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

Item No. 11.4.1
Halifax Regional Council
June 29, 2021

TO: Mayor Savage and Members of Halifax Regional Council

SUBMITTED BY: **ORIGINAL SIGNED**
Councillor Mancini, Chair, Environment & Sustainability Standing Committee

DATE: June 3, 2021

SUBJECT: **Water Quality Monitoring Policy & Program Development**

ORIGIN

June 3, 2021 meeting of the Environment & Sustainability Standing Committee, Item 12.1.1.

LEGISLATIVE AUTHORITY

Administrative Order 1, *The Procedures of the Council Administrative Order*, Schedule 5 the Terms of Reference for the Environment and Sustainability Standing Committee (ESSC), Section 1 (1) and 2 (c) indicate purpose of the Committee as follows:

> 1. (1) Subject to subsection 1A, the purpose of the Environment and Sustainability Standing Committee is to provide advice to the Council relating to the Environment and Sustainability including Solid Waste Resources, energy security and sustainable parks, forests (urban and rural) and open spaces and water resource management.
>
> *(2) The other purposes of the Environment and Sustainability Standing Committee are to:*
> *(c) promote policies appropriate to protect water resources, parks, open spaces and green environment in the Municipality.*

RECOMMENDATION

It is recommend that Halifax Regional Council direct the Chief Administrative Officer to adopt and implement a detailed water quality monitoring program based on Framework 1 as outlined by AECOM in their Water Quality Monitoring Policy and Program Development Report, as outlined in the Discussion section of the staff report dated May 6, 2021.

BACKGROUND

The Environment & Sustainability Standing Committee received a staff recommendation report dated May 6, 2021, at their June 3, 2021 meeting respecting Water Quality Monitoring Policy & Program Development.

For further information on the background of this item, refer to the staff report dated May 6, 2021.

DISCUSSION

The Environment & Sustainability Standing Committee reviewed the staff recommendation report dated May 6, 2021. Following a discussion of the item, the Standing Committee approved the recommendation as outlined in the "Recommendation" portion of this report.

For further discussion on this item, refer to the staff report dated May 6, 2021.

FINANCIAL IMPLICATIONS

Financial implications are outlined in the attached staff report dated May 6, 2021.

RISK CONSIDERATION

Risk consideration is outlined in the attached staff report dated May 6, 2021.

COMMUNITY ENGAGEMENT

In accordance with the July 29, 2020 direction of the Minister of Municipal Affairs and Housing under section 14 of the Emergency Management Act, the Environment and Sustainability Standing Committee meetings are being held virtually.

The Meeting held on June 3, 2021 was livestreamed and video recordings are available at Halifax.ca.

The agenda and reports of the Environment and Sustainability Standing Committee are posted on Halifax.ca, and draft minutes of the meeting will be made available on Halifax.ca within three business days.

Standing Committee meetings are open to public attendance and members of the public are invited to address the Standing Committee for up to five minutes at the end of each meeting during Public Participation.

ENVIRONMENTAL IMPLICATIONS

Environmental implications are outlined in the attached staff report dated May 6, 2021.

ALTERNATIVES

Alternatives are outlined in the attached staff report dated May 6, 2021.

ATTACHMENTS

Attachment 1 – A staff recommendation report dated May 6, 2021

If the report is released to the public, a copy can be obtained by contacting the Office of the Municipal Clerk at 902.490.4210, or Fax 902.490.4208.

Report Prepared by: Haruka Aoyama, Legislative Assistant, Office of the Municipal Clerk, 902.490.6517

Attachment 1

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

Item No. 12.1.1
Environment & Sustainability Standing Committee
June 3, 2021

TO: Chair and Members of the Environment and Sustainability Standing Committee

SUBMITTED BY: ***Original Signed***

Kelly Denty, Director, Planning & Development

Original Signed

Jacques Dubé, Chief Administrative Officer

DATE: May 6, 2021

SUBJECT: **Water Quality Monitoring Policy & Program Development**

ORIGIN

On March 22, 2019, the following motion of Regional Council regarding agenda item 3 was put and passed:

THAT the Budget Committee direct the CAO to finalize the 2019/20 Proposed Budget and Business Plans as previously directed, including:

- *Water Quality Monitoring Program - $150,000*

LEGISLATIVE AUTHORITY

Section 227 of the *Halifax Regional Municipality Charter* provides that "The Council may adopt a municipal planning strategy for all, or part of the Municipality …"

Clause 229(1)(c) of the *Halifax Regional Municipality Charter* provides that "A municipal planning strategy may include statements of policy with respect to …. the protection, use and development of lands within the Municipality, including the identification, protection, use and development of lands subject to flooding, steep slopes, lands susceptible to subsidence, erosion or other geological hazards, swamps, marshes or other environmentally sensitive areas;"

Policy E-24 of the *Regional Municipality Planning Strategy* provides that "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."

Subclause 79(1)(av)(iii) of the Halifax Regional Municipality Charter provides that "The Council may expend money required by the Municipality for … all other expenditures … incurred in the due execution of the duties, powers and responsibilities by law vested in, or imposed upon, the Municipality, the Mayor, Council or officers."

RECOMMENDATION ON PAGE 2

RECOMMENDATION

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

1. Adopt and implement a detailed water quality monitoring program based on Framework 1 as outlined by AECOM in their Water Quality Monitoring Policy and Program Development Report, as outlined in the Discussion section of this report.

BACKGROUND

Water quality monitoring is an essential component to successful management of water resources, a shared responsibility between each level of government, the private sector and the general community. Each stakeholder has roles and responsibilities to protect and manage water resources. As described in the AECOM report, the federal government has sole jurisdiction for fisheries, navigation, federal lands and international relations. The federal and provincial governments share the responsibility over water issues related to agriculture, health and significant national water issues. The province of Nova Scotia takes a holistic approach managing inland waters with jurisdiction over flow regulation, water use development, water supply, pollution control and thermal and hydroelectric power development. As noted in the AECOM report, provincial and federal monitoring programs have different areas of focus and do not have sufficient level of detail to align with needs at the local level. As the level of government closest to residents and with responsibilities for planning, parks and recreation, community enjoyment and wellbeing, and environmental sustainability, the Municipality has a critical role to play.

Efforts to understand, protect and manage watershed health are supported by the Halifax Regional Municipal Planning Strategy (Regional Plan), the Green Network Plan and HalifACT. The Regional Plan section on Water Resources (Section 2.3) contains supportive policy for the protection of water resources including potable water supply sources, wildlife habitats, recreational enjoyment and aesthetic value. Relevant policies for a lake water monitoring program include protecting wetlands, retaining buffers, and restricting development within floodplains for designated watercourses. Watershed Planning (Section 2.4) relates to planning policies for new developments, requiring watershed or sub-watershed studies prior to undertaking secondary planning strategies in areas where new or additional development could adversely impact watercourses. These sections provide guidance on how developing a water quality monitoring program could positively impact our shared water resources.

The Halifax Regional Municipality's Water Resources Management Study (2003) recommended that the Municipality establish a water quality monitoring program. This program ran from 2007 to 2011, with additional monitoring of select lakes carried out by contractors (AECOM) between 2015 and 2017.

In 2019, Regional Council, the Regional Watersheds Advisory Board, and members of the community requested that the program be reinstated, or that a new program be introduced.

In 2019, staff contracted AECOM Canada Ltd. to explore the policy basis for corporate water quality monitoring and to develop options for water quality monitoring programming that were scientifically grounded, and which built on previous municipal monitoring programs. AECOM's project scope included considerations of the former monitoring program (2006-2011); monitoring conducted through Development Agreements; watershed studies; beach programming; stormwater monitoring; emerging issues such as blue-green algae blooms; pollutants of key interest including phosphorous, bacteria, and chloride; development of lake management plans, and data management. AECOM's project and final report[1] was completed in September 2020 and forms the basis for the recommendations presented in this report.

[1] https://www.halifax.ca/sites/default/files/documents/city-hall/boards-committees-commissions/210211rwabsp911.pdf

AECOM's review included limiting factors related to the 2014 Regional Plan, which help identify an opportunity for the Municipality to further protect water resources:

- Water quality monitoring is only triggered under secondary planning strategies for new or expanded developments. The policies do not address water quality monitoring related to existing conditions and recent human impacts from the built environment that may impact the type and extent of requirements for monitoring and mitigation.
- There are no requirements for monitoring to assess the impacts of historical activities and existing infrastructure and the absence of adequate infrastructure. To establish priorities for restoration and mitigation to protect and restore natural water resources, monitoring needs to document existing conditions.
- Policy E-11, which supports development of the Halifax Green Network Plan (HGNP), does not require water quality monitoring to inform land-use designation and protect lakes as open spaces within greenbelts for ecological and recreational purposes. The HGNP plan itself does not comment how the Municipality can support other groups monitoring lake quality nor offer how monitoring from others can be used to manage impacts.
- Policies to protect wetlands, retain riparian buffers, and restrict development within floodplains for designated watercourses also do not require water quality monitoring.

DISCUSSION

The purpose of water quality monitoring is to establish baseline conditions, answer questions, address key concerns, or meet other legislated requirements. A water quality monitoring program is a tool to capture information for which an organization can act to either remediate or improve the overall health of the ecosystem. It should not be a standalone program, but instead collect data to inform actions. Lakes within the municipality are stressed from land uses such as new development or resource extraction, all of which is exacerbated by a changing climate. Any funding allocated to a municipal monitoring program can be viewed as an investment, not only into water resources, but into tourism, recreation, ecosystem health, community wellbeing, climate risk management and more. These principles along with AECOM's recommendations (Attachment 1) form the basis of the recommendations presented in this report.

AECOM found that the current municipal policy framework for water quality monitoring lacks cohesion and does not adequately respond to the foundational principles cited above. Though this report's mandate was to focus on reinstating a water quality monitoring program, staff will continue to seek out opportunities to improve policy related to water resources management, as outlined by AECOM. The findings, analysis and data collected through the water quality monitoring program can be used as indicators for further action. Water is a shared resource and there is a shared responsibility to its maintenance and remediation. The proposed monitoring program provides another opportunity to improve the overall health of our region's watersheds.

One of AECOM's key recommendations is to develop and implement a core corporate monitoring program. The purpose of a core monitoring program is to have a standardized approach to lake monitoring and sampling that can be applied to all lakes of interest. It is based on scientifically accepted and proven approaches used by other jurisdictions but adapted to the unique needs of the municipality. If adopted, the program will be designed to ensure the collection of pertinent data which directly addresses key water quality concerns and management issues facing our community, while making effective use of resources.

The proposed monitoring program would consist of sampling 74 lakes on an annual basis, with the number of sampling events determined based on lakes' priority concerns and vulnerability (i.e. risk of harmful algae bloom, high chloride concentration, historical E. coli contamination, or other risks from land use). Class A lakes are listed as high vulnerability and Class b is moderate vulnerability. Water quality would be tested using routine parameters for lake trophic status, chloride levels, and important observational information such as ice in/out, presence of algae blooms, invasive species or nuisance aquatic plant growth. These

baseline parameters, especially when collected over several seasons, and when compared to previous study findings, will provide the Municipality with a foundational understanding of lake health. This will be critical to informing management and land development strategies.

Sample frequency may decrease in lakes after year 2 of the program if no significant changes have occurred since the 2007-2011 program, Additional monitoring approaches may be triggered for lakes with concerning trends or detrimental water quality results. These can be designed with specific objectives and implemented on a lake-by-lake basis as a supplement to the core monitoring program. The triggered monitoring would be led by HRM but would include cooperation with academia and community groups as appropriate. Costing for this work would be specific to the task. While setting the criteria is beyond the scope of this undertaking, lake specific monitoring that may be triggered upon analysis of the results of the core monitoring program could include upward trends in total phosphorus, chlorophyll, chloride and conductivity; exceedance of total phosphorus, chlorophyll, chloride or E. coli guidelines, or reoccurring harmful algal blooms.

Framework Options

AECOM developed three frameworks for a core monitoring program, distinguished by the number of lakes sampled, the involvement of community, and the basis for selecting lakes for monitoring. Framework 1 proposes to sample 74 lakes twice a year, would be led by HRM staff in conjunction with community support. Framework 2 proposes to sample 23 lakes and would be community-led with HRM support. Framework 3 proposed to sample 74 lakes twice a year, led and implemented fully by HRM staff with observational information from residents or other stakeholders. A summary of these frameworks can be found below in Table 1.

Table 1. Comparison of Frameworks developed by AECOM

Element	Framework 1	Framework 2	Framework 3
Sample Size	Class A Lakes (High Vulnerability; 2 events per year) Class B Lakes (Moderate Vulnerability; spring only) Reference Lakes Total Number of Lakes: ~74	Priority Eutrophication Lakes Priority Chloride Enrichment Lakes Total Number of Lakes: ~23	Class A Lakes (2 events per year) Class B Lakes (spring only) Reference Lakes Total Number of Lakes: ~74
Operations and Management (Monitoring Staff)	• HRM staff led • Community support for lakes with community volunteers; monitoring by HRM staff to be reduced over time with progressively more volunteer commitment • Observational information from residents or other stakeholders	• Community-led with HRM support for lakes without community volunteers; monitoring by HRM staff to be reduced over time with progressively more volunteer commitment • Observational information from residents or other stakeholders	• HRM staff is responsible for all aspects of program operation and management, including monitoring activities. • Observational information from residents or other stakeholders
Cost Responsibility	• HRM funded with in-kind support from volunteers (to conduct monitoring, provide equipment if available)	• HRM funded with in-kind support from volunteers (to conduct monitoring, provide equipment if available)	• HRM funded and implemented

Of the three frameworks developed by AECOM, staff recommend that Framework 1 be used as a basis for a long-term, comprehensive lake monitoring program. Framework 1 builds on the existing community-based monitoring activities, covers a broad geographic area and is led by the Municipality. This will allow for regional stressors on water quality to be identified. Through this approach, volunteer support can also be maximized while still maintaining ownership of the data in order to ensure data acquisition and quality, data sharing and financial support. From a financial perspective, Framework 1 allows for a consistent approach for budgeting while maximizing return on investment and building partnerships. A summary of potential core monitoring program elements is presented below in Table 2.

Table 2. Proposed Program based on Framework 1

Element	Description
	Core Monitoring Elements (Applicable to All Frameworks)
Design	• a single, fixed station in a central deep lake location • additional stations for lakes with complex morphometry/distinct basins

Frequency and Timing	• Annual sampling
	• Number of sampling events dependent on lake vulnerability classification
	• Class A – High Vulnerability Lakes have 2 sampling events per year at each lake
	  ○ once in spring during mixed-water column conditions
	  ○ once at the end of summer
	• Class B – Moderate Vulnerability Lakes are sampled once per year at each lake:
	  ○ once in spring during mixed water column conditions (ahead of thermal stratification)

Parameters and Collection Methods	**Routine:**
	• Secchi depth
	• Lake depth
	• Field measurements
	  ○ Full water column profiles (temperature, pH, dissolved oxygen concentration, specific conductivity)
	• Laboratory Analysis
	  ○ TP (low-level detection limit) (euphotic zone composite)
	  ○ Chlorophyll α (euphotic zone composite)
	  ○ E. coli
	
	Supplemental (if triggered):
	• TP (1 metre off bottom, end of summer sampling only)
	• Chloride (1 metre off bottom)
	
	Observational:
	• Aquatic invasive species incidental sightings
	• Algae bloom incidental sightings
	• Ice-on and ice-off dates
	• Other water quality related observations (e.g., nuisance aquatic plant growth, unusual visual appearance of water or odours)

Operations and Management	• Municipality responsible for program coordination and management, provision of equipment, data verification, analysis and management, reporting

Quality Assurance	• Implementation of a Quality Assurance Plan to include:
	  ○ monitoring protocols for collecting samples
	  ○ only accredited laboratories be used for chemical analysis
	  ○ data review and management protocols
	  ○ methods for handling suspect data or outliers
	  ○ randomized duplication of samples

Program Evaluation and Reporting	Annually: • Overview Report on monitoring activities and summarizing data by lake (i.e., trends, relative to guidelines/targets)

	After Two Years Following Program Start-Up: • Detailed Program Report that addresses monitoring objectives with recommendations for management needs/policy and planning considerations on a lake-by-lake basis and on a regional basis • Water Quality Report Card that concisely documents water quality in lakes using appropriate metrics based on a scientific assessment with presentation appropriate for public understanding. Potential for comparison of lakes monitored both through this new program and the 2007-2011 study. • Monitoring Program Framework Review to identify and resolve program issues, improve programming based on new information (e.g., reclassify lakes, address new or emerging concerns, identify trigger monitoring requirements) and potential next steps to fix identified issues • Determine frequency of subsequent program reports • Data available on Halifax Open Data and other data sharing platforms • Look for linkages to public education campaigns • Identify opportunities for next steps for remediation and changes in policy

Framework 2 samples a much smaller subset of lakes and sampling would be entirely carried out by community volunteers. This framework is not desirable as it could potentially overlook key areas of concern and the Municipality would not have direct control of the program and its outcomes.

Framework 3 samples the same number of lakes as Framework 1 but would be run exclusively by the Municipality and would not include coordinated volunteer monitoring. This approach is not desirable as it would not build lake stewardship by engagement concerned residents. Volunteer groups play an important role in water quality monitoring at a local level and community engagement is important for overall improvement in lake health. Therefore, Framework 1 provides the ideal approach that allows the Municipality to maintain control over the monitoring program for future decision-making while also engaging the public.

Resourcing

A new municipally-led water quality monitoring program requires a full-time program manager. As the program expands to support more community groups, the Program Manager will likely need to support from a full-time program assistant and seasonal staff members for field monitoring and working with volunteer teams from community groups.

In the start-up year there will be additional costs for the purchase of monitoring equipment kits for volunteer groups and for the purchase of data management software. Ongoing costs for program operation include replacement probes and consumables for monitoring equipment, costs for the core monitoring program, and continued licencing costs for data management software. Additional costs may be incurred and saved over time as more community groups become involved. Other costs include consulting services, annual grants for community groups, and collaboration with academia where funds can be doubled or tripled by academic fund matching programs.

Seasonal costs are the expected, yearly funds required for laboratory, personnel and expenses associated with sampling activities. This metric is estimated based on the amount of sampling events (or sampling effort) put forth by the Municipality. As more community organizations join the program, some of the sampling costs will shift from the Municipality collecting the data to the Municipality training and supporting participating community groups as they collect the data. The Municipality would still need to coordinate sample pick up and submission to accredited laboratories.

It is expected that additional resources will be required to develop lake-specific management plans and targeted next steps if collected data reveals unfavourable trends. More detailed lake management plans and targeted monitoring for specific lakes has not been incorporated into the program budget. These focussed plans will vary in scope and duration, so they will need to be considered separately from the core monitoring program. In these circumstances, staff will bring this to the attention of Regional Council with proposed next steps.

FINANCIAL IMPLICATIONS

As outlined in the discussion section, Framework 1 requires a new full-time staff member and start up costs for the 2021/2022 fiscal year. These costs are included in the 2021/22 operating budget for Planning & Development.

The program will be setup in year one with costs totaling $145,000. This will include staffing, purchasing equipment and setting up an internal data management software. Year 2 is expected to be approximately $230,500, which will include the first year of sampling and associated lab fees as well as funding for consulting, research and community grants. There will be ongoing costs associated with equipment maintenance, water sample collection, and data management licensing in subsequent years and throughout the duration of the program. Should Council approve the program, staff will seek funding and other partnership opportunities to further support the program from provincial and academic sources.

Table 3. Proposed budget breakdown for Water Quality Monitoring Program

HRM Water Quality Monitoring Program		Total
Year 1 (No sampling)	• WQM Staffing - $ 85,000 • Equipment - $50,000 • Data Management software - $10,000	$145,000
Year 2 (Sampling Begins)	• WQM Staffing - $133,000 • Sampling costs - $30,000 • Ongoing Costs - $10,000 • Consulting & Research - $50,000 • Grant Program - $7,500	230,500
Subsequent Years	• WQM Staffing - $133,000 • Sampling - $30,000 • Ongoing costs - $10,000 • Consulting & Research - $50,000 • Grant Program - $7,500	230,500

The 4- year estimated financial implications are summarized as follows:

Fiscal Year	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Operating – Cost Centre	$145,000	$230,500	$235,110	$239,812

There is $380K included in Planning & Development's operating budget for 2021/22. The remaining funds will be used for further investigations and remediation where appropriate.

RISK CONSIDERATION

There are no significant risks associated with the recommendations in this Report. All community volunteers will be required to take mandatory safety training. The risks considered rate low. To reach this conclusion, consideration was given to environmental risks.

COMMUNITY ENGAGEMENT

AECOM engaged several community groups, regulators and local university representatives as part of their report. The consultations were held between December 13, 2019 and February 6, 2020. In these meetings, information on the project objective and mandate were shared, and feedback was gathered. This process was also used to identify opportunities for partnership and collaboration with water quality specialists from external organizations, which the HRM could pursue to aid in achieving HRM-led corporate water quality monitoring program objectives that it may not be able to accomplish independently.

A group consultation session was held on February 5, 2020 with lake stewardship and community group representatives. The community groups were asked to fill a 'Community Group Profile Questionnaire' to gain a better understanding of the roles of these groups, and whether they currently conduct monitoring activities. AECOM noted that more groups do exist in the HRM than those that attended the meeting. These other groups were not intentionally excluded, and future consultations should aim to engage all existing groups.

Upon approval of this report's recommendation, as part of program development, staff will re-engage with the community on their potential participation on program.

ENVIRONMENTAL IMPLICATIONS

The purpose of conducting water quality monitoring in HRM lakes is foundational to effective water resource management and can inform planning policies for how future growth and development should take place. Consequently, there are positive environmental implications in running this type of program.

ALTERNATIVES

1. Council could decide not to establish a water quality monitoring program in the 2021-2022 budget year or fund a new position for a "Water Quality Program Manager". This is not the recommended for the reasons outlined in this report.

2. Council could decide on an alternative approach to the program based on either Framework 2 or 3 as proposed by AECOM. These are not recommended approaches. Framework 2 would sample a smaller number of lakes compared to the framework recommended in this report, leaving out several lakes of interest. Framework 3 would sample the same number of lakes but would be conducted entirely by municipal staff. Neither of these are recommended alternatives as they would exclude potentially important lake systems and/or not allow for community engagement and action. The cost of Framework #2 and #3 is in the table below for comparison.

Fiscal Year	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Operating Cost of Framework #2	$172,202	$167,952	$171,311	$174,737
Operating Cost of Framework #3	$239,739	$247,390	$252,338	$257,385

ATTACHMENTS

Attachment 1. Summary of Recommendations for Consideration by HRM Regarding the Establishment of a Municipally Led Lake Monitoring Program (AECOM Canada Ltd.)

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: Emma Wattie, Water Resources Specialist, Energy & Environment, 902.223.2479

Table 18:Summary of Recommendations for Consideration by HRM Regarding the Establishment of a Municipally Led Lake Monitoring Program

Ref #	TOC Item #	Topic	Summary of Observation	Recommendation
A. Program Wide Recommendations				
A1	7.2	Core Water Quality Monitoring Program for HRM	The responsibility for implementing water resource management within the bounds of HRM, by default lies with local governments. This has been evidenced with examples from other jurisdictions, all of which (Muskoka, Sudbury, King's County, Carleton River and Minneapolis – St. Paul) have taken the lead to protect and manage their natural resources from impacts within their jurisdictional control. Commonly, this control is affected through land-use planning for current and future developments but frequently includes taking responsibility for old infrastructure (e.g. historic dams or out-dated approaches to managing stormwater).	A core water quality monitoring program is recommended for HRM that addresses those water quality issues and concerns that are likely to result from land use practices that HRM can control or manage through implementation of municipal policies, planning and programming or that directly affect HRM's ability to provide valued services (e.g., public beaches). The lake water quality concerns identified from policy direction in HRM's regional plan, a review of background studies, consultation with water resource managers and the evaluation of development agreements include: • Eutrophication; • Chloride enrichment; • Bacteria contamination; and • Invasion of non-native aquatic species Climate change and its potential to exacerbate water quality issues is also of concern and requires consideration in the development of a monitoring program but it is recognized that HRM will be directly influencing mitigation of climate induced impacts while direct controls are largely outside of their responsibility. Three (3) core monitoring program frameworks are proposed for consideration. Framework 1 combines the core regional scale monitoring led by HRM and builds on the existing community-based monitoring activities. Framework 2 is community-based monitoring program that leverages active participation of volunteers to conduct monitoring and is focused to provide long-term monitoring of lakes that are most vulnerable to eutrophication and chloride enrichment. Framework 3 implements the core monitoring at a regional scale in HRM and is led by HRM without integrating the community-based support.
A2	1.6	Policy Review	Water quality monitoring is conducted federally and provincially in Nova Scotia and monitoring, and research is undertaken by academia.	All of these monitoring programs have different areas of focus and are not sufficiently detailed or aligned with the needs of HRM to meet decision making needs for water resource management at the local level.
A3	5.5.2	Policy Overview	HRM needs to define a broad social policy statement that integrates and subsumes existing environmental policies to achieve a sustaining socio-economic objective for the community.	HRM Council should consider adopting an overarching policy toward development within the region that addresses broad social policy objectives where one measurement of accountability of the HRM Council will be the effective implementation and reporting of the achievements of development agreement environmental monitoring plans. This broad policy document will need to integrate all of the individual policies adopted for development agreements and provide a comprehensive statement for all of the individual policies such that Council and residents can clearly understand the objective(s) and know that these actions are contributing to the socio-economic sustainability of the community as a whole.

Ref #	TOC Item #	Topic	Summary of Observation	Recommendation
A4	9.1	Collaboration	Partnerships and collaborations should be maximized for the delivery of an effective lake monitoring program	Creation of an HRM lake stewardship community committee to be led by HRM, to unite lake stewardship and community groups and HRM and to serve as a forum for communicating and sharing information relating to the management and protection of water resources. Establish an ongoing grant program with sustained funding for lake stewardship groups to apply for, for funding associated with projects/equipment/training deemed important and relevant by HRM. Establish an ongoing annual budget to be set-aside for leveraging funding opportunities associated with academic researchers for the purpose of lake-specific investigations, and/or investigations associated with key water concerns relevant on a region-wide basis. Continue to participate and support provincial and federal government initiatives.
B Recommendations Related to Monitoring Associated with Development Agreements				
B1	5.5.1	Developers Concerns	The success of a monitoring program for development agreements depends on a clear objective and consistency to the extent possible so that all developers are treated openly and that developers have full, advanced awareness of expectations.	Adopt a standardized process to create consistency for developers and for HRM staff that effectively considers the variations in development, the nature of the land to be developed and the differences among the receiving water bodies.
B2	5.5.1	Stormwater Management	Storm water management should not take an “end of pipe” approach. HRM and developers pay for stormwater discharges released off-site. Rather, storm water management is most cost-effective and beneficial to the natural environment by managing stormwater on-site both for the short term and the long term through the integration of BMPs and LID practices into the developments.	Full implementation of the ISMPF (Halifax, 2017) requirement that “a new property must retain the first inch of rainfall on site, as well as remove 80% TSS, using green stormwater infrastructure. These standards will be backed by a new by-law and will be triggered with development permits”. Monitoring programs implemented under development permits need to confirm the achievement of these requirements and provide documentation of the best practices as they apply to the Halifax area. Implementation of the approved HRWC stormwater service charge exemptions and the stormwater credit program to encourage stormwater users including HRM to pursue BMPs to reduce their loading to the stormwater system by managing stormwater to the extent possible on their own sites, including roadways. The approved credits result in a reduction to the stormwater service charges Consideration should be given to expanding the current approved credit program against stormwater service charges to include “credit banking” such that developers who exceed minimum targets in one area can apply them in others or sell them to a municipally operated credit bank as a means of encouraging developers to go beyond the minimum standards. Credit banking could move stormwater management to another level with promising results from other jurisdictions.

Ref #	TOC Item #	Topic	Summary of Observation	Recommendation
B3	5.5.1	Objective of Development Agreement Monitoring Programs	The objective of development agreement-based monitoring programs should be restricted to establishing existing conditions and effectively measuring impacts of the development and the benefits of the BMPs and LID practices incorporated into the development plan.	Any monitoring program designed to assess the impact of development or the effectiveness of mitigation measures including BMPs and LID should not be used as a replacement of well-planned and ongoing lake monitoring programs. Development agreement monitoring programs must be used to measure the effectiveness of these planning initiatives in order to demonstrate their benefits. Monitoring associated with developments could augment a core lake monitoring program but should not replace it.
B4	5.5.1	Monitoring a subset of small catchments for TP export and stormwater management	CWRS (2016) recommended monitoring a small set of sub-catchments for the Bedford West site.	The Phosphorus Net Loading Assessment (PNLA) approach for the River Lakes Planning District be adopted or adapted to other developments such that the developer must demonstrate in advance that there will be no significant change to water quality and quantity exports from the project through the application of BMPs and LID practices on-site and incorporate a monitoring program appropriate to measuring the benefits and confirming model predictions.
B5	5.5.1	Enhance HRM staff complement	AECOM's review of reporting activities for the Bedford West Planning Strategy identified a number of concerns with the contracted reporting that can be overcome by stronger and timely oversight by municipal staff.	Enhance the staff complement to ensure sufficient resources are available to provide the necessary input to the design of the monitoring program and either to provide the technical and plain language reporting or to provide effective oversight of this reporting by others as reporting is critical to obtaining the ongoing support from HRM Council, citizens and developers; If reporting is to be contracted out, HRM staff need to ensure that expectations are clearly specified and followed and that preceding reports are effectively considered, and analytical methodologies are consistent and relevant to the available data and the purpose of the monitoring.
B6	5.5.1	Reporting of results	Effective and comprehensive progress reporting is essential to reviewing the outcomes of development agreement monitoring programs and to ensure that lessons are learned and implemented in a timely manner.	The approach to presenting data and synthesizing the data to provide an ongoing evaluation of the success, limitations or gaps in the monitoring program needs to be established early and comprise an integral part of the development monitoring agreement from pre-development, construction and through post-development phases. Interpretive reports must effectively consider broader activities in the study area that could affect the water quality data, not just limit the scope of the report to the initial purpose of the monitoring program.
B7	5.5.1	Clearly defined roles	Definition of roles and responsibilities of the multiple pieces of government, the developer and the community in successfully implementing the development-based monitoring programs is required.	Clearly defined roles and responsibilities of all stakeholders are essential (e.g., each HRM staff department involved in the development process, the Regional Watershed Advisory Board, the Province, and the developers). A clear assignment of responsibility for monitoring should be made to the developer (not to general contractor or sub-contractors) with the added requirement that the developer must ensure trained and qualified personnel are undertaking the monitoring. In addition, it must be clear that the developer is clearly responsible for maintenance during the construction period of the development as well as being responsible for ensuring a mechanism for maintaining all mitigation measures incorporated into the design that are on private property.

Ref #	TOC Item #	Topic	Summary of Observation	Recommendation
B8	5.5.2	Policy Overview	HRM needs to define a broad social policy statement that integrates and subsumes existing environmental policies to achieve a sustaining socio-economic objective for the community.	HRM Council should consider adopting an overarching policy toward development within the region that addresses broad social policy objectives where one measurement of accountability of the HRM Council will be the effective implementation and reporting of the achievements of development agreement environmental monitoring plans. This broad policy document will need to integrate all of the individual policies adopted for development agreements and provide a comprehensive statement for all of the individual policies such that Council and residents can clearly understand the objective(s) and know that these actions are contributing to the socio-economic sustainability of the community as a whole.
C Recommendations Related to Municipal Led Lake Monitoring Program				
C1	7.4	Lake Specific Management Plans and Triggered Monitoring	More complex or different monitoring approaches are warranted to more thoroughly investigate water quality issues that go beyond a core water quality monitoring program. These approaches are best designed and implemented on a lake-by-lake basis. These types of focused lake monitoring approaches need to consider the specific issue at hand and the individual characteristics of the lake in question and are therefore best developed as part of a lake management plan specifically designed and costed to fulfill the objectives of the plan.	Additional monitoring based on specific lakes with known water quality issues may be required and this monitoring should be designed as a part of **Lake Specific Management Plans**. Future work should be completed to determine the lakes which require lake specific management plans, which should be developed based upon a review of data that may identify issues, public concerns or external development pressures. Lake management plans would be developed under the direction of HRM with input from the community lake associations if they exist, academics and professionals in the field. Monitoring specifics and costs and the sharing of the workload among HRM, the community, academia and others would be addressed in the plan and is beyond the scope of this report. **Triggered Monitoring** – a future core monitoring program may identify special needs that need to be investigated. This triggered monitoring is derived from management considerations for an individual lake and would be based on a set of management threshold criteria and the monitoring program would be designed to address these criteria. Future undertakings are required to determine the set of management threshold criteria for HRM's purposes.
C2	9.2.1	Staffing	Implementation of either comprehensive frameworks 1 or 3 requires HRM staffing	HRM establish a full-time position for a dedicated corporate lake water quality Program Manager. It is further recommended that the Program Manager be supported by a full-time program assistant and these full-time personnel would be supported by seasonal staff members who are responsible for field monitoring as may be necessary as well as working with the volunteer teams.
C3	9.2.3	Community involvement	Leveraging support from community volunteers and existing stewardship or lake associations	Frameworks 1 and 2 propose and AECOM recommends leveraging support from volunteers from the community and lake-base stewardship groups for those lakes where groups are already established. Both frameworks propose utilizing community-based volunteers to conduct the field activities including collecting the scheduled samples during each of the spring and summer sampling events, along with collection of associated field observations. These frameworks utilize and empower members of the community who have a strong interest, commitment and knowledge pertaining to the lakes in their area. It is also anticipated that community members will be helpful contributors for observational data collection such as incidental sightings of aquatic invasive species and algae blooms, ice-on and ice-off dates and other water quality observations.

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C4	9.2.4	Involvement of Academics	Ongoing involvement and support of locally based academics in the monitoring program	Partnership opportunities should be explored to gain assistance from academia for monitoring activities (e.g., student participation) in exchange for data sharing. HRM should also consider partnerships with academia for research-related activities that may be applicable to the municipality, or applicable to lakes with similar vulnerability classifications. To effectively achieve this we recommend that funds should be set aside on an annual basis to plan for future undertakings whereby these collaborations are expected, and funds invested by the Municipality can be essentially doubled or tripled through project-specific collaboration with academics/student researchers through NSERC match funding opportunities.
C5	9.2.5	Contract expertise as required	Specialized technical support for the new HRM staff be contracted as necessary	All three (3) proposed program frameworks recommend program operation and management by HRM through the hiring of a full-time program manager. Additional resources are recommended, depending on the framework that is chosen. Depending on the education and experience of the future direct hires by HRM, additional support by way of paid service arrangements will likely be required. However, the type and scope of additional support that may be needed will be determined based on the skills and expertise of the future program manager and/or program assistant. Specific budget allotments should be provided for this support.
C6	9.2.6	Equipment needs	An allocation for key equipment is required for purchase, rental and maintenance	A list of essential standard equipment that HRM should acquire for the lake monitoring program and their cost is provided.
C7	9.3	Quality Assurance / Quality Control	Effective implementation of a lake monitoring program requires a QA/QC program	A quality assurance and quality control (QAQC) plan is essential to a successful monitoring program to ensure that data are of adequate quality to meet the project objectives and to avoid potential loss of data due to sampling errors, malfunctioning equipment, data transcription errors, loss or breakage of samples in transit to the laboratory, etc.
C8	9.4	Program evaluation and reporting	Periodic review of the monitoring program is required.	Periodic review and evaluation of the monitoring program should be undertaken to determine if the program met or will continue to meet decision needs for HRM, to correct issues or challenges faced during implementation, and to incorporate changes that reflect improved understanding of the system or new or enhanced monitoring techniques and additional water quality variables. This review should consider all aspects of the program.
C9	9.4	Program evaluation	Receive input and maintain records	To inform the program evaluation, it is recommended that HRM obtain input from other municipal departments and agencies (i.e., Halifax Water), as well as from partners or collaborators. This can be achieved by a questionnaire, tailored to obtain feedback on specific elements of the program. It is also recommended that the Program Manager maintain a log of monitoring program successes and challenges, and comments or feedback obtained over the course of the program that can be brought forward into the evaluation
C10	9.4	Reporting	Evaluation undertaken with detailed reporting and plain language reporting	The program should be evaluated two years following program start-up. It is recommended that the evaluation be completed as a component of the detailed monitoring program report so that findings from the monitoring can be used in the evaluation and recommendations made in that report. These will be carried through into the plain language and administrative reports. After the initial two-year period following program start-up, reporting and program evaluation frequencies should be re-assessed to determine optimum frequencies.

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				The success of the lake monitoring program will be judged based upon its ability to communicate effectively the outcomes of the program. Reporting, as noted above, must be technically competent, but without effective plain language reporting to Council and the community, it will not receive the sustained support that is required. This will be a primary responsibility of the HRM team.