision support tool developed by the U.S. Environmental Protection Agency called SUSTAIN that runs thousands of stormwater management options. Each spatially derived management option includes associated costs and benefits. Plots of management options are then used to create 'optimization curves' which help determine the most cost-effective strategy for a given targeted area.

Once established, this stormwater optimization model will test the efficacy of various economic principles such as equitable responsibility, aggregation, and scale. Equitable responsibility is the term being applied to the concept of cost and resource sharing for stormwater management planning (and potentially design, construction and operation) amongst municipalities and Indigenous communities within a watershed.

D. BEACHES AND BACTERIOLOGICAL CONTAMINATION

For many Ontarians and visitors, our beaches are where we spend the most time enjoying the Great Lakes. Beaches are valuable community assets, bringing in thousands of visitors to large cities and small towns each year, contributing to our quality of life and to local economies. There are 800 beaches in Ontario, many of them on the shoreline of the Great Lakes. Beach owners, including municipalities, Indigenous communities, provincial parks, Conservation Authorities, and private resort owners, working with public health units, have generally maintained a strong track record of preventing waterborne diseases from people enjoying these recreational waters.

Notwithstanding Ontario's good track record, between 15-20% of Ontario's beaches have chronic bacterial contamination issues. According to public health data compiled by Swim Drink Fish, of the 800 beaches regularly monitored in Ontario, approximately 15-20% of these exceed the *E. coli* standard 20% of the swimming season. It should be noted that this estimate is based on pass/fail testing results in 2017 and 2018, for beaches with varying frequency of testing and varying monitoring start and end dates. Taking these variations into account, it is estimated that the recommendations presented below with regard to 'impaired beaches' would impact around 120 beaches. To determine which beaches would be categorized as 'impaired' according to the recommendations below, a more thorough analysis of data over several years would need to be conducted.

Bacteriological contamination at beaches may be caused by one or more of a number of sources including untreated sewage, waterfowl feces, leaking septic tanks, domestic animals, and urban and agricultural run-off. All are important to track and assess as contributors to beaches contamination. However, from a risk-based approach, due to its high concentration of pathogens, and its potentially serious health effects including gastroenteritis, febrile respiratory illness, or skin illness, addressing untreated sewage is a top priority. Untreated sewage may be released directly as a bypass, or it may be gathered through cross connections to the stormwater collection system that is discharged at an outfall close to a beach. During heavy rainfalls, these sources of bacteriological contamination may increase significantly.

The persistent nature of this bacteriological contamination in 15-20% of beaches in Ontario suggests its sources are unknown and/or not being addressed. While public health units monitor the quality of beaches, they are not vested with the authority to require action to be taken by the beach owner to identify and addresses these sources. The public health unit's authority is limited to protecting public health by requiring public posting of the beaches as unsafe for swimming. It is the responsibility of the environmental and water quality regulator, the Ontario Ministry of Environment, Conservation and Parks to ensure that sources of bacteriological contamination are identified and addressed.

The number of chronically impaired beaches in Ontario is not commonly known because there is no system to track beaches performance. Currently, if a member of the public would like to look up the beach quality test results, s/he must look them up on each of the relevant municipalities' websites. Unlike the United States, the European Union, and a number of other jurisdictions, there is no central database to keep track of overall beach quality across the Province, nor is there a system to rank or categorize beaches to provide a relative evaluation of beaches to the public.

In Ontario, there is also a challenge in communicating test results in a timely manner. Public Health Ontario's 'Public Beach Water guidance on test methods for *E. coli*' requires membrane filtration testing as per the Ontario Ministry of Environment's drinking water testing methods E3371. Weekly testing using this method is paid for by the Province. Samples are sent to Ontario laboratories for analysis. Using this required testing method, analysis takes 24 to 48 hours. If a sample exceeds the *E. coli* standard, Public Health will require that the beach be posted as unfit for swimming. However, given the length it takes to evaluate the results of membrane filtration testing, by the time it is posted, the information often no longer reflects the quality of the water. From a public health protection point of view, it is of little value as it is posted 24-48 hours after the sample was originally taken. Other sampling methods used in the U.S., Québec, and Europe, provide more

timely information. However, these are not permitted nor are they paid for by the Ministry of Health and Long Term Care in Ontario.

The need to address these deficiencies is all the more urgent given the impacts of climate change. Over the next 30-40 years, it is projected that the lower Great Lakes region will be transformed from its current temperate climate to a subtropical climate. This will bring longer and hotter beach seasons, attracting many more people to the shoreline. It will also bring more intense and extreme storms which will worsen episodes of bacteriological contamination of beaches that go unaddressed. The impact of high water levels and strong wind and wave energy may degrade beach and shoreline integrity.

Regulating and Managing Beaches - Who Does What

There are two aspects to the monitoring, regulation and enforcement of beaches quality. The first, protection of public health through regular monitoring and public notification of water quality, is the responsibility of the Ontario Ministry of Health and Long Term Care through local public health units. The authority of public health officials only extends to informing the public of a public health risk.

The second aspect is the quality of the recreational waters. Recreational water quality is evaluated based on the best indicator of bacteriological contamination, the *E. coli* standard. Where there are repeated exceedances of the *E. coli* standard, the water quality must be addressed, and any enforcement activity to address the source of contamination is the responsibility of the Ontario Ministry of the Environment, Conservation and Parks, under the Ontario Water Resources Act.

The Government of Canada, through Health Canada, maintains national guidelines for the management of the recreational waters, Guidelines for Canadian Recreational Water Quality. These standards, or more stringent ones, have been adopted at the provincial and territorial level through public health programs.

The Guidelines for Canadian Recreational Water Quality recommends Escherichia coli (*E. coli*) as an indicator of fecal contamination in freshwaters and sets a standard limit of 200 *E. coli*/100mL for recreational water use. Up until 2018, the Government of Ontario maintained a more stringent standard of 100 *E. coli* per/100mL. In 2018, this was changed to 200 *E. coli*/100 mL to harmonize with the Federal Guideline.

In most provinces including Ontario, municipalities take all the day-to-day decisions related to the operation and maintenance of public beaches within their boundaries. Under the Ontario Health Protection and Promotion Act, public health units are responsible for monitoring beach water quality. Responsibility for beach monitoring in Ontario Parks lies with the Ministry of the Environment, Conservation and Parks (MECP) and the Ministry of Natural Resources and Forestry (MNRF). Indigenous Services Canada is responsible for ensuring the quality of recreational water on reserve. The First Nations and Inuit Health Branch (FNIHB) is ultimately responsible for monitoring recreational water quality in the First Nations. In First Nations, recreational water quality is tested in the on-reserve water lab or the samples are sent to provincial or contracted labs. FNIHB's Environmental Public Health program provides equipment and training for recreational water quality monitoring in First Nations.

The Ontario Ministry of Health and Long-Term Care (MOHLTC) publishes two key guidance documents related to beaches, the 'Recreational Water Protocol' and the 'Beach Management Guidance' Document. The 'Recreational Water Protocol' (2018) provides the Boards of Health with details on the delivery of recreational water programs and services. The 'Beach Management Guidance' Document supports the Boards of Health (BOHs) in the implementation of 'Recreational Water Protocol' and describes task-specific best practices. The 'Operational Approaches for Recreational Water Guideline' (2018) provides direction to Boards of Health about the manner in which to approach the requirements described in the 'Recreational Water Protocol' (2018).

The Ontario Water Resources Act (OWRA) deals with sewage works and prohibits or regulates the discharge of sewage and stormwater into water bodies. The 'Stormwater Management Planning and Design Manual' provides technical and operational support in planning, designing and reviewing the stormwater management practices. Guideline F-5-5 under the OWRA outlines rules for treating municipal and private combined and partially separated sewage systems, and specifies that plants with a history of combined sewage overflows must meet the *E. coli* standard 95% of the swimming season.

Notable Beach Programs

The Blue Flag program, administered in Canada by the non-profit organization Environmental Defence is an international beach quality certification program. Blue Flags are awarded to beaches and marinas that meet stringent criteria for beach water quality, environmental education, cleanliness and accessibility, safety standards, environmental protection, and management.

The Healthy Lake Huron – Clean Water, Clean Beaches Partnership is a collective effort of various levels of government to reduce the amount of phosphorus and bacteria (such as *E. coli*) entering the water due to failing private septic systems, municipal wastewater, and natural sources such as waterfowl.

Swim Drink Fish (SDF) is a non-profit organization dedicated to building a movement of active, informed and engaged individuals working in their communities to make their recreational waters swimmable, drinkable and fishable. SDF's Swim Guide provides the most comprehensive online information on weather, water and beaches quality in Ontario.

Desired Outcome and Recommended Actions

The desired outcome is to ensure that Great Lakes beaches are clean and protect public health by moving from a public notification approach to a risk-based, centrally monitored pollution reduction and prevention approach, involving both MOHLTC and MECP.

Adopting a risk-based, science-based approach, the Collaborative is recommending that a more robust response to beaches with chronic bacteriological contamination be adopted, involving targeted action to identify and address the sources of bacteriological contamination.This will require the involvement of communities who benefit from beaches as community assets. As this is both a public health and water quality problem, it demands coordination and collaboration between the Ontario Ministries of Health and of Environment, Conservation and Parks. To the extent that some of the contamination can be attributed to sewage and stormwater, it will also require financing where costly infrastructure upgrades may be necessary.

This new approach would involve three key actions:

1. Ontario would adopt a risk-based, science-based approach to beach management that would target beaches with chronic bacteriological contamination issues and require action to track and address the persistent sources of bacteriological contamination, with funding support.
2. Both the Governments of Canada and Ontario would modernize their guidelines on the use of new techniques and technologies that allow for more time-sensitive monitoring, assessment and reporting of beach quality.
3. Ontario would create a centralized portal to communicate beach quality information, making beach quality categorization, testing and survey results easily accessible to the public.

It Is Recommended That

13. The Ontario Government introduce a new risk-based categorization system for Ontario beaches, that would require those beaches categorized as 'impaired' to trace the source of the chronic bacteriological contamination and take action to address it.

This new system would require coordination, collaboration and information sharing between the Ontario Ministry of Health and Long Term Care and the Ontario Ministry of Environment, Conservation and Parks to identify chronically impaired beaches and to determine the appropriate actions to bring beaches with chronic *E. coli* exceedances into compliance. It would also require a collaborative approach locally where chronic beaches are identified, to determine the right course of action and to build support to take these actions. It would serve to provide beach users, beach owners, public health units, and the Ontario Ministry of Environment, Conservation and Parks, an indication of the comparative quality of beaches and progress in addressing bacteriological contamination where it exists.

This new beaches categorization system is modelled on similar systems in Europe and the US.

Categorization would be based on the following criteria:

a. Percentage of the swimming season when beach samples met or exceeded the E. coli standard, based on minimum of 20 data points over 3-5 yrs of testing.

b. Bacteriological contamination has been traced to its source/s.

c. A beach management plan is in place to address these sources and communicate publicly on progress.

d. Beach is known to be impacted by combined sewage overflows, and therefore subject to F5 guideline's more stringent requirements re: meeting *E. coli* standard.

Summary of Beaches Categorization System

(n/a=not applicable)

	1-Combined Sewer Overflow (CSO)-impacted beaches	**2-Impaired beaches**	**3-Fair-Good beaches**	**4-Good-Excellent beaches**
Exceedance of *E. coli* standard	>5% of swimming season	>20% of swimming season	>20% of swimming season	< 20% of swimming season
Response plan	yes	required but not in place	yes and showing progress	yes
Source tracking	n/a	required but not undertaken	yes	yes
Subject to F55 guidelines	yes	n/a	n/a	n/a

13.1 For impaired beaches (including in Indigenous communities, areas of concern and provincial parks)

a) MECP, in consultation with public health units (Indigenous Services Canada in the case of First Nations) would be responsible for introducing requirements for the beach owner to track and address sources of bacteriological contamination, and to prepare a beaches management plan.

i) the beach owner would be required to undertake the tracking and address the sources of contamination and develop and implement beaches management plan, in consultation with community and with federal and provincial financial support; The beach owner would have up to three years to identify the sources of contamination and prepare a source tracking and response plan to address the sources.

ii) In extreme cases, where the beach owner is not able to mitigate the chronic source of bacteriological contamination, the beach owner would be permitted to undertake an assessment of the suitability of the site for a beach in consultation with the community. If sufficient evidence that mitigation of pollution sources is not possible, the beach owner, in consultation with Public Health, MECP and the community, would be permitted to close the beach.

b) Where the party responsible for the contamination is not the beach owner, MECP would take action to require responsible party to mitigate source of contamination.

13.2 For those 'fair-good' beaches open under 80% but implementing a risk management plan, beach owners would be required to continue to put beach management actions in place that were known to protect the public, e.g. automatic rain rules.

13.3 For those 'good-excellent' beaches that have reduced testing frequency requirements, (e.g. once a month), recommend the criteria of Blue Flag beach be adopted (80% of the geometric mean results must fall below the limit value).

13.4 For those beaches designated under MECP's F5 guideline (CSOs), beaches must meet the *E. coli* standard 95% of the time during the swimming season.

13.5 For all beaches, annual environmental health and safety surveys should be completed, as well as regular short field surveys when taking samples throughout the beach season.

While the Collaborative was asked by Environment and Climate Change Canada to focus bacteriological contamination, it is not the only threat to public health on beaches. Other threats, such as cyanobacteria in harmful algal blooms, high waves, or rip currents, can pose an equal or greater threat to human health. For this reason, it is recommended that conditions beyond the presence of *E. coli* as an indicator of bacteriological contamination should be documented through regular field surveys.

14. It is recommended that Ontario Ministry of Health and Long-Term Care (MOHLTC) create and maintain a central portal with beach quality information, including information on the 'status' of the beach (based on above four categories: impaired, fair-good, good-excellent, under CSO advisory)

Once the categorization system is established, it will then be important for MOHLTC and MECP to keep track of the relative performance of beaches across the province, the number of beaches that are categorized 'impaired', and to make beach quality information easily available to the beach goers. In the U.S. and a number of other jurisdictions, this is done through a central portal.

- MOHLTC should prepare guidelines for municipalities on required standardized format of data to upload to a centralized portal
- Require beach owners or public health unit to upload verified beach testing data to central portal in compatible format as it becomes available (e.g. following weekly sampling and verification of data; less frequent in provincial parks or northern or remote beaches).
    - Allow for registration for text service linked to portal, that would send individuals texts of water/beach quality at specific beaches.
    - Include E. coli testing info as well as other risks, including presence of cyanobacteria, red tide, and common daily information like water temperature, wind direction, wave action.

15. It is recommended that MOHLTC amend the Public Health Ontario's Public Beach Water guidance on test methods for *E. coli* to allow for alternate testing methods other than membrane filtration as per Ontario MECP's drinking water testing methods E3371. Federal recreational water guidelines (2012) currently under review should likewise include a review and revisions to testing methods.

Testing methods that have been commonly used in other jurisdictions over the last decade should be permitted. This would allow for more timely communication of actual water quality to beach goers rather than a retrospective test that is 24-48 hours out of date by the time it is communicated publicly. There are also other efficiencies to be gained, in terms of reduced 'hands on' time for staff undertaking the testing, and simpler methods that can be conducted in-house rather than sending samples to a lab.

a. Both provincial and federal guidelines should allow for other testing methods and predictive modelling.

b. The cost of these additional methods would be subsidized by Province at same rate as membrane filtration. Additional cost for testing by labs borne by beach owner.

c. Guidelines should allow for 'in-house' testing of samples by public health units.

d. Any methods that have received USEPA approval for analysis of fecal indicator bacteria in recreational waters OR is a method that has been reasonably validated (e.g. by CSA or NSF) and used appropriately, should be permitted at cost to beach owner, and may be sent to accredited labs.

e. Further research should be conducted on sampling and testing methods for other water-borne risks to human health, including cyanobacteria toxins. In areas where harmful algal blooms are a common occurrence, funding should be made available to public health units to test for cyanobacteria.

4. INVESTING IN THE GREAT LAKES

The Action Plan to protect the Great Lakes will require significant and sustained investment to be implemented. The benefits of protecting the world's largest freshwater system, that supports over one third of Canada's population, and one third of Canada's GDP, ensure that the return on investment will be substantial. Investments through the U.S. Great Lakes Restoration Initiative realized a 3:1 return on investment.

Level of investment needed

It is estimated that the level of investment needed to implement the recommendations over ten years, as outlined in this plan, is in the order of $1.5-3 billion. This is a preliminary estimate, and requires further analysis based on actual needs of shoreline communities, beach owners, communities impacted by toxics and harmful pollutants, and agricultural and urban actions to reduce phosphorus run-off.

As a catalyst for the investment needed, and to lay the foundation for many of the recommendations, it is proposed that the Federal Government invest $100 million a year, over ten years. This should be new investment, above and beyond the current level of investment in Great Lakes programs, public infrastructure and climate adaptation- related funding. This amount will serve as leverage for further investment from provincial and municipal governments, as well as investment from other private and non-governmental sources, including pension funds, the private sector, foundations, and alternative finance mechanisms like green bonds and pollution trading.

The Case for Great Lakes investment

The business case for investments in Great Lakes protection is strong. A Brookings Institute cost benefit analysis showed a 2:1 return on Great Lakes investments. A follow up report that specifically assessed the return on investment of investments by the federal government under the Great Lakes restoration initiative found a 3:1 return. Some individual investments under GLRI realized a 6:1 ROI.

A 2007 Canadian study undertaken by Dr. Gail Krantzberg of McMaster University provided some valuation of key sectors that would be impacted in the absence of action to protect the Great Lakes, including:

- Recreational bathing -$250m
- Recreational boating- $2.2B
- Sports fishing- $7.5 B
- Commercial fishing- $95 m, direct and indirect (sales, employment)

While it was beyond the scope of this report to quantify the value of the anticipated benefits of the Action Plan's 15 recommendations, an illustrative list points to broad based, extensive benefits to the Great Lakes and all who live within the region, including:

- Improved water quality to benefit fish and wildlife habitat, commercial and recreational fisheries;
- Improved nearshore water quality, to improve water-based recreational experiences;
- Improved drinking water quality, particularly in areas susceptible to harmful algal blooms;
- Avoided damage to shoreline natural assets, public infrastructure and private property;
- Enhancing the value of green infrastructure and naturalization of shorelines for the benefit of biodiversity, shoreline species, recreational amenities, and stormwater/flood water management;
- More geographically relevant and accurate climate information on which to base land use planning and public works decisions will avoid costs associated with climate impacts;
- Reduced toxics loadings in our waters;
- Reduced exposure in our bodies, particularly in those communities most at risk, including select indigenous communities
- Lower cost of morbidity and mortality, including health care costs and higher productivity;
- Improved water quality in great lakes tributaries, particularly those impacted by urban and agricultural run-off;

- Improved agricultural yield at lower cost (less phosphorus, improved soil health)
- Avoided public health costs associated with harmful algal blooms, waterborne diseases from bacteriological contamination;
- Avoided lost revenue of current beach closures, including tourism revenue, and added value of beaches in the future as information on the high quality of great lakes beaches is made more widely available.

Current Funding Available

The Government of Canada has a number of funding mechanisms that contribute to some of the areas identified in the Action Plan. Some of these funds could be topped up and have a portion of their funding directed specifically to Action Plan recommendations. As some of these existing programs are time-limited, or have specific eligibility criteria, they would have to reviewed and updated to align with the Action Plan funding needs .

These include:

Investing in Canada Infrastructure Program (ICIP) : $9.2 B between 2018-2028, cost-shared with the Governmentof Ontario; through the Green Infrastructure Stream , for projects that support public infrastructure including Sub-streams for climate change mitigation and adaptation adaptation, resilience and disaster mitigation, and environmental quality (primarily water and wastewater).

Federal Gas Tax Fund: Over $2 billion every year to 3600 communities across the country, supporting a range of projects including public transit, wastewater infrastructure, and drinking water. The Federal Government announced a one-time top up of the Gas Tax Fund of an additional $2.2 B in 2019.

Disaster Mitigation and Adaptation Fund (DMAF) : $2 billion to support large-scale infrastructure projects (>$20M) to help communities manage risks of disasters triggered by natural hazards.

National Disaster Mitigation Program (NDMP) : $200 million over five years, from 2015 to 2020, to identify disaster risks and costs, conduct shoreline flooding assessment, flood mapping, mitigation planning and non-structural mitigation projects.

Canada Infrastructure Bank (CIB): Funding up to $35 billion for investment in transformative infrastructure projects to 2028. At least $5 billion will be invested through CIB in green infrastructure projects

Municipalities for Climate Innovation Program (MCIP), Federation of Canadian Municipalities (FCM), $75 million program (2017-2022), funded by the Federal Government, supporting more than 600 municipalities in updating infrastructure and address climate change, including assessing flood risks.

Green Municipal Fund (GMF), (Federation of Canadian Municipalities): funding from the Federal Government, to reduce municipal greenhouse gases, with opportunity to support municipal natural asset management.

Canadian Agriculture Partnership : $3B over five years (CAP) across Canada, with $61.2M over 5 years for agricultural environmental work in Ontario.

Great Lakes Protection Initiative: Environment Canada and Climate Change's fund that supports, among other things, preventing toxic and nuisance algae, assessing and enhancing the resilience of Great Lakes coastal wetlands, evaluating and identifying at risk nearshore waters; reducing releases of harmful chemicals; and engaging Indigenous Peoples in addressing Great Lakes issues

Provincial and Municipal investment

While this report is primarily focused on federal actions and investment to benefit the Great Lakes, investments by the Government of Ontario and municipal governments will be critical to the successful implementation of Action Plan 2030. These investments could range from direct provincial programs , as outlined in the Action Plan's recommendations, to provincial prioritization of capital projects to be funded through ICIP (see above), to capital plans, utility fees and other charges at the local government level.

Alternative Sources of Investment

Financing from other sources of non-government investment is also essential, particularly over the longer term. This could come in the form of:

- Privately funded reserve funds or endowment funds financed by companies that contribute to some of the challenges identified in the Action Plan;
- Investments by pension funds or by other green-oriented investment firms
- Innovative pay-for-performance, outcome-based impact bonds, green bonds, water bonds
- Direct payments for ecosystem services
- Pollution offsets or water quality trading
- Voluntary carbon offsets

Investment by private and other non-government sources should follow these general principles:

- Be sensitive to market conditions: companies that benefit from the great lakes, or that impact the great lakes, should make bigger investments in protecting the lakes when their revenues are highest;
- Externalized costs: those companies that profit from activities or products that contribute to pollution should address the gap between the market price and the environmental impact of their activities.
- Cost-effectiveness: a cost-benefit analysis can demonstrate the value of specific investments over others.

Delivering and financing Action Plan 2030 will take a collaborative approach. While the Federal Government needs to take a leadership role in protecting these globally significant, binationally-managed waterways, provincial, municipal and private interests must step up to the challenge and match the federal foundational investment.

CONCLUSIONS

Protecting a system of water and a region as vast and as valuable as the Great Lakes requires an ambitious plan, new and innovative approaches using new tools and data, mobilization of many individuals, businesses, communities, and organizations on the ground, and significant, sustained investment.

This Action Plan proposes 15 key actions to protect the Great Lakes and those who live in the region, in order to:

- Protect Great Lakes shoreline communities that are most vulnerable to high water levels and prepare them to be 'climate resilient and climate ready';
- Act more quickly to prevent and reduce environmental and human exposure to harmful chemicals in the great lakes region;
- Accelerate actions to reduce agricultural and urban nutrient runoff in priority areas that cause harmful algal blooms to improve the health of our waters, and
- Ensure that all Great Lakes beaches are clean and protect public health.

Implementing these 15 key actions requires an investment of between $2-3 billion. A foundational investments of $100 million a year over ten years by the Federal Government will serve as leverage for further investment by provincial and municipal government, and private and non-governmental interests.

Protecting and restoring the Great Lakes provides immediate and long-term benefits to all Canadians. It is time for all levels of government to show leadership by committing to the necessary investments and by delivering on this innovative and bold action plan.

APPENDIX 1

Members of the Expert Panel

Gord Miller, Co-Chair; former Environmental Commissioner of Ontario

Jean Cinq-Mars, Co-Chair; Québec's former Sustainable Development Commissioner

Regional Deputy Grand Council Chief Edward Wawia, Anishinabek Nation

Mayor Walter Sendzik, City of St. Catherines

Denis Lapointe, Former Mayor of the City of Salaberry-de-Valleyfield; Co-Chair, Table de Concertation Montreal

Hélène Lauzon, President, Conseil Patronal de l'environnement du Québec (CPEQ) (Québec Business Council on the Environment)

Theresa McClenaghan, Executive Director and Counsel, Canadian Environmental Law Association (CELA)

Denise Cloutier, Executive Director, Centre d'interprétation de l'eau (C.I. EAU) (Water Interpretation Centre)

Dr. Robert Slater, Professor, Environmental Policy, Carleton University

Dr. Ariane Plourde, Director, Institut des sciences de la mer de Rimouski (ISMER), Université du Québec à Rimouski (UQAR)

Members of the Steering Committee

Mark Fisher, President and CEO, Council of the Great Lakes Region

Tony Maas, Manager of Strategy, Freshwater Future Canada

John Dickert, President and CEO, Great Lakes and St. Lawrence Cities Initiative

Sarah Rang, Deputy Director, Great Lakes and St. Lawrence Cities Initiative

Scott McKay, Québec Manager, Great Lakes and St. Lawrence Cities Initiative

Bob Lambe, Executive Secretary, Great Lakes Fishery Commission

Marc Gaden, Legislative and Communications Director, Great Lakes Fishery Commission

Jacques Durocher, Chairman, Stratégies Saint-Laurent

Issue Table Co-Chairs

Climate Change

Al Douglas, Executive Director, Climate Risk Institute; former Director, Ontario Centre for Climate Impacts and Resources (OCCIAR)

Ewa Jackson, Managing Director, International Council on Local Environmental Initiatives (ICLEI) Canada

Toxics and Other Harmful Pollutants

Dr. John Carey, former Director General, National Water Research Institute, Environment Canada

Helen Doyle, Chair of Ontario Public Health Association's Environmental Health Work Group, recently retired from York Region Public Health

Nutrients

Dale Cowan, Senior Agronomist and Sales Manager, AGRIS and Wanstead Cooperatives

Gayle Wood, Interim Chief Administrative Officer and Secretary-Treasurer, Niagara Peninsula Conservation Authority

Beaches and Bacteriological Contamination

Sandra Cooper, Former Mayor of Collingwood; Immediate Past Chair, Great Lakes and St. Lawrence Cities Initiative

Bernard Mayer, Safe Water Program Manager, Haliburton Kawarthas Pine Ridge Public Health Department

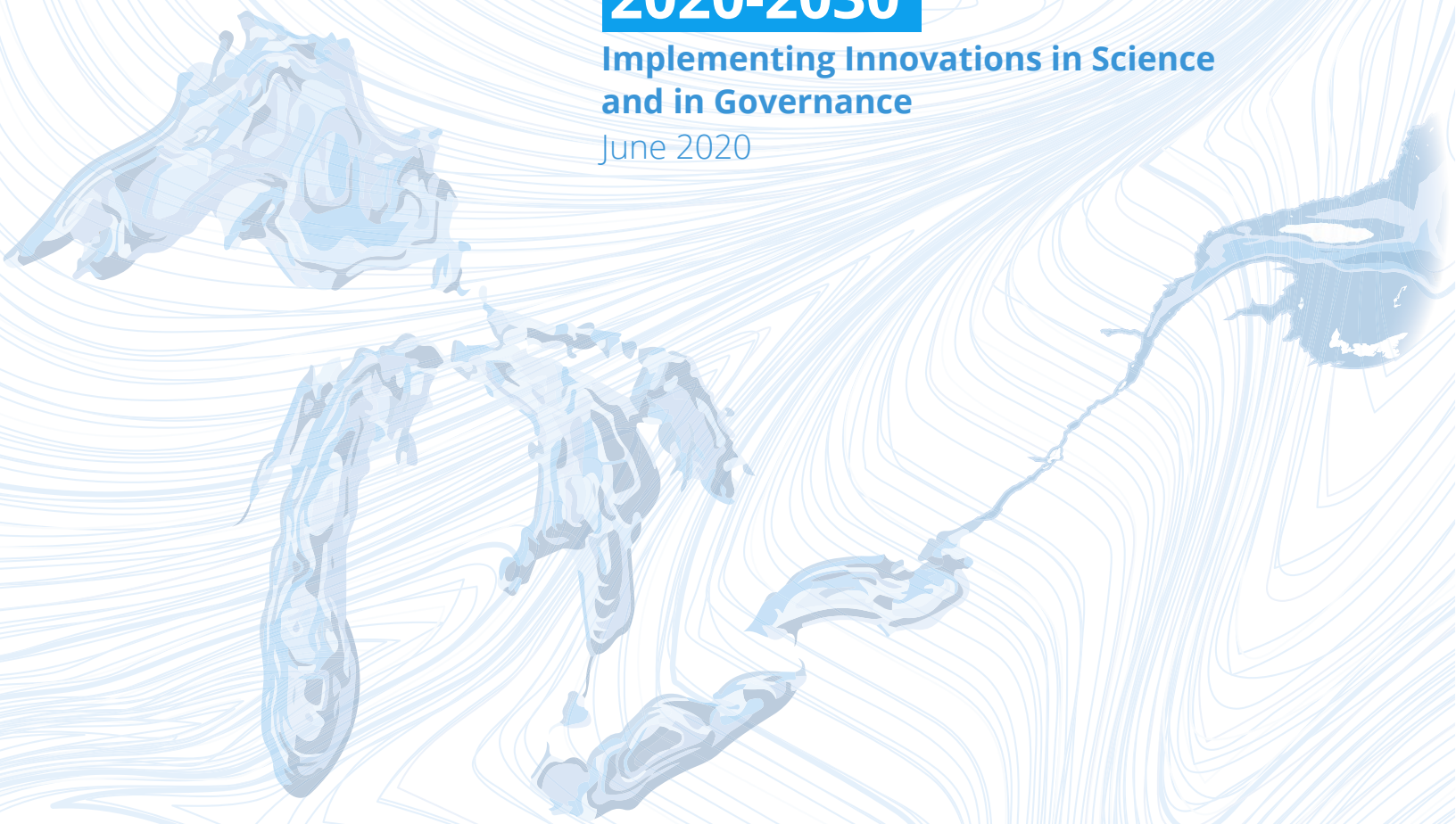
For full list of issue table members, click here.

Nine months ago, we were tasked by the Minister of Environment and Climate Change, the Honourable Catherine McKenna, to give her and her provincial counterparts advice on new and innovative approaches to tackle four of the most compelling and complex problems facing one of the largest systems of fresh water in the world, the Great Lakes and the St. Lawrence.

ACTION PLAN TO PROTECT THE GREAT LAKES AND ST. LAWRENCE 2020-2030

Implementing Innovations in Science and in Governance

June 2020



The Great Lakes and St. Lawrence Collaborative

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COUNCIL OF THE GREAT LAKES REGION
BUILDING OUR FUTURE TODAY
Discover. Connect. Influence.

STRATÉGIES Saint-Laurent

GREAT LAKES FISHERY COMMISSION
PROTECTING OUR FISHERY

FRESHWATER FUTURE CANADA

L'ALLIANCE DES VILLES DES GRANDS LACS ET DU SAINT-LAURENT
GREAT LAKES AND ST. LAWRENCE CITIES INITIATIVE

Prepared by:

Westbrook Public Affairs

ÉCOGESTION SOLUTIONS

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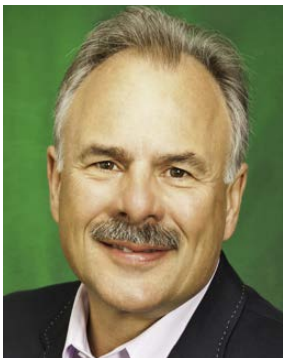

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ACKNOWLEDGEMENTS

The five Collaborative partner organisations, the Great Lakes Fishery Commission, the Great Lakes and St. Lawrence Cities Initiative, Stratégies Saint-Laurent, the Council of the Great Lakes Region, and Freshwater Future Canada, thank the following individuals and organisations who each contributed significantly to the success of the Collaborative process and the final recommendations.

The Collaborative partners would like to express their heartfelt appreciation to the Expert Panel, co-chaired by Mr. Jean Cinq-Mars and Mr. Gord Miller, whose leadership and guidance has resulted in the inspirational vision laid out in this report and the two foundational reports on the Great Lakes and St. Lawrence. In addition to the co-chairs, the Expert Panel members include Anishinabek Nation Deputy Grand Council Chief Edward Wawia, Denise Cloutier, Dr. Yves Comeau, Denis Lapointe, Hélène Lauzon, Theresa McClenaghan, Dr. Ariane Plourde, Mayor Walter Sendzik, and Sarah Zammit. Members during the Great Lakes phase also included Dr. Bob Slater and Karen Clarke-Whistler.

The recommendations were the product of extensive deliberations by the Great Lakes and St. Lawrence issue tables, ably led by issue table co-chairs who devoted many hours to provide content expertise and ensure the quality of the recommendations proposed to the Expert Panel.

In addition to these experts and stakeholders, the Collaborative benefitted from the feedback and advice of stakeholders who participated in a number of webinars and in two summits held in Toronto and Quebec respectively.

The Collaborative partners would also like to thank the many people behind the scenes who contributed to the Collaborative and who helped shape the Action Plans. The Collaborative is particularly grateful to the members of the Secretariat, Nicola Crawhall of Westbrook Public Affairs, Stephanie Allard, Rose Savard-Paquet and Ines Singhe of Ecogestion Solutions, Korice Moir of Korice Moir Consulting, and Sophie Afriat. The Secretariat received research support from members of the McMaster research team led by Dr. Gail Krantzberg, and Sonja Behmel of Watershed Monitoring.

Economic analysis was provided by Dave Thompson of PolicyLink, which informed the investment strategy and the preliminary cost-benefit analysis.

Graphic design and formatting was performed by Julian Irwin of Julian Irwin Design.

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EXECUTIVE SUMMARY

This is the final report of the Great Lakes St. Lawrence Collaborative. This report integrates the findings of the two foundational reports, the Great Lakes Action Plan 2030, and the Action Plan for the future of the Saint Lawrence 2020-2030.

Key Findings

The Great Lakes and St. Lawrence Action Plan 2030 provides a forward-looking roadmap over the next ten years, to tackle some of the greatest challenges facing our region. To ensure the successful implementation of the Action Plan over the next ten years, new approaches and institutional arrangements are needed.

The recommendations developed for the Great Lakes and St. Lawrence regions share much common ground, demonstrating the shared goals and aspirations of those working for their protection and restoration. Where there are significant differences in approach between the Great Lakes and the St. Lawrence, these reflect differences in geographic context, severity of impacts, or provincial legislative or regulatory regimes.

To address the complex challenges outlined in the Great Lakes St. Lawrence Action Plan 2020-2030, the Expert Panel recommends a new approach, based on the following principles:

1. Alignment and integration of actions and investments from the federal level, right through to those living, working and visiting the shorelines of the Great Lakes and St. Lawrence, to overcome the fractured nature of activities across this enormous geography.
2. Risk-based prioritization and risk management to devote investment and effort where it is needed most, and to minimize risk to avoid impacts and costs in the future.
3. Purpose-oriented research and innovation to inform locally relevant technical assistance.
4. Formal monitoring and evaluation, to measure progress and to provide the public with an independent evaluation of the governments' performance.

To bring about the changes needed to adopt the above principled approach, a new institutional arrangements model, an investment strategy, and roll-out plan are proposed.

The proposed institutional arrangements are inspired by two similarly complex, multijurisdictional water system management programs, the Great Lakes Restoration Initiative and the Chesapeake Bay Program. The new institutional arrangements propose six elements:

i. A federal cross departmental taskforce, that is responsible for federal financing and alignment of departmental effort with regard to Great Lakes St. Lawrence protection.

ii. A Great Lakes St. Lawrence Commission with indigenous, business, NGO, academic and municipal representation that guides and coordinates implementation;.

iii. An Indigenous Great Lakes St. Lawrence organisation, with representation of indigenous organisations and communities in the region.

iv. Implementation teams on the four main challenges

v. Centres of research and innovation and technical assistance teams.

vi. Additionally, oversight by the Federal Commissioner of Environment and Sustainable Development is recommended.

The investment strategy involves a federal commitment of at least $2 billion over ten years to implement Action Plan 2020-2030. A large portion of this investment is focused on shoreline resiliency along the Saint Lawrence and in the Great Lakes that have experienced acute and repeated flooding and erosion. Another significant area of investment is in upgrading wastewater treatment plants, particularly those that are already required to upgrade from primary to secondary treatment to come into compliance with the federal wastewater effluent regulation, that could attain a higher level of treatment to remove new and emerging harmful substances with additional investment.

Faced with one of the most serious economic downturns in the modern era as a consequence of the COVID-19 global pandemic, it is anticipated that the Federal, Quebec and Ontario governments will adopt major economic stimulus and job creation programs. In addition to improving the

quality of the Great Lakes and St. Lawrence, the actions outlined in the Action Plan 2020-2030 and its investment strategy offer an effective means to stimulate the economy and create jobs. For example, based on Statistics Canada estimates, $500 million in shoreline restoration investments would be expected to create upwards of 3,500 person-years employment.

This is why the proposed Action Plan 2020-2030 roll-out plan recommends immediate activity and investments in shoreline resiliency and flood mitigation, to provide much needed relief to those flood-prone areas, and in the process, create jobs and stimulate the regional and national economy. Design work on upgrades to wastewater treatment in key municipalities should also be prioritized, proceeding as quickly as possible to approvals and tenders for work.

The Action Plan 2020-2030 Implementation Plan will result in a revitalized and well-resourced commitment on the part of governments, indigenous communities, watershed organisations, businesses, and property owners that will deliver more effective protection and greater climate resiliency for the Great Lakes and St. Lawrence region over the coming decade and beyond.

Recommendations

In addition to the 27 recommendations contained in the two Action Plans, this report proposes three final recommendations.

1. **It is recommended that** the Government of Canada, in collaboration with the Governments of Quebec and Ontario, establish the institutional arrangements outlined in this report. The institutional arrangements will be free standing, but may be integrated into the Canada Water Agency once it is established.

   It is further recommended that the Government of Canada request that the federal Commissioner of Environment and Sustainable Development undertake a performance audit of Action Plan 2020-2030 every 2-3 years and report its findings to Parliament.

2. **It is recommended that** the Government of Canada commit at least $2.2 billion in investments over ten years to implement the Great Lakes St. Lawrence Action Plan 2020-2030, guided by the implementation roll-out and investment strategy in this report, and seek shared funding arrangements where appropriate from the Governments of Quebec and Ontario and municipalities.

3. **It is recommended that** the Great Lakes St. Lawrence Collaborative Commission regularly review progress towards desired outcomes, consider adapting recommended actions to changing circumstances, and recommend new issues to add to the Action Plan, including biodiversity, nuclear operations and waste, and road salts.

1. WHAT IS ACTION PLAN 2020-2030?

1.1 An Action Plan Developed by and for those it affects

The Action Plan to Protect the Great Lakes and St. Lawrence 2020-2030 (Action Plan 2020-2030) is a $2 billion, 10-year, forward looking strategy to protect the Great Lakes and St. Lawrence and those who live by them. The Action Plan is the product of an unprecedented stakeholder-led engagement process to re-envision and re-invigorate Great Lakes St. Lawrence protection over the next decade. It has been developed ***by and for*** those it affects the most- the communities, stakeholders and on the ground organisations in the Great Lakes and St. Lawrence region. In total, over 200 experts, stakeholders and indigenous representatives were consulted in the development of Action Plan 2020-2030, the largest stakeholder-led engagement effort in the Great Lakes and St. Lawrence region of its kind.

The development of the Action Plan 2020-2030 was initiated by the Great Lakes St. Lawrence Collaborative, a partnership of five leading Great Lakes St. Lawrence advocacy organisations, the Great Lakes Fishery Commission, the Great Lakes St. Lawrence Cities Initiative, the Council of the Great Lakes Region, Freshwater Future Canada, and Stratégies Saint Laurent. With financing from Environment and Climate Change Canada, the Collaborative established an eighteen-month process to engage economic, NGO, and academic stakeholders and First Nations in an intensive period of reflection and consultation on ways in which current efforts and resources could be modernized using new and innovative approaches to more effectively protect the Great Lakes and St. Lawrence region.

The Collaborative was led by a Panel of Experts, co-chaired by two esteemed environmental experts, Gord Miller, former environment commissioner of Ontario, and Jean Cinq-Mars, former Commissioner of Sustainable Development for Quebec. The expert panel consisted of indigenous, private sector, academic, municipal and NGO representatives from the Great Lakes and St. Lawrence regions. The Expert Panel was directly advised by over 200 experts and stakeholders, in Ontario and Quebec, respectively. The Expert Panel and issue tables were supported by a Secretariat led by Westbrook Public Affairs in Toronto, and supported by Ecogestion Solutions during the St. Lawrence phase of the process.

The Collaborative acknowledges and thanks Environment and Climate Change Canada for providing financial support for the Collaborative process.

Expert Panel member Deputy Grand Chief Wawia at Great Lakes Summit, June 2019, Toronto. © Quinn Corkal

1.2 What will the Great Lakes St. Lawrence Action Plan 2030 achieve?

The Great Lakes and St. Lawrence Action Plan 2030 provides a forward-looking roadmap over the next ten years, to tackle some of the greatest challenges facing our region. It consists of strategic and specific actions to improve environmental protection in four areas outlined in this section. It also proposes new institutional arrangements to drive a new, integrated approach to Great Lakes St Lawrence protection, which are explained in greater detail in Sections 3 and 4.

When implemented, the Action Plan will:

- **Protect and build resiliency in Great Lakes and St. Lawrence shoreline communities** and ecosystems that are most vulnerable to high water levels and erosion, through new collaborative partnerships, direct financial and technical assistance, with a strong emphasis on naturalizing shorelines.

- **Reduce human and environmental exposure to toxics** and other harmful chemicals in the Great Lakes and St. Lawrence region through a proactive surveillance program that actively seeks out impacts on people and species and engages affected communities in the monitoring and response to exposure;
- **Reduce agricultural nutrient runoff** that causes harmful algal blooms, eutrophication and hypoxia by using new technologies and conservation measures, and harnessing big data to target areas and properties that contribute the most;
- **Introduce enforceable requirements to trace and address sources of bacteriological contamination at beaches** that pose a public health threat and reduce access to the Great Lakes and St. Lawrence shorelines and beaches.
- **Upgrade treatment and capacity of wastewater treatment plants** to effectively remove emerging contaminants, total nitrogen, and pathogens in select areas**.**

For Action Plan 2020-2030 to successfully combat complex problems facing the region, it will require a new approach that involves the injection of significant new investment, the application of cutting edge research and innovation, and institutional arrangements that drive the integration of effort and resources amongst senior governments, First Nations, and local organisations and communities in the region. This new approach will reinvigorate and modernize water resources protection in the Region.

Launch of St. Lawrence report, Salon des Teq, March 2020. L to R: Line Beauchamp, Jean Cinq-Mars, Michelle Morin-Doyle, Denise Cloutier, Dr. Yves Comeau

2. ACTION PLAN 2020-2030: A COMMON, INTEGRATED VISION

This report outlines an implementation plan for Action Plan 2020-2030. The details of the plan are found in two foundational documents, Great Lakes Action Plan 2030, released in June 2019, and Action Plan 2020-2030 for the future of the St Lawrence, released in March 2020. While the recommendations were developed separately, to reflect geographic and jurisdictional differences, the Expert Panel oversaw the entire process, and ensured a common vision and approach.

A primary motivation for establishing the Great Lakes and St. Lawrence Collaborative was to create an integrated vision for the two regions. Due to jurisdictional reasons, the two water systems are managed separately, this despite the fact that they are hydrologically one system. The similarity in the desired outcomes and recommended actions that experts and stakeholders arrived at in the two regions through the Collaborative process underlines the common ground between the two regions and their shared vision for the future. Where differences in recommended actions exist, they reflect unique circumstances in the regional environmental conditions, in the scale of impacts, and in legislative or regulatory requirements in Ontario and Quebec respectively. Notwithstanding these differences, the core prescriptions remain essentially the same.

This section explores common ground and key differences in approaches in the two parts of the region. The Expert Panel felt that a number of differences were justified and should remain differentiated in each region. Other recommendations were transferable to both regions.

A complete list of recommendations can be found in Section 4. To fully understand and appreciate the rationale for these recommended actions, readers are encouraged to return to the original Action Plans for important contextual detail.

2.1 Building climate change resiliency in shoreline communities

Context in each region

Shoreline communities in both the Great Lakes and St. Lawrence regions have experienced severe flooding in 2017 and 2019, erosion, and intensified wind and wave energy due to the effects of climate change.

Within the Great Lakes basin, the impacts have been felt in discrete areas, along the north shore of Lake Erie in Chatham Kent and further west, along the Lake Huron shoreline between Amberley and Grand Bend, along the Lake Ontario shoreline from the City of Toronto through to Prince Edward County, along the soft shoreline at Fort William First Nation and Thunder Bay on Lake Superior, and to a lesser extent in the south-east corner of Georgian Bay, around Tiny Township and Penetanguishene.

Flooding in the Saint Lawrence region has affected communities along hundreds of kilometres of shoreline, particularly from south of Montreal to north of Quebec City. Erosion is also a significant threat to the St. Lawrence estuary and its islands, and is expected to accelerate in the Côte-Nord, Bas-Saint-Laurent, and Gaspésie–Îles-de-la-Madeleine regions.

Common Ground

For both the Great Lakes and St. Lawrence affected shorelines, the Action Plan calls for four key actions. First, there is a need for coordinated support from senior governments for technical and financial assistance for communities, including First Nations. Secondly, there is a need for coordinated support from senior governments to work with communities and First Nations to assess impacts and develop and implement shoreline resiliency plans to respond to these impacts. In undertaking this work, there should be a strong emphasis on the deployment of natural infrastructure along shorelines as opposed to the hardening of shorelines. All of this will require access to climate data to inform resiliency plans.

Key Differences due to context

The key difference in recommendations in each region is one of scale. Given the more localized nature of flooding and climate impacts along Great Lakes shorelines, the Great Lakes actions prioritize 5 shoreline resiliency zones for coordinated assistance and funding: i) between Chatham-Kent and Leamington on Lake Erie; ii) between Amberley to Grand Bend on Lake Huron; iii) between the City of Toronto to Prince Edward County, on Lake Ontario; iv) between Fort William First Nation and Thunder Bay on Lake Superior; and v) between Penetanguishene and Tiny Township on Georgian Bay.

Coordination of effort and resources on the ground is an imperative. In the US, a National Coastal Zone management program has provided such coordination since 1972. There are eight regional coastal zone management programs in the US Great Lakes Region. These could serve as a model for the priority zones.

Given the more pervasive climate impacts along the Saint Lawrence shoreline, the Saint Lawrence actions call for a province-wide adaptation and resiliency strategy and action plan, as well as an annual reporting system on progress.

Recommended actions that may be adopted in both regions

The St. Lawrence actions call for the establishment of a federal-provincial climate resiliency centre as well as an ecological services payment system for landowners. These could be extended to and benefit the Great Lakes region. The Great Lakes actions call for a Great Lakes regional subportal to be created within the Canadian Centre for Climate Services portal. This could be extended to the Saint Lawrence region. The Centre mentioned above could advise on the creation of this subportal.

2.2 Improve beaches quality by cleaning up untreated sewage and other sources of bacteriological contamination

Context in each region

There are many more beaches on Great Lakes shorelines than on the St. Lawrence. The regulatory regime to ensure beaches quality has been in place for years in Ontario, whereas Quebec lacks a regulatory framework for beaches management and quality. The problem identified in the Great Lakes region was the number of beaches that experience chronic bacteriological contamination. Up to 20% of all beaches post a public health advisory repeatedly during the swimming season as a result of contamination, including untreated wastewater following heavy rainfall. Another significant concern was the outdated approach to testing and notifying the public of beaches quality. For St. Lawrence stakeholders, establishing a robust regulatory framework to encourage the opening and proper maintenance of beaches is a main objective. This would facilitate greater access to St. Lawrence shorelines.

Common Ground

Both the Great Lakes and St. Lawrence actions include a reorientation of beach quality management towards a risk-based approach, whereby beaches would be monitored, and categorized. Those beaches with chronic bacteriological contamination over several swimming seasons would be declared 'impaired' and their owners or operators would be required to track the sources of the contamination and take actions to mitigate them.

Key Differences due to context

Key differences are due to differences in the current regulatory regime in Quebec compared with Ontario, as well as the limited access points in the St. Lawrence basin.

Given the current absence of regulatory authority, the St. Lawrence actions call for a whole new regime to ensure beaches quality, including a new risk-based regulation, a new water quality data and monitoring protocol, a best practices guide, and public awareness campaign.

Reflecting the large percentage of wastewater that receives only primary treatment in Quebec, St. Lawrence actions call on the Quebec Government to provide financial assistance to municipalities for upgrades to wastewater treatment plants identified as sources of bacteriological contamination at nearby beaches. This could be combined with recommendations on upgrading treatment to remove toxics in Quebec, to take advantage of a generational opportunity as municipalities upgrade their systems to comply with the federal wastewater effluent regulation.

Recommended actions that may be adopted in both regions

The Great Lakes actions provide greater specificity with regard to requirements under the risk-based system, including frequency of testing and contamination source-tracking required based on beach quality. Those beaches deemed 'impaired', that have chronic contamination issues, would be required to track the source of contamination and take action to eliminate the source of contamination.

The Great Lakes actions also call for the modernization of testing methods to reduce the lag in testing and public notification to hours rather than days.

These recommended actions would be of benefit to the Saint Lawrence and could be integrated into the new regulatory regime for beaches quality proposed under the Saint Lawrence actions.

2.3 Eliminate harmful algal blooms by reducing phosphorus in agricultural and urban runoff entering waterways

Context in each region

The western end of Lake Erie has experienced repeated algal blooms that have impacted aquatic ecosystems and drinking water sources. Canada's contribution to phosphorus entering western Lake Erie comes primarily from the Thames River and the Leamington tributaries. The St. Lawrence river has experienced hypoxia zones that impact the aquatic ecosystem and fishing. The Collaborative has identified 11 priority zones within the St. Lawrence watershed. In addition to phosphorus, excess nitrogen is also a concern, as it has a greater impact in creating hypoxia zones in the marine or salt water section of the St. Lawrence basin. The need to combine efforts to reduce phosphorus and pesticide loss was considered a priority in the St. Lawrence region.

Common Ground

Both the Great Lakes and St. Lawrence actions include the establishment of research centres to bring together expertise and information on agricultural conservation to support best practices. Such research and expertise would provide consistent, well researched information to agricultural extension teams that would be established, with expertise in best practices and technologies to reduce phosphorus loss from agricultural lands and/or remove phosphorus from runoff before it enters waterways.

Key Differences due to context

Notably, the St. Lawrence recommended actions address phosphorus, nitrogen and pesticides, whereas the Great Lakes actions are focused exclusively on phosphorus reduction. The St. Lawrence actions also do not identify urban runoff as a significant enough source of phosphorus to warrant specific actions. In contrast, the Great Lakes actions call on municipalities that are identified as significant sources of phosphorus to adopt a stormwater plan to reduce phosphorus runoff.

Recommended actions that may be adopted in both regions

The Great Lakes actions call for a data management strategy that would facilitate the use of data sets in GIS based platforms to precisely identify which properties are likely to contribute the most phosphorus, and direct financing and technical support to these properties. A strategy that ensured the availability of data and the use of innovative data platforms would also be of great use in the St. Lawrence region.

The Saint Lawrence actions call for changes to current agricultural income support and technical programs to incorporate payment for ecosystem services, green infrastructure and other measures to support water quality and reduce phosphorus and pesticides in run off. Although programs differ in Ontario for the Great Lakes, financial support for these types of activities would also be welcome, either directly through Ontario income support and technical programs, or through the Canadian Agricultural Partnership (CAP) or equivalent federal-provincial funding mechanisms.

2.4 Reduce our exposure to toxics and other harmful pollutants

Context in each region

Both the Great Lakes and St. Lawrence regions have concerns with toxics and other harmful pollutants in waterways, coming from industrial and municipal sources, as well as from products. Given that over half of wastewater effluent is only subject to primary treatment, there was greater concern with toxics in treated wastewater effluent in the St. Lawrence region. As a result, there was greater emphasis on upgrading municipal wastewater treatment in the St. Lawrence region, whereas there was more emphasis placed on preventing toxics from entering the wastewater stream in the Great Lakes region.

Common Ground

Both the Great Lakes and St. Lawrence actions call for the Federal Government to establish a targeted environmental and human health effects biomonitoring and surveillance program to provide early detection of effects. They also both call for greater support for the development, use and promotion of toxics substitution in products as a means to prevent toxics and harmful pollutants from entering waterways through products like personal care products, cleaning products, and pharmaceuticals, among others.

Key Differences due to context

The St. Lawrence actions put a greater emphasis on wastewater treatment as a means to remove toxics entering waterways, calling on federal and provincial treatment standards to be strengthened, including the addition of total nitrogen discharge limit, and funding for testing innovative treatment technologies

The St. Lawrence actions call on the Government of Canada to broaden the scope of the Canadian Environmental Protection Act (CEPA) to eliminate toxics, by reviewing the evaluation and approvals process for new substances. During Great Lakes discussions, it was felt that recommended actions could be achieved within the existing legislative framework.

Recommended actions that may be adopted in both regions

The Great Lakes actions call for guidelines on the generation and communication of surveillance data to affected communities, with particular emphasis on those indigenous communities affected by historical or industrial pollution. Guidelines for the co-development of data generation and communication with communities should also be considered in Quebec.

The Great Lakes actions call for the establishment of a Centre for Chemical Substitution and a chemical substitution recognition program, modelled on similar initiatives in the U.S. The St. Lawrence actions also prioritized chemical substitution. The St. Lawrence region would benefit from the expertise and guidance from such a Centre as well as a recognition program.

In addition to the recommendations in the two Action Plans, the Expert Panel also identified further research and action on the impacts of road salts on aquatic organisms as a priority under the Toxics and Harmful Pollutants issue area.

3. NEW INSTITUTIONAL ARRANGEMENTS AND APPROACHES NEEDED TO DELIVER ACTION PLAN 2020-2030

The Great Lakes and St. Lawrence is a vast and complex ecological region whose waters alone cover 1.6 million km^2, roughly equivalent to the surface area of France, Germany, Italy, the UK and Spain combined. Across this enormous canvas, a patchwork of government investments, policies and actions across Federal and Provincial departments and local activities in First Nations communities, at the watershed level, by municipalities and many stakeholders, make up a fractured approach to environmental protection. Efforts to put in place institutional arrangements to link federal and provincial commitments through to those on the ground have been chronically under-resources, including the Zones d'intervention Prioritaires (ZIPs) in the Saint Lawrence region, and the Remedian Action Plans in each Area of Concern in the Great Lakes region.

The limited ability of this existing fractured and under-resourced approach to address the complexity of problems facing the region is exacerbated by the impacts of climate change, that are hammering shoreline communities, bringing intense rainfall and snowmelts that cause combined overflows and increased agricultural and urban runoff, and generally worsen the impact of diffuse pollution sources.

Tackling the complexity of this vast ecoregion in the era of climate change with existing institutional arrangements and management will only enshrine the weaknesses of the current approach. Delivering Action Plan 2020-2030 necessitates a purpose-driven approach like the one that enabled the Collaborative to be successful in securing the voluntary participation of hundreds of experts from different organizations in the preparation of the Great Lakes Saint-Lawrence Action Plan 2020 – 2030. It also needs to be principle-led to guide decisions and actions. Finally, it needs to be performance-based with direct accountability to ensure that investments are made wisely and that they are managed to bring their intended benefits. Only with such a new management 'playbook' can we ensure that the Collaborative's ambitious results are achieved.

This section outlines elements of a new approach that is needed to deliver Action Plan 2020-2030. This new approach is based on:

i. New institutional arrangements to drive alignment across government departments and across governments, First Nations, and ultimately with those who are impacted at the local level.

ii. A risk-based approach that prioritizes actions and resource allocation across the Region's enormous geography while using risk management to avoid impacts in the future.

iii. Research-intensive innovation using emerging technologies, digital applications, and best practices (AI, big data, genetics, precision conservation, etc.) that is made relevant to those impacted and communicated locally through technical assistance.

iv. Monitoring and evaluation to measure and report publicly on progress.

3.1 Institutional Arrangements to drive alignment

As noted in the report 'Water Security for Canadians', water management in Canada is fractured, with First Nations, shoreline communities and conservation organisations trying to cope with overwhelming water management problems at the local level that at times originated many kilometres away, and for which they lack the authority, capacity, knowledge or resources to address them.

The continuing exposure of residents to toxic pollution in Aamjiwnaang First Nation near Sarnia that is documented in Great Lakes Action Plan 2030, painfully illustrates the fractured approach to human health and environmental protection in First Nation communities, and the failure of governments to align their efforts to decisively address the problem.

The UN Special rapporteur on Human Rights and Toxics, Mr. Baskut Tuncak, who investigated environmental contamination in Aamjiwnaang First Nation in 2019, concluded that Canada showed a 'blatant disregard for Indigenous rights' in its handling of toxic chemicals and industrial discharges, and called on the federal government to improve the speed with which it responds to situations where indigenous peoples are disproportionately exposed to pollutants.

The Action Plan makes specific recommendations that call for intergovernmental protocols to more effectively address exposure to pollution that would require federal and provincial authorities to commit to timely action to address the sources of pollution, clarify their respective roles and responsibilities, and involve and communicate with affected communities, throughout the process.

Alignment is needed with respect to actions ***and*** budgets to achieve shared desired outcomes. Alignment will create coherence in the work across federal departments, in the coordination of effort between federal, indigenous, and provincial governments, and in meeting the needs of those impacted at the local level.

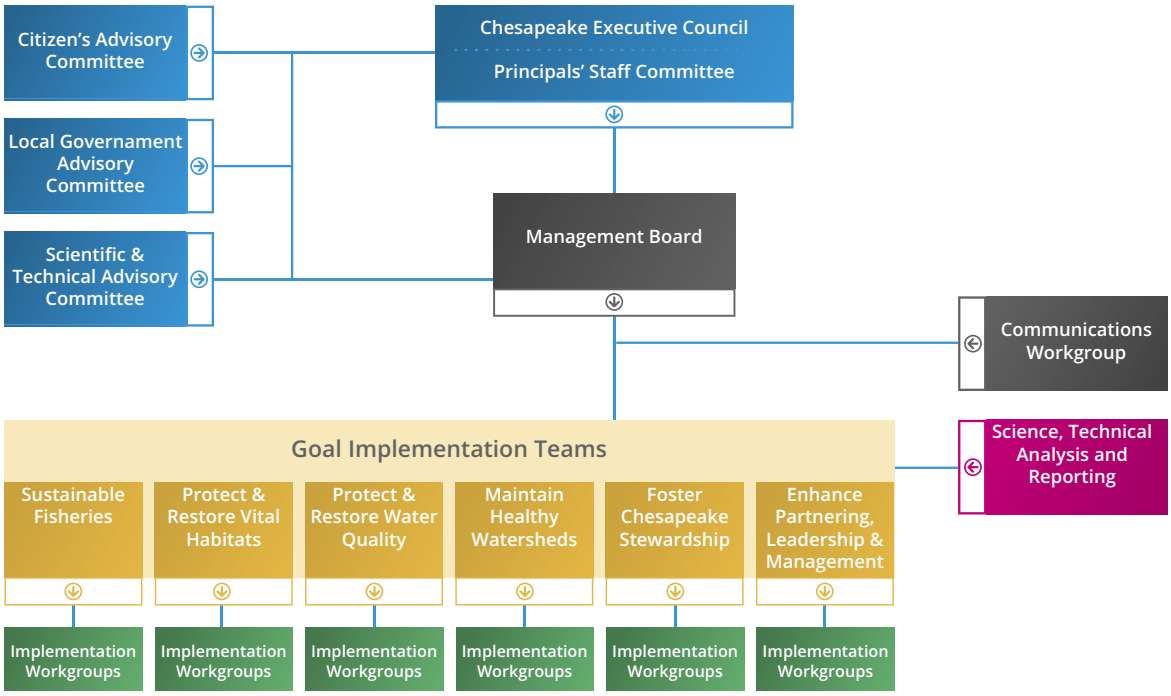
To be clear, the alignment contemplated here does not mean that the Federal Government takes over water management in the Great Lakes St. Lawrence region. Rather, it requires that the resources and expertise available through the Government of Canada are deployed in a more coordinated and integrated way and reflect the needs of indigenous and other communities on the ground. Quebec and Ontario must remain the leads in water management except for those areas of exclusive federal or Indigenous jurisdiction (e.g. toxics assessment and regulation) and for those policies and targets that are associated with binational or international agreements that are negotiated by the Federal Government.

To provide the support needed to address these challenges, alignment is needed at four levels:

a. Across the 20 federal departments and agencies with shared responsibility for water management

b. Across all orders of government, federal, provincial and municipal

Figure 1. Organizational Structure of the Chesapeake Bay Program



c. At the local level, with municipalities, the Zones d'Intervention Prioritaires (ZIPs),watershed and conservation organisations and other community-based organisations, and impacted residents and businesses.

d. With indigenous councils, communities and organisations

To conceive of a governance structure that could create this alignment, the Collaborative drew inspiration from five large scale regional water management programs in Canada and the U.S., the Great Lakes Restoration Initiative (GLRI) Chesapeake Bay program Partnership, Puget Sound Partnership, the Fraser Basin Council, and Everglades Restoration Working Group. In recognition of the fractured nature of management over a large and complex geography, each of these governance structures integrates the work of multiple parties across jurisdictions, and directly connects the national or regional administration to local government and key constituencies on the ground.

In the case of the GLRI, the most analogous program, all Great Lakes federal funding is coordinated across federal departments through an interagency taskforce. This authority and alignment over Great Lakes protection was achieved through a Presidential order, that brought 11 federal departments together to deliver the Great Lakes Restoration Initiative program. Executive Order 13340, '***Establishment of Great Lakes Interagency Task Force and Promotion of a Regional Collaboration of National Significance for the Great Lakes'*** signed by President George W. Bush in 2004 created the Great Lakes Interagency Task Force (IATF). With representation from all eleven federal departments, the US Environmental Protection Agency (EPA) was charged with chairing the IATF. Congress passed a law putting EPA in charge of coordinating implementation and funding.

The Chesapeake Bay program's governance structure is particularly instructive in the way that it coordinates and integrates activities across the federal government, 3 states (Maryland Virginia, Pennsylvania) and the District of Columbia. The partnership also brings together academic and local watershed organizations to build and adopt policies that support Chesapeake Bay restoration. It also connects the federal and state level action with actions on the ground through implementation teams.

The question of the authority invested in any new institutional arrangement is one that requires careful consideration, in a way that is sensitive to the existing rights of indigenous peoples, the leading role of provinces in water management, and existing intergovernmental arrangements for water management under the Great Lakes Water Quality Agreement, the St. Lawrence Action Plan and the Canada-Ontario Agreement respecting Great Lakes.

Some Great Lakes specific governance structures can offer some solutions in this regard. Two treaty-based organisations, the International Joint Commission and the Great Lakes Fishery Commission, were created to establish working arrangements across jurisdictions to manage specific water-related issues. In the case of the International Joint Commission, in addition to its responsibilities in preventing and resolving transboundary water disputes, it has specific authority with respect to regulating the water levels and the flow of water through dams at Sault Ste Marie and Cornwall. The Great Lakes Fishery Commission is responsible for establishing working arrangements amongst a number of agencies to control the proliferation of sea lamprey and other invasive species in the Great Lakes. These Commissions, with limited authority on issues assigned to them by governments, could serve as models for the limited authority bestowed to institutions set up to deliver the Great Lakes St. Lawrence Action Plan.

Learning from these models, new institutional arrangements to ensure integration, alignment and limited authority are proposed in Section 4.

3.2 Evidence driven risk-based prioritization and risk management

In a world with diffuse sources of pollution, from agricultural and urban runoff, long range air pollution, pharmaceuticals and other products, combined with limited resources to address them, we must focus our efforts where evidence shows that there is greatest risk.

Regulators need to adopt a risk-based prioritization or a risk-based targeting approach to address sources of pollution and climate impacts. This approach to prioritizing action must be steeped in evidence and risk assessment that identifies and manages sources of pollution that cause the greatest environmental degradation or have the most negative impacts to human health, preferably on a geographically specific basis.

The digital revolution has made prioritization based on evidence and risk increasingly precise and publicly accessible, with the development of more sophisticated modelling, real-time remote sensing, and GIS based platforms that can synthesize massive amounts of data to pinpoint specific sources of pollution. In the case of reducing phosphorus loss from agricultural lands, this approach goes beyond priority watersheds (where programs are currently focused) to the micro scale of individual properties using GIS based data platforms.

A parallel aspect to the risk-based approach is the importance of risk management to reduce risk. By using evidence-based risk management methodologies, we can prevent impacts and avoid costs in the future.

Creating this type of data-dependent risk-based prioritization and risk management framework to guide water protection interventions requires the modernization of data systems, greater access to data, including some of which that are currently considered proprietary, and a new data management strategy. Data and information gathering must also include the involvement of those impacted, and timely communication of information to the interested public. This will require significant investments in data gathering (modelling, testing, monitoring), data management systems and data sharing and access protocols.

Information Strategy to Support Risk Based Prioritization

NUTRIENTS	BEACHES
GIS based agricultural conservation platforms to identify high phosphorus loss properties to prioritize technical assistance and resources	Centralised portal with beaches testing results to identify chronically impaired beaches that require action
TOXICS EXPOSURE	**CLIMATE RESILIENCY**
Aquatic surveillance program to locate priority areas with evidence of effects of human and ecosystem toxics exposure	LIDAR, floodplain mapping, modelling to identify priority zones, communicate risk to shoreline communities

By prioritizing interventions where and when the evidence shows that there is greatest risk, we can deliver results and save money that is otherwise inefficiently deployed through broad but unfocused interventions.

3.3 Purpose-Oriented Research and innovation to inform locally relevant technical assistance

There is tremendous knowledge and expertise available through academic institutions, research centres and amongst outreach and extension professionals that must be harnessed and directed to benefit local efforts to address the challenges identified in Action Plan 2020-2030.

Unfortunately, there is a lack of coordination with respect to innovation and technical assistance that is accessible to local communities, agricultural enterprises and small businesses.

The need for centres of knowledge directly linked to technical assistance teams was identified in three of the four Action Plan areas.

These centres would provide invaluable information and advice at the local level that would:

- Provide impartial advice independent of commercial interests;
- Harness expertise of academic research and translating it into practical hands on advice;
- Ensure consistency of advice across decentralised sectors, including thousands of farms, hundreds of municipalities, and hundreds of manufacturers; and
- Relay information through existing Great Lakes, St. Lawrence and watershed organisations, including ZIP committees, agro-advisory groups, etc.

There are three important aspects to this vital function that must work hand-in-glove

i. Purpose-oriented research and innovation,

ii. Training of researchers and technical outreach professionals, and

iii. Locally relevant technical advice and outreach.

The purpose-oriented research and innovation program would address specific challenges identified in the Great Lakes and St. Lawrence Action Plans, including removal of nutrients from agricultural and urban runoff, agricultural best practices to retain nutrients on the field, proactive surveillance of exposure to toxics and other harmful pollutants, substitution of toxics in products, climate adaptation and building resiliency along shorelines, and advanced treatment of wastewater and stormwater.

This work would be undertaken by the centres recommended in the Action Plan. The second component is to connect this research and knowledge to locally-relevant technical assistance on the ground. This type of extension work requires the recruitment and training of extension experts who can foster trusting relationships with their client base on the ground. This could include existing organisations with established relationships on the ground, such as ZIPs or conservation authorities.

Training and education to support both the research and innovation side and technical outreach side of the equation is essential. This would require dedicated programs at key academic institutions and training for technical assistance teams to ensure the generation and transmission of up-to-date and consistent advice as well as succession planning over time.

Purpose Oriented Research and Innovation and Locally Relevant Technical Assistance

CLIMATE RESILIENCY	TOXICS EXPOSURE	NUTRIENTS AND ALGAL BLOOMS
A joint climate adaptation and resiliency centre as well as shoreline priority shoreline zone management teams to help shoreline communities with professional services and expertise.	A Toxics Substitution Centre to undertake research and with the capacity to work directly with companies on substituting harmful substances in products	A Centre for water quality and nutrient management with trained technical assistance teams to work with farmers

Funding purpose-oriented research and innovation and making it available at the local level through direct extension support would have a transformative effect on the ability of indigenous communities, municipalities, conservation and watershed organisations, agricultural operations, and other small businesses to contribute to building climate resiliency and protecting water resources.

3.4 Monitoring and evaluation

The implementation of Action Plan 2020-2030 must strive for continuous improvement. This requires an investment in monitoring and evaluation, and in the public reporting of results.

Having clear objectives, principles and indicators that measure progress is essential in the context of a collaborative approach that involves numerous government and non-government organizations in the implementation of recommendations. Objectives, principles and indicators provide directions and guide decision-making.

In order to evaluate progress, each recommended action in Action Plan 2020-2030 will need:

- Targets or anticipated outcomes for tri-annual environment results for 2023, 2026, 2029;
- Environment baseline indicators to track progress.

The results from this monitoring and evaluation activity should be communicated publicly through

- Annual reports that are submitted to the Great Lakes and St. Lawrence Collaborative Commission by the implementation teams;
- An annual report submitted by the Great Lakes and St. Lawrence Collaborative Commission to the federal government;
- A bi-annual meeting of stakeholders, various government organizations and First Nations organised by the Great Lakes and St. Lawrence Collaborative Commission to present results, share experiences and further a community approach in the management of a shared ecosystem, with meetings alternating between Ontario and Québec;
- Develop and populate a dashboard to communicate results on outcomes and outputs (live).

Furthermore, to establish accountability to the public, it is proposed that Action Plan 2020-2030 be periodically (every 2-3 years) audited by

- The Commissioner for Environment and Sustainable Development (federal) for the overall plan;
- The Auditor-General (Ontario) for the Great Lakes region;
- Commissioner for Sustainable Development (Québec) for the Saint Lawrence region.

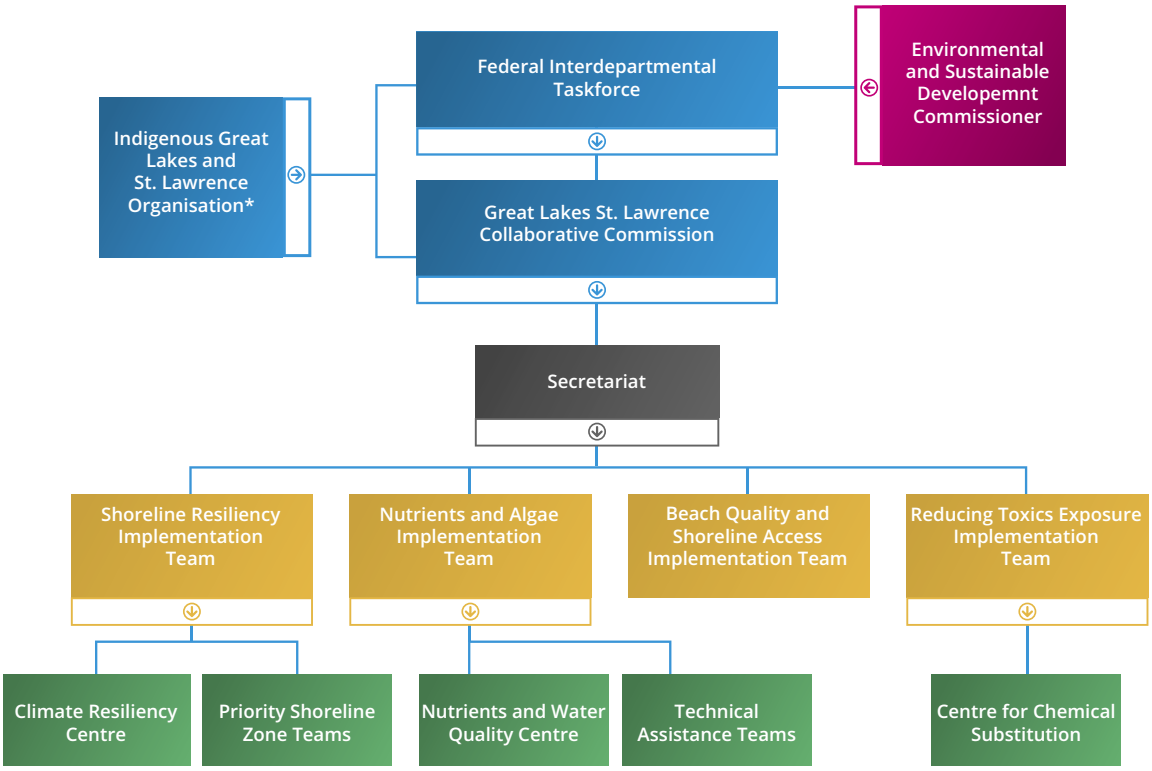
4. IMPLEMENTING ACTION PLAN 2020-2030

To implement Action Plan 2020-2030, the following institutional arrangements, roll-out plan and investment strategy is proposed.

4.1 Great Lakes St. Lawrence Action Plan 2020-2030 Institutional Arrangements

As explained in Section 3, new institutional arrangements are needed to overcome the current fragmented approach, to integrate Great Lakes St. Lawrence protection, align federal actions and funding across departments, and connect federal and provincial action to indigenous and other key constituencies to make it locally relevant.

Integrated Great Lakes St. Lawrence Institutional Arrangements to Deliver Action Plan 2020-2030



* Institutional arrangements involving indigenous groups will be determined following further consultations with Great Lakes and St. Lawerence indigenous groups

Great Lakes St. Lawrence Collaborative Commission

There is currently no cross-cutting forum or institutional structure within which to coordinate Great Lakes-St. Lawrence issues together. The Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health (COA) and the Saint Lawrence Action Plan (SLAP) are planned and implemented entirely separately, despite the ecological connection and shared economic significance of the waterways. This lack of cross-cutting coordination and knowledge sharing was one of the primary motivations to undertake the Great Lakes St. Lawrence Collaborative. Any institutional structures that are established or built upon to deliver the Great Lakes St. Lawrence Action Plan must undertake this work with an approach that promotes regional integration.

To coordinate and align actions across the Great Lakes and St. Lawrence regions, it is proposed that a Great Lakes St. Lawrence Collaborative Commission be created. This Commission would be an eight person Commission, half from the Great Lakes and half from the St. Lawrence regions respectively. Commissioners would be chosen from key constituencies in the Region, including indigenous, business (e.g. maritime, agriculture),

conservation and climate resiliency, science/engineering/academia, municipal and NGO/civil society. Federal, Quebec and Ontario Government officials would be invited to attend as observers. A representative from the US Federal Interagency Taskforce would also be invited as an observer to consider synergies with the US GLRI program.

The mandate of the Great Lakes St. Lawrence Collaborative Commission would be to:

- Oversee the implementation of the Great Lakes St. Lawrence Action Plan,
- Work with the Federal Taskforce to secure funding to implement the Action Plan,
- Facilitate working arrangements among responsible agencies to deliver the Action Plan,
- Recommend to the Federal Government new issues to add to the Action Plan on a periodic basis,
- When a new issue is assigned to it by the Federal Government, convene and oversee a new issue table to develop recommended actions to address the new issue,
- Review progress towards desired outcomes, consider adapting recommended actions to changing circumstances.

The Commission would be co-chaired by two representatives from the Great Lakes and St. Lawrence regions respectively. They would be appointed to 5 year terms by the Minister of Environment and Climate Change. The Commission would meet quarterly, and would be supported by a secretariat.

Federal Great Lakes St. Lawrence Taskforce

At the federal level, alignment of budgets and actions is needed across 20 departments and agencies with responsibility for water management. The primary departments that should be involved in a Federal Great Lakes St. Lawrence Taskforce include Environment and Climate Change Canada, Health Canada, Natural Resources Canada, Agriculture and Agrifood Canada, Infrastructure Canada, Public Safety Canada, Global Affairs Canada, Indigenous and Northern Affairs, Transport Canada, Fisheries and Oceans Canada, Heritage Canada and Treasury Board.

It is proposed that the GLRI Interagency Taskforce serve as a model for the Canadian federal government to drive interdepartmental alignment on Great Lakes and St. Lawrence protection.

The federal Great Lakes St. Lawrence Taskforce's mandate would be:

1. To advance collaboration across federal government departments and with Great Lakes and St. Lawrence Collaborative Commission in support of the Great Lakes St. Lawrence Action Plan 2020-2030;
2. To coordinate the development of coherent Federal policies, strategies, projects, and priorities for addressing those issues identified in the Great Lakes and St. Lawrence Action Plan and assisting in the appropriate management of the Great Lakes and St. Lawrence system;
3. To allocate federal funding across departments and federal funding to specific projects of Action Plan 20202-2030 through Great Lakes and St. Lawrence Collaborative Commission.
4. To negotiate shared financing of aspects of the Action Plan with the Governments of Quebec and Ontario.
5. To consider recommendations of the Commission for new issues to add to the Great Lakes St. Lawrence Action Plan 2020-2030, and approve, deny or request further information of the Commission.

The Taskforce would be co-chaired by the Federal Minister of the Environment and the Federal Minister of Infrastructure. It would meet twice a year.

Indigenous Great Lakes St. Lawrence body

To coordinate and align actions with First Nations and Metis Councils, it is proposed that an Indigenous Great Lakes and St. Lawrence organisation be created. The structure must be mindful of the pre-eminence of the direct government to government relationship between indigenous peoples and the Federal Government, as well as the Crown's duty to consult. This suggests a number of options, whether it be a direct relationship with the Federal taskforce, an advisory role to the Great Lakes St. Lawrence Collaborative Commission, or another institutional arrangement. Rules, responsibilities and authority of this organisation will be explored through consultation with indigenous groups in the Great Lakes St. Lawrence basin, and ultimately agreed to through negotiations between indigenous representatives and the Federal Government.

Issue-specific Implementation Teams

To coordinate delivery of programs and funding on the ground, it is proposed that four issue-specific implementation teams be created in the four areas outlined in the Great Lakes and St. Lawrence Action Plans:

i. Shoreline climate resiliency

ii. Nutrients and algae

iii. Beaches quality and shoreline access

iv. Exposure to toxics

These implementation teams would include representation from the federal government, Quebec and Ontario government representatives, as well as representation from local and regional municipalities, and existing St. Lawrence, Great Lakes and local watershed organisations. Economic sectors associated or dependent on the regional water systems would also be represented on the implementation teams.

It should be noted that neither the Commission nor the implementation teams are meant to replace the work of existing government programs, but rather are meant to supplement and assist these programs in linking the programs with local needs by engaging local stakeholders, communities, and academic and technical expertise.

To that end, implementation teams should work through existing regional and local organisations and programs. It is vital that Governments maintain and increase financial support of those regional initiatives that have demonstrated their local efficiency such as Stratégies Saint-Laurent and the Zones d'Intervention Prioritaires (ZIP) Program under the St. Lawrence Plan.

Other important organisations with which the implementation teams should work include Organismes des Basins Versants, the tables de concertations established by the Quebec Government to promote integrated management of the St. Lawrence, and Conservation Authorities in Ontario. Other conservation groups and NGOs active on the ground may also be invited to work with the implementation teams. These may include Nature Conservancy Canada, field naturalist organisations, ALUS Canada, Ducks Unlimited, Forest Ontario, among others.

The mandate of the implementation teams would be to:

- Coordinate funding and programming to meet local needs
- Monitor and report on progress on outputs and outcomes
- Support and steer watershed initiatives
- Review and approve workplans to implement the action plan
- Communicate and consult with stakeholders
- Link local needs with academic and technical expertise

Three of the four implementation teams would be supported by research centres and technical assistance teams as outlined in the organisational chart above.

4.1.1 Assigning New Issues

The Great Lakes Action Plan 2020-2030 is focused on four important issues that have been identified as requiring alignment and new institutional arrangements to be addressed effectively.

The Great Lakes and St. Lawrence Collaborative Commission will have the authority to recommend new issues to the federal taskforce for its consideration. Three new issues already identified by the Expert Panel include i) the protection of biodiversity in the Great Lakes St. Lawrence region, ii) the operations of nuclear facilities and the storage of low level, intermediate and high level nuclear waste in the Great Lakes St. Lawrence basin, and iii) long term impacts of exposure to road salt on sensitive species such as crustaceans.

The protection of biodiversity has a number of important aspects that would need to be considered. The question of relative species abundance and the protection of endangered species across the Great Lakes St. Lawrence region is an acute concern. Habitat degradation, particularly the hardening and development of shorelines and the destruction of wetlands is devastating spawning areas. The introduction of invasive species, including Asian Carp, zebra and quagga mussels, among others, continue to threaten aquatic species and the health of the waters. Climate change impacts, including warming waters, more intense polluted runoff, among other impacts, is exacerbating all of these pressures. The economic, social and cultural significance and value of biodiversity must also be recognised.

The issue of activity of nuclear facilities within the Great Lakes St. Lawrence basin is also of great concern. This includes existing and newly proposed operations of nuclear facilities within the Great Lakes St. Lawrence watershed. The ongoing question of nuclear waste storage, both low and medium level waste and high level waste, remain unresolved, resulting in aboveground stockpiles. The potential impact of these activities requires an aligned and coordinated response.

A third issue, the concentration of chloride harming aquatic organisms in wetlands and tributaries to the Great Lakes and St. Lawrence from the application of road salt, was recently highlighted in the Ontario Auditor General's report. Chloride from road salt is transported more easily than sodium, and accumulates in wetlands and streams near roads. During periods of snowmelt, concentrations of chloride have been found to greatly exceed the Canadian water guidelines for chronic and acute exposure to chloride (120mg/litre and 640mg/litre respectively). The Ontario auditor general found that road salt studies in Ontario and across North America show the problem is widespread and getting worse. While this issue should be championed under the Toxics and Harmful pollutants recommended actions in terms of proactive surveillance, testing and reporting, there is also a need for a long term study of the impacts of road salts on aquatic organisms in various parts of the Great Lakes and St. Lawrence basin, particularly crustaceans and amphibians including salamanders and frogs. Chloride is known to be harmful to these organisms because it affects the way they can regulate the uptake of salt into their bodies.

It is recommended that the Government of Canada, in collaboration with the Governments of Quebec and Ontario, establish the institutional arrangements outlined in this report. The institutional arrangements will be free standing, but may be integrated into the Canada Water Agency once it is established.

> **It is further recommended that** the Government of Canada request the federal Commissioner of Environment and Sustainable Development to undertake a performance audit of Action Plan 2020-2030 every 2-3 years and report its findings to Parliament.

It is recommended that the Great Lakes St. Lawrence Collaborative Commission regularly review progress towards desired outcomes, consider adapting recommended actions to changing circumstances, and recommend new issues to add to the Action Plan, including biodiversity, nuclear operations and waste, and road salts.

4.2 Implementation Roll Out Plan and Investment Strategy

In order to ensure that the Action Plan 2020-2030 is implemented in a timely manner, the following Roll-out Plan and Investment Strategy is proposed, with dates assigned to each of the 30 recommended actions.

The needed investment indicated is new funding, unless otherwise indicated. Only the Federal share is included. No figures are provided where the responsible parties are provincial governments only. Cost sharing with provincial governments, First Nations and municipalities should be sought where indicated.

For those recommendations where First Nations and other shoreline communities are specifically identified, further consultation will be needed to ensure that the needs of each community is met.

Date	Action	Responsible Party	Federal Share only, over ten years
Commit to Implementation of Great Lakes St. Lawrence Action Plan 2020-2030			
2020	1. Commit to implementation of the Great Lakes St. Lawrence Action Plan 2020-2030 and a 10-year $2 billion investment strategy.	GOC	
2020	2. Establish institutional arrangements including a Federal Interdepartmental taskforce, a Great Lakes St. Lawrence Collaborative Commission, an indigenous body (to be determined following consultation) , implementation teams, and supporting research centres and technical assistance teams. Request to Environment and Sustainable Development Commissioner to report on progress every 2-3 years.	GOC	$50M
2021	3. Regularly review progress towards desired outcomes, consider adapting recommended actions to changing circumstances, and recommend new issues to add to the Action Plan, including biodiversity, nuclear operations and waste, and road salts.	GLSL Collaborative Commission	
Build Shoreline Climate Resiliency			
2020	4. Commit to establishing and funding five Shoreline Resiliency Priority zones and management teams to identify and address significant threats from climate change (high water levels, stronger wind/ wave energy, erosion, sudden spring thaws, ice jams) impacting natural and built infrastructure on Great Lakes shorelines, with an emphasis on naturalization and green infrastructure solutions, beginning with five shoreline priority zones 5. Offer ongoing guidance and funding (on a competitive basis) to all shoreline municipalities and Indigenous communities to support actions to make their shorelines more climate resilient	GOC, ON	$330M + existing funding program commitments (e.g Disaster Mitigate and Adaptation Fund). Seek cost sharing on 40% federal / 40% provincial / 20% municipal basis.

Date	Action	Responsible Party	Federal Share only, over ten years
2021-2024	6. Establish a joint Office of Shoreline Climate Change Adaptation and Resilience (2022), to a. Develop a regional shoreline adaptation and resiliency strategy and provincial action plans (2023) and coordinate their implementation b. Report annually on progress with respect to shoreline adaptation and resilience c. Provide professional services and expertise to regional and local governments and First Nations (2021)	GOC, QC, ON	$38.5M Seek 1/3 federal 1/3 QC 1/3 ON cost share
	7. Facilitate the development and implementation and track progress of local climate adaptation and resiliency plans in the St. Lawrence region (2023), while • financing professional services in priority zones and extension services during and following a catastrophic event, including 5 First Nations: Abénakis (Odanak, Wôlinak), Huron-wendat (Wendake), Innus (Essipit, Pessamit, Uashat, Ekuanitshit), Mi'gmaq (Gespeg and Gesgapegiag) and Mohawks (Akwesasne, Kahnawake, Kanesatake) • review and revise financial assistance programs to include education and awareness programs.		$500M Seek cost sharing on 40% federal / 40% provincial / 20% municipal or First Nation basis.
2021	8. Invest further in the development of Light Detection and Ranging (LIDAR), flood plain mapping, and monitoring/modelling data to benefit shoreline communities	ON, QC	
2021-2023	9. Create a climate data sub- portal for Great Lakes and St. Lawrence shoreline priority zones within the Canadian Centre for Climate Services portal (2021-2023) 10. Ensure **access to climate change data and information (2021)** for local communities and support the development of information based on current and futures needs of communities.	GOC, QC, ON	$0.3M Seek 1/3 federal 1/3 QC 1/3 ON cost share

Date	Action	Responsible Party	Federal Share only, over ten years
2022	11. Develop an **ecosystem services payment program (2022)** for land owners in exchange for the deployment of ecosystem service measures on their land, particularly to support flood risk mitigation. 12. Support natural and green infrastructure solutions in land use and infrastructure management, particularly in developing a plan for land acquisition in underdeveloped zones.	GOC, QC	$5.5M Seek 50% federal, 50% QC cost share
Reduce Bacteriological Contamination of Shorelines, Beaches			
2022	13. Introduce a new risk-based categorization system for Ontario beaches, and require actions of owners of 'impaired' beaches that have chronic bacteriological contamination issues	ON, QC	$160M Seek cost sharing on 40% federal / 40% provincial / 20% municipal or First Nation basis.
	14. Develop and put in place a risk-based approach for the opening and operation of beaches on the St. Lawrence (2022) a. Including implementation of beach management plan in 5 First Nation communities : Gespeg, Gesgapegiag, Akwesasne, Kahnawake, and Kanesatake.		$33M Seek cost sharing on 40% federal / 40% provincial / 20% municipal or First Nation basis.
2023	15. Create and maintain a central portal with beach quality information, including information on the 'status' of the beach	ON, QC	
2022-2030	16. Provide financial support for wastewater treatment facility upgrades and the installation of green infrastructure to reduce the number of sewer overflows in priority sectors, remove emerging contaminants and support other measures proposed by beach operators in their beach plans.	GOC, QC	$400M Seek cost sharing on 40% federal / 40% provincial / 20% municipal or First Nation basis.
2023	17. Amend the Public Health Ontario's Public Beach Water guidance on test methods for E. coli to allow for alternate testing methods other than membrane filtration as per Ontario Ministry of Environment, Conservation and Parks (MECP) guidance on drinking water testing methods	ON	

Date	Action	Responsible Party	Federal Share only, over ten years
Reduce nutrients entering waterways			
	18. Adopt a targeted geographically specific approach to reducing nutrients entering waterways, employing precision conservation and stormwater optimization.	GOC, ON, QC	
2023	19. Establish a research centre supported by a university consortium and an interministerial committee to develop measures and provide extension support to farmers in 11 priority zones in Quebec , using agricultural conservation and living lab models to support farmers in adopting best practices. 20. Together with partner universities, Indigenous communities, and relevant organizations, create a Centre for Water Quality and Nutrient Management to generate and coordinate information to support precision conservation and stormwater optimization approaches in the Great Lakes and St. Lawrence Basin.	GOC, QC, ON	$80M Seek 1/3 federal, 1/3 QC, 1/3 ON cost share
2023	21. Develop a data management strategy and tools to support the precision conservation approach and to facilitate the collection and use of datasets (e.g. elevation, soil type, property boundaries, land use) needed to prioritize properties, and best practices, and to coordinate monitoring and modelling data at a watershed level.	ON, QC, GOC	$0.15M Seek 1/3 federal 1/3 QC 1/3 ON cost share
2023	22. Review and adapt agricultural income support and technical programs to reduce water contamination as well as technical assistance outreach to farmers, especially incorporating green infrastructure, payment for ecosystem services for landowners, a. Including support for changes in agricultural practices in 3 First Nations communities: Akwesasne, Kahnawake, and Kanesatake. 23. Designate a dedicated network of extension workers that receive standardized training and provide consistent technical advice to farmers	GOC, QC, ON	$300M Seek 50% federal, 50% provincial cost share $20M Seek 50% federal, 50% provincial cost share

Date	Action	Responsible Party	Federal Share only, over ten years
2025	24. Where subwatershed modelling and monitoring identifies urban areas as significant contributors of phosphorus loading, require the relevant municipalities in consultation with conservation authorities to develop an urban stormwater optimization/prioritization plan with steps to achieve measurable phosphorus reductions	ON	
Prevent exposure to harmful chemicals			
2022	25. Review and strengthen the standards and upgrade the performance of existing wastewater treatment facilities for municipalities, businesses, and institutions. • carry out and finance small scale pilot projects to test innovative approaches, strategies and technologies • meet obligations under international conventions, particularly with respect to persistent organic pollutants. • amend wastewater treatment regulations to include a total nitrogen discharge standard.	GOC, QC	Included in investments under Rec. #16, above.
2024	26. Develop a targeted environmental and human health effects monitoring, human biomonitoring and surveillance program to provide early detection of unexpected effects in the Great Lakes basin that feeds directly into a regulatory and non-regulatory response plan to reduce exposure 27. Develop and implement a proactive program of targeted surveillance on human health and environmental effects and determine the priority zones where effects are most likely to be found, Including implementation of a human health and environmental surveillance program focused on 5 First Nations: Uashat Mak Mani-Utenam, Ekuanitshit, Nutashkuan and Unamen Shipu.	GOC	$120M $120M
2024	28. Broaden CEPA's scope to eliminate toxics, particularly with respect to authorizing the entry of new substances into the market	GOC	$0.25M

Date	Action	Responsible Party	Federal Share only, over ten years
2024	29. Develop guidelines to guide the generation and communication of data collected through the surveillance program and develop Guidance on the Appropriate Response to Exposure and Effects surveillance program data	GOC	$0.4M
2024	30. Introduce a Strategy to Promote Substitution of Harmful Chemicals in Products, including a Centre for Chemical Substitution, and a Chemical Substitution Recognition Program	GOC	$20.4M
TOTAL (Federal share over ten years)			**$2,178.50**

4.3 Investment Highlights and Economic Benefits

Based on a high-level assessment of investments needed to implement the Action Plan 2020-2030, it is estimated that the Federal share is in the order of $200 million per year for ten years. The investments would be unevenly distributed over the ten years, as per the proposed Roll Out plan and Investment Strategy, above.

Highlighting specific investments in two areas, shoreline resiliency and wastewater treatment and capacity upgrades serves to demonstrate the magnitude of the investments needed to implement the Action Plan 2020-2030. The investment strategy will require further refinement as the specific investments and projects are more clearly defined by the governments, First Nations, and communities involved. Further details may be found in the two foundation reports.

4.3.1 Shoreline Resiliency Investments

The first highlighted investment area is $840 million for shoreline resiliency work to mitigate climate change impacts in the St. Lawrence and Great Lakes basin. These could include flood and erosion protection measures along shorelines, appropriation of properties that are not able to be protected, and the transformation of these lands to a natural state, among other measures. The total cost of needed measures far exceeds the amount recommended in this investment strategy. The investment in Action Plan 2020-2030 is meant to accelerate ongoing work in a way that integrates the efforts of a number of authorities and the communities and residents involved. In doing so, the projects undertaken under the Action Plan will serve as templates for future shoreline work.

In the Great Lakes region, five priority zones are identified in the Action Plan. In three of the zones, the Lake Erie, Lake Huron, and Lake Ontario priority zones, adaptation and resiliency planning and projects are already underway. In the case of Fort William First Nation and Thunder Bay, there is a specific shoreline risk that needs addressing involving a contaminated sediment site and remaining remediation work that involves multiple federal and provincial agencies. In the case of the Georgian Bay zone, while there is no specific shoreline resiliency plan in place in Tiny or Penetanguishene, it would serve as an important case study to build resiliency before more severe impacts are experienced. The Action Plan recommends creating intergovernmental and interdisciplinary teams in each of the five zone to integrate financing and planning efforts, and to provide technical and financial assistance with planning and implementation of plans. Financial assistance would be provided to undertake the resiliency work identified in each zone's plans.

In the St. Lawrence region, the needs and the geographic scale of climate impacts are so great that the Action Plan recommends the development of a provincial strategy to guide resiliency planning and implementation, and creation of a centre to provide detailed climate information and technical advice. In terms of where to start this work, while the impacts are felt along hundreds of kilometres of shoreline from south of Montreal through to north of Quebec City, there are three zones that could be prioritized to demonstrate the benefits of an integrated approach due to the complexity of agencies and institutions involved, and the dire socio-economic impacts in failing to take action. These include the Montreal region (including consideration of the impact of the Outaouais river), the Quebec City region, and the region surrounding Lac St. Pierre.

First Nations communities along the St. Lawrence are particularly at risk, given the fractured response of governments and limited resources. Five First Nation zones have been identified in the St. Lawrence Action Plan 2020-2030, including the Abenakis of the Odanak and Wolinak, the Huron-Wendat of the Wendake, the Innus of the Essipit, Pessamit, Washat, and Ekuanitshit, the Mi'gmaq of Gespeg and Gesgapegiag, and the Mohawks of Akwesasne, Kahnawake and Kanesatake.

In terms of investments to mitigate the impact of erosion, the accelerating erosion in the St. Lawrence estuary and the Cote Nord region has been well documented. The Action Plan investments could be directed to one or two areas experiencing acute erosion in this region, such as Sainte Flavie north of Rimouski, and Pessamit, an Innu community north of Baie Comeau mentioned above.

In both the Great Lakes and the St. Lawrence region, it is anticipated that an aspect of integrated resiliency planning will include identifying specific areas where flooding or erosion are so severe that the only appropriate resiliency strategy is retreat and re-naturalisation. In these areas, the Federal and provincial governments will need to work with municipalities to appropriate properties while fairly compensating the municipalities and residents. These areas would then be naturalised, to allow for the free flow of water in expanded flood zones. These areas could be designated as federal or provincial parks and/or natural heritage areas to promote biodiversity and eco-tourism.

4.3.2 Wastewater Treatment and Capacity Investments

The need for investments in more effective wastewater treatment and expanded wastewater capacity was identified as a need in 3 of the 4 principal issue areas:

- to prevent bacteriological contamination from bypasses and combines sewer overflows during heavy rains that contaminate beaches and shorelines;
- to remove total nitrogen that contributes to areas of hypoxia in the Saint Lawrence;
- to more effectively remove emerging contaminants like pharmaceuticals.

Investments to install more effective treatment technology would benefit at least five treatment stations, in Montreal, Laval (2 stations), Longueuil, and Repentigny. These investments would be timely given that the municipal owners of these plants are currently considering designs to upgrade the plants to comply with the federal wastewater treatment regulation by the end of 2030. With additional funding, these plants could install treatment technology to go beyond compliance, to remove either total nitrogen and/or emerging pollutants such as pharmaceuticals, depending on the location. It is estimated that each treatment upgrade would require investments ranging from $100 million to $400 million, based on the size of the plant and the nature of the upgrade, for a total of about $1 billion in investment, which could be shared on a 40% federal, 40% provincial, 20% municipal basis. This would represent a $400 million investment commitment by the Federal Government.

Investments are also required to assist municipalities to eliminate bacteriological contamination caused by bypasses or combined sewer overflows that contribute to chronic contamination of beaches and shorelines. In Ontario, 15-20% of beaches have chronic contamination problems. Large cities like Toronto, Hamilton and Kingston are already investing multi millions of dollars to eliminate their combined sewer overflows (CSOs). For those smaller municipalities whose plants are found to be the source of bacteriological contamination of beaches, it is anticipated that they will need financial assistance to eliminate the source of contamination. It is proposed that $400 million be provided to accelerate work by big cities to eliminate CSOs, and to assist up to 15 smaller municipalities to increase their

sewage treatment and/or storage capacity at an estimated cost of $20 million each. With 40%/40%/20% cost share, that would represent an investment commitment of $160 million by the Federal Government.

It is recommended that the Government of Canada commit to $2.2 billion in new investments over ten years to implement the Great Lakes St. Lawrence Action Plan 2020-2030 and seek shared funding arrangements where required from the Governments of Quebec and Ontario and municipalities.

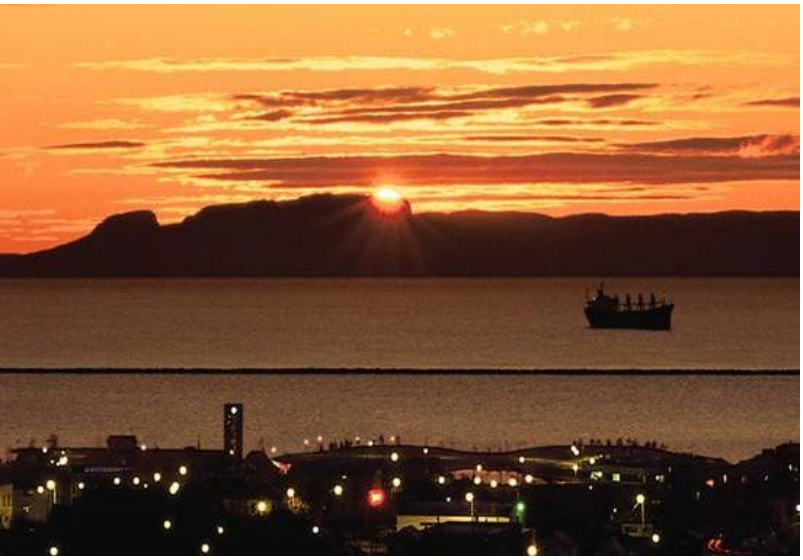
4.3.3 Benefits of Action Plan Investments

While it was beyond the scope of the Collaborative's work to conduct a comprehensive assessment of the multiplier effect of the proposed investments, a preliminary assessment revealed significant benefits, in terms of quality of life, revenue generation, avoided costs and employment generation.

These investments in Great Lakes St. Lawrence protection would reap considerable ecological, public health, economic, and lifestyle benefits. At a time when the region will be recovering from the economic impacts of the COVID-19 pandemic, employment generation effects would also be very attractive.

The economic benefits would largely be reaped based on increased employment due to construction and restoration activity and increased revenue from tourism and property values.

For example, based on Statistics Canada estimates, $500 million in shoreline construction costs would be expected to create upwards of 3,500 person-years employment, in the industries below and their supply chains, plus induced employment.



Person-years of employment (direct and indirect only) per $ million invested

Industry	PYE / $M
Engineering construction	6.82
Repair construction	11.47
Professional, scientific and technical services	9.53
Administrative and support, waste management and remediation services	13.96
Other federal government services	7.05
Other provincial and territorial government services	7.77

Source: Statistics Canada, "Provincial Input-Output Multipliers 2013", published 2017

As a comparator, a recent US study found similarly-scaled results. It noted a total of $1.4 billion in US federal spending on Great Lakes Restoration Initiative (GLRI) projects between 2010 and 2016 (matched by $360 million from state and local governments) and estimated that every dollar of federal spending will produce a total of $3.35 of additional economic output in the Great Lakes region through 2036, and that the GLRI created or supported an average of 5,180 jobs per year from 2010–2016.

Another US study with a larger focus on the overall economic impact of Great Lakes restoration estimated present-value economic benefits from implementing the Great Lakes Regional Collaboration Strategy at over $50 billion in long-term benefits; and between $30 and $50 billion in short term multiplier benefits.

The benefits of shoreline resiliency work include avoided costs, including preservation of residences, businesses, and public buildings, the value of which greatly exceeds the costs of protection (and the value of which increases due to the protection being added); prevention of potential

financial losses to property owners; and amenities to local residents and visitors, akin to that of existing conservation areas. A 2015 study by the climate change research consortium Ouranos suggested that anticipated costs of erosion in the Cote Nord and St. Lawrence estuary region alone could exceed $1 billion. A 2020 study by the World Resources Institute predicted that the costs of flood impacts in Canada could triple by 2030, from between US$2.4B – $6.6B.

Benefits of reducing human exposure to toxics and other harmful pollutants would include reduced toxics loading for humans and other species, lower costs of morbidity and mortality, lower health-care costs, and higher productivity (reduced productivity losses caused by illness). Recent studies show a reduction in productivity and a rise in health costs as a result of exposure to toxic substances. In the United States, health costs associated with toxics exposure have been estimated at US $340B per year, and US$217B per year for Europe, corresponding to 2.3% and 1.3% of gross domestic product respectively.

The primary benefits of reducing nutrient loss from agricultural land would include cleaner streams and shorelines, cost savings to agricultural operators due to more efficient phosphorus application, enhanced recreational and fishing uses of cleaner waterways, and the preservation of property values and tourism income for shoreline communities, among others.

Benefits of improved beach and shoreline quality would include avoidance of the costs of beach closures, which can be tens of thousands of dollars per day for a single beach, as well as avoidance of illnesses and associated costs, e.g. health care, loss of productivity. Based on a recent US study, in Ontario alone these avoided costs could be in the range of $96 million to $162 million per year. Other benefits would include resident convenience in using beaches, potential improvements in demand for businesses near beaches due to increased confidence in water quality.

These benefits suggest a significant return on investment from Action Plan 20202-2030, in terms of economic, ecological, human health, and quality of life improvements.

5. CONCLUSION

The Great Lakes and St. Lawrence Action Plan 2030, has been developed over the last eighteen months with the input of hundreds of experts, stakeholders, concerned citizens, and indigenous representatives. Together they have forged a common, integrated vision for Great Lakes and St. Lawrence protection over the next ten years.

To ensure the successful implementation of the Action Plan over the next ten years, new approaches and institutional arrangements are needed. This new approach must embrace alignment and integration of actions and investments, risk-based prioritization and risk management, intensive research and technical assistance, and monitoring and evaluation.

By adopting the implementation plan outlined in this report, including new institutional arrangements, the roll out plan, and the investment strategy, the Federal Government, with its indigenous, provincial and municipal partners, economic, watershed and local stakeholders, can embark on a new era of freshwater protection, one that will reap benefits in human and ecological health, nurture biodiversity, and contribute to the region's economic recovery.

The Great Lakes and St. Lawrence Action Plan 2030, has been developed over the last eighteen months with the input of hundreds of experts, stakeholders, concerned citizens, and indigenous representatives. Together they have forged a common, integrated vision for Great Lakes and St. Lawrence protection over the next ten years.