HALIFAX

P.O. Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

Item No. 13.1.2
Environment & Sustainability Standing Committee
December 4, 2025

TO: Chair and Members of Environment & Sustainability Standing Committee

SUBMITTED BY: Jaqueline Hamilton, Acting Commissioner of Operations

DATE: September 9, 2025

SUBJECT: LakeWatchers 2022-24 Update

ORIGIN

June 29, 2021 Halifax Regional Council Item 11.4.1:

MOVED by Councillor Russell, seconded by Councillor Austin

THAT Halifax Regional Council direct the Chief Administrative Officer to adopt and implement a detailed water quality monitoring program based on Framework 1 as outline by AECOM (2020)[1] as outlined in the Discussion section of the staff report dated May 6, 2021.

MOTION PUT AND PASSED UNANIMOUSLY.

EXECUTIVE SUMMARY

The Halifax Regional Municipality (HRM) continues to advance its efforts in understanding and protecting lake water quality through the HRM LakeWatchers Program. The following recommendation report summarizes the key findings of the first three years of lake monitoring (2022-2024) completed as part of the HRM LakeWatchers program and provides recommendations based on these initial trends. The 2nd ***State of the Lakes*** report, provided as **Attachment A**, includes additional background information and a more detailed analysis of the dataset.

Since 2022, the LakeWatchers program has collected bi-annual water quality data for over 70 local lakes within the Municipality, focusing on three key indicators of lake health: eutrophication, chloride enrichment, and bacterial contamination.

RECOMMENDATIONS ON PAGE 2

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[1]AECOM. 2020. Water Quality Monitoring Policy and Program Development for the Halifax Regional Municipality

A cornerstone of the LakeWatchers program is its community-driven approach. As of August 2024, over half of the lakes are monitored by community volunteers.

From a eutrophication, or nutrient enrichment, perspective, there is growing evidence that many lakes in HRM are becoming capable of supporting more aquatic plants, cyanobacteria and algae. This is supported by elevated summertime levels of chlorophyll-α, frequent resident reports of increasing aquatic plant and algae growth, and widespread deepwater oxygen loss observed in many lakes during the summer months. Additionally, chloride enrichment, or salinization, has emerged as a significant and chronic stressor for many lakes within HRM, particularly those receiving direct discharge from the municipal stormwater system. Normally, freshwater lakes in the region should have chloride levels at or below 10 mg/L; However, between 2022–2024 there were nine monitored lakes whose average levels of dissolved chloride exceeded the Canadian Council of Ministers of the Environment (CCME) long-term guideline of 120 mg/L.

Despite the low number of *E. coli* exceedances observed between 2022-2024 as part of LakeWatchers, municipal supervised beaches have seen a significant increase in the number of beach days under water quality advisories due to elevated *E. coli* levels, rising from 3% in 2019 to 11% in 2024. This difference suggests the sources of contamination are related to the shoreline and the near-shore environment. Likely sources of contamination include waterfowl feeding and congregating at beaches, improper pet waste disposal, and proximity to possible stormwater outfalls, among others.

These findings underscore that shoreline management interventions such as enhancing shoreline vegetation, deterring waterfowl, and in some cases rerouting or setting back stormwater outfalls could be solutions for improving overall lake water quality and reducing bacterial contamination at municipality owned public beaches, and near-shore lake environments more generally.

RECOMMENDATION

It is recommended that the Environment & Sustainability Standing Committee recommend that Halifax Regional Council direct the Chief Administrative Officer to:

1. Direct staff to add the supervised beaches at Kidston Lake, Long Pond, Penhorn Lake, Albro Lake, Birch Cove (Lake Banook), Lake Echo, Springfield Lake, and Kearney Lake to the Naturalization Program.

2. Direct staff to explore shoreline and in-lake green infrastructure options for addressing stormwater discharge locations within 100 m of supervised beaches.

BACKGROUND

Efforts to understand, protect, and manage watershed health at the municipal level date back to the Halifax Regional Municipality's Water Resources Management Study[2], which recommended that the Municipality establish a lake water quality monitoring program. The first municipal lake monitoring program, the HRM Lakes Water Quality Monitoring Program (HRM LWQMP), was initiated in 2006 but was later suspended in 2011.

Since that time, the municipality has seen unprecedented growth and changes across the region and in 2021, Regional Council approved the creation of a new municipal lake monitoring program. There are many municipal programs and services that have the potential to impact lake health and water quality, making HRM strategically situated to proactively address arising issues and manage ongoing concerns by

[2] Halifax Regional Council Report. 2003. Water Resource Management Study Project.

monitoring lake water quality.

The HRM LakeWatchers Program was subsequently launched in the spring of 2022 to complete bi-annual (spring & summer) water quality monitoring on more than 70 selected lakes across the municipality. The primary goal of the program is to establish current baseline conditions and monitor these lakes for three key water quality concerns identified for Halifax-area lakes; i) eutrophication (nutrient enrichment), ii) chloride enrichment (salinization), and iii) bacterial contamination.

The HRM LakeWatchers Program was designed to actively engage and involve community groups and individual volunteers in lake water quality monitoring. Since its launch in the Spring of 2022, the number of community groups and volunteers who have been trained and are now participating in the LakeWatchers Program has continuously grown to include 40 of the 75 monitored lakes as of August 2024.

In addition to the LakeWatchers Program, *E. coli* and enterococci bacteria concentrations are collected annually (between July 1st and Sept. 1st) as part of the municipality's supervised beach season. At the conclusion of each beach season, staff prepare an annual ***Beach Season Water Quality*** report, which is provided as **Attachment B.** Since 2019, the number and duration of water quality advisories issued at municipal supervised beaches has been trending upward due to bacteria concentrations that exceed Health Canada's *Guidelines for Recreational Water Quality*[3].

DISCUSSION

2024 marked another successful year for the HRM LakeWatchers Program. All selected lakes were monitored during both the spring and summer sampling events and volunteer participation continued to grow to include 40 of the selected lakes. Additionally, two more lakes were added to the sampling roster, Mortons Lake in Hammonds Plains and Nelson Lake in East Preston, bringing the total number of monitored lakes to 75.

All data collected in 2024 as part of the HRM LakeWatchers Program is made publicly available through the Halifax Open Data portal[4], as well as Atlantic DataStream[5], an online platform for sharing water quality data in Atlantic Canada.

Eutrophication

Eutrophication describes a process where lakes with naturally low nutrient levels become increasingly enriched with nutrients over time, changing their levels of productivity. This can occur naturally over thousands of years, but is more commonly associated with land use changes and human activity over a period of several decades. This increase in nutrients is often accompanied by decreasing water clarity, increasing aquatic plant and algae growth, and changes to deepwater dissolved oxygen levels. In turn, these changes can significantly decrease the recreational value of a lake and can also be harmful to local fish populations and other wildlife, potentially reducing overall biodiversity.

Based on the amount of nutrients in the water, lakes can be categorized into different levels of productivity or trophic states. For Canadian lakes, the Canadian Council of Ministers of the Environment (CCME), has developed trophic state classifications (Table 1) based on the concentration of total phosphorus (TP)[6] in

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[3] Guidelines for Canadian recreational water quality: Summary document - Canada.ca
[4] Halifax Data, Mapping and Analytics Hub – Open Data.
[5] Atlantic DataStream – Home Page.
[6] Canadian Council of Ministers for the Environment. 2004. Phosphorus, Canadian Guidance Framework for Management of Freshwater Systems.

lake water, but trophic state classifications can also be made from the concentration of chlorophyll-α[7,8].

Table 1. Trophic Status Classifications and Anticipated Lake Conditions*

Trophic State	**Expected Total Phosphorus (TP) range**	**Expected Chlorophyll-α range**	**Anticipated Lake Conditions**
Ultra-oligotrophic	<4 µg/L	< 0.95 µg/L	Clear water with very few aquatic plants. Usually well oxygenated throughout, even deeper water during the summer months, such that salmonids (e.g. trout and salmon) can survive.
Oligotrophic	4 – 10 µg/L	0.95 to 2.6 µg/L	
Mesotrophic	>10 – 20 µg/L	>2.6 to 7.3 µg/L	Moderately clear water with varying degrees of aquatic plant growth. Increasing chance of deepwater oxygen loss during summer which can result in the loss of salmonids. Invasive smallmouth bass and chain pickerel may dominate.
Meso-eutrophic	>20 – 35 µg/L	>7.3 to 20 µg/L	
Eutrophic	>35 – 100 µg/L	>20 to 56 µg/L	Low water clarity and nuisance aquatic plant growth may discourage swimming and boating. Harmful algae blooms and deepwater oxygen loss during the summer become likely. Invasive smallmouth bass and chain pickerel are likely to dominate.
Hyper-eutrophic	>100 µg/L	>56 µg/L	Murky water with poor water clarity is likely to discourage recreational activities. Aquatic plants and algae may cover large areas of the lake's surface. Deep-water oxygen loss during the summer and fish kills are possible. Harmful cyanobacteria blooms are likely (detected or not). Invasive smallmouth bass and chain pickerel are likely to dominate.

*Adapted from A Coordinator's Guide to Volunteer Lake Monitoring Methods (North American Lake Management Society).

Prior to European settlement and the establishment of Halifax as we know it today, most lakes in the region are thought to have been naturally low in nutrients and would have been classified as oligotrophic or ultra-oligotrophic. However, previous studies have suggested that current and historic land-use practices and development have contributed excess nutrients to local lakes, and is accelerating the eutrophication process[9,10]. This issue can already be seen affecting the recreational value of Lake Banook and Lake Micmac[11], requiring the Municipality to hire a contractor to harvest excessive aquatic plant growth in these lakes during the summer months. This example demonstrates the importance of monitoring for signs of accelerating eutrophication so that proactive measures can be taken if nutrient levels are shown to be

[7] Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. 22:361-369.
[8] Carlson, R.E. and J. Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.
[9] Clement, P. et al. 2007. Synoptic Water Quality Survey of Selected Halifax Regional Municipality Lakes on 28-29 March 2000.
[10] Clement, P.M., and Gordon, D.C. 2019. Synoptic water quality study of selected Halifax-area lakes: 2011 results and comparison with previous surveys.
[11] Stantec Consulting Limited. 2019. Pollution Source Control Study for Lake Banook & Lake Micmac.

increasing over time.

Although the total phosphorus concentrations observed between 2022-2024 have generally been lower than expected based on previously collected data (HRM LWQMP 2006-2011)[12] nearly all monitored lakes are still showing some signs of increasing eutrophication.

The most observable signs of increasing eutrophication in Halifax-area lakes are the increasing amounts of aquatic plant growth being reported by residents and the growing number of confirmed harmful algae blooms identified in recent years. Additionally, the majority of monitored lakes can be classified as mesotrophic or higher when assessing their summertime chlorophyll-α concentrations, rather than relying on total phosphorus alone. Lastly, many monitored lakes are also exhibiting some degree of deepwater oxygen loss during the summer months, a condition closely associated with higher trophic states.

Extended periods of deepwater oxygen loss are especially concerning because it can lead to a process known as internal loading. This process, which occurs in low oxygen conditions, can allow nutrients and other harmful contaminants trapped within lakebed sediments to be released back into the water column, potentially fuelling further eutrophication. This process is discussed in more detail in Attachment A to this report.

Recent studies have shown that the process of internal loading is already occurring at some lakes within HRM[13,14] and those findings have been supported by the first three years of LakeWatchers sampling. Between 2022 and 2024, most monitored lakes that developed de-oxygenated deepwater conditions by mid-summer also showed evidence for internal loading.

Chloride Enrichment

Chloride enrichment, or salinization, describes the process of a freshwater lake becoming saltier over time. Naturally occurring chloride levels in freshwater lakes within the Atlantic region, including Nova Scotia, are normally less than 10 mg/L for inland lakes, mostly due to local geology[15]. However, de-icing and anti-icing materials made from salt (Sodium-Chloride / Na-Cl) and used for winter road safety can easily dissolve into run-off water and be transported to lakes and other waterbodies. This is a problem because chloride is unable to break down once released into the environment, and can build-up in lakes over time.

This build-up of chloride has two major implications for our lakes. The first is that too much dissolved chloride in lake water can harm and even kill the aquatic organisms that depend on and live in freshwater systems. The second implication is that elevated deepwater chloride has the potential to disrupt a lake's natural mixing cycle, which regulates nutrient and oxygen levels throughout a lake.

The fish, plants, and other organisms that depend on and live in our lakes are adapted to life in freshwater. If chloride levels become high, it can begin to harm individual organisms, disrupt ecosystem balance and reduce overall biodiversity. In Canada, the CCME *Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL)* provide guideline values for both long-term and short-term exposure limits to dissolved chloride that are designed to protect freshwater organisms. The short-term exposure limit is 640 mg/L intended to protect most species against lethal exposure during severe, but short-term events. The long-term exposure limit is 120 mg/L intended to protect against the negative impacts on freshwater aquatic

[12] Stantec Consulting Limited. 2012. An Analysis of the HRM Lakes Water Quality Data (2006 – 2011).
[13] Sivarajah, B. et al. 2024. Historical gold mining increased metal(oid) concentrations in lake sediments from Nova Scotia, Canada.
[14] Doucet, C. et al. 2023. Synoptic snapshots: monitoring lake water quality over 4 decades in an urbanizing region.
[15] CCME (Canadian Council of Ministers of the Environment). 2011. Canadian water quality guidelines for the protection of aquatic life: Chloride.

ecosystems during extended exposures lasting more than 7 days.

Fortunately, none of the freshwater lakes monitored between 2022 to 2024 exceeded the CCME short-term exposure limit for dissolved chloride (more than 640 mg/L). Unfortunately, there were nine lakes whose average deepwater chloride levels exceeded the long-term CCME FWAL guideline of ≥120mg/L, including five lakes whose deepwater chloride levels were above the guideline during every monitoring event. As chloride does not break down in the environment, the persistently high levels of dissolved chloride observed in these lakes likely indicates a consistent exceedance of the long-term CCME FWAL guideline over the three-year period. Another seven lakes had average deepwater chloride values more than 8x what could be expected naturally (more than 80 mg/L), but just below the long-term CCME guideline (Table 2).

Table 2. Summary of the 16 Freshwater Lakes with Deepwater Dissolved Chloride values that exceed or approach the CCME FWAL long-term exposure guideline (**BOLD** indicates exceedance ≥120 mg/L).

	2022		2023		2024		
Lake Name	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**'22 – '24 Average**
1. Lake Banook	**240**	**240**	**180**	**200**	**180**	**180**	**203.3**
2. Lovett Lake	**260**	**200**	**270**	**190**	**150**	**150**	**203.3**
3. Lake Micmac	**240**	**220**	**220**	**120**	**170**	**160**	**188.3**
4. Russell Lake	**220**	**180**	**190**	**170**	**160**	**150**	**178.3**
5. Oat Hill Lake	**190**	**160**	**180**	**170**	**180**	**180**	**176.7**
6. Bayers Lake	**190**	**170**	**170**	76	110	**130**	**141.0**
7. Governor Lake	**150**	**150**	**120**	**120**	110	110	**126.7**
8. Penhorn Lake	**140**	**130**	**130**	**130**	110	110	**125.0**
9. First Lake	**140**	**140**	**120**	**120**	110	110	**123.3**
10. Bissett Lake	**140**	110	**150**	100	96	95	115.2
11. Settle Lake	**150**	**130**	110	57	100	110	109.5
12. Albro Lake	110	110	100	86	92	110	101.3
13. Cranberry Lake	**160**	110	**120**	44	86	83	100.5
14. Chocolate Lake	57	**160**	**120**	89	74	70	95.0
15. Maynard Lake	91	94	87	89	88	78	87.8
16. Morris Lake	100	93	90	69	73	72	82.8

As illustrated by Table 2 (above), there is a clear trend linking lakes with the highest levels of dissolved chloride being located in some of the most densely developed areas of the municipality, such as the Dartmouth core and Bayer's Lake business district. In comparison, lakes with protected watersheds (e.g. Topsail Lake - 13 mg/L and Bell Lake – 10.8 mg/L) and those located in less developed areas (e.g., Kidston Lake – 6.3 mg/L, Wrights Lake – 6.3 mg/L, and Lake Echo – 7.7 mg/L) tended to have some of the lowest levels of dissolved chloride over the same time period.

Development usually increases runoff and stormwater to lakes by replacing natural, porous groundcover with impervious surfaces like roads and buildings that prevent water from soaking into the soil. This forces rainwater to flow directly into storm drains, where it can pick up and dissolve contaminants such as road salt along the way. Without any intervention, this often results in a larger volume of now polluted stormwater that reaches lakes more quickly and in greater quantities. Other recent studies have also linked many lakes in HRM, often those with the most developed watersheds, with dissolved chloride concentrations regularly above the long-term CCME FWAL guideline[15 & 16]. Collectively, these findings highlight what is a relatively overlooked, but increasingly chronic stressor negatively impacting some of HRM's most high-value recreational lakes.

Bacteria Contamination

Bacterial contamination of a lake refers to the presence of water-borne microorganisms that can cause illness to humans. The source of these illness-causing microorganisms is the digestive system of warm-blooded animals such as humans, dogs, birds, and other wildlife. So, when these pathogens are detected, it almost always indicates that a source of fecal material, be it human or animal, is reaching a lake. In freshwater environments, *E. coli* is used as an indicator of fecal contamination, for brackish or marine settings, fecal enterococci is also assessed. All lakes monitored by the LakeWatchers Program are assessed for bacterial contamination by testing for *E. coli*, while only Porters Lake, due to its brackish waters, is also tested for fecal enterococci.

Fecal bacteria, such as *E. coli* and enterococci, are measured in 'colony forming units' per 100 ml of water (CFU/100ml) and the Health Canada *Guidelines for Canadian Recreational Water Quality* (2024)[17] indicates that for primary contact activities, such as swimming, *E. coli* levels should be less than 235 CFU/100ml, and enterococci levels should be less than 70 CFU/100ml.

Between 2022 and 2024, there were only 8 exceedances of the HC Guideline for *E. coli* detected from a total of 760 samples collected, a rate of approximately 1% of the time, and there were no exceedances for fecal enterococci detected (Table 3). There is a strong seasonal pattern in the data, as most of these exceedances (7 of 8) were detected during the summer sampling periods. In contrast, over 70% of lakes had non-detectable levels of *E.coli* (less than 2.0 CFU/100ml) during the spring sampling events of 2022 and 2023. Consequently, starting in 2024, *E. coli* sampling in the spring was suspended and efforts are now focused on the summer sampling period when conditions for bacterial growth are more favourable and more residents are engaged in recreational activities at lakes. Nevertheless, even during the summer monitoring periods *E. coli* levels for most monitored lakes remained quite low, with many still registering *E.coli* levels below detectable levels (less than 2.0 CFU/100ml) (Table 3).

Table 3. Summary of *E. coli* detection rate and exceedances between 2022 to 2024

Monitoring Period	% Below Detectable Levels for *E. coli* (less than 2.0 CFU/100ml)	Exceedances of the Health Canada *Guidelines for Canadian Recreational Water Quality* for *E. coli* (more than 235 CFU/100ml)
Spring 2022	75.0%	None
Summer 2022	22.7%	Bell Lake (Outlet – 340 CFU/100ml) Springfield Lake (Outlet – 290 CFU/100ml)
Spring 2023	72.7%	Sandy Lake (Outlet – 250 CFU/100ml)
Summer 2023	13.0%	Lovett Lake (Outlet – 500+ CFU/100ml) Lovett Lake (Surface – 500+ CFU/100ml) Kidston Lake (Surface – 250 CFU/100ml)
Spring 2024	-	Not collected (Spring *E.coli* sampling is suspended)

[16] Bermarija, T. et al. 2023. Assessing and predicting Lake Chloride Concentrations in the Lake-Rich Urbanizing Halifax Region, Canada.
[17] Health Canada. 2024. Guidelines for Canadian Recreational Water Quality

Summer 2024	26.0%	Russell Lake (Surface – 330 CFU/100ml) Albro Lake (Outlet – 260 CFU/100ml)

However, while there have been relatively few exceedances for *E.coli* detected by the LakeWatchers Program, the Municipal Beach Monitoring Program has seen a dramatic increase in the number and length of supervised beach closures and water quality advisories issued due to unsafe levels of *E. coli*. Since the Municipality began tracking beach closures and advisories in 2015, four of the five years with the highest beach closure rates have occurred since 2021. Moreover, the number of beach days under water quality advisories has risen dramatically over time from 3% in 2019 to 11% in 2024. The highest rate of water quality advisories issued was in 2023 when supervised beaches were under a water quality advisory ~20% of the time.

Fortunately, the very low number of detected exceedances for *E. coli* over a three-year period (2022-2024) of LakeWatchers monitoring suggests that bacterial contamination of Halifax-area lakes does not appear to be widespread and only rarely poses a risk to human health. Instead, the growing issue of bacterial contamination and high fecal bacteria levels at municipal supervised beaches appears to be mostly related to contamination sources originating from the shoreline and near-shore environment. If a contamination source is present at a beach area, *E. coli* and other fecal pathogens can multiply and grow rapidly in the warmer, shallower water closer to the shoreline and quickly create unsafe conditions for swimmers. Additionally, shallow beach sediments will often act as a reservoir for *E. coli* and other fecal pathogens which can become resuspended into the water column by swimmers and other beach users, or even by natural events, such as heavy rainfall or strong winds.

Potential contamination sources at municipal beach locations include the improper disposal of canine fecal waste at parks and around beaches, the preferential use of beach areas by waterfowl (e.g. ducks and Canada geese), and municipal stormwater outfalls discharging near a beach area or other sources of stormwater runoff, to name a few. Current management methods for reducing fecal contamination at supervised beaches include an annual Standing Offer for both waterfowl waste raking and removal, as well as a nuisance wildlife contractor that operates on an as-needed basis to deter waterfowl. These more reactive measures could be augmented by corrective green infrastructure solutions installed at or near municipal beaches to naturalize and restore shorelines, better capture stormwater runoff, prevent erosion, and further deter waterfowl loitering. Naturalization efforts will help improve fecal bacteria concentrations at municipal supervised beaches, as well as have an overall positive impact on lake water quality. To date, two shoreline restoration projects have been installed at Birch Cove beach (Lake Banook) and Penhorn Lake beach through the Naturalization Strategy[18].

Recommendations

The data and findings provided by the LakeWatchers Program have largely supported the findings of previous studies and suggest that many Halifax-area lakes are at increased risk of eutrophication and likely also suffer from some level of chloride enrichment. While the LakeWatchers' data indicate that the open-water areas of local lakes generally maintain safe *E. coli* levels, the Municipal Beach Monitoring Program has experienced a dramatic increase in the number and length of closures and water quality advisories due to unsafe levels of *E. coli* over a similar time period.

The water quality concerns discussed in this report are mostly connected to how stormwater is managed and delivered to lakes. Unsurprisingly, the issue is most pronounced in densely developed areas of the municipality that have a high percentage of impervious, paved surfaces, such as asphalt or concrete. Whenever it rains on these areas, water is unable to soak into the ground and instead moves as 'runoff' picking up excess nutrients, salts, and other contaminants from roadways and other paved surfaces. This now polluted flow of runoff is then collected by the municipal stormwater system before being directly

[18] Naturalization Strategy

discharged to nearby lakes and streams without any treatment at all.

In 2024, staff made three recommendations[19] aimed at mitigating the impact of this regular, untreated flow of nutrients, salts and other contaminants currently being delivered to our lakes whenever it rains. All three recommendations were passed. The first of these recommendations was to initiate a review of the municipality's current Salt Management Plan which had been last updated in 2011. This work has now been contracted out by Public Works. The second recommendation was to investigate policy options for setbacks of new stormwater discharge locations into lakes and consider options for naturalization at existing stormwater discharge locations on selected priority lakes. At present, staff have developed a methodology to identify high-impact stormwater discharge locations for potential naturalization solutions for priority lakes. Staff will continue to pursue this work in 2026-2027, in collaboration with Planning and Development. Lastly, the third recommendation was to signal the Municipality's support for the adoption of provincial stormwater quality standards, which the Province had committed to implementing by 2026. In a letter dated January 20, 2025, Mayor Andy Filmore, on behalf of Halifax Regional Municipality, expressed the Municipality's full support for the development and release of provincial water quality objectives (WQOs), including WQOs for stormwater.

To continue to address the key water quality concerns facing our lakes, staff now recommend that the Environment & Sustainability Standing Committee recommend that Halifax Regional Council direct the Chief Administrative Officer to:

1. Direct staff to add the supervised beaches at Kidston Lake, Long Pond, Penhorn Lake, Albro Lake, Birch Cove (Lake Banook), Lake Echo, Springfield Lake, and Kearney Lake to the Naturalization Program.
2. Direct staff to explore shoreline and in-lake green infrastructure options for addressing stormwater discharge locations within 100 m of supervised beaches.

FINANCIAL IMPLICATIONS

Recommendation 1

Lead Department: Parks and Recreation

The Naturalization Strategy is currently funded through the HalifACT capital account CZ230700.

Council direction to add these 8 sites (as outlined in recommendation 1) to the strategy will allow Parks to incorporate them into annual planning for the Naturalization Strategy. In 2026-27, work is planned to take place at Albro Lake with an estimated cost of $50,000 and will come out of CZ230700.

Planning for the additional sites will take place during Parks and Recreation's future business planning process and be implemented through Parks operating budget starting in 2027-28. Each site will cost between $30,000 - $50,000 and 1-2 sites will be completed each year.

Recommendation 2

Lead: Environment and Climate Change

In 2026-27, staff will explore shoreline and in-lake green infrastructure options at Lake Banook and Penhorn Lake. The total cost for the two projects at Lake Banook and Penhorn Lake is expected to be $100,000 and will be completed over 2 years. In 2026-2027, staff will complete the design for the two

[19] LakeWatchers Water Quality Monitoring Program Report 2022-2023

sites at a cost of $50,000. Once design work is complete the projects will be implemented in 2027-28 at cost of $50,000. Costs for these two projects will come from Environment and Climate Change's operating budget D935.

RISK CONSIDERATION

The risks associated with implementing the proposed recommendations in this report are very low.

By selecting low-impact, nature-based solutions, often designed as vegetation restoration in places where it has previously been lost, we can ensure a low-risk approach with minimal disturbance. Furthermore, by implementing the proposed recommendations at or near municipal supervised beaches it is likely to reduce bacterial risk to residents and decrease instances of high fecal bacteria counts at supervised beaches.

COMMUNITY ENGAGEMENT

Community engagement and participation are core to the LakeWatchers Program as volunteers and community groups are encouraged to actively take part and conduct water quality sampling on Halifax-area lakes.

ENVIRONMENTAL IMPLICATIONS

The proposed recommendations are aimed at improving lake water quality and are focused on preserving the current recreational uses at municipality owned supervised beaches. If implemented, data collected through both the LakeWatchers, and the Beach Monitoring programs will be able to assess if water quality conditions improve over time. If not implemented, the current recreational value of some municipal supervised beaches may continue to decline with time, which is likely to result in increasingly costly management solutions or the permanent closure of some sites as supervised beaches.

LEGISLATIVE AUTHORITY

Halifax Regional Municipality Charter, 2008 SNS, c 39:

7A The purposes of the Municipality are to (a) provide good government; (b) provide services, facilities and other things that, in the opinion of the Council, are necessary or desirable for all or part of the Municipality; and (c) develop and maintain safe and viable communities.

79A (1) Subject to subsections (2) to (4), the Municipality may only spend money for municipal purposes if (a) the expenditure is included in the Municipality's operating budget or capital budget or is otherwise authorized by the Municipality; (b) the expenditure is in respect of an emergency under the Emergency Management Act; or (c) the expenditure is legally required to be paid.

Part VIII Planning and Development

Policy E-24 Regional Municipality Planning Strategy:

HRM may consider preparing a water quality monitoring protocol to provide guidance for water quality monitoring plans accepted by HRM under clause (n) of policy E-23 and any other monitoring programs to be undertaken for HRM by landowners.

ALTERNATIVES

That the Environment & Sustainability Standing Committee:

1. Refuse to recommend to Halifax Regional Council to direct the CAO to direct staff to add the supervised beaches at Kidston Lake, Long Pond, Penhorn Lake, Albro Lake, Birch Cove (Lake Banook), Lake Echo, Springfield Lake, and Kearney to the Naturalization Strategy.
2. Refuse to recommend to Halifax Regional Council to direct the CAO to direct staff to explore shoreline and in-lake green infrastructure options for addressing stormwater discharge locations within 100m of supervised beaches.

ATTACHMENTS

Attachment A State of the Lakes Report 2022-24
Attachment B 2024 Beach Season Water Quality Report

A copy of this report can be obtained online at halifax.ca or by contacting the Office of the Municipal Clerk at 902.490.4210.

Report Prepared by: Chris Kennedy, Water Quality Monitoring Program Coordinator, Property, Fleet & Environment 902-476-1853

ATTACHMENT A

LakeWatchers State of the Lakes Report

Monitoring Years 2022-2024

Report Prepared by: Chris Kennedy, Water Quality Monitoring Program Coordinator, Property, Fleet & Environment 902-476-1853

Glossary

Anoxic conditions describe an aquatic environment with little or no dissolved oxygen. For the purposes of this report, anoxic refers to conditions below 1.0 mg/L dissolved oxygen.

Baseline conditions refer to the current-day conditions that are now being established with the data collected through the LakeWatchers program. Once established, these baseline conditions will represent an initial condition against which any later changes or trends can be measured against.

Chlorophyll-α (chl-α) and other chlorophylls are green pigments that allow plants and algae to complete photosynthesis, the process of making energy from sunlight, carbon and water. Chlorophyll-α is the most abundant type of chlorophyll used by algae and cyanobacteria. It can be used to estimate the quantity of these organisms in a lake, as well as to identify a trophic state.

Colony-forming unit (CFU) is a measure of the number of viable bacteria in a sample and represents the number of cells capable of multiplying under lab-controlled conditions.

Enteric pathogens are harmful bacteria, viruses and parasites that can infect the gastrointestinal tract of humans resulting in illness. Common examples of enteric pathogens include *E. coli*, salmonella, giardia and norovirus.

Freeze-thaw event refers to when temperatures alternate between freezing and thawing, causing ice and snow on roads to melt, before re-freezing. These events often require the re-application of de-icing salts to maintain road safety.

Headwater lake is a lake located at or near the source (headwaters) of a river or stream. These lakes are almost always the most elevated lake from sea level within their watersheds and often represent the starting points for river systems.

Hypolimnetic anoxia refers to the near complete depletion of dissolved oxygen (less than 1.0 mg/L) in the deepest water layer (hypolimnion) of a lake during thermal stratification.

Impervious surfaces are those such as roads, rooftops, parking lots and any other hard surfaces that can prevent rainwater from soaking into the ground, instead causing it to run-off, mobilizing and carrying contaminants and pollutants into local waterways.

Internal loading is a process that occurs in lakes and reservoirs when nutrients or other contaminants are re-introduced into the water from the lake sediment. Along with external loading, when nutrients or contaminants come from terrestrial sources, internal loading can lead to lake eutrophication and cause other contaminants to re-mobilize back into the lake's water.

Meromixis is a condition in which a lake does not mix completely. Most lakes follow a seasonal cycle of stratification and natural mixing (see Figure 2), however, lakes subject to meromixis generally have upper layers that mix seasonally, and a lower layer that remains isolated and de-oxygenated.

Non-point source pollution originates from numerous and widespread sources, such as runoff from urban and suburban areas, agricultural fields and construction sites, making it difficult to pinpoint a single source. Non-point source pollution is harder to control because of the difficulty in identifying and targeting specific sources.

Point source pollution originates from a single, identifiable and easily tracked location, such as a wastewater treatment plant outfall or factory discharge pipe. Point sources are often regulated and require permits to discharge pollutants into natural water bodies.

Run-off is any water, either from rain or outdoor water use, that flows overland and doesn't soak into the ground, instead often flowing directly into lakes and streams.

Spring turnover is a natural process where a lake's water layers mix together, re-distributing dissolved oxygen and nutrients equally throughout. It is driven by warming spring temperatures and wave action following the melt of winter ice cover.

Stormwater run-off is run-off that mostly originates from streets, rooftops, parking lots and other impervious surfaces that is able to carry contaminants like salts and nutrients and pollutants like oil and heavy metals to lakes and streams. Most stormwater run-off is collected and discharged through municipal stormwater systems.

Summer stratification describes a process where lakes develop distinct layers based on temperature and density during the summer months.

Tannins are naturally occurring chemicals that can give lake water a tea-colored appearance. Tannins are found in many plants and can leach out of living and decaying plant matter into groundwater, lakes, rivers and streams. Although they can make the water slightly more acidic, it is important to note that tannins are not harmful to humans, fish or wildlife.

Trophic state/status is a measure of the nutrient levels and biological productivity of a lake. It indicates how much living biological material, such as algae and aquatic plants, can be produced in the ecosystem (see Table 1).

Purpose

The purpose of the LakeWatchers program is to establish current ***baseline conditions*** for Halifax-area lakes related to three key water concerns: eutrophication, chloride enrichment, and bacterial contamination. Over time, the ongoing monitoring of local lakes combined with a robust baseline dataset will provide a reliable source of data that can inform how to best tackle and manage existing concerns, proactively address arising issues at vulnerable lakes, and provide a mechanism to assess the effectiveness of any mitigation measures implemented.

Volunteer Acknowledgement & Appreciation

Without the help and dedication of the many volunteers who contributed to the LakeWatchers program this report would not be possible. The LakeWatchers program is proud to acknowledge the contributions of the many volunteers who have participated in the collection of the data presented in this report.

Community participation in the LakeWatchers program has grown steadily over its first three years of operation and in 2024, over 40 lakes are now regularly monitored by volunteers and community groups.

Introduction

The Halifax Regional Municipality contains over one thousand lakes. Our lakes are an invaluable resource, providing a clean water supply, opportunities for outdoor recreation and relaxation, as well as providing crucial habitat for the region's wildlife, supporting both aquatic and terrestrial biodiversity.

Urban and suburban development within the municipality often imposes various stressors on lakes and their surrounding watersheds. This makes careful environmental planning and management necessary to maintain an acceptable level of lake water quality across the region. While lake management is a shared responsibility between all levels of government, the private sector and community stakeholders, the municipality recognizes that it has an important role to play.

Proper lake management requires an understanding of the processes that control lake water quality and a baseline assessment of the existing contaminants within lakes and their possible origins. This is where LakeWatchers comes in. Previously, water quality monitoring initiatives conducted by the municipality were completed in response to water quality issues as they arose (e.g., the First Lake Pollution Study, Lake Micmac & Lake Banook Pollution Control Study and related nuisance aquatic weeds removal, request for a Kearney Lake management plan, and so on). In contrast, LakeWatchers seeks to establish a long-term dataset of ***baseline conditions*** to address key concerns in lake water quality and provide ongoing monitoring so that trends can be identified proactively.

The LakeWatchers program is a community-based water quality monitoring program established by the municipality in 2022. It is a hybrid program that works with consultants, volunteers and local lake associations to monitor over 70 lakes across the municipality bi-annually.

This report gives an overview of the current state of our lakes based on the most recently collected data from the 2024 monitoring year and provides recommendations for the LakeWatchers program.

The previous 2022-2023 State of the Lakes report is available at www.halifax.ca/lakewatchers.

Key Water Quality Concerns

Human activities and land development can significantly impact the water quality of lakes. Most types of development increase ***impervious surfaces***—such as roads, rooftops and parking lots—which prevent rainwater from being absorbed into the ground. Instead, this water 'runs off', carrying pollutants like salts, nutrients and other contaminants into lakes and urban waterways.

To address these concerns, LakeWatchers was established to monitor water quality issues resulting from land-use practices that affect the ability of lakes to provide essential services. The municipality can mitigate these impacts through municipal policies, land-use by-laws, and strategic community planning and programming.

Three key water quality concerns were identified through community consultation, and collaboration with local and regional water resource managers (AECOM 2020). These concerns include:

- eutrophication
- chloride enrichment (salinization)
- bacterial contamination

The following sections provide an overview of these key water quality issues, their effects on recreation and ecological health and the potential impacts of climate change on lakes within the municipality. For more information on lake health and water quality, refer to **DataStream's Water Quality Guide** or the **Atlantic Water Network's Knowledge Hub**.

Eutrophication

Eutrophication refers to a process through which a lake becomes enriched with nutrients causing an increase in aquatic plant and algae growth. In temperate, freshwater lakes, such as those found within the HRM, phosphorus is generally considered to be most important nutrient for managing the amount of aquatic plant and algae growth (Janus and Vollenweider 1981; Vollenweider and Kerekes 1982). To put it simply, the more phosphorus there is in lake water, the more plants and algae there will be.

Many human activities on land can increase phosphorus levels in lakes. These include ***point sources*** such as wastewater treatment plants and combined sewer overflows, but also less obvious ***non-point sources***, such as failing septic systems, overland flow or ***stormwater run-off*** carried to lakes by stormwater infrastructure.

Eutrophication usually results in substantial changes to the amount of aquatic plants and algae that can thrive in a lake system. These changes often directly reduce water quality for human use and can also negatively impact native fish populations and fish habitat. Areas of concern for the region's lakes include:

- interference to boating and swimming caused by excessive plant and algae growth in nearshore and shallow areas
- health hazards to swimmers and other water users caused by potentially toxin-producing cyanobacteria
- reduced fishing opportunities caused by long-term deep-water oxygen loss, and in extreme situations, possibly even fish kills
- poor aesthetics due to reduced water clarity and possible odour issues

In Canada, the Canadian Council of Ministers of the Environment (CCME) have developed national guidelines for eutrophication management which rely on Total Phosphorus (TP) as the key indicator of ***trophic state*** in freshwater systems (CCME 2004). Using this guideline, the concentration of TP can be used to estimate the ***trophic state*** of a given lake.

Similarly, the North American Lake Management Society (NALMS 1996) has published guidelines which use the concentration of ***chlorophyll-α*** (***chl-α***) to estimate ***trophic status***.

These ***trophic states***, their expected TP or ***chl-α*** concentration ranges and the anticipated lake conditions that accompany them are summarized in Table 1.

Table 1. Summary of Trophic States, expected TP and chl-α ranges, and anticipated lake conditions

Trophic State	Expected TP range (CCME 2004)	Expected chl-α range (NALMS 1996)	Anticipated lake conditions*
Ultra-oligotrophic	< 4 µg/L	< 0.95 µg/L	Clear water with very few aquatic plants. Usually well oxygenated throughout, even deep stratified layers, such that salmonids (e.g. trout) can survive in deeper, cooler water.
Oligotrophic	4 to 10 µg/L	0.95 to 2.6 µg/L	
Mesotrophic	> 10 to 20 µg/L	> 2.6 to 7.3 µg/L	Moderately clear water with varying degrees of aquatic plant growth. Increasing probability of deep-water oxygen loss during summer results in the likely loss of salmonids. Invasive smallmouth bass and chain pickerel may dominate.
Meso-eutrophic	> 20 to 35 µg/L	> 7.3 to 20 µg/L	
Eutrophic	> 35 to 100 µg/L	> 20 to 56 µg/L	Low water clarity and nuisance aquatic plant growth may discourage swimming and boating. Harmful cyanobacteria blooms and deep-water oxygen loss during the summer becomes likely. Invasive smallmouth bass and chain pickerel are likely to dominate.
Hyper-eutrophic	> 100 µg/L	> 56 µg/L	Murky water with poor water clarity is likely to discourage recreational activities. Aquatic plants and algae may cover large areas of the lake's surface. Deep-water oxygen loss during the summer and fish kills are possible. Harmful cyanobacteria

			blooms are likely (detected or not). Invasive smallmouth bass and chain pickerel are likely to dominate.

*Adapted from A Coordinator's Guide to Volunteer Lake Monitoring Methods (North American Lake Management Society – Carlson and Simpson 1996).

Chloride Enrichment

Chloride enrichment, or salinization, is the process of increasing concentrations of dissolved chloride (Cl) in freshwater systems beyond what occurs naturally. Once released into the environment, chloride does not break down. This can result in the chloride concentrations in lakes increasing over time and remaining at a high level long after its initial introduction.

According to the CCME (2011), naturally occurring chloride concentrations in lakes within the Atlantic region, including Nova Scotia, are normally less than 10 mg/L. However, in urban environments that experience ***freeze-thaw events***, chloride concentrations in lakes can become elevated due to the use of de-icing and anti-icing salts for winter road safety. Road salt, usually sodium chloride (NaCl), and other treatments used on ***impervious surfaces*** to melt snow and ice can result in salty urban **run-off** which can negatively impact freshwater bodies, such as lakes, rivers, and streams.

Elevated concentrations of dissolved chloride beyond what would occur naturally can be harmful to many aquatic species including fish, turtles, amphibians, plants and invertebrates. These organisms are all adapted for life in freshwater, so if chloride levels become too high it can disrupt their ability to thrive and survive. As a result, some species may struggle, decline or even disappear, leading to shifts in the biological community and a reduction in the overall biodiversity of the ecosystem (CCME 2011).

The CCME *Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL)* provides guideline values that are designed to protect aquatic life from elevated concentrations of dissolved chloride in both the 'long-term' and 'short-term'.

The short-term exposure limit is 640 mg/L and is intended to protect against lethal exposure during severe but short-lived events. The long-term exposure limit is 120 mg/L and is intended to protect aquatic life against the persistent negative impacts of chloride to the freshwater aquatic ecosystem over consistent, extended exposures (CCME 2011). (In the context of these guidelines, "long-term" refers to an exposure period of longer than seven days.)

In extreme cases, chloride enrichment can disrupt or even prevent lakes from completing their natural, seasonal mixing cycle. This condition, known as ***meromixis***, can lead to prolonged periods of low or no dissolved oxygen in the lower depths of a lake. This can dramatically limit the availability of habitat for fish and other aquatic organisms, as they require oxygen to breathe and carry out their life functions.

Low oxygen levels at the lakebed can also result in the release of nutrients and other pollutants bound to sediments. This process, known as ***internal loading,*** can increase the risk of eutrophication and allow for the release of potentially harmful contaminants back into a lake's water column.

Bacterial Contamination

Bacterial contamination of freshwater bodies refers to the detectable presence of micro-organisms such as bacteria, viruses and parasites that can cause intestinal illness (i.e. ***enteric pathogens***). The presence of ***enteric pathogens*** almost always indicates that fecal material is reaching the waterbody.

There has been increasing concern over the number and length of municipal beach closures and advisories in recent years because of detected levels of *E. coli* exceeding the Health Canada *Guidelines for Canadian Recreational Water Quality*.

Since 2015, the municipality has tracked how many days supervised beaches are open each summer. Four of the five years with the highest closure rates have occurred since 2021. On average, during the supervised period from July 1 to August 31, beaches were open only 80% of the time in 2023 and 89% in 2024.

The degree of risk posed by ***enteric pathogens*** varies between sources of fecal contamination. For instance, human sources carry the highest concentrations of infectious enteric bacteria, viruses and parasites. Non-human sources of fecal contamination like canine waste or bird droppings pose a lower risk. Nevertheless, the Health Canada Guidelines for Canadian Recreational Water Quality (2023) recommends issuing swimming advisories when E. coli in fresh water used for recreation is greater than 235 ***colony forming units*** (CFU) per 100 milliliters (ml).

Lakes may become impacted by fecal material containing ***enteric pathogens*** from numerous sources, including:

- discharged sewage
- treated and untreated wastewater effluent
- stormwater run-off from urban, suburban and agricultural areas
- industrial processes
- wild or domesticated animal droppings
- fecal shedding by swimmers

Monitoring Program

Currently, the LakeWatchers program monitors over 70 freshwater lakes, and one tidal lake (Figure 1). Three reference lakes are included, which are intended to serve as benchmarks for natural conditions. These reference lakes are relatively unaffected by current local land uses and are unlikely to be impacted due to their isolation or the protection of their watershed(s). A complete list of monitored lakes, sampling coordinates, and approximate maximum lake depths is provided as Appendix A.

The LakeWatchers program conducts lake monitoring in early spring (i.e. April and May) and late summer (i.e. August and September) (Table 2). This provides data for each monitored lake during two important lake phases; i) following the ***spring turnover*** when lakes are mixed and ii) during the ***summer stratification*** period when lakes may be thermally stratified (Figure 2).

Monitoring includes collecting lake water samples for laboratory analysis, as well as measuring physical parameters like temperature, pH, dissolved oxygen and specific conductance (SPC) directly in the field using a handheld water quality meter.

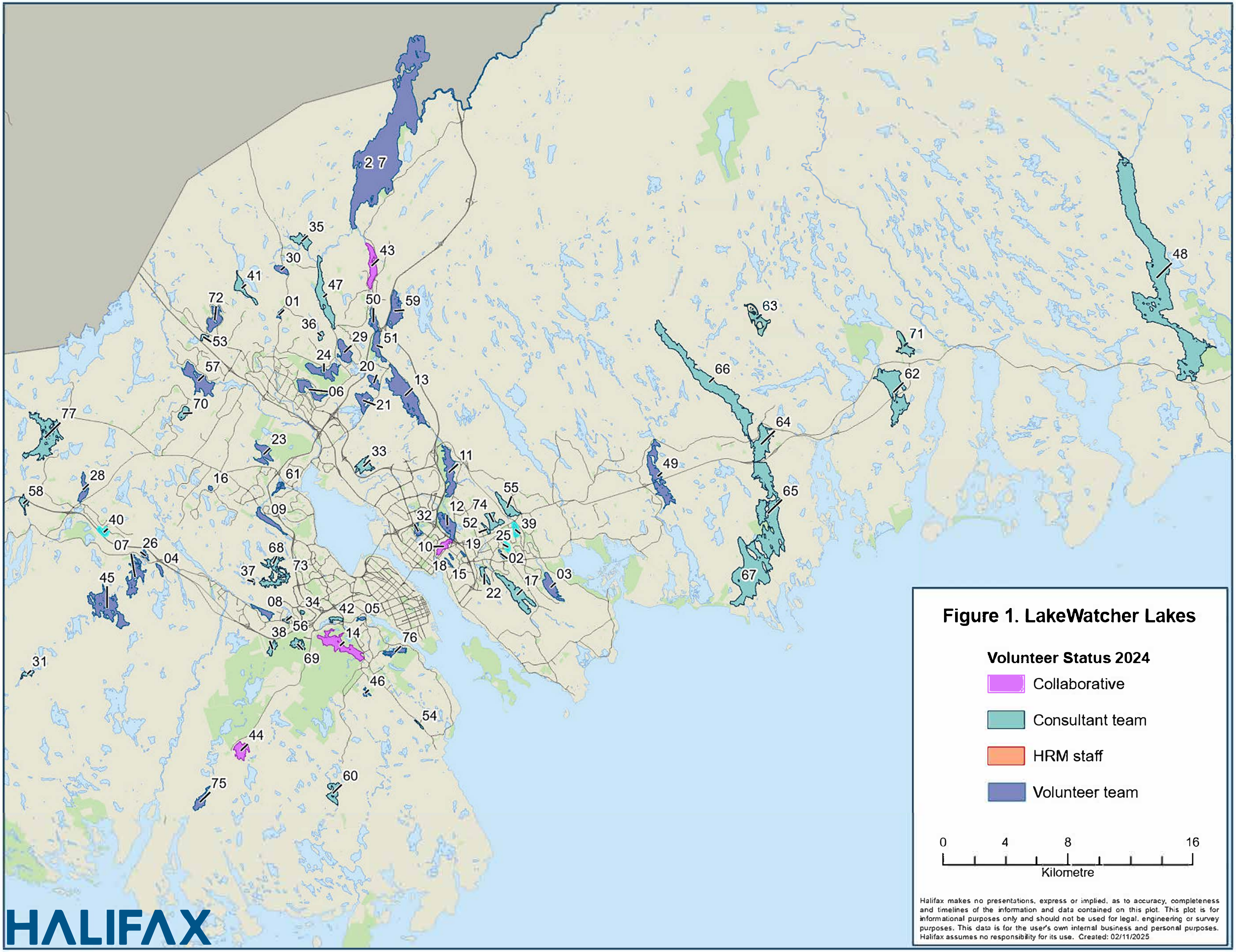

Figure 1. LakeWatcher Lakes

Number	Lake Name	Volunteer Status 2024	Number	Lake Name	Volunteer Status 2024
01	Barrett Lake	Volunteer team	40	Elbow Lake	HRM staff
02	Bell Lake	Volunteer team	41	Fenerty Lake	Consultant team
03	Bissett Lake	Volunteer team	42	First Chain Lake	Consultant team
04	Black Point Lake	Volunteer team	43	Fletchers Lake	Collaborative
05	Chocolate Lake	Volunteer team	44	Hatchet Lake	Collaborative
06	First Lake	Volunteer team	45	Hubley Big Lake	Volunteer team
07	Five Island Lake	Volunteer team	46	Kidston Lake	Volunteer team
08	Governors Lake	Volunteer team	47	Kinsac Lake	Consultant team
09	Kearney Lake	Volunteer team	48	Lake Charlotte	Consultant team
10	Lake Banook	Collaborative	49	Lake Echo	Volunteer team
11	Lake Charles	Volunteer team	50	Lake Thomas (North Basin)	Volunteer team
12	Lake MicMac	Volunteer team	51	Lake Thomas (South Basin)	Volunteer team
13	Lake William	Volunteer team	52	Lemont Lake	Consultant team
14	Long Lake	Collaborative	53	Little Springfield Lake	Consultant team
15	Maynard Lake	Volunteer team	54	Long Pond	Consultant team
16	McQuade Lake	Volunteer team	55	Loon Lake	Consultant team
17	Morris Lake	Consultant team	56	Lovett Lake	Consultant team
18	Oat Hill Lake	Volunteer team	57	McCabe Lake	Volunteer team
19	Penhorn Lake	Volunteer team	58	Mill Lake	Consultant team
20	Powder Mill Lake	Volunteer team	59	Miller Lake	Volunteer team
21	Rocky Lake (North East Basin)	Volunteer team	60	Moody Lake	Consultant team
22	Russell Lake	Consultant team	61	Paper Mill Lake	Volunteer team
23	Sandy Lake (Bedford)	Volunteer team	62	Petpeswick Lake	Consultant team
24	Second Lake	Volunteer team	63	Pine Lake	Consultant team
25	Settle Lake	HRM staff	64	Porters Lake (Middle North)	Consultant team
26	Sheldrake Lake	Volunteer team	65	Porters Lake (Middle South)	Consultant team
27	Shubenacadie Grand Lake	Volunteer team	66	Porters Lake (North)	Consultant team
28	Stillwater Lake	Volunteer team	67	Porters Lake (South)	Consultant team
29	Third Lake	Volunteer team	68	Quarry Lake (Birch Cove)	Consultant team
30	Tucker Lake	Volunteer team	69	Ragged Lake	Consultant team
31	Albert Bridge Lake	Consultant team	70	Sandy Lake (Glen Arbour)	Consultant team
32	Albro Lake	Volunteer team	71	Scots Lake	Consultant team
33	Anderson Lake	Consultant team	72	Springfield Lake	Volunteer team
34	Bayers Lake	Consultant team	73	Susies Lake (Birch Cove)	Consultant team
35	Beaver Bank Lake	Consultant team	74	Topsail Lake	Consultant team
36	Beaver Pond	Consultant team	75	Whites Lake	Volunteer team
37	Big Cranberry Lake	Consultant team	76	Williams Lake (Spryfield)	Volunteer team
38	Blueberry Lake	Consultant team	77	Wrights Lake	Consultant team
39	Cranberry Lake	HRM staff			

Water quality samples collected for laboratory analysis are analyzed for parameters that address the three key water quality concerns identified earlier (eutrophication, chloride enrichment and bacterial contamination). Total Phosphorus (TP) and ***chl-α*** are assessed to investigate eutrophication risk. Dissolved chloride is assessed to investigate chloride enrichment risk. Finally, *E. coli* levels are assessed to investigate issues regarding bacterial contamination.

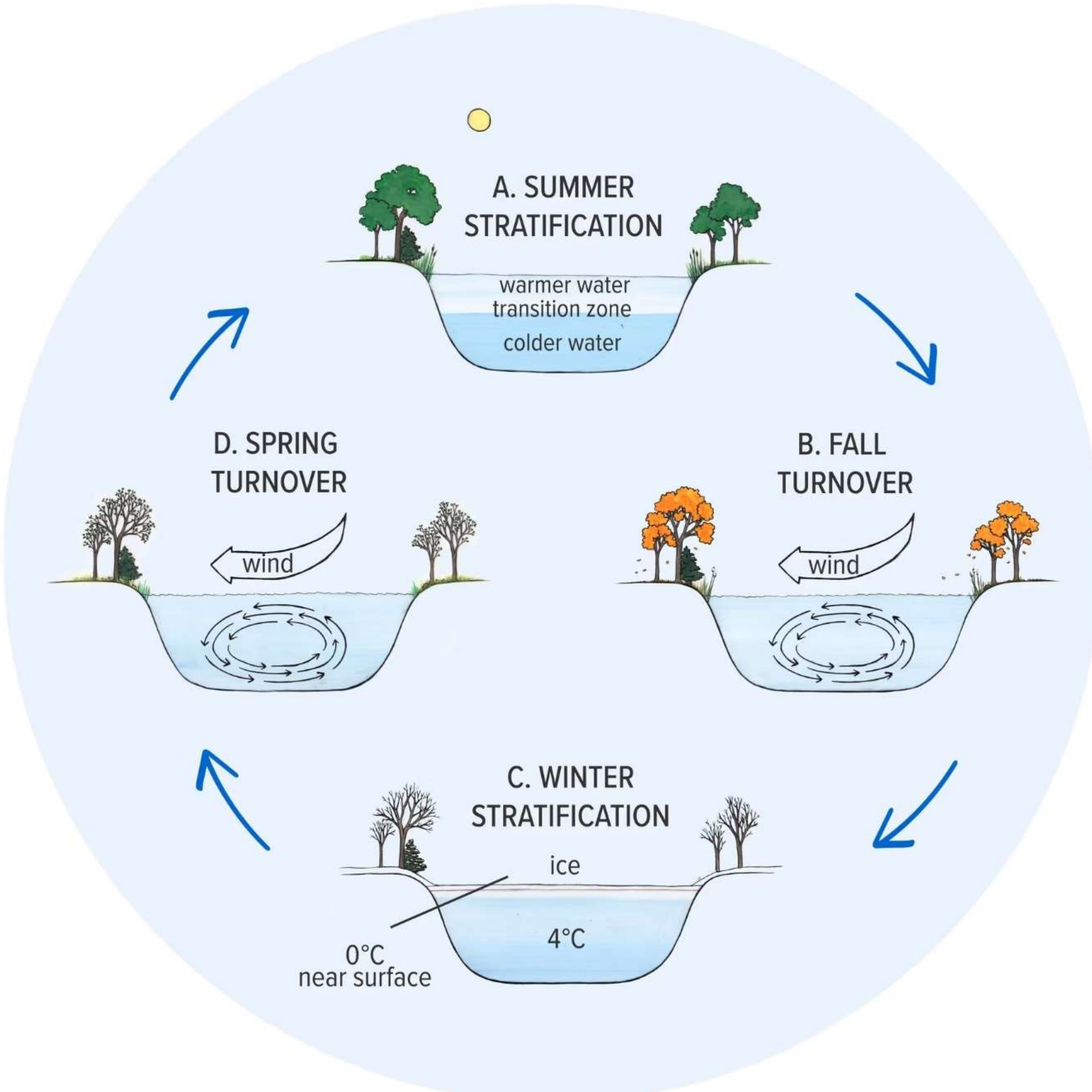

Figure 2. Seasonal Lake Mixing for a Typical Lake - Illustration provided courtesy of Atlantic DataStream (https://datastream.org/en-ca/)

Field Results

The following sections detail the results of the field measurements collected as part of the LakeWatchers program. The results are presented in terms of the entire dataset and when possible, values are assessed against relevant federal guidelines and other benchmarks. Accompanying lake data for individual lakes is provided as fact sheets in **Appendix B**.

Secchi Depth

Secchi depth is a measure of water clarity or water transparency. It is measured as the depth at which a Secchi disc is no longer visible when lowered into water from the shaded side of a boat, and the point at which it reappears after raising it (Figure 3). Secchi depth measurements can be used to estimate the amount of algae in the water because algal particles block light in the water column. Deeper Secchi depth measurements may indicate less algae, while shallower Secchi depth measurements can indicate more algae.

However, other things like suspended sediments, ***tannins*** and any other particles in the water column can also impact Secchi depth measurements. This is a challenge in the Halifax region, as many lakes have relatively high, naturally occurring ***tannin*** levels that can make them appear tea-coloured. As a result, Secchi depth measurements may be a less reliable assessment of algae counts in some lakes.

Measuring water clarity is also important for recreational safety. According to Health Canada, a recreational swimming area should have water that is clear enough for a Secchi disc to be visible at a minimum depth of 1.2 m. Clear water is important for swimmers to estimate depth and see subsurface hazards. It also aids lifesaving efforts in emergencies by allowing first responders to detect submerged swimmers.

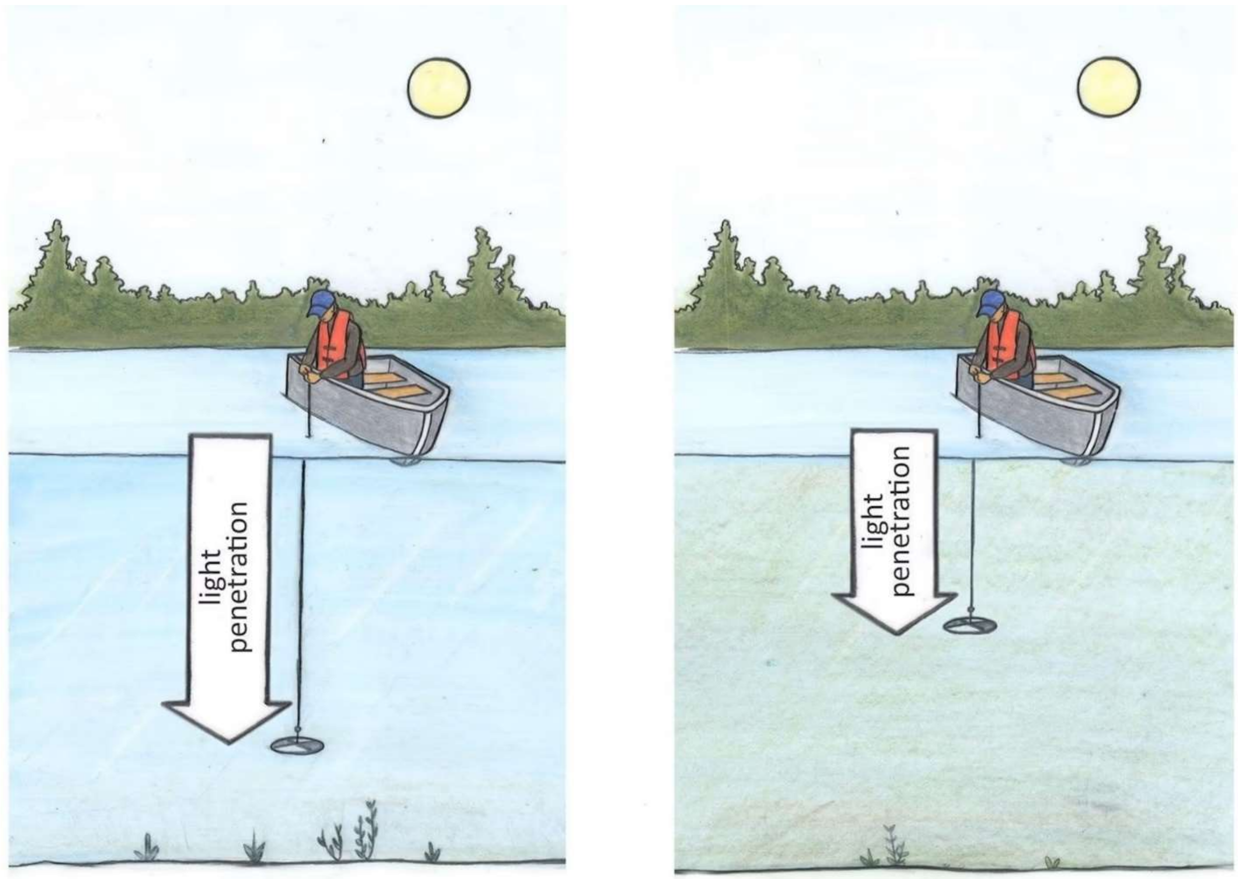

Figure 3. Example of different Secchi depth measurements due to differences in light penetration. Illustration provided courtesy of Atlantic DataStream (https://datastream.org/en-ca/)

In the first 2 years of monitoring (2022-23), there were 33 instances where the minimum Secchi depth of 1.2 m was not met (Table 3). However, 21 out of those 31 instances occurred during the 2023 summer sampling period, which took place in the weeks that followed the historic rainfall event of July 21 and 22, 2023. This heavy rainfall is believed to have resulted in the large number of low Secchi depth measurements in the summer 2023 monitoring period by delivering huge amounts of suspended sediments and other particles to lakes through overland flow and as ***stormwater run-off***.

In 2024, there were only 9 instances where the minimum Secchi depth of 1.2 m was not met, five in the spring and another four in the summer (Table 2).

Table 2. Summary of Secchi Depth Results for the 2022-24 LakeWatchers Program

Monitoring Period	Number of Lakes w/ Secchi depth measurements below the Health Canada recommendation (less than 1.2 m)	Average Secchi depth across all monitored lakes
Spring 2022	3	3.23 m
Summer 2022	7	3.18 m
Spring 2023	2	2.95 m

Summer 2023	*21	1.95 m
Spring 2024	5	2.66 m
Summer 2024	4	3.15 m

*The 2023 summer sampling occurred in the weeks that followed the historic rainfall and flooding event of July 22nd and July 23rd, 2023.

pH

The power of hydrogen, or pH, is a measure of the concentration of hydrogen ions in water on a scale of 1 to 14. A pH reading of 7 represents neutral conditions, while lower values indicate acidic conditions, and higher ones indicate alkaline conditions. Due to the bedrock geology of the region, most lakes in Halifax are naturally acidic and would likely have had pH values below 6.0 before European settlement (Clement et al. 2007). Lakes with elevated pH values may be associated with higher levels of urban, commercial or industrial run-off.

A lake's pH is important to monitor for both recreational and biological reasons. To protect against the risk of eye irritation, Health Canada's *Guidelines for Canadian Recreational Water Quality* recommends a guideline pH range of 5.0 to 9.0. Similarly, the CCME *Water Quality Guidelines for the Protection of Freshwater Aquatic Life* provide an optimal guideline pH range of 6.5 to 9.0 (Figure 4) which is preferred for most aquatic species. Many lakes in the municipality have pH values that naturally fall outside of the CCME FWAL guideline range. This is generally due to high organic content and the lingering effects of acid rain (Clement et al. 2007). So, while most freshwater aquatic species would prefer a pH range between 6.5 to 9.0, the current community of species inhabiting the region's lakes are well adapted to these relatively low pH values.

Through three years of monitoring, LakeWatchers has observed a wide range of surface pH values in lakes across the region, ranging from a low of 4.06 (Big Cranberry Lake – Summer 2024) to a high of 9.25 (Fenerty Lake – Summer 2024). Lakes with the lowest pH values consistently have relatively undisturbed or protected watersheds (e.g. Ragged Lake, Big Cranberry Lake, First Chain Lake). The highest pH values are generally found in lakes with densely developed watersheds (e.g. First Lake, Lake Banook, Albro Lake), although there are some exceptions.

During the first three years of LakeWatchers, there have been 22 instances where a lake's measured surface pH fell outside the recommended Health Canada range of 5.0 to 9.0 (Table 3). Fortunately, none of these instances occurred at a lake where the municipality operates a supervised beach.

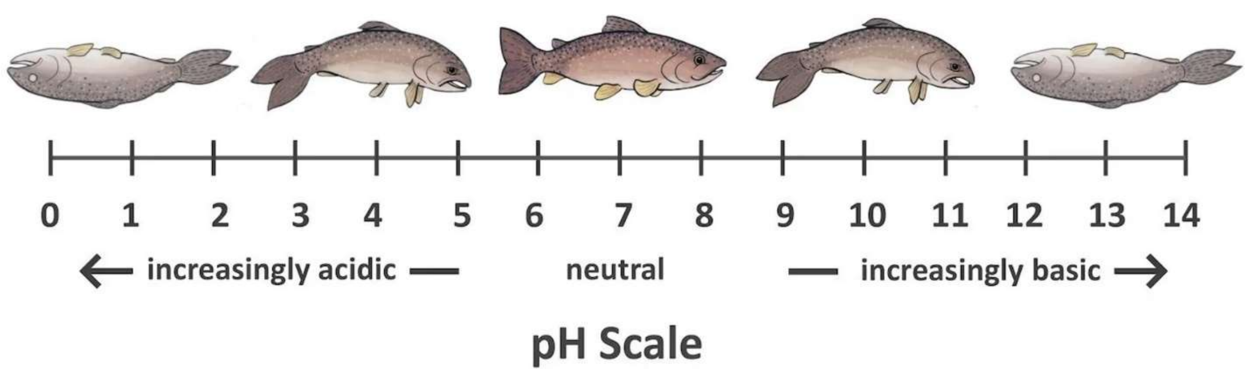

Figure 4. pH scale illustrating the preferred range for many species of freshwater fish and other aquatic organisms. Illustration provided courtesy of Atlantic DataStream (https://datastream.org/en-ca/)

Table 3. Summary of surface pH values during each monitoring period (BOLDED indicates a value outside the Health Canada recommended range of 5.0 to 9.0).

Monitoring Period	Range of pH values	Average pH	Lowest 5 pH Values	Highest 5 pH Values
Spring 2022	4.69 to 8.84	6.88	**First Chain Lake (4.69)** **Ragged Lake (4.76)** **Big Cranberry Lake (4.98)** **Loon Lake (5.00)** Pine Lake (5.16)	Hatchet Lake (8.84) Petpeswick Lake (8.52) First Lake (8.43) Beaver Pond (8.34) McQuade Lake (8.34)
Summer 2022	4.42 to 8.75	6.90	**First Chain Lake (4.42)** **Ragged Lake (4.90)** Blueberry Lake (5.17) Pine Lake (5.43) Hubley Big Lake (5.45)	Fenerty Lake (8.75) Albro Lake (8.52) Maynard Lake (8.1) Anderson Lake (8.05) Lake Banook (7.96)
Spring 2023	4.41 to 8.40	6.61	**Big Cranberry Lake (4.41)** **First Chain Lake (4.76)** **Ragged Lake (4.87)** **Susies Lake (4.88)** Hubley Big Lake (5.1)	First Lake (8.4) Hatchet Lake (8.13) Lake Banook (7.99) Lemont Lake (7.84) Porters Lake – south (7.84)
Summer 2023	4.55 to 8.78	6.54	**Big Cranberry Lake (4.55)** **First Chain Lake (4.68)** **Albert Bridge Lake (4.96)** Blueberry Lake (5.02) Ragged Lake (5.05)	Settle Lake (8.78) Hatchet Lake (7.94) Porters Lake – south (7.87) Rocky Lake (7.86) Penhorn Lake (7.75)
Spring 2024	4.46 to 7.91	6.60	**Big Cranberry Lake (4.46)** **Ragged Lake (4.62)** **Susies Lake (4.66)** **First Chain Lake (4.74)** **Pine Lake (4.96)**	First Lake (7.91) Russell Lake (7.87) Topsail Lake (7.85) Lake Charles (7.83) Porters Lake – south (7.75)
Summer 2024	4.06 to 9.25	6.70	**Big Cranberry Lake (4.06)** **First Chain Lake (4.56)** **Ragged Lake (4.82)** Mill Lake (5.15) Wrights Lake (5.21)	**Fenerty Lake (9.25)** Rocky Lake (8.23) Lake Charles (8.14) First Lake (7.95) Powder Mill Lake (7.88)

Specific Conductance (SPC)

Similar to conductivity, specific conductance (SPC) is a measure of all the non-water material that is dissolved into water that allows for an electrical current to be passed through it. Because conductivity values will fluctuate depending on water temperature, SPC is used instead to provide a standardized value, allowing for comparisons to be made between lake samples taken at different temperatures.

There has been a huge range of surface SPC values observed in the region's lakes over the first three years of LakeWatchers, ranging from a low of 24.7µS/cm (Big Cranberry Lake – Summer 2023) to a high of 1081.2 µS/cm (Lovett Lake – Spring 2023) (Table 4). Generally, SPC values below 200 µS/cm are seen as low, often reflecting relatively little human impact. SPC values ranging between 200 to 1000 µS/cm are seen as moderate, while values exceeding 1000 µS/cm are seen as high. This wide range of SPC values is reflective of the wide variety of development a nd land use pressures faced by lakes within the HRM.

Increases in SPC are strongly associated with urbanization (Kaushal et al. 2005). Human activities on land, such as development and road salting, can increase the amount of dissolved solids in ***run-off*** water that reaches nearby lakes and streams. As dissolved solids break down into ions, there is an increase in the water's ability to conduct electricity. Accordingly, lakes with the highest SPC readings are typically those under the most stress from ***stormwater run-off***, while lakes with the lowest SPC readings can be seen as being under the least stress from ***run-off***.

Studies have shown (Clement et al. 2019, Kanabar 2021, Doucet et al. 2023) that Halifax-area lakes with consistently low SPC values have relatively undisturbed watersheds with very little or no impervious ground cover, such as Big Cranberry Lake, Pine Lake, or Scots Lake, to name a few. These more natural SPC levels are the result of wind-blown sea salt and the weathering of bedrock and soil, which slowly dissolves minerals into the water.

The highest SPC values were routinely found in lakes with highly developed watersheds (e.g. Lake Banook, Lake Micmac, Russell Lake, Oat Hill Lake, Lovett Lake), as these areas have an abundance of ***impervious surfaces*** that receive routine road salt use during the winter months to maintain road safety (Table 4).

Table 4. Summary of surface SPC values during each monitoring period (2022-2024)*.

Monitoring Period	Range of SPC Values (µS/cm)	Lowest 5 SPC Values (µS/cm)	Highest 5 SPC Values (µS/cm)
Spring 2022	25.1 to 745.8	Pine Lake (25.1) Big Cranberry Lake (25.9) Scots Lake (27.3) Mill Lake (28.1) Kidston Lake (28.7)	Bayers Lake (745.8) Lake Micmac (648.5) Lake Banook (631.9) Lovett Lake (624.3) Governor Lake (607.6)
Summer 2022	26.3 to 930.6	Big Cranberry Lake (26.3) Pine Lake (27.0) Scots Lake (27.7) Mill Lake (30.1 Lake Charlotte (36.1)	Lake Banook (930.6) Lake Micmac (892.6) Bayers Lake (727.8) Stillwater Lake (670.4) Lovett Lake (646.3)
Spring 2023	26.0 to 1081.2	Pine Lake (26.0) Big Cranberry Lake (27.8) Scots Lake (28.0)	Lovett Lake (1081.2) Lake Micmac (904.2) Russell Lake (803.0)

		Wrights Lake (36.9) Lake Echo (37.8)	Lake Banook (798.0) Oat Hill Lake (728.0)
Summer 2023	24.7 to 521.7	Big Cranberry Lake (24.7) Pine Lake (25.3) Scots Lake (26.4) Lake Echo (27.8) Mill Lake (28.6)	Lake Banook (521.7) Lake Micmac (471.8) Russell Lake (425.0) Penhorn Lake (390.5) Oat Hill Lake (372.2)
Spring 2024	25.5 to 704.0	Pine Lake (25.5) Scots Lake (25.9) Mill Lake (27.1) Big Cranberry Lake (28.0) Lake Echo (30.6)	Lake Banook (704.0) Oat Hill Lake (644.0) Lovett Lake (632.0) Russell Lake (630.0) Lake Micmac (617.0)
Summer 2024	25.0 to 718.0	Pine Lake (25.0) Scots Lake (28.0) Big Cranberry Lake (28.0) Lake Charlotte (35.0) Lake Echo (36.8)	Lake Banook (718.0) Lake Micmac (695.0) Russell Lake (670.0) Oat Hill Lake (633.0) Lovett Lake (614.0)

*locations sampled within Porters Lake were excluded from this analysis as Porter's Lake is a tidal waterbody and therefore subject to the salty influence of the ocean.

Temperature

The temperature of the water throughout a lake is important because it can directly influence many physical, chemical and biological processes occurring within a lake system. In temperate regions like Nova Scotia, changing seasonal water temperatures often drives an important and natural mixing process in many lakes, cycling nutrients and determining dissolved oxygen content (Figure 2).

Following ***spring turnover***, we expect water temperatures to be quite similar from the surface to the bottom of a lake, whereas by summer we anticipate most lakes to stratify. This phenomenon, known as ***summer stratification,*** is caused by the sun's heat during the summer months. The surface layer of the water gradually becomes warmer, while deeper layers remain cooler (Figure 5). Over time, this temperature difference creates distinct layers in a lake's water column, each with different characteristics.

There are three primary layers in a summer stratified lake (Figure 5):

1. **Warm Surface Layer (or Epilimnion)**: This layer is warmed by the sun and is well-mixed by wind and wave action. During summer, the epilimnion is the most active zone for biological activity, such as plant and algae growth.

2. **Transition Zone (or Thermocline)**: This is the middle layer where there can be a sharp decline in temperature and dissolved oxygen. This layer acts as a barrier and limits the mixing of water between the warmer surface and cooler deep layers.

3. **Cool Bottom or Deep Layer (or Hypolimnion)**: This layer is cooler and denser than those above it. This lower layer tends to remain at a more consistent, cooler temperature throughout the year, with limited mixing and less biological activity compared to the upper layers.

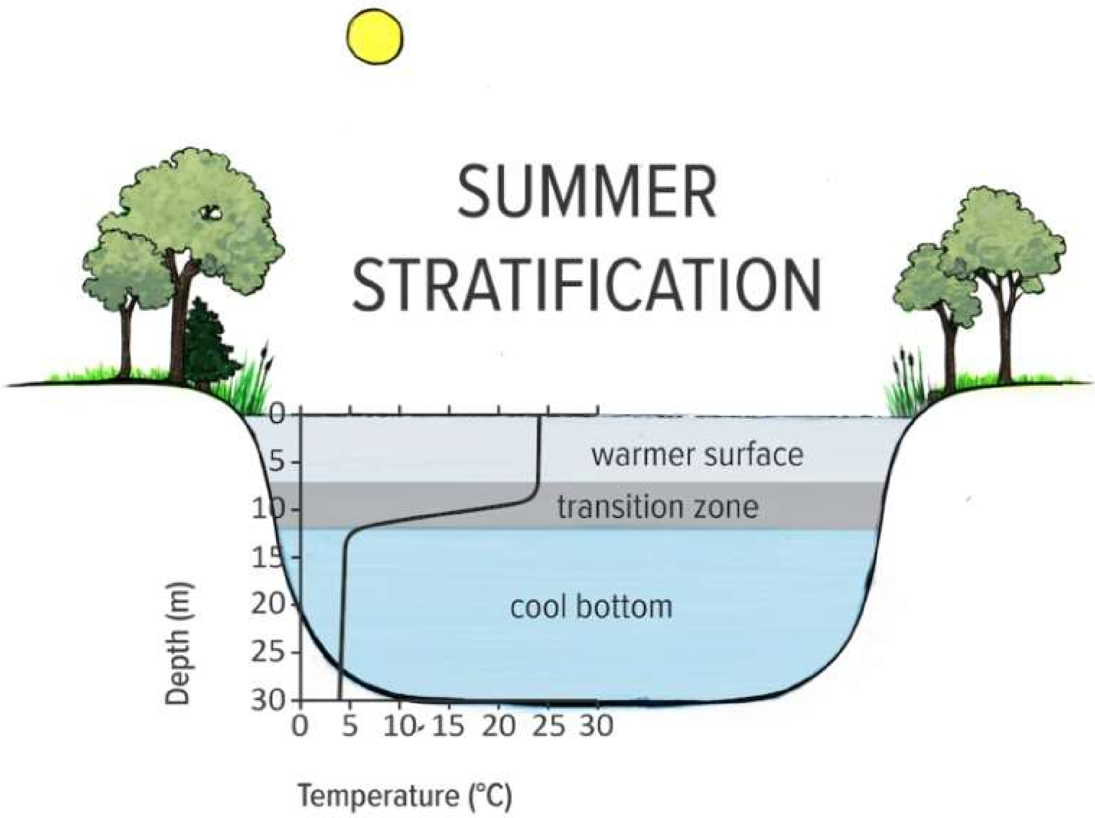

Figure 5. Typical Summer Stratification of a Temperate Lake in Mid-Summer. Illustration provided courtesy of Atlantic DataStream (https://datastream.org/en-ca/).

Over the past three years, ***summer stratification*** was observed in at least 60 of the monitored lakes during each summer monitoring period (Table 5). Weak or absent stratification tended to occur in shallower lakes with greater exposure to wind, while stronger stratification was generally found in deeper lakes and in those that have less wind exposure.

Table 5. Summary of Summer Stratification among monitored lakes during each summer (2022-2024).

Monitoring Period	Number of lakes that exhibited Summer Stratification	Range of Thermocline Temperatures	Average Temperature of Thermoclines	Range of Thermocline Depths	Average Depth to Thermocline
Summer 2022	62/77 (80.5%)	16.9°C to 23.2°C	20.8°C	1.5 to 11.5 m	5.2 m

Summer 2023	68/77 (88%)	16.4°C to 22.1°C	19.4°C	0.5 to 9.5 m	4.4 m
Summer 2024	60/77 (78%)	14.6°C to 24.1°C	19.9°C	1.5 to 11.0 m	5.2 m

Surface water temperatures in 2024 ranged from 6.9°C to 13.6°C during the spring sampling period and 19.6°C to 26.0°C during the summer sampling period (Table 6). Higher springtime surface temperatures were generally found in smaller, shallower lakes (e.g. Black Point, Blueberry, Bayers) that lose their ice cover earlier and have more time to warm up. In contrast, larger lakes tend to hold their ice cover longer and have more water volume to resist spring warming.

This is important because an earlier ice-out in the spring can allow for a longer growing season for plants and algae, including potentially harmful cyanobacteria. Additionally, earlier ice-out in the spring and warmer overall surface water temperatures during the summer can strengthen and prolong a lake's ***summer stratification*** period such that it can potentially disrupt ecological processes and contribute to eutrophication risk.

Table 6. Summary of Surface Water Temperatures during each monitoring period (2022-2024)*.

Sampling Period	Range	Average
Spring 2022	8.2°C to 18.9°C	12.1°C
Summer 2022	21.4°C to 26.4°C	24.1°C
Spring 2023	7.4°C to 13.9°C	10.7°C
Summer 2023	20.0°C to 24.4°C	22.4°C
Spring 2024	6.9°C to 13.6°C	11.6°C
Summer 2024	19.6°C to 26.0°C	23.2°C

*can vary significantly depending on the date or time of day they are sampled. For instance, lakes monitored earlier in the spring (i.e. April) typically will have colder recorded water temperatures than those sampled later in the spring (i.e. May).

Dissolved Oxygen (DO)

Dissolved oxygen (DO) is a measure of the amount of oxygen that is dissolved into water. DO levels in lake water can depend on a wide variety of factors, such as the amount of aquatic plants and algae, water temperature, fetch length (for wind action), and lake depth, among many others. Measuring DO levels is important because fish and many other aquatic organisms rely on it to survive (Figure 7).

According to the CCME *Water Quality Guidelines for the Protection of Freshwater Aquatic Life*, a minimum DO level of 6.0 mg/L is recommended for fish in their early life stages, while a minimum of 5.5 mg/L is recommended for later life stages (i.e. adult fish).

The DO levels in lakes are generally higher in the spring when water temperatures are colder because water holds dissolved oxygen more effectively when it is colder. This is illustrated by comparing surface water DO levels from the spring monitoring periods with those from the summer monitoring periods.

The average DO levels for surface water in sampled lakes during the spring monitoring periods was 10.98 mg/L, while in the summer it was 7.87 mg/L (Table 7). With only one exception, the DO levels in the surface water of all monitored lakes during all monitoring events were above the more stringent CCME guideline of 6.0 mg/L. During the summer sampling in 2024, Cranberry Lake was measured to have DO levels of 5.48mg/L, just below the guideline minimum.

Table 7. Summary of surface DO levels during each monitoring period (2022-2024).

Monitoring Period	Range	Average
Spring 2022	9.41 to 14.58 mg/L	10.95 mg/L
Summer 2022	6.60 to 9.60 mg/L	8.13 mg/L
Spring 2023	10.00 to 12.52 mg/L	11.12 mg/L
Summer 2023	6.21 to 9.44 mg/L	7.73 mg/L
Spring 2024	8.75 to 13.27 mg/L	10.86 mg/L
Summer 2024	5.48 to 9.69 mg/L	7.76 mg/L
Spring AVERAGE	**9.39 to 13.46 mg/L**	**10.98 mg/L**
Summer AVERAGE	**6.10 to 9.58 mg/L**	**7.87 mg/L**

Additionally, as discussed in the previous section (see *Temperature* section), many lakes in the Halifax region will become stratified by mid-summer, forming several distinct layers based on water temperature. During this period of ***summer stratification,*** the warm and oxygen-rich surface layer of a lake (epilimnion) is cut-off from the cooler deep layer (hypolimnion) by a middle transition layer (thermocline) (Figure 5).

This means that levels of DO in the deep layer can become slowly depleted over time as it is breathed by fish and consumed by micro-organisms but cannot be replenished by mixing with the surface layer. When DO levels in deeper layers of a lake drop too low, many fish species may struggle to breathe and instead be forced into shallower, warmer areas where oxygen is more abundant.

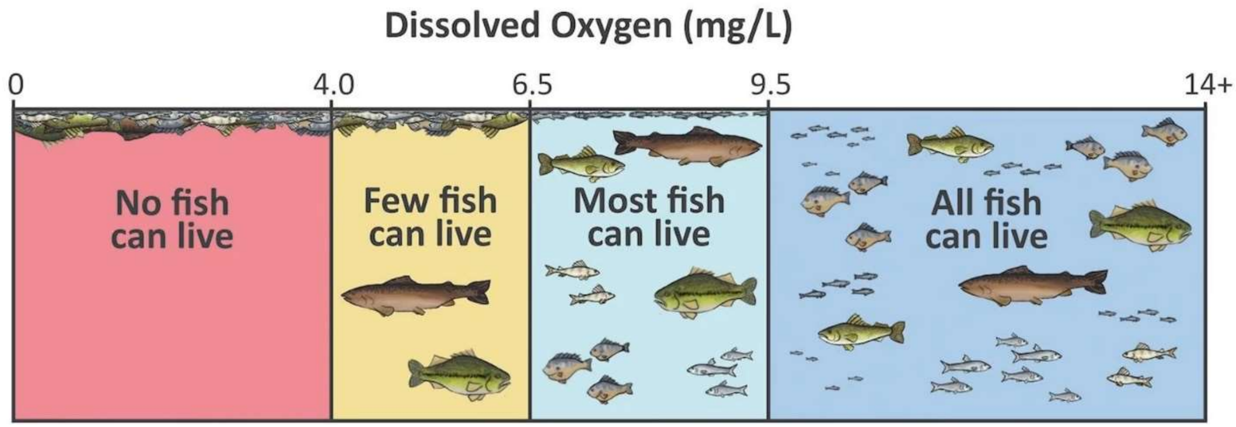

Figure 7. Dissolved oxygen levels (mg/L) and its effect on fish diversity and survival - Illustration provided courtesy of Atlantic DataStream (https://datastream.org/en-ca/)

If DO levels drop below 1.0 mg/L in the deep lake layer (hypolimnion), then a lake has developed a condition known as ***hypolimnetic anoxia*** (see Lake Banook example in Figure 6). This extreme lack of DO can trigger changes in how deep-water micro-organisms produce energy and may result in a process known as ***internal loading*** (discussed further in the *Total Phosphorus* section).

During the summer sampling event in 2022 and 2023, ***hypolimnetic anoxia*** was detected in 47 lakes, but in 2024 this number had decreased to 37 lakes (Table 8). The thickness of these anoxic layers, as measured up from the lakebed at the deepest part of a lake, varied widely between lakes but maintained a similar range during each summer sampling event. Lakes with thicker anoxic layers may have become stratified earlier in the summer than those with thinner anoxic layers, allowing for a longer period for DO levels to become depleted.

Table 8. Summary of lakes exhibiting fish exclusion zones and hypolimnetic anoxia during each summer monitoring period (2022 - 2024).

Monitoring Period	Number of lakes w/ anoxic conditions at lakebed	Range of Anoxia thickness (measured from the lakebed at the deepest part of a lake)
Summer 2022	47	0.5 to 12.5 m (Avg: 4.0 m)
Summer 2023	47	0.2 m to 15.9 m (Avg: 4.2 m)
Summer 2024	37	0.4 to 11.2 m (Avg: 3.8 m)

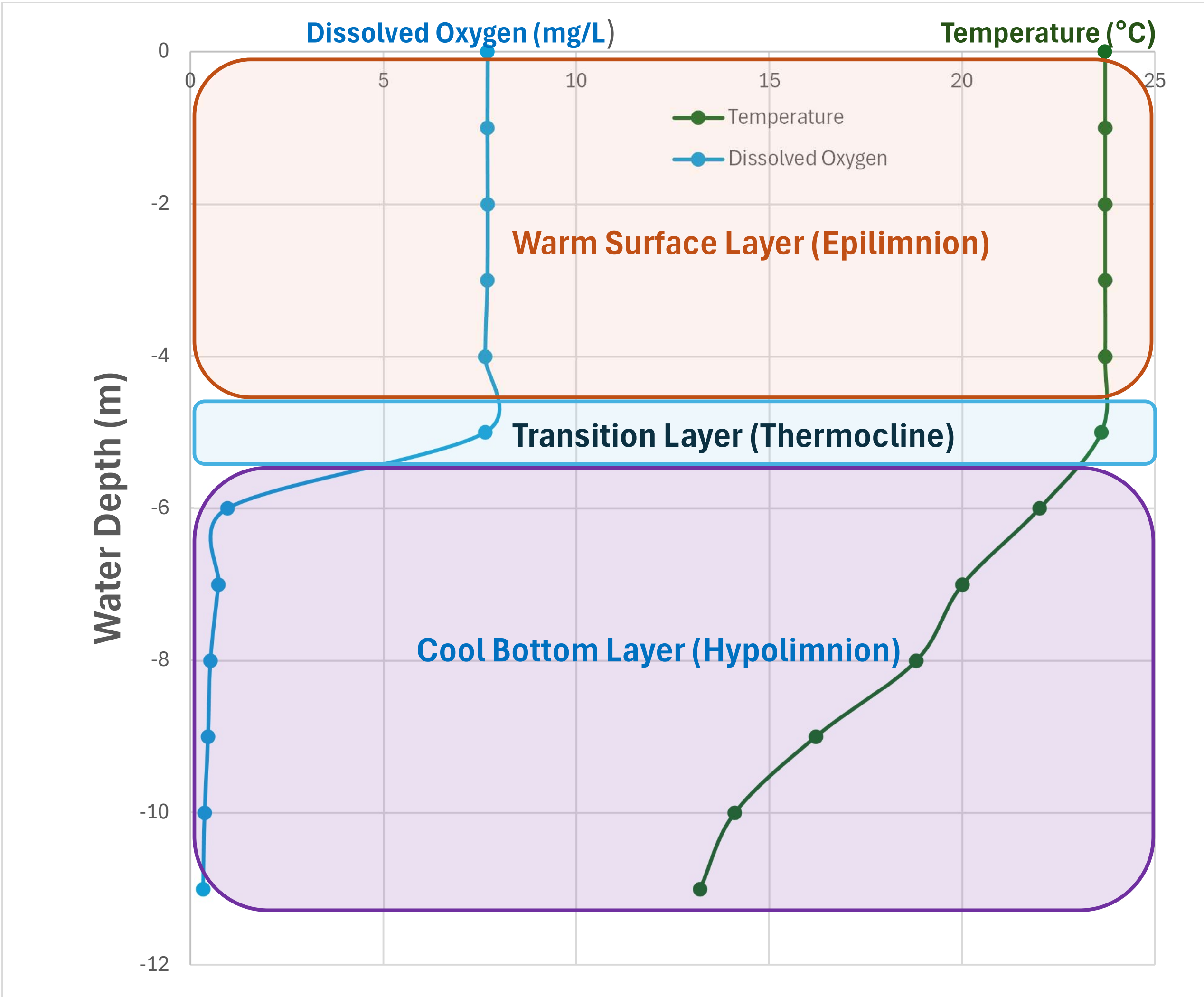

Figure 6. Example of summer stratification and hypolimnetic anoxia (or very low dissolved oxygen levels in the deep lake layer) in Lake Banook observed during the summer monitoring in 2024.

Laboratory Results

The following sections detail the results of the laboratory analysis of water samples collected fas part of the LakeWatchers program. The results are presented in terms of the entire dataset and when possible, values are assessed against relevant federal guidelines and other benchmarks. Accompanying lake data for individual lakes is provided as fact sheets in **Appendix B**.

Total Phosphorus (TP)

Spring TP values were used to estimate ***trophic status*** using the CCME TP Framework (Table 1). In the springtime, low temperatures in the lakes limit plant and algae growth. At the same time, lakes have undergone ***spring turnover*** and will have mixed nutrients from deeper lake layers throughout the entire water column. As a result, spring TP values are thought to be most reflective of ***trophic status*** as nutrient levels are peaking, but colder water temperatures are still limiting uptake to plants and algae.

Overall, 69 of 77 lakes sampled as part of LakeWatchers were classified as either ultra-oligotrophic or oligotrophic, and only 8 were classified as mesotrophic or meso-eutrophic (Table 9). These results are based on the averaged TP results collected during the 2022 to 2024 spring monitoring periods.

Table 9. Estimated Trophic State distribution based on the CCME TP Framework and Average Spring TP

Trophic State	Spring 2022	Spring 2023	Spring 2024	**Average**
Ultra-oligotrophic	25	34	37	**31**
Oligotrophic	41	39	31	**38**
Mesotrophic	10	4	7	**7**
Meso-eutrophic	1	0	0	**1**
Eutrophic	0	0	2	**0**
Hyper-eutrophic	0	0	0	**0**
TOTAL	77	77	77	**77**

This finding clashes with the anticipated lake conditions described in Table 1, which indicates that ultra-oligotrophic and oligotrophic lakes are usually oxygenated throughout, even in their deeper stratified layers. Instead, our data shows that a majority of monitored lakes exhibit some degree of deep-water oxygen loss during the summer months, often leading to ***hypolimnetic anoxia.*** These findings are much more consistent with mesotrophic, meso-eutrophic and eutrophic lake conditions. This is further supported by reports from residents of increasing aquatic plant growth and potentially harmful algae blooms in many lakes across the region.

Internal Loading

Lakes are also monitored for evidence of ***internal loading*** by comparing the summertime concentration of TP in a lake's surface water against the sample taken from deeper in the water column, just above the lakebed. If there is evidence for ***internal loading***, the concentration of TP in the deep-water sample will be greater than the concentration of TP in the surface sample. On average, 46 lakes per year have shown signs of ***internal loading*** since monitoring began in 2022. The strength of evidence for this finding ranged from a weaker signal, when summertime deep-water TP was 1.25 to 2x greater than at surface, to a very strong signal, when summertime deep-water TP was 8x greater than at surface sample. These findings are summarized in Table 10.

Table 10. Summary of evidence for internal loading during each summer monitoring period (2022-2024).

Monitoring Period	Weak Internal Loading (≥1.25x – 2x increase)	Moderate Internal Loading (>2x – 4x increase)	Strong Internal Loading (>4x to 8x increase)	Very Strong Internal Loading (>8x increase)	**TOTAL**
Summer 2022	8	12	6	17	**43**

Summer 2023	14	15	6	4	**39**
Summer 2024	13	17	14	12	**56**
AVERAGE	**12**	**15**	**9**	**11**	**46**

Chlorophyll-α (chl-α)

Along with TP, the concentration of ***chl-α*** in lake water can be used to estimate the overall productivity or ***trophic status*** of a lake system (Carlson 1977, Carlson and Simpson 1992). The concentration of ***chl-α*** in the surface water of a lake during the summer months is a measure of the amount of algae present and is seen by some as the most accurate predictor of ***trophic status*** (Carlson 1977, Carlson and Simpson 1992). By contrast, TP represents a measure of the amount of nutrients available for algae and plant growth and can be seen as a less direct indicator of lake productivity.

Like the CCME TP Framework, the North American Lake Management Society (NALMS) provides a gradient of ***chl-α*** concentration ranges and their anticipated ***trophic states*** (Table 1).

In contrast to the CCME TP Framework, when using the NALMS ***chl-α*** gradient the majority of monitored lakes were assigned into higher ***trophic states***; mesotrophic (49), meso-eutrophic (4) and eutrophic (3) (Table 11). This finding is much more aligned with the anticipated lake conditions described in Table 1, as lakes in these higher ***trophic states*** are more likely to experience the deep-water oxygen loss and ***hypolimnetic anoxia*** that has been observed in most monitored lakes during the summer sampling period since the program began.

Table 11. Estimated Trophic State distribution based on Average Summer Chlorophyll-α (chl-α**)**

Trophic State	Summer 2022	Summer 2023	Summer 2024	**All Years**
Ultra-oligotrophic	5	4	1	**1**
Oligotrophic	31	18	22	**20**
Mesotrophic	37	45	42	**49**
Meso-eutrophic	3	9	10	**4**
Eutrophic	1	0	1	**3**
Hyper-eutrophic	0	1	1	**0**
TOTAL	77	77	77	**77**

Dissolved Chloride

As stated earlier, naturally occurring chloride concentrations for lakes in the Atlantic region are normally less than 10 mg/L (CCME 2011). In 2024, the three reference lakes (Big Cranberry Lake, Pine Lake and Topsail Lake) that were selected to represent natural lake conditions in the region had average deep-water dissolved chloride values of 3.8 mg/L, 4.9 mg/L and 13.0 mg/L, respectively.

In 2024, deep-water chloride levels were slightly lower in most lakes compared to the previous two years of monitoring. Nevertheless, only 19 of the over 70 freshwater lakes monitored had chloride values below the highest recorded value for a reference lake in 2024 (Topsail Lake –13.0 mg/L). In contrast, 24 lakes had deep-water chloride values at least four times higher (i.e. ≥ 52.0 mg/L).

Fortunately, over the past three years (2022-2024), the CCME short-term exposure limit (≥ 640 mg/L), which could have lethal effects on some aquatic organisms, was not seen to be exceeded at any of the over 70 freshwater lakes sampled during monitoring.

Unfortunately, there were nine freshwater lakes whose three-year average deep-water chloride levels exceeded the long-term CCME FWAL guideline value (>120 mg/L), including five lakes which exceeded the guideline value during each monitoring period (Table 12). Additionally, there were seven other lakes whose three-year average deep-water chloride values are approaching the guideline (i.e. between 80 mg/L and 120 mg/L) (Table 12).

Table 12. Summary of Freshwater Lakes whose Deep-water Dissolved Chloride concentrations approach or exceed the CCME FWAL long-term exposure guideline (**RED** indicates an exceedance, i.e. ≥ 120 mg/L; **ORANGE** indicates a value approaching an exceedance, i.e. ≥ 80 mg/L to < 120 mg/L).

	2022		2023		2024		'22 – '24
Lake Name	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**	**Average**
1. Lake Banook	**240**	**240**	**180**	**200**	**180**	**180**	**203.3**
2. Lovett Lake	**260**	**200**	**270**	**190**	**150**	**150**	**203.3**
3. Lake Micmac	**240**	**220**	**220**	**120**	**170**	**160**	**188.3**
4. Russell Lake	**220**	**180**	**190**	**170**	**160**	**150**	**178.3**
5. Oat Hill Lake	**190**	**160**	**180**	**170**	**180**	**180**	**176.7**
6. Bayers Lake	**190**	**170**	**170**	76	**110**	**130**	**141.0**
7. Governor Lake	**150**	**150**	**120**	**120**	**110**	**110**	**126.7**
8. Penhorn Lake	**140**	**130**	**130**	**130**	**110**	**110**	**125.0**
9. First Lake	**140**	**140**	**120**	**120**	**110**	**110**	**123.3**
10. Bissett Lake	**140**	**110**	**150**	**100**	**96**	**95**	**115.2**
11. Settle Lake	**150**	**130**	**110**	57	**100**	**110**	**109.5**
12. Albro Lake	**110**	**110**	**100**	**86**	**92**	**110**	**101.3**
13. Cranberry Lake	**160**	**110**	**120**	44	**86**	**83**	**100.5**
14. Chocolate Lake	57	**160**	**120**	**89**	74	70	**95.0**
15. Maynard Lake	**91**	**94**	**87**	**89**	**88**	**78**	**87.8**
16. Morris Lake	**100**	**93**	**90**	69	73	72	**82.8**

*locations sampled within Porters Lake were excluded from this analysis as Porter's Lake is a tidal waterbody and therefore subject to the salty influence of the ocean.

As shown in previous studies, the lowest concentrations of chloride routinely occur in lakes with relatively undeveloped watersheds (e.g. Scots Lake, Pine Lake, Lake Charlotte, Kidston Lake), while the highest values are consistently found in lakes with the most developed watersheds and densest road networks (e.g. Lake Banook, Lovett Lake, Lake Micmac, Russell Lake and Oat Hill Lake).

Many lakes with the highest deep-water chloride levels are ***headwater lakes*** or located near the top of their watersheds, allowing salty water to flow downstream and impact numerous other lakes. These 'salty pathways', or chloride-enriched watersheds, have been identified using the seasonal deep-water chloride data collected over the first three years of LakeWatchers monitoring (2022 – 2024). These watersheds include the Cow Bay River Watershed (Figure 8), Nine Mile River Watershed, Shubenacadie River-Lakes Watershed and the Sullivan's Pond/Dartmouth Cove Sub-watershed.

In these watersheds, lakes located in more densely developed areas and receiving larger volumes of ***stormwater run-off*** collect and carry that saltier, chloride-enriched water to downstream lakes. This has two important implications. The first is that it can result in a compounding effect where chloride values become increasingly elevated in downstream connected lakes. This effect is illustrated in Figure 8, where both Russell Lake and Bissett Lake have higher concentrations of deep-water chloride than the lakes immediately upstream. The second implication is that saltier, chloride-enriched water derived from the use of de-icing salt in more developed areas of the municipality results in impacts to lakes outside the urban core. This effect is also illustrated in Figure 8, where the deep-water chloride concentration for Morris Lake (82.8 mg/L) is significantly elevated by the input from Russell Lake, despite the relatively low chloride inputs coming from Topsail Lake, Lemont Lake and Bell Lake.

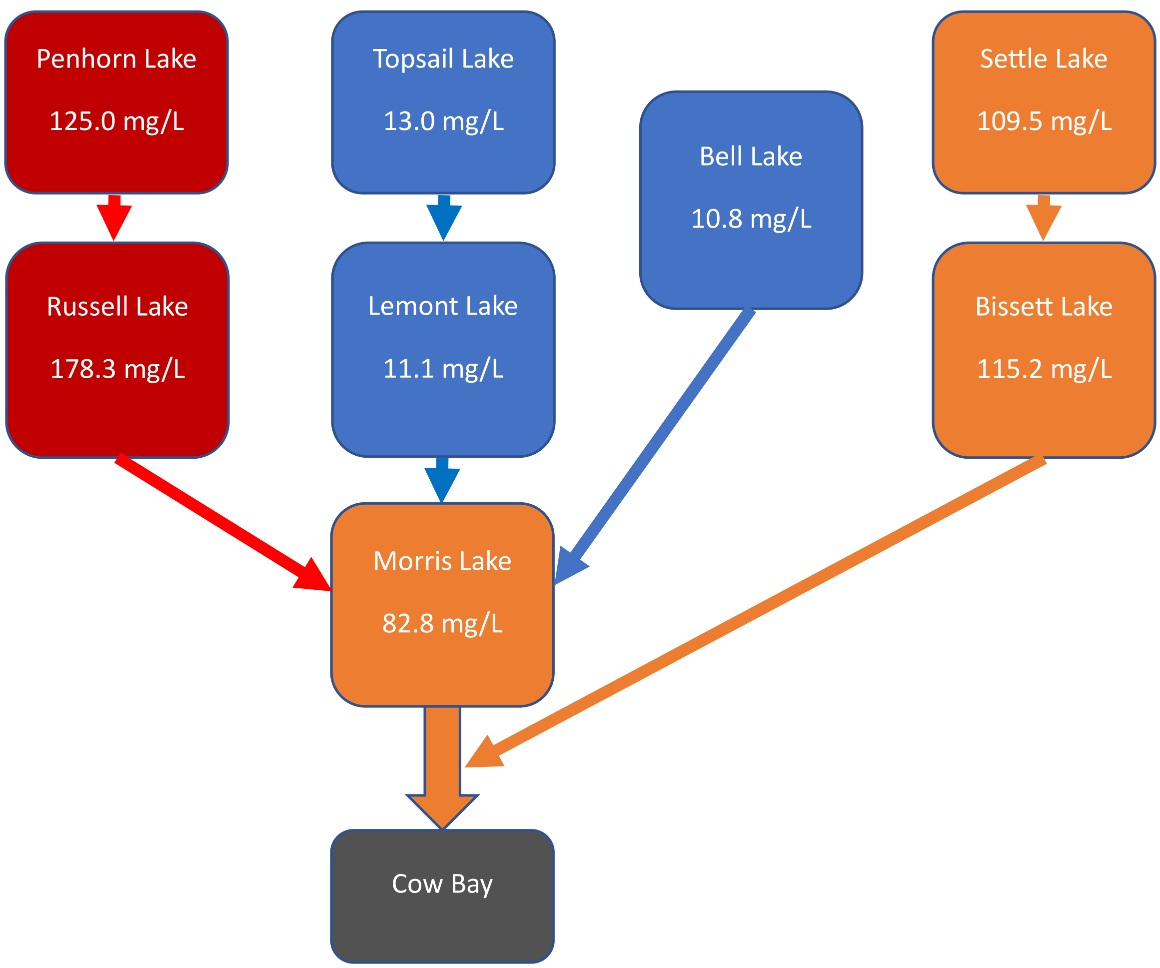

Figure 8. Simplified Cow Bay River Watershed diagram illustrating 'Salty Pathways' between several monitored lakes (2022-2024 average deep-water chloride values). (**RED** indicates an exceedance of CCME FWAL long-term exposure

guideline, i.e. ≥ 120 mg/L; **ORANGE** indicates a value approaching an exceedance of the CCME FWAL long-term exposure guideline, i.e. ≥ 80 mg/L to < 120 mg/L; and **BLUE** indicates a value well below the CCME FWAL long-term exposure guideline).

E. coli

E. coli results collected during the spring sampling periods of 2022 and 2023 were generally very low, with more than 70 per cent of samples found to be below detectable levels (<2.0 CFU). This result was expected, as lakes in the spring are still relatively cold and biological activity is generally lower than during the warmer summer months. As a result, in 2024, *E. coli* sampling was only conducted during the summer monitoring period.

During the summer monitoring periods, *E. coli* results for most lakes generally remained low, with only a few exceedances of Health Canada's *Guidelines for Canadian Recreational Water Quality* (Table 13). Despite warmer conditions, 22.7 per cent, 13.0 per cent and 26.0 per cent of samples were found to be below detectable levels in the summers of 2022, 2023 and 2024, respectively.

Table 13. Summary of *E. coli* results and exceedances during each monitoring period (2022-2024)

Monitoring Period	% Non-detect (less than 2.0 CFU/100ml)	Exceedances (more than 235 CFU/100ml)
Spring 2022	75.0%	None
Summer 2022	22.7%	Bell Lake (Outlet – 340 CFU/100ml) Springfield Lake (Outlet – 290 CFU/100ml)
Spring 2023	72.7%	Sandy Lake (Outlet – 250 CFU/100ml)
Summer 2023	13.0%	Lovett Lake (Outlet – 500+ CFU/100ml) Lovett Lake (Surface – 500+ CFU/100ml) Kidston Lake (Surface – 250 CFU/100ml)
Spring 2024	-	Not collected (Spring *E.coli* sampling is suspended)
Summer 2024	26.0%	Russell Lake (Surface – 330 CFU/100ml) Albro Lake (Outlet – 260 CFU/100ml)

Discussion

With the completion of another year of monitoring, the LakeWatchers program continues to amass a comprehensive dataset reflecting the current state of over 70 lakes across the Halifax Regional Municipality. Although the program is still in its early years, key trends and areas of concern are beginning to emerge, highlighting the importance of long-term monitoring.

Trophic Status and Eutrophication Risk

The most notable inconsistency in the data is the discrepancy between the ***trophic status*** assessments of lakes made based on TP compared to ***chl-α***. As with data collected in 2022 and 2023, the TP values observed in 2024 remained lower than expected based on the historical Water Quality Monitoring Program (WQMP) data (2006-2011). Still many monitored lakes are exhibiting signs of higher ***trophic states*** than the CCME TP Framework predicts, including deep-water oxygen loss (frequently leading to ***hypolimnetic anoxia),*** as well as growing reports of increasing aquatic weed growth and harmful cyanobacteria blooms. This suggests that summertime ***chl-α***, which more directly measures the amount of algae and other plant life present during the peak of the growing season, may be the more accurate indicator of ***trophic state*** in the Halifax-area, than using TP alone (and not paired with other nutrient analyses).

Chloride Enrichment and Impacts on Lake Mixing

Deep-water chloride concentrations remain a significant concern, particularly for lakes located in more densely developed areas with more impervious surfaces requiring de-icing salts for winter road safety. Although deep-water chloride levels were slightly lower in 2024, than the previous two years of monitoring, the fact remains that most monitored lakes are exhibiting varying degrees of chloride enrichment. This suggests that over time, most lakes are receiving and accumulating more chloride over time than they can flush from their system. Currently, there are eight lakes whose average deep-water chloride values exceed the CCME FWAL long-term exposure guideline (120 mg/L), and another 8 lakes with average values that are approaching the guideline (>80 mg/L). Unsurprisingly, these 16 lakes are all situated in highly developed areas of the municipality with dense road networks. The elevated levels of deep-water chloride in these 16 lakes is likely already reducing overall biodiversity and may also be contributing to deep-water oxygen loss, possibly leading to ***anoxic conditions*** and ***internal loading*** in those lakes. Without adaptive management or other interventions, such as changes to relevant policy measures, these lakes and most others are likely to continue to suffer from the effects of chloride enrichment.

Hypolimnetic Anoxia and Internal Loading

Anoxic conditions at the lakebed were observed in 37 lakes in 2024, a slight improvement from previous years, but still a significant concern. Prolonged periods of anoxia can lead to ***internal loading***, where phosphorus and other contaminants previously bound to lakebed sediments are released back into the water column. The results indicate that lakes with de-oxygenated deep waters consistently show higher TP concentrations at depth compared to surface samples, suggesting that ***internal loading*** is already occurring in many monitored lakes. This process can further fuel and accelerate lake eutrophication and is likely to cause an overall increase in aquatic plant growth and late-season HABs observed in Halifax-area lakes.

Bacterial Contamination and Recreational Water Quality

Bacterial contamination, as indicated by *E. coli* levels, was generally low across all monitoring events. Only a handful of exceedances were recorded, mainly during the summer and at heavily used recreational lakes such as Russell Lake and Albro Lake. While widespread bacterial contamination does not appear to be a major issue, localized pollution sources such as ***stormwater run-off***, waterfowl activity, and improper canine waste disposal may be contributing to elevated *E. coli* levels at some sites. The low detection rate of *E. coli* during routine sampling contrasts with the increasing number of municipal beach closures, suggesting that bacterial contamination is primarily a nearshore issue rather than a lake-wide concern.

Climate Change and Future Considerations

Climate change is expected to exacerbate many of the observed trends. Warmer spring and summer temperatures are likely to extend the growing season for aquatic plants and algae, as well as lengthen ***summer stratification*** periods which may intensify ***hypolimnetic anoxia*** leading to ***internal loading***.

Additionally, more frequent ***freeze-thaw events*** may necessitate increased use of de-icing and anti-icing salts, potentially leading to further chloride accumulation in freshwater systems. These factors, among others, highlight the importance of continued monitoring and adaptive management strategies to mitigate future water quality deterioration.

Conclusions & Recommendations

The findings from the 2024 monitoring year reinforce the need for long-term data collection and proactive lake management. While progress has been made in understanding the current ***baseline conditions*** of the over 70 monitored lakes in the region, ongoing monitoring will be required to better understand the interactions between nutrient cycling, chloride enrichment, and ***summer stratification*** patterns. Overall, our data suggest that many Halifax-area lakes have changed over time and are still changing due to human development and activity on land. Addressing these challenges will likely involve the need for multiple municipal policy interventions, improved stormwater management, and ongoing community support to ensure the long-term health of HRM's lakes.

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APPENDIX A

Lake Names, Coordinates of Sampling Locations and Approximate Maximum Depths

Lake Name	Community Name(s)	Primary Outlet Coordinates	Deepwater Coordinates	Approximate Max Depth
Class A Lakes – High Vulnerability Lakes (25)				
Albro Lake	Dartmouth	44° 41' 08" N 63° 34' 37" W	44° 41' 18"N 63° 34' 39" W	10.5 m
Bell Lake	Dartmouth	44° 40' 19"N 63° 30' 24"W	44° 40' 24"N 63° 30' 31"W	8.1 m
Chocolate Lake	Halifax	44° 38' 19" N 63° 37' 14" W	44° 38' 20"N 63° 37' 24" W	13.3 m
Cranberry Lake	Cole Harbour	44° 41' 22" N 63° 29' 51" W	44° 41' 22"N 63° 29' 50" W	3.5 m
Five Island Lake	Hubley	44° 39' 32" N 63° 48' 41" W	44° 39' 59" N 63° 48' 19" W	9.5 m
Fletchers Lake	Fall River	44° 51' 23" N 63° 37' 02" W	44° 50' 52" N 63° 36' 41" W	10.6 m
Governor Lake	Lakeside	44° 38' 51" N 63° 42' 46" W	44° 38' 29" N 63° 41' 55" W	14.5 m
Kearney Lake	Bedford	44° 42' 12" N 63° 42' 15" W	44° 41' 42" N 63° 41' 49" W	27.5 m
Kidston Lake	Spryfield	44° 35' 53" N 63° 37' 14" W	44° 35' 42" N 63° 37' 16" W	6.8 m
Lake Banook	Dartmouth	44° 40' 29" N 63° 33' 44" W	44° 40' 50"N 63° 33' 20" W	12.2 m
Lake Charles	Portobello	44° 42' 31" N 63° 33' 14" W	44° 43' 18" N 63° 32' 49" W	25.7 m
Lake Micmac	Dartmouth	44° 41' 03" N 63° 33' 01" W	44° 41' 23"N 63° 33' 26" W	7.1 m
Long Pond	Herring Cove	44° 34' 32" N 63° 34' 29" W	44° 34' 32" N 63° 34' 33" W	6.6 m
Loon Lake	Lake Loon	44° 42' 37" N 63° 30' 50" W	44° 42' 15" N 63° 30' 26" W	5.9 m
Maynard Lake	Dartmouth	44° 40' 05" N 63° 33' 00" W	44° 40' 12"N 63° 33' 05" W	12.6 m
McQuade Lake	Hammonds Plains	44° 42' 51" N 63° 44' 33" W	44° 42' 52" N 63° 44' 39" W	7.8 m
Morris Lake	Portland Estates	44° 38' 53" N 63° 29' 21" W	44° 39' 02"N 63° 29' 42" W	12.4 m
Oat Hill Lake	Dartmouth	44° 40' 33" N 63° 33' 08" W	44° 40' 23"N 63° 32' 59" W	8.9 m
Paper Mill Lake	Bedford	44° 42' 52" N 63° 41' 03" W	44° 42' 56" N 63° 41' 07" W	5.9 m

Penhorn Lake	Dartmouth	44° 40' 26" N 63° 32' 19" W	44° 40' 32" N 63° 32' 27" W	9.2 m
Russell Lake	Portland Estates	44° 40' 02" N 63° 31' 18" W	44° 39' 57"N 63° 31' 30" W	8.8 m
Sandy Lake (Bedford)	Bedford	44° 44' 25" N 63° 42' 25" W	44° 44' 13" N 63° 42' 06" W	21.0 m
Settle Lake	Dartmouth	44° 40' 39" N 63° 30' 16" W	44° 40' 42" N 63° 30' 17" W	7.9 m
Springfield Lake	Middle Sackville	44° 48' 58" N 63° 44' 03" W	44° 48' 45" N 63° 44' 18" W	4.8 m
Williams Lake	Williams Lake	44° 37' 11" N 63° 35' 18" W	44° 37' 12" N 63° 35' 30" W	21.1 m
Class B – Moderate Vulnerability Lakes (49)				
Albert Bridge Lake	Seabright	44° 36' 27" N 63° 53' 53" W	44° 36' 35" N 63° 53' 20" W	11.7 m
Anderson Lake	Burnside	44° 43' 19" N 63° 37' 23" W	44° 43' 33" N 63° 37' 15" W	24.7 m
Barrett Lake	Beaver Bank	44° 49' 04" N 63° 41' 05" W	44° 48'55" N 63° 41' 14" W	6.3 m
Bayers Lake	Bayer's Lake	44° 38' 32"N 63° 40' 09"W	44° 38' 31"N 63° 40'17"W	2.6 m
Beaver Bank Lake	Beaver Bank	44° 51' 04" N 63° 39' 50" W	44° 51' 25" N 63° 39' 59" W	8.8 m
Beaver Pond	Windsor Junction	44° 48' 14" N 63° 39' 20" W	44° 48' 02" N 63° 39' 15" W	8.2 m
Bissett Lake	Cole Harbour	44° 38' 51" N 63° 27' 36" W	44° 39' 12" N 63° 28' 06" W	8.4 m
Black Point Lake	Hubley	44° 39' 50" N 63° 47' 00" W	44° 40' 08" N 63° 47' 09" W	2.5 m
Blueberry Lake	Beechville	44° 37' 04" N 63° 41' 52" W	44° 37' 25" N 63° 41' 38" W	3.0 m
Elbow Lake	Stillwater Lake	44° 41' 29" N 63° 50' 06" W	44° 41' 29" N 63° 50' 06" W	2.8 m
Fenerty Lake	Beaver Bank	44° 50' 24" N 63° 43' 14" W	44° 50' 02" N 63° 43' 13" W	9.5 m
First Lake	Lower Sackville	44° 46' 01"N 63° 39' 05"W	44° 46' 24"N 63° 39' 56"W	21.9 m
First Chain Lake	Bayer's Lake	44° 38' 19"N 63° 38' 17"W	44° 38' 19'N 63° 38' 40"W	12.2 m
Hatchet Lake	Hatchet Lake	44° 33' 36"N 63° 43' 04"W	44° 33' 56"N 63° 43' 25"W	22.6 m
Hubley Big Lake	Hubley	44° 38' 41" N 63° 49' 56" W	44° 38' 11" N 63° 48'54" W	13.8 m
Kinsac Lake	Beaver Bank	44° 50' 49" N	44° 49' 12" N	18.6 m

		63° 39' 07" W	63° 39' 01" W	
Lake Charlotte	Lake Charlotte	44° 47' 18"N 62° 55' 53"W	44° 51' 42"N 62° 59' 36"W	44.3 m
Lake Echo	Lake Echo	44° 42' 23" N 63° 22' 21" W	44° 43' 19" N 63° 23' 11" W	11.3 m
Lake William	Waverley	44° 44' 54"N 63° 33' 58"W	44° 46' 19"N 63°35' 13"W	27.2 m
Lemont Lake	Dartmouth	44° 41' 13" N 63° 31' 13" W	44° 41' 21" N 63° 31' 16" W	6.1 m
Little Springfield Lake	Middle Sackville	44° 48' 01" N 63° 45' 04" W	44° 48' 05" N 63° 45' 02" W	7.5 m
Long Lake (Provincial Park)	Halifax	44° 37' 03" N 63° 37' 45" W	44° 37' 32" N 63° 38' 57" W	26.8 m
Lovett Lake	Beechville	44° 38' 19" N 63° 41' 14" W	44° 38'15" N 63° 41' 00" W	7.4 m
McCabe Lake	Glen Arbour	44° 46' 36" N 63° 45' 06" W	44° 46' 24" N 63° 45' 09" W	17.2 m
Mill Lake	Head of St. Margarets Bay	44° 42' 02" N 63° 53' 40" W	44° 42' 23" N 63° 53' 46" W	8.1 m
Miller Lake	Fall River	44° 48' 30"N 63° 36' 01"W	44° 48' 42" N 63° 35' 29" W	13.0 m
Moody Lake	Williamswood	44° 31' 54"N 63° 38' 41"W	44° 32' 07"N 63° 38' 46"W	13.2 m
Petpeswick Lake	Gaetz Brook	44° 46' 18" N 63° 12' 12" W	44° 46' 16" N 63° 11' 44" W	22.6 m
Porters Lake (North basin)	Porters Lake	44° 44' 18" N 63° 18' 26" W	44° 46' 02" N 63° 19' 59" W	26.7 m
Porters Lake (mid-North basin)	Porters Lake	44° 43' 34" N 63° 18' 10" W	44° 44' 32" N 63° 17' 45" W	11.5 m
Porters Lake (mid-South basin)	West Porters Lake	44° 42' 07" N 63° 16' 59" W	44° 43' 20" N 63° 17' 58" W	7.5 m
Porters Lake (South basin)	East Lawrencetown	44° 39' 28" N 63° 17' 35" W	44° 39' 27" N 63° 18' 37" W	9.7 m
Powder Mill Lake	Waverley	44° 46' 18"N 63° 36' 24"W	44° 46' 34"N 63° 36' 43"W	12.5 m
Quarry Lake	Blue Mountain – Birch Cove Lakes Wilderness Area	44° 40' 24" N 63° 41' 09"W	44° 40' 15" N 63° 41' 30" W	8.0 m
Ragged Lake	Beechville	44° 37' 25" N 63° 40' 52" W	44° 37' 30" N 63° 40' 35" W	5.6 m
Rocky Lake (Northeast basin)	Waverley	44° 46' 08"N 63° 37' 32"W	44° 45' 54"N 63° 37' 20"W	3.8 m
Sandy Lake (Glen Arbour)	Hammonds Plains	44° 45' 41" N 63° 45' 44" W	44° 45' 23" N 63° 46' 06" W	9.3 m

Scots Lake	Musquodoboit Harbour	44° 47' 21" N 63° 10' 22" W	44° 47' 22" N 63° 10' 45" W	18.5 m
Second Lake	Windsor Junction	44° 47' 05"N 63° 38' 19"W	44° 46' 48"N 63° 39' 21"W	12.2 m
Sheldrake Lake	Hubley	44° 40' 31" N 63° 48' 00" W	44° 40' 33" N 63° 47' 49" W	7.5 m
Shubenacadie Grand Lake	Wellington	44° 55' 33"N 63° 34' 15"W	44° 55' 52" N 63° 35' 18" W	40.0 m
Stillwater Lake	Stillwater Lake	44° 42' 33"N 63° 50' 48"W	44° 42' 38"N 63° 50' 56"W	17.5 m
Susies Lake	Blue Mountain – Birch Cove Lakes Wilderness Area	44° 40' 06" N 63° 41' 26" W	44° 39' 34" N 63° 41' 40" W	11.8 m
Third Lake	Windsor Junction	44° 47' 15" N 63° 37' 45" W	44° 47' 30"N 63° 37' 57" W	24.2 m
Thomas Lake (North basin)	Fall River	44° 48' 57"N 63° 36' 43"W	44° 48' 43" N 63° 36' 37" W	6.2 m
Thomas Lake (South basin)	Waverley	44° 48' 13"N 63° 36' 32"W	44° 47' 26" N 63° 36' 24" W	13.9 m
Tucker Lake	Beaver Bank	44° 50' 27" N 63° 41' 21" W	44° 50' 21" N 63° 41' 13" W	19.2 m
Whites Lake	Whites Lake	44° 31' 51"N 63° 45' 28"W	44° 31' 56"N 63° 45' 18"W	11.3 m
Wrights Lake	Upper Hammonds Plains	44° 43' 59" N 63° 53' 39" W	44° 44'13" N 63° 53' 01" W	20.2 m
Reference Lakes (3)				
Big Cranberry Lake	Blue Mountain – Birch Cove Lakes Wilderness Area	44° 39' 42" N 63° 42' 35" W	44° 39' 33" N 63° 42' 35" W	4.0 m
Pine Lake	Porters Lake	44° 48' 05" N 63° 18' 00" W	44° 48' 33" N 63° 18' 06" W	20.6 m
Topsail Lake	Dartmouth	44° 41' 21" N 63° 31' 07" W	44° 41' 42" N 63° 31' 03" W	7.4 m

APPENDIX B

Individual Lake Fact Sheets

(SAMPLE ONLY)

Albro Lake

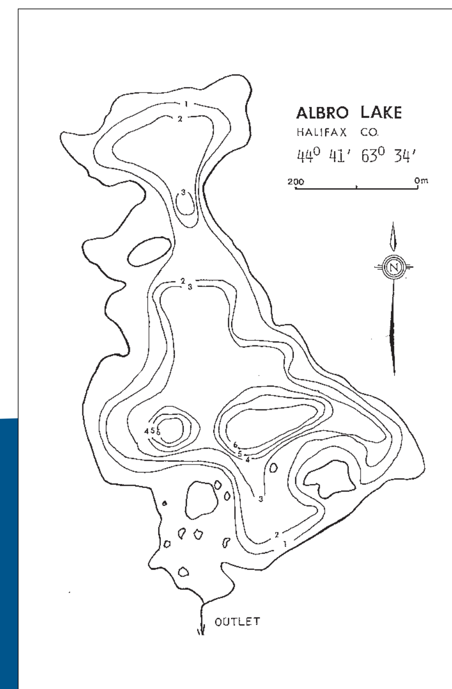
(Approximate maximum depth: 10.5 m)

DARTMOUTH, HALIFAX COUNTY, NOVA SCOTIA

Parameter	Spring 22	Summer 22	Spring 23	Summer 23	Spring 24	Summer 24
Team	Consultant	Consultant	Consultant	Consultant	Volunteer	Volunteer
Date	April 22	August 15	April 18	August 10	April 24	September 3
Secchi Depth	4.1 m	4.4 m	2.8 m	2.0 m	3.4 m	4.0 m
Surface pH	7.86	8.52	6.60	7.21	7.31	7.35
Surface SpC	0.2797 ms/cm	0.4849 ms/cm	0.4354 ms/cm	0.3585 ms/cm	0.3444 ms/cm	0.4295 ms/cm
Surface Temp	10.0°C	24.8 °C	10.6 °C	22.0 °C	10.7 °C	21.2 °C
Surface DO	10.17 mg/L	8.94 mg/L	11.09 mg/L	7.82 mg/L	11.07 mg/L	7.37 mg/L
Summer Strati-fied?		Yes		Yes		Yes
Thermocline Depth (from lake surface)		5.5 m		5 m		6 m
Anoxic Layer Thickness (from lakebed at deepest loca-tion)		3.5 m (33%)		4.5 m (43%)		3.5 m (33%)
Strength of evi-dence for Inter-nal Loading		Very Strong		None		Strong
Estimated Trophic Status (based on sum-mer Chl-a)		Oligotrophic		Mesotrophic		Mesotrophic
Deepwater Chloride	110 mg/L	110 mg/L	100 mg/L	86 mg/L	92 mg/L	110 mg/L
E. coli Out-let/Surface (CFU/100ml)	ND / ND	78 / 36	ND / 6	150 / 56	Not Collected	260 / 34

**ND = 'non-detect' for E.coli, indicating less than 2 CFU / 100 ml*

Satellite Imagery Map of Albro Lake w/ Sampling Locations



Bathymetry Map of Albro Lake

halifax.ca/lakewatchers

HalifACT Acting on Climate Together

LakeWatchers

ATTACHMENT B

2024 Beach Season Water Quality Report

Background

In 2024, Halifax Regional Municipality operated 19 supervised beaches between July 1 – August 31, with Chocolate Lake Beach, Kearney Lake Beach, and Penhorn Beach remaining open through the Labour Day weekend ending September 3. Routine water quality monitoring took place weekly at all 19 supervised beaches.

Halifax Regional Municipality's beach water quality monitoring program is designed to meet the standards set in Health Canada's Guidelines for Recreational Water Quality. Region specific procedures are outlined in the municipality's 2024 Beach Water Quality Monitoring Protocol.

Water Quality Monitoring

E. coli *and Enterococci*

Samples for bacteria analysis are collected by Beaches staff weekly and submitted to an accredited laboratory for analysis. In 2024, the municipality contracted Bureau Veritas Laboratories in Beford for this service. 18 supervised beaches are located on freshwater lakes and are screened for *E. coli*. One supervised beach is located on a brackish lake, and is screened for enterococci.

Both *E. coli* and enterococci are fecal bacteria, can come from bird or mammal (including human) sources, and are human pathogens. High concentrations of these fecal bacteria indicate fecal contamination in water, as well as the possible presence of other disease-causing microorganisms. These organisms can cause numerous types of infections, including but not limited to gastrointestinal, skin, ear, eye, and respiratory infections.

At all locations, trained beach staff collect five samples across the beach profile every week. When the results are received, a geometric mean (geomean) is calculated of all five samples to assess recreational water quality of the entire beach. If the geomean and all five individual samples report bacteria concentrations within the Recreational Water Quality Guidelines (Table 1), the beach will remain open. If the geomean and/or any of the five individual samples report bacteria concentrations above the Guidelines, a water quality advisory against using the beach will be issued, and resampling will take place immediately. This process will continue until the samples are within the acceptable bacteria concentration.

Table 1: Health Canada's Recreational Water Quality Guidelines for Fecal Bacteria, 2024

	Geometric Mean	**Individual Sample**
E. coli	≤126 CFU/100mL	≤235 CFU/100mL
Enterococci	≤35 CFU/100mL	≤70 CFU/100mL

Water quality results are shared by Halifax Regional Municipality on our website, halifax.ca/beaches, on our social media channels, and on Swim Guide.

Cyanobacteria

Cyanobacteria, also known as blue-green algae, are native to freshwater lakes, rivers, and ponds in the Halifax Regional Municipality. They are some of the oldest organisms on Earth. Under favourable conditions, cyanobacteria populations can expand quickly, forming large, floating surface blooms, or spreading as benthic mats growing along the riverbed or lakebed. Some species of cyanobacteria can produce toxins that can be harmful to mammals, including humans. Microcystins are the most commonly produced algal toxins.

Human activities can change the conditions in a lake or river and encourage the proliferation of cyanobacteria, both directly and indirectly. Directly, changes to land use leading to soil erosion, fertilizing lawns, removal of vegetation in riparian areas, malfunctioning on-site septic systems, and inadequate stormwater management can all contribute nutrients to water bodies that allow cyanobacteria populations to boom. Indirectly, the effects of climate change, including warmer water temperatures and lower water levels, can extend the season where ideal growing conditions allow cyanobacteria to thrive.

Halifax Regional Municipality only monitors for and responds to cyanobacteria blooms at our supervised beaches. Lifeguards, who spend the most time at the beach and are best suited to identify changing conditions, are trained to visually identify cyanobacteria and do visual monitoring for the duration of their shifts (daily, 11am-6pm). If a suspected bloom or mat is observed, the affected beach is closed, and a sample of the material is collected for taxonomic identification. If potentially-toxin producing species are observed, the beach will remain closed. When the bloom is no longer visible (to allow for toxicity to peak and dissipate), a sample is collected for toxin analysis. If this sample indicates toxin concentrations in the water are below Health Canada's Recreational Water Quality Guideline for cyanotoxins, 10 µg/L total microcystins, the beach will be reopened. Confirmation that conditions have not changed between sample collection and receipt of toxin results is done using microcystin test strips.

A surface bloom of cyanobacteria was first reported in the municipality in Lake Banook, Dartmouth, in 2018. Since 2018, additional supervised beaches, Cunard Pond Beach in Halifax, Birch Cove Beach in Dartmouth, and Penhorn Beach in Dartmouth, have experienced confirmed cyanobacteria blooms that led to beach closures. In 2024, Cunard Pond Beach was closed for 44 days due to the persistent presence of a cyanobacteria bloom, and Springfield Beach was closed for five days due to a confirmed cyanobacteria bloom. Suspected blooms were reported to Nova Scotia Environment & Climate Change (NSECC) and shared on their website at Penhorn Beach, Springfield Beach (in May), Chocolate Lake and Lake Echo leading up to and during the supervised beach season. HRM staff were unable to confirm these reports, as no cyanobacteria were observed nor were measurable toxin concentrations identified when follow-up investigations were undertaken.

Benthic cyanobacteria mats were first observed near Oakfield Beach in 2021, which was closed as a precautionary measure after the mats were associated with the death of two dogs. In 2022, benthic mat material washed up on Oakfield Beach, causing another closure. To date, no other supervised beaches have experienced closures due to the presence of benthic mats.

2024 Water Quality Monitoring Results

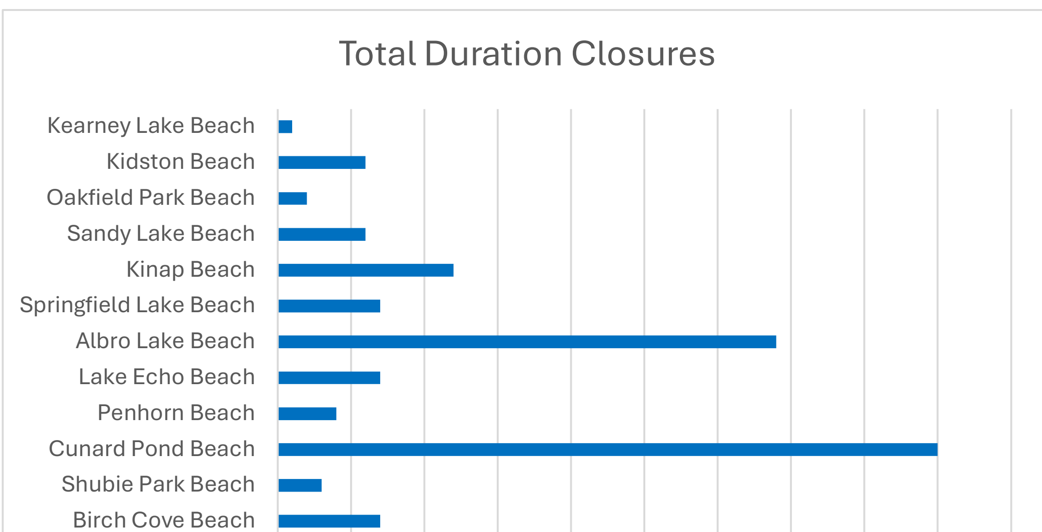


Figure 1: 2024 Supervised Beach Closures

During the supervised beach season, from July 1 to August 31, HRM issued advisories and closures at supervised beaches 27 times for a total duration of 134 days (*Figure 1*) where recreation was not advised at municipal beaches. This is a decrease from 225 closure days in 2023 and 163 closure days in 2021, and an increase from 103 and 81 closure days in 2022 and 2020 respectively.

Of the 134 days where swimming was not advised, 82 were water quality advisories due to elevated fecal bacteria concentration (either *E. coli* or enterococci), 49 were closures due to suspected and/or confirmed cyanobacteria blooms, and 3 were due to reports of skin symptoms at Birch Cove Beach where swimmer's itch was suspected but not confirmed.

<u>Water Quality Advisories Due to Elevated Fecal Bacteria</u>

There were several changes to the municipality's Beach Water Quality Monitoring Protocol in 2024, the primary of which was incorporating a 2024 update to Health Canada's *Guidelines for Recreational Water Quality* that lowered the acceptable concentration of *E. coli* for primary contact activities like swimming.

Staff anticipated that the lowered standards would lead to increased beach closure frequency and duration in 2024 compared to previous years. Public outreach, including direct engagement with local media, was done prior to the supervised beach season to advise the public of the guidelines changes and what to expect from the coming beach season.

To align with the practices of other Canadian jurisdictions, in 2024 the Beaches program shifted from "closing" beaches with elevated concentrations of bacteria to issuing water quality advisories where primary contact activities are not advised. Bacteria concentrations exceeding the guideline values were posted on the Beaches webpage on halifax.ca while a water quality advisory was in effect.

In 2024, there were 82 days where supervised beaches were under water quality advisory due to elevated bacteria concentrations, down up from 147 in 2023, but up from 46 in 2022. Weather conditions in 2024 (low rainfall, high humidity) are more reflective of those experienced in 2022 than 2023. Exceedances of both the *E. coli* and enterococci guidelines were most common when a rainfall event preceded testing, indicating that stormwater inputs continue to be a major contributor to reduced water quality at municipal beaches.

Albro Lake Beach, Kinap Beach, Birch Cove Beach and Lake Echo Beach all experienced above-average water quality advisories due to high bacteria concentrations. As discussed below, these beaches are all popular with ducks, geese, and other waterfowl, who create large volumes of fecal waste. Staff believe this bird waste, combined with heavy rainfall volumes and inadequate stormwater management, is the primary source of increased bacteria concentration at these beaches.

In June 2024, as proposed in the *2023 Beach Season Water Quality Report* to address frequent exceedances of recreational water quality guidelines, a 300" length of the shoreline at Birch Cove Beach on Lake Banook was naturalized. This project, which follows up on the recommendations of the Pollution Source Control Study for Lake Banook & Lake Micmac, took place in partnership with the HRM Parks Naturalization program and Helping Nature Heal Inc. The goal of the project is to reduce habitat for waterfowl near the supervised swimming area, and to increase the coverage of native plant species to capture overland flow and reduce shoreline erosion. It is expected to contribute to improved water quality at this beach as the vegetation becomes established. The project was done in consideration of the ongoing Coordination Strategy being implemented around Lake Banook by HRM's Parks Department.

<u>Cyanobacteria-related Closures</u>

In 2024, Cunard Pond Beach and Springfield Beach were closed due to confirmed toxin-producing cyanobacteria blooms. Starting July 9, Cunard Pond Beach was closed for 44 of the 62 days of the supervised beach season due to a persistent bloom. Springfield Beach was closed for 5 days at the end of the supervised beach season. Adverse health outcomes were not reported resulting from contact with either bloom occurrence.

The Centre for Water Resource Studies (CWRS) at Dalhousie University has been conducting passive monitoring for algal toxins at Cunard Pond Beach, among other sites, since 2022. While these samplers do not capture all water quality conditions in the full volume of water within the supervised swimming area, they are considered representative of swimming conditions. Even when the bloom was visible on the beach, no toxin concentration above, or even nearing the recreational guideline for total microcystins was observed. Improving access to local, relatively quick algal toxin testing would likely increase the number of days beaches affected by cyanobacteria blooms can safely remain open. Currently, lab turnaround time for microcystin samples is approximately 4 days, which is too slow to make operational decisions in response to water quality conditions.

Staff are also supporting research into benthic cyanobacteria mats at the CWRS. The research goals are to identify water bodies in the municipality where benthic cyanobacteria are growing, to better understand the conditions that support their growth, and to correlate the occurrence of benthic cyanobacteria to the risk to people and pets using the water.

Next Steps

Throughout summer 2024, the Halifax Regional Municipality experienced above-average air temperatures and below average rainfall. As the municipality continues to experience the effects of extreme weather due to climate change, we can expect to see changes in water quality at our supervised beaches. Acting now to offset these effects and improve water quality will help maximize both the health and safety of beach users and the number of days the municipality's supervised beaches remain open and without water quality advisories.

Adaptive Cyanobacteria Monitoring and Response

In 2024, Cunard Pond Beach experienced a prolonged closure (44 days) due to the presence of toxin-producing cyanobacteria in the swim area. This is down from 48 days in 2023, but up significantly from 20 days in 2022 and 21 days in 2021. Due to increased urban development and the effects of climate change, the likelihood of cyanobacteria blooms in the municipality's lakes will increase with time.

Staff did implement updates to the cyanobacteria closure protocol this year, removing the seven-day waiting period before reopening a beach after a bloom is last observed. Due to the persistent nature of the bloom, which appeared to blow into the beach area on a near daily basis, this change did not have an impact on the amount of time the beach was open for recreational use. Furthermore, the repeated closures appear to be discouraging the public from using Cunard Pond Beach even when it is open. Water levels in Cunard Pond are maintained by the dam at the outlet to Williams Lake, which is connected to Cunard Pond via a culvert under Williams Lake Road. The dam on Wiliams Lake is known to be leaking, causing water levels to drop below the bottom of the connecting culvert each summer, and preventing water circulation between Williams Lake and Cunard Pond. Due to this shallow water and poor hydraulic circulation in this area of the lake, it is likely that persistent blooms will continue to occur at Cunard Pond Beach in the future, at least until the Williams Lake dam is repaired.

Steps to further integrate monitoring being conducted by the CWRS into programming decisions are being explored. Should the municipality have access to more responsive and reliable toxin concentration testing, closure decisions could be made based on the concentration of toxins present in the water, rather than on visible presence of blooms. The current process is likely leading to more beach closures than are necessary even within the context of the recreational water quality guidelines.

Proposed Actions for Improved Water Quality

Albro Lake Beach, Birch Cove Beach, Lake Echo Beach and Kinap Beach all experienced an increase in closures due to the presence of elevated fecal bacteria (enterococci at Kinap Beach and *E. coli* at the others listed) levels as compared to 2022[1]. At all four of the freshwater locations, a significant population of waterfowl were consistently observed by beach staff throughout the beach season, leaving behind a significant volume of waste. Measures were taken to deter the birds from the beach and surrounding lawn area, including flashing lights and reflective materials, but these have not proven effective in the long term.

Stormwater runoff, both overland and from the piped stormwater system, also had a negative effect on water quality at all supervised beaches in 2024. Any material on land is available to be carried into surface water during a heavy rain event. Higher bacteria concentrations were observed at all urban beaches after rainfall events, even if they were not high enough to require the issuing of a water quality advisory.

Without action to improve water quality at these beaches with persistent bacteria exceedances, Lake Echo Beach and Albro Lake Beach in particular, it is likely that the high number of closure days will drive decision-makers to stop supervision. This would be a real loss to both communities, who benefit from monitored recreational water access, and free swimming lessons during the summer.

The primary proposed measure to improve water quality outcomes at supervised beaches are the reduction of lawn space at supervised beaches, especially at the riparian edge, and the replacement of this mowed lawn with naturalized landscaping. Reestablishing naturalized riparian edges will have many benefits for water quality:

- Waterfowl, especially geese, prefer mowed lawn spaces for resting and feeding,
- Low, mowed grass provides less water retention and contaminant capture during heavy rainfall events than less homogenous naturalized environments,
- Vegetation overhanging shallow water will provide shade and reduce local water temperature, improving fish habitat, reducing sunlight penetration needed by cyanobacteria species to photosynthesize and form potentially toxic blooms, and providing a less hospitable environment for bacteria to reproduce,
- Increased pollinator habitat,
- Increased populations of native plants,
- Alignment with municipal policies such as HalifACT and the Parks Naturalization Strategy, and
- Lower maintenance costs due to a reduced mowed area.

Another option that staff could explore to manage waterfowl populations at supervised beaches is hiring trained dogs to create an ‘ecology of fear’ and discourage waterfowl from congregating in the vicinity of the beaches. This method, first proposed in the Lake Banook Pollution Control Study completed for the municipality by Stantec in 2019, would have dogs regularly visit the beach area while it is not in use by people and outside of supervised hours to agitate waterfowl and drive them to occupy other areas of the lake. The principle is that over time, the waterfowl will consider the beach an unsafe environment, and would avoid this area of the lake. It should be noted that the dogs will not harm the birds directly, instead making an association of fear with the space.

Managing lakes as dynamic systems, rather than looking for solutions only within the beach area, will improve water quality outcomes over time, and provide added resilience to the impacts of climate change.

[1] Due to the above-average rainfall experienced in 2023, water quality advisory numbers in 2024 are being compared to beach closure numbers from 2022.