Halifax Regional Municipality

Preston Area Watershed Study Final Report

Prepared by:

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Project Number:

60303077

Date:

October 2014

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October 31, 2014

Mr. Cameron Deacoff
Planning and Infrastructure
Halifax Regional Municipality
88 Alderney Drive, 3rd Floor
Dartmouth, Nova Scotia

Dear Mr. Deacoff:

Project No: **60303077**
Regarding: **Halifax Regional Municipality**

AECOM is pleased to submit the attached Final Report for the Preston Area Watershed Study. The report focuses on surface water and groundwater quality issues to provide HRM and the related communities current information that can be used for municipal and community planning. The report fulfills the requirements of a watershed study as defined in the Regional Plan policy E-17.

We look forward to receiving your comments. Please do not hesitate to contact the undersigned should you have any questions or require additional details.

Sincerely,
AECOM Canada Ltd.

REDACTED

Steve Murphy, MBA, P.Eng.
Senior Manager, Atlantic Canada

SM:am
Encl.
cc:

Distribution List

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	Timothy Bachiu	August 5, 2014	Draft of Final Report issued to client
2	Timothy Bachiu	September 2, 2014	Final Report issued to client for public comment
3	Timothy Bachiu	October 17, 2014	Final Report including public comments issued to client
4	Timothy Bachiu	October 31, 2014	Final Report incorporating comments from Steering Committee

AECOM Signatures

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Executive Summary

Development in the Halifax Regional Municipality (HRM) is guided by the Regional Municipality Planning Strategy (the Regional Plan) which provides a framework that outlines how future sustainable growth can be achieved while preserving the environment and growing the economy. The Regional Plan is implemented through processes that include secondary planning strategies informed by background studies. The secondary planning strategies in HRM include Municipal Planning Strategies (MPS) that are reviewed through Community planning exercises to ensure the MPS reflects the current community issues. This watershed study is an example of a background study that will be used by HRM and community groups in future MPS or Community planning processes to inform the type and degree of development that is suitable for the area.

This study area is defined by the Salmon River watershed and the Partridge River watershed which includes the communities of Cherry Brook, North Preston, Lake Loon, Montague Gold Mines and East Preston, and also includes a portion of the Lake Major Protected Water Area (PWA). The areas of Lawrencetown and Mineville are between the Salmon River watershed and Partridge River watershed and are not part of the original study area. At the request of residents during the study, the areas of Lawrencetown and Mineville were included in portions of the study, including surface water sampling and groundwater sampling.

The biophysical conditions of the watersheds are influenced by development in the southern portions of the watersheds and largely remain undeveloped in the northern portions of the watersheds.

Surface water quality in the Salmon River watershed displays limited influence from urban development, while the Partridge River watershed is rich in nutrients. The upstream portion of the Partridge River watershed contains the North Preston Waste Water Treatment Plant (WWTP) which treats waste water (sewage) from North Preston and discharges the treated effluent to Winder (Whynder) Lake. The discharge to Winder (Whynder) Lake is very high in nutrients, such as nitrate and phosphorus, which promotes growth of algae in Winder (Whynder) Lake. High concentrations of nutrients and excessive algae growth can deplete the oxygen in the lake, making it difficult for other lake organisms to survive, such as fish. This process of high nutrient inputs resulting in a reduction of the available oxygen is called eutrophication. Winder (Whynder) Lake is an example of a lake that has under eutrophication from discharge of the WWTP. The results of this study suggest the lakes downstream of Winder (Whynder) Lake, such as Eagle Lake and Frog Lake, also have high nutrient concentrations and are at risk of deteriorating water quality including eutrophication.

Follow up water quality monitoring is recommended for Long Lake, Lake Major, Eagle Lake, Frog Lake and Winder (Whynder) Lake, with a priority focus on the Eagle Lake and Frog Lake.

Water quality objectives have been established for the main waterbodies based on historical sampling and sampling completed during the course of this study. Current conditions have been compared to the water quality objectives to estimate the assimilative capacity of the waterbodies.

Lake	Water Quality Objective	Representative Phosphorus Concentration	Assimilative Lake Capacity (Amount of Phosphorus the lake can assimilate without exceeding water quality objective)
Lake Major	< 10 µg/L	8 µg/L	2 µg/L
Long Lake	< 20 µg/L	17 µg/L	3 µg/L
Eagle Lake	< 20 µg/L	20 µg/L	0 µg/L

Groundwater is utilized for potable water in portions of the study area. Groundwater quality and quantity issues in the study area were addressed using historical data and the results of a residential well survey completed as part of this study. The East Preston area, Montague Mines and the Lawrencetown/Mineville communities were grouped together based on similar geography and geology conditions. Each community has specific groundwater issues with Coliform bacteria being the primary issue of concern in East Preston, arsenic in the Montague Mines area and arsenic and groundwater quantity concerns in the Lawrencetown/Mineville area. Not all residences utilize water treatment systems and the proportion of people using water treatment systems is variable between the communities. However, approximately 50% of residences surveyed in each community are at risk of consuming untreated water that may pose a health risk.

Areas within the watershed that have environmental conditions that may be sensitive to development have been identified for consideration during the planning of future development. These areas include watercourses, wetlands, riparian zones, high groundwater recharge and steep slopes.

The objectives of Policy E-17 in the Regional Plan are addressed by providing:

a. Recommendations to protect and manage quantity and quality of groundwater resources;
b. Recommendations for water quality objectives for key receiving watercourses in the study area;
c. Determination of the amount of development and maximum inputs that receiving lakes and rivers can assimilate without exceeding the water quality objectives recommended for the lakes and rivers within the watershed;
d. Determination of the parameters to be attained or retained to achieve marine water quality objectives;
e. Identification of sources of contamination within the watershed;
f. Identification of remedial measures to improve fresh and marine water quality;
g. Recommendations for strategies to adapt HRM's stormwater management guidelines to achieve the water quality objectives set out under the watershed study;
h. Recommendations for methods to reduce and mitigate loss of permeable surfaces, native plants and native soils, groundwater recharge areas and other important environmental functions within the watershed and create methods to reduce cut and fill and overall grading of development sites;
i. Identification of and recommendations to protect and manage natural corridors and critical habitats for terrestrial and aquatic species, including species at risk;
j. Identification of appropriate riparian buffers for the watershed;
k. Identification of areas that are suitable and not suitable for development within the watershed;
l. Recommendations for potential regulatory controls and management strategies to achieve the desired objectives; and
m. Recommendations for a monitoring plan to assess if the specific water quality objectives for the watershed are being met.

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1. Development in HRM

Development in the Halifax Regional Municipality (HRM) is guided by the Regional Municipality Planning Strategy (the Regional Plan) which provides a framework that outlines how future sustainable growth can be achieved while preserving the environment and growing the economy. The Regional Plan is implemented through processes that include secondary planning strategies informed by background studies. The secondary planning strategies in HRM include Municipal Planning Strategies (MPS) that are reviewed through Community Planning exercises to ensure the MPS reflects the current community issues. This watershed study is an example of a background study that will be used by HRM and community groups in future MPS or Community processes to inform the type and degree of development that is suitable for the area.

1.1 HRM Regional Plan

The Regional Plan outlines strategies for HRM through commitments, policies and objectives; several of which are relevant to development plans in the Preston area including:

- Cost effective rural community design by directing new growth to Designated Growth Areas where municipal infrastructure services already exist;
- Managing growth to make the best use of existing water, wastewater and storm infrastructure;
- Avoiding unnecessary or premature extensions to existing services;
- Supporting environmentally sustainable practices for developments services with on-site water and wastewater services;
- Designing communities that protect neighborhood stability and support neighborhood revitalization;
- Maintaining the integrity of rural communities; and
- Engaging citizens in the development of policies, programs and services as the basis for building healthy, strong and inclusive communities.

These commitments provide a framework for future Community Planning in the Preston Area.

Under the Regional Plan the Preston Area is designated as Rural Commuter which includes rural communities within commuting distance of the Regional Centre. The intent of the designation is to protect the character of rural communities and conserve open space and natural resources by focussing growth within the Local Centres and carefully controlling the amount and form of development between the Centres. North Preston and East Preston/Cherry Brook/Lake Loon are designated as Rural Local Centres which are areas where a mix of low to medium density residential development will be supported with convenience commercial, institutional and recreation uses. The Regional Plan designates these areas as areas where cost sharing may be undertaken to support community based public transit; where access to active transportation routes can be supported and where short block connectivity and shared surface parking can be supported in future community designs.

1.2 Development Plans in the Preston Watershed Study Area

The Study Area for the Preston Area Watershed Study is defined by the watershed boundary of the Partridge River and the southern portion of the Little Salmon River watershed (**Figure 1**). The Study Area includes the communities of Cherry Brook, North Preston, Lake Loon, Montague Gold Mines, Mineville and East Preston (**Figure 2)** and also includes a portion of the Lake Major Protected Water Area (PWA) where activities are prohibited or restricted through the *Lake Major Watershed Protected Water Area Regulations 106(6) of the Environment Act.*

A Municipal Planning Strategy (MPS) for North Preston/Lake Major/Lake Loon/Cherry Brook and East Preston was completed in 1993. The goal of the MPS was to make the area a more attractive and desirable place to live and to stop the outflow of people leaving to live in other localities. Issues identified in the MPS include watershed protection, services, buildable land, community facilities, new development, community opportunities, resource related activities, industry, transportation and community leadership. The MPS recommended policies to achieve the goal and address the issues through a community driven process.

The 1993 MPS identifies potable water supply as an issue in areas that rely on groundwater for potable water. A sampling program completed in 1979 (Porter and Associates 1979) identified that a high percentage of dug wells did not meet accepted chemical and bacteriological criteria, and a water quality survey completed in 1989 by the Department of Health and Fitness in Cherry Brook identified that a high proportion of dug wells tested positive for coliform bacteria. The MPS identified the drilled wells in the area are susceptible to arsenic contamination, but found most wells in the East Preston and Cherry Brook communities did not encounter these problems. The MPS recommended well water quality monitoring, substituting road salts where there is potential for contamination of wells and investigation of ways to provide central water services to the East Preston community.

Development in the Study Area since 1993 has been limited and minimal growth is anticipated in the near future. Since the completion of the 1993 MPS, the community of Cherry Brook has been provided with municipal water services and the community of North Preston has had upgrades to the waste water treatment facility. Little development has occurred in East Preston since 1993 and the community continues to utilize on-site water and waste water services. Development applications in the Study Area identified during the Regional Plan Review Process are minimal, indicating that growth in the Study Area will be limited in the near future.

Future development in North Preston, Cherry Brook and East Preston is regulated under the Municipal Planning Strategy and Land Use By-law for these areas. The Mixed Use Designation has been applied to the communities of North Preston and East Preston, and is intended to retain the traditional mix of land uses through regulation of building size and setbacks aimed at reducing any potential land use incompatibilities. Development agreements are required for residential and commercial uses which exceed certain size limitations, for extensive industrial uses and for certain types of resource uses within the Lake Major Watershed. In addition, provisions are made for rezoning within the designation, specifically in support of more restrictive residential development where desired and in support of more extensive commercial development at desired locations.

The Residential Designation has been applied to existing residential areas which were identified when the Municipal Planning Strategy was adopted for these areas in 1993. The designation is primarily intended to reflect and support the predominantly residential character and increasing urbanization of the communities Cherry Brook.

Two community consultation events (July and December 2013) during this study provided opportunity for community members to contribute to the study and comment on development in the area. A variety of opinions and perspectives were provided during the meetings, including those expressing an interest in promoting development in the Study Area, those opposed to extension of municipal services to East Preston and those concerned with addressing water quality issues in the watershed. The feedback received during the community consultation events highlights the diversity of opinion in the community regarding development and suggests the community may benefit from a revision of the MPS through a future Community Planning exercise. Despite the differences in opinion regarding the type of development in the Study Area, the importance of understanding water issues and identifying options to address these issues was commonly acknowledged during the community consultation events.

The following table summarizes the comments received and provides comments indicating how the comments are addressed in the report.

Table of Concordance Listing Reviewer Comments

Item	Reviewer Comment	Source	Addressed
1	A list of registered water supplies within the Preston Area that may be suitable for well water collection stations & other data was presented by Tom Mills. These locations are required by law to conduct well water tests every two years at minimum.	Regional Watershed Advisory Board; March 12, 2014	Data from publically available sources were included in the report.
2	There is substantial growth occurring in the Mineville area, particularly near the south end (bottom) of the area where Mineville Road intersects the Lawrencetown Road (Highway #207). This is in your study area; why is this not being addressed? (Tom Mills)	T. Mills of Regional Watershed Advisory Board; March 12, 2014	Mineville and Lawrencetown areas were added to the study area as part of a scope change identified in Section 1.3.
3	Is there growth happening in the communities within the Preston Area like that in Tantallon, Porter's Lake, etc.?	P. Lund of Regional Watershed Advisory Board; March 12, 2014	Limited growth is anticipated as identified in Section 1.2.
4	Why was the study scope changed?	Community Meeting; September 17, 2014	Development pressure in the communities was determined to be very low, and it was determined by staff of HRM and AECOM that it would not be beneficial to proceed with the modelling of water quality based on development scenarios as originally intended. This finding presented the opportunity to conduct additional water quality monitoring in three lakes (Nelson, Gammon & Robinson) and additional groundwater monitoring within the original project budget. Described in Section 1.3.
5	Figure 14 format is confusing.	Community Meeting; September 17, 2014	See revised figure in Section 4.6.2
6	Is it dangerous to be drinking water with high levels of iron or arsenic in our water: a) over a period of 30-40 years? b) for babies?	Community Meeting; September 17, 2014	Arsenic ingestion is a health risk as discussed in Section 4.5.3.2. See references Dummer et al. 2104 and Chappels et al. 2014 for information specific to Nova Scotia.
7	How are you informing people about health concerns for water contaminated with arsenic?	Community Meeting; September 17, 2014	Results from residential well sampling were sent to residents with comparisons to the Canadian Drinking Water Quality Guidelines to identify exceedances. Nova Scotia Environment information document in the Drop on Water series were included with all results sent to residents.
8	Have you contacted public health regarding the findings of the study?	Community Meeting; September 17, 2014	Halifax Regional Municipality has committed to forward a final copy of the

Item	Reviewer Comment	Source	Addressed
			report to the Nova Scotia Departments of Public Health and Environment.
9	How was the scope of the study changed to include Mineville and Lawrencetown?	Community Meeting; September 17, 2014	The study scope was modified to conduct additional surface water and groundwater sampling within the original geographic study area and in the space between the southern lobes of that area. Eleven groundwater samples were collected from residences outside the initial study area.
10	How did (the scope change) affect the East Preston Community information regarding water quality? Concern was expressed that the groundwater results from Mineville/Lawrencetown and Montague Mines areas would be grouped with the East Preston groundwater quality to give the impression that groundwater quality in East Preston is not good.	Community Meeting; September 17, 2014	The groundwater results observed from wells located within the Lawrencetown / Mineville area are presented/grouped separately from the East Preston results in the report (Section 4.5.3). The result for each community do not affect the interpretation for those groundwater wells located in the other areas (Montague Mines/East Preston), or any recommendations made in the study based on findings on the Montague Mines or East Preston areas.
11	The spelling of Winder (Whynder) Lake is wrong – it should be Whynder Lake.	Community Meeting; September 17, 2014	The official name of the lake, according to the Canadian Geographical Names Data Base (administered by Natural Resources Canada) is Winder Lake. The spelling of the name of the lake most widely recognized in the community is Whynder Lake. This dual spelling is addressed in the report (Section 2.2),
12	Why is the water bill going up?	Community Meeting; September 17, 2014	Out of Scope. Refer to Halifax Water, customer service.
13	What is the purpose of the study?	Community Meeting; September 17, 2014	The purpose of the study is to gather technical information about the environment within the study area that will be used as background material for future community planning in the area.
14	Is the study intended to provide background material to justify the extension of central water services to the area?	Community Meeting; September 17, 2014	The study does not consider or recommend servicing considerations for the area.
15	Eagle Lake is a bird sanctuary and the waste water facility at Whynder Lake is polluting Eagle Lake. What are you going to do about it?	Community Meeting; September 17, 2014	Out of scope. For clarification, however, the Eagle Lake area does not bear any designation for the protection of birds. The presence of 19 bird species that are identified as Species of Conservation Concern does not imply or require the creation of such protection.

Item	Reviewer Comment	Source	Addressed
16	My mother was forced to pay for city water and it cost her $5000. We have ample water and good water.	Community Meeting; September 17, 2014	No comment.
17	In the presentation, you mentioned historical water quality data but didn't tell us where it came from or why it (wasn't presented)?	Community Meeting; September 17, 2014	The sources of historical water quality data, and the data itself, are provided in Appendix A of the final report. The data set was not examined during the presentation because of time limit considerations.
18	Was sampling done at a time when there was a lowering of the lakes, because (we all know) that contaminant levels climb in the lakes when water levels drop?	Community Meeting; September 17, 2014	Surface water sampling was completed three different times of year: Summer 2013, Fall 2013 and Spring 2014. Water levels in the lake were not monitored to assess lake levels at the time of sampling events. It is acknowledged that seasonal variations in water quality can be significant.
19	Why is a watershed study a big deal now, instead of when (the city) decided to discharge wastewater into Winder (Whynder) Lake? It appears to be a big issue now because some people in Lawrencetown have arsenic in their water.	Community Meeting; September 17, 2014	Watershed studies were initiated by Halifax only after the Regional Plan was adopted in 2006 – years after the construction and start of operations of the Winder (Whynder) Lake wastewater treatment facility. The likelihood of arsenic presence in drilled wells is high across the province due to its predominance in bedrock formations. Groundwater sample locations were selected to represent unserviced areas within the study area and the same geological conditions beyond the study area where residents offered to participate.
20	Now my mother is going to have to pay for an expensive water distribution system that we cannot afford to pay.	Community Meeting; September 17, 2014	Out of scope. This study does not pre-suppose, recommend, or otherwise imply the construction of a water distribution system within the study area.
21	One practice that can put old wells at risk is salting roads for winter maintenance. Roads on which most homes have old wells near the road should be sanded not salted.	Community Meeting; September 17, 2014	A recommendation is made in Section 6 (a) to use alternatives to salt as road de-icers in areas that rely groundwater for potable water.
22	What will be the scope of the secondary planning process?	Community Meeting; September 17, 2014	The scope of the secondary planning process has not been determined at this time.
23	Something needs to be done to address the discharge issues at Winder (Whynder) Lake.	Community Meeting; September 17, 2014	Out of scope. This concern should be addressed directly to staff at Halifax Water.
24	A) There must be representation of the community in the negotiation of resolution to pollution issues stemming from the Winder (Whynder) Lake wastewater treatment facility; the Water	Community Meeting; September 17, 2014	A) Out of scope. These concerns should be addressed directly to staff at Halifax Water. B) Out of scope. This study does not pre-suppose, recommend, or otherwise imply

Item	Reviewer Comment	Source	Addressed
	Commission should not make them alone. There has to be a full participatory process in the determination of the water quality issue. B) Before you do anything (regarding water service extension) we must have cost information.		the construction of a water distribution system within the study area.
25	Does the report determine the development potential in your community?	Community Meeting; September 17, 2014	The study does not address the potential for development within the community. The number of current development applications in process with the municipality's Development Approvals department, and the land area to which they applied, was assessed to identify development scenarios for land use modelling. The small number of applications and limited area affected by them led HRM and AECOM to refocus project resources on additional surface water and groundwater sampling and assessment.
26	The study seems thorough but in regards to surface waters I am disappointed by the lack of modelling and by the recommendation to set the objectives for Winder Lake 'maintained at current median phosphorus levels'. Table 1 suggests why there can't be modelling. There are ten lakes listed, each has an estimate of area (a simple mapping exercise) but only one has any other critical physiographic measures like average and max depth required to estimate volume. Clearly the sewage treatment that feeds into winder is a problem. The report notes that Eagle and Frog lakes show effects and that there have been complaints. I wonder how the city can allow such an unhealthy situation to continue and that a recommendation would be to keep it as is? I suggest the city reconsider these objectives, in particular in the Partridge River watershed. Also that they invest in a more thorough study that would allow for recommendations that could improve surface water quality in the area.	Email from Regional Watershed Advisory Board. October 7, 2014.	In regard to water quality objectives, the report recommends maintaining the current trophic status which is accordance with the Regional Plan which states 'The Plan will seek to achieve public health standards for body contact recreation and to maintain current trophic status of our lakes and waterways to the extent possible. Regarding the modeling scenarios, the modeling of development scenarios was considered during the project, but the planned developments for the area are minimal. It was determined that modeling development scenarios would not be an effective use of funds because of the limited development. Modeling could be useful to assess the potential changes in water quality under different scenarios of phosphorus output from Winder Lake. This approach could be an effective first step to evaluate options for the North Preston WWTF. However, it was not included within the scope of work for this study.

1.3 Objectives of Report

Watershed studies are background reports that provide a high level snap shot of the physical and biological characteristics of the watershed and are used to inform future Community Planning. Typical watershed studies completed to satisfy the objectives of policy E-17 of the Regional Plan are in watersheds that are expected to have new developments in the watershed. Examples of typical watershed studies include Sandy Lake watershed (AECOM), Lake Echo watershed (CBCL) and Porters Lake watershed (CBCL). As discussed above, since historical development applications in the Preston Area have been low, high rates of land development activity and substantial impacts on receiving waters are not expected. This information was provided to AECOM following the start of the project, necessitating a scope change to the Preston Area watershed study. The scope change (February 2014) reallocated project resources from tasks designated to model water quality changes resulting from development scenarios and assigned the resources to allow for more groundwater sampling and surface water sampling. The additional sampling occurred in the Mineville and Lawrencetown areas that were not originally part of the Preston Area. These areas were included in the scope change as a result of comments provided at the December 2013 community consultation event which identified the need for groundwater and surface water sampling because the areas have experienced significant development growth. This report also differs from other watershed studies in that it has a greater focus on groundwater quality, as identified in the original scope of work.

The overarching goal of this watershed study is to provide the residents of the Study Area and HRM with an assessment of the watershed and identify issues that may influence development plans in the watershed rather than focussing on the impacts of development. This assessment will be a resource for the community and HRM to use as it shapes the development plans for the watershed.

The assessment of areas that are suitable for development is completed through three general tasks:

1. Documentation of environmental conditions to identify environmentally sensitive areas.
2. Assessment of surface water quality conditions to define the assimilative capacity of lakes in the watershed.
3. Assessment of groundwater quality and quantity to evaluate groundwater resources.

Through the completion of these tasks, areas in the watershed are categorized as suitable for development, suitable for development with conditions/constraints and not suitable for development.

A secondary objective of the study is to identify methods that can be used to promote development that supports a sustainable future. The secondary objective is completed by addressing the objectives for watersheds as defined in the Regional Plan which include:

a. Recommend measures to protect and manage quantity and quality of groundwater resources;
b. Recommend water quality objectives for key receiving watercourses in the study area;
c. Determine the amount of development and maximum inputs that receiving lakes and rivers can assimilate without exceeding the water quality objectives recommended for the lakes and rivers within the watershed;
d. Determine the parameters to be attained or retained to achieve marine water quality objectives;
e. Identify sources of contamination within the watershed;
f. Identify remedial measures to improve fresh and marine water quality;
g. Recommend strategies to adapt HRM’s stormwater management guidelines to achieve the water quality objectives set out under the watershed study;
h. Recommend methods to reduce and mitigate loss of permeable surfaces, native plants and native soils, groundwater recharge areas and other important environmental functions within the watershed and create methods to reduce cut and fill and overall grading of development sites;
i. Identify and recommend measures to protect and manage natural corridors and critical habitats for terrestrial and aquatic species, including species at risk;
j. Identify appropriate riparian buffers for the watershed;

k. Identify areas that are suitable and not suitable for development within the watershed;
l. Recommend potential regulatory controls and management strategies to achieve the desired objectives; and
m. Recommend a monitoring plan to assess if the specific water quality objectives for the watershed are being met.

1.4 Report Organization

The report is organized to provide an increasing level of detail on issues of importance as the report progresses. **Section 2 (Environmental Conditions)** provides general information on the biophysical characteristics of the watersheds. The information in Section 2 is used for context in the following sections. **Section 3 (Surface Water Quality)** provides a summary of historical water quality and the results of the surface water sampling completed as part of this study. This section is concluded by providing water quality objectives for each water body that was sampled during this study. **Section 4 (Groundwater)** is a standalone study assessing the groundwater quality and quantity in the Groundwater Study Area (GSA). It provides historical data combined with the results of the residential wells survey completed for this study and provides context for water quality and quantity issues in the GSA. **Section 5 (Environmental Considerations for Future Development)** summarizes areas of environmental significance and provides recommendations to mitigate impacts for future development scenarios. **Section 6 (Policy E-17 Objectives)** provides a summary of information to address the Policy E-17 objectives.

2. Environmental Conditions

2.1 Watershed Boundaries

The Preston Area Watershed Study includes two watersheds: the Little Salmon River watershed and the Partridge River watershed. The study area includes the southern half of the Little Salmon River watershed, the entire Partridge River watershed and by means of the scope change identified in Section 1.3, portions of the Lawrencetown and Mineville area between the southern extents of the Salmon River and Partridge River watershed boundaries (**Figure 1**). The study area measures approximately 17 km from north to south and 9 km from east to west and occupies a surface area of approximately 6,626 ha (66.3 km^2).

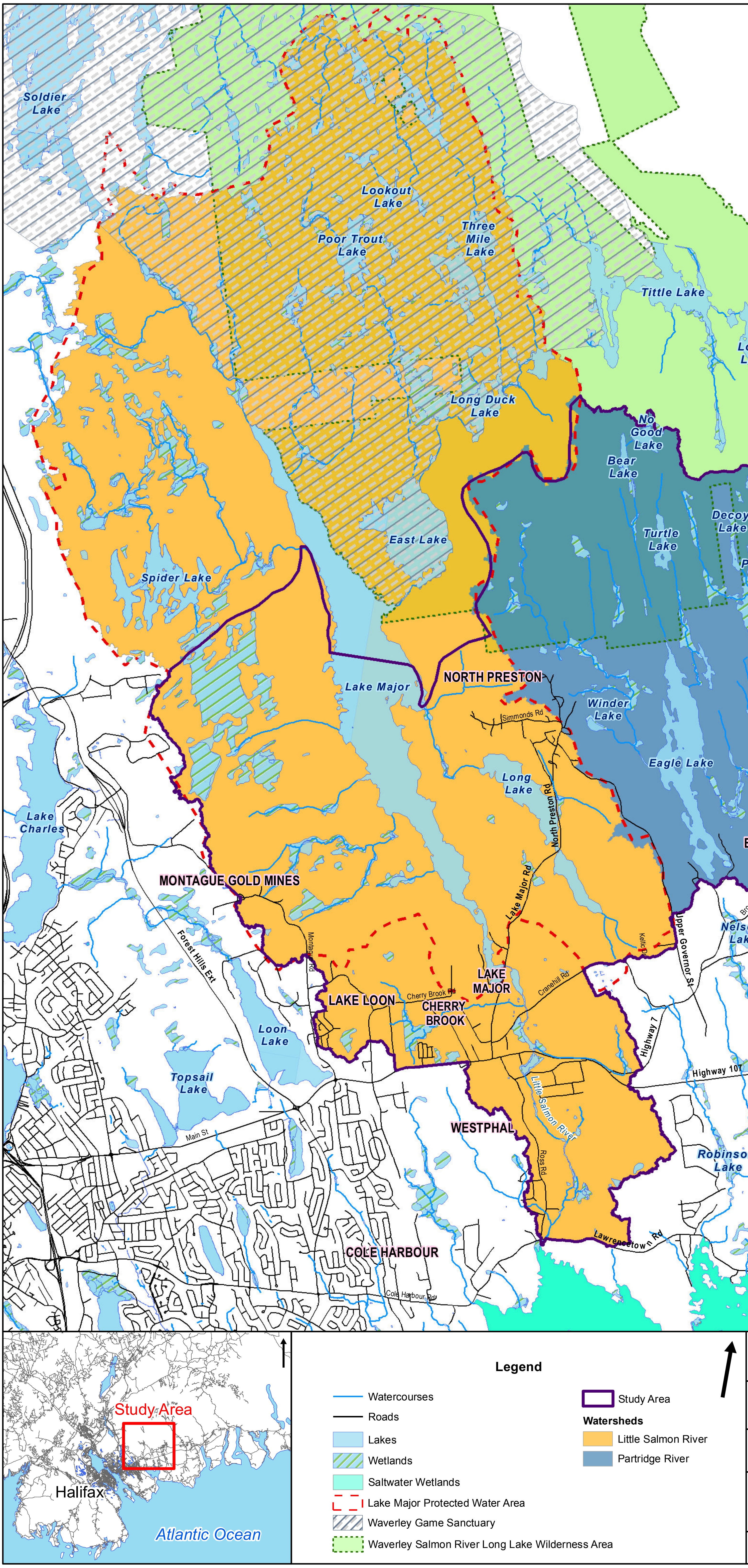
The northern portion of the Little Salmon River watershed is within the Lake Major Protected Water Area (PWA) and the Waverly Salmon River Long Lake Wilderness Area. The southern limit of the Little Salmon River watershed is the outlet to Cole Harbour. The Partridge River watershed extends from the river's outlet into Lawrencetown Lake in the south to a topographic high just north of Bear and No Good Lakes. Both watershed boundaries were defined using a LiDAR derived Digital Elevation Model.

The surface area of the Little Salmon River watershed is 7,833 ha (73.3 km^2) and the surface area of the Partridge River watershed is 3,150 ha (31.5 km^2). Together, these two rivers drain an area of 105 km^2. A ridge between Long Lake and Eagle Lake separates the two watersheds.

2.2 Lakes and Watercourses

The Little Salmon River watershed contains Lake Major and Long Lake, and numerous small ponds and wetlands. Lake Major is the potable water supply for Dartmouth. By provincial legislation, the lake is within a Protected Water Area (PWA); swimming, fishing, forestry and other activities are restricted within the PWA.

Drainage is generally from north to south, except for Long Lake, which drains north into Lake Major. Lake Major receives inflow from several unnamed tributaries flowing east into the lake. A dam at the southern end of Lake Major controls lake water levels and regulates discharge from the lake into the Little Salmon River. Downstream from the dam, a tributary called Cherry Brook joins the Little Salmon River. The Little Salmon River flows south and discharges into the Cole Harbour salt marsh approximately 3.6 km downstream from Lake Major.



Preston Area Watershed Study

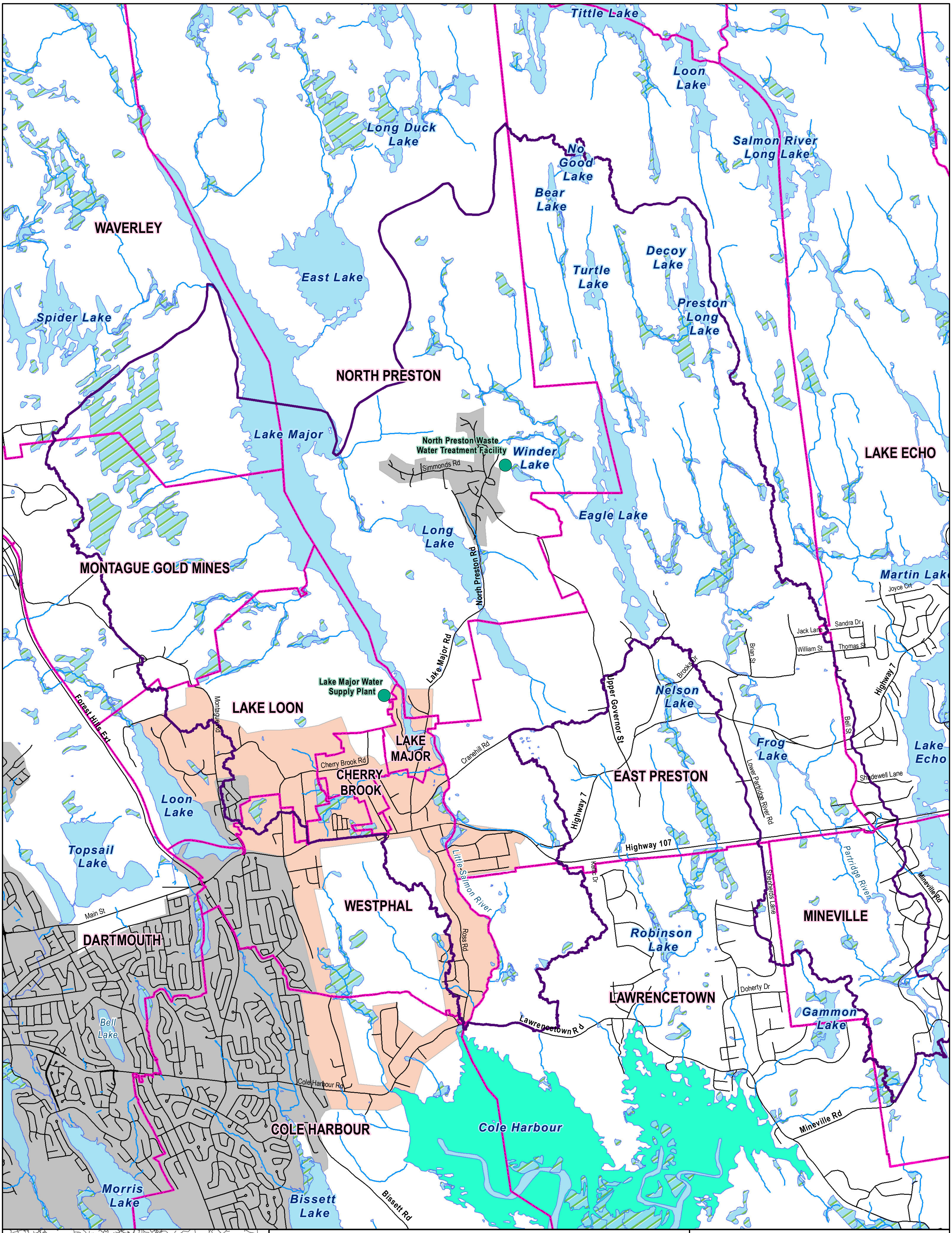
Watershed Boundaries and Project Study Area

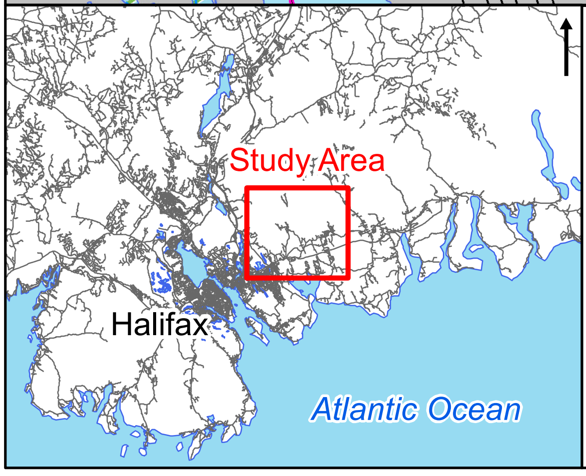
September 2014	1:52,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM

AECOM

Figure 1

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 1 - Watershed Boundaries and PSA 20140624.mxd





Legend

- Watercourses
- Roads
- Lakes
- Wetlands
- Saltwater Wetlands
- Study Area
- Community Boundaries

Municipal Water Services

- Water and Waste Water Services
- Water Service Area

Preston Area Watershed Study

Local Communities and Service Areas

September 2014	1:45,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM

AECOM

Figure 2

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 1 - Local Communities and Service Areas 20140624.mxd

The Partridge River watershed contains Eagle Lake, which drains south through Rodgers Brook to Frog Lake and into the Partridge River. Several small waterbodies drain south into Eagle Lake, including Bear Lake, Turtle Lake and Tittle Lake. A tributary system northwest of Eagle Lake drains into the west side of Eagle Lake, including Winder[1] (Whynder) Lake. Winder (Whynder) Lake receives treated wastewater discharge from the North Preston wastewater treatment facility. In the northwest, a tributary system drains into Preston Long Lake which discharges to Rodgers Brook downstream of Eagle Lake. The Partridge River ultimately flows south into Lawrencetown Lake.

Table 1 presents the characteristics of the largest lakes within the study area.

Table 1: Lake Characteristics in the Preston Area

Lake	Surface Area (ha)	Maximum Depth (m)	Average Depth (m)	Volume (m^3)[1]
Little Salmon River Watershed				
Lake Major	386.0	50	30	116,000,000
Long Lake	65.0	NA	NA	NA
Partridge River Watershed				
Eagle Lake	100	NA	NA	NA
Frog Lake	10.5	NA	NA	NA
Winder (Whynder) Lake	3.1	NA	NA	NA
Preston Long	17.1	NA	NA	NA
Turtle	8.9	NA	NA	NA
No Good	5.2	NA	NA	NA
Bear	5.1	NA	NA	NA
Decoy	2.7	NA	NA	NA

Notes: 1. Based on surface area and average depth. Source GNS 2013
2. NA = Not available

2.3 Climate

The climate of the Preston Area is influenced by the Atlantic Ocean and is characterized by warm summers and mild, snowy winters. This region is classified as having an Atlantic high cool temperature ecoclimate (Webb and Marshall 1999).

Temperature, precipitation, wind speed and evaporation normals between 1981 and 2010 were obtained from Environment Canada's Stanfield Airport meteorological station located 25 km northeast of the Preston Area (Environment Canada 2013). These data are presented in **Table 2** to **Table 4**. The climate data are used as inputs for the water budget and groundwater recharge calculation.

The mean annual temperature is 6.6°C, while the mean summer temperatures are from 15 to 19°C and the mean winter temperatures are from -2 to -6°C. The mean annual precipitation is 1,396 mm with 16% precipitation as snowfall and 84% as rainfall. In comparison, mean annual precipitation in Toronto is approximately 790 mm, in Winnipeg approximately 515 mm and in Vancouver is approximately 1200 mm.

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[1] *The official spelling of the lake according to the Canadian Geographical Names Database administered by Natural Resources Canada is Winder Lake. The spelling of the name of the lake most widely recognized in the community is Whynder Lake. Both names are included in the document of the report.*

Table 2: Temperature and Precipitation Climate Normals

Air Temperature Climate Normals (1981 -2010)				Precipitation Climate Normals (1981 -2010)			
Month	**Mean Daily Maximum (^{0}C)**	**Mean Daily Minimum (^{0}C)**	**Daily Average (^{0}C)**	**Month**	**Rainfall (mm)**	**Snowfall (mm)**	**Precipitation (mm)**
January	-1.3	-10.38	-5.86	January	83.45	58.45	134.31
February	-0.59	-9.72	-5.17	February	64.99	45.39	105.79
March	3.14	-5.69	-1.28	March	86.93	37.13	120.06
April	9.05	-0.28	4.41	April	98.17	15.94	114.51
May	15.31	4.63	9.99	May	109.81	1.99	111.89
June	20.39	9.73	15.08	June	96.21	0	96.21
July	23.84	13.73	18.81	July	95.51	0	95.51
August	23.62	13.72	18.69	August	93.46	0	93.46
September	19.39	9.69	14.56	September	102.04	0	102.04
October	13.13	4.23	8.7	October	124.58	0.37	124.93
November	7.32	-0.37	3.49	November	139.13	16.58	154.19
December	1.72	-6.38	-2.35	December	101.77	45.37	143.27
Year	**11.25**	**1.91**	**6.59**	**Year**	**1196.05**	**221.22**	**1396.17**

Wind data over the same period and location are summarized in Table 3.

Table 3: Wind Speed and Direction Normals

Wind Climate Normals (1981-2010)			
Month	**Mean Hourly Wind Speed (km/h)**	**Most Frequent Wind Direction**	**Maximum Hourly Speed (km/h)**
January	17.69	315	80
February	18.27	315	89
March	18.45	360	77
April	18.3	360	71
May	16.51	180	64
June	15.19	180	65
July	14.22	180	79
August	13.17	180	65
September	14.37	180	85
October	15.95	270	68
November	17.48	315	93
December	18.31	315	85
Year	**16.49**	**180**	**93**

Lake evaporation normals were obtained from Environment Canada's Truro Climate station (**Table 4**). This is the closest Environment Canada monitoring station with long-term evaporation data that could be related to the lakes.

Table 4: Lake Evaporation Normals

Month	Lake Evaporation (mm/day)	Lake Evaporation (mm/month)
January	0	0
February	0	0
March	0	0
April	0	0
May	2.86	88.7
June	3.39	101.7
July	3.75	116.3
August	3.14	97.3
September	2.33	69.9
October	1.33	41.2
November	0	0
December	0	0
	Total mm/year	**515.1**

2.3.1 Climate Change

The potential consequences of climate change on river runoff patterns and quantities are not yet clearly determined. Rainfall and evaporation patterns (spatial and temporal) will be modified and it is expected that the variability of extreme events (floods and droughts) will increase, but it is not possible to quantify this change (Pancura and Lines 2005). Analysis of the effect of climate change on hydrologic and water quality in temperate urban streams is further complicated by the usually much stronger signal resulting from direct human activities, such as land clearing and urbanization.

The potential impacts of climate change include effects on precipitation and temperature patterns that will influence the runoff to surface water features, groundwater recharge and evaporation. These factors will affect the hydrological cycle of the study area.

In Atlantic Canada, a literature review identified two recent references to the anticipated effects of climate change within the region:

- **Scenarios and guidance for adaptation to climate change and sea-level rise – NS and PEI municipalities** (Richards and Daigle 2011). This report provides an excellent background and useful information on climate change variables in Nova Scotia. The report reinforces the difficulties in climate change predictions and the limitations in current practices. The report appendices include a variety of climate change variables related to temperature, rainfall, and coastal water levels for a wide range of return periods and time horizons for many Nova Scotia municipalities including Halifax (rainfall and temperature, extreme total sea levels, plausible upper bound water levels). The report cites a study by Kharin et al (2007) that indicates an average increase in daily rainfall extremes of 16% for North America by the 2080s and applies this value to Halifax; and,

- **Risk-based assessment of climate change impacts and risks on the biological systems and infrastructure within Fisheries and Oceans Canada's mandate – Atlantic Large Aquatic Basin**. (FOC 2013). This document presents a very high-level overview that is specific to conditions in Nova Scotia and highlights important and broad considerations for climate adaptation.

In Nova Scotia, climate projections suggest that the climate will become increasingly variable with more frequent and more extreme storm events. There is expected to be increased evaporation due to increased atmospheric and ocean temperatures, reduced precipitation in summer and increased precipitation in winter. Generally speaking, there will be changes to the amount, timing and nature of precipitation. The rising ocean temperature may promote cyclonic activity further north than is currently the case, placing Atlantic Canada along the trajectory for more numerous, stronger hurricanes and tropical storms.

In forested watersheds, reports indicate that water quality and quantity are likely to be affected by climate change resulting in reduced snowpack, earlier peak snowmelts, warmer summer temperatures, and flooding (Hodgkins *et al.* 2003). With respect to changes to vegetation cover, both positive and negative outcomes are predicted. On one hand, transitional forest types as found in the Acadian Forest Region are forecasted to support additional stands of temperate broadleaved species with climate change. These species are associated with high water quality. On the other hand, climate change effects such as increased frequency and severity of insect/disease outbreak, windthrow, and forest fires have negative implications for water quality (Jones *et al.* 2009), as does increased erosion and flooding.

In summary, climate change is expected to result in dryer summers, wetter winters and more extreme precipitation events that can lead to flooding. Extreme storm events can flush nutrients from forested and urban areas into the watercourses resulting in rapid but temporary deterioration in water quality as the nutrients are flushed through the watershed. These events may also re-suspend and remove phosphorus-laden sediments from ponds, rivers and lakes. Dryer summers suggest forest and aquatic ecosystems will be stressed and vulnerable to unusual weather events, while low stream flow reduces the potential that natural and man-made nutrient inputs can be adequately diluted, leading to an overall lowering of water quality. Finally, flooding liberates nutrients from dry forest soils and in-ground septic systems, leading to water quality impacts.

2.3.2 Acid Rain

The pH of precipitation unaffected by industrial development is typically below 6 making it slightly acidic. From the 1950s to the 1980s Nova Scotia experienced an influx of precipitation with reduced pH (<5) due to the emission of sulphur oxides produced locally and in the industrial centers of eastern Canada and the United States (Watt et al. 1979). This low pH precipitation is known as acid rain. Deposition of acid rain depleted the buffering capacity of Nova Scotia soils (the ability of soil minerals to neutralize acidity) and resulted in reduced pH in surface waters, which now typically ranges from 4.5 to 5.5 (Clair et al. 2007). Although federal and provincial regulations have since restricted the sulphate concentrations in sulphur oxide emissions, the pH of many water bodies remains acidic and represents one of the main challenges to restoring healthy fish populations.

2.4 Forests and Wetlands

The Preston Area watershed is situated within the Eastern Interior Ecodistrict of the Eastern Ecoregion. Ecodistricts are composed of several ecosections as defined by the Ecological Land Classification Map of Nova Scotia (NSDNR 2007). The ecosections are derived from soil texture and topography to describe soil moisture and vegetation assemblages. Areas underlain by granite typically have shallow, medium to coarse grained soils with good drainage. These areas support mixed upland vegetation types such as hardwood and softwood forests. Areas underlain by metasediments have thicker, finer grained soils which retain more moisture and hence are poorly drained. Poorly drained areas support more water tolerant vegetation such as willows, sedges, and certain softwoods.

The predominant soils within the Eastern Interior Ecodistrict are sandy loams, often quite stony and well drained on till derived from quartzites (Neily *et al.* 2003). There are a few drumlins and hills scattered throughout the ecodistrict with fine textured soils derived from slates. The composition of the forests strongly reflects the depth of the soil profile. On shallow soils repeated forest fires have reduced forest cover to scrub hardwoods such as red maple and white birch. On the deeper, well drained soils stands of red spruce are found. On the crests and upper slopes of hills, drumlins and some hummocks stands of tolerant hardwood occur. On the imperfectly and poorly drained soils, black spruce dominate the stand composition (Neily *et al.* 2003).

The forest in the Little Salmon River watershed is comprised of mixed hard and softwood in the slopes around Lake Major with higher proportions of softwood in the upland areas. Sections of hardwood are present on the southwestern side of Lake Major and the eastern side of Long Lake. The Protected Water Area status of Lake Major restricts the harvesting of lumber within the subwatershed, resulting in a mature forest landscape that has experienced minimal disturbance in the past 20 years.

The forest within the Partridge River watershed is a mosaic made of stands of hardwood, softwood and mixed tree cover. The northern portion of the watershed is underlain by granite near or at surface. Due to the thin or absent soils, this area is classified as barren land and has minimal tree cover.

Wetlands perform a variety of ecological functions. They provide important habitat for flora and fauna, improve water quality, mitigate flooding and are valued for educational and aesthetic purposes by the public. In Nova Scotia, a wetland is defined as

> “an area commonly referred to as marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land’s surface or that is saturated with water. Such an area sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation and biological activities adapted to wet conditions” (Government of Nova Scotia 2011).

As shown on the Nova Scotia Wetland Inventory and municipal GIS data layers (**Figure 3**), wetlands are found throughout the watersheds, but do not constitute a large proportion of the total area. In total, wetlands occupy 397 ha or 6% of the study area. The largest wetland complex in the Preston Area is a 105 hectare bog/fen west of Lake Major. This wetland has not been assessed for habitat of significant species. However, large wetlands provide habitat for waterfowl, migrating birds, amphibians and other species. This large wetland also likely moderates the flow into Lake Major and influences its water quality. Wetlands within the Lake Major Protected Water Area are designated as Wetlands of Special Significance (Figure 3). The Nova Scotia Wetland Conservation Policy identifies a goal of no loss in Wetlands of Special Significance.

Several small wetlands are located in the Partridge River watershed, such as those found in the northern headwaters of the watershed, along the discharge of Eagle Lake to Partridge River and near the confluence of Rodgers Brook and the Partridge River.

2.5 Fish and Wildlife

The lakes and streams in the Preston Area provide habitat for freshwater fish common to near-coastal water systems. Little research data is available regarding fish species within the Study Area; however, the fish species identified in Cherry Brook, a tributary of the Little Salmon River, include brook trout, American eel, white sucker and brown bullhead (Clean Nova Scotia 2013). In Eagle Lake within the Partridge River watershed, white sucker, brook trout and banded killifish have been observed (Alexander 1986). As noted, fishing is not permitted in Lake Major. The dam at outlet of Lake Major is an obstruction to the return of Atlantic salmon to spawning grounds, but a seven-pool fish ladder is installed to facilitate the return of salmon to the lake.

Fish species are sensitive to pH, and to metals such as aluminum that are mobilized at low pH. Aluminum can impact fish survival by interfering with the transport of oxygen through the gills (Exley *et al.* 1991). The low pH of surface water resulting from historical acid rain deposition is a factor in the low populations of salmon and trout in southern Nova Scotia, including the Preston Area.

Although little ecological research is available regarding the Waverly Salmon River Long Lake Wilderness Area, its provincial website lists 39 species of mammals and 11 species of amphibians whose range overlaps with the Wilderness Area. The mammals include the American beaver, American black bear, American mink, bobcat, ermine, fisher, moose, muskrat, otter, northern flying squirrel, raccoon, red fox, red squirrel and a variety of mice, shrew and bats, among other mammals. Amphibian species include the American toad, blue-spotted salamander, common bullfrog, eastern newt, green frog, northern leopard frog, pickerel frog, redback salamander, spotted salamander, spring peeper and wood frog.

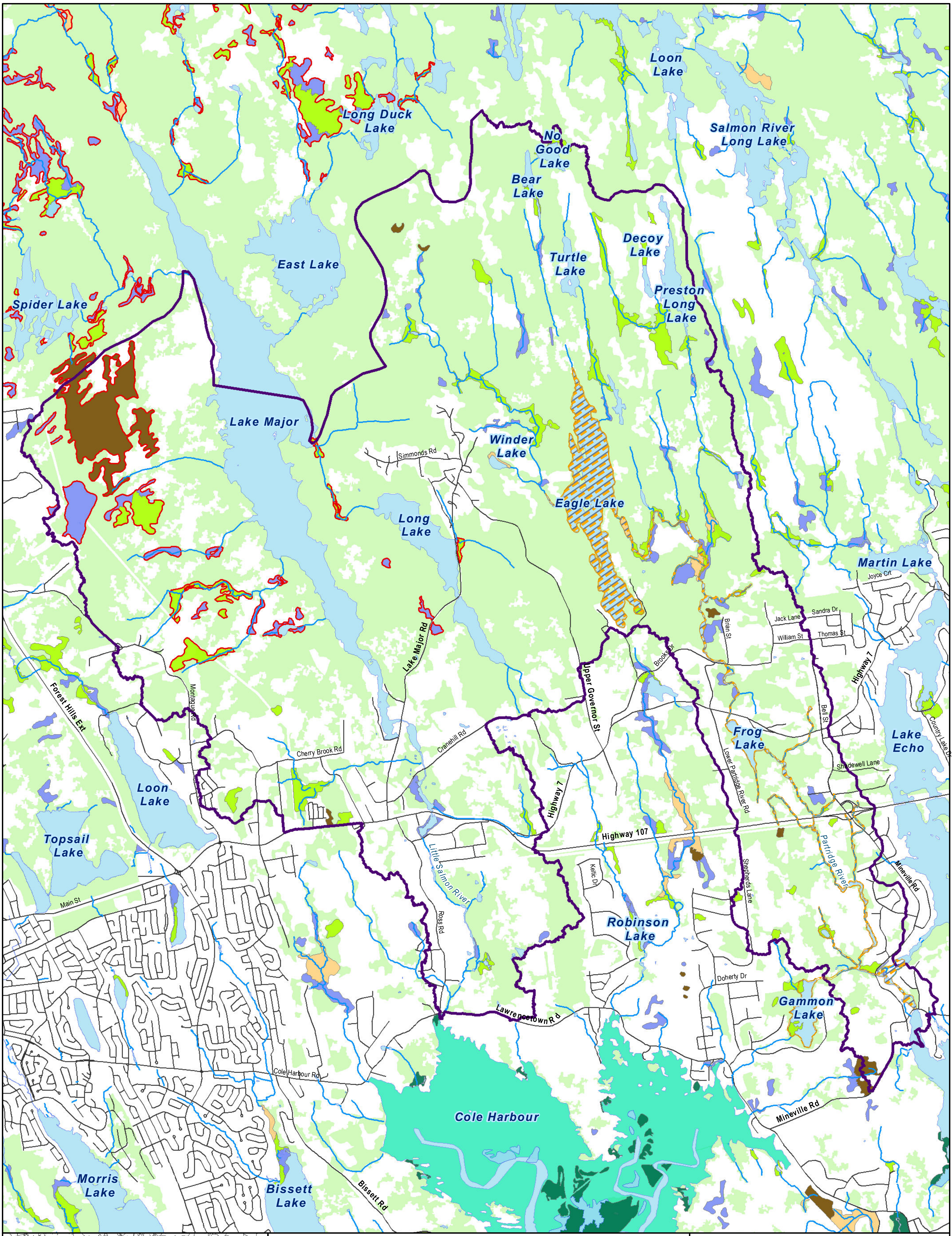
The Atlantic Canada Conservation Data Centre records 19 species of conservation concern within the Preston Area watershed. Although the precise locations of the species sightings are not recorded, most of these species have been identified in the Eagle Lake area.

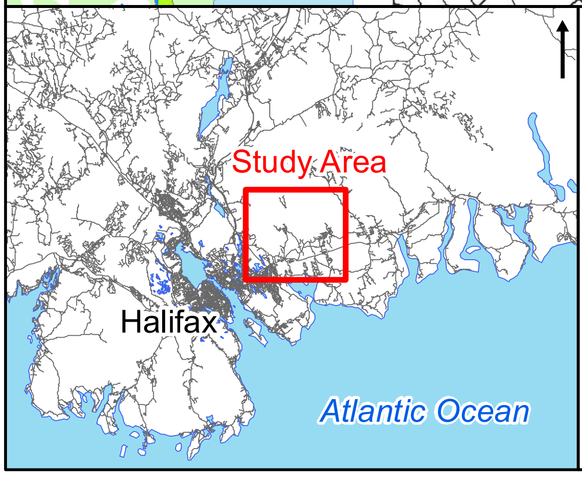
Table 5: Wildlife Species of Conservation Concern

Scientific Name	Common Name	COSEWIC	Provincial Legal Status	Provincial Rarity
Gavia immer	Common Loon	Not At Risk	-	S3B,S4N
Cathartes aura	Turkey Vulture		-	S2S3B
Charadrius vociferus	Killdeer	-	-	S3S4B
Spotted Sandpiper	Chevalier grivelé	-	-	S3S4B
Chordeiles minor	Common Nighthawk	T	Threatened	S3B
Contopus cooperi	Olive-sided Flycatcher	T	Threatened	S3B
Contopus virens	Eastern Wood-Pewee	SC	Vulnerable	S3S4B
Empidonax flaviventris	Yellow-bellied Flycatcher	-	-	S3S4B
Riparia riparia	Bank Swallow	T	-	S3B
Hirundo rustica	Barn Swallow	T	Endangered	S3B
Poecile hudsonica	Boreal Chickadee	-	-	S3
Dumetella carolinensis	Gray Catbird	-	-	S3B
Vermivora peregrina	Tennessee Warbler	-	-	S3S4B
Wilsonia canadensis	Canada Warbler	T	Endangered	S3B
Cardinalis cardinalis	Northern Cardinal	-	-	S3S4
Pheucticus ludovicianus	Rose-breasted Grosbeak	-	-	S3S4B
Molothrus ater	Brown-headed Cowbird	-	-	S2S3B
Pinicola enucleator	Pine Grosbeak	-	-	S3?B,S5N
Carduelis pinus	Pine Siskin	-	-	S3S4B,S5N

COSEWIC	The Committee on the Status of Endangered Wildlife in Canada
S1	Extremely rare: May be vulnerable to extirpation (typically 5 or fewer occurrences or very few remaining individuals).
S2	Rare. May be vulnerable to extirpation due to rarity or other factors (6 to 20 occurrences or few individuals).
S3	Uncommon or found only in a restricted range, even if abundant at some locations (21 to 100 occurrences).
S4	Usually widespread, fairly common, and apparently secure with many occurrences, but of longer-term concern (e.g., watch list) (100+ occurrences).
S5	Widespread, abundant, and secure, under present conditions.
S#S#	Numeric range rank: A range between two consecutive ranks for a species/community. Denotes uncertainty about the exact rarity (e.g., S1S2).
B	Breeding (migratory species)
N	Non-breeding (migratory species)
-	No status indicated

A provincially designated Significant Habitat for the common loon is present within the study area. The Significant Habitat occupies all of Eagle Lake and the Partridge River and is shown on **Figure 3**.





Legend

- Watercourses
- Roads
- Saltwater Wetlands
- Study Area
- Species of Conservation Concern
- > 70% Forest Cover

Wetland Class

- Bog
- Fen
- Marsh
- Salt Marsh
- Swamp
- Water
- Wetlands of Special Significance

Preston Area Watershed Study

Wetlands and Forest Cover

September 2014	1:45,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM

AECOM

Figure 3

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 3 - Wetland and Forest Cover 20140624.mxd

2.6 Marine

Both the Little Salmon River and the Partridge River discharge to coastal salt marshes. The Little Salmon River discharges to the Cole Harbour salt marsh while the Partridge River discharges to Lawrencetown Lake. Salt marshes are intertidal areas that host high biodiversity and biological productivity. Salt marshes are inhabited by many plant species, molluscs, insects, crustaceans, worms, fish and birds. Salt marshes are sensitive to changes in both water quality and water quantity. Nutrient inputs from freshwater discharges to salt marshes may affect species diversity and ecosystem function, while changes to the volume of discharge may affect the salinity of the estuary systems, adversely affecting organisms adapted to a particular salinity.

As compensation for the alteration or destruction of fish habitat and wetlands elsewhere, Nova Scotia Transportation and Infrastructure Renewal restored a portion of the Lawrencetown Lake Salt Marsh in 2007 (CBWES 2011). Later, the Cole Harbour salt marsh was assessed to evaluate the infrastructure required for the Cole Harbour Salt Marsh Trail (Coldwater 2011). While these studies do not directly inform the Preston watershed study, they highlight the importance of these nearby habitats. Changes in water quality or quantity in the upstream freshwater rivers may negatively affect these downstream salt marshes.

2.7 Geology

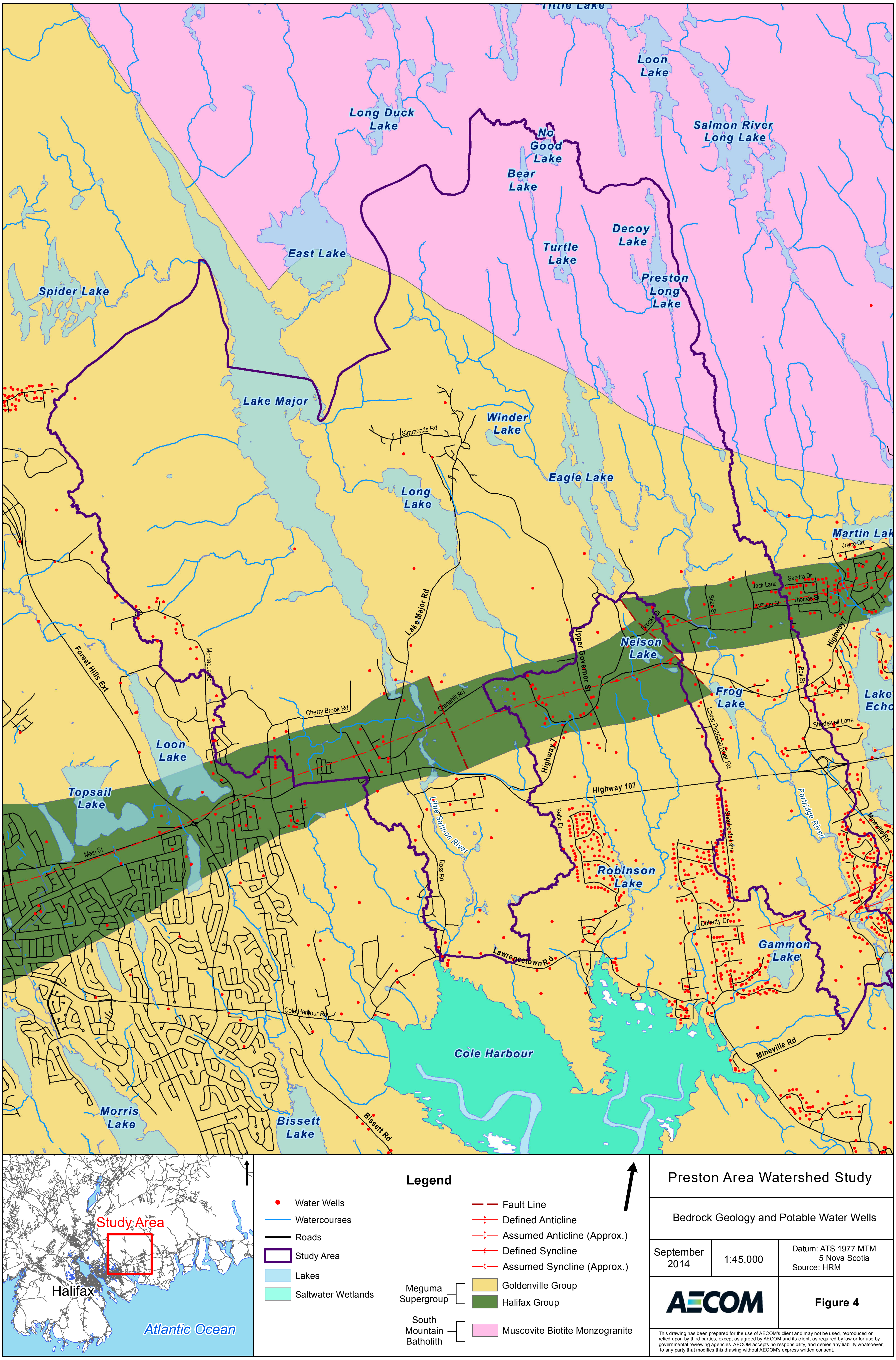
2.7.1 Bedrock

The geology of southern Nova Scotia is dominated by the Meguma Supergroup composed of fine to medium grained sedimentary rocks that have undergone metamorphism, and Devonian aged granitic rocks that intruded the Meguma rocks (**Figure 4**). The geology of the Preston Area is typical of southern Nova Scotia and is composed of these rock types.

The Meguma Supergroup was deposited in the Cambrian period (approximately 500 million years ago) as a series of interbeded sand, silt and mud deposits. Within the Meguma Supergroup, the older Goldenville Group is composed of higher proportions of metasandstone (also called quartzite) with minor beds of metasiltstone and slate. The Halifax Group was deposited on top of the Goldenville Group and is composed of higher proportions of slate and metasiltstone, with minor beds of metasandstone. The flat lying sedimentary rocks of the Goldenville and Halifax Groups were deformed during a continental collision about 400 million years ago (White and Barr 2012). They were deformed into northeast trending, tight, upright folds. The traces of the folds (center part of the folds) are shown on **Figure 4**. Approximately 375 million years ago, the Meguma rocks were intruded by granitic rocks referred to as the South Mountain Batholith.

In the Preston Area the regional deformation is expressed as a series of folds trending northeast/east to southwest/west. A syncline (bottom of fold with younger rocks in the core) exposes the younger Halifax Group metasiltstones and slates in the central portion of the study area, from Cherry Brook to East Preston. The older Goldenville metasandstones underlie the north and the south portions of the study area and are folded into anticline structures (older rocks in the core of the fold) near Montague Gold Mines and in the Mineville area.

The structure of the bedrock and the location of the folds are related to the gold deposits in the area. Gold mineralization occurrences are located in the hinge area of tight anticline folds (Horne and Pelly 2007). Arsenic, typically in the mineral form of arsenopyrite, is associated with gold deposits in Nova Scotia because both the gold and arsenic were mobilized and deposited by hydrothermal fluids that preferentially migrated through the fractures in the anticlines. At the time of this report, the most recent bedrock mapping of the area identified the general fold pattern identified above. NSDNR bedrock mapping of the study area is scheduled for the summer of 2014 and the results of this mapping may provide more precise mapping of the folds.



Preston Area Watershed Study

Bedrock Geology and Potable Water Wells

September 2014	1:45,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM

AECOM

Figure 4

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 4 - Bedrock Geology 20140624.mxd

Two northwest trending faults are identified in the Preston Area; one east of Lake Major trending in the orientation of the length of the lake, and one inferred from the south end of Lake Eagle to Frog Lake.

The rock type (lithology) and the structure (folds and fractures) are influencing factors on the distribution of arsenic in rock and groundwater in Meguma Supergroup rocks. **High concentrations of arsenic in rocks are more likely to be found in rocks of the Goldenville Group where the rocks are folded into anticline structures**. The relationship between arsenic in groundwater and the bedrock geology is discussed in more detail in Section 4.4.2.

Acid rock drainage (ARD) is a naturally occurring process that results from the oxidation of sulphide minerals when the rock is exposed to oxygen. The breakdown of the sulphide minerals releases sulphuric acid, iron, and may also release arsenic, aluminum, cadmium, copper, manganese and zinc into the environment. The oxidation process and release of ARD is accelerated when bedrock is exposed to air by excavation or blasting. In HRM, several examples of ARD impacting water quality (Fox et al. 1997) are documented, resulting in low pH surface waters that were attributed to fish kills (Porter-Dillon 1985 as referenced in Fox et al. 1997). The Nova Scotia Environment Act limits the excavation and requires disposal of displaced rock with sulphide weight more than 0.4%. The Halifax Formation rocks in have higher proportions of sulphide bearing minerals and are more likely to produce ARD when exposed.

2.7.2 Surficial Geology

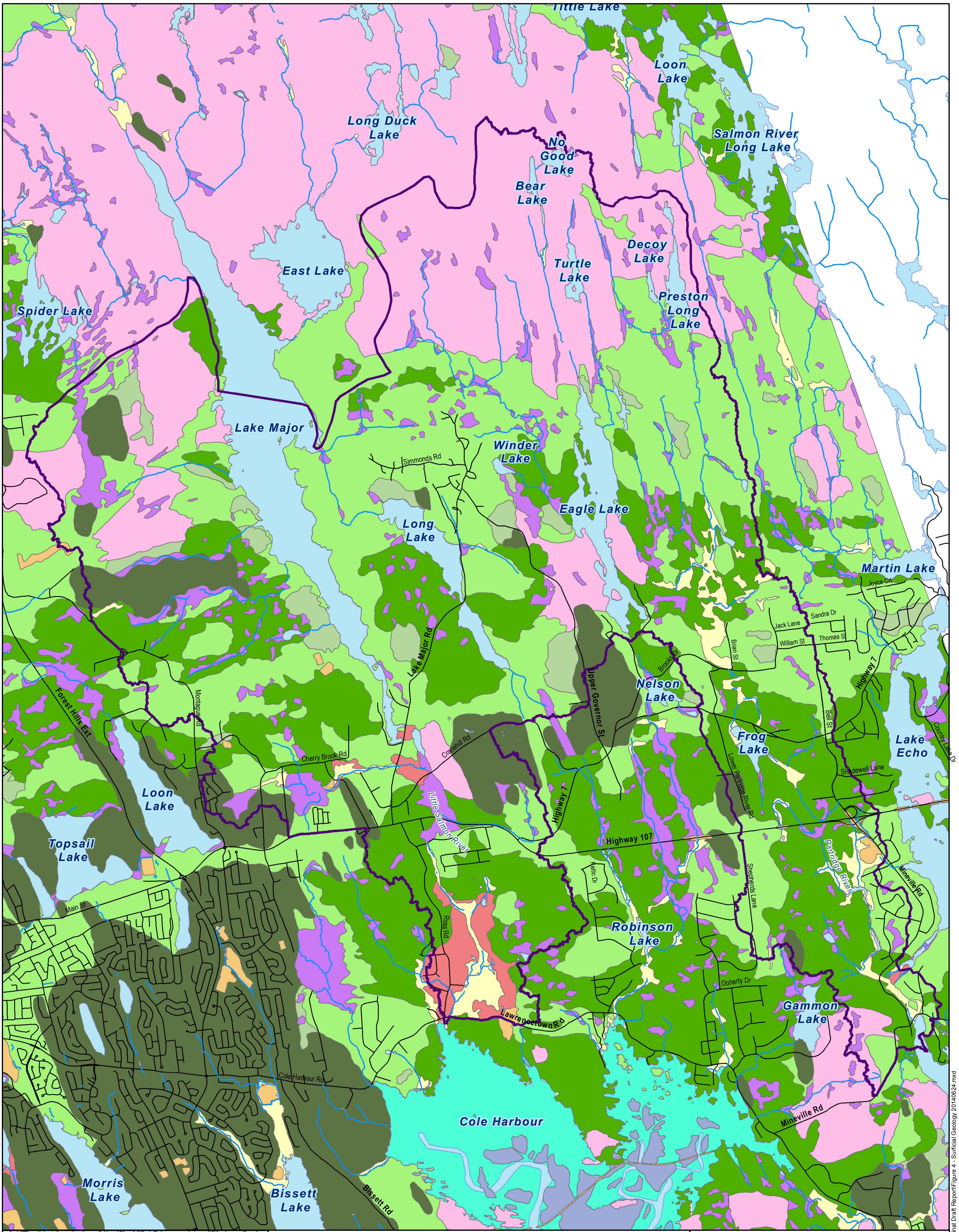
The surficial geology in southern Nova Scotia (**Figure 5)** generally consists of glacial till (a mix of clay, sand, gravel and boulders) combined with alluvial deposits (left by moving water) and lacustrine deposits (deposited as lake sediments (Utting 2011). Glacial sediments are primarily composed of material that was entrained during glacial flow and deposited during glacial retreat. Generally, the composition of the surficial sediments is similar to the composition of bedrock in the area. The glacial sediments in the study area are expected to be derived from the Meguma metasedimentary rocks and contain elevated concentrations of iron, sulphides and potentially arsenic. The high sulphide content in the sediments produces soils with low pH, low alkalinity and low buffering capacity.

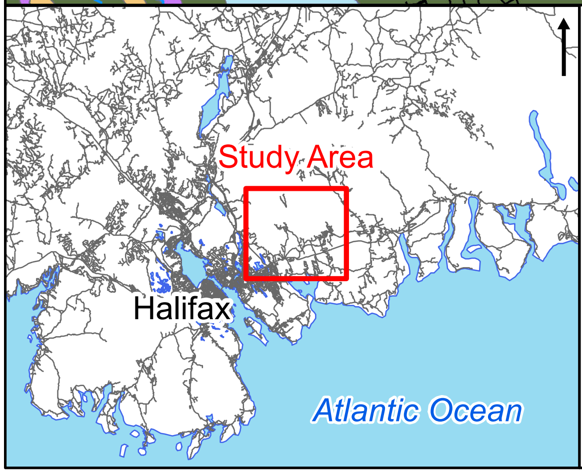
In general, the thickness of the glacial till is quite variable across the region, ranging from 1 - 10 m but averaging less than 3 m (Neily *et al.* 2003). The Beaver River Till, deposited over bedrock when the glaciers began to melt approximately 12,000 years ago, covers approximately 88% of the Preston Area watershed. The Beaver River Till is typically composed of poorly sorted sediment that contains a wide range of particle sizes in a sandy matrix. These deposits are mainly found near the western and northwestern limits of the watershed. Thicknesses range 5-10 m (till blanket) and < 5m (till veneer). The till was also deposited in an irregular hummocky pattern where thicknesses range from 1 to 10 m.

Glaciofluvial outwash is composed of sand and gravel sediments deposited by melting glaciers. Outwash deposits form plains and terraces. An extensive deposit of glaciofluvial outwash is located along the southern reaches of the Little Salmon River, directly upstream of Cole Harbour. Glaciofluvial outwash is also found along Cherry Brook (**Figure 5**).

Alluvial and lacustrine deposits represent 2% and 5% of the land cover within the Preston Area watershed, respectively. Alluvial deposits consist of gravel, sand, and silt with lesser amounts of clay and organic material. These deposits were laid down in streams and rivers in channels and floodplains. Alluvial deposits are present along the Partridge River. Lacustrine deposits, consisting of sand, silt, clay and organics, were deposited from suspension in freshwater lakes, ponds and wetlands primarily along watercourses (Utting 2011).

Drumlins (low, smoothly rounded, elongate oval mounds of glacial till) occupy approximately 5% of the watershed and are prominent features in the central part of the Preston Area.





Legend

― Watercourses

― Roads

▭ Study Area

🟦 Lakes

▨ Wetlands

🟦 Saltwater Wetlands

Holocene

🟧 Anthropogenic

🟨 Alluvial

🟦 Marine intertidal flat

🟦 Marine littoral

🟪 Lacustrine

Pleistocene

🟥 Glaciofluvial outwash

🟩 Hummocky till

🟩 Till blanket

🟩 Till veneer

🟩 Drumlins

Paleozoic

🟪 Bedrock

Preston Area Watershed Study

Surficial Geology

September 2014	1:45,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM, Utting 2011

AECOM

Figure 5

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 4 - Surficial Geology 20140624.mxd

2.8 Sensitive Habitats

Three protected areas are within or adjacent to the Preston Area (**Figure 1**).

Established in 1998 under the provincial *Wilderness Areas Protection Act*, the **Waverley-Salmon River Long Lake Wilderness Area** covers of 8,700 ha of rugged wilderness containing lakes, barren granite hills, and pockets of old-growth pine and hemlock. Within the study area, the Wilderness Area contains numerous lakes that have not been subjected to development pressure, pristine rivers, and wetlands. The area is characterized by a series of gullies between high granite ridges that support well drained coniferous forests, with red spruce, white pine, fir, and hemlock, some in immature old-growth condition (NSDNR 2013a). Grey granite cliffs drop off steeply to narrow gullies, hosting wet, hummocky black spruce - balsam fir forests. Old-growth pine stands occur on some lakeshores, and in isolated pockets are rare, pure stands of old-growth hemlock.

The **Lake Major Protected Water Area** (PWA) supplies water to Dartmouth, Cole Harbour, Eastern Passage, Westphal, Cherry Brook, North Preston, and Montague Gold Mines and overlaps with the western portion of the Wilderness Area. The PWA is provincially designated under subsection 106(5) of the Environment Act and subject to land use and activity restrictions listed the *Lake Major Protected Water Area Regulations*.

Originally established in 1926 and later extended, the 5,228 ha **Waverley Game Sanctuary** is made up of 3478 ha of woodland, 729 ha of lakes and ponds, 360 ha of wetlands, 583 ha of barrens, 62 ha of built-up land and 13 ha of road and pipeline corridors. The Sanctuary overlaps with the larger Waverley Salmon River Long Lake Wilderness Area, with 3,224 hectares having both designations. Hunting and trapping are prohibited within the Sanctuary (GNS 2013b).

2.9 Potential Sources of Contamination

Developed areas can produce discharges that have negative impacts on water quality, and are considered, in a general way, to contaminate the receiving water bodies. Contamination in this context are inputs to water bodies that degrade water quality compared to conditions before development and does not necessarily imply that specific guidelines (i.e.; the Canadian Council of Ministers of the Environment – CCME) are likely to be exceeded.

A list of potential contaminant sources and the types of contamination each source may produce is presented in **Table 6**. Surface and groundwater water quality results were assessed in light of these potential pollutant sources to determine if negative water quality effects could be correlated.

Table 6: Potential Sources of Contamination

Potential Source of Contamination	Nutrients	Metals	Arsenic	Low pH	Sediments	Petroleum Hydrocarbons	Pesticides	Herbicides	Chloride
Malfunctioning Septic Systems	X								
Unauthorized Garbage Disposal		X				X			
Golf Courses	X						X	X	
Wastewater Treatment Plants	X								
Agricultural Operations	X				X		X	X	

Potential Source of Contamination	Nutrients	Metals	Arsenic	Low pH	Sediments	Petroleum Hydrocarbons	Pesticides	Herbicides	Chloride
Past/Present Mining Activities		X	X	X					
Bedrock		X	X	X					
Auto Salvage Yards		X				X			
Forestry Practices	X				X		X	X	
Road Salt Application and Storage									X
Urban Development	X	X			X	X	X	X	X
Gas Stations						X			
Residential Oil Tanks						X			
Landfills	X	X		X		X			

Two types of potential contamination to surface water are non-point sources and point sources. Non-point sources of contamination are spread over a wide area and cannot be defined by a single location. An example of non-point source of contamination is runoff from streets. As rainfall or snow melts passes over road, parking lots and other surfaces, it can pick up contaminants and transport them to streams and lakes. Point sources of contamination can be identified at a single location, such as discharge from a pipe into a stream.

2.9.1 Non Point Sources

In general, non-point sources of pollution pose the most serious threat to the water quality of lakes in areas surrounded by development. During rainstorms, non-point sources of pollution contribute sediments, oil, anti-freeze, road salt, pesticides, nutrients and pet and waterfowl droppings. These are carried into surface waterways by overland runoff and storm sewer systems. This runoff generally accelerates the eutrophication or natural aging process of urban lakes by adding sediment and nutrients. These added nutrients can result in algal blooms, decreased water clarity, and an increase in the amount of rooted aquatic plants growing in the shallow near-shore waters of a lake. All of these can reduce the recreational value of a lake by hindering swimming, boating, fishing and reducing its overall aesthetics. Moreover, large algae populations can cause odour problems and can lead to the depletion of a lake’s oxygen supply and possibly fish kills. Additionally, the increase in impervious surfaces and heat retention of these surfaces can result in the increased speed and volume of runoff in urban areas and during the summer may increases water temperature, which can also adversely affect the lake’s aquatic health.

In the Preston Area, development is concentrated in the southern portions of the watersheds. Non-point sources of contaminants are expected to contribute to nutrient and contaminant loads to lakes that are near developed areas such as Frog Lake and Long Lake.

The contributions of non-point sources of contamination can be reduced in at least two ways. The residents of the area can reduce the potential for contaminants to enter the water systems by reducing the contaminants (i.e.; oil, fertilizers, and animal droppings) that are able to be carried away by runoff. The impacts of runoff to water bodies can also be reduced through infrastructure design and management such as stormwater management. Stormwater management uses engineering methods to reduce the volume of water entering water bodies and may also provide various forms of treatment to runoff before entering water bodies.

2.9.2 Point Sources of Contamination

Point sources of contamination are specific and identifiable locations that contribute to water quality problems. Examples of point source contaminants to lakes include outfalls from wastewater treatment plants, industrial effluent, landfill sites, illegal dump sites, underground fuel reservoirs and septic systems. Point source pollutants may also degrade the quality of lake waters depending on the quality and quantity of discharge. In the case of outfalls from wastewater treatment plants, wastewater discharge may carry high nutrient loads, especially phosphorus and can significantly add to the loading of phosphorus to lakes resulting in their rapid eutrophication.

The major point sources of contaminants in the Preston Area include the North Preston WWTP, septic systems and illegal dumps. The North Preston WWTP treats waste water from North Preston and discharges treated effluent that contains high nutrient concentrations to Winder (Whynder) Lake. At times when the WWTP receives volumes of water greater than capacity, waste water bypasses the treatment and disinfection stage in the building and is released to a two-stage engineered wetland before discharging to Winder (Whynder) Lake. The high concentrations of nutrients in Winder (Whynder) Lake flow to Eagle Lake and the rest of the Partridge River watershed.

Septic systems near lakes may be contributing to nutrient loads to lakes. Septic systems are designed to allow a slow discharge of waste water into a septic field that allows for dispersal into the soil. A septic system that is functioning properly will allow a slow discharge of nutrients to the soil that can partly be consumed by organisms and slowly saturate the soils with nutrients. The slow saturation of soils may eventually allow for a discharge of nutrients to water bodies. A malfunctioning septic system allows for greater discharge to the surrounding soils and quickly saturates soils with nutrients. This creates a situation where the discharge from the septic system is too much for the surrounding soils to incorporate and can contribute high concentrations of nutrients to surface water. Most forms of septic systems are likely to contribute nutrients to waterbodies, but ones that are not working properly are more likely to contribute high nutrient loads.

The function of septic systems can be assessed using publically available resources. The *Environmental Home Assessment Program* is designed to inform Nova Scotians about the importance of the on-site water wells and septic systems. The home assessment provides educational information about the importance of regular well water testing, pumping of septic systems and the maintenance of oil tanks. The Program can be accessed through the Clean Foundation (clean.ns.ca/programs/water/ehap/). Nova Scotia Environment (NSE) is responsible for regulating on-site septic systems. The NSE website (http://www.novascotia.ca/nse/wastewater/on.site.sewage.disposal.asp) describes septic systems and provides information on regulations, technical guidelines, lists of qualified installers and additional information resources. NSE also provides a guidebook to septic system maintenance, how systems may fail and the role of homeowners and the NSE. The homeowners guidebook to wells, septic systems and oil tanks can be access on-line at http://www.gov.ns.ca/nse/groundwater/docs/Homeowners-Guide-Wells-Septic-Oil-Tanks-2013.pdf. NSE also provides a fact sheet on wastewater disposal, septic systems, individual components of these systems and a glossary describing the components in detail (http://www.novascotia.ca/nse/water/docs/droponwaterFAQ_Wastewater-Septic.pdf). The Waste Water Nova Scotia Society is an industry association for septic systems in Nova Scotia. The website (http://www.wwns.ca) provides resource documents and a directory of society members including qualified persons and installers.

Illegal dumping of garbage is reported to occur near Winder (Whynder) Lake and near Eagle Lake. The disposal of garbage near lakes without containment, planning or control can contribute nutrients, metals and other contaminants to lake water that decrease water quality in the short term and the long term. The impacts of existing illegal dumps on water quality can be mitigated by removing the materials and disposing of them at municipal landfills.

3. Surface Water Quality

3.1 Water Quality Data Sources

Historical water quality data provide a benchmark for understanding how conditions change over time. Up to eight years of monitoring data were obtained from Halifax Regional Municipality (HRM) and Halifax Water. The HRM water quality data are from Winder (Whynder) Lake from the period 2006 to 2011. The Halifax Water data was collected as a part of the Lake Major Protected Water Area, Source Water Protection Plan monitoring program and represent the period 2009 to 2013. Four additional sampling locations within the watershed were added by AECOM to supplement the spatial coverage of the data. **Table 7** presents the data sources used for this report, which are presented in full in **Appendix A**. All sampling locations are shown on **Figure 6**.

Table 7: Data used to Establish Current Water Quality

Sampled by	Sampling Location Description	Sampling Period	Parameters
HRM	Winder (Whynder) Lake	2006-2011	Nutrients, General Chemistry, Bacteria, Ammonia, Metals
Halifax Water	Sampling locations within the Lake Major Protection Area. Sample stations include various locations within Lake Major and Long Lake and their tributary inlets.	2009-2013	Nutrients, General Chemistry, Bacteria, Ammonia, Metals
AECOM	Long Lake, Lake Major Outlet, Eagle Lake Outlet, Partridge River Outlet	2013-2014	Nutrients, Bacteria, Metals
AECOM	Frog Lake, Nelson Lake, Gammon Lake, Robinson Lake	May, July 2014	Nutrients, Bacteria, Metals

As shown on **Figure 6,** water samples have been collected from eight sampling locations by Halifax Water within the Lake Major Protection Area:

- Five active stations sampled between 2009 and 2013:
  - LMG1 (Long Lake lift station)
  - LMG3 (East Lake inlet)
  - LMG6/LMG6A (Flat Barrens inlet – LMG6 is no longer active)
  - LMG7 (north of Cranehill Drive)
  - LMDL (Lake Major Deep Station)
- Three inactive stations sampled between 2009 and 2011
  - LMG2 (Long Lake outlet)
  - LMG4 (Soldier Lake Brook Inlet)
  - LMG5 (Spider Lake Brook Inlet)

This data was supplemented by water quality samples collected by AECOM in August and November, 2013 and May 2014:

- Long Lake (at Lake Major Road)
- Lake Major (at Lake Major Dam)
- Eagle Lake (Eagle Lake Outlet)
- Partridge River (at Mineville Road Bridge)
- Frog Lake (May and July 2014 only)

Additional samples were collected from surface water bodies outside the Preston Area that are under development pressure. These water bodies were sampled in May and July 2014:

- Nelson Lake
- Robinson Lake
- Gammon Lake

Finally, HRM provided six years of water quality data collected from Winder (Whynder) Lake, which receives wastewater treatment plant effluent.

3.2 Water Quality Data Analysis

As described more fully in **Appendix B**, data analysis focussed on several key “indicator parameters”. These parameters are particularly sensitive to changes in land use within a watershed, such as when forested land is converted to residential and commercial developments. By examining changes to these parameters over time, probable causes of water quality impacts may be identified. Where available, these parameters included:

Indicators of nutrient enrichment and trophic status

- Total phosphorus (TP)
- Total Kjeldahl nitrogen (TKN)
- Chlorophyll α

Indicators of water clarity

- Total suspended solids (TSS)
- Secchi depth

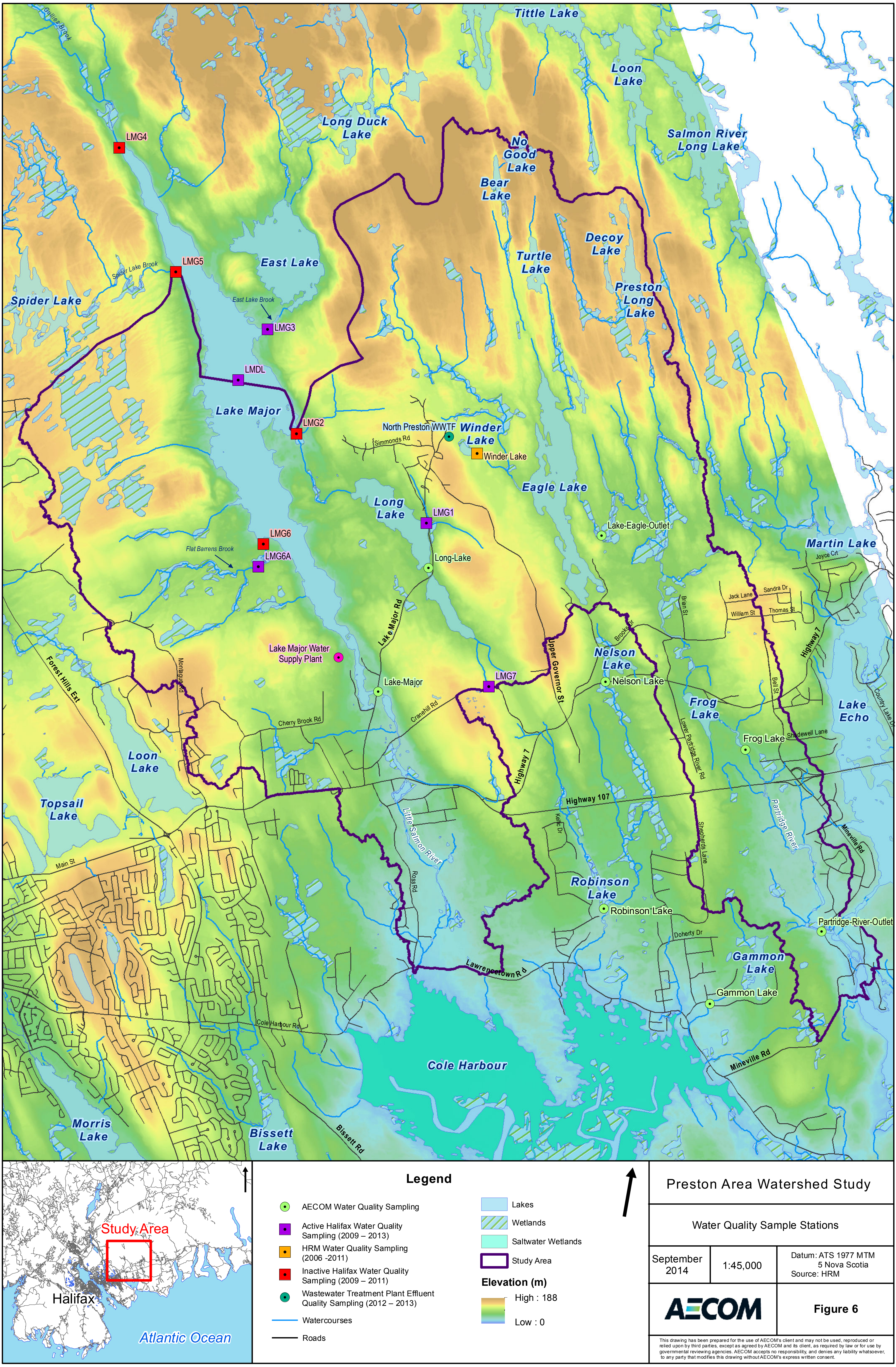
Indicators of anthropogenic or “human” inputs

- Nitrate
- Ammonia
- E. coli
- Chloride

When analyzing laboratory results for most parameters, data points that were less than the detection limit were considered equivalent to the detection limit concentration. For example, for TSS with a detection limit of 1 mg/L, reported values of <1 mg/L were processed as 1 mg/L. If however, results showed that some detection limits were well above the background values based on the results from samples with lower detection limits, then these high detection limit data were discarded. This was especially the case for total phosphorus where the use of ‘high detection limit’ data could significantly affect the determination of average lake concentrations.

Total phosphorus (TP) has different detection limits depending on the technique used to analyze the samples. Care was taken to use only those results with sufficiently low detection limits in the statistical analysis. For example, any phosphorus result equal to or below the detection limit of 20 µg/L was removed from analysis, because the actual concentration could range very widely – from 0 to 20 µg/L. If a result was above the detection limit of 20 µg/L, the value was retained for data analysis, and was considered representative of an actual phosphorus concentration. Data points less than the lowest detection limits possible for total phosphorus analysis were considered equal to the detection limit for the purposes of data analysis. This approach is considered conservative and does not interfere with the interpretation of the trophic status.

The minimum, maximum, median, average, and standard deviations were calculated for the indicator parameters where a sufficient number of data points were available.



Legend

- ● AECOM Water Quality Sampling
- ■ Active Halifax Water Quality Sampling (2009 – 2013)
- ■ HRM Water Quality Sampling (2006 -2011)
- 🟥 Inactive Halifax Water Quality Sampling (2009 – 2011)
- ● Wastewater Treatment Plant Effluent Quality Sampling (2012 – 2013)
- Watercourses
- Roads
- Lakes
- ▨ Wetlands
- Saltwater Wetlands
- ☐ Study Area

Elevation (m)

High : 188

Low : 0

Preston Area Watershed Study

Water Quality Sample Stations

September 2014	1:45,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM

AECOM

Figure 6

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 6 - Water Quality Sample Stations 20140624.mxd

3.3 Little Salmon River Watershed

3.3.1 Long Lake

Historically within Long Lake and its tributary inlets, water samples have been collected from three locations. They include (from southeast to northwest):

1. The drainage area on the north side of Cranehill Road (station LMG7).
2. Within Long Lake at the lift station off Lake Major Road (station LMG1).
3. At the outlet of Long Lake Brook (station LMG2) prior to discharge into Lake Major.

The historical data for water quality indicator parameters for these stations, as well as the results from AECOM's sampling events at Lake Major Road, are summarized in **Table 8**.

Table 8: Long Lake Water Quality Summary

Sample Name			**Anthropogenic Influence Indicator Parameters**				**Nutrient Enrichment and Trophic Status Indicator Parameters**			**Water Clarity Indicator Parameter**
Description	Sample ID		Chloride	Nitrate	Total Ammonia	*E. Coli*	TKN	Total Phosphorus	Chlorophyll α	Total Suspended Solids
			mg/L	mg/L	mg/L	MPN/ 100mL	mg/L	µg/L	µg/L	mg/L
North side of Cranehill Road	LMG7	n	11	43	0	43	0	43	0	42
		min	27	0.011	NA	1	NA	8.0	NA	1
		max	81	0.170	NA	25	NA	34.0	NA	180
		average	64.7	0.067	NA	3.5	NA	19.8	NA	16
		median	67.0	0.050	NA	1	NA	20.0	NA	9
		standard deviation	15.2	0.031	NA	5.1	NA	6.4	NA	28
Long Lake Lift Station	LMG1	n	28	45	0	45	0	45	0	45
		min	1	0.05	NA	0.5	NA	1.0	NA	1
		max	97	1.30	NA	250	NA	26.0	NA	8
		average	46	0.40	NA	23	NA	12.0	NA	2
		median	46	0.30	NA	5	NA	10.0	NA	1
		standard deviation	22	0.27	NA	49	NA	7.3	NA	2
Long Lake (AECOM)	Long Lake	n	3	3	2	3	3	3	3	3
		min	14	0.05	0.05	1	0.40	7.0	0.33	2
		max	22	0.07	0.05	4	0.90	24.0	2.78	5
		average	17	0.06	0.05	2	0.60	13.0	1.24	3
		median	16	0.05	0.05	1	0.50	8.0	0.60	2
		standard deviation	4	0.01	0.00	2	0.26	10.0	1.34	2
Long Lake Brook Inlet	LMG2	n	0	10	0	10	0	10	0	10
		min	NA	0.050	NA	1.0	NA	2.0	NA	1
		max	NA	0.070	NA	8.0	NA	33.0	NA	110
		average	NA	0.052	NA	1.7	NA	15.4	NA	13
		median	NA	0.050	NA	1.0	NA	17.0	NA	1
		standard deviation	NA	0.006	NA	2.2	NA	9.3	NA	34

n = total number of available samples; MPN = most probable number; TKN = total Kjeldahl nitrogen; NA = not analyzed

Epilimnetic or lake surface total phosphorus (TP) concentrations ranged from 2 µg/L to 34 µg/L between 2009 and 2013. Phosphorus concentrations for the three historic stations are in the **mesotrophic** range with median TP concentrations of 20 µg/L at station LMG7, 10 µg/L at station LMG1 and 17 µg/L at station LMG2. The phosphorus concentrations of the samples collected within Long Lake by AECOM have a similar range with the summer (7 µg/L) and fall (8 µg/L) concentrations much lower than the spring (24 µg/L) concentration. The slightly higher phosphorus concentrations measured at station LMG7 are suggestive of possible phosphorus inputs from Grandview Golf Course located hydraulically upstream and across Cranehill Road from station LMG7.Considering the LMG2 sampling location is where Long Lake discharges to Lake Major, it is considered representative of the water quality of Long Lake. The median concentration of Long Lake is 17 µg/L.

Nitrate concentrations, often associated with fertilizer use and wastewater treatment plant discharges, are generally low within Long Lake. Median concentrations ranged up to 0.300 mg/L at station LMG1 (Long Lake Lift Station) but were considerably below this at the other stations. The Long Lake Lift Station exhibited elevated nitrate concentrations on several occasions, including in October 2010 when a maximum of 1.3 mg/L was recorded. Ammonia and TKN data was not available for the Halifax Water sampling stations, but concentrations of these parameters were low in the samples collected by AECOM (ammonia = <0.05 mg/L; TKN < 0.9 mg/L).

Dissolved chloride, which can be elevated in local municipal lakes due to salt spray from the ocean, is also used to assess inputs from road salt. Total suspended solids (TSS) can also indicate road runoff or other sources of eroded particles. Chloride concentrations in Long Lake are low, with median concentrations in the range of 45-65 mg/L and maximum concentrations at about 80-100 mg/L. These values are comparable to those found in Washmill, Kearny and Paper Mill Lakes within the Birch Cove Lakes watershed (AECOM 2013). Total suspended solids are low at all Long Lake stations (the median is typically less than 15 mg/L) although the occasional elevated value is noted (e.g. 110 mg/L in June, 2010 at LMG2 or 180 mg/L at LMG7 in August of the same year). Since little, if any road runoff is discharged to Long Lake, the chloride values suggest the source of chloride is salt spray or chloride from precipitation.

The bacteria *Escherichia coli* (*E. coli*) is an indicator of human and animal waste, and may originate from treatment plant discharges, aging septic systems, and runoff from livestock operations or residential developments. Samples taken at the Long Lake Lift Station (LMG1) often contain *E. coli* but median concentrations are quite low (5 MPN/100 mL[2]). This station (LMG1) shows the highest *E. coli* concentrations, ranging up to 250 MPN/100 mL but concentrations over 25 MPN/100 mL are not common (8 of 45 samples). Other Long Lake samples station also report *E. coli* on a regular basis, but concentrations tend to be lower with maximum concentrations rarely exceeding 10 MPN/100 mL.

3.3.2 Lake Major

Lake Major is the largest lake within the Little Salmon River watershed. Its water quality is influenced by stream flow inputs from several subwatersheds to the north, west and east, including Long Lake. Tributaries to Lake Major include, from north to south, Soldier Lake Brook (station LMG4), Spider Lake Brook (station LMG5), East Lake Brook (station LMG3), Long Lake Brook (station LMG2) and Flat Barrens Brook (stations LMG6A and LMG6). The mixing of the inputs from each of these tributary inlets contributes to the overall water quality of Lake Major as represented by samples collected from the middle of Lake Major (LMDL1) and its discharge to the south (Lake Major Dam).

Sufficient data are available to demonstrate that Lake Major stratifies during the summer. Measurements of temperature versus depth within the lake indicate that cool water persists at depths of 20 m over the summer months, leading to development of a marked thermocline separating warm surface waters (the epilimnion) from cool deep waters (hypolimnion). Dissolved oxygen concentrations also decline markedly across the thermoline. In early

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[2] *MPN = most probable number per 100 mL of sample, a standard unit used in bacteria analyses.* Two common measurements of bacteria in aquatic environments are most probable number (MPN) and colony-forming unit (CFU). *E. coli* concentrations reported in both units were deemed essentially equivalent and combined for the purpose of data analysis.

September 2010, dissolved oxygen levels were 10-6-10.9 mg/L within 5 m of the bottom, dropping to 5.4 mg/L at bottom. By November, dissolved oxygen levels were 1.3 mg/L at bottom and oxygen saturation was 12.9%. This suggests near-anoxic lake bottom conditions are common for at least part of year.

Water quality data are summarized in **Table 9.**

Table 9: Lake Major Water Quality Summary

Sample Name			**Anthropogenic Influence Indicator Parameters**				**Nutrient Enrichment and Trophic Status Indicator Parameters**			**Water Clarify Indicator Parameter**
			Chloride (Cl)	Nitrate (N)	Total Ammonia	*E. Coli*	TKN	Total Phosphorus	Chlorophyll *α*	Total Suspended Solids
			mg/L	mg/L	mg/L	MPN/ 100mL	mg/L	µg/L	µg/L	mg/L
Soldier Lake Gullies Brook Inlet	LMG4	n	4	12	0	12	0	12	0	12
		min	3	0.05	NA	1	NA	3.0	NA	1
		max	5	0.08	NA	7	NA	30.0	NA	3
		average	3.75	0.05	NA	2	NA	13.9	NA	1.41
		median	3.5	0.05	NA	1	NA	17.0	NA	1
		standard deviation	0.95	0.008	NA	1.7	NA	9.0	NA	0.66
Spider Lake Brook Inlet	LMG5	n	3	9	0	9	0	10	0	10
		min	4	0.05	NA	1	NA	2.0	NA	1
		max	5	0.05	NA	3	NA	20.0	NA	23
		average	4.33	0.05	NA	1.4	NA	11.9	NA	3.3
		median	4	0.05	NA	1	NA	10.5	NA	1
		standard deviation	0.57	0	NA	0.88	NA	7.6	NA	6.92
East Lake Brook Inlet	LMG3	n	0	43	0	43	0	43	0	43
		min	NA	0.05	NA	1	NA	1.0	NA	1
		max	NA	0.15	NA	19	NA	20.0	NA	6
		average	NA	0.05	NA	2.1	NA	9.9	NA	1.2
		median	NA	0.05	NA	1	NA	8.0	NA	1
		standard deviation	NA	0.020	NA	3.3	NA	6.3	NA	0.80
Long Lake Brook Inlet	LMG2	n	0	10	0	10	0	10	0	10
		min	NA	0.050	NA	1	NA	2.0	NA	1.00
		max	NA	0.070	NA	8	NA	33.0	NA	110.0
		average	NA	0.052	NA	1.7	NA	15.4	NA	12.9
		median	NA	0.05	NA	1.0	NA	17.0	NA	1
		standard deviation	NA	0.006	NA	2.21	NA	9.3	NA	34.2
Flat Barren Brook Inlet	LMG6 & LMG6A	n	14	42	0	42	0	42	0	41
		min	5	0.05	NA	1	NA	1.0	NA	1
		max	25	0.18	NA	41	NA	31.0	NA	3
		average	14.8	0.07	NA	3.8	NA	14.9	NA	1.2
		median	16.0	0.05	NA	1	NA	15.0	NA	1
		standard deviation	6.4	0.03	NA	7.4	NA	7.0	NA	0.45
Lake Major Deep Station	LMDL-1A (Depth = 0.5 m)	n	4	4	4	4	0	4	4	4
		min	5.00	0.05	0.05	1	NA	2.0	1.10	1
		max	6.00	0.05	0.06	4	NA	6.0	1.47	1
		average	5.60	0.05	0.05	1.8	NA	3.0	1.24	1
		median	5.70	0.05	0.05	1	NA	2.0	1.20	1
		standard deviation	0.49	0	0	1.50	NA	2.0	0.16	0
Lake Major	Lake Major	n	3	3	2	3	3	3	3	3
		min	5	0.05	0.05	1	0.40	7	0.50	2

Sample Name			**Anthropogenic Influence Indicator Parameters**				**Nutrient Enrichment and Trophic Status Indicator Parameters**			**Water Clarify Indicator Parameter**
			Chloride (Cl)	Nitrate (N)	Total Ammonia	*E. Coli*	TKN	Total Phosphorus	Chlorophyll α	Total Suspended Solids
			mg/L	mg/L	mg/L	MPN/ 100mL	mg/L	µg/L	µg/L	mg/L
(AECOM)		max	10	0.05	0.05	5	0.70	23	1.54	5
		average	7	0.05	0.05	2	0.50	13	0.86	3
		median	7	0.05	0.05	1	0.40	8	0.54	2
		standard deviation	3	0.00	0.00	2	0.17	9	0.59	2

n = total number of available samples; MPN = most probable number; TKN = total Kjeldahl nitrogen; NA = not analyzed

The distribution of the Lake Major sample stations allows an assessment of incoming water quality at five tributary locations and comparison of this assessment to the water quality at two lake sample locations. In general, the water entering the lake from these tributaries has similar high quality.

Water entering Lake Major from Spider Lake Brook (station LMG5), Soldier Lake Brook (station LMG4), East Lake Brook (LMG3), Long Lake Brook (station LMG2) and Flat Barrens Brook (stations LMG6 and nearby LMG6A) have similar median TP concentrations, ranging from 8 to 17 µg/L. The average median TP concentration for these creeks is 13.2 µg/L, which is typical for near pristine creeks and rivers (CCME 2004). Nitrate is also low, and is typically not found above the detection limit. Maximum total suspended solids concentrations are very low and rarely exceed 20 mg/L. The bacteria *E. coli* is transported via the tributaries to Lake Major but the tributaries are not a significant source of bacteria. A maximum of 41 MPN/100 mL was recorded at Flat Barren Brook, but these five stations typically report maximum *E. coli* concentrations of less than 10 MPN/100 mL and median concentrations of 1 MPN/100 mL. Taken together, these analytical results describe very good quality water largely unaffected by human influences. This is not surprising since most of these tributaries drain south from the undeveloped Waverly Salmon River Long Lake Wilderness Area, while the lake itself is located within a Protected Water Area.

Comparing these tributary results to actual lake water samples (station LMDA 1A and station Lake Major Dam), TP concentrations appear considerably lower in the lake (2-7 µg/L), although only five samples have been analyzed. These TP concentrations place Lake Major in the lower end of the **oligotrophic** range, indicating exceptionally low nutrient enrichment consistent with the lack of upstream and shoreline urban development.

Other water quality indicators, such as chloride and *E. coli* are similarly low and indicative of minimal human disturbance within the watershed. The only exception is chloride in Flat Barrens Brook (stations LMG6 & LMG6A). The median concentration is 16 mg/L which is elevated compared to chloride levels at the other tributary inlets and lake sample stations. This elevated chloride may indicate road runoff containing de-icing salts from the nearby Montague Estates subdivision.

3.4 Partridge River Watershed

As discussed in Section 2.2, the Partridge River watershed includes several lakes connected by the Partridge River. The upper reaches of the watershed are divided into two catchments. To the northeast is a series of small lakes draining an area underlain by granite and connected to the Partridge River downstream of Eagle Lake. There is little to no development/disturbances in this part of the watershed. The north and northwest part of the watershed includes several small lakes with little to no surrounding development draining into the northern portion of Eagle Lake. The northwestern portion of the watershed includes Winder (Whynder) Lake which flows into the western side of Eagle Lake. Winder (Whynder) Lake is the receiving water for the North Preston Wastewater Treatment Plant. The discharge from Eagle Lake joins the watercourse from the northeastern portion of the watershed, as described above, and flows as the Partridge River into Frog Lake. South of Frog Lake the Partridge River receives water from several small tributaries and discharges into Lawrencetown Lake.

The water quality description in the Partridge River watershed is based on historical data from Winder (Whynder) Lake collected as a part of the former HRM Water Quality Sampling Program (17 sample events), and sampling results from three locations sampled by AECOM: Eagle Lake Outlet, Frog Lake and Partridge River Outlet.

Water quality data for the indicator parameters are summarized in **Table 10.**

Table 10: Partridge River Watershed Water Quality Summary

Sample Name		**Anthropogenic Influence Indicator Parameters**			**Nutrient Enrichment and Trophic Status Indicator Parameters**				**Water Clarify Indicator Parameter**
		Chloride (Cl)	Nitrate (N)	Total Ammonia	E. Coli	TKN -	Total Phosphorus	Chlorophyll *α*	Total Suspended Solids
		mg/L	mg/L	mg/L	MPN/100mL	mg/L	µg/L	µg/L	mg/L
Winder (Whynder) Lake	n	16	15	14	8	16	7	16	17
	min	18	0.05	0.05	2	0.40	100	1.49	4
	max	65	1.62	1.19	50	29.50	300	340	112
	average	37	0.66	0.31	9	3.81	157	86	17
	median	35	0.67	0.12	2	2.10	100	31	8
	standard deviation	12	0.54	0.35	17	6.94	79	106	26
Eagle Lake Outlet	n	3	3	2	3	3	3	3	3
	min	5	0.05	0.05	1	0.40	15	0.50	2
	max	9	0.05	0.05	3	1.50	27	1.55	5
	average	7	0.05	0.05	2	0.77	21	1.10	3
	median	6	0.05	0.05	1	0.40	20	1.26	2
	standard deviation	2	0.00	0.00	1	0.64	6	0.54	2
Frog Lake	May 2014	9	0.05	-	13	0.6	23	1.42	3
	July 2014	7	0.05	0.03	12	2.2	33	0.73	2
Partridge River Outlet	n	3	3	3	3	3	3	3	3
	min	7	0.05	0.05	2	0.40	15	0.50	2
	max	14	0.50	0.50	30	1.10	21	0.95	5
	average	11	0.20	0.20	15	0.63	17	0.65	3
	median	11	0.05	0.05	12	0.40	15	0.50	2
	standard deviation	4	0.26	0.26	14	0.40	3	0.26	2

n = total number of available samples; MPN = most probable number; TKN = total Kjeldahl nitrogen.

As noted, Winder (Whynder) Lake receives discharge from the North Preston WWTP, which was initially built in 1988 and replaced in 2009. The WWTP is located on the western shore of the lake and discharges treated effluent on a continuous basis into the lake (**Figure 6**). Based on 94 effluent discharge samples collected by Halifax Water between January, 2012 and July, 2013 (not reported here), the effluent from the WWTP is near-neutral (median pH=6.7) with elevated phosphorus (median=260 µg/L) and ammonia (median=0.81 mg/L) concentrations. The effluent has moderate TSS (median=4.2 mg/L) and high fecal coliform detections (median count=100 MPN/100 ml). This effluent is naturally expected to have a negative impact on the quality of Winder (Whynder) Lake.

Winder (Whynder) Lake water quality is assessed from the lake samples collected at 1.0 m depth by HRM from 2006 to 2012. Lake water is nutrient-enriched: median TP concentration is 100 µg/L with concentrations ranging from 100 to 300 µg/L. Nitrogen compounds are also elevated: median TKN is 2.1 mg/L, median nitrate is 0.67 mg/L and median total ammonia is 0.12 mg/L. Algae within the lake consume these nutrients, leading to population increases as recorded by elevated median chlorophyll α concentrations of 31.3 µg/L and maximum values in excess of 340 µg/L. These results place the lake into the **eutrophic** category (bordering on hypereutrophic) and reflect nutrients found in the WTTP effluent discharge.

Winder (Whynder) Lake flows into Eagle Lake, and so downstream effects of nutrient inputs from the WWTP may be expected at the AECOM sample location of Eagle Lake Outlet and further downstream at Frog Lake and Partridge River Outlets.

The water quality of Eagle Lake was evaluated based on three AECOM sampling events. The phosphorus concentration from the summer sampling event (15 µg/L) as reported in the preliminary report is the lowest result of the three sampling events. The fall sampling event (27 µg/L) and the spring sampling event (20 µg/L) indicate the lake is bordering the mesotrophic to eutrophic category. Nitrogen compounds (nitrate and ammonia) are at or below detection limits (0.05 mg/L) and TKN is slightly higher than the concentrations in Lake Major. E.coli counts and TSS are low and also comparable to water quality in Lake Major. The results of the sampling from Eagle Lake suggest that inputs from Winder (Whynder) Lake such as nitrogen compounds, TSS and E.coli are reduced by the time water discharges from Eagle Lake. However, elevated concentrations of total phosphorus discharging from Eagle Lake indicate the lake is changing or has changed from mesotrophic to eutrophic. These results are consistent with comments provided by residents that live on or near Eagle Lake indicating algae growth in the lake has been increasing during the past three to five years. Considering there are few (<10) residences near the shore of Eagle Lake, the primary source of total phosphorus to Eagle Lake is likely the nutrient rich discharge from Winder (Whynder) Lake and the North Preston WWTP.

As noted above, sampling from Frog Lake was requested at a community meeting because the lake has several residences surrounding it and is the most likely to experience development pressure in the future. Two sampling events were completed in the spring (May) and summer (July) of 2014. The total phosphorus concentrations were in the eutrophic range with values of 22 µg/L (spring) and 33 µg/L (summer). E.coli counts in Frog Lake are higher than counts from Eagle Lake, suggesting inputs of bacteria from sources near the lake. Nitrogen compounds and chlorophyll-a are consistent with values from Eagle Lake and other lakes in the area. As Frog Lake receives discharge from Eagle Lake, it is expected that the high phosphorus concentrations from Eagle Lake would be carried to Frog Lake as well. The high phosphorus concentrations in Frog Lake and the higher E.coli counts suggest that the residences utilizing septic systems near Frog Lake may also be contributing to the nutrient loading of Frog Lake.

AECOM collected three samples from the Partridge River near the discharge to Lawrencetown Lake. The total phosphorus concentrations indicate the river is lower in phosphorus levels than Frog and Eagle Lakes and in the mesotrophic range. The total phosphorus concentrations observed from the Partridge River samples compared to Frog Lake and Eagle Lake suggest that dilution from low phosphorus tributaries may contribute decreases in total phosphorus as it discharges to Lawrencetown Lake. Nitrogen compounds and chlorphyll-a are comparable to the rest of the watershed. However E.coli counts are higher than upstream samples suggesting that inputs to the river from septic systems may be occurring.

3.5 Lawrencetown/Mineville Area

The Lawrencetown and Mineville areas are not within the Preston Area (Figure 1). However, as described in Section 1.3, these areas were identified as being under development pressure, but lacked water quality data. Considering that these areas are surrounded by the Preston watershed study area, sampling of the waterbodies was added to the project.

Nelson Lake is a small lake with a watercourse surrounded by wetlands before flowing into Robinson Lake. Robinson Lake is also a small lake with inputs from Nelson Lake and other tributaries and discharges into Cole Harbour. Gammon Lake is in a separate catchment and also discharges into Cole Harbour. Water quality results are included in **Appendix A** and summarized in **Table 11**.

Table 11: Gammon, Nelson and Robinson Data

Sample Name		Anthropogenic Influence Indicator Parameters			Nutrient Enrichment and Trophic Status Indicator Parameters				Water Clarify Indicator Parameter
		Chloride (Cl)	Nitrate (N)	Total Ammonia	E. Coli	TKN -	Total Phosphorus	Chlorophyll *α*	Total Suspended Solids
		mg/L	mg/L	mg/L	MPN/100mL	mg/L	µg/L	µg/L	mg/L
Gammon-Lake	20-May-14	10	0.09	-	2	1.6	21	0.33	2
Gammon-Lake	10-Jul-14	8	0.10	0.03	40	1.2	16	0.1	2
Robinson-Lake	20-May-14	26	0.05	-	11	0.4	22	1.05	2
Robinson-Lake	10-Jul-14	21	0.05	0.03	18	1.9	18	0.96	2
Nelson-Lake	20-May-14	23	0.05	-	5	0.6	24	0.86	2
Nelson-Lake	10-Jul-14	21	0.05	0.13	34	2.3	16	0.35	2

The water quality of Gammon Lake, Nelson Lake and Robinson Lake have similar total phosphorus concentrations and have higher total phosphorus concentrations in May. All three lakes border the mesotrophic to eutrophic categories, indicating the lakes have high nutrient loads and are at risk of deteriorating water quality and possibly eutrophication. Gammon Lake has higher nitrate concentrations, and Nelson Lake has a higher ammonia concentration. E.coli counts in all three lakes are highest in the summer results. Results of the limited sampling program indicate that on-site septic systems may be having an impact on water quality as described in Section 2.9.2.

3.6 Metals in Surface Water

Many different dissolved metals can be present as natural background elements in surface waters. Elevated metal concentrations are not necessarily an indicator of human influence, since dissolved metal concentrations often reflect the chemistry of the surface soils and bedrock geology. It is also well documented that deposition of acid rain has depleted the buffering capacity of Nova Scotia soils (the ability of soil minerals to neutralize acidity) and resulted in reduced pH in surface waters, which now typically ranges from 4.5 to 5.5 (Clair et al. 2007). Low pH (acidic) water promotes the dissolution of soil minerals and the liberation and transport of dissolved metals in water.

Table 12 summarizes the average metal concentrations in water samples and shows the number of samples (n) that make up each average value. Values in bold red indicate those values that exceed the CCME Guidelines[3] limit.

The low pH values are immediately apparent. Low pH in inlet streams may be naturally occurring, particularly if the streams drain wetlands with high concentrations of dissolved organic matter. In this case, low pH is likely results from a combination of wetland inputs and historic acid rain. In addition to other metals, low pH often promotes the dissolution of aluminum resulting in elevated aluminum concentrations, and this is the situation at most sample stations shown in **Table 12**.

Arsenic was not measured during most sample events, although excessive arsenic is noted in the average result from six samples taken at an inlet to Lake Major, Flat Barren Brook (stations LMG6 and 6A). Copper is present in several samples but is only marginally elevated in one location, Winder (Whynder) Lake. Other metals, including boron, barium, cobalt, nickel, lead, strontium, titanium and zinc are present in natural or background values, although it is difficult to be conclusive given the lack of samples for certain metals.

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[3] *Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Aquatic Life.*

Table 12: Metals Chem Table

Sample Name	Lake Name	Sample Location Descriptions	pH	Aluminum	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc
		CCME Guidelines Fresh Water Aquatic Life (Applied)	6.5-9	5-100	5.00	-	-	0.02	1.00	-	2.0-4.0	300.00	1.0-7.0	-	73.00	25-150	1.00	0.10	-	0.80	-	-	-	-	30.00
LMG7	North Side of Cranehill Road	n	44	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		min	4.9	24.5	1.0	11.4	5.0	0.0	1.0	0.5	2.0	2660.0	0.5	562.0	2.0	2.0	1.0	0.1	15.3	0.1	2.0	2.0	0.1	2.0	5.4
		max	6.5	335.0	4.0	21.3	10.0	0.4	1.0	3.9	3.5	30100.0	0.5	3450.0	2.0	7.0	1.0	0.1	24.9	0.1	2.0	4.7	0.1	2.0	51.6
		mean	5.9	90.6	2.2	16.0	5.6	0.1	1.0	1.7	2.2	10360.7	0.5	1244.6	2.0	2.8	1.0	0.1	19.5	0.1	2.0	2.3	0.1	2.0	15.4
		median	6.0	58.6	2.3	15.5	5.0	0.1	1.0	1.2	2.0	8785.0	0.5	898.0	2.0	2.0	1.0	0.1	18.8	0.1	2.0	2.0	0.1	2.0	13.2
Long-Lake	Long Lake at Lake Major Road	August, 2013	-	36.0	2.0	7.0	8.0	0.0	1.0	1.0	2.0	50.0	0.5	34.0	2.0	2.0	1.0	0.1	16.0	0.1	2.0	2.0	0.1	2.0	6.0
		n	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LMG1	Below Long Lake Lift Station	n	46	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
		min	5.2	26.4	1.0	7.6	5.0	0.0	1.0	0.4	2.0	50.0	0.5	18.9	2.0	2.0	1.0	0.1	16.0	0.1	2.0	2.0	0.1	2.0	5.0
		max	6.9	149.0	1.0	26.2	24.3	0.2	1.0	0.5	2.0	793.0	0.5	501.0	2.0	2.0	1.0	0.1	98.3	0.1	2.0	2.8	0.1	2.0	8.5
		mean	6.2	84.4	1.0	14.6	9.4	0.1	1.0	0.4	2.0	308.1	0.5	194.9	2.0	2.0	1.0	0.1	48.3	0.1	2.0	2.2	0.1	2.0	5.6
		median	6.3	74.2	1.0	14.5	5.0	0.1	1.0	0.4	2.0	232.0	0.5	150.0	2.0	2.0	1.0	0.1	43.7	0.1	2.0	2.0	0.1	2.0	5.0
LMG2	Long Lake Brook Inlet	n	10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		min	4.7	309.0	1.0	7.5	5.0	0.0	1.0	0.4	2.0	532.0	0.9	25.6	2.0	2.0	1.0	0.1	8.0	0.1	2.0	1.0	0.1	2.0	5.0
		max	5.3	309.0	1.0	7.5	5.0	0.0	1.0	0.4	2.0	532.0	0.9	25.6	2.0	2.0	1.0	0.1	8.0	0.1	2.0	1.0	0.1	2.0	5.0
		mean	4.9	309.0	1.0	7.5	5.0	0.0	1.0	0.4	2.0	532.0	0.9	25.6	2.0	2.0	1.0	0.1	8.0	0.1	2.0	1.0	0.1	2.0	5.0
		median	4.8	309.0	1.0	7.5	5.0	0.0	1.0	0.4	2.0	532.0	0.9	25.6	2.0	2.0	1.0	0.1	8.0	0.1	2.0	1.0	0.1	2.0	5.0
LMG4	Soldier Lake Gullies Brook Inlet	n	13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		min	4.1	207.0	1.0	5.4	5.2	0.1	1.0	0.4	2.0	93.0	0.5	59.6	2.0	2.0	1.0	0.1	6.9	0.1	2.0	1.0	0.1	2.0	7.2
		max	6.1	207.0	1.0	5.4	5.2	0.1	1.0	0.4	2.0	93.0	0.5	59.6	2.0	2.0	1.0	0.1	6.9	0.1	2.0	1.0	0.1	2.0	7.2
		mean	4.8	207.0	1.0	5.4	5.2	0.1	1.0	0.4	2.0	93.0	0.5	59.6	2.0	2.0	1.0	0.1	6.9	0.1	2.0	1.0	0.1	2.0	7.2
		median	4.8	207.0	1.0	5.4	5.2	0.1	1.0	0.4	2.0	93.0	0.5	59.6	2.0	2.0	1.0	0.1	6.9	0.1	2.0	1.0	0.1	2.0	7.2
LMG5	Spider Lake Brook Inlet	n	11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		min	4.2	314.0	1.0	5.0	5.0	0.0	1.0	0.5	2.0	501.0	0.6	59.2	2.0	2.0	1.0	0.1	6.3	0.1	2.0	1.0	0.1	2.0	6.3
		max	4.5	314.0	1.0	5.0	5.0	0.0	1.0	0.5	2.0	501.0	0.6	59.2	2.0	2.0	1.0	0.1	6.3	0.1	2.0	1.0	0.1	2.0	6.3
		mean	4.4	314.0	1.0	5.0	5.0	0.0	1.0	0.5	2.0	501.0	0.6	59.2	2.0	2.0	1.0	0.1	6.3	0.1	2.0	1.0	0.1	2.0	6.3
		median	4.4	314.0	1.0	5.0	5.0	0.0	1.0	0.5	2.0	501.0	0.6	59.2	2.0	2.0	1.0	0.1	6.3	0.1	2.0	1.0	0.1	2.0	6.3
LMG3	East Lake Brook Inlet	n	43	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		min	3.8	281.0	1.0	3.3	5.0	0.0	1.0	0.4	2.0	75.0	0.5	25.9	2.0	2.0	1.0	0.1	3.8	0.1	2.0	2.0	0.2	2.0	5.0
		max	5.2	344.0	1.0	4.1	5.0	0.1	1.0	0.4	2.0	125.0	0.5	30.6	2.0	2.0	1.0	0.1	4.4	0.1	2.0	3.2	0.2	2.0	9.2
		mean	4.3	307.0	1.0	3.7	5.0	0.0	1.0	0.4	2.0	103.7	0.5	28.5	2.0	2.0	1.0	0.1	4.2	0.1	2.0	2.0	0.2	2.0	5.8
		median	4.3	312.5	1.0	3.6	5.0	0.0	1.0	0.4	2.0	104.5	0.5	28.6	2.0	2.0	1.0	0.1	4.2	0.1	2.0	2.0	0.2	2.0	5.0
LMG6A	Flat Barren Brook Inlet	n	43	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
		min	4.3	175.0	20.6	3.2	5.0	0.0	1.0	0.4	2.0	626.0	0.5	70.4	2.0	2.0	1.0	0.1	8.8	0.1	2.0	1.0	0.1	2.0	5.0
		max	6.8	391.0	39.5	6.6	7.6	0.3	1.0	1.7	2.0	1150.0	0.6	354.0	2.0	2.0	1.0	0.1	10.7	0.1	2.0	3.8	0.1	2.2	14.0
		mean	5.3	273.3	27.8	4.8	5.4	0.1	1.0	0.9	2.0	828.3	0.5	184.2	2.0	2.0	1.0	0.1	9.8	0.1	2.0	2.6	0.1	2.0	6.6
		median	5.3	250.5	26.7	4.7	5.0	0.0	1.0	0.7	2.0	783.0	0.5	137.5	2.0	2.0	1.0	0.1	9.9	0.1	2.0	2.7	0.1	2.0	5.0
Lake-Major	at Lake Major Dam	August, 2013	-	178.0	2.0	5.0	6.0	0.0	1.0	1.0	1.0	87.0	0.5	53.0	2.0	2.0	1.0	0.1	7.0	0.1	2.0	2.0	0.1	2.0	24.0
Winder LAKE	Winder LAKE	n	16	7	7	7	7	7	7	7	14	14	7	14	7	7	7	7	7	7	7	7	7	7	14
		min	5.9	52.0	2.0	9.0	38.0	0.0	1.0	1.0	2.0	0.1	0.5	0.1	2.0	2.0	1.0	0.1	29.0	0.1	2.0	2.0	0.1	2.0	5.0
		max	10.8	130.0	2.0	14.0	55.0	0.3	2.0	1.0	25.0	3570.0	1.2	309.0	2.0	2.0	2.0	0.5	46.0	2.0	2.0	2.0	0.1	2.0	76.0
		mean	7.4	79.6	2.0	11.3	46.4	0.2	1.6	1.0	4.3	363.8	0.6	82.6	2.0	2.0	1.6	0.3	35.3	0.9	2.0	2.0	0.1	2.0	15.9
		median	6.9	76.0	2.0	11.0	47.0	0.3	2.0	1.0	2.0	123.0	0.5	64.5	2.0	2.0	2.0	0.5	35.0	0.1	2.0	2.0	0.1	2.0	10.0
Lake-Eagle-Outlet	Lake Eagle	August, 2013	-	223.0	2.0	5.0	14.0	0.0	1.0	1.0	1.0	145.0	0.5	17.0	2.0	2.0	1.0	0.1	9.0	0.1	2.0	2.0	0.1	2.0	7.0
Partridge-River-Outlet	Partridge River	August, 2013	-	145.0	2.0	5.0	12.0	0.0	1.0	1.0	1.0	289.0	0.5	38.0	2.0	2.0	1.0	0.1	12.0	0.1	2.0	2.0	0.1	2.0	5.0
Gammon-Lake	Gammon Lake	July, 2014	6.4	111.0	13.0	5.0	8.0	0.017	1.0	1.0	1.0	269.0	0.5	78.0	2.0	2.0	1.0	0.1	13.0	0.1	2.0	2.0	0.1	2.0	7.0
Robinson-Lake	Robinson Lake	July, 2014	7.0	92.0	2.0	7.0	9.0	0.017	1.0	1.0	1.0	464.0	0.5	425.0	2.0	2.0	1.0	0.1	24.0	0.1	2.0	2.0	0.1	2.0	23.0
Frog-Lake	Frog Lake	July, 2014	6.0	251.0	2.0	5.0	9.0	0.017	1.0	1.0	1.0	432.0	0.8	91.0	2.0	2.0	1.0	0.1	10.0	0.1	2.0	2.0	0.1	2.0	11.0
Nelson-Lake	Nelson Lake	July, 2014	7.2	29.0	2.0	16.0	13.0	0.017	1.0	1.0	1.0	990.0	0.5	2240.0	2.0	2.0	1.0	0.1	50.0	0.1	2.0	2.0	0.1	2.0	9.0

3.7 Water Quality Objectives

The Salmon River watershed exhibits good to excellent water quality, while the Partridge River watershed has high nutrient concentrations, likely from the discharge of the North Preston WWTP.

Water quality in Lake Major continues to benefit from the lake's position within the Dartmouth water supply Protected Water Area. At the same time, many of the inlet tributaries to Lake Major originate in the Waverly Salmon River Long Lake Wilderness Area, an expansive, undeveloped and relatively inaccessible region of pristine lakes and rivers. Although TP concentrations in these tributaries may appear to be slightly elevated relative to concentrations measured within the lake, they are in fact quite low and consistent with concentrations found in non-impacted watercourses.

The tributary Flat Barrens Brook may be importing low concentrations of road salt and possibly other pollutants such as *E. coli* from the Montague Estates subdivision, but these inputs are small compared to the volume of Lake Major. The lake's relatively large volume allows it to assimilate a certain degree of nutrient input before water quality degradation becomes evident. Should residential development be proposed within its watershed, continued water quality monitoring will be needed to identify long term impacts to this lake.

The Partridge River watershed has high concentrations of nutrient inputs from the North Preston WWTP into Winder (Whynder) Lake which is one of the headwater tributaries of the watershed. Residential on-site septic systems along the Partridge River and associated lakes also contribute to the nutrient loading of the watershed.

Appendix B presents a discussion on how the key water quality indicators respond to human induced changes within the watershed and a justification why they were selected for use in this study. It also presents a review of water quality guidelines and objectives used in other jurisdictions, both nationally and internationally, as background to establishing water quality objectives for this study.

As noted, recommended water quality objectives (WQOs) for the Preston Area have been derived for the indicator parameters most sensitive to changes in land use within the watershed. The WQOs and early warning alert values for these indicators can be used with the monitoring data to signal deterioration in water quality and prompt management action or mitigation. Early warning alert values are provided with the WQOs on the basis that it is desirable to have a warning that an objective is being approached. This permits a response and implementation time for mitigation measures. Objectives and alerts should not be based on single data points as there is considerable natural variability in water quality within a watershed. In light of this natural variation, a water quality evaluation methodology is proposed.

Water quality in the Preston Area, as represented by the median concentrations of the indicator parameters, is presently below the CCME Guidelines. Because the Guidelines are set to protect the most sensitive aquatic species, and because water quality in the study area is currently better than these objectives, **we recommend that the CCME Guidelines for nitrate, total suspended solids, and chloride be adopted for the Preston Area.** HRM currently uses the guideline of 200 CFU/100 mL for *E. coli* for body contact recreation, which is the same as the Health Canada value of 2000 *E. coli*/L[4]. We suggest this value is appropriate for the *E. coli* parameter. These values are illustrated in **Table 13.**

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[4] *Note these are the same measurements but expressed for a different volume (mL versus L) and consequently the number of allowable counts changes in accordance with the volume of the sample.*

Table 13: Recommended Water Quality Objectives for the Preston Area Excluding TP

Parameter	Derivation of Objective	Preston Area Water Quality Objective	Early Warning Alert Value	Evaluation Method for Objective/Alert Value
NO_3 – Nitrate	CCME	• 13 mg NO_3/L	• ≤10 mg/L	• 75th percentile of 3 year historical data[3].
Total Suspended Solids (TSS)	CCME	• Short term[1]: 25 mg/L increase • Long term[2]: 5 mg/L increase	• Lake dependent	• 75th percentile of 3 year historical data not to exceed base line by more than 5 mg/L
Chloride	CCME	• 120 mg/L	≤90 mg/L	• 75th percentile of 3 year historical data
E. coli	Nova Scotia and Health Canada	• 200 *E. coli*/100 mL • (geometric mean of 5 samples)	• 200 *E. coli*/ 100 mL	• Geometric mean of 5 most recent samples

1: Short term refers to variation between discreet sampling events

2: Long term refers to variation defined by the 75th percentile of 3 year historical data

3: 75th percentile of the reported values from the results of previous 3 years of monitoring. This assumes the results are from a technically justifiable monitoring program.

For the Preston Area we recommend building on Environment Canada's classification with each water body categorized into trophic status based on existing conditions.

In this case, the management objective would be to maintain the trophic status of the lake. **The water quality objective for TP becomes the upper limit of the TP range for each trophic state**. If a monitoring program shows that the trophic status of the water body was changing to the next higher trophic state (i.e., the water quality objective was being exceeded as water quality deteriorated) then management action would be warranted to protect the lake. In this approach the WQO becomes a "trigger value" for action. This approach is consistent with the objectives of the Regional Plan, which seeks "to maintain the existing trophic status of our lakes and waterways to the extent possible."

In the sections above, existing water quality data were reviewed. Lake Major was classified as oligotrophic with low concentrations (<10 µg/L) of total phosphorus and Long Lake as mesotrophic with moderate (10 to 20 µg/L) TP concentration. Lake Eagle TP concentrations indicate the lake is in the mesotrophic to eutrophic category and Winder (Whynder) as eutrophic with median phosphorus concentrations of 100 µg/L.

Unfortunately, mitigation measures to reduce TP concentrations are seldom instantaneous or completely effective, so water quality objectives combined with early warning values are often used to evaluate lake quality rather than waiting for the specific TP water quality objective to be met or exceeded. Early warning indicators such as trends in phosphorus concentrations or trigger concentrations just below the objective value are highly useful management tools for water bodies. As can be seen from the water quality summary of the Preston Area above, there is considerable variability in TP measurements and single values (low or high) are not an appropriate basis for management decisions. Thus, the approach to setting phosphorus water quality objectives needs to be accompanied by a scientific rationale for testing whether or not the water quality is changing.

Lake-specific TP objectives and early warning values have been developed based on existing data. **Table 14** provides a summary of the TP water quality objectives and early warning values and a method to evaluate whether or not the objective or alert value is being approached for each lake. Insufficient data exist to conclusively establish phosphorus objectives for Eagle Lake, but the objective in Table 14 is tentatively established until more data can be collected.

Table 14: Water Quality Objectives and Early Warning Values for Total Phosphorus

Lake	Trophic State Objective	Numerical Objective	Early Warning	Evaluation
Lake Major	Oligotrophic	< 10 µg/L	9 µg/L	Based on 3 year running average
Long Lake	Mesotrophic	< 20 µg/L	15 µg/L	
Eagle Lake	Mesotrophic	< 20 µg/L	18 µg/L	
Winder (Whynder) Lake	Eutrophic / Hyper eutrophic	<100 µg/L	Not Applicable	Winder (Whynder) Lake should be maintained at its current median phosphorus concentration of 100 µg/L.

Water quality results from this study suggest the lakes in the Partridge River watershed and in Mineville/Lawrencetown area have high nutrient loads and are bordering or are now in the low end of the eutrophic category. This characterization should be considered preliminary considering there is no historical data available to compare these results to and the limited sampling completed as part of this study is insufficient to accurately characterize the water quality. However, the results clearly indicate the waterbodies are experiencing nutrient loading and if the general water quality objective is to keep the trophic status below eutrophic conditions, then actions should be completed to improve water quality and further sampling should be completed to monitor changes in water quality.

4. Groundwater

Historically, the residents in the communities of the Preston Area (Lake Loon, North Preston, Cherry Brook, Lake Major and East Preston) have used on-site wells for potable water supply. In 1989, water and waste water services were installed and provided for North Preston. Cherry Brook, Lake Major and part of Lake Loon are supplied with water services. The remaining residents in the Preston Area, primarily in East Preston, obtain potable water for domestic use from drilled and dug wells. The Municipal Planning Strategy [MPS (HRM 1993)] for the Preston Area identified groundwater quality and quantity concerns including exceedances of Guidelines for Canadian Drinking Water Quality (CDWQ) for the aesthetic objectives (not a health concern) of iron, manganese, turbidity and pH. Health related water quality concerns identified in the MPS included arsenic in wells located in East Preston and coliform bacteria in dug wells. Road salts and poor road construction and management practices were identified to impact water quality, primarily in dug wells. The yield of groundwater supply in the Preston Area is also an issue of concern (HRM 1993). Dug wells experience inadequate water supply during dry seasons and some drilled wells may have limited yield.

The issues of groundwater quality and quantity have not been directly addressed since the MPS. The watershed study for the Preston Area provides an opportunity to revaluate the groundwater issues in the Preston Area which will be used by HRM and the community to evaluate water and waste water service needs and guide future development plans.

4.1 Objectives

The objectives of the groundwater study for the Preston Area are defined by the E-17 policy:

> *Assessing the quantity and quality of groundwater resources available to support future development and recommending ways to protect these resources*

The objective to assess the quantity of groundwater resources is addressed by estimating the potential development densities. The density estimates are made using available data to estimate aquifer parameters and Nova Scotia Environment's (NSE) Guide to Groundwater Assessments for Subdivisions Serviced by Private wells (NSE 2011).

The assessment of water quality is addressed by evaluating existing water quality data in conjunction with results from a residential well survey completed for this study.

Recommendations for ways to protect groundwater resources include an evaluation of groundwater recharge. Groundwater recharge is estimated for the Preston Area using a general water budget and a GIS based recharge model.

4.2 Study Area

The Preston Area is defined by the watershed boundaries of the Salmon River and the Partridge River. This Study Area encompasses the communities of Cherry Brook, North Preston, Lake Loon, Montague Gold Mines and East Preston. Municipal water services are supplied to residents in Cherry Brook, North Preston, Lake Major and portions of Wesphal, Lake Loon and East Preston (**Figure 2**). Most of the residents of East Preston use wells for water supply and septic systems for waste water. However, many of the residents in East Preston are in the watershed including Nelson Lake and Robinson Lake. Considering that groundwater quantity and quality effect residents inside and outside the WSA, the geographic scope of the Groundwater Study Area (GSA) was expanded to include areas of East Preston along Highway 7 that rely on groundwater.

In addition to the areas of East Preston outside the watershed boundaries, the area south of East Preston was included at a late stage in the study. At a community presentation in December 2013, it was pointed out that the residential developments near Robinson Lake, Lake Gammon and Mineville utilize on-site wells for potable water supply and septic systems for waste water disposal and these communities may also have water quality and water supply issues. In consultation with HRM, the scope of the GSA was expanded to include groundwater sampling in the area between the southern extents of the watersheds.

4.3 Methods

4.3.1 Residential Well Sampling

The objective to assess groundwater quality was addressed through a residential well sampling program. The residential well sampling program was completed in three phases of sampling: summer (August and September) and fall (November and December) of 2013 in the East Preston area and spring (March) of 2014 in the Lake Gammon and Mineville area. A total of seventy (70) groundwater samples were collected from thirty eight (38) residences. Six (6) of the sampling locations were from dug wells and the remaining thirty two (32) sample locations were from drilled wells.

Samples were collected as raw water samples prior to any water treatment systems. In an attempt to collect samples that were representative of well water, cold water from the sampling tap was allowed to run for a minimum of 1 minute, followed by disinfection of the water outlet with alcohol antiseptic wipes and allowing water to flow for 30 seconds. Samples were collected in laboratory-supplied bottles and immediately stored in coolers with ice until the samples were delivered to the laboratory.

All samples were analyzed for the following parameters:

- General chemistry
  - Colour, total dissolved solids (TDS), turbidity, alkalinity, hardness, electrical conductivity, chloride, fluoride, nitrogen (nitrate, nitrite, ammonia), orthophosphate, reactive silica, sulphate, total organic carbon, pH
- Total metals
  - Aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, silver, sodium, strontium, thallium, tin, titanium, uranium and zinc

- Bacteriological
  - Total coliforms, Escherichia coli (E.coli)

Results were compared to the Guidelines for Canadian Drinking Water Quality. Reportable detection limits (RDL) for each parameter are presented with the analytical results. Quality control of the sampling program was assessed by duplicate sampling at four (4) locations during each sampling event.

A survey or questionnaire was completed during the first sampling event at each residence. The intention of the survey was to collect information related to water quality and quantity concerns. Details of the well and treatment systems were collected to assess if exposure risks are present resulting from consumption of wells with water quality issues.

To supplement the results of the residential well survey, bedrock samples analyzed for bulk geochemistry using the NSDNR portable XRF machine. Four bedrock samples were collected from the Mineville and Lawrencetown area in March of 2014. The rock samples were prepared and analyzed at the NSDNR facilities in Halifax.

4.3.2 Groundwater Recharge Mapping

Groundwater recharge mapping involves two steps: water budget and recharge mapping. The water budget identifies the quantity of water available for recharge and the recharge mapping evaluates recharge based on designated parameters

The water budget for the GSA estimates the water available for recharge. For a given time period (often one year), the water budget balances the gains and losses of water within the watershed with the quantities of water stored in the watershed. The water budget equation is expressed as follows:

$$P = RO + R + ET + \Delta S_s + \Delta G_s$$

Where:

P = Precipitation (mm/yr);
RO = Runoff (mm/yr);
R = Groundwater Recharge (mm/yr);
ET = Evapotranspiration (mm/yr);
ΔS_s = Change in soil moisture storage (mm/yr); and,
ΔG_s = Change in groundwater storage (mm/yr).

In a large watershed where the groundwater system boundaries coincide with surface water divides, the change in groundwater storage can be assumed to equal zero ($\Delta G_s = 0$). For precipitation, long term meteorological data averaged over the 30 year period of 1981 – 2010 were obtained from Environment Canada for the Stanfield Airport climate station. Evapotranspiration can be defined as either potential evapotranspiration or actual evapotranspiration. Potential evapotranspiration can be estimated using temperature data and incoming solar radiation (often referred to as the daylight correction factors) from data measured within the watershed. The daylight correction factors are dependent upon the latitude of the watershed or meteorological station, with the understanding that areas closest to the equator will have the most daily sunlight and therefore the highest potential evapotranspiration rates. Actual evapotranspiration expands upon potential evapotranspiration to include changes in soil moisture and monthly precipitation rates. Actual evapotranspiration rates are used in the analysis of the water budget for the Preston Area watershed.

Soil moisture storage was assumed to be 200 mm. This low value reflects the generally shallow soils and till deposits. Assuming that changes in soil moisture storage (ΔS_s) are negligible and that there is no change in groundwater storage (ΔG_s) in the watershed, the total *water surplus* that is available for *surface runoff* to the surface water system and *infiltration* as groundwater recharge, can be determined. Using the same formula terms described above, the water surplus (mm/yr) is expressed as:

$$Surplus = P - ET$$

The proportion of the water surplus that infiltrates into the soil and ultimately into the underlying bedrock aquifer or runs off as overland surface sheet flow to streams and lakes depends primarily upon the characteristics of the soils, the topography, the land use and the vegetative cover present. This concept is based upon the fact that water will infiltrate more easily through flat lying, high permeability soils than through steep slopes or low permeability soils. Water that infiltrates to the ground "recharges" the shallow water table and flows laterally towards streams and lakes. In areas with thick soil cover, this recharge may migrate first into deeper groundwater aquifer systems before eventually discharging into surface water systems.

Surface runoff or sheet flow, on the other hand, generally coincides with rainfall events. As the surficial soil become saturated by rainfall, water may runoff overland to low lying areas. This process is especially pronounced during the spring snow melt where the melting snowpack is forced to runoff because the upper soil layers are still frozen and do not allow infiltration. In Nova Scotia where the temperature can fluctuate between above and below freezing conditions, the melting of the snowpack is not usually a major runoff event compared to colder regions where the snow precipitation remains as snow for many months and melts over a short time period in the spring.

The actual evapotranspiration for the GSA was calculated using the method described in Thornthwaite and Mather (1957), using a monthly time step and assuming soil moisture of 200 mm. A daylight correction factor for 44 degrees latitude was applied. The overall water surplus determined for the Stanfield Airport meteorological station represents the difference between the mean annual precipitation (P) and the actual evapotranspiration (ET). The water surplus is presented in **Table 15**.

Table 15: Summary of Metrological Data

Meteorological Station	Total Annua/ Precipitation (mm)	Actual Annual Evapotranspiration (mm)	Annual Water Surplus (mm)
Stanfield Airport	1,396	543	853

Notes: 1. Data obtained from the 1971 – 2000 average at Halifax Citadel (Environment Canada) weather station.
2. Actual Evapotranspiration calculated using the Thornthwaite and Mather (1957) method.

The annual water budget and water surplus calculations for the GSA require a number of assumptions, including:

- Temperature and precipitation data measured at the Stanfield Airport weather station from 1981-2010 are representative of the climate conditions in the Preston Area.
- Soil moisture storage remains relatively constant at 200 mm annually and is representative of conditions throughout the watersheds.
- Based on the calculated annual water surplus, groundwater recharge and surface water runoff rates were calculated for the Preston Area watersheds using a Geographic Information System (GIS) based analytical model. This model assumes that volumes of domestic and municipal groundwater taking are negligible compared to flow through the system, and that groundwater and/ or surface water inflow from outside the watershed is also negligible. The model integrates slope, land use (vegetative cover), and geology over a 1000 x 1000 m grid to estimate potential groundwater recharge rates and runoff volumes for the watershed.
- The second step was to partition the surplus water into runoff and infiltration. A variety of infiltration coefficients were determined for each of the different geologic, vegetative and topographic units within the watershed. The

land use mapping and digital elevation model were used to assign values for slope and vegetative cover. Once coefficients were applied to each unit, they were combined within the GIS model to create a layer of infiltration distribution over the entire watershed.
- The infiltration distribution, in combination with the distribution of water surpluses, produced a model of the spatial variability of groundwater recharge across the GSA watershed, from which the estimated recharge distribution mapping was produced.

4.4 Local Hydrogeology

The hydrogeology in the Preston Area consists of two hydrostratigraphic groups: surficial deposits composed of unconsolidated glacial and post-glacial sediments and bedrock composed of metasedimentary and igneous rocks. Descriptions of the characteristics of these groups provides context for the development of conceptual groundwater movement in the Groundwater Study Area and for designation of infiltration coefficients used for the groundwater recharge model.

4.4.1 Surficial Hydrogeology

Hydraulic tests of surficial deposits are limited in the GSA. One pumping test was completed in 5.5 m thick unit of glaciofluvial outwash in Upper Lawrencetown. The apparent transmissivity was estimated to 14.32 m^2/day with a hydraulic conductivity of 3.0×10^{-5} m/sec (**Table 16**).

Table 16: Summary of Aquifer Parameters from NSDNR Database

Community	Test Start	Test End	Hydrostratigraphic Unit	Geology	Depth (m)	Casing Diameter (mm)	Static Level (m)	Average Rate (m^3/d)	Tapp (m^2/d)	SC (m^2/d)	Q_{20} (L/min)
Upper Lawrencetown	Sat, 26 Aug 1978	Tue, 29 Aug 1978	Surficial Aquifer	Glaciofluvial/ Alluvial	5.49	914.4	2.77	51.71	14.32	26.93	11.4
North Preston	Mon, 15 Jun 1970	Thu, 18 Jun 1970	Meguma Metasedimentary Aquifer	Goldenville	17.98	152.4	3.89	22.42	1.82	2.04	9.1
East Preston	Wed, 17 Jan 1979	Sat, 20 Jan 1979	Meguma Metasedimentary Aquifer	Goldenville	35.97	152.4	3.6	26.18	0.41	1	4.5
Upper Lawrencetown	Sat, 25 Aug 1984	Mon, 27 Aug 1984	Meguma Metasedimentary Aquifer	Goldenville	n/a	0	4.27	32.73	2.89	7.41	22.7
Upper Lawrencetown	Tue, 23 Aug 1977	Tue, 23 Aug 1977	Meguma Metasedimentary Aquifer	Goldenville	60.96	127	0.46	26.18	0.14	0.57	3.4
Upper Lawrencetown	Tue, 30 Aug 1977	Tue, 30 Aug 1977	Meguma Metasedimentary Aquifer	Goldenville	22.86	152.4	0.55	6.55	0.16	0.39	1.4
Upper Lawrencetown	Thu, 25 Aug 1977	Thu, 25 Aug 1977	Meguma Metasedimentary Aquifer	Goldenville	53.34	152.4	2.65	52.36	2.76	11.69	36.4
Upper Lawrencetown	Mon, 29 Aug 1977	Mon, 29 Aug 1977	Meguma Metasedimentary Aquifer	Goldenville	22.86	152.4	4.51	6.55	0.12	0.56	0.7
Upper Lawrencetown	Sun, 15 Feb 1976	Wed, 18 Feb 1976	Meguma Metasedimentary Aquifer	Goldenville	60.96	152.4	9.45	62.18	0.66	1.4	12.3
Upper Lawrencetown	Sat, 01 May 1976		Meguma Metasedimentary Aquifer	Goldenville	78.03	152.4	7.32	22.91	0.47	n/a	6.8
Cherry Brook	Wed, 07 Oct 1970	Sat, 10 Oct 1970	Meguma Metasedimentary Aquifer	Halifax	96.01	152.4	19.02	13.09	0.06	n/a	2.3
Cherry Brook	Fri, 05 Mar 1971	Mon, 08 Mar 1971	Meguma Metasedimentary Aquifer	Halifax	88.39	152.4	9.14	17.67	0.11	0.24	4.5
Lake Echo	Fri, 16 Apr 1976	Mon, 19 Apr 1976	Meguma Metasedimentary Aquifer	Halifax	121.92	152.4	0.38	65.45	0.49	0.81	18.2

Based on general grains size descriptions of other units, the hydraulic conductivity is expected to be low in the Beaver River Till and lacustrine deposits and moderate to low in drumlin deposits.

The hydrostratigraphic unit of Surficial aquifers is used to represent all surficial aquifers in the GSA. This results in a range of hydraulic properties and sediment chemistry in this grouping. However, based on the grain size distribution and the interpretation of hydraulic parameters the surficial deposits in the GSA could be grouped into three hydrostratigraphic units with further refinement based on detailed mapping and testing. For this study distinctions between these units were not made for the residential well survey or for summaries of hydraulic parameters because of limited information available regarding the surficial stratigraphy at each well location.

Groundwater elevations and available head in surficial deposits are expected to be variable seasonally and spatially. Groundwater elevations in surficial deposits are reportedly lower during summer and higher during the winter and spring. Based on the results of the questionnaires completed during the residential well survey of this study, dug wells on higher topography (drumlins) are more frequently dry during summer than the dug wells at lower topography and wells closer to surface water bodies. Groundwater flow in surficial deposits is expected to follow the topography and generally flow to the south/southwest, with variations based on local topography.

4.4.2 Bedrock Hydrogeology

The bedrock hydrostratigraphy has two major units; the Meguma metasedimentary aquifer (Goldenville and Halifax Group rocks) and the granite aquifer. All of the water wells in the GSA are completed in the Meguma metasedimentary aquifer; therefore the discussion of hydraulic properties is limited to this unit.

The Meguma metasedimentary aquifer is a unit with a large range in hydraulic properties resulting from water moving through fractures in the rock. In the GSA, thirteen pumping tests have been completed in drilled wells in Meguma. The average transmissivity of the Meguma rocks in the GSA is 0.84 m^2/day (**Table 17**). The long term sustainable yield, represented by Q_{20}, has a large range in bedrock wells from < 1 L/min to 36 L/min. This large range is consistent with aquifer units that have water flow through the secondary permeability of fractures rather than the primary permeability of flow through the rock pore space. In practice, this range is also consistent with anecdotal observations from the residential well survey completed for this study where residents would describe a large difference in well yield compared to a nearby neighbor.

A regional assessment of groundwater resource potential of HRM (FracFlow 2004), also groups the Goldenville Group and Halifax Group into the same hydrostratigraphic unit because they have similar, low primary permeability. However, the assessment recognizes that the Groups may have different secondary permeability controlled by fracture density and orientation. The fractures in the Halifax Group are generally well developed, slaty cleavage oriented along the axis of the regional deformation (NE to SW). The fractures in the Halifax Group are also generally an order of magnitude greater than the Goldenville Group. The Goldenville Group rocks have a larger proportion of massive quartzite, which fractures into a three dimensional network reflective of the conjugate fractures related to regional deformation. The different fracture patterns result in different groundwater pathways. The high density, planar fractures in the Halifax Group suggests groundwater movement is more rapid in these units. However, the planar pattern suggests the fractured layers may not be well connected and limit yield. The lower density of the blocky fractures and joints in the Goldenville Group suggests lower secondary permeability, but the networks of fractures are more connected, resulting in more connectivity between fractures. A hydrogeological study in the Lawrencetown area identified fracture flow in the bedrock related to fault systems and fractures associated with changes in lithology (Cross 1980). This study also identified saltwater intrusion to the bedrock aquifer in near coastal areas. These descriptions of how the fracture patterns in the rocks may affect groundwater movement provides a conceptual model of groundwater flow patterns. In the GSA, the level of detail in the well logs and the level of detail in the bedrock mapping does not allow for the verification of detailed groundwater flow patterns in the Meguma metasedimentary aquifer.

4.5 Groundwater Quality

Groundwater quality depends on the travel pathway of water. Residence time, the type of rock in contact with water, and the composition of water as it enters the groundwater system all contribute to the chemical composition of groundwater.

Groundwater from surficial aquifer units typically have a short residence time. The amount of time it takes for rainfall to infiltrate the soils and into the surficial aquifer depends on the permeability of the unit, but is typically less than 50 years. As the water travels through surficial unit(s) the quality of the water will be influenced by the composition of the sediments. In areas where the sediments are glacial deposits derived from the local bedrock, the water quality would be expected to be similar to the bedrock aquifers. However, the relatively short residence time may not allow for dissolution of minerals that have low solubility. The short residence time also means that changes to water and soil chemistry on the surface are more likely to impact surficial aquifers. Surface contaminants such as road salts, hydrocarbons, bacteria and metals may have short pathways to surficial aquifers resulting in potential for contamination of these units.

Groundwater quality in the Meguma Metasedimentary aquifer is controlled by the pathway of groundwater flow. As noted above, the majority of groundwater yield from this aquifer is from fractures in the bedrock. Fracture systems that are influenced by previous movement of hydrothermal fluids that produced gold and arsenopyrite mineralization will have high concentrations of arsenic and may also have higher concentrations of other minerals associated with mineralized fracture zones such as calcite ($CaCO_3$), silica (quartz), sulphate (SO_4) and iron (Bottomley 1984). Fracture systems that do not have mineralized veins and fractures associated with them are more likely to reflect the chemistry of the main bedrock lithology. The Halifax Group and Goldenville Group rocks are lumped into the same hydrostratigraphic unit based on generalized physical characteristics related to yield. Chemically, the rocks in the Groups are distinct. The Halifax Group rocks have higher proportions of sulphide minerals, metals and have lower buffering capacity than the Goldenville Group (White and Goodwin 2011). The Halifax Group rocks are also associated with elevated concentrations of arsenic. However, arsenic is also associated with structurally controlled mineralized areas that have arsenopyrite interspersed with gold deposits (Section 2.7.1). The gold deposit in Montague Gold Mines west of the GSA and the gold deposit in Mineville are hosted by Goldenville Group rocks in anticline structures. The groundwater quality near these historic mining areas have elevated concentrations of arsenic, copper, zinc and sulphur from the oxidation of sulphide minerals (Bottomley 1984). The groundwater quality in the GSA depends on the type of minerals and rock the water passes through as it flows through the fracture systems in the bedrock. The structure of the bedrock can influence both the flow patterns and the groundwater quality and the bedrock lithology can also influence the groundwater quality. Regional interpretations of groundwater quality in the Meguma Metasedimentary aquifer are aided by detailed mapping and interpretation of the bedrock geology.

4.5.1 Historic Groundwater Quality

Historical groundwater quality in the GSA provides data from 1977 to 2011 as a comparison to current groundwater quality. Three sets of historical groundwater quality data are available for the Preston Area. The Nova Scotia Environment well database includes seven (7) water samples from pumping tests completed in wells from the Meguma metasedimentary aquifer. The results from one groundwater sample collected from the Eagle Quest Golf Course in 2010, was provided through a freedom of information and protection of privacy request. The Camp Harris Scouts camp in Mineville has two water supply wells (New well and Old well) less than 100 apart. The wells are a registered water supply requiring regular water quality testing including analysis of metals and general chemistry once every two years. The water quality data from Camp Harris was provided for this study and includes eleven (11) samples from each well over the time period from 1988 to 2011.

Table 17 includes water quality data from each location. The Camp Harris data is represented as mean values in **Table 17** and the complete set of data is presented in **Table 18**.

Table 17: Summary of Historic Groundwater Data in the GSA

Sample ID	Sample Date	Easting	Northing	Hydrostratigraphic Unit	Alk (mg/L)	HCO3 (mg/L)	CO3 (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	F (mg/L)	SO4 (mg/L)	Cl (mg/L)	Hardness (mg/L)	TDS (mg/L)	pH	NO3 - NO2N (mg/L)	Al (ug/L)	As (ug/L)	B (ug/L)	Cu (ug/L)	Fe (ug/L)	Mn (ug/L)	Pb (ug/L)	Sr (ug/L)	U (ug/L)	Zn (ug/L)
					CDWQ Guidelines			**200**				**1.5**	**500**	**250**		**500**		**10**	**100**	**10**	**1000**	**1000**	**300**	**50**	**10**		**20**	**5000**
Ptest223	1977	464181	4947681	Meguma Metasedimentary Aquifer	42	n/a	n/a	**235**	4.9	37	14	0.1	0.5	**455**	151	**826**	8	0.05	n/a	9	n/a	n/a	110	**60**	n/a	n/a	n/a	n/a
Ptest263	1977	464181	4947681	Meguma Metasedimentary Aquifer	53	n/a	n/a	95	19	31	12	0.2	24	206	126	442	7.6	0.05	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ptest264	1977	464181	4947681	Meguma Metasedimentary Aquifer	73	n/a	n/a	63	5.3	24	7.8	0.1	5.8	122	93	268	8	0.05	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ptest424	1979	465841	4951104	Meguma Metasedimentary Aquifer	59	n/a	n/a	19	1.7	50	4	0.05	14	70	142	220	7.4	0.9	n/a	2.5	n/a	n/a	170	**90**	n/a	n/a	n/a	n/a
Reg1535	2006	467835	4953871	Meguma Metasedimentary Aquifer	28	28.1	n/a	37	0.5	3.8	0.6	0.5	19	26	12	110	7.54	n/a	n/a	n/a	n/a	n/a	92	33	n/a	n/a	0.1	n/a
Reg2271	2008	465846	4952030	Meguma Metasedimentary Aquifer	182	182	5	11	1.5	61.3	13.9	0.32	9.6	15.1	211	228	7.72	0.1	n/a	1.5	n/a	n/a	25	15.8	n/a	n/a	6.1	n/a
Obs48	2008	464172	4947712	Meguma Metasedimentary Aquifer	82	81	1	98	1.9	27	8.8	0.1	1	180	100	375	8.14	0.025	n/a	**58**	n/a	n/a	25	32	n/a	n/a	0.05	n/a
Golf Course	2010	n/a	n/a	Meguma Metasedimentary Aquifer	42	42	0	4.6	0.5	12.9	4.1	0.1	28	15	49.1	104	6.9	0.05	11	2	8	49	**13800**	**191**	**39.3**	27	1	123
Camp Harris - New Well	1988 - 2011	470223	4947760	Meguma Metasedimentary Aquifer	123	122	1	9.5	0.7	50	3.5	0.1	11.9	17.4	138	178.9	7.91	0.88	1.6	**105**	9.6	11.8	38	3.45	2	n/a	2.9	58
Camp Harris Old Well	1988 - 2011	470203	4947730	Meguma Metasedimentary Aquifer	84	84	1	7.5	0.7	34	2.9	0.1	15.7	10.5	97	133.8	7.2	0.7	10	**12.3**	9.3	62.5	**867**	34.5	4	n/a	3.6	41

Note: Grey Shading & Bold Type = CDWQ Exceedance; CDWQ = Guidelines for Canadian Drinking Water Quality; AO = Aesthetic Objective; MPN is Most Probable Number

Table 18: Camp Harris Well Water Quality

Well Name	Sample Date	Northing	Easting	True Color	Total Dissolved Solids (Calculated)	Turbidity	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Hardness (as $CaCO_3$)	Electrical Conductivity, Lab	Aluminum	Antimony	Arsenic
				TCU	**mg/L**	**NTU**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**µmohm/cm**	**µg/L**	**µg/L**	**µg/L**
					500	**1**						**100**	**6**	**10**
New Well	7-Jan-88	4947760	470223	-	-	-	-	-	93	115	-	-	-	**110**
	20-Jun-94			3.0	-	0.22	116.0	0.9	117	146	342	0.1	5	**120**
	16-Jun-19			5.0	-	0.10	131.0	0.6	132	138	284	-	-	**99**
	1-Jun-98			2.5	-	0.05	124.0	1.1	125	136	339			**101**
	10-Sep-99						109.0	0.5	110	128				**122**
	4-Oct-01			2.5		0.12				145	325	0.0	2	**110**
	16-Oct-03			2.5	188	0.22	124.0	0.9	125	147	351	2.0	2	**90**
	28-Oct-05			3.0	194	0.17	127.0	1.9	129	142	317	3.0	2	**128**
	17-Oct-07			5.0	148	0.41	125.5	0.5	126	136	307	2.0	2	**117**
	9-Oct-09			5.0	183	0.11			141	151	348	2.0	2	**96**
	31-Oct-11			5.0	183	0.61	-	-	138	143	340	2.0	2	**67**
	Mean value			*4*	*179*	*0.22*	*122.4*	*0.9*	*124*	*139*	*328*	*1.6*	*2*	***105***
Old Well	2-Jul-87	470203	4947730	-	-	-	-	-	98	128	-	-	-	**20**
	20-Jun-94			3.0	-	0.73	63.9	0.1	64	91	205	0.1	5	5
	16-Jun-97			5.0	-	0.50	75.9	0.1	76	87	214	-	-	**18**
	1-Jun-98			3.0	-	**2.00**	108.0	0.4	108	123	277	-	-	**28**
	10-Sep-99			-	-	-	64.0	0.0	64	81	-	-	-	2
	4-Oct-01			2.7	-	0.98	-	-	-	66	174	0.0	2	2
	16-Oct-03			6.7	172	**9.14**	114.9	0.1	115	129	299	8.0	2	**10**
	28-Oct-05			3.0	222	**5.59**	141.3	1.7	143	161	341	12.0	2	**25**
	17-Oct-07			7.7	45	**4.54**	34.0	0.0	34	41	115	7.0	2	8
	9-Oct-09			5.0	115	**1.33**	72.2	0.1	72	79	195	5.0	2	5
	31-Oct-11			10.1	115	**7.41**	-	-	72	80	200	38.0	2	-
	Mean value			*5*	*134*	*3.58*	*84.3*	*0.3*	*85*	*97*	*224*	*10.0*	*2*	***12***

Note: Grey Shading & Bold Type = CDWQ Exceedance; CDWQ = Guidelines for Canadian Drinking Water Quality; AO = Aesthetic Objective; MPN is Most Probable Number

Table 18: Camp Harris Well Water Quality

Well Name	Sample Date	Northing	Easting	Barium	Boron	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Potassium	Selenium
				µg/L	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**mg/L**	**µg/L**
				1000	**5000**	**5**		**50**	**1000**	**300**	**10**		**50**		**10**
New Well	7-Jan-88	4947760	470223	-	-	-	42.0	-	-	20	-	2.4	20	-	-
	20-Jun-94			5	10	2	53.1	20	20	20	2	3.4	10	0.8	10
	16-Jun-19			-	-	-	49.4	-	10	20	2	3.6	10	0.7	-
	1-Jun-98						49.0		10	20	2	3.4	10	0.8	-
	10-Sep-99						46.2			120	2	3.1	10	-	-
	4-Oct-01			5	12	2	52.0	2	10	50	2	3.7	10	0.6	2
	16-Oct-03			5	12	2	52.7	2	11	21	2	3.8	4	0.6	2
	28-Oct-05			5	10	2	51.1	2	8	20	2	3.4	2	0.7	2
	17-Oct-07			4	9	2	48.5	2	14	20	2	3.6	2	0.7	2
	9-Oct-09			5	10	1	53.6	2	2	50	2	4.1	2	0.8	2
	31-Oct-11			5	6	1	51.2	2	22	56	2	3.6	35	0.7	2
	Mean value			*5*	*10*	*2*	*49.9*	*5*	*12*	*38*	*2*	*3.5*	*10*	*1*	*3*
Old Well	2-Jul-87	470203	4947730	-	-	-	46.0	-	-	80	-	3.2	50	-	-
	20-Jun-94			10	10	2	32.1	20	30	**2710**	9	2.7	**90**	0.8	10
	16-Jun-97			-	-	-	30.2	-	50	70	2	2.8	**140**	0.7	-
	1-Jun-98			-	-	-	44.0	-	200	100	2	3.2	20	0.8	-
	10-Sep-99			-	-	-	28.2	-	-	220	7	2.6	10	-	-
	4-Oct-01			5	8	2	22.0	2	10	290	2	2.6	30	0.5	2
	16-Oct-03			8	10	2	45.0	2	24	**1478**	2	3.8	14	0.7	2
	28-Oct-05			7	10	2	57.7	2	18	**615**	3	4.1	6	0.7	2
	17-Oct-07			7	11	2	13.3	2	146	**881**	2	1.8	4	0.6	2
	9-Oct-09			6	10	1	26.7	2	29	282	2	2.9	3	0.6	2
	31-Oct-11			6	6	1	28.0	3	56	**2816**	8	2.5	13	0.6	2
	Mean value			*7*	*9*	*2*	*33.9*	*5*	*63*	***867***	*4*	*2.9*	*35*	*0.7*	*3.1*

Note: Grey Shading & Bold Type = CDWQ Exceedance; CDWQ = Guidelines for Canadian Drinking Water Quality; AO = Aesthetic Objective; MPN is Most Probable Number

Table 18: Camp Harris Well Water Quality

Well Name	Sample Date	Northing	Easting	Sodium	Uranium	Zinc	Chloride	Fluoride	Nitrate + Nitrite as N	Reactive Silica (SiO_2)	Sulfate	Total Organic Carbon	pH	Ammonia(as N)
				mg/L	**µg/L**	**µg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**-**	**µg/L**
				200	**20**	**5000**	**250**	**1.5**	**10**		**500**		**6.5-8.5**	
New Well	7-Jan-88	4947760	470223	-	-	-	14.0	-	0.6	-	9.8	-	7.8	50
	20-Jun-94			8.9	-	60	16.8	0.1	1.0	10.5	11.0	0.5	7.9	50
	16-Jun-19			9.9	-	10	16.8	0.1	1.0	10.6	12.0	-	7.7	190
	1-Jun-98			10.0	-	20	19.0	0.1	1.2	10.0	12.9	1.1	8.0	50
	10-Sep-99			7.9	5	-	14.0	-	0.3		13.0		7.7	50
	4-Oct-01			9.7	5	70	25.0	0.1	0.6		12.1	1.9	7.9	50
	16-Oct-03			10.0	2	117	27.0	0.1	1.1		13.0	1.1	7.9	50
	28-Oct-05			9.6	2	20	17.0	0.1	0.8		12.0		8.2	50
	17-Oct-07			8.7	2	52	14.0	0.1	0.9		12.0	1.0	7.6	50
	9-Oct-09			10.6	2	27	16.0	0.1	1.3	-	11.0	0.5	8.2	50
	31-Oct-11			9.6	2	146	12.6	0.1	0.9	-	12.2	0.5	8.2	50
	Mean value			*9*	*3*	*58*	*17.5*	*0.1*	*0.9*	*10.4*	*11.9*	*0.9*	*7.9*	*63*
Old Well	2-Jul-87	470203	4947730	-	5	-	17.0	-	0.6	-	17.7	-	7.2	50
	20-Jun-94			7.8	-	15	11.0	0.1	0.6	7.6	20.0	0.9	7.1	50
	16-Jun-97			8.1	-	20	13.0	0.1	0.5	8.1	14.0	-	7.2	120
	1-Jun-98			8.5	-	20	14.0	0.1	0.4	8.9	19.8	1.7	7.6	50
	10-Sep-99			7.2	5	-	13.0	-	0.5	-	16.0	-	6.7	50
	4-Oct-01			6.9	9	30	8.3	0.1	1.5	-	8.8	1.1	7.3	50
	16-Oct-03			8.5	2	34	12.0	0.1	0.7	-	19.0	1.5	7.1	50
	28-Oct-05			8.8	2	16	9.8	0.1	1.4	-	19.0	-	8.1	50
	17-Oct-07			6.3	2	110	5.7	0.1	0.8	-	9.5	1.0	**6.3**	50
	9-Oct-09			6.3	2	65	5.2	0.1	0.4	-	15.0	0.5	7.0	50
	31-Oct-11			6.3	2	59	7.1	0.1	0.4	-	14.0	0.7	7.6	50
	Mean value			*7.5*	*4*	*41*	*10.6*	*0.1*	*0.7*	*8.2*	*15.7*	*1.1*	*7.2*	*56*

Note: Grey Shading & Bold Type = CDWQ Exceedance; CDWQ = Guidelines for Canadian Drinking Water Quality; AO = Aesthetic Objective; MPN is Most Probable Number

The historic water quality data is presented on a Piper diagram to show relative proportions of the major ions (**Figure 7**). The water from pumping tests in the 1970s is from wells in the Lawrencetown area. The Piper diagram plots these samples in the sodium-chloride area indicating these wells may be influenced by seawater. The two Camp Harris wells and the 2008 sample plot in the calcium-bicarbonate area which is common in bedrock and surficial aquifers. The remaining samples are in the transition area of the Piper plot. In general the dominant anions are bicarbonate and chloride, with minimal sulphate influence. The dominant cations are calcium and sodium with little magnesium influence. These general chemistry results are consistent with bedrock aquifers in near coastal environments.

Tables 4 and 5 include the Guidelines for Canadian Drinking Water Quality (CDWQ) as a reference to identify potential water quality issues. Several samples are above guidelines for aesthetic objectives such as chloride, TDS, iron and manganese. Water above these guidelines may affect the taste of water or may result in staining, but do not have direct health implications. Arsenic is above guidelines in three of the samples and represents a health concern. Arsenic in groundwater is a common problem in bedrock wells completed in the MMA as indicated by the arsenic risk map published by NSE (NSE 2005). The Preston GSA is included in a grouping of communities that had 18% of well water analyses above 10 µg/L (Chappells et al. 2014).

The mean values from the two Camp Harris wells exceed the CDWQ for arsenic. Discussion with Camp maintenance staff indicate the results from the New Well are influenced by samples that were mixtures of the two wells, suggesting the mean value from the New Well is likely below the guideline. The arsenic concentration in the Old Well is an order of magnitude greater than the New Well. The well record for the Old Well indicates it was drilled in 1964 to a depth of 74 meters below ground surface (mbgs) or 242 feet and had a yield of 7 L/min. The well record does not provide any details on the lithology or the water bearing fractures encountered during the drilling. The New Well was drilled in 1987 to a depth of 80 mbgs (260 feet) and had a yield of 54 L/min. The well record indicates water bearing fractures were encountered at a depth of 75 mbgs and 80 mbgs. The two wells are less than 100 m horizontal distance from each other. As shown on the Piper plot, the two wells have similar general chemistry. However, the New Well has higher concentrations of arsenic, calcium, alkalinity and silica, while the Old Well has higher concentrations of aluminum, copper, iron, manganese and sulphate. The suite of higher concentration elements and the higher yield of the New Well suggest the groundwater movement is dominated by flow through fractures in connection with mineralized veins that would have calcite, quartz and arsenopyrite. The lower yield and suite of high concentration elements from the Old Well suggest the groundwater yield is primarily through small fracture systems that are not related to hydrothermal mineralization.

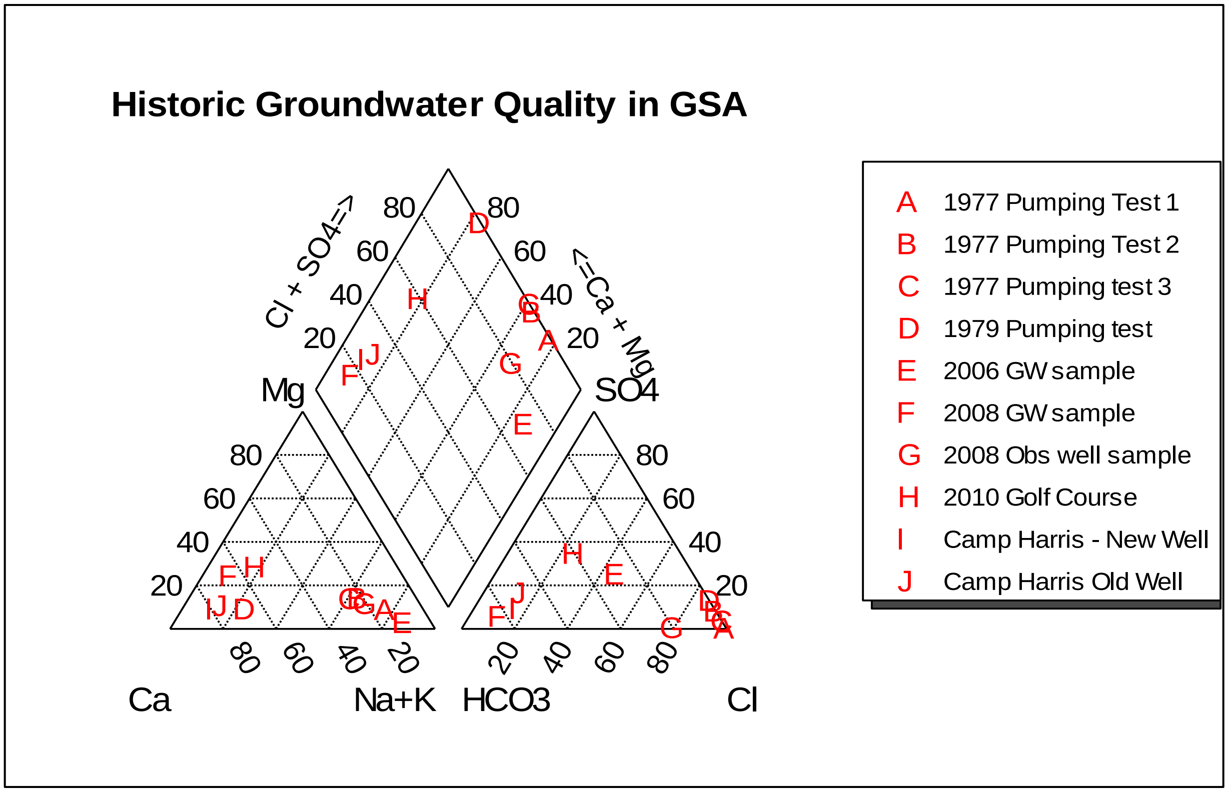

Figure 7: Preston Historic Groundwater - Piper Plot

4.5.2 Residential Well Survey Results

A residential well survey was conducted for the Study to assess current groundwater quality conditions. A total of seventy (70) groundwater samples were collected from thirty eight (38) residences. Six (6) of the sampling locations were from dug wells and the remaining thirty two (32) sample locations were from drilled wells. The sample results are presented in **Tables 19** and **20**. The first five characters of the sample identification (Sample ID) represent the sample location and remaining characters represent the season of the sampling event. For example, the Sample ID DEP 03 FALL was collected from sample point DEP 03 in the fall of 2013.

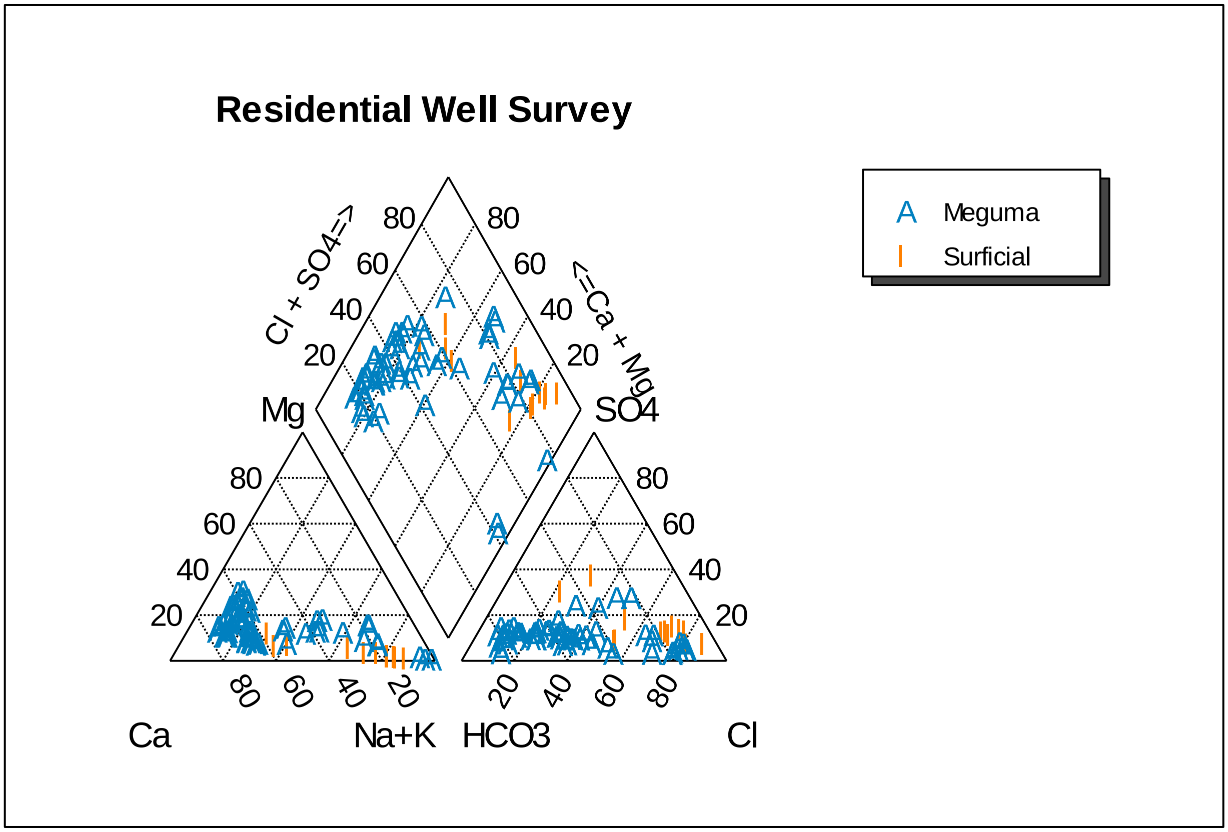

Figure 8: Piper plot from residential well survey

4.5.2.1 *Dug Wells*

Thirteen (13) samples collected from six (6) locations were from dug wells located primarily along Highway 7 in East Preston (**Table 19**). These wells are generally less than 10 m deep and are completed in surficial sediments and have good water quality. As shown in **Figure 8**, the water from the surficial aquifer is dominated by sodium and chloride major ions when compared to the Meguma Metasedimentary aquifer. The water is slightly acidic (pH < 7) and has little acid buffering capacity as represented by low alkalinity. Dissolved metal concentrations are typically below CDWQ guidelines for both aesthetic and health related parameters. These general observations from the residential well survey are consistent with information provided by residents describing general water quality.

Table 19: Residential Well Survey Results - Dug Wells

Sample ID	Sample Date		Langelier Index (at 20 °C)	Langelier Index (at 4 °C)	Saturation pH (at 20 °C)	Saturation pH (at 4 °C)	True Color	Anion Sum	Cation Sum	Ion Balance	Total Dissolved Solids (Calculated)	Turbidity	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Hydroxide (OH)	Hardness (as $CaCO_3$)	Electrical Conductivity, Lab
		Units	**none**	**none**	**none**	**none**	**tcu**	**meq/L**	**meq/L**	**%**	**mg/L**	**ntμ**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**umhos/cm**
		CDWQ_Include AO					**15**				**500**	**1.0**						
DEP 03 FALL	11/28/2013		-3.32	-3.64	9.86	10.2	7	2.11	2.48	8.1	134	**1.4**	10	< 10	10	< 5	15.4	233
DEP 03 FD	11/28/2013		-3.44	-3.76	9.86	10.2	< 5	2.54	2.40	2.8	148	**1.3**	10	< 10	10	< 5	15.6	298
DEP 03 SUM	8/22/2013		-2.65	-2.97	9.38	9.7	< 5	9	8.87	0.7	**528**	0.6	13	< 10	13	< 5	40.3	1060
DEP 05 SUM	8/21/2013		-3.12	-3.44	9.85	10.2	< 5	1.18	1.40	8.5	75	**1.5**	7	< 10	7	< 5	22.4	175
DEP 09 FALL	11/26/2013		-3.03	-3.35	9.71	10.0	< 5	1.76	1.93	4.4	109	0.2	14	< 10	14	< 5	15.1	211
DEP 09 FD	11/26/2013		-2.94	-3.26	9.63	9.95	8	1.83	2.03	5.1	113	0.3	16	< 10	16	< 5	15.9	212
DEP 09 SUM	8/26/2013		-2.52	-2.84	9.43	9.75	< 5	3.17	3.47	4.5	194	0.5	16	< 10	16	< 5	27.3	383
DEP 10 FALL	11/28/2013		0.02	-0.30	7.98	8.30	< 5	4.79	4.76	0.2	263	0.2	95	< 10	95	< 5	133	524
DEP 10 SUM	8/28/2013		-0.12	-0.44	8.07	8.39	< 5	3.90	4.31	5.0	223	0.4	76	< 10	76	< 5	131	442
DEP 11 FALL	11/28/2013		-2.54	-2.86	9.53	9.85	6	0.62	0.58	3.7	35	**1.2**	15	< 10	15	< 5	19.9	68
DEP 11 SUM	8/28/2013		-3.51	-3.83	9.80	10.1	9	0.55	0.57	2.2	33	**1.8**	9	< 10	9	< 5	18.5	70
DEP 13 FALL	11/26/2013		-2.60	-2.92	9.42	9.74	10	1.61	1.74	4.1	97	0.3	24	< 10	24	< 5	18.1	186
DEP 13 SUM	9/10/2013		-2.44	-2.76	9.18	9.50	< 5	3.11	2.51	10.6	168	0.5	24	< 10	24	< 5	31.8	358

Notes:

Grey Shading & Bold Type = CDWQ Exceedances;

CDWQ = Guidelines for Canadian Drinking Water Quality;

AO = Aesthetic Objective;

MPN = Most Probable Number

Table 19: Residential Well Survey Results - Dug Wells

Sample ID	Sample Date		Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum
		Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**
		CDWQ_Include AO	**100**	**6**	**10**	**1000**			**5000**	**5**		**50**		**1000**	**300**	**10**		**50**	
DEP 03 FALL	11/28/2013		**126**	< 2	< 2	14	< 2	< 2	7	0.079	5.5	< 1	< 1	27	171	2.4	0.4	43	< 2
DEP 03 FD	11/28/2013		**130**	< 2	< 2	13	< 2	< 2	6	0.064	5.6	2	< 1	38	184	3.6	0.4	41	< 2
DEP 03 SUM	8/22/2013		64	< 2	< 2	59	< 2	< 2	< 5	0.137	14.8	< 1	< 1	20	173	5.3	0.8	**121**	< 2
DEP 05 SUM	8/21/2013		7	< 2	< 2	7	< 2	< 2	8	< 0.017	7.5	< 1	< 1	6	283	< 0.5	0.9	25	< 2
DEP 09 FALL	11/26/2013		40	< 2	3	8	< 2	< 2	14	0.120	5.4	< 1	< 1	371	159	0.9	0.4	2	< 2
DEP 09 FD	11/26/2013		37	< 2	3	9	< 2	< 2	14	< 0.017	5.7	< 1	< 1	285	65	1.0	0.4	< 2	< 2
DEP 09 SUM	8/26/2013		21	< 2	< 2	19	< 2	< 2	12	0.028	9.6	< 1	< 1	409	161	0.8	0.8	7	< 2
DEP 10 FALL	11/28/2013		< 5	< 2	**182**	12	< 2	< 2	11	< 0.017	46.9	< 1	< 1	2	87	< 0.5	3.9	**66**	< 2
DEP 10 SUM	8/28/2013		5	< 2	**162**	11	< 2	< 2	18	< 0.017	47.0	< 1	< 1	2	55	< 0.5	3.3	**66**	< 2
DEP 11 FALL	11/28/2013		**125**	< 2	< 2	16	< 2	< 2	31	< 0.017	6.8	< 1	< 1	8	85	1.2	0.7	18	< 2
DEP 11 SUM	8/28/2013		88	< 2	< 2	23	< 2	< 2	40	0.033	6.1	< 1	< 1	11	< 50	1.2	0.8	36	< 2
DEP 13 FALL	11/26/2013		8	< 2	< 2	27	< 2	< 2	9	< 0.017	6.1	< 1	< 1	130	< 50	1.3	0.7	2	< 2
DEP 13 SUM	9/10/2013		12	< 2	< 2	47	< 2	< 2	15	0.037	11.1	< 1	< 1	119	163	1.2	1.0	4	< 2

Notes:

Grey Shading & Bold Type = CDWQ Exce

CDWQ = Guidelines for Canadian Drinkin

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Table 19: Residential Well Survey Results - Dug Wells

Sample ID	Sample Date		Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Chloride	Fluoride	Nitrate (as N)	Nitrate + Nitrite as N	Nitrite (as N)
		Units	**µg/L**	**mg/L**	**mg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
		CDWQ_Include AO				**10**		**200**					**20**		**5000**	**250**	**1.5**	**10**		**1**
DEP 03 FALL	11/28/2013		< 2	0.03	0.6	< 1	< 0.1	49.0	19	< 0.1	< 2	< 2	< 0.1	< 2	26	57	0.2	0.41	0.41	< 0.05
DEP 03 FD	11/28/2013		< 2	0.03	0.6	< 1	< 0.1	47.1	19	< 0.1	< 2	< 2	< 0.1	< 2	27	71	< 0.1	0.33	0.33	< 0.05
DEP 03 SUM	8/22/2013		2	< 0.02	1.6	< 1	< 0.1	184	50	< 0.1	< 2	< 2	< 0.1	< 2	17	**286**	< 0.1	0.36	0.36	< 0.05
DEP 05 SUM	8/21/2013		3	< 0.02	1.0	< 1	< 0.1	20.9	36	< 0.1	< 2	< 2	< 0.1	< 2	48	30	< 0.1	0.39	0.39	< 0.05
DEP 09 FALL	11/26/2013		< 2	< 0.02	0.9	1	< 0.1	36.3	19	< 0.1	< 2	< 2	< 0.1	< 2	19	43	< 0.1	0.88	0.88	< 0.05
DEP 09 FD	11/26/2013		< 2	0.02	0.9	< 1	< 0.1	38.5	20	< 0.1	< 2	< 2	< 0.1	< 2	17	44	< 0.1	0.88	0.88	< 0.05
DEP 09 SUM	8/26/2013		< 2	< 0.02	1.4	< 1	< 0.1	66.0	37	< 0.1	< 2	< 2	< 0.1	< 2	35	91	< 0.1	1.08	1.08	< 0.05
DEP 10 FALL	11/28/2013		< 2	0.02	0.9	< 1	< 0.1	47.6	367	< 0.1	< 2	< 2	3.3	< 2	15	89	< 0.1	< 0.05	< 0.05	< 0.05
DEP 10 SUM	8/28/2013		< 2	< 0.02	0.9	< 1	< 0.1	38.2	370	< 0.1	< 2	< 2	3.5	< 2	< 5	73	< 0.1	0.06	0.06	< 0.05
DEP 11 FALL	11/28/2013		< 2	0.03	1.1	< 1	< 0.1	3.1	29	< 0.1	< 2	< 2	< 0.1	< 2	12	5	< 0.1	0.22	0.22	< 0.05
DEP 11 SUM	8/28/2013		< 2	< 0.02	0.9	< 1	< 0.1	3.8	27	< 0.1	< 2	< 2	< 0.1	< 2	12	6	< 0.1	0.14	0.14	< 0.05
DEP 13 FALL	11/26/2013		< 2	< 0.02	0.6	< 1	< 0.1	31.3	20	< 0.1	< 2	< 2	< 0.1	< 2	19	30	< 0.1	0.13	0.13	< 0.05
DEP 13 SUM	9/10/2013		< 2	< 0.02	1.0	< 1	< 0.1	42.2	36	< 0.1	< 2	< 2	< 0.1	< 2	27	80	< 0.1	0.42	0.51	0.09

Notes:

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Table 19: Residential Well Survey Results - Dug Wells

Sample ID	Sample Date		Orthophosphate (as P)	Reactive Silica (SiO_2)	Sulfate	Total Organic Carbon	pH	Ammonia (as N)	Escherichia coli (E.Coli)	Total Coliforms
		Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**n/a**	**mg/L**	**mpn/100mL**	**mpn/100mL**
		CDWQ_Include AO			**500**		**6.5-8.5**			
DEP 03 FALL	11/28/2013		< 0.01	3.8	13	3.5	6.54	< 0.03	1	1733
DEP 03 FD	11/28/2013		< 0.01	3.8	15	3.2	**6.42**	< 0.03	1	2420
DEP 03 SUM	8/22/2013		< 0.01	4.7	31	1.1	6.73	< 0.03	< 1	62
DEP 05 SUM	8/21/2013		< 0.01	4.6	8	< 0.5	6.73	0.03	< 1	111
DEP 09 FALL	11/26/2013		< 0.01	3.9	10	2.0	6.68	< 0.03	1	210
DEP 09 FD	11/26/2013		< 0.01	3.9	10	2.3	6.69	< 0.03	< 1	179
DEP 09 SUM	8/26/2013		< 0.01	4.6	10	1.3	6.91	< 0.03	< 1	1203
DEP 10 FALL	11/28/2013		0.05	10.3	18	0.9	8.00	< 0.03	< 1	< 1
DEP 10 SUM	8/28/2013		0.04	10.4	15	< 0.5	7.95	< 0.03	< 1	2
DEP 11 FALL	11/28/2013		< 0.01	4.1	8	2.4	6.99	< 0.03	< 1	< 1
DEP 11 SUM	8/28/2013		< 0.01	5.3	9	1.2	**6.29**	< 0.03	< 1	60
DEP 13 FALL	11/26/2013		< 0.01	3.9	13	1.6	6.82	< 0.03	< 1	10
DEP 13 SUM	9/10/2013		< 0.01	4.6	16	0.8	6.74	< 0.03	< 1	189

Notes:

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Variations from the general good water quality are in arsenic, chloride and bacteria. Samples collected from DEP 10 are different from the other dug wells. DEP 10 has higher alkalinity, arsenic, calcium, magnesium, manganese, silica and pH, suggesting the well is influenced by soil or rocks related to a gold deposit. No information provided during the survey with the resident indicated the source of these elements. It is possible the surficial sediments in the localized area were transported from a mineralized area to the location of DEP 10. It is also possible that waste rock from a mineralized area could have been used as backfill when the well was completed or as fill for the property.

Chloride concentrations in the dug wells are generally higher than the bedrock wells. A portion of this can be attributed to salt in precipitation, but is also likely the result of road salt applied and infiltrating to the surficial aquifer. Bacteria in the form of total coliform were present in eleven (11) of thirteen (13) samples and Escherichia coli (E. coli) were present in three (3) of thirteen (13) samples collected from dug wells.

4.5.2.2 Drilled Wells

The drilled wells in the GSA are all completed in the Meguma Metasedimentary aquifer (MMA). A total of fifty seven (57) samples were collected from thirty three (33) locations to assess groundwater quality in the MMA (**Table 20**). In general, the water from the MMA plots in the calcium-bicarbonate portion of the Piper plot (**Figure 8)**. The water quality is typical of groundwater in bedrock aquifers in Nova Scotia with common occurrences of aesthetic objectives above guidelines such as iron and manganese (Kennedy and Finlayson-Bourque 2011). Results from total coliform and E.coli analyses indicate bacterial issues in wells are uncommon with six (6) or 11% of samples testing positive for total coliform and one (1) sample testing positive for E.coli. Chloride concentrations exceed the CDWQ guideline in five (5) samples from three (3) locations. Turbidity is above CDWQ guideline (1 NTU) in twenty one (21) sample from thirteen (13) locations

Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Langelier Index (at 20 °C)	Langelier Index (at 4 °C)	Saturation pH (at 20 °C)	Saturation pH (at 4 °C)	True Color	Anion Sum	Cation Sum	Ion Balance	Total Dissolved Solids (Calculated)	Turbidity	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)
		Units	none	none	none	none	tcu	meq/L	meq/L	%	mg/L	ntµ	mg/L	mg/L
		CDWQ_ Include AO					15				500	1.0		
GEP 09 FALL	11/26/2013		-5.31	-5.63	10.9	11.2	6	0.22	0.30	14.7	15	0.9	< 5	< 10
GEP 09 SUM	8/28/2013		-5.56	-5.88	10.9	11.2	< 5	0.30	0.33	4.9	19	**1.2**	< 5	< 10
GEP 09 SUM-DUP	8/28/2013		-5.61	-5.93	10.9	11.2	9	0.30	0.33	4.1	19	**1.2**	< 5	< 10
GEP 10 FALL	11/26/2013		-0.61	-0.93	8.41	8.73	7	1.65	1.71	1.6	84	**1.6**	70	< 10
GEP 10 SUM	8/28/2013		-0.65	-0.97	8.55	8.87	< 5	1.33	1.63	9.9	73	**2.4**	54	< 10
GEP 12 FALL	11/27/2013		-0.57	-0.89	8.26	8.58	< 5	1.88	1.93	1.3	99	0.4	76	< 10
GEP 12 SUM	8/28/2013		-0.84	-1.16	8.33	8.65	< 5	1.67	1.83	4.7	91	**1.7**	67	< 10
GEP 13 FALL	11/27/2013		-2.82	-3.14	9.64	9.96	< 5	1.11	1.12	0.1	66	0.3	14	< 10
GEP 13 SUM	8/29/2013		-1.89	-2.21	8.84	9.16	< 5	1.34	1.41	2.7	77	0.3	38	< 10
GEP 14 FALL	11/27/2013		-1.18	-1.50	8.57	8.89	5	1.61	1.71	3.2	90	0.5	48	< 10
GEP 14 SUM	8/29/2013		-1.30	-1.62	8.60	8.92	< 5	1.71	1.75	1.1	95	**2.3**	45	< 10
GEP 15 SUM	8/29/2013		-3.51	-3.83	9.78	10.1	< 5	0.64	0.59	4.1	37	0.7	12	< 10
GEP 16 FALL	11/26/2013		-0.87	-1.19	8.34	8.66	9	1.81	2.06	6.6	98	0.2	68	< 10
GEP 16 FD	11/26/2013		-0.66	-0.98	8.33	8.65	< 5	1.85	2.06	5.3	100	0.2	69	< 10
GEP 16 SUM	8/29/2013		-0.72	-1.04	8.35	8.67	6	1.94	2.04	2.5	103	0.2	67	< 10
GEP 17 FALL	11/27/2013		-1.49	-1.81	8.90	9.22	< 5	3.43	3.63	2.8	201	0.3	42	< 10
GEP 17 SUM	9/3/2013		-2.00	-2.32	8.81	9.13	< 5	5.40	4.62	7.8	293	0.4	41	< 10
GEP 18 SUM	9/3/2013		-1.72	-2.04	8.92	9.24	< 5	4.63	4.54	1.0	264	0.3	32	< 10
GEP 19 FALL	12/12/2013		-0.26	-0.58	8.29	8.61	9	2.12	1.88	5.9	106	**1.4**	84	< 10
GEP 19 SUM	9/3/2013		-0.23	-0.55	8.30	8.62	< 5	1.81	2.04	6.0	99	**1.1**	75	< 10
GEP 20 FALL	11/27/2013		-0.23	-0.55	8.20	8.52	< 5	2.02	2.08	1.4	106	0.2	82	< 10
GEP 20 SUM	9/3/2013		-0.25	-0.57	8.28	8.60	< 5	1.85	1.92	1.9	98	0.1	72	< 10
GEP 21 SUM	9/4/2013		-2.61	-2.93	9.19	9.51	< 5	1.04	1.14	4.9	65	0.4	21	< 10
GEP 22 FALL	11/26/2013		-0.73	-1.05	8.49	8.81	< 5	2.06	2.05	0.4	108	**6.7**	56	< 10
GEP 22 SUM	9/4/2013		-0.77	-1.09	8.51	8.83	< 5	1.79	2.03	6.5	98	**4.4**	51	< 10
GEP 23 FALL	11/27/2013		0.05	-0.27	7.89	8.21	< 5	3.84	3.86	0.3	209	1.0	109	< 10
GEP 23 SUM	9/10/2013		-0.18	-0.50	7.98	8.30	< 5	3.56	3.77	2.9	199	0.8	90	< 10
GEP 24 FALL	11/26/2013		-0.99	-1.31	8.54	8.86	< 5	1.43	1.52	3.1	77	0.4	53	< 10
GEP 24 SUM	9/11/2013		-1.03	-1.35	8.62	8.94	< 5	1.33	1.56	7.9	74	0.2	46	< 10
GEP 25 SUM	9/11/2013		-0.94	-1.26	8.59	8.91	< 5	1.32	1.58	8.9	75	0.5	47	< 10

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Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	**Sample Date**		**Alkalinity, Total (as $CaCO_3$)**	**Hydroxide (OH)**	**Hardness (as $CaCO_3$)**	**Electrical Conductivity, Lab**	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Bismuth**	**Boron**	**Cadmium**	**Calcium**	**Chromium**	**Cobalt**
		Units	**mg/L**	**mg/L**	**mg/L**	**umhos/cm**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**
		CDWQ_ Include AO					**100**	**6**	**10**	**1000**			**5000**	**5**		**50**	
GEP 09 FALL	11/26/2013		< 5	< 5	3.6	33	**301**	< 2	< 2	17	< 2	< 2	7	< 0.017	0.8	< 1	< 1
GEP 09 SUM	8/28/2013		< 5	< 5	4.3	43	**373**	< 2	< 2	21	< 2	< 2	9	0.030	0.9	< 1	< 1
GEP 09 SUM-DUP	8/28/2013		< 5	< 5	4.3	42	**361**	< 2	< 2	20	< 2	< 2	8	0.028	0.9	< 1	< 1
GEP 10 FALL	11/26/2013		70	< 5	73.1	166	< 5	< 2	< 2	< 5	< 2	< 2	39	< 0.017	21.2	< 1	< 1
GEP 10 SUM	8/28/2013		54	< 5	69.0	163	9	< 2	< 2	< 5	< 2	< 2	49	< 0.017	19.7	< 1	< 1
GEP 12 FALL	11/27/2013		76	< 5	79.8	196	< 5	< 2	6	< 5	< 2	< 2	9	< 0.017	28.0	< 1	< 1
GEP 12 SUM	8/28/2013		67	< 5	76.6	178	6	< 2	7	< 5	< 2	< 2	11	< 0.017	26.9	< 1	< 1
GEP 13 FALL	11/27/2013		14	< 5	21.8	114	58	< 2	< 2	14	< 2	< 2	12	< 0.017	6.1	< 1	< 1
GEP 13 SUM	8/29/2013		38	< 5	40.9	150	23	< 2	< 2	12	< 2	< 2	15	< 0.017	14.4	< 1	< 1
GEP 14 FALL	11/27/2013		48	< 5	59.7	185	< 5	< 2	**16**	6	< 2	< 2	10	< 0.017	21.6	1	< 1
GEP 14 SUM	8/29/2013		45	< 5	59.9	192	6	< 2	**22**	6	< 2	< 2	12	< 0.017	21.5	< 1	< 1
GEP 15 SUM	8/29/2013		12	< 5	15.3	70	69	< 2	< 2	12	< 2	< 2	16	0.048	4.8	< 1	< 1
GEP 16 FALL	11/26/2013		68	< 5	84.5	188	< 5	< 2	< 2	7	< 2	< 2	10	< 0.017	26.1	< 1	< 1
GEP 16 FD	11/26/2013		69	< 5	84.9	191	< 5	< 2	< 2	7	< 2	< 2	11	< 0.017	26.4	< 1	< 1
GEP 16 SUM	8/29/2013		67	< 5	85.9	213	7	< 2	< 2	8	< 2	< 2	12	< 0.017	26.0	< 1	< 1
GEP 17 FALL	11/27/2013		42	< 5	43.7	409	6	< 2	8	< 5	< 2	< 2	8	< 0.017	12.4	< 1	< 1
GEP 17 SUM	9/3/2013		41	< 5	55.0	579	11	< 2	6	8	< 2	< 2	10	< 0.017	16.1	< 1	< 1
GEP 18 SUM	9/3/2013		32	< 5	54.5	576	10	< 2	6	5	< 2	< 2	10	< 0.017	15.9	< 1	< 1
GEP 19 FALL	12/12/2013		84	< 5	69.1	203	< 5	< 2	**65**	11	< 2	< 2	20	< 0.017	23.7	< 1	< 1
GEP 19 SUM	9/3/2013		75	< 5	75.5	209	16	< 2	**63**	13	< 2	< 2	23	< 0.017	25.6	< 1	< 1
GEP 20 FALL	11/27/2013		82	< 5	89.6	213	< 5	< 2	< 2	10	< 2	< 2	13	< 0.017	29.6	< 1	< 1
GEP 20 SUM	9/3/2013		72	< 5	84.2	213	6	< 2	< 2	8	< 2	< 2	11	< 0.017	28.1	< 1	< 1
GEP 21 SUM	9/4/2013		21	< 5	35.9	133	9	< 2	< 2	10	< 2	< 2	23	< 0.017	11.4	< 1	< 1
GEP 22 FALL	11/26/2013		56	< 5	83.4	208	< 5	< 2	< 2	9	< 2	< 2	10	0.098	22.7	< 1	< 1
GEP 22 SUM	9/4/2013		51	< 5	85.1	218	11	< 2	< 2	9	< 2	< 2	10	0.017	23.2	< 1	< 1
GEP 23 FALL	11/27/2013		109	< 5	138	412	< 5	< 2	**12**	9	< 2	< 2	19	< 0.017	49.4	< 1	< 1
GEP 23 SUM	9/10/2013		90	< 5	136	393	11	< 2	**13**	10	< 2	< 2	19	< 0.017	48.7	< 1	< 1
GEP 24 FALL	11/26/2013		53	< 5	62.4	149	8	< 2	**30**	< 5	< 2	< 2	7	< 0.017	20.7	< 1	< 1
GEP 24 SUM	9/11/2013		46	< 5	61.7	152	16	< 2	**23**	< 5	< 2	< 2	15	< 0.017	19.6	< 1	< 1
GEP 25 SUM	9/11/2013		47	< 5	63.5	156	19	< 2	**24**	< 5	< 2	< 2	11	< 0.017	20.3	< 1	< 1

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Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin
		Units	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**mg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**
		CDWQ_ Include AO	**1000**	**300**	**10**		**50**					**10**		**200**			
GEP 09 FALL	11/26/2013		17	**752**	1.1	0.4	**71**	< 2	< 2	< 0.02	0.4	< 1	< 0.1	3.5	7	< 0.1	< 2
GEP 09 SUM	8/28/2013		14	282	1.3	0.5	**65**	< 2	< 2	< 0.02	0.5	< 1	< 0.1	4.0	9	< 0.1	< 2
GEP 09 SUM-DUP	8/28/2013		21	270	1.2	0.5	**65**	< 2	< 2	< 0.02	0.5	< 1	< 0.1	3.9	9	< 0.1	< 2
GEP 10 FALL	11/26/2013		< 1	**426**	< 0.5	4.9	**207**	< 2	< 2	0.02	0.7	< 1	< 0.1	4.7	55	< 0.1	< 2
GEP 10 SUM	8/28/2013		< 1	**385**	< 0.5	4.8	**236**	< 2	< 2	< 0.02	0.8	< 1	< 0.1	4.7	59	< 0.1	< 2
GEP 12 FALL	11/27/2013		14	< 50	< 0.5	2.4	< 2	< 2	< 2	< 0.02	0.5	3	< 0.1	7.4	279	< 0.1	< 2
GEP 12 SUM	8/28/2013		11	< 50	0.5	2.3	< 2	< 2	< 2	< 0.02	0.5	1	< 0.1	6.6	330	< 0.1	< 2
GEP 13 FALL	11/27/2013		351	< 50	2.1	1.6	17	< 2	< 2	0.03	0.7	1	< 0.1	14.8	32	< 0.1	< 2
GEP 13 SUM	8/29/2013		153	53	0.9	1.2	4	< 2	< 2	< 0.02	0.8	< 1	< 0.1	12.9	71	< 0.1	< 2
GEP 14 FALL	11/27/2013		92	91	1.1	1.4	< 2	< 2	< 2	0.03	1.0	< 1	< 0.1	11.2	82	< 0.1	< 2
GEP 14 SUM	8/29/2013		128	**371**	0.5	1.5	10	< 2	< 2	< 0.02	1.0	< 1	< 0.1	11.6	95	0.1	< 2
GEP 15 SUM	8/29/2013		146	69	3.0	0.8	18	< 2	< 2	< 0.02	1.2	< 1	< 0.1	5.4	24	< 0.1	< 2
GEP 16 FALL	11/26/2013		5	< 50	0.6	4.7	7	< 2	< 2	< 0.02	0.6	< 1	< 0.1	8.2	103	< 0.1	< 2
GEP 16 FD	11/26/2013		5	< 50	1.3	4.6	9	< 2	< 2	< 0.02	0.6	< 1	< 0.1	7.9	103	< 0.1	< 2
GEP 16 SUM	8/29/2013		4	< 50	< 0.5	5.1	11	< 2	< 2	< 0.02	0.7	< 1	< 0.1	7.0	119	< 0.1	< 2
GEP 17 FALL	11/27/2013		45	76	< 0.5	3.1	2	< 2	< 2	0.04	0.6	2	< 0.1	62.9	48	< 0.1	< 2
GEP 17 SUM	9/3/2013		50	87	0.6	3.6	2	< 2	< 2	< 0.02	0.7	< 1	< 0.1	80.3	65	< 0.1	< 2
GEP 18 SUM	9/3/2013		53	82	0.5	3.6	3	< 2	< 2	< 0.02	0.7	< 1	< 0.1	78.7	63	< 0.1	< 2
GEP 19 FALL	12/12/2013		< 1	152	0.6	2.4	11	< 2	< 2	< 0.02	0.6	< 1	< 0.1	10.9	520	< 0.1	< 2
GEP 19 SUM	9/3/2013		1	138	0.8	2.8	**65**	< 2	< 2	< 0.02	0.7	< 1	< 0.1	11.5	528	< 0.1	< 2
GEP 20 FALL	11/27/2013		20	90	4.6	3.8	**88**	< 2	< 2	0.02	0.7	1	< 0.1	6.1	132	< 0.1	< 2
GEP 20 SUM	9/3/2013		2	59	0.6	3.4	**62**	< 2	< 2	< 0.02	0.6	< 1	< 0.1	5.0	108	< 0.1	< 2
GEP 21 SUM	9/4/2013		26	< 50	0.6	1.8	18	< 2	2	< 0.02	1.6	< 1	< 0.1	8.8	121	< 0.1	< 2
GEP 22 FALL	11/26/2013		23	**740**	3.1	6.5	**266**	< 2	< 2	< 0.02	0.6	< 1	< 0.1	7.5	35	< 0.1	< 2
GEP 22 SUM	9/4/2013		41	**735**	5.3	6.6	**292**	< 2	< 2	< 0.02	0.7	< 1	< 0.1	6.3	40	< 0.1	< 2
GEP 23 FALL	11/27/2013		4	151	1.6	3.5	6	< 2	< 2	< 0.02	0.8	1	< 0.1	24.7	665	< 0.1	< 2
GEP 23 SUM	9/10/2013		6	111	2.8	3.6	5	< 2	< 2	< 0.02	0.8	< 1	< 0.1	23.4	755	< 0.1	< 2
GEP 24 FALL	11/26/2013		11	54	< 0.5	2.6	3	< 2	< 2	< 0.02	0.4	< 1	< 0.1	6.0	43	< 0.1	< 2
GEP 24 SUM	9/11/2013		8	< 50	0.6	3.1	3	< 2	< 2	< 0.02	0.5	< 1	< 0.1	7.1	39	< 0.1	< 2
GEP 25 SUM	9/11/2013		7	< 50	< 0.5	3.1	3	< 2	< 2	< 0.02	0.4	< 1	< 0.1	6.9	37	< 0.1	< 2

Note: Grey Shading Bold Type = CDWQ Exceedance;
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Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Titanium	Uranium	Vanadium	Zinc	Chloride	Fluoride	Nitrate (as N)	Nitrate + Nitrite as N	Nitrite (as N)	Orthophosphate (as P)	Reactive Silica (SiO_2)	Sulfate	Total Organic Carbon	pH	Ammonia (as N)	Escherichia coli (E.Coli)	Total Coliforms
		Units	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**n/a**	**mg/L**	**mpn/100mL**	**mpn/100mL**
		CDWQ_ Include AO		**20**		**5000**	**250**	**1.5**	**10**		**1**			**500**		**6.5-8.5**			
GEP 09 FALL	11/26/2013		< 2	< 0.1	< 2	11	5	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	3.8	4	1.1	**5.60**	< 0.03	< 1	< 1
GEP 09 SUM	8/28/2013		< 2	< 0.1	< 2	12	7	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	4.4	5	0.7	**5.31**	< 0.03	< 1	< 1
GEP 09 SUM-DUP	8/28/2013		< 2	< 0.1	< 2	14	7	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	4.2	5	0.9	**5.26**	< 0.03	< 1	1
GEP 10 FALL	11/26/2013		< 2	0.4	< 2	6	6	0.2	< 0.05	< 0.05	< 0.05	< 0.01	6.3	4	< 0.5	7.80	< 0.03	< 1	< 1
GEP 10 SUM	8/28/2013		< 2	0.3	< 2	< 5	6	0.2	< 0.05	< 0.05	< 0.05	< 0.01	6.8	4	< 0.5	7.90	< 0.03	< 1	< 1
GEP 12 FALL	11/27/2013		< 2	2.1	< 2	22	7	< 0.1	0.30	0.30	< 0.05	< 0.01	10.7	7	1.6	7.69	< 0.03	< 1	< 1
GEP 12 SUM	8/28/2013		< 2	2.4	< 2	21	6	0.1	0.22	0.22	< 0.05	0.01	11.0	7	0.9	7.49	< 0.03	< 1	< 1
GEP 13 FALL	11/27/2013		< 2	< 0.1	< 2	32	22	< 0.1	1.53	1.53	< 0.05	< 0.01	2.6	5	2.5	6.82	< 0.03	< 1	< 1
GEP 13 SUM	8/29/2013		< 2	< 0.1	< 2	13	13	< 0.1	1.46	1.46	< 0.05	0.02	8.5	5	1.1	6.95	< 0.03	< 1	1
GEP 14 FALL	11/27/2013		< 2	0.3	< 2	15	16	< 0.1	0.72	0.72	< 0.05	0.02	8.3	7	1.0	7.39	< 0.03	< 1	< 1
GEP 14 SUM	8/29/2013		< 2	0.4	< 2	16	21	< 0.1	0.68	0.68	< 0.05	< 0.01	8.4	8	1.0	7.30	< 0.03	< 1	< 1
GEP 15 SUM	8/29/2013		< 2	< 0.1	< 2	233	8	< 0.1	0.76	0.76	< 0.05	< 0.01	5.8	6	1.1	**6.27**	< 0.03	< 1	17
GEP 16 FALL	11/26/2013		< 2	0.2	< 2	13	10	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	7.7	8	1.1	7.47	< 0.03	< 1	< 1
GEP 16 FD	11/26/2013		< 2	0.2	< 2	13	10	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	7.7	9	0.6	7.67	< 0.03	< 1	1
GEP 16 SUM	8/29/2013		< 2	0.3	< 2	9	14	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	3.5	10	< 0.5	7.63	< 0.03	< 1	< 1
GEP 17 FALL	11/27/2013		< 2	0.2	< 2	7	79	< 0.1	0.10	0.10	< 0.05	0.02	6.0	17	2.1	7.41	< 0.03	< 1	< 1
GEP 17 SUM	9/3/2013		< 2	0.2	< 2	6	148	< 0.1	0.08	0.08	< 0.05	0.01	6.1	19	1.1	6.81	< 0.03	< 1	< 1
GEP 18 SUM	9/3/2013		< 2	0.2	< 2	15	130	< 0.1	0.09	0.09	< 0.05	0.01	6.0	15	1.1	7.20	< 0.03	< 1	< 1
GEP 19 FALL	12/12/2013		< 2	1.7	< 2	< 5	8	< 0.1	0.05	0.05	< 0.05	0.11	10.7	10	0.6	8.03	0.05	< 1	< 1
GEP 19 SUM	9/3/2013		< 2	1.7	< 2	7	5	0.2	< 0.05	< 0.05	< 0.05	0.01	10.7	8	< 0.5	8.07	< 0.03	< 1	< 1
GEP 20 FALL	11/27/2013		< 2	0.5	< 2	23	7	0.20	< 0.05	< 0.05	< 0.05	< 0.01	11.5	9	1.1	7.97	< 0.03	< 1	< 1
GEP 20 SUM	9/3/2013		< 2	0.5	< 2	5	7	0.2	0.05	0.05	< 0.05	< 0.01	11.4	10	< 0.5	8.03	< 0.03	< 1	< 1
GEP 21 SUM	9/4/2013		< 2	< 0.1	< 2	12	9	< 0.1	2.47	2.47	< 0.05	< 0.01	5.9	9	0.5	6.58	< 0.03	< 1	< 1
GEP 22 FALL	11/26/2013		< 2	0.1	< 2	30	27	< 0.1	0.15	0.21	0.06	< 0.01	6.2	8	12.6	7.76	< 0.03	< 1	< 1
GEP 22 SUM	9/4/2013		< 2	< 0.1	< 2	41	22	0.2	< 0.05	< 0.05	< 0.05	< 0.01	6.6	7	1.6	7.74	< 0.03	< 1	< 1
GEP 23 FALL	11/27/2013		< 2	1.2	< 2	7	45	< 0.1	1.07	1.07	< 0.05	0.01	10.2	15	< 0.5	7.94	< 0.03	< 1	< 1
GEP 23 SUM	9/10/2013		< 2	1.2	< 2	8	48	< 0.1	0.94	1.00	0.06	0.01	10.6	16	< 0.5	7.80	< 0.03	< 1	< 1
GEP 24 FALL	11/26/2013		< 2	1.2	< 2	6	7	< 0.1	0.39	0.39	< 0.05	0.01	7.5	7	0.6	7.55	< 0.03	< 1	< 1
GEP 24 SUM	9/11/2013		< 2	1.1	< 2	13	10	0.3	0.34	0.34	< 0.05	0.01	7.7	5	< 0.5	7.59	< 0.03	< 1	< 1
GEP 25 SUM	9/11/2013		< 2	1.1	< 2	13	9	0.2	0.37	0.37	< 0.05	0.02	7.8	5	< 0.5	7.65	< 0.03	< 1	< 1

Note: Grey Shading Bold Type = CDWQ Exceedance;
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Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Langelier Index (at 20 °C)	Langelier Index (at 4 °C)	Saturation pH (at 20 °C)	Saturation pH (at 4 °C)	True Color	Anion Sum	Cation Sum	Ion Balance	Total Dissolved Solids (Calculated)	Turbidity	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)
		Units	none	none	none	none	tcu	meq/L	meq/L	%	mg/L	ntμ	mg/L	mg/L
		CDWQ_ Include AO					15				500	1.0		
GEP 30 SPR	3/18/2014		-1.54	-1.86	9.17	9.49	< 5	3.18	3.69	7.4	193	0.6	92	< 10
GEP 31 SPR	3/18/2014		0.37	0.05	7.35	7.67	< 5	10.5	10.1	1.7	**562**	3.7	155	< 10
GEP 32 SPR	3/19/2014		-1.79	-2.11	8.95	9.27	< 5	0.98	1.01	1.6	54	0.5	31	< 10
GEP 33 SPR	3/19/2014		-0.18	-0.50	7.98	8.30	< 5	2.92	3.26	5.6	157	0.3	102	< 10
GEP 34 SPR	3/19/2014		-0.37	-0.69	8.02	8.34	< 5	3.62	3.58	0.6	189	0.8	92	< 10
GEP 35 SPR	3/19/2014		-4.10	-4.42	11.1	11.4	< 5	2.87	3.55	10.6	189	0.1	35	< 10
GEP 36 SPR	3/20/2014		-1.38	-1.70	8.25	8.57	< 5	2.24	2.45	4.5	127	1.4	64	< 10
GEP 37 SPR	3/20/2014		-0.77	-1.09	7.82	8.14	< 5	4.24	5.08	9.0	254	0.4	95	< 10
GEP 38 SPR	3/20/2014		-0.73	-1.05	7.82	8.14	< 5	4.61	4.99	4.0	253	4.2	106	< 10
GEP 39 SPR	3/20/2014		-0.01	-0.33	7.63	7.95	< 5	6.48	7.38	6.5	365	2.5	146	< 10
GEP 40 SPR	3/20/2014		-1.49	-1.81	9.24	9.56	< 5	3.55	4.18	8.1	213	2.3	110	< 10
GMG 01 FALL	11/27/2013		-0.12	-0.44	7.91	8.23	< 5	3.35	3.53	2.5	174	0.2	127	< 10
GMG 01 SUM	8/22/2013		-0.17	-0.49	7.91	8.23	< 5	3.43	3.66	3.2	181	**1.1**	118	< 10
GMG 02 FALL	11/26/2013		0.18	-0.14	7.47	7.79	9	14.5	14.6	0.2	**805**	**9.2**	154	< 10
GMG 02 SUM	8/22/2013		0.26	-0.06	7.47	7.79	6	14.0	14.9	3.0	**794**	**10.2**	143	< 10
GMG 03 FALL	11/27/2013		-0.91	-1.23	8.08	8.40	< 5	2.92	2.99	1.1	158	1.0	93	< 10
GMG 03 SUM	8/26/2013		-0.15	-0.47	7.83	8.15	< 5	3.43	3.77	4.7	191	**1.3**	114	< 10
GMG 04 FALL	11/27/2013		0.11	-0.21	7.83	8.15	< 5	14.1	13.3	3.0	**781**	**1.7**	123	< 10
GMG 04 SUM	8/27/2013		0.34	0.02	7.67	7.99	9	15.5	13.7	6.2	**822**	**1.2**	113	< 10
GMG 04 SUM-DUP	8/27/2013		0.40	0.08	7.64	7.96	< 5	16.4	13.8	8.6	**858**	**1.2**	115	< 10
HEP 02 FALL	11/26/2013		-0.67	-0.99	8.45	8.77	< 5	1.58	1.70	3.6	81	**1.3**	69	< 10
HEP 02 SUM	8/21/2013		-0.43	-0.75	8.45	8.77	< 5	1.62	1.65	0.8	82	**1.2**	69	< 10
HEP 03 FALL	11/27/2013		-0.09	-0.41	8.09	8.41	< 5	2.40	2.39	0.3	126	**1.7**	91	< 10
HEP 03 SUM	8/21/2013		-0.05	-0.37	8.11	8.43	< 5	2.24	2.29	1.1	118	**1.4**	90	< 10
HEP 09 FALL	11/27/2013		-0.33	-0.65	8.22	8.54	< 5	2.58	2.57	0.2	139	0.7	73	< 10
HEP 09 FD	11/27/2013		-0.31	-0.63	8.21	8.53	< 5	2.39	2.53	2.9	131	0.4	72	< 10
HEP 09 SUM	8/26/2013		-0.17	-0.49	8.23	8.55	5	2.35	2.47	2.3	129	0.3	68	< 10

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Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Alkalinity, Total (as $CaCO_3$)	Hydroxide (OH)	Hardness (as $CaCO_3$)	Electrical Conductivity, Lab	Aluminum	Antimony	Arsenic	Barium	Beryllium	Bismuth	Boron	Cadmium	Calcium	Chromium	Cobalt
		Units	mg/L	mg/L	mg/L	umhos/cm	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	µg/L
		CDWQ_ Include AO					100	6	10	1000			5000	5		50	
GEP 30 SPR	3/18/2014		92	< 5	10.0	353	< 5	< 2	**14**	< 5	< 2	< 2	10	< 0.017	3.0	< 1	< 1
GEP 31 SPR	3/18/2014		155	< 5	372	1100	9	< 2	**174**	106	< 2	< 2	14	< 0.017	132	< 1	8
GEP 32 SPR	3/19/2014		31	< 5	37.3	102	< 5	< 2	**12**	< 5	< 2	< 2	7	< 0.017	13.3	< 1	< 1
GEP 33 SPR	3/19/2014		102	< 5	143	321	< 5	< 2	**95**	10	< 2	< 2	15	< 0.017	41.9	< 1	< 1
GEP 34 SPR	3/19/2014		92	< 5	147	378	< 5	< 2	**171**	16	< 2	< 2	31	< 0.017	42.3	< 1	< 1
GEP 35 SPR	3/19/2014		35	< 5	0	327	19	< 2	< 2	< 5	< 2	< 2	24	< 0.017	< 0.1	< 1	< 1
GEP 36 SPR	3/20/2014		64	< 5	101	229	< 5	< 2	**49**	< 5	< 2	< 2	10	< 0.017	34.5	< 1	< 1
GEP 37 SPR	3/20/2014		95	< 5	187	425	< 5	< 2	**15**	< 5	< 2	< 2	8	< 0.017	66.9	< 1	< 1
GEP 38 SPR	3/20/2014		106	< 5	189	441	< 5	< 2	**184**	13	< 2	< 2	8	< 0.017	60.5	7	2
GEP 39 SPR	3/20/2014		146	< 5	229	670	5	< 2	**577**	27	< 2	< 2	55	< 0.017	70.8	< 1	< 1
GEP 40 SPR	3/20/2014		110	< 5	5.5	389	5	< 2	**46**	< 5	< 2	< 2	17	< 0.017	2.2	< 1	1
GMG 01 FALL	11/27/2013		127	< 5	152	349	< 5	< 2	**31**	< 5	< 2	< 2	13	< 0.017	39.7	< 1	< 1
GMG 01 SUM	8/22/2013		118	< 5	161	359	6	< 2	**34**	< 5	< 2	< 2	8	< 0.017	42.9	< 1	< 1
GMG 02 FALL	11/26/2013		154	< 5	356	1550	< 5	< 2	**251**	7	< 2	< 2	8	0.101	106	< 1	< 1
GMG 02 SUM	8/22/2013		143	< 5	372	1560	6	< 2	**258**	9	< 2	< 2	< 5	0.167	112	< 1	< 1
GMG 03 FALL	11/27/2013		93	< 5	109	319	13	< 2	2	6	< 2	< 2	14	< 0.017	36.5	< 1	27
GMG 03 SUM	8/26/2013		114	< 5	154	379	13	< 2	4	< 5	< 2	< 2	10	0.040	53.9	< 1	8
GMG 04 FALL	11/27/2013		123	< 5	199	1480	6	< 2	8	< 5	< 2	< 2	11	0.111	57.3	< 1	1
GMG 04 SUM	8/27/2013		113	< 5	344	1760	7	< 2	**49**	11	< 2	< 2	8	0.034	89.4	1	< 1
GMG 04 SUM-DUP	8/27/2013		115	< 5	359	1760	6	< 2	**48**	11	< 2	< 2	8	0.035	96.4	1	< 1
HEP 02 FALL	11/26/2013		69	< 5	66.4	163	< 5	< 2	< 2	6	< 2	< 2	19	< 0.017	19.5	< 1	< 1
HEP 02 SUM	8/21/2013		69	< 5	65.9	172	7	< 2	< 2	5	< 2	< 2	16	< 0.017	19.3	< 1	< 1
HEP 03 FALL	11/27/2013		91	< 5	104	234	< 5	< 2	5	23	< 2	< 2	10	< 0.017	35.7	< 1	< 1
HEP 03 SUM	8/21/2013		90	< 5	99.6	236	5	< 2	6	24	< 2	< 2	9	< 0.017	33.8	< 1	< 1
HEP 09 FALL	11/27/2013		73	< 5	103	266	< 5	< 2	**55**	< 5	< 2	< 2	8	< 0.017	33.3	< 1	< 1
HEP 09 FD	11/27/2013		72	< 5	105	266	< 5	< 2	**55**	< 5	< 2	< 2	8	< 0.017	34.4	< 1	< 1
HEP 09 SUM	8/26/2013		68	< 5	105	268	7	< 2	**60**	< 5	< 2	< 2	< 5	< 0.017	34.1	< 1	< 1

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Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin
		Units	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**	**mg/L**	**µg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**
		CDWQ_ Include AO	**1000**	**300**	**10**		**50**					**10**		**200**			
GEP 30 SPR	3/18/2014		15	< 50	< 0.5	0.6	< 2	< 2	< 2	< 0.02	0.8	< 1	< 0.1	79.7	11	< 0.1	< 2
GEP 31 SPR	3/18/2014		40	**633**	5.6	10.3	**1840**	< 2	2	< 0.02	2.1	< 1	< 0.1	57.6	2060	< 0.1	< 2
GEP 32 SPR	3/19/2014		9	53	0.9	1.0	3	< 2	< 2	< 0.02	0.4	< 1	< 0.1	5.7	36	< 0.1	< 2
GEP 33 SPR	3/19/2014		8	56	< 0.5	9.3	6	< 2	< 2	< 0.02	0.9	< 1	< 0.1	8.7	669	< 0.1	< 2
GEP 34 SPR	3/19/2014		7	88	< 0.5	10.1	22	< 2	< 2	< 0.02	0.8	< 1	< 0.1	13.9	346	< 0.1	< 2
GEP 35 SPR	3/19/2014		10	< 50	1.3	< 0.1	15	< 2	< 2	< 0.02	< 0.1	< 1	< 0.1	81.5	< 5	< 0.1	< 2
GEP 36 SPR	3/20/2014		48	131	1.5	3.6	4	< 2	< 2	< 0.02	0.8	< 1	< 0.1	8.8	117	< 0.1	< 2
GEP 37 SPR	3/20/2014		23	51	< 0.5	4.8	< 2	< 2	< 2	< 0.02	0.9	< 1	< 0.1	29.5	225	< 0.1	< 2
GEP 38 SPR	3/20/2014		2	**528**	< 0.5	9.3	**805**	< 2	< 2	< 0.02	1.1	< 1	< 0.1	25.4	358	< 0.1	< 2
GEP 39 SPR	3/20/2014		55	295	**12.4**	12.6	**1220**	< 2	< 2	< 0.02	2.1	< 1	< 0.1	61.8	952	< 0.1	< 2
GEP 40 SPR	3/20/2014		11	215	3.3	< 0.1	42	< 2	< 2	< 0.02	0.4	< 1	< 0.1	92.7	17	< 0.1	< 2
GMG 01 FALL	11/27/2013		76	66	1.0	12.9	4	< 2	< 2	0.02	1.2	< 1	< 0.1	10.3	104	< 0.1	< 2
GMG 01 SUM	8/22/2013		75	< 50	1.1	13.1	< 2	< 2	< 2	< 0.02	1.3	< 1	< 0.1	9.2	115	< 0.1	< 2
GMG 02 FALL	11/26/2013		23	**1000**	5.1	22.2	**714**	< 2	5	< 0.02	3.0	< 1	< 0.1	169	251	< 0.1	< 2
GMG 02 SUM	8/22/2013		13	**1270**	5.7	22.4	**707**	< 2	4	< 0.02	3.4	< 1	< 0.1	167	268	< 0.1	< 2
GMG 03 FALL	11/27/2013		4	254	< 0.5	4.4	**2210**	< 2	6	0.02	0.9	1	< 0.1	15.8	151	< 0.1	< 2
GMG 03 SUM	8/26/2013		2	**312**	0.8	4.7	**667**	< 2	3	< 0.02	0.7	1	< 0.1	14.6	170	< 0.1	< 2
GMG 04 FALL	11/27/2013		7	204	0.8	13.5	47	< 2	3	0.02	1.6	2	< 0.1	**213**	225	< 0.1	< 2
GMG 04 SUM	8/27/2013		6	67	< 0.5	29.3	4	< 2	3	< 0.02	1.9	< 1	< 0.1	155	538	< 0.1	< 2
GMG 04 SUM-DUP	8/27/2013		6	62	< 0.5	28.7	4	< 2	4	< 0.02	1.9	< 1	< 0.1	151	529	< 0.1	< 2
HEP 02 FALL	11/26/2013		3	**301**	0.8	4.3	**222**	< 2	< 2	0.02	0.7	< 1	< 0.1	7.6	73	< 0.1	< 2
HEP 02 SUM	8/21/2013		< 1	250	< 0.5	4.3	**229**	< 2	< 2	< 0.02	0.8	< 1	< 0.1	6.6	73	< 0.1	< 2
HEP 03 FALL	11/27/2013		1	203	< 0.5	3.6	**59**	< 2	< 2	0.02	1.0	< 1	< 0.1	6.3	143	< 0.1	< 2
HEP 03 SUM	8/21/2013		1	106	0.9	3.7	47	< 2	< 2	< 0.02	1.1	< 1	< 0.1	6.0	143	< 0.1	< 2
HEP 09 FALL	11/27/2013		16	71	0.5	4.9	< 2	< 2	< 2	0.03	0.6	1	< 0.1	11.2	105	< 0.1	< 2
HEP 09 FD	11/27/2013		18	69	< 0.5	4.6	< 2	< 2	< 2	0.02	0.5	1	< 0.1	9.7	97	< 0.1	< 2
HEP 09 SUM	8/26/2013		16	< 50	0.5	4.7	< 2	< 2	< 2	< 0.02	0.5	< 1	< 0.1	8.3	98	< 0.1	< 2

Note: Grey Shading Bold Type = CDWQ Exceedance;
CDWQ = Guidelines for Canadian Drinking Water Quality;
AO = Aesthetic Objective;
MPN is Most Probable Number

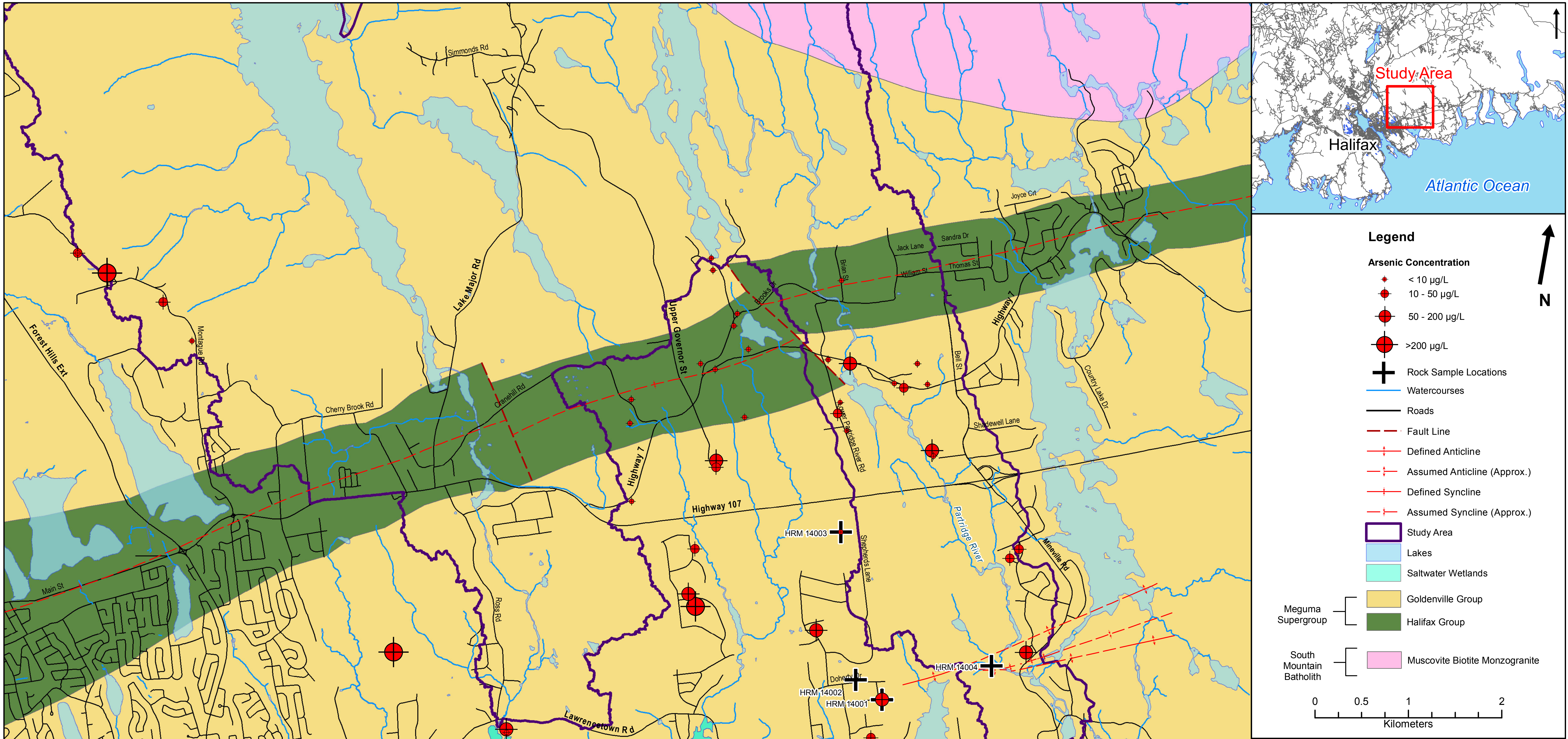
Table 20: Residential Well Survey Results - Drilled Wells

Sample ID	Sample Date		Titanium	Uranium	Vanadium	Zinc	Chloride	Fluoride	Nitrate (as N)	Nitrate + Nitrite as N	Nitrite (as N)	Orthophosphate (as P)	Reactive Silica (SiO_2)	Sulfate	Total Organic Carbon	pH	Ammonia (as N)	Escherichia coli (E.Coli)	Total Coliforms
		Units	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	n/a	mg/L	mpn/100mL	mpn/100mL
		CDWQ_ Include AO		20		5000	250	1.5	10		1			500		6.5-8.5			
GEP 30 SPR	3/18/2014		< 2	1.5	< 2	11	36	< 0.1	1.88	1.88	< 0.05	< 0.01	9.6	9	< 0.5	7.63	< 0.03	< 1	< 1
GEP 31 SPR	3/18/2014		< 2	0.6	< 2	53	**251**	< 0.1	< 0.05	< 0.05	< 0.05	0.04	11.6	13	4.4	7.72	0.14	< 1	< 1
GEP 32 SPR	3/19/2014		< 2	0.1	< 2	19	8	< 0.1	0.38	0.38	< 0.05	0.01	8.7	5	< 0.5	7.16	< 0.03	< 1	< 1
GEP 33 SPR	3/19/2014		< 2	2.1	< 2	9	22	< 0.1	0.36	0.36	< 0.05	0.03	11.0	11	1.5	7.80	< 0.03	< 1	< 1
GEP 34 SPR	3/19/2014		< 2	1.9	< 2	17	54	< 0.1	0.33	0.33	< 0.05	0.04	9.7	11	< 0.5	7.65	0.04	< 1	< 1
GEP 35 SPR	3/19/2014		< 2	< 0.1	< 2	26	61	< 0.1	3.38	3.38	< 0.05	0.01	7.5	10	3.5	6.97	0.03	< 1	222
GEP 36 SPR	3/20/2014		< 2	0.5	< 2	37	20	< 0.1	0.89	0.89	< 0.05	0.01	8.2	16	< 0.5	6.87	0.28	< 1	< 1
GEP 37 SPR	3/20/2014		< 2	0.6	< 2	16	60	< 0.1	2.66	2.66	< 0.05	< 0.01	10.7	22	< 0.5	7.05	0.42	< 1	< 1
GEP 38 SPR	3/20/2014		< 2	1.5	< 2	30	80	< 0.1	< 0.05	< 0.05	< 0.05	0.03	11.9	11	0.9	7.09	0.29	< 1	< 1
GEP 39 SPR	3/20/2014		< 2	0.3	< 2	79	120	< 0.1	0.09	0.09	< 0.05	0.17	12.8	8	1.6	7.62	0.05	< 1	< 1
GEP 40 SPR	3/20/2014		< 2	0.6	< 2	20	40	< 0.1	0.23	0.23	< 0.05	0.01	9.3	10	3.4	7.75	0.28	< 1	< 1
GMG 01 FALL	11/27/2013		< 2	0.6	< 2	23	17	< 0.1	0.59	0.59	< 0.05	0.01	8.4	14	2.4	7.79	< 0.03	< 1	< 1
GMG 01 SUM	8/22/2013		< 2	1.0	< 2	18	24	0.4	0.58	0.58	< 0.05	0.02	8.7	17	0.6	7.74	< 0.03	< 1	< 1
GMG 02 FALL	11/26/2013		< 2	1.6	< 2	36	**393**	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	9.8	18	2.9	7.65	0.04	< 1	< 1
GMG 02 SUM	8/22/2013		2	1.8	< 2	22	**379**	< 0.1	< 0.05	< 0.05	< 0.05	< 0.01	10.5	22	1.2	7.73	0.06	< 1	< 1
GMG 03 FALL	11/27/2013		< 2	0.3	< 2	20	25	< 0.1	0.35	0.35	< 0.05	< 0.01	8.6	16	4.5	7.17	< 0.03	1	< 1
GMG 03 SUM	8/26/2013		< 2	0.7	< 2	16	25	< 0.1	0.74	0.74	< 0.05	< 0.01	10.0	19	2.2	7.68	< 0.03	< 1	1
GMG 04 FALL	11/27/2013		< 2	0.5	< 2	49	**389**	< 0.1	0.23	0.28	0.05	< 0.01	7.0	31	1.5	7.94	< 0.03	< 1	< 1
GMG 04 SUM	8/27/2013		2	2.1	< 2	24	**443**	< 0.1	< 0.05	< 0.05	< 0.05	0.02	8.6	35	1.0	8.01	< 0.03	< 1	< 1
GMG 04 SUM-DUP	8/27/2013		2	2.0	< 2	26	**475**	< 0.1	0.14	0.14	< 0.05	0.02	8.7	35	1.6	8.04	< 0.03	< 1	< 1
HEP 02 FALL	11/26/2013		< 2	0.2	< 2	9	7	0.1	< 0.05	< 0.05	< 0.05	0.01	6.1	< 2	0.6	7.78	< 0.03	< 1	< 1
HEP 02 SUM	8/21/2013		< 2	0.2	< 2	7	7	0.2	< 0.05	< 0.05	< 0.05	< 0.01	6.5	2	< 0.5	8.02	0.03	< 1	< 1
HEP 03 FALL	11/27/2013		< 2	1.8	< 2	9	10	< 0.1	0.15	0.15	< 0.05	< 0.01	11.1	14	1.1	8.00	< 0.03	< 1	< 1
HEP 03 SUM	8/21/2013		< 2	2.1	< 2	15	6	0.1	< 0.05	< 0.05	< 0.05	< 0.01	11.6	13	< 0.5	8.06	< 0.03	< 1	< 1
HEP 09 FALL	11/27/2013		< 2	2.1	< 2	7	28	< 0.1	1.45	1.45	< 0.05	0.02	7.9	11	0.9	7.89	< 0.03	< 1	< 1
HEP 09 FD	11/27/2013		< 2	1.9	< 2	7	23	< 0.1	1.34	1.34	< 0.05	0.02	7.9	10	0.8	7.9	< 0.03	< 1	< 1
HEP 09 SUM	8/26/2013		< 2	2.3	< 2	< 5	23	< 0.1	1.34	1.34	< 0.05	0.03	8.5	12	< 0.5	8.06	< 0.03	< 1	< 1

Note: Grey Shading Bold Type = CDWQ Exceedance;
CDWQ = Guidelines for Canadian Drinking Water Quality;
AO = Aesthetic Objective;
MPN is Most Probable Number

Arsenic concentrations were below the detection limit (2 µg/L) in nineteen (19) samples from eleven (11) locations and exceed the CDWQ guideline (10 µg/L) in twenty eight (28) or 49 % of the samples collected from eighteen (18) different drilled wells. Six (6) of the samples had arsenic concentrations greater than 100 µg/L with a maximum arsenic concentration of 577 µg/L. The distribution of arsenic concentrations in the GSA is presented in **Figure 9.**

Four bedrock samples were collected from the Goldenville Group in the Lawrencetown and Mineville area for analysis of bulk chemistry using x-ray diffraction (XRF). The locations of the samples are presented in **Figure 9.** Results of the analyses are provided in **Table 21**. Arsenic concentrations in the rock samples range from 6 ppm (mg/kg) to 36 ppm. These results are consistent with arsenic concentrations in the Goldenville Group in other parts of HRM (White and Goodwin 2011). The sample with the lowest arsenic concentration in the surface bedrock (Sample HRM 14003) was collected from the same location as well water sample with arsenic concentration < 10 µg/L. This observation further supports the link between bedrock composition and arsenic concentrations in well water. As noted above, detailed mapping of the area will be completed in 2014 and may provide more insight to the links between bedrock lithologies and structures to arsenic distribution in groundwater.



Preston Area Watershed Study

Arsenic Concentrations in Groundwater and Bedrock

June 2014	1:40,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM
P#: 60303077	V#: 004	

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Figure 9

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 9 - Arsenic Concentrations in Groundwater and Bedrock 20140626.mxd
Date Saved: 6/26/2014 9:05:11 AM

Table 21: XFR Results

Sample ID	P	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Co	Cu	Zn	As	Se	Rb	Sr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
HRM 14001	1136	350	407	15367	8881	2558	56	42	341	19743	8	8	27	20	-	71	144
HRM 14002	588	195	190	13344	397	2429	49	40	482	15194	6	6	15	23	-	63	127
HRM 14003	711	274	461	14942	4221	2180	56	49	383	20824	8	10	29	6	1	64	165
HRM 14004	860	523	1029	28637	938	5286	108	93	385	32594	13	20	39	36	1	125	115

Table 21: XFR Results

Sample ID	Y	Zr	Nb	Mo	Ag	Sn	Sb	Ba	La	Ce	Nd	Sm	W	Hg	Bi	Th	U
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
HRM 14001	16	141	10	1	3	10	5	439	111	113	204	23	8	3	6	37	1
HRM 14002	18	145	9	1	8	8	3	371	64	103	195	46	6	4	5	43	2
HRM 14003	19	125	10	2	2	7	5	420	73	47	196	21	5	2	9	54	1
HRM 14004	23	144	19	2	12	10	2	703	40	121	159	16	15	7	9	33	-

4.5.2.3 Survey Questionnaire Results

A questionnaire was completed during the residential well survey which included questions to qualitatively describe water quality (excellent, good, poor) and to identify if treatment systems were in place to improve water quality. Responses to the questionnaire indicate 40% of the residences have a water treatment system in place that prevents consumption of raw well water. Treatment systems included reverse osmosis (RO), softener, filtration and ion exchange. Consumption of bottled water was also considered a water quality treatment solution for the purposes of assessing potential risk.

The questionnaire provided a general indication of water supply issues by asking if the water well had ever gone dry (ran out of water) or if the well had ever been deepened to increase the yield. Water quantity is an issue in 15 % of the residences sampled. Four (4) of the eleven (11) residences in the Lawrencetown/Mineville area, one (1) of four (4) residences in the Montague Gold Mines area and one (1) in twenty two (22) of residences in the East Preston area reported water quantity issues as shown in **Figure 10.**

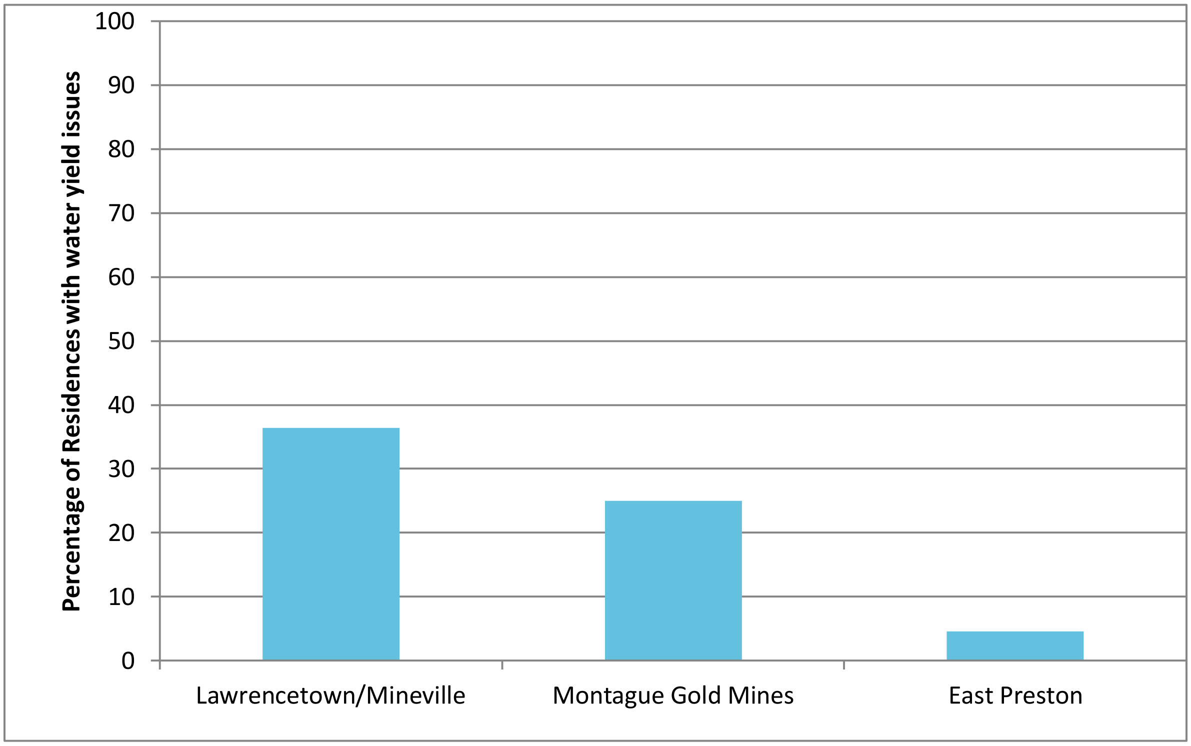


Figure 10: Water Quantity Issues by Community

4.5.3 Groundwater Quality Concerns

The results of the residential well survey indicate both aesthetic and health related groundwater quality issues are present in the GSA. Aesthetic groundwater quality issues include chloride, iron and manganese. Health related groundwater quality issues are the presence of bacteria and arsenic.

4.5.3.1 Aesthetic Groundwater Quality Concerns

Groundwater quality issues that are an aesthetic concern are for parameters that may affect the taste of water, leave stains on fixtures or lead to corrosion of plumbing. In the GSA iron, manganese and chloride are above CDWQ guidelines and represent a concern for residential well users.

Chloride is found at low concentrations in groundwater from the weathering and leaching of soils and sedimentary rocks. Chloride at concentrations above CDWQ guidelines (250 mg/L) typically result from dissolution of salts or seawater intrusion. Soils and bedrock in the GSA do not have significant sources of salts and are unlikely to be the source of elevated chloride concentrations found in groundwater. Application of road salts can impact water quality of both dug wells and drilled wells. Two of the locations with elevated chloride in drilled wells were in the Montague Gold Mines area. One other resident in the Montague Gold Mines area identified that a well on his property had to be replaced because of road salt impact on the well water. One dug well in the GSA had chloride concentrations above CDWQ guidelines in the summer sample. One well (GEP 31 SPR) in the Lawrencetown area has a chloride concentration of 251 mg/L and one well (GEP 39 SPR) had a chloride concentration of 120 mg/L suggesting saltwater intrusion as indicated in the hydrogeology report for the Lawrencetown area (Cross 1980). However, GEP 31 SPR is approximately 2 km from Cole Harbour and GEP 39 SPR is < 300 m from Cole Harbour. The pattern of chloride distribution along the coast increases with decrease in distance from the ocean, suggesting that seawater intrusion may not control chloride concentrations in groundwater. However, the pattern of seawater intrusion in the Meguma Metasedimentary Aquifer (MMA) depends on the connectivity of water bearing fractures with seawater suggesting the pattern of seawater intrusion is more complex than a simple relationship of distance from the coastline (Kennedy 2012). Chloride can be removed from drinking water with treatment systems such as anion exchange, distillation and reverse osmosis (NSE *Drop on Water Chloride*).

Elevated levels of iron and manganese may affect the taste, smell or colour of well water. The iron and manganese, from primarily drilled wells, is from groundwater coming in contact with bedrock that has soluble iron and manganese and may indicate the groundwater is in reducing conditions. Elevated concentrations of iron and manganese are common for bedrock wells in the MMA, generally more common in deeper wells accessing water that has a long residence time. Removal of iron and manganese can be achieved using readily available in-home treatment systems such as adsorption systems, ion exchange and reverse osmosis among others (NSE *Drop on Water Iron and Manganese).*

4.5.3.2 Health-related Groundwater Quality Concerns

Bacteria and arsenic in the groundwater of the GSA have health implications and are groundwater quality concerns in the GSA.

Coliform Bacteria

Total coliforms are a group of bacteria commonly found in the environment and are not likely to cause illness, but their presence indicates the well may be vulnerable to more harmful microorganisms. Escerichia coli (E.coli) is a subgroup of total coliforms that is found in the intestines of mammals including humans. The presence of E.coli indicates recent fecal contamination and may indicate the possible presence of disease-causing pathogens such as bacteria, viruses and parasites. Total coliforms and E.coli are indicators useful to assess the integrity of the well and the susceptibility of the well to the contamination by pathogens (NSE *Drop on Water Coliform Bacteria*).

Results of the residential survey indicate coliform bacteria were present in eight (8) residences. The distribution of occurrences by community area is displayed in **Figure 11.**

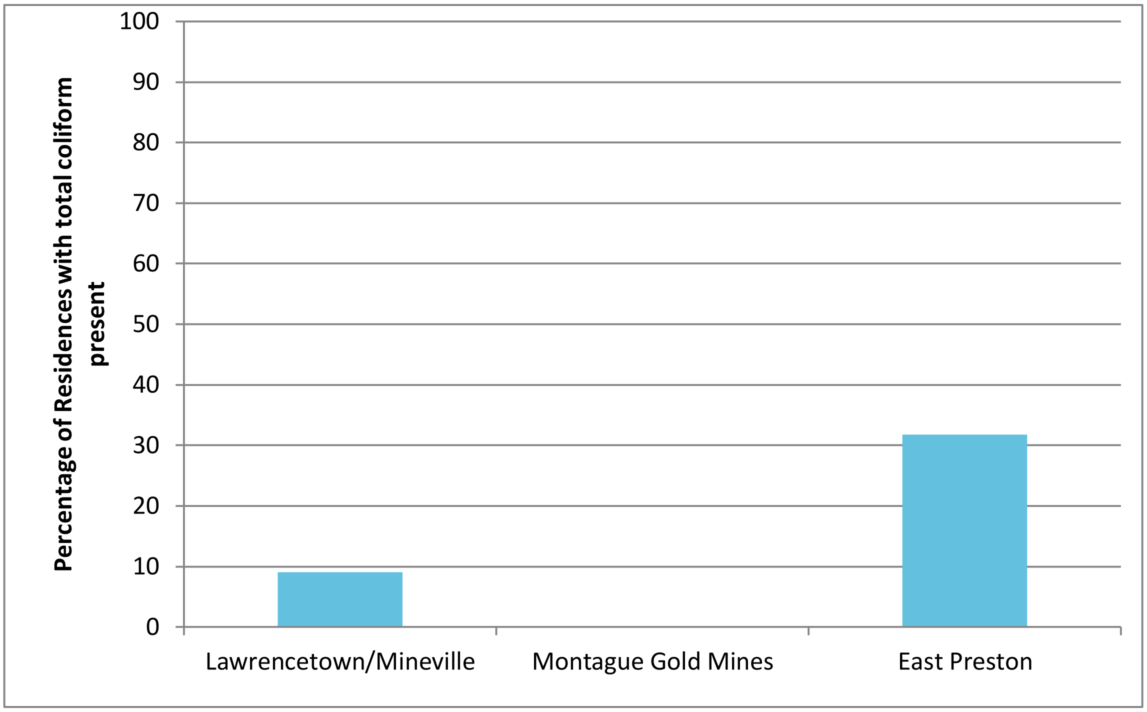


Figure 11: Coliform Bacteria Results by Community

Of the residences with total coliforms present, seven (7) were from dug wells in the East Preston area. Bacteria in the dug wells suggest that surface water may be flowing directly into the wells without infiltration through the soils. Considering many of the dug wells in the GSA were constructed more than 20 years ago, it is reasonable to assume the seal of the wells could be compromised and allow for direct influence of surface water. Further evidence for surface water flowing into the dug wells is the results of turbidity > 1 NTU which is a general indication of surface water influence. Treatment of bacteria can be completed by shocking the well with bleach to kill the bacteria that are present. However, if the bacteria in the well is from surface water flowing into the well, then the treatment options include replacing the well or installation of a water treatment system that can remove bacteria such as a UV light treatment system.

Arsenic

Arsenic is a toxic metalloid with adverse health effects such as skin, lung, bladder and kidney cancer. Nova Scotia ranks in the top three provinces in Canada for incidence rates of bladder and kidney cancer (Canadian Cancer Society 2014). Studies examining the potential effects of arsenic consumption in Nova Scotia are being completed through the Atlantic Partnership for Tomorrow's Health (PATH) including studies examining the relationship between arsenic in drinking water wells and toenail concentrations in Nova Scotia (Dummer et al, 2014 *in Press*) and how the risk of arsenic exposure is understood in Nova Scotia (Chappells et al. 2014 *in Press*).

Arsenic related health issues in Nova Scotia were first identified in 1976 when a resident of Waverley was diagnosed with arsenic intoxication (McCurdy 1980). Well water investigations completed in the 1980's (Meranger et al. 1984) and the 1990's (NSE 1998) followed by the development of an arsenic risk map in 2005 (NSE 2005) have identified the general distribution of elevated concentrations of arsenic in groundwater and increased public awareness of the issue.

As discussed in previous sections, the distribution of arsenic in groundwater is related to the rock type, mineralization and structure of the geology the wells are completed in. The results of the residential well survey suggest the wells completed in the syncline structure of the Halifax Group rocks that underlie the portions of East Preston along Highway 7 are less likely to have elevated concentrations of arsenic in groundwater. This is represented in the results from the residential well survey grouping the occurrences of arsenic present at concentrations greater than the CDWQ guideline of 10 µg/L by each community area. The water samples collected from Lawrencetown/Mineville areas have the highest proportion of elevated arsenic occurrences, followed by Montague Gold Mines and East Preston (**Figure 12**).

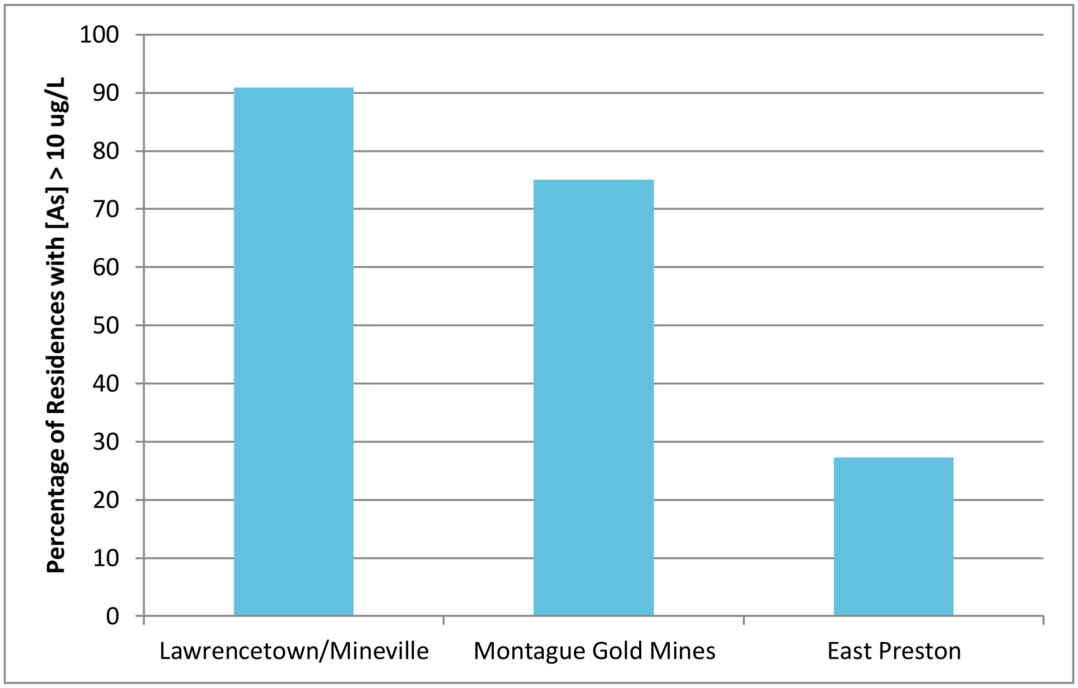


Figure 12: Arsenic in Groundwater by Community

Treatment options for arsenic include adsorption, anion exchange, distillation and reverse osmosis. The questionnaire asked if in house treatment systems were used and, if so, general descriptions of the systems were recorded. Nine (9) residences utilize water treatment systems that effectively remove arsenic from water. Of the nineteen (19) residences that have arsenic concentrations greater than 10 µg/L, thirteen (13) do not utilize water treatment systems indicating that 34 % of the residents consume water that may pose a health risk. Including total coliforms as a potential health risk, the total number of residences that are supplied with water than may pose a health risk is nineteen (19) or 50%.

4.6 Groundwater Quantity

4.6.1 Wells Summary

A search of the Nova Scotia Department of Natural Resources (NSDNR) Groundwater Map Viewer was conducted to compile potable water well construction information for wells within the Preston Area (NSDNR 2013b). The NSDNR contains geo-referenced well information based on the Nova Scotia Environment (NSE) 2013 Well Driller's Database for wells constructed between 1940 and 2013. Four hundred and fifty eight (458) wells in the GSA are identified in the water well data base, and are shown on **Figure 4**. Fourteen well records are of dug wells and 444 are of drilled wells. Summaries of well depth, depth to bedrock, static water level and yield are in **Table 22**. The dug wells are likely completed in the surficial aquifer or in the upper part of the bedrock. The dug wells are less than 6.1 m deep and have static water levels within 3.7 m of ground surface. The drilled wells are completed in the Meguma

Metasedimentary aquifer and have an average depth of 52 m. Average well yield interpreted from air lifting at the time of well completion is 337.8 L/min for dug wells and 26.5 L/min for drilled wells. Drilled well yield is consistent with pumping test data compiled for HRM, which indicates the average bedrock well yield is less than 45 L/min.

Table 22: Summary of Water Wells Registered in NSE Well Driller's Database

Well type	Statistical Summary	Well Depth (m)	Depth to Bedrock (m)	Static Water Level (mbgs)	Air-Lift Yield (L/min)
Dug	Minimum	3.0	1.8	1.2	13.6
	Maximum	6.1	1.8	3.7	3632.0
	Median	4.6	1.8	2.4	590.2
	Geometric Mean	4.5	1.8	2.3	337.8
	Number	14	2	11	7
Drilled	Minimum	7.6	0.0	0.0	0.0
	Maximum	150.4	27.4	88.3	227.0
	Median	47.5	3.0	3.4	13.6
	Mean	52.5	3.9	4.7	26.5
	Number	444	388	215	424

Well yield from airlifting during well completion provides a general estimate of the well capacity, but many factors such as well development, lack of flow monitoring, short duration testing and limited water level monitoring during and following the airlift, contribute to uncertainty in the yield estimates. Pumping tests provide more reliable estimates of aquifer parameters and yield. The results of fourteen pumping tests in the Preston Area are available from the NSDNR Groundwater Map Viewer (NSDNR 2013b). The tests were completed between 1970 and 1978 on two surficial aquifers and 12 bedrock aquifers (**Table 16**). The long term sustainable yield, represented by Q_{20}, has a large range in bedrock wells from 0.7 L/min to 36.4 L/min. This range of sustainable yield is consistent with aquifers that rely on fracture flow where some wells could intersect high yield fracture systems and some wells do not intersect fracture networks with significant yield.

The range of yield values in the historic data is also reflected in the responses of the residential well survey questionnaire that indicate 84% of wells have sufficient yield for household needs and 16% of wells have gone dry in the past or had to be deepened to increase yield.

4.6.2 Groundwater Use

The Nova Scotia Environment *Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells* (NSE 2011) indicates private well supplying water for a four bedroom home should yield 1.35 m^3/day (1,350 L/day) and be able to provide this amount within a two hour period each day to meet peak demands (CBCL 2004). Resident responses during the residential well survey suggest household water use ranges from 0.05 to 0.5 m^3day (50 to 500 L). However, a value of 1.35 m^3/day from each well is used to estimate total groundwater usage in the Preston Area watershed. This value is consistent with NSE guidelines, previous groundwater reports (CBCL 2013), and account for groundwater use from wells that are not registered in the NSE well water database. Assuming the well yield of 1.35 m^3/day is representative of water consumption from each of the 458 wells in the GSA, the estimated current groundwater consumption is 618.3 m^3/day (225,680 m^3/year).

Wells installed following the *Well Construction Regulations (Sections 66 and 110 of the Environment Act)* have an well yield estimated using a bail or airlift test of 1 hour or a pumping test of 2 hours duration. Well yields produced using these methods provide a general description of well capacity. In the GSA the average well yield of dug wells is 337 L/min (485 m^3/day) and is more than sufficient to supply residential use. The average yield of drilled wells is 26.5 L/min (18.4 m^3/day) and is also sufficient to supply residential use.

An estimate of safe yield for drilled wells in the MMA is made for the GSA based on parameters generalized from historic pumping tests (**Table 16**) and available head based on the average static water level recorded in drilling records (**Table 22**). The average transmissivity estimated for the MMA is 0.84 m^2/day and the available head is 47.8 m. Using the Farvolden method (Farvolden 1959) as described in the NSE Groundwater Assessments for Subdivision Developments Toolkit, the average safe yield (Q_{20}) for the GSA is 19.2 m^3/day or 13.3 L/min. This value is less, but comparable to the average yield estimated from airlift tests reported in well records.

Estimates of yield for the GSA indicate groundwater quantity is sufficient for on-site groundwater use in a regional or generalized scale. This is consistent with results from the residential well survey that indicate water quantity is not an issue for most residents. Examining the responses to the survey on a community scale indicates the Lawrencetown area has the highest proportion of residences with water quantity issues (36%), followed by Montague Gold Mines area (25%) and East Preston (5%) as displayed in **Figure 13.**

The results of the residential well survey provide indications of water quality and water quantity issues in three community areas. The Lawrencetown/Mineville area has the highest rates of water quality issues (100%) and the highest rates of water quantity issues (36%), followed by Montague Gold Mines and East Preston (**Figure 13).**

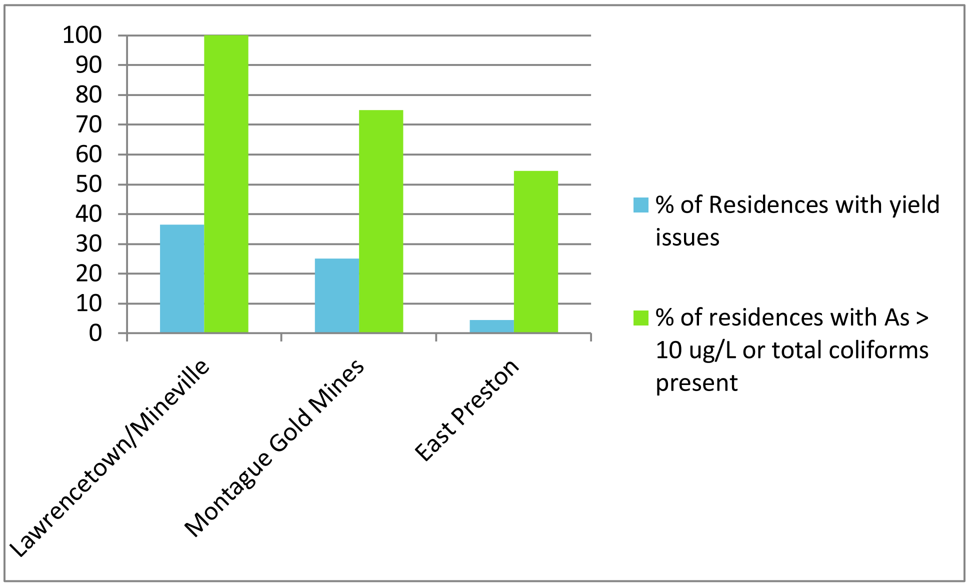


Figure 13: Groundwater Quality and Quantity Issues by Community

The use of effective treatment systems significantly reduces the risk of consumption of water that may pose a health risk. While the Lawrencetown/Mineville area has the highest rates of water quality issues, it is also the area with the highest proportion of water treatment methods. **Figure 14** displays the proportion of residences in each community that may be at risk of consuming water that may pose a health risk indicating the proportions are similar in three community areas. For example in the Lawrencetown/Mineville area >50% of the residences surveyed do not have appropriate treatment systems (45% at risk of arsenic consumption and 10% at risk of coliform consumption). Chappells et al. (2014) discuss factors that influence the knowledge of arsenic risk in Nova Scotia and discuss strategies to improve public awareness of risk exposure.

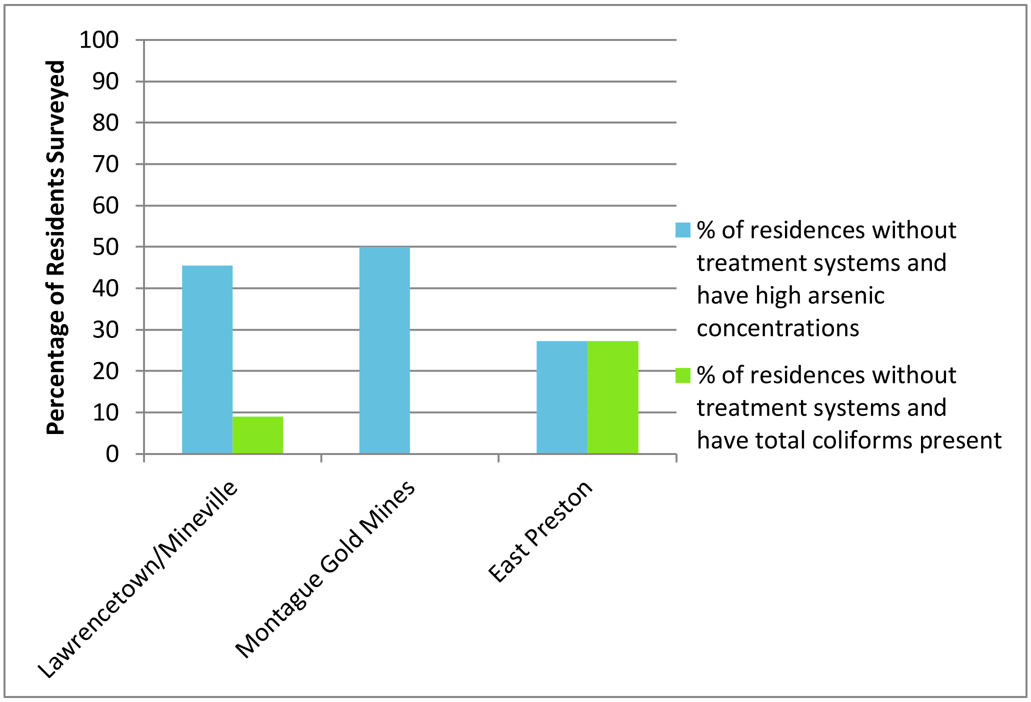


Figure 14: Drinking Water Quality and Treatment Systems by Community

4.7 Groundwater Recharge Mapping

Precipitation falling within a watershed may flow overland as runoff or infiltrate into the soil. Groundwater recharge is the portion of precipitation that infiltrates into soil and reaches the groundwater system. Groundwater discharging to watercourses provides “baseflow” to streams throughout the year. Baseflow is essential to maintaining stream flow for aquatic ecosystems during periods with limited precipitation. The baseflow contribution to the rivers in HRM such as the Sackville River and the Shubenacadie River is estimated to between 11% and 14 % of the mean annual flow (Caissie and Robichaud 2009, NSE 2011). This estimate of baseflow provides an approximation of baseflow in the Little Salmon River and Partridge River watershed. However, the larger watersheds of the Sackville River and the Shubenacadie have portions of the watershed with thick surficial sediments, while the Little Salmon River and Partridge River watersheds area generally covered by thin tills suggesting the baseflow contribution in the Preston area may be less than 10%.

Groundwater recharge potential was defined for the Little Salmon River and Partridge River watersheds using a Geographic Information System (GIS) based recharge model. The groundwater recharge model partitions **surplus water** into groundwater **recharge** and overland **runoff** using slope, vegetation cover and soil infiltration rates as determining factors. The results of the model identify areas of high recharge potential that in turn are potentially subject to protective recommendations as required by Regional Plan Policy E-17.

4.7.1 Water Budget

A water budget is used in the groundwater recharge model to calculate the surplus water available for groundwater recharge. The surplus water is the total precipitation falling as rain and snow minus loses to the atmosphere from evapotranspiration (a combination of evaporation and transpiration of moisture through plant foliage). Precipitation (mm/year) is the yearly average from climate normal data averaged over the 30 year period from 1981 to 2010 at

Environment Canada's Halifax Stanfield International Airport climate station (Station ID 8202250). Evapotranspiration is estimated using the methods of Thornthwaite and Mather (1957).

The surplus water calculations assume that changes in soil moisture storage are negligible and there is no change in groundwater storage in the watershed. The water surplus – that is, water available for both surface runoff and infiltration - is presented in **Table 15**.

4.7.2 Groundwater Recharge Model

The groundwater recharge model uses three factors to partition the surplus water between groundwater recharge and overland runoff:

1. Slope;
2. Vegetative cover; and,
3. Permeability of the earth materials (surficial geology).

This model design is based on the concept that more water will infiltrate to groundwater under conditions of low grade slope, thick vegetation canopy and high permeability (loose) soils rather than when slopes are steep, vegetation cover is minimal and the soils are impermeable.

The three factors separating recharge and runoff were represented for the Preston Area using a GIS based analytical model. This model assumes that volumes of domestic and municipal groundwater taking for consumption and irrigation are negligible compared to flow through the system, and that groundwater and surface water inflow from outside the watershed is also negligible.

The first step of the groundwater recharge model is to define the slope factor using a GIS-derived digital elevation model (DEM). The raster DEM is transformed into polygons based on the slope factor. The smallest polygon unit is 100 m^2. The second step is to designate a vegetative cover value for each polygon created for the slope factor. The vegetative cover value is derived from data files obtained from the Nova Scotia Forest Inventory (NSDNR 2013). Values range from 0.07 to 0.2 with higher values representing more recharge and lower values representing less recharge.

The third step is to define the soil infiltration factor. Surficial geology mapping (**Figure 5**) was used to define the areas of differing soil infiltration factors. The values assigned to each surficial geology type (**Table 23**) are based on soil infiltration factors developed for Ontario surficial sediments. Higher values indicate more permeable, less compact soils.

Table 23: Soil Infiltration Factors

Surficial Geology Deposit	Ontario Soil Infiltration Factors	Nova Scotia Adjusted Soil Infiltration Factors
Alluvial	1.20	1.20
Anthropogenic	0.05	0.05
Bedrock	0.10	0.10
Drumlins	0.40	0.60
Glaciofluvial outwash	1.30	1.30
Hummocky till	0.60	0.40
Lacustrine	0.50	0.50
Lacustrine (lake)	0.75	0.75

Surficial Geology Deposit	Ontario Soil Infiltration Factors	Nova Scotia Adjusted Soil Infiltration Factors
Organic Deposits	0.60	0.60
Till blanket	0.40	0.35
Till veneer	0.10	0.15

The slope and vegetation GIS layers for each factor were added together and then multiplied by the soil infiltration factor to estimate an overall infiltration factor for each polygon. The infiltration factors for the polygons ranged from <0.05 in areas with exposed bedrock to >0.30 where mature forest cover and permeable soils dominate. To determine how much water infiltrates to groundwater compared with how much remains as surface runoff, the infiltration factors for each polygon were multiplied by the surplus water value (853 mm). Soil infiltration factors that were calibrated to the Sandy Lake watershed hydraulic budget were used for the Preston area (**Table 23**).

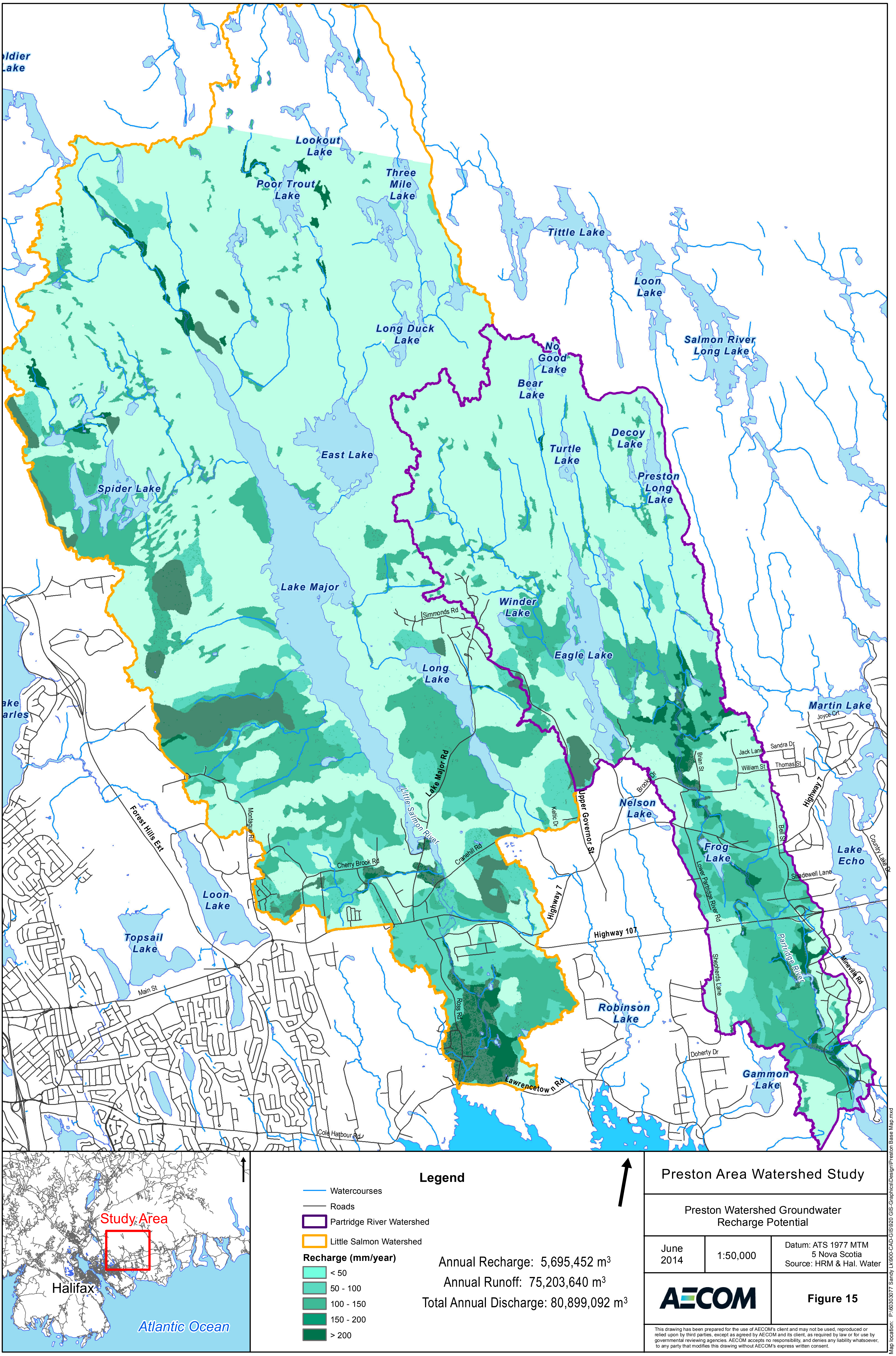
The total annual groundwater recharge estimated for the Little Salmon River is 3.86 x10^6 m^3/yr and surface runoff 51.65 x10^6 m^3/yr and the recharge for the Partridge River is estimated to be 1.83 x10^6 m^3/yr and surface runoff is estimated to be 23.55 x10^6 m^3/yr (**Table 24). I**n the combined watersheds the proportion of recharge to total flow predicted by the recharge model is 7%, that is, 7% of the surplus water within the watershed infiltrates into the soil while 93% remains as surface runoff. The groundwater recharge predicted using the adjusted soil infiltration factors is consistent with baseflows estimated for other watershed with thin soil/till cover (AECOM 2013).

Table 24: Watershed Flow Contributions

Watershed	Area (km^2)	Recharge x 10^6 (m^3/yr)	Runoff x 10^6 (m^3/yr)	Total Flow x 10^6 (m^3/yr)	Baseflow %
Little Salmon River	72.4	3.86	51.65	55.51	7.0
Partridge River	34.2	1.83	23.55	25.38	7.2

The results of the groundwater recharge model are represented as recharge in **Figure 15**. The purpose of this map is to highlight areas where there is greater infiltration and hence a greater estimated potential for groundwater recharge, which in turn correspond to more productive hydrostratigraphic units.

The map of groundwater recharge map indicates little groundwater recharge is generated in the northern portion of the watershed where the surficial geology is thin. Areas with elevated recharge potential are in wetlands west of Lake Major, at the locations of drumlins and alluvial deposits east of Eagle Lake and near the mouth of the Little Salmon River. Future development in the areas of high recharge should include design features that maintain groundwater recharge to maintain groundwater supply to well water users, streams, lakes and wetlands. The protection of these areas is a priority identified in Regional Plan Policy E-17.



Legend

- Watercourses
- Roads
- Partridge River Watershed
- Little Salmon Watershed

Recharge (mm/year)

- 🟩 < 50
- 🟩 50 - 100
- 🟩 100 - 150
- 🟩 150 - 200
- 🟩 > 200

Annual Recharge: 5,695,452 m^3
Annual Runoff: 75,203,640 m^3
Total Annual Discharge: 80,899,092 m^3

Preston Area Watershed Study

Preston Watershed Groundwater Recharge Potential

June 2014	1:50,000	Datum: ATS 1977 MTM 5 Nova Scotia Source: HRM & Hal. Water

AECOM

Figure 15

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Preston Base Map.mxd

5. Environmental Considerations for Future Development

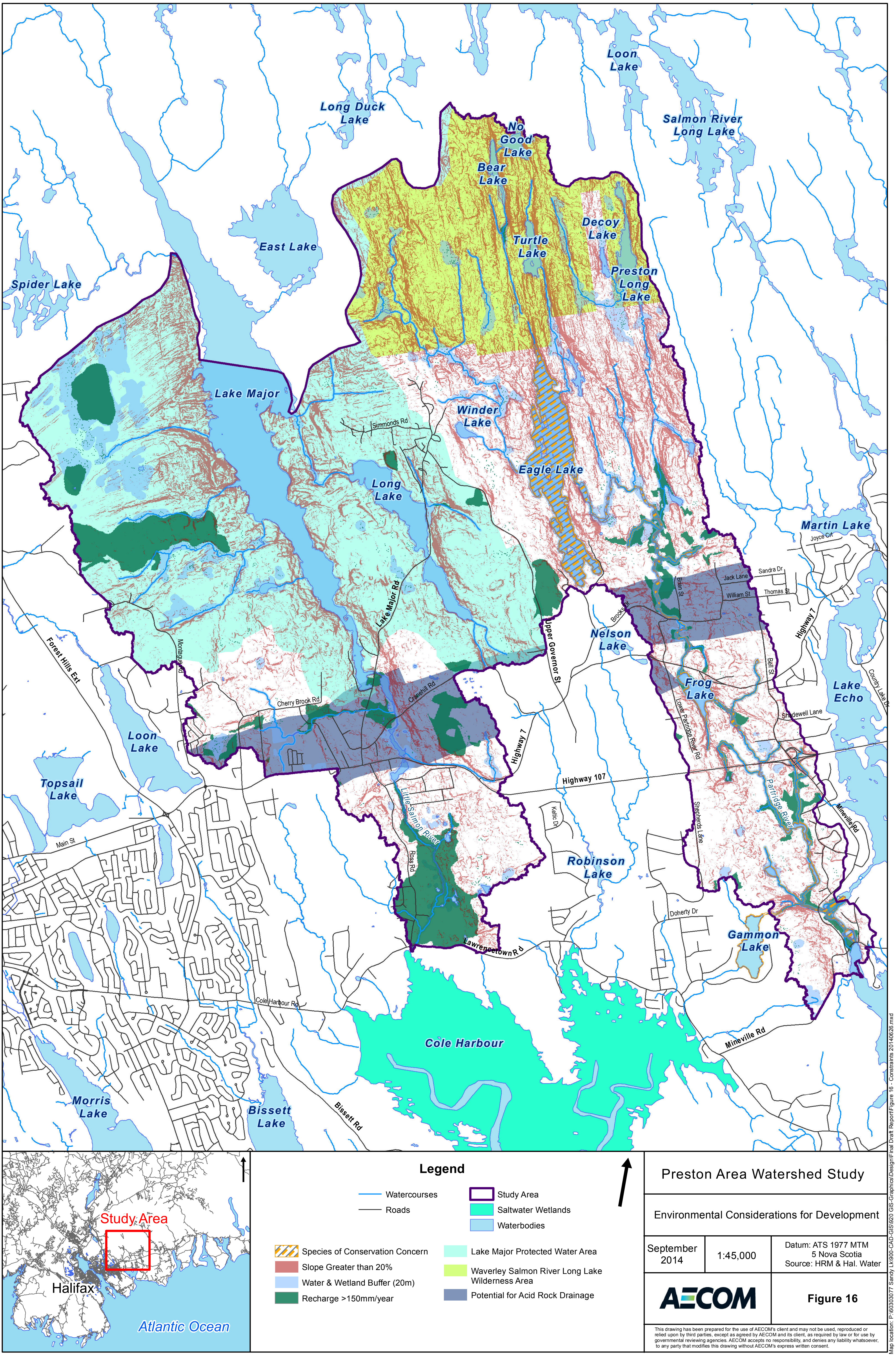
Development in the Preston Area will be guided by community visioning and secondary planning strategies. During these processes the community and HRM will define the style and scale of development for the various communities. To aid sustainable development in these communities, a map was prepared (**Figure 16**) identifying environmentally important or sensitive areas that may require constraints or conditions to development to minimize impacts on the environment.

The elements of the environmental considerations map include regulated areas such as protected watersheds and protected habitat, proximity to watercourses, protection of wetlands, slope, areas with high groundwater recharge and the presence of acid generating rock close to the surface.

The Preston Area has two protected areas in the northern portions of both the Little Salmon River watershed and the Partridge River watershed (**Figure 1**). The catchment area of Lake Major is designated as a Protected Water Area (PWA) that limits activities to protect the water supply to water to Dartmouth, Cole Harbour, Eastern Passage, Westphal, Cherry Brook, North Preston, and Montague Gold Mines. Activities such as swimming, fishing, forestry and other activities are restricted within the PWA. The Waverley Salmon River Long Lake Wilderness area is a protected wilderness area under the Wilderness Areas Protection Act. Development is limited in both protected areas and any proposed development would need to be guided by Provincial legislation.

Water courses, wetlands and species of concern on **Figure 16** indicate areas that should have buffers or setbacks to protect environmentally important habitats. We have assumed there will be an automatic 20 m setback for all development along watercourses, wetlands contiguous with watercourses, and lakes. This buffer should ideally be retained in a natural vegetation state to eliminate overland flow during storm events and to provide a buffer zone for nutrients, pesticides and other pollutants from developed areas both during and following construction. Wetlands provide important aquatic habitat and potentially retain nutrients and other pollutants rather than allowing them to reach watercourses. The Partridge River is identified in a generalized way to provide habitat for several species of concern (**Table 5**). Prior to large scale development near the Partridge River, specific areas of habitat for species of concern should be identified for protection.

Physical features including slope, geology and groundwater recharge may require special consideration in future development. Areas with slope greater than 20% are identified on **Figure 16**. Development in these areas may contribute large sediment loads to streams. Development in these areas may require sediment retention to prevent influxes sediments to water courses. Many water bodies in the HRM area are sensitive to acidification. The slates of the Halifax Group are especially prone to producing acid drainage when exposed to the air. These slates occur in a band trending roughly east to west across the Preston Area (**Figure 4**). Development in these areas may require measures to prevent acid rock drainage as specified by the Sulphide Bearing Minerals Act of Nova Scotia. The groundwater recharge model completed for the Preston Area used surficial geology, slope and vegetative cover to predict how precipitation is partitioned into groundwater recharge and surface runoff. Areas with high groundwater recharge (>150 mm/yr) provide pathways for water to enter the groundwater system. Protecting these areas with high recharge is important to the groundwater quantity of the watershed which is utilized by water source wells and contributes to the hydraulic budget of the lakes in the watershed. Protecting these areas also provides protection to groundwater quality in the watershed because they are potential pathways for contaminants to enter the groundwater system. Therefore, areas with recharge >150 mm/yr are included as an environmental consideration for future development in **Figure 16.**



Preston Area Watershed Study

Environmental Considerations for Development

September 2014

1:45,000

Datum: ATS 1977 MTM
5 Nova Scotia
Source: HRM & Hal. Water

Figure 16

Map location: P:\60303077 Sandy Lk\900-CAD-GIS\920 GIS-Graphics\Design\Final Draft Report\Figure 16 - Constraints 20140626.mxd

6. Policy E-17 Objectives

A complementary objective of the study is to provide a number of guidelines and recommendations for the planning, design and implementation of new developments that will protect water quality and quantity from further degradation. More specifically, the objectives of watershed study are listed in Policy E-17 of the Regional Plan. Each sub-heading of Policy E-17 listed below with a reference to where the item is addressed within the report, or if the sub-heading is not addressed directly in the report, it is addressed below.

a) Recommend measures to protect and manage quantity and quality of groundwater resources.

Sections 4.6 and 4.7 address groundwater quantity and Section 4.5 addresses groundwater quality. Areas with the potential for high groundwater recharge are identified on Figure 15 and Figure 16. These areas provide pathways for water to enter the groundwater system at higher rates than other areas in the watershed. Protection measures during future development are recommended to preserve the hydraulic properties of these areas. Recommendations to protect these areas include maintaining a high proportion of permeable surfaces, maintaining native plants, avoiding over-compaction of soils and use of rain gardens. Protecting the areas with high recharge rates to encourage sustainable groundwater use will need to be coupled with measures to protect the quality of water entering the groundwater system. Recommendations to protect the quality of recharge water include prohibition of bulk fuel storage, prohibition of hazardous material facilities, prohibition of aggregate extraction, spill prevention for home heating fuel tanks, limited lawn fertilizer use and reduced use of road salts in these areas of high recharge potential.

Section 4.5.3.2 on health related groundwater quality concerns identifies bacteria and arsenic as two groundwater issues with potential health impacts. Bacteria are predominantly an issue in dug wells completed in surficial aquifers. The water supply for dug wells can be protected on a lot-sized scale by maintaining a grass buffer zone around the well, disposing of wastes safely, keeping sources of E.coli away from the well and generally keeping the area around the well and up gradient of the well clean and free of materials that could host harmful bacteria. On-site treatment of bacteria is available through methods such as ultra-violet (UV) treatment systems.

Arsenic is naturally occurring in the bedrock and groundwater in Nova Scotia. Protection measures will not prevent or remove arsenic occurrences in groundwater. On-site treatment methods or alternative water supplies are the primary methods recommended to avoid the risk of health issues related to arsenic consumption. Effective methods of removing arsenic from drinking water supplies include reverse osmosis, adsorption, anion exchange and distillation. It is recommended that all residents in the Preston Area and the Groundwater Study Area that utilize groundwater as a supply of potable water have their water quality tested for arsenic and take appropriate measures to avoid consumption of water with arsenic concentrations above the CDWQ guideline (10 µg/L).

Areas that rely on groundwater for potable water supply may be vulnerable to increases in chloride concentrations where road salt is applied to roads in the winter as a de-icing agent. Dug wells are particularly sensitive to increases in chloride concentrations from road salt applications. It is recommended that de-icing agents other than salt be used in areas that rely on groundwater for potable water. Specifically, it is strongly recommended that road salt use be discontinued along Highway 7 in East Preston where many residences rely on dug wells for potable water.

b) Recommend water quality objectives for key receiving watercourses in the watershed.

Water quality objectives for lakes sampled in this study are recommended in Section 3.7 Water Quality Objectives for nitrate, ammonia, total suspended solids, chloride and *E. coli.* These were selected as key water quality indicators that will be impacted by urbanization. Several of the waterbodies do not have sufficient data to accurately characterize current water quality conditions. For instance, Eagle Lake and Frog Lake have three or fewer sample results to assess current water quality. The water quality objectives set out in this report are considered preliminary and should be reviewed and revised following further sampling.

c) Determine the amount of development and maximum inputs that receiving lakes and rivers can assimilate without exceeding the water quality objectives recommended for the lakes and rivers within the watershed.

The phosphorus assimilative capacity of lakes in the Preston Area is estimated by calculating the difference in the water quality objectives and the representative conditions (**Table 25**). The high water quality of Lake Major sets the water quality objective at the upper end of the oligotrophic category (10 µg/L). The representative water quality from Lake Major is 8 µg/L allowing for 2 µg/L of phosphorus the lake can receive while still remaining oligotrophic. Lake Major is a large water body with many inputs. Increasing the phosphorus concentration by 2 µg/L would represent large increases in phosphorus influx.

The phosphorus water quality objective for Long Lake is the upper end of the mesotrophic category (20 µg/L). The discharge from Long Lake to Lake Major has a median concentration of 17 µg/L, indicating the lake has 3 µg/L of assimilative capacity before entering the eutrophic category.

The phosphorus water quality objective for Eagle Lake is 20 µg/L. The median concentration of Eagle Lake (n=3) is 20 µg/L, indicating the lake is high in nutrients and is bordering mesotrophic to eutrophic conditions. Data from this study suggest Eagle Lake is at the upper limit of nutrients it can handle and has no assimilative capacity for phosphorus. However, the time range and number of samples used to characterized Eagle Lake water quality are limited. We recommend follow up sampling at Eagle Lake to verify lake water quality conditions and to monitor changes in water quality. Based on the limited sampling completed during this study we recommend no further development within 300 m of Eagle Lake and actions completed to reduce the nutrient load to Eagle Lake from Winder (Whynder) Lake (North Preston WWTP).

Table 25: Estimate of Assimilative Capacity of Lakes in the Preston Area

Lake	Water Quality	Representative Phosphorus Concentration	Assimilative Lake Capacity
Lake Major	< 10 µg/L	8 µg/L	2
Long Lake	< 20 µg/L	17 µg/L	3
Eagle Lake	< 20 µg/L	20 µg/L	0

d) Determine the parameters to be attained or retained to achieve marine water quality objectives

The Salmon River discharges to Cole Harbour and the Partridge River discharges to Lawrencetown Lake. These brackish systems host high biodiversity and biological productivity that are sensitive to changes in both water quality and water quantity. Nutrient inputs from freshwater discharges to salt marshes may affect species diversity and ecosystem function, while changes to the volume of discharge may affect the salinity of the estuary systems, adversely affecting organisms adapted to a particular salinity. Changes in water quality or quantity in the upstream freshwater rivers may negatively affect these downstream salt marshes.

Maintaining high water quality in the Little Salmon River and the Partridge River will protect the ecosystems of Cole Harbour and Lawrencetown Lake. The water quality objectives that are set for the lakes and watercourses of the Preston Area will provide high quality fresh water to the brackish ecosystems they discharge into.

e) Identify sources of contamination within the watershed

Several sources and potential sources of contamination are located in the Preston Area. Non-point sources of sources are distributed throughout the watersheds and point sources of contamination have discreet locations. Both types of contamination present risks and impacts to the water quality of the waterbodies in the Little Salmon River and Partridge River watersheds.

Non-point sources:

- Deforestation
  - Deforestation may impact water quality by increasing the organic content and sedimentation of runoff. Studies completed in the Pockwock watershed (NFA 2005) indicate the impact of deforestation on water quality is negligible when compared to the changes in phosphorus, chlorophyll-a, Secchi depth or pH from seasonal variations. However, best management practices for logging will limit the potential for impacts on water quality from deforestation.

- Stormwater runoff
  - Stormwater runoff directs overland flow from developed areas through rudimentary drainage systems to streams and lakes. Overland flow from developed areas represents a significant urban non-point source of pollution and contributes sediments, oil, anti-freeze, road salt, pesticides, nutrients and pet and waterfowl droppings to the receiving waterbodies. This urban runoff generally accelerates the eutrophication or natural aging process of urban lakes by adding sediment and nutrients. The added nutrients can contribute to algal blooms, decreased water clarity, and an increase in the amount of rooted aquatic plants growing in the shallow near-shore waters of a lake. All of these can reduce the recreational value of a lake by hindering swimming, boating, fishing and reducing its overall aesthetics.

- Bedrock
  - Acid rock drainage (ARD) is a naturally occurring process that results from the oxidation of sulphide minerals when the rock is exposed to oxygen. The breakdown of the sulphide minerals releases sulphuric acid, iron, and may also release arsenic, aluminum, cadmium, copper, manganese and zinc into the environment. The oxidation process and release of ARD is accelerated when bedrock is exposed to air by excavation or blasting. In HRM, several examples of ARD impacting water quality (Fox et al. 1997) are documented, resulting in low pH surface waters that were attributed to fish kills (Porter-Dillon 1985 as referenced in Fox et al. 1997). The Nova Scotia Environment Act limits the excavation and requires disposal of displaced rock with sulphide weight more than 0.4%. The Halifax Formation rocks in have higher proportions of sulphide bearing minerals and are more likely to produce ARD when exposed. Development, excavation or aggregate removal that disturbs bedrock in the band of acid generating rocks is likely to have significant ARD and development in that area should avoid exposing bedrock to air and in situations where this is unavoidable, mitigation measures should be put in place to prevent ARD entering surface water bodies.

- Road salt application
  - Road salts pose a risk to plants and animals in the aquatic environment. Road salt application can also impact groundwater quality, leading to elevated concentrations of chloride in drinking water. HRM recognizes the potential impacts to surface and groundwater quality and utilizes several best management practices to reduce the impacts when possible (HRM 2012). However, the application of road salts along Highways 7 and 107 contributes to chloride loading of surface water. Chloride concentrations above Guidelines for Canadian Drinking Water Quality were observed in summer sampling of a dug well near Highway 7 and in both sampling events in two drilled wells in Montague Gold Mines.

Point sources:

- Septic systems: Properly functioning septic systems allow the infiltration of clarified discharge to soils with the nutrients and bacteria incorporated into the soil. Septic systems less than 300 m to water bodies and malfunctioning septic systems likely contribute nutrients and bacteria to the water bodies in the Preston Area.

- Illegal garbage disposal occurs when garbage is dumped in ditches, forests, pits or ponds that are not designated for waste disposal. Contamination from illegal dumping depends on the quantity and type of materials disposed. The Preston area reportedly has several significant illegal dumping locations. One location identified by a resident is near the southern reach of Eagle Lake. It is reported that the area is used as a dumping location for private garbage removal services. While this is unconfirmed, dumping at this scale has the potential to contribute significant contaminants to Eagle Lake. Contaminants could include hydrocarbons, metals and controlled or hazardous substances.

- Wastewater treatment facility: The North Preston Wastewater Treatment Plant (WWTP) is located in the Partridge River watershed and discharges to Winder (Whynder) Lake. During periods of peak flow, the facility bypasses the treatment cycle and is discharged to engineered wetlands prior to discharge to Winder (Whynder) Lake. Wastewater discharge carries high nutrient loads, especially phosphorus and can significantly add to the natural and non-point loading of phosphorus to lakes resulting in their rapid eutrophication. The impact of the wastewater treatment bypasses is difficult to quantify for several reasons:
  - Bypasses typically occur during extreme weather events. The timing, frequency and severity of these events are not possible to predict and so the water quality impacts from system bypasses cannot be quantified or modeled.
  - Halifax Water monitors the volumes and locations of treatment bypasses but does not measure the concentration of effluent released to the environment during a bypass event. Given this, it is not possible to gauge the nutrient loading that may occur during these events.

- Residential oil tanks: Nova Scotia Environment considers a domestic oil spill to be a release of petroleum at a private residence such as an oil tank leak. A domestic fuel spill can impact soils, groundwater and potentially surface water. Hundreds of residential oil spills occur in Nova Scotia each year (NSE 2013). The risk of residential oil spills on the surface water of nearby waterbodies is low considering the small volumes of oil and the distance of most residences from water bodies.

- Landfills (current or historic): There are currently no active landfills in the Study Area. However, considering the watershed has been populated for a long period of time, there is potential for historic landfills or dumping areas that have been abandoned. Neglected historic landfills could leach metals and toxic chemicals into the waterbodies of the Preston Area.

- Fertilizers used on lawns and gardens are used to promote healthy lawns and gardens on residential and commercial properties. Excessive or improper application of fertilizers can lead to nutrient loading of surface water bodies.

- Auto Salvage Yard: an auto salvage yard is located on Ross Road and within 100 m of Salmon River. The auto salvage yard is a potential point source for hydrocarbon, anti-freeze, refrigerants, mercury, lead, acid and metal pollutants.

f) Identify remedial measures to improve fresh and marine water quality

There are several ways that water quality can be improved. These improvements generally fall into two categories: management practices and engineered solutions. Not all the improvements identified below are necessarily practical or viable: some may be cost prohibitive or lack a regulatory requirement or enforcement mechanism. Nevertheless, these remedial measures represent options that may be considered to improve water quality.

1. Undertake a survey of septic systems to better characterize their age, maintenance and functionality. Older systems (more than 15 years) can be subjected to a dye test to verify they continue to function as designed. Replace degraded septic systems or require alternatives (aerobic systems, holding tanks etc.) if the site is not capable of accommodating a conventional septic system under current design specifications. Encourage residents to have systems inspected and pumped on a regular basis. HRM can consider adopting a by-law that requires period inspection, testing and pumping of private septic systems, similar to that enacted in Chelsea, QC;

2. Retrofit or improve existing stormwater management systems through the introduction of sediment/water control basins, constructed wetlands, vegetated swales, flow-through filter strips, stormwater infiltration systems and disconnection of roof drains from stormwater systems;

3. Ban phosphorus-containing fertilizers and encourage proper and minimal use of other fertilizers and herbicides;

4. Encourage homeowners to plant naturalized riparian buffers or increase the width and density of existing buffers;

5. Encourage homeowners to pick up after pets;

6. Educate residents to use non phosphate soaps when washing vehicles or use a car wash;

7. Educate residents to refrain from disposing oil, antifreeze or other potentially harmful wastes into municipal drains and provide collection centers for these liquid wastes for safe disposal;

8. Encourage auto salvage companies to utilize best practices for hazardous material handling and storage, and to implement a site specific stormwater drainage plan that will limit the discharge of pollutants to surface water.

9. Require sediment management on construction projects including silt fencing to control runoff and washing of vehicles prior to departing the site to avoid mud and dirt being deposited on roadways for eventual runoff into storm sewers;

10. Report illegal dumping or unusual conditions in lakes and streams (high suspended sediments, oil sheens, algae blooms);

11. Strive to eliminate sewage system overflows through expansion of the system and upgrades as appropriate;

12. Maintain the water quality and water quantity monitoring program at a base level such as recommended to ensure compliance with water quality objectives and expand the database for future modeling enhancements; and,

13. Apply a no net change to flow, suspended sediment and phosphorus loads from new developments by requiring site specific evaluations and implementation and maintenance of storm water mitigation measures.

g) Recommend strategies to adapt HRM’s stormwater management guidelines to achieve the water quality objectives set out under the watershed study

HRM’s Stormwater Management Guidelines (Dillon Consulting Ltd. 2006) describes criteria for the design of stormwater management best management practices (BMPs) to minimize the negative water quality effects of stormwater runoff from urban development. In this report, the term “best management practice” applies to both in-ground infrastructure (pipes, retention basins, etc.) as wells as activities, such as street cleaning and land use restrictions, that may impact water quality. As the report notes:

> There is no single BMP that suits every development, and a single BMP cannot satisfy all stormwater control objectives. Therefore, cost-effective combinations of BMPs may be required that will achieve the objectives.

At this time, stormwater control infrastructure requires provincial approval from Nova Scotia Environment under the Environment Act and in accordance with the Storm Drainage Works Approval Policy. HRM’s authority with respect to stormwater management comes from the HRM Charter Act, which allows HRM to make and enforce municipal by-laws related to land use. Existing municipal planning strategies already include certain land use restrictions that have beneficial effects on water quality. These restrictions include, for example, prohibiting or limiting construction within flood plains, wetlands and steep slopes. In addition, municipal planning strategies also include stormwater management provisions, such as the requirement to obtain municipal approval of stormwater management plans, water quality monitoring plans and erosion and remediation control plans prior to development approval.

HRM by-laws and policies that address stormwater include the Halifax Water Regulations and Guidelines for Stormwater Management, which describe the design requirements for stormwater infrastructure, the Halifax Water Rules and Regulations, and Design and Construction Guidelines that regulate the quality of discharges into HRM sewers. However, these mechanisms are limited in the extent to which they can protect water quality (Dillon Consulting Ltd. 2006). The Rules and Regulations specify single point source water quality limits, but there is no direction for how to achieve the limits. The most effective way of adapting HRM’s Stormwater Management Guidelines to achieve the water quality objectives outlined in the current report is to implement a stormwater and erosion control by-law. Such a by-law would have statutory authority under the Environment Act and would permit direct enforcement of its provisions by municipal regulators. An example by-law is present in Dillon Consulting Ltd (2006).

Other strategies that may be useful in adapting HRM’s stormwater management guidelines to achieve the water quality objectives include:

- Implementation of financial resources or financial mechanisms (including cost sharing) to fund infrastructure, testing, operating and maintenance;
- Exploration of new stormwater management and treatment technology;
- Educational programs to encourage homeowners to reduce sediment and other pollutant discharge (fertilizers, grass cuttings) to storm sewers; and,
- Apply a no net change to flow, suspended sediment and phosphorus loads from new developments by requiring site specific evaluations and implementation and maintenance of storm water mitigation measures.

h) Recommend methods to reduce and mitigate loss of permeable surfaces, native plants and native soils, groundwater recharge areas, and other important environmental functions within the watershed and create methods to reduce cut and fill and overall grading of development sites;

The protection of areas and functions that are important to a healthy watershed can be achieved through the implementation of general planning principles and through the integration of site specific design plans.
The replacement of permeable soils by roads, sidewalks and roofs can be reduced during the planning process and through specific design features. An effective planning method is to cluster buildings and infrastructure in defined, less permeable or otherwise less sensitive areas in order to maximize permeable vegetated open space. Stormwater management best management practices and design standards aimed at promoting infiltration rather than runoff can be required during the site plan approval process. These measures are described in detail in HRM's Stormwater Management Guidelines and would include, for example, discharge of roof drainage to infiltration trenches or ponds, the use of vegetated swales and perforated conveyance pipes, and the installation of wet ponds and artificial wetlands. Design of properties and landscape provides opportunities to improve infiltration and partially offset the loss of permeable surfaces. Lawns and driveways can be designed to promote infiltration and water from roof drains can be collected in rain barrels, discharged to rain gardens or retained with roof top gardens. Disconnecting foundation drainage from storm sewer reduces the flow to the stormwater system and increases infiltration. Landscaping effects water drainage and when used effectively can be designed to encourage infiltration and reduce runoff.

Reducing the loss of native plants and soils is an effective way of reducing sediment and water runoff to stormwater systems. The design of new developments requires the removal and displacement of some native soils and plants, but the extent of the displacement can be mitigated through planning and local design.

Development may inadvertently disturb or destroy vegetation communities such as wetlands, riparian buffers and vegetation found in indistinct flow conveyance channels that play a significant role in maintaining water quality. Developers should be requested to provide detailed "wet areas mapping" of properties proposed for development so these vegetation communities can be accurately delineated and their hydrological functions maintained.

Groundwater recharge in the Preston Area is presented in **Figure 15**. The areas of highest recharge are located on drumlins and in the discharge area of the Little Salmon River. These areas contribute to local groundwater and to the watercourses. Development in the areas of high recharge should include specific plans to reduce impermeable surfaces. In addition, development in the areas of high recharge should include aquifer protection measures similar to wellhead protection areas. Recommended land use restrictions include prohibition of bulk fuel storage, prohibition of hazardous material facilities, prohibition of aggregate extraction, spill prevention for home heating fuel tanks, limited lawn fertilizer use and reduced use of road salts.

i) Identify and recommend measures to protect and manage natural corridors and critical habitats for terrestrial and aquatic species, including species at risk

As noted in Section 2.5 (Fish and Wildlife) the Atlantic Canada Conservation Data Centre records 19 bird species that are identified to be of conservation concern within the Preston Area watershed identified in the Eagle Lake area. Eagle Lake has few residences surrounding it, and much of the area upstream of Eagle Lake is undeveloped providing relatively undisturbed habitat for nesting and feeding grounds for birds. Protecting the aquatic health of Eagle Lake will in turn protect the habitat of the birds of conservation concern.

Two sources of pollutants discussed in Section e) are directly applicable to Eagle Lake: illegal dumping of garbage and the Winder (Whynder) Lake WWTF. Actions that would protect Eagle Lake include measures to deter illegal dumping of garbage such as increased monitoring or response rate to complaints of illegal dumping and management of the Winder (Whynder) Lake WWTF to prevent system overflows.

Maintaining the protected areas in the northern portion of the watersheds and north of the watersheds will provide areas for critical habitat of terrestrial and aquatic species.

j) Identify appropriate riparian buffers for the watershed

Under Watercourse Setbacks and Buffers The Halifax Mainland Land Use By-Law" [14QA(1)] states:

> "No development permit shall be issued for any development within 20 m of the ordinary high water mark of any watercourse. Where the average positive slopes within the 20 m buffer are greater than 20%, the buffer shall be increased by 1 m for each additional 2% of the slope, to a maximum of 60 m."

A 20 m buffer along all water courses is reported to eliminate more than 70% of suspended sediment and more than 60% of phosphorus (Hydrologic Systems Research Group 2012). The maintenance of a minimum 20 m wide riparian buffer is appropriate for all watercourses within the watershed.

k) Identify areas that are suitable and not suitable for development within the watershed

Section 5, Environmental Considerations for Future Development identifies areas that are suitable and unsuitable for development. Unsuitable areas include:

- Watercourses;
- Wetlands including Wetlands of Special Significance;
- Watercourse riparian buffers; and
- Protected areas.

Areas that are suitable for development, but may require methods to prevent environmental impacts include:

- Areas with high groundwater recharge;
- Areas with slope greater than 20%; and
- Areas underlain by rocks with acid generating potential (sulphide bearing rocks).

If land is not constrained, then it is potentially suitable for development. The total area that can or should be developed and the nature of the development both need to be carefully planned so that established water quality objectives will be maintained following development.

l) Recommend potential regulatory controls and management strategies to achieve the desired objectives

Regulatory controls and programs already in place that contribute to the maintenance of water quality include:

- Halifax Water Regulations and Guidelines for Stormwater Management;
- Lake Major Watershed Protected Water Area Designation and Regulations;
- Halifax Charter;
- Halifax Regional Water Commission Act;
- Nova Scotia Wetland Conservation Policy;
- North Preston/Lake Major Municipal Planning Strategy and Land Use Bylaw

- Regional Municipal Planning Strategy Water Supply Policy
- Design and Construction Specifications (Municipal Water & Wastewater Systems, 2012);
- HRM Municipal Design Guidelines 2013;
- 2009 Stormwater Inflow Reduction program; and,
- Source Control / P2 (Pollution Prevention Division).
- **Other programs (Wastewater/Stormwater Collection Division)**
  - Cleaning, inspection, repair and maintenance of sewers and pumping stations;
  - Asset Management Assessment;
  - Regional Wastewater Functional Plan; and,
  - Integrated Resource Plans.

As noted earlier in this section, a stormwater management by-law would be helpful to manage and enforce stormwater related nutrient and sediment inputs to watercourses. In addition to such a by-law, the following additional controls and strategies are recommended for consideration:

1. Adopt the proposed water quality objectives;

2. Preserve natural storage, infiltration and filtration functions; develop SWM systems that reproduce or mimic natural functions;

3. Revisit land use planning restrictions that provide for stormwater management (such as restricting development in flood zones, in sensitive areas, on slopes, in wetlands, etc.) and compare them with similar policies in other jurisdictions to determine if these policies should be updated or upgraded to improve their effectiveness;

4. Require developers to demonstrate no net increase of sediment and TP loadings to adjacent water features;

5. Require developers to financially support a water quality monitoring program to assess compliance with the water quality objectives;

6. Enforcement of stormwater management for quality and quantity as per the HRM Stormwater Management Guidelines;

7. Elimination of sanitary sewer overflows within the watershed;

8. Elimination of Waste Water Treatment Plant by-passes; and,

9. Inspection and testing of septic systems in the watershed; phased replacement if they are not functioning due to high water table, poor design, inadequate maintenance, close to surface water. Consideration of alternative treatment systems to replace existing septic systems.

Canadian Auto Recyclers' Environmental Code provides a set of methods to decrease the impact of auto salvage yards on the environment. Practices include the containment and proper disposal of hazardous materials and ensure proper handling of materials to prevent large spills.

m) Recommend a monitoring plan to assess if the specific water quality objectives for the watershed are being met

A surface water quality monitoring plan is recommended for the lakes in the Preston Area and follow-up monitoring is also recommended for lakes added late in the study that are outside the Study area (Nelson Lake, Gammon Lake and Robinson Lake).

Two lakes in the Salmon River watershed, Lake Major and Long Lake, are recommended for long term monitoring to assess trends in water quality. These two water bodies are recommended to be sampled three times per year in each of the spring, summer and fall. Sample locations should be selected to provide a representative sample of the entire water body. Parameters for sampling should include pH, nitrogen compounds, total phosphorus, chloride, E.coli and total suspended solids. Long term monitoring of these water bodies will provide insight on changes in water quality and will be used to identify patterns in water quality. In the Partridge River watershed, Winder (Whynder) Lake, Eagle Lake and Frog Lake are recommended for long term monitoring. Results from this study indicate Eagle Lake and Frog Lake have high nutrient loads and are at risk of eutrophication. However, these conclusions are based on limited sampling. Therefore we recommend a monitoring plan be implemented with water quality sampling every month for one year, followed by seasonal sampling three times per year in each of the spring, summer and fall. The water quality of Winder (Whynder) Lake is controlled by the inputs from the North Preston WWTP. We recommend water quality monitoring of Winder (Whynder) Lake three times per year in each of the spring, summer and fall to assess nutrient loads to Winder (Whynder) Lake. Sample locations should be selected to provide a representative sample of the entire water body. Parameters for sampling should include pH, nitrogen compounds, total phosphorus, chloride, E.coli and total suspended solids.

Nelson Lake, Robinson Lake and Gammon Lake are not in the Preston Area, but were sampled twice to provide a preliminary indication of water quality. Each of these lakes appears to be experiencing nutrient loading presumed to be related to urban development. It is recommended that further sampling of these lakes be completed to assess the current water quality conditions and to identify patterns in water quality. Sample locations should be selected to provide a representative sample of the entire water body. Parameters for sampling should include pH, nitrogen compounds, total phosphorus, chloride, E.coli and total suspended solids.

7. References

AECOM. 2013. Birch Cove Lakes Watershed Study – Final report. April 1, 2013. Project 60221657. 419 pp

Alexander, D.R., Kerekes, J. J. and B.C. Sabean. 1986. Description of Selected Lake Characteristics and Occurrence of Fish Species in 781 Nova Scotia Lakes, PROC. N.S. INST. SCI (1986) Volume 36: Part 2, pp. 63-106.

Bottomley D.J. 1984. Origins of some arseniferous groundwaters in Nova Scotia and New Brunswick, Canada. Journal of Hydrology; 69, 223-257.

Caissie D., Robichaud S. 2009. Towards a better understanding of the natural flow regimes and streamflow characteristics of rivers of the Maritime Provinces. Canadian Technical Report of Fisheries and Aquatic Sciences 2843. Fisheries and Oceans Canada.

CBCL 2013. Porters Lake Watershed Servicing Study – Final Report. Prepared for Halifax Regional Municipality.

CB Wetlands and Environmental Specialists Inc. 2011. Post-restoration monitoring (Year 3) of the Lawrencetown Lake Salt Marsh Restoration Project. Prepared for Nova Scotia Department of Transportation and Infrastructure Renewal.

CBCL Limited 2004. Atlantic Canada guidelines for the supply, treatment, storage, distribution and operation of drinking water supply systems. Prepared by CBCL Limited for the Atlantic Canada Water Works Association (ACWWA) in association with the four Atlantic Canada provinces.

CCME - Canadian Council of Ministers of the Environment 2004. Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems Report No. 1-8. Prepared and published by National Guidelines and Standards Office Water Policy and Co-ordination Directorate, Environment Canada, Ottawa. Cat. No. En1-34/8-2004E-PDF.

Clair T.A., Dennis I.F., Scruton D.A., Gilliss M. 2007. Freshwater acidification research in Atlantic Canada: a review of results and predictions for the future. Environmental Review; 15: 153-167.

Clean Nova Scotia. 2013. Completed Stream Restoration Projects. 2013 Project. Accessed October 2013 from: http://clean.ns.ca/programs/water/stream-restoration/completed-projects/

Chappells H., Campbell N., Drage J., Fernandez C.V., Parker L., Dummer T.J.B. 2014. Understanding the translation of scientific knowledge about arsenic risk exposure among private well users in Nova Scotia. Science of the Total Environment. *In press*.

Coldwater Consulting Ltd. 2011. Cole Harbour / Salt Marsh Trail Hydrodynamic modelling and coastal engineering technical report. Prepared for Halifax Regional Municipality.

Cross H.J. 1980. Report on Test Drilling Program, Upper Lawrencetown, Halifax County. Nova Scotia Department of the Environment Water Planning and Management Division.

Dillon Consulting 2006. Stormwater Management Guidelines. Prepared for Halifax Regional Municipality.

Dodds W.K., J.R. Jones, E.B Welch. 1998. Suggested classification of stream trophic state: Distributions of temperate stream types by chlorophyll, total nitrogen, and phosphorus. Water Res. 32:1455-1462.

Dummer T.J.B, Yu Z.M., Nauta L., Murimboh J.D., Parker L.. 2014. Geostatistical modeling of arsenic in drinking water and related toenail arsenic concentrations across Nova Scotia, Canada. *In press*.

Environment Canada. 2013. Canadian Climate Normals. 1981-2010 Climate Normals and Averages. Microsoft Access Database.

Exley C. Chappell J.S., Birchall J.D. 1991. A mechanism for acute aluminum toxicity in fish. Journal of Theoretical Biology; 151, 3: 417-428.

Fisheries and Oceans Canada (FOC) 2013. Risk-based assessment of climate change impacts and risks on the biological systems and infrastructure within Fisheries and Oceans Canada's mandate – Atlantic Large Aquatic Basin. Canadian Science Advisory Secretariat Science Response 2012/044.

Farvolden R.N. 1959. Groundwater supply in Alberta. Alberta Research Council.

Fox, D., Robinson, C. and M. Zentilli (1997) Pyrrhotite and associated sulphices and their relationship to acid rock drainage in the Halifax Formation, Meguma Group, Nova Scotia. Atl. Geol. 33, 87-103.

Fracflow Consultants Inc. (Fracflow) 2004. Screening Level Assessment of the Groundwater Resource Potential of Bedrock in HRM: a Component of HRM's Wastewater Management Options Study. Submitted to Land Design Engineering Services.

Government of Nova Scotia (GNS) 2011. Nova Scotia Wetland Conservation Policy. September 2011. Available online: http://www.gov.ns.ca/nse/wetland/docs/Nova.Scotia.Wetland.Conservation.Policy.pdf

Government of Nova Scotia (GNS). 2013a. Lakes Inventory Maps. Website: http://novascotia.ca/fish/programs-and-services/industry-support-services/inland-fisheries/lake-inventory-maps/ updated July 2013.

GNS: Government of Nova Scotia (GNS). 2013b Game Sanctuaries and Wildlife Management Areas. Webstie: http://novascotia.ca/natr/wildlife/habitats/sanctuaries/existing.asp Updated: Oct 2013

Halifax Regional Municipality Planning Services (HRM). 1993. Municipal Planning Strategy for North Preston, Lake Major, Lake Loon, Cherry Brook and East Preston. http://www.halifax.ca/planning/NorthPrestonLakeMajorLakeLoonCherryBrookEastPreston.php

Health Canada 2010. Guidelines for Canadian Drinking Water Quality – Summary Table. Federal-Provincial-Territorial Committee on Drinking Water of the Federal-Provincial-Territorial Committee on Health and the Environment.

Hodgkins G.A., Dudley R.W., Huntington T.G. 2003. Changes in the timing of high river flows in New England over the 20th Century. Journal of Hydrology; 278: 244-252.

Horne R.J., Pelley D. 2007. Geological Transect of the Meguma Terrane from Centre Musquodoboit to Tangier. in Mineral Resources Branch Report of Activities 2006; Nova Scotia Department of Natural Resources, Report ME 2007-1.

Jones, J. A., Achterman, G. L., Augustine, L. A., Creed, I. F., Folliot, P. F., MacDonald, L., & Wemple, B. C. 2009. Hydrologic effects of a changing forested landscape – challenges for the hydrological sciences. *Hydrological Processes, 23*, 2699-2704.

Kennedy G.W. 2012. Development of a GIS-based approach for the assessment of relative seawater intrusion vulnerability in Nova Scotia, Canada. IAH conference 2012. http://www.xcdtech.com/iah2012/iah/2012/papers/Paper661.pdf

Kennedy G.W., Finlayson-Bourque D.S. 2011. Groundwater chemistry from bedrock aquifers in Nova Scotia (open file map ME 2011-031). Nova Scotia Department of Natural Resources.

Kharin V.V., Zwiers F.W., Zhang X., Hegerl G.C. 2007. Changes in Temperature and Precipitation Extremes in the IPCC Ensemble of Global Coupled Model Simulations. Journal of Climate; 20.

McCurdy R.F. 1980. Groundwater variations in Arsenic (III) and Arsenic (V). Ph.D. Thesis. Technical University of Nova Scotia Department of Civil Engineering.

Meranger J.C., Subramanian K.S., McCurdy R.F. Arsenic in Nova Scotian groundwater. Science of the Total Environment. Volume 39; 49-55.

Neily, P.D., Quigley E., Benjamin, L., Stewart, B., Duke T. 2003. Ecological Land Classification for Nova Scotia Volume 1 - Mapping Nova Scotia's Terrestrial Ecosystems Nova Scotia Department of Natural Resources Renewable Resources Branch April 2003 Report DNR 2003 -2

Nova Scotia Environment (NSE) 2011. Guide to Groundwater assessments for subdivisions serviced by private wells. July 2011.

Nova Forest Alliance. 2005. Watershed Study Understanding the Impacts of Forest Practices on Water. Technical Bulletin.

NSDNR Nova Scotia Department of Natural Resources 2004a. Wetland Inventory. Updated May 3, 2011. Available online at: http://gis4.natr.gov.ns.ca/website/nssighabnew/viewer.htm.

NSDNR - Nova Scotia Department of Natural Resources 2004b. Significant Species and Habitats Database. Updated April 11, 2012. Available online at: http://gis4.natr.gov.ns.ca/website/nssighabnew/viewer.htm.

NSDNR Nova Scotia Department of Natural Resources. 2007. Ecological Land Classification Map Ecodistricts of Nova Scotia Map DNR 2007-2 1:500,000.

NSDNR Nova Scotia Department of Natural Resources 2013a. The Waverly Salmon River Long Lake Wilderness Area. Website: https://www.novascotia.ca/nse/protectedareas/wa_waverly.asp

NSDNR Nova Scotia Department of Natural Resources 2013b. Groundwater Maps and Databases, On-line Viewer. Nova Scotia Department of Natural Resources. Website http://gis4.natr.gov.ns.ca/website/nsgroundwater

NSE Nova Scotia Environment 1998. The state of the Nova Scotia environment 1998.

NSE Nova Scotia Environment 2005. Arsenic Risk Map – Test your well for Naturally Occurring Arsenic. http://www.novascotia.ca/nse/water/contaminants.asp

NSE Nova Scotia Environment 2011. Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells.

NSE Nova Scotia Environment 2013. Nova Scotia Well Logs Database, Microsoft Access Format (2013). http://www.gov.ns.ca/nse/groundwater/welldatabase.asp.

Pancura, M. and G.S. Lines 2005. Variability and Extremes in Statistically Downscaled Climate Change Projections at Greenwood, Nova Scotia. Meteorological Service of Canada, Atlantic Region Science Report Series 2005-10.

Porter H.J. and Associates Limited. 1979. Geochemical, Water Supply and Sewage. Section 3.0 as referenced in *HRM North Preston, Lake Major, Lake Loon, Cherry Brook, East Preston Municipal Planning Strategy*.

Porter Dillon Limited. 1985. Environmental study of the Salmon River watershed in the vicinity of the Halifax International Airport, Nova Scotia. Prepared for Transport Canada.

Richards W.,Daigle R. 2011. Scenarios and Guidance for Adaptation to Climate Change and Sea-Level Rise – NS and PEI Municipalities. Prepared for Nova Scotia Department of Environment. Pg15

Thornthwaite C.W., Mather J.R. (1957). Instructions and tables for computing potential evapotranspiration and the water balance: Centerton, NJ., Laboratory of Climatology, Publications in Climatology, v.8 1-104.

Utting, D.J. 2011. Digital Geological Data Generated as Part of the Surficial Mapping Project of the Halifax Metropolitain and Surrounding Areas, Halifax, and Hants Counties, Nova Scotia. DP ME 447, Version 1, 2011.

Watt W.D. Scott D., Ray S. 1979. Acidification and other chemical changes in Halifax County Lakes after 21 years. Limnology and Oceanography; 24.

Webb, K.T. and L.B. Marshall 1999. Ecoregions and Ecodistricts of Nova Scotia. Agriculture and Agi-Foods Canada, Environment Canada 47 p.

White, C.E., Bell, J.A., McLeish, D.F., MacDonald, M.A., Goodwin, T.A., MacNeil, J.D. (2008) Geology of the Halifax Regional Municipality, Central Nova Scotia. In Mineral Resources Branch, Report of Activities 2007, Nova Scotia Department of Natural Resources, Report ME 2008-1.

White, C.E., Goodwin, T.A. 2011. Lithogeochemistry, petrology and the acid-generating potential of the Goldenville and Halifax groups and associated granitoid rocks in metropolitan Halifax Regional Municipality, Nova Scotia, Canada. Atlantic Geology; 47, 158-184.

White C.E., Barr S.M. 2012. Meguma Terrane Revisited: Stratigraphy, Metamorphism, Paleontology and Provenance. Journal of the Geological Association of Canada. Vol 39.

8. Glossary

Alluvial	Soil or earth material which has been deposited by running water, as in a riverbed, floodplain, or delta.
Anoxic	(1) Denotes the absence of oxygen, as in a body of water. (2) Of, relating to, or affected with anoxia; greatly deficient in oxygen.
Anthropogenic	Referring to changes or activities that are man-made, rather than those resulting from natural processes.
Aquifer	A geologic formation, a group of formations, or a part of a formation that is water bearing. A geological formation or structure that stores or transmits water, such as to wells and springs.
Aquitard	A saturated, but poorly permeable bed that impedes groundwater movement and does not yield water freely to wells, but which may transmit appreciable water to or from adjacent aquifers and, where sufficiently thick, may constitute an important groundwater storage unit.
Baseflow	Runoff that has passed into the ground, has become groundwater, and has been discharged into a stream channel as spring or seepage water.
Batholith	A mass of intrusive, crystalline igneous rock, often composed of granite and related rock types.
Bathymetry	(1) The measurement of the depth of water bodies. (2) The measurement of seafloor or lake bottom topography.
Bedrock	Solid rock that lies beneath soil or loose sediments.
Bog	A wet, overwhelmingly vegetative substratum which lacks drainage and where humic and other acids give rise to modifications of plant structure and function.
Watershed	All lands enclosed by a continuous hydrologic drainage divide and lying upslope from a specified point on a stream.
Chloride	Negative chlorine ions, Cl-, found naturally in some surface waters and groundwater and in high concentrations in seawater. The use of highway de-icing salts introduces chlorides to surface water or groundwater. Elevated groundwater chlorides in drinking water wells near coastlines may indicate saltwater intrusion.
Chlorophyll	(1) The green pigments of plants. *Chlorophyll α* and *Chlorophyll b* are the most common forms. A green photosynthetic coloring matter of plants found in plant chloroplasts. (2) Major light gathering pigment of all photosynthetic organisms and is essential for the process of photosynthesis. The amount present in lake water depends on the amount of algae and is therefore used as a common indicator of water quality.

Dissolved Oxygen	The amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid. Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms and the prevention of offensive odours. The ideal dissolved oxygen level for fish is between 7 and 9 milligrams per litre (mg/L); most fish cannot survive at levels below 3 mg/L of dissolved oxygen.
Drumlin	An elongated hill or ridge of glacial drift.
Ecoregion	A recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterize that region.
Epilimnetic	Relation to an eplimnion. An eplimnion is the warm upper layer of a body of water with thermal stratification, which extends down from the surface to the thermocline, which forms the boundary between the warmer upper layers of the epilimnion and the colder waters of the lower depths, or hypolimnion. The epilimnion is less dense than the lower waters and is wind-circulated and essentially homothermous.
Eutrophication	The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates. These typically promote excessive growth of algae. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish. Eutrophication is a natural, slow-aging process for a water body, but human activity greatly speeds up the process.
Fen	Low land covered wholly or partly with water. A type of wetland that accumulates peat deposits. Fens are less acidic than bogs, deriving most of their water from groundwater rich in calcium and magnesium.
Fluvial	Of or pertaining to rivers and streams; growing or living in streams ponds; produced the action of a river or stream.
Glaciation	Alteration of the earth’s solid surface through erosion and deposition by glacier ice.
Hydraulics	(1) The study of liquids, particularly water, under all conditions of rest and motion. (2) The branch of physics having to do with the mechanical properties of water and other liquids in motion.
Hydrology	The science of waters of the earth, their occurrence, distribution, and circulation; their physical and chemical properties; and their reaction with the environment, including living beings.
Hypolimnion	The lowermost, non-circulating layer of cold water in a thermally stratified lake or reservoir that lies below the thermocline, remains perpetually cold and is usually deficient of oxygen. Also see Thermal Stratification.
Impervious Surface	A surface that prevents or severely limits the infiltration of surface precipitation from rainwater and snowmelt to the soil below. Typical impervious surfaces include roads, driveways, sidewalks, and buildings.
Lacustrine	Pertaining to, produced by, or inhabiting a lake.

LiDAR	An acronym for Light Detection And Ranging. A system for measuring ground surface elevation from an airplane.
Marsh	An area of soft, wet, low-lying land, characterized by grassy vegetation that does not accumulate appreciable peat deposits and often forming a transition zone between water and land. A tract of wet or periodically inundated treeless land, usually characterized by grasses, cattails, or other monocotyledons (sedges, lilies, irises, orchids, palms, etc.). Marshes may be either fresh or saltwater, tidal or non-tidal.
Mesotrophic	A lake or other body of water characterized by moderate nutrient concentrations such as nitrogen and phosphorus and resulting significant productivity. Slightly or moderately eutrophic water can be healthful and support a complex web of plant and animal life.
Morphometry	The shape and structure of the lake basin
Non-Point Source of Pollution	Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land use activities, which are carried to lakes and streams by surface runoff. Non-point source pollution is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants such as nutrients and pesticides. Originating from numerous small sources, non-point source pollution is widespread, dispersed, and hard to pinpoint.
Oligotrophic	Pertaining to a lake or other body of water characterized by extremely low nutrient concentrations such as nitrogen and phosphorus and resulting in low biological productivity. Such lakes are often deep, with sandy bottoms and very limited plant growth, but with high dissolved-oxygen levels.
Phosphorus	An element that is essential to plant life but contributes to an increased trophic level (eutrophication) of water bodies.
Point Source Pollution	Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.
Quartzite	A hard metamorphic rock made up of interlocking quartz grains that have been cemented by silica. Quartzite was originally deposited as sand, later converted to sandstone by heat and pressure, and subsequently further metamorphosed through additional heat and pressure to quartzite.
Surficial Geology	The loose deposits of soil, sand, gravel and other material deposited on top of the bedrock
Recharge	Introduction of surface or groundwater to groundwater storage such as an aquifer.
Riparian	Pertaining to the banks of a river, stream, waterway, or other, typically, flowing body of water as well as to plant and animal communities along such bodies of water.
Runoff	(1)That part of the precipitation, snow melt, or irrigation water that appears in uncontrolled surface streams, rivers, drains or sewers. (2) The total discharge described above, during a specified period of time.

Stormwater Runoff	The water and associated material draining into streams, lakes, or sewers as the result of a storm.
Swamp	Wet, spongy land; low saturated ground, and ground that is covered intermittently with standing water, sometimes inundated and characteristically dominated by trees or shrubs, but without appreciable peat deposits. Swamps may be fresh or salt water and tidal or non-tidal.
Till	The mixture of rocks, boulders, and soil picked up by a moving glacier and carried along the path of the ice advance. The glacier deposits this till along its path on the sides of the ice sheet, at the toe of the glacier when it recedes, and across valley floors when the ice sheet melts.
Thermal Stratification	The vertical temperature stratification of a lake which consists of: (a) the upper layer, or epilimnion, in which the water temperature is virtually uniform; b) the middle layer, or thermocline, in which there is a marked drop in temperature with depth; and (c) the lowest stratum, or hypolimnion, in which the temperature is again nearly uniform.
Thermocline	(1) The region in a thermally stratified body of water which separates warmer oxygen-rich surface water from cold oxygen-poor deep water and in which temperature decreases rapidly with depth. (2) A layer in a large body of water, such as a lake, that sharply separates regions differing in temperature, so that the temperature gradient across the layer is abrupt. (3) The intermediate summer or transition zone in lakes between the overlying epilimnion and the underlying hypolimnion, defined as that middle region of a thermally stratified lake or reservoir in which there is a rapid decrease in temperature with water depth. Typically, the temperature decrease reaches 1°C or more for each metre of descent.
Total Kjeldahl Nitrogen	Total concentration of nitrogen in a sample present as ammonia or bound in organic compounds.
Total Phosphorus	The sum of reactive, condensed and organic phosphorus.
Total Suspended Solids	Solids, found in wastewater or in a stream, which can be removed by filtration. The origin of suspended matter may be man-made wastes or natural sources such as silt.
Trophic State	A measurement of the biological productivity of a water feature.
Turbidity	Water containing suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. The turbidity may be caused by clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton and other microscopic organisms and similar substances.
Uplands	(1) The ground above a floodplain; that zone sufficiently above and/or away from transported waters as to be dependent upon local precipitation for its water supplies. (2) Land which is neither a wetland nor covered with water.
Water Budget	A method for measuring the amount of water entering, being stored and leaving a watershed.
Wetland	Areas where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment. The single feature that all wetlands have in common is a soil or substrate that is saturated with water during at least a part of the growing season. Common wetland types are swamp, fen, bog, and marsh.

9. Acronyms

ACCDC	Atlantic Canada Conservation Data Centre
ARD	Acid Rock Drainage
CCME	Canadian Council of Ministers of the Environment
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DEM	Digital Elevation Model
DOC	Dissolved Organic Carbon
DSM	Digital Surface Model
GCDWQ	Guidelines for Canadian Drinking Water Quality
GHG	Greenhouse Gas
GIS	Geographical Information System
GNR	Government of Nova Scotia
GPS	Global Positioning System
HRM	Halifax Regional Municipality
IPCC	Intergovernmental Panel on Climate Change
LCM	Lakeshore Capacity Model
LiDAR	Light Detection and Ranging
NH_3	Ammonia
NO_3	Nitrate
NSDFA	Nova Scotia Department of Fisheries and Aquaculture
NSE	Nova Scotia Environment
NSDNR	Nova Scotia Department of Natural Resources
NSEA	Nova Scotia Endangered Species Act
SARA	Species at Risk Act
SWMM	Stormwater Management Model
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
WWTP	Wastewater Treatment Plant

Appendix A

Water Quality Data Summary Tables

Sample Name				Winder Lake									Winder Lake									Winder Lake Outlet	Winder Lake Outlet								Winder Lake Outlet				Long-Lake	
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Long Lake	
Sample Location Descriptions			Units	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	East Preston	
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	
				Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Lake	
Easting	-	-	-	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463721	463459	463459
Northing	-	-	-	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4954881	4953155	4953155
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	
Sampling Date	-	-		24-May-06	31-Oct-06	1-Jun-07	28-Aug-07	21-Nov-07	30-May-08	4-Sep-08	20-Nov-08	3-Jun-09	29-Sep-09	22-Oct-09	18-May-10	12-Aug-10	28-Oct-10	14-Apr-11	18-Aug-11	14-Nov-11	1-Jun-07	21-Nov-07	30-May-08	4-Sep-08	20-Nov-08	29-Sep-09	22-Oct-09	18-May-10	12-Aug-10	28-Oct-10	14-Apr-11	18-Aug-11	14-Nov-11	27-Aug-13	14-Nov-13
Sampling Time	-	-	hh:mm	12:01	11:15	9:40	9:29	9:44	10:45	9:35	10:00	10:25	11:10	12:10	2:20	12:40	12:25	10:00	10:05	10:50	9:40	9:44	10:45	9:35	10:00	11:10	12:10	2:20	12:40	12:25	10:00	10:05	10:50	-	
Sampled By / Data Source	-	-	-	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	HRM	AECOM	
FIELD DATA		x	-																																
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	0.3	0.5	0.5	0.5	0.75	0.9	1.4	0.8	-	1.2	>2.2	ND	ND	3.6	2.2	0.8	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	15.71	7.44	15.96	21.49	4.81	15.60	18.37	5.65	-	20.4	8.5	15.4	21.33	10.43	8.60	21.60	8.76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	15.86	13.05	14.63	10.14	14.34	15.44	7.73	10.64	-	10.8	7.2	117.2	7.80	8.75	13.68	6.21	8.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Air Saturation	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	10.81	7.43	9.95	6.68	7.13	9.49	6.41	6.85	-	5.9	6.0	7.5	6.33	6.68	7.20	6.78	6.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.75
Specific Conductance	-	-	uS/cm	226	204	288	435	172	236	205	181	-	195	180	222	208	223	316	191	147	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	-	-	g/L	-	-	0.19	0.28	0.11	0.15	0.13	0.12	-	0.13	0.12	0.14	0.14	0.15	0.206	0.124	0.096	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	0.14	0.21	0.08	0.11	0.10	0.09	-	0.09	0.09	0.11	0.10	0.11	0.15	0.09	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INORGANICS																																			
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	18	-	17	14	24	16	27	30	20	11	23	28	20	39	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dissolved Chloride (Cl)	-	-	mg/L	39	32	55	-	28	47	36	32	48	31	27	42	36	34	65	28	18	-	-	-	-	-	-	-	-	-	-	-	-	-	22	14
Colour	-	-	TCU	-	19	14	21	20	34	47	40	17	24	51	14	29	16	10	27	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	0.26	-	0.74	0.62	0.35	1.0	1.71	<0.05	0.98	0.95	<0.05	1.20	1.54	<0.05	0.96	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	-
Nitrate (N)	-	13000.00	mg/L	0.14	0.67	<0.05	-	-	0.59	0.30	1.0	1.62	<0.05	0.98	0.78	<0.05	1.09	1.54	<0.05	0.96	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	0.07
Nitrite (N)	-	60.00	mg/L	0.02	0.06	-	-	-	0.03	0.05	0.02	0.09	<0.05	<0.05	0.17	<0.05	0.11	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	0.1	-	<0.05	<0.05	0.53	0.13	0.72	0.08	1.19	0.18	<0.05	0.63	<0.05	<0.05	0.49	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Nitrogen TKN - water (as N)	-	-		3.5	4.6	2.6	-	1.9	1.4	1.6	2.3	2.3	1.1	2.7	<0.4	0.8	1.3	1.4	3.6	29.5	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.9
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	6.1	-	3.6	5.5	6.4	6.5	11.5	8.4	7.9	7.2	8.9	6.8	4.8	10.2	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	<0.01	-	0.01	<0.01	0.02	<0.01	0.03	0.01	0.06	0.01	<0.01	0.11	<0.01	<0.01	1.06	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01	<0.01
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	8.63	-	7.24	7.34	6.99	6.80	7	7.6	7.3	7.3	7.4	7.3	7.5	7.7	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	11	-	8.6	8.7	8.1	8.1	13.7	9.3	7.9	10.3	13.1	9.4	12.4	7.0	6.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	1.5	-	1.1	1.1	1.1	1.1	1.7	1.2	1.0	1.5	1.4	1.0	1.1	1.0	0.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	-	-	0.3	-	-	0.1	<0.1	0.2	-	-	<0.1	-	0.1	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.007	0.008
Total Phosphorus Detection Limits										<0.1				<0.1																					
Total Phosphorus (1M depth)	-	-	mg/L	0.36	0.44	0.18	0.1	0.11	0.11	0.088	0.15	0.152	0.059	0.086	0.061	0.053	0.130	0.042	0.128	0.062	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	N/A	-	-	-	-	-	N/A	-	-	-	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	3.9	-	3.1	3	3.1	3.4	4.1	2.5	2.5	3.5	3.6	4.1	2.8	2.5	2.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	42	-	23	34	29	25	41.7	32	20.9	40	34.6	27.2	42.1	27.9	17.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	3.8	-	5.1	2.1	1.5	3.0	4	1.3	2.6	0.6	0.6	2.3	1.3	2.9	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	20	33	24	8	11	10	4	10	112	<5	<5	<5	<5	<5	<5	15	<5	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	<5
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	17	-	19	16	16	17	26	15	18	23	17	16	19	14	13.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Lab Turbidity (NTU)	50.00	-	NTU	7.3	11.0	7.7	2.5	4.1	2.6	0.7	2.3	6.2	2.0	0.9	0.8	2	0.7	1.1	9.9	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	260	-	170	230	210	180	305	192	199	233	203	217	316	-	141	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																			
Anion Sum	-	-	me/L	-	-	2.28	-	1.57	1.98	1.86	1.64	2.56	1.76	1.61	1.95	1.83	1.93	2.74	1.86	1.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	17	-	17	14	24	16	27	30	20	11	23	28	20	39	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	147	-	101	123	112	104	164	300	294	364	323	114	161	104	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	ND	-	ND	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	2.62	-	1.6	2.1	1.86	1.68	2.94	2.03	1.55	2.49	2.39	1.85	2.62	1.73	1.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	35	-	26	26	25	25	41	28	24	32	39	27.6	36	22	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	6.94	-	0.95	2.94	0	1.20	6.9	7.2	1.7	12.1	13.2	2.1	2.10	3.6	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-0.439	-	-1.95	-1.93	-2.08	-2.43	-2.04	-1.59	-2.14	-2.29	-1.76	-1.87	-1.71	-1.45	-1.99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-0.689	-	-2.2	-2.18	-2.33	-2.68	-2.36	-1.91	-2.46	-2.61	-2.08	-2.19	-2.03	-1.77	-2.31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	9.07	-	9.19	9.27	9.07	9.23	9.04	9.19	9.44	9.59	9.16	9.17	9.21	9.15	9.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	9.32	-	9.44	9.52	9.32	9.48	9.36	9.51	9.76	9.91	9.48	9.49	9.53	9.47	9.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																			
Total Aluminum (Al)	-	5-100	µg/L	-	-	130	-	-	80	56	110	-	-	76	-	52	-	-	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Arsenic (As)	-	5.00	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Barium (Ba)	-	-	µg/L	-	-	11	-	-	10	12	9	-	-	9	-	14	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-
Total Beryllium (Be)	-	-	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Bismuth (Bi)	-	-	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Boron (B)	-	-	µg/L	-	-	48	-	-	38	47	43	-	-	46	-	55	-	-	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	<0.3	-	-	<0.3	<0.3	<0.3	-	-	<0.017	-	0.022	-	-	<0.017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.017	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<1	-	<1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-
Total Cobalt (Co)	-	-	µg/L	-	-	<1	-	-	<1	<1	<1	-	-	<1	-	<1	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	4	-	<2	4	2	5	25	2	2	4	<2	<2	2	<2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
Total Iron (Fe)	-	300.00	µg/L	-	-	94.00	-	0.08	88.00	130.00	100.00	3570.00	121.00	140.00	140.00	121.00	130.00	98.00	236.00	125.00	-	-	-	-	-	-	-	-	-	-	-	-	-	<50	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	<0.5	-	-	<0.5	<0.5	<0.5	-	-	<0.5	-	1.20	-	-	<0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.5	-
Total Manganese (Mn)	-	-	µg/L	-	-	98.00	-	0.07	99.00	85.00	94.00	309.00	44.00	36.00	43.00	143.00	26.00	31.00	133.00	15.00	-	-	-	-	-	-	-	-	-	-	-	-	-	34.00	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Selenium (Se)	-	1.00	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<1	-	<1	-	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-
Total Silver (Ag)	-	0.10	µg/L	-	-	<0.5	-	-	<0.5	<0.5	<0.5	-	-	<0.1	-	<0.1	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-
Total Strontium (Sr)	-	-	µg/L	-	-	46	-	-	37	36	33	-	-	31	-	35	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	<0.1	-	-	<2	<2	<2	-	-	<0.1	-	<0.1	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-
Total Tin (Sn)	-	-	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Titanium (Ti)	-	-	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Uranium (U)	-	-	µg/L	-	-	<0.1	-	-	<0.1	<0.1	<0.1	-	-	<0.1	-	<0.1	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-
Total Vanadium (V)	-	-	µg/L	-	-	<2	-	-	<2	<2	<2	-	-	<2	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	11	-	<5	12	13	16	41	6	7	9	76	<5	11	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-
MICROBIOLOGICAL																																			
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	>4838	>4838	234	1990	58			-	-	-	-	-	-	>4838	582	209	>2420	37.00	-	-	2420	172
E. Coli	-	-	MPN/100mL	-	9	-	-	-	-	-	-	-	-	<2	<2	2	3	<2	2	50	-	-	-	-	-	-	<2	<2	2	10	<2	<1	41	4	<1
Fecal Coliform	-	400	MPN/100mL	-	31	<1	>10,000	5	<1	<1	750	-	-	-	-	-	-	-	-	-	1	17	2	2	520	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	3	-	-	-	-	-	-	-	PRESENT	<1	2	-	-	-	-	-	-	-	-	-	-	-	50	6	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	340.09	214.22	-	29.02	260.74	113.24	13.45	159.92	13.23	19.06	2.73	1.49	33.52	2.60	48.35	118.89	7.17	-	-	-	-	-	-	-	-	-	-	-	-	-	2.78	0.6
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	146.15	28.71	266.18	120.78	15.14	165.31	15.50	20.02	3.26	1.42	30.35	2.73	44.90	92.19	6.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ORGANICS																																			
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.2	2.6
Source	-	-	-	HRM Lakes Water Quality Sampling Program									HRM Lakes Water Quality Sampling Program										HRM Lakes Water Quality Sampling Program								HRM Lakes Water Quality Sampling Program					
	Note: RWQ - Raw Water Quality (Reference); FWAL - Fresh Water Aquatic Life (Applied)																																		

Sample Name					Lake-Major			Lake-Eagle Outlet			Partridge-River Outlet			Gammon Lake		Robinson-Lake		Frog-Lake		Nelson-Lake		LMG1 (2080F)							LMG1 (2080F)			
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)			Lake Major	Lake Major	Lake Major	Lake Eagle	Lake Eagle	Lake Eagle	Partridge River	Partridge River	Partridge River	Gammon Lake	Gammon Lake	Robinson Lake	Robinson Lake	Frog Lake	Frog Lake	Nelson Lake	Nelson Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake
Sample Location Descriptions			Units		East Preston	East Preston	East Preston	East Preston	East Preston	East Preston	East Preston	East Preston	East Preston	Lawrencetown	Lawrencetown	Lawrencetown	Lawrencetown	East Preston	East Preston	East Preston	East Preston	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-									-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-		SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
					Lake	Lake	Lake	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake
Easting	-	-	-	463459	463007	463007	463007	465684	465684	465684	469486	469486	469486									463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98
Northing	-	-	-	4953155	4951434	4951434	4951434	4954010	4954010	4954010	4949145	4949145	4949145									4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35
Applicable Watershed	-	-	-		Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston									Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		20-May-14	27-Aug-13	14-Nov-13	20-May-14	27-Aug-13	14-Nov-13	20-May-14	27-Aug-13	14-Nov-13	20-May-14	20-May-14	10-Jul-14	20-May-14	10-Jul-14	20-May-14	10-Jul-14	20-May-14	10-Jul-14	29-Oct-09	30-Nov-09	14-Dec-09	27-Jan-10	25-Feb-10	12-Mar-10	21-Apr-10	13-May-10	23-Jun-10	21-Jul-10	20-Aug-10
Sampling Time	-	-	hh:mm		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11:22	14:00	12:35	10:13	12:26	11:24	11:15	13:53	14:37	11:30	10:15
Sampled By / Data Source	-	-	-		AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	AECOM	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																													
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.91	8.97	5.05	3.45	3.49	5.06	8.29	13.85	16.58	18.99	19.28
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.76	10.4	12.69	11.48	11.97	11.73	9.04	9.69	7.55	8.28	6.78
% Air Saturation	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	86.5	90.1	98.7	86.3	90.3	92	77	93.8	77.5	89.3	73.6
pH	5.0-9.0	6.5-9	pH	6.53	-	5.69	5.6	-	5.77	5.93	-	5.66	5.52	6.26	6.4	6.77	6.97	6.12	6.04	6.96	7.23	6.35	6.04	5.89	6.46	6.31	6.67	6.41	6.31	6.63	6.91	6.88
Specific Conductance	-	-	uS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	279	255	181	*	553	265	506	385	388	597	417
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.01	0.42	0.69	1.38	3.09	1.51	2.86	0.62	0.84	4.87	0.59
INORGANICS																																
Total Alkalinity (as CaCO3)	-	-	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	16	10	5	7	9	5	6	14	7	11	10	8	26	21	9	7	23	21	59	79	84	51	66	51	-	23	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	<0.05	-	-	<0.05	-	-	<0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	0.09	0.1	<0.05	<0.06	<0.07	<0.08	<0.09	<0.10	0.67	0.57	0.61	0.91	0.3	0.49	0.22	0.08	0.13	0.56	0.1
Nitrite (N)	-	60.00	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	<0.05	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	-									-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		0.4	<0.4	0.7	<0.4	<0.4	1.5	0.4	<0.4	1.1	<0.4	1.6	1.2	<0.4	1.9	0.6	2.2	0.6	2.3	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-								-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	6.3		8.4		9.0		4.3	2.6	3.4	3.4	2.5	1.6	1.9	2.3	2.3	2.3	6.1	3.6
Orthophosphate (as P)	-	-	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.6	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.024	0.007	0.008	0.023	0.015	0.027	0.020	0.015	0.015	0.021	0.021	0.016	0.022	0.018	0.023	0.033	0.024	0.016	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	0.004	0.001	0.026	0.005
Total Phosphorus Detection Limits																						<0.02	<0.02	<0.02		<0.02	<0.02	<0.02				
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.13	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75.3	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	<2	<2	<5	<2	<2	<5	2	<2	<5	<2	2	<2	<2	<2	3	<2	2	<2	<1	<1	<1	1	<1	2	7	3	4	8	<2
Dissolved Sulphate (SO4)	-	-	mg/L		-			-			-				3.0		3.0		3.0		9.0	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																
Total Aluminum (Al)	-	5-100	µg/L	-	178	-	-	223	-	-	145	-	-	-	111	-	92		251		29	-	-	-	-	-	-	-	-	-	64.9	-
Total Antimony (Sb)	-	5-100	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-
Total Arsenic (As)	-	5.00	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	13	-	<2		<2		<2	-	-	-	-	-	-	-	-	-	<1	-
Total Barium (Ba)	-	-	µg/L	-	<5	-	-	<5	-	-	<5	-	-	-	<5	-	7		<5		16	-	-	-	-	-	-	-	-	-	26.2	-
Total Beryllium (Be)	-	-	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-		-						-	-	-	-	-	-	-	-	-	<1	-
Total Bismuth (Bi)	-	-	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-		-						-	-	-	-	-	-	-	-	-	<2	-
Total Boron (B)	-	-	µg/L	-	6	-	-	14	-	-	12	-	-	-	8	-	9		9		13	-	-	-	-	-	-	-	-	-	24.3	-
Total Cadmium (Cd)	-	0.02	µg/L	-	<0.017	-	-	<0.017	-	-	<0.017	-	-	-	<0.017	-	<0.017		<0.017		<0.017	-	-	-	-	-	-	-	-	-	0.06	-
Total Chromium (Cr)	-	1.00	µg/L	-	<1	-	-	<1	-	-	<1	-	-	-	<1	-	<1		<1		<1	-	-	-	-	-	-	-	-	-	<1	-
Total Cobalt (Co)	-	-	µg/L	-	<1	-	-	<1	-	-	<1	-	-	-	<1	-	<1		<1		<1	-	-	-	-	-	-	-	-	-	0.5	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	1	-	-	1	-	-	<1	-	-	-	<1	-	<1		<1		<1	-	-	-	-	-	-	-	-	-	<2	-
Total Iron (Fe)	-	300.00	µg/L	-	87.00	-	-	145.00	-	-	289.00	-	-	-	269.00	-	464.00		432.00		990.00	-	-	-	-	-	-	-	-	-	793.00	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	<0.5	-	-	<0.5	-	-	<0.5	-	-	-	<0.5	-	<0.5		0.80		<0.5	-	-	-	-	-	-	-	-	-	<0.50	-
Total Manganese (Mn)	-	-	µg/L	-	53.00	-	-	17.00	-	-	38.00	-	-	-	78.00	-	425.00		91.00		2240.00	-	-	-	-	-	-	-	-	-	501.00	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	<2	-	<2		<2		<2	-	-	-	-	-	-	-	-	-	<2	-
Total Nickel (Ni)	-	25-150	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	<2	-	<2		<2		<2	-	-	-	-	-	-	-	-	-	<2	-
Total Selenium (Se)	-	1.00	µg/L	-	<1	-	-	<1	-	-	<1	-	-	-	<1	-	<1		<1		<1	-	-	-	-	-	-	-	-	-	<1	-
Total Silver (Ag)	-	0.10	µg/L	-	<0.1	-	-	<0.1	-	-	<0.1	-	-	-	<0.1	-	<0.1		<0.1		<0.1	-	-	-	-	-	-	-	-	-	<0.1	-
Total Strontium (Sr)	-	-	µg/L	-	7	-	-	9	-	-	12	-	-	-	13	-	24		10		50	-	-	-	-	-	-	-	-	-	98.3	-
Total Thallium (Tl)	-	0.80	µg/L	-	<0.1	-	-	<0.1	-	-	<0.1	-	-	-	<0.1	-	<0.1		<0.1		<0.1	-	-	-	-	-	-	-	-	-	<0.1	-
Total Tin (Sn)	-	-	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	<2	-	<2		<2		<2	-	-	-	-	-	-	-	-	-	<2	-
Total Titanium (Ti)	-	-	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	<2	-	<2		<2		<2	-	-	-	-	-	-	-	-	-	<2	-
Total Uranium (U)	-	-	µg/L	-	<0.1	-	-	<0.1	-	-	<0.1	-	-	-	<0.1	-	<0.1		<0.1		<0.1	-	-	-	-	-	-	-	-	-	<0.1	-
Total Vanadium (V)	-	-	µg/L	-	<2	-	-	<2	-	-	<2	-	-	-	<2	-	<2		<2		<2	-	-	-	-	-	-	-	-	-	<2	-
Total Zinc (Zn)	-	30.00	µg/L	-	24	-	-	7	-	-	<5	-	-	-	7	-	23		11		9	-	-	-	-	-	-	-	-	-	8.5	-
MICROBIOLOGICAL																																
Total coliform	-	-	MPN/100mL	248	1300	308	276	2420	291	1986	1986	613	2420	1986	>2420	548	>2420	>2420	>2420	345	>2420	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	<1	5	<1	<1	3	<1	1	12	2	30	2	40	11	18	13	12	5	34	27	7	0.5	250	1	0.5	0.5	1	3	180	15
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	0.33	1.54	<0.50	0.54	1.55	0.50	1.26	<0.5	0.50	0.95	0.33		1.05		1.42		0.86		-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	0.36	-	<0.50	0.57	-	<0.50	1.21	-	0.60	0.88	0.35		1.05		1.35		0.83		-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L		-			-			-											-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L		-			-			-											-	-	-	-	-	-	-	-	-	-	-
ORGANICS																																
Biochemical Oxygen Demand	-	-	(mg/L)		-			-			-											-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	3.0	4.5	5.8	6.0	7.4	10.0	6.6	7.8	10.0	7.7	5.2	6.1	5.6	8.8	7.2	8.7	2.9	4.2	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	AECOM 2013 Sandy Lake and East Preston Sampling Program												AECOM 2013 2014 Preston Sampling	AECOM 2013 2014 Preston Sampling	AECOM 2013 2014 Preston Sampling	AECOM 2013 2014 Preston Sampling	AECOM 2013 2014 Preston Sampling	AECOM 2013 2014 Preston Sampling	Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality m			
	Note: RWQ - Raw Water Quality (Reference);																															

Sample Name							LMG1 (2080F)							LMG1 (2080F)							LMG1 (2080F)							LMG1 (2080F)			
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake
Sample Location Descriptions			Units	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake
Easting	-	-	-	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98
Northing	-	-	-	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		21-Sep-10	29-Oct-10	18-Nov-10	2-Dec-10	24-Jan-11	Feb-11	17-Mar-11	18-Apr-11	27-May-11	24-Jun-11	29-Jul-11	26-Aug-11	28-Sep-11	27-Oct-11	16-Nov-11	9-Dec-11	23-Jan-12	24-Feb-12	30-Mar-12	30-Apr-12	31-May-12	28-Jun-12	30-Jul-12	29-Aug-12	25-Sep-12	30-Oct-12	29-Nov-12	14-Dec-12
Sampling Time	-	-	hh:mm	9:55	10:39	10:19	10:36	10:10	-	10:20	9:40	12:39	14:07	12:30	9:40	10:30	10:30	14:32	9:40	11:00	9:20	10:07	11:56	9:49	10:09	10:09	10:23	9:21	10:02	10:07	9:51
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	17.1	12.47	9.69	6.69	3.6	-	4.36	5.95	13.17	16.59	13.4	18.5	16.77	8.63	11.07	7.09	0.38	2.67	3.62	9.64	11.41	15.17	16.12	23.25	18.15	12.63	4.10	4.47
Dissolved Oxygen	-	5.5-9.5	mg/L	8.43	9.38	8.93	10.18	11.62	-	9.69	6.99	9.74	6.98	-	7.38	7.01	9.99	12.38	10.96	14.08	13.65	12.4	11.72	10.02	8.68	7.86	8.09	7.85	9.66	10.68	11.26
% Air Saturation	-	-	%	87.5	88.1	78.6	83.3	87.9	-	74.7	56.2	90.3	71.6	-	78.8	72.3	85.6	112.5	90.6	97.4	100.6	93.7	103	91.8	86.4	79.9	94.7	83.2	90.9	81.7	87.0
pH	5.0-9.0	6.5-9	pH	6.34	6.23	6.2	6.3	6.45	-	6.13	6.45	6.62	5.95	6.26	6.73	6.24	6.37	6.76	6.65	6	5.7	5.83	6.04	6.08	5.96	6.00	5.69	5.71	6.31	6.06	5.83
Specific Conductance	-	-	uS/cm	202	305	324	117	614	-	123	417	328	171	280	254	425	107	154	193	92	254	262	322	358	223	208	83	79	157	130	129
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	1.35	2.2	2.71	2.48	0.51	-	1.23	1.44	0.83	1.04	2.59	0.89	2.13	0.6	2.8	3.22	1.6	0.82	0.59	1.31	1.31	0.96	0.79	0.67	0.98	2.28	1.55	1.12
INORGANICS																															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	61	-	-	-	32	97	-	-	61	30	20	-	1	27	52	32	36	74	-	-	55	33	15	-	29	23	40
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	0.27	1.3	0.76	0.69	0.82	-	0.2	0.77	0.35	0.29	0.38	0.15	<0.05	0.14	0.33	0.91	0.61	0.25	0.25	0.49	0.24	0.26	0.30	0.093	0.056	0.29	0.29	0.24
Nitrite (N)	-	60.00	mg/L	<0.01	0.02	<0.01	<0.01	<0.01	-	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	5.3	4.3	3.9	2.8	2.5	-	2.1	2.4	2.8	3.8	6.6	4.4	4.9	3.5	2.9	3.9	2.1	2.5	2.2	2.6	2.6	3.9	4.0	3.1	3.3	3.8	2.6	3.0
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	19.4	-	-	-	-	-	-	-	-	-	12.4	-	3.77	-	-	-	-	-	-	-	-	-	10.3	-	3.36	-	-	-
Total Magnesium (Mg)	-	-	mg/L	1.74	-	-	-	-	-	-	-	-	-	1.23	-	0.756	-	-	-	-	-	-	-	-	-	1.09	-	0.617	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.014	0.008	0.013	0.013	0.021	-	0.009	0.01	0.017	0.02	0.024	0.012	0.011	0.006	0.016	0.02	0.01	0.007	0.008	0.003	0.001	0.005	0.025	0.009	0.01	0.012	0.004	0.005
Total Phosphorus Detection Limits																															
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	2.22	-	-	-	-	-	-	-	-	-	1.69	-	737	-	-	-	-	-	-	-	-	-	1.36	-	0.666	-	-	-
Total Sodium (Na)	-	-	mg/L	71.4	-	-	-	-	-	-	-	-	-	38.5	-	11.4	-	-	-	-	-	-	-	-	-	36.6	-	9.12	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	6	<2	2	1	1	-	4	1	<1	2	3	2	<1	<1	<1	2	<2	1.8	1	1.4	1.4	1	<1	1	1	5.6	1.4	1.2
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																															
Total Aluminum (Al)	-	5-100	µg/L	74.2	-	-	-	-	-	-	-	-	-	149	-	26.4	-	-	-	-	-	-	-	-	-	105	-	65.3	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-
Total Arsenic (As)	-	5.00	µg/L	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-
Total Barium (Ba)	-	-	µg/L	17	-	-	-	-	-	-	-	-	-	13.6	-	7.6	-	-	-	-	-	-	-	-	-	14.7	-	8.4	-	-	-
Total Beryllium (Be)	-	-	µg/L	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-
Total Bismuth (Bi)	-	-	µg/L	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-
Total Boron (B)	-	-	µg/L	16.4	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	<0.017	-	-	-	-	-	-	-	-	-	0.159	-	<0.017	-	-	-	-	-	-	-	-	-	0.074	-	0.063	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-
Total Cobalt (Co)	-	-	µg/L	0.53	-	-	-	-	-	-	-	-	-	<0.4	-	<0.4	-	-	-	-	-	-	-	-	-	<0.4	-	<0.4	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-
Total Iron (Fe)	-	300.00	µg/L	368.00	-	-	-	-	-	-	-	-	-	451.00	-	<50	-	-	-	-	-	-	-	-	-	232.00	-	70.00	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	<0.50	-	-	-	-	-	-	-	-	-	<0.50	-	<0.50	-	-	-	-	-	-	-	-	-	<0.50	-	<0.50	-	-	-
Total Manganese (Mn)	-	-	µg/L	377.00	-	-	-	-	-	-	-	-	-	171.00	-	18.90	-	-	-	-	-	-	-	-	-	150.00	-	33.40	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-
Total Selenium (Se)	-	1.00	µg/L	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-
Total Silver (Ag)	-	0.10	µg/L	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-
Total Strontium (Sr)	-	-	µg/L	73.4	-	-	-	-	-	-	-	-	-	53.8	-	17.9	-	-	-	-	-	-	-	-	-	43.7	-	16	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-
Total Tin (Sn)	-	-	µg/L	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-
Total Titanium (Ti)	-	-	µg/L	<2	-	-	-	-	-	-	-	-	-	2.8	-	<2	-	-	-	-	-	-	-	-	-	2.3	-	<2	-	-	-
Total Uranium (U)	-	-	µg/L	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-
Total Vanadium (V)	-	-	µg/L	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	<5	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-	-	-	-	-	-	-	-	5.5	-	<5	-	-	-
MICROBIOLOGICAL																															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	43	29	13	3	0.5	-	0.5	100	15	110	17	44	1	5	9	61	0.5	15	0.5	5	1	5	14	0.5	18	0.5	1	5
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	onitoring program			Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality m			
	Note: RWQ - Raw Water Quality (Reference);																														

Sample Name							LMG1 (2080F)					LMG2 (20810)		LMG2 (20810)							LMG2 (20810)							LMG2 (20810)			
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake
Sample Location Descriptions			Units	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	Long Lake Lift S	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake
Easting	-	-	-	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	463299.98	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20
Northing	-	-	-	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4953806.35	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		29-Jan-13	26-Feb-13	19-Mar-13	18-Apr-13	29-May-13	24-Jun-13	31-Jul-13	20-Aug-13	28-Oct-09	30-Nov-09	14-Dec-09	Jan-10	Feb-10	Mar-10	22-Apr-10	18-May-10	17-Jun-10	28-Jul-10	Aug-10	9-Sep-10	3-Nov-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11
Sampling Time	-	-	hh:mm	10:20	10:07	10:03	10:00	10:55	11:10	10:20	9:59	12:44	12:00	10:20	-	-	-	10:35	10:35	10:43	11:27	-	12:55	11:14	-	-	-	-	-	-	-
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	0.17	1.67	1.57	5.36	12.54	16.21	18.1	17.89	7.97	6.32	3.74	-	-	-	5.64	11.66	13.76	16.9	-	17.66	7.95	-	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	9.48	11.23	11.47	8.82	11.09	8.85	8.9	7.61	9.79	9.69	10.75	-	-	-	9.32	4.86	8.51	4.44	-	4.99	11.75	-	-	-	-	-	-	-
% Air Saturation	-	-	%	65.2	80.6	82.0	69.7	104.3	90.1	94.3	80.2	82.6	78.8	81.5	-	-	-	74.7	44.8	82.1	45.9	-	52.3	99.1	-	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	5.15	5.35	5.54	6.78	6.4	6.31	6.43	6.3	4.68	4.82	4.77	-	-	-	4.96	4.86	4.74	5.27	-	5.15	4.82	-	-	-	-	-	-	-
Specific Conductance	-	-	uS/cm	184	459	203	207	199	249	163	238	32	30	33	-	-	-	28	29	34	34	-	39	36	-	-	-	-	-	-	-
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	2.18	0.62	0.46	0.46	0.4	2.94	2.04	1.56	0.44	0.33	0.39	-	-	-	0.3	1.21	0.61	0.73	-	0.3	0.29	-	-	-	-	-	-	-
INORGANICS																															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	41	50	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	0.58	0.37	0.35	0.3	0.22	0.23	0.34	-	<0.05	<0.05	<0.05	-	-	-	0.07	<0.05	<0.05	<0.05	-	<0.05	<0.05	-	-	-	-	-	-	-
Nitrite (N)	-	60.00	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	2.1	1.4	1.5	1.7	2.3	3.2	3.8	-	3.3	4.4	2.8	-	-	-	3.3	3.3	5.5	7	-	11	4.8	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	8.03	-	-	-	-	-	-	-	-	-	-	0.872	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	0.89	-	-	-	-	-	-	-	-	-	-	0.313	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.006	0.005	<0.002	0.006	0.003	0.007	0.02	-	<0.02	<0.02	<0.02	-	-	-	<0.02	0.006	0.033	0.014	-	0.014	0.002	-	-	-	-	-	-	-
Total Phosphorus Detection Limits						<0.002						<0.02	<0.02	<0.02				<0.02													
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	1.17	-	-	-	-	-	-	-	-	-	-	0.18	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	24.6	-	-	-	-	-	-	-	-	-	-	2.59	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	3.2	<1	<1	<1	<1	3.8	2.6	-	<1	<1	<1	-	-	-	<1	4	110	8	-	1	1	-	-	-	-	-	-	-
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																															
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	106	-	-	-	-	-	-	-	-	-	-	309	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	14.5	-	-	-	-	-	-	-	-	-	-	7.5	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	0.027	-	-	-	-	-	-	-	-	-	-	0.027	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	193.00	-	-	-	-	-	-	-	-	-	-	532.00	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	<0.50	-	-	-	-	-	-	-	-	-	-	0.87	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	113.00	-	-	-	-	-	-	-	-	-	-	25.60	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	34.9	-	-	-	-	-	-	-	-	-	-	8.0	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL																															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	<1	<1	1	<1	2	7	30	-	<1	<1	1	-	-	-	<1	<1	<1	<1	-	8	1	-	-	-	-	-	-	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	onitoring program			Halifax Water's raw water quality monitoring program							Halifax Water's raw water quality monitoring program							Halifax Water's raw water quality monitoring program							Halifax Water's raw water quality m			
	Note: RWQ - Raw Water Quality (Reference);																														

Sample Name							LMG2 (20810)			LMDL-1A				LMDL-2SD	LMDL-2SD			LMDL-1B		LMDL-1C				LMG3 (20811)									
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Long Lake	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major
Sample Location Descriptions			Units	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook In	ng Lake Brook Inlet															East Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook Inl
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW															SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Lake	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	461358.20	461358.20	461358.20	461358.20	461358.20	461358.20															460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99
Northing	-	-	-	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55	4954733.55															4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston															Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	16-Nov-11	9-Sep-10	3-Nov-10	16-Nov-11	18-May-12	9-Sep-10	3-Nov-10	16-Nov-11	18-May-12	9-Sep-10	16-Nov-11	9-Sep-10	3-Nov-10	16-Nov-11	18-May-12	28-Oct-09	30-Nov-09	14-Dec-09	27-Jan-10	Feb-10	18-Mar-10	22-Apr-10	18-May-10	17-Jun-10	28-Jul-10
Sampling Time	-	-	hh:mm	-	-	-	-	-	12:49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11:16	11:30	9:51	9:38	-	13:37	10:05	10:03	10:21	10:56
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																														
Depth	-	-	Meters	-	-	-	-	-	-	0.50	0.50	0.50	0.50	10.00	8.00	6.00	6.00	20.00	20.00	41.00	36.00	40.00	37.00	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	9.34															8.98	6.77	4.08	1.51	-	4.41	7.43	12.53	17.21	22.67
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	11.19															11.18	12.58	14.04	14.15	-	12.25	11.42	10.33	9.38	8.36
% Air Saturation	-	-	%	-	-	-	-	-	97.6															96.6	103.1	107.3	101	-	94.4	95.1	97	97.5	96.8
pH	5.0-9.0	6.5-9	pH	-	-	-	-	-	4.93															4.28	4.29	4.35	4.82	-	4.42	4.39	4.34	4.38	4.59
Specific Conductance	-	-	uS/cm	-	-	-	-	-	37															27	27	28	23	-	27	26	25	24	23
TDS	-	-	g/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	0.38															0.45	0.51	0.89	0.38	-	0.34	0.37	0.7	0.61	0.9
INORGANICS																																	
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	5.00	5.00	5.00	5.00	-	-	-	-	5.00	5.00	5.00	5.00	5.00	5.00	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	-	-	5.00	6.00	6.00	5.40	-	-	-	-	5.00	6.00	5.00	6.00	6.00	5.60	-	-	-	-	3	4	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	-	-	-	-	<0.05					-	-	-	-							<0.05	<0.05	<0.05	<0.05		<0.05	0.07	<0.05	<0.05	<0.05
Nitrite (N)	-	60.00	mg/L	-	-	-	-	-	<0.01					-	-	-	-							<0.01	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-					-	-	-	-							-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.1	6.2	7.0	5.6	-	6	6.9	5	5.2	5.2
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	0.36
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	0.249
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	-	-	-	-	-	0.005															<0.02	<0.02	<0.02	<0.02	-	<0.02	<0.02	0.002	0.003	0.001
Total Phosphorus Detection Limits										0.002	0.002	0.002	0.002	-	-	-	-	0.002	0.002	0.002	0.002	0.002	0.002	<0.02	<0.02	<0.02	<0.02		<0.02	<0.02			
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	0.272
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	2.03
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	-	-	-	-	-	<1															<1	<1	<1	<1	-	<1	<1	<1	6	<2
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																	
Anion Sum	-	-	me/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																	
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	269
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<1
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<1
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	3.4
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<1
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<2
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<5
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	0.029
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<1
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<0.4
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<2
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	125.00
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<0.50
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	29.10
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<2
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<2
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<1
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<0.1
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	4.2
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<0.1
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<2
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<1
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	0.22
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	<2
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	5.4
MICROBIOLOGICAL																																	
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	-	-	-	-	1															<1	<1	<1	<1	-	<1	<1	<1	1	1
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
ORGANICS																																	
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-															-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	onitoring program			Halifax Water’s raw water quality monitoring program								Halifax Water’s raw water quality monitoring program									Halifax Water’s raw water quality monitoring program							Halifax Water’s ra		
	Note: RWQ - Raw Water Quality (Reference);																																

Sample Name				LMG3 (20811)				LMG3 (20811)							LMG3 (20811)							LMG3 (20811)									
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major
Sample Location Descriptions			Units	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99
Northing	-	-	-	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		Aug-10	9-Sep-10	3-Nov-10	30-Nov-10	22-Dec-10	26-Jan-11	Feb-11	31-Mar-11	2-May-11	27-May-11	24-Jun-11	29-Jul-11	26-Aug-11	28-Sep-11	27-Oct-11	16-Nov-11	9-Dec-11	23-Jan-12	24-Feb-12	30-Mar-12	30-Apr-12	31-May-12	28-Jun-12	30-Jul-12	29-Aug-12	25-Sep-12	30-Oct-12	29-Nov-12
Sampling Time	-	-	hh:mm	-	12:30	11:36	10:55	10:35	12:15	-	15:09	12:40	12:11	13:44	14:45	10:05	11:00	11:00	12:33	10:20	10:50	9:40	10:38	12:46	10:28	10:37	10:43	10:58	10:00	10:31	10:31
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	21.59	8.73	-	5.54	1.43	-	4.29	8.72	13.56	18.26	16.5	22.02	18.72	12	9.32	6.35	1.17	2.21	4.34	10.48	15.94	18.71	21.94	22.94	18.45	12.78	5.54
Dissolved Oxygen	-	5.5-9.5	mg/L	-	8.81	11.42	-	9.94	11.65	-	6.24	9.93	9.15	8	-	8.94	9.29	10.73	14.27	10.66	14.13	13.99	13.54	11.79	10.35	8.98	8.07	7.82	8.99	10.30	11.33
% Air Saturation	-	-	%	-	100	98.1	-	78.9	82.9	-	47.9	85.3	87.9	85	-	102.3	99.6	99.5	124.4	86.4	99.9	101.7	104.2	105.6	104.8	96.3	92.1	91.1	95.8	97.3	90.0
pH	5.0-9.0	6.5-9	pH	-	4.32	4.56	-	4.03	4.13	-	4.3	4.35	4.35	4.09	4.91	4.62	4.5	4.42	4.39	4.31	4.17	5.24	4.21	4.06	4.19	4.03	4.91	3.94	4.05	4.41	3.98
Specific Conductance	-	-	uS/cm	-	23	24	-	29	33	-	33	32	31	29	27	27	26	29	29	30	30	30	28	27	26	25	24	24	26	26	27
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	0.58	0.51	0.67	0.78	0.78	-	0.41	0.61	0.8	1.15	1.36	0.72	0.83	0.85	0.71	0.74	0.46	0.63	0.56	0.55	1.23	0.71	0.86	0.66	1.25	0.67	0.43
INORGANICS																															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	3	-	-	5	4	-	5	15	-	4	4	4	4	4	4	4	-	-	-	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	<0.05	<0.05	<0.05	<0.05	<0.05	-	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite (N)	-	60.00	mg/L	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	4.6	5	5.1	6.2	6.3	-	5.8	5.8	6.1	6.4	5.6	6.2	5.5	7.2	2.9	6.6	6.5	7	6	6.4	5.4	5.1	4.2	4.3	6.5	7.1	6.6
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	0.502	-	0.463	-	-	-	-	-	-	-	-	-	0.42	-	0.521	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	0.282	-	0.304	-	-	-	-	-	-	-	-	-	0.279	-	0.292	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	-	0.006	0.004	0.006	0.007	0.01	-	0.015	0.008	0.013	0.01	0.014	0.005	0.002	0.006	0.016	0.013	0.011	0.008	0.006	0.003	0.001	0.001	0.007	0.001	0.013	0.011	0.008
Total Phosphorus Detection Limits																															
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	0.3	-	0.287	-	-	-	-	-	-	-	-	-	0.278	-	0.303	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	2.79	-	2.66	-	-	-	-	-	-	-	-	-	2.57	-	2.52	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	-	1	<1	<1	<1	<1	-	<1	<1	<1	1	<1	1	2	<1	<1	1	1	1	<1	1.8	2	<1	1	<1	<1	<1	<1
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																															
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	305	-	323	-	-	-	-	-	-	-	-	-	281	-	344	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	3.9	-	3.3	-	-	-	-	-	-	-	-	-	3.4	-	3.8	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	-	-	-	-	0.021	-	0.059	-	-	-	-	-	-	-	-	-	0.044	-	0.036	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	<0.4	-	<0.4	-	-	-	-	-	-	-	-	-	<0.4	-	<0.4	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	91.00	-	101.00	-	-	-	-	-	-	-	-	-	75.00	-	122.00	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	<0.50	-	<0.50	-	-	-	-	-	-	-	-	-	<0.50	-	<0.50	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	26.80	-	30.50	-	-	-	-	-	-	-	-	-	28.00	-	30.60	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	4.2	-	4.4	-	-	-	-	-	-	-	-	-	3.8	-	4.4	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	3.2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	0.2	-	0.19	-	-	-	-	-	-	-	-	-	0.2	-	0.23	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-	-	-	-	-	-	-	-	<5	-	9.2	-	-
MICROBIOLOGICAL																															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	2	1	<1	2	<1	-	<1	1	1	2	10	4	3	2	1	<1	<1	<1	<1	<1	1	4	19	1	4	<1	<1
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	w water quality monitoring program				Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality monitoring program							Halifax Water’s ra		
	Note: RWQ - Raw Water Quality (Reference);																														

Sample Name				LMG3 (20811)				LMG3 (20811)					LMG4 (20812)		LMG4 (20812)							LMG4 (20812)									
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake
Sample Location Descriptions			Units	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	ast Lake Brook In	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	460747.99	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81
Northing	-	-	-	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4956075.52	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		14-Dec-12	26-Jan-13	26-Feb-13	19-Mar-13	18-Apr-13	29-May-13	24-Jun-13	31-Jul-13	20-Aug-13	28-Oct-09	30-Nov-09	14-Dec-09	27-Jan-10	Feb-10	18-Mar-10	22-Apr-10	18-May-10	17-Jun-10	28-Jul-10	Aug-10	9-Sep-10	3-Nov-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11
Sampling Time	-	-	hh:mm	10:15	10:56	10:36	10:37	10:25	11:22	11:37	10:43	10:26	11:41	10:25	9:03	13:18	-	11:11	9:15	9:22	9:39	10:14	-	11:51	12:10	-	-	-	-	-	-
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	4.47	1.68	2.09	2.98	6.26	14.22	21.18	23.3	23:49	7.13	5.13	2.63	0.47	-	4.75	7.31	11.83	14.88	19.64	-	21.91	6.13	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	13.39	12.22	11.92	11.68	9.58	10.74	8.9	8.53	8.44	11.87	12.57	14.11	15.58	-	11.97	11.18	10.21	9.24	8.22	-	8.71	11.98	-	-	-	-	-	-
% Air Saturation	-	-	%	103.4	87.6	86.4	86.7	77.5	104.7	100.2	100	99.3	98.1	98.70	103.8	108	-	93.2	92.8	94.4	91.4	89.8	-	99.4	96.6	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	4.12	3.96	3.77	3.91	3.98	4.63	4.52	4.61	4.51	4.11	4.39	4.64	4.51	-	5.03	5.39	6.09	4.88	4.85	-	5	4.27	-	-	-	-	-	-
Specific Conductance	-	-	uS/cm	27	30	32	29	28	28	26	25	24	33	35	34	31	-	24	25	26	32	29	-	34	39	-	-	-	-	-	-
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	0.65	1.87	0.86	0.36	0.79	0.57	0.51	1.24	0.65	0.5	0.51	0.72	0.98	-	0.49	1.31	0.79	0.48	0.84	-	0.28	0.61	-	-	-	-	-	-
INORGANICS																															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	-	-	-	-	5	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	0.12	0.06	0.15	0.059	<0.05	0.053	<0.05	<0.05	-	<0.05	<0.05	<0.05	<0.05	-	<0.05	0.08	<0.05	<0.05	<0.05	-	<0.05	<0.05	-	-	-	-	-	-
Nitrite (N)	-	60.00	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	6.7	7.2	6.7	5.7	6	6	6.3	5.8	-	11	11	8.4	7.2	-	5.3	10	5.7	9.4	4.5	-	4.6	13	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	0.415	-	-	-	-	-	-	-	-	-	-	0.95	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	0.286	-	-	-	-	-	-	-	-	-	-	0.377	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.007	0.008	0.005	0.01	0.017	0.017	<0.02	0.01	-	<0.02	<0.02	<0.02	0.03	-	<0.02	<0.02	0.007	0.004	0.004	-	0.005	0.003	-	-	-	-	-	-
Total Phosphorus Detection Limits										<0.02			<0.02	<0.02	<0.02			<0.02	<0.02												
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	0.251	-	-	-	-	-	-	-	-	-	-	0.425	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	2.84	-	-	-	-	-	-	-	-	-	-	3.22	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	<1	1.4	2	<1	<1	<1	<1	<1	-	<!	1	<1	1	-	<1	3	2	<2	<1	-	<1	<2	-	-	-	-	-	-
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																															
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	320	-	-	-	-	-	-	-	-	-	-	207	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	4.1	-	-	-	-	-	-	-	-	-	-	5.4	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	0.018	-	-	-	-	-	-	-	-	-	-	0.073	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-	-	<0.4	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	108.00	-	-	-	-	-	-	-	-	-	-	93.00	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	<0.50	-	-	-	-	-	-	-	-	-	-	<0.50	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	25.90	-	-	-	-	-	-	-	-	-	-	59.60	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	4.2	-	-	-	-	-	-	-	-	-	-	6.9	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	0.21	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	7.2	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL																															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	<1	<1	<1	<1	<1	<1	<1	<10	-	<1	<1	<1	3	-	<1	<1	2	<1	7	-	2	3	-	-	-	-	-	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	w water quality monitoring program				Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality monitoring program							Halifax Water’s raw water quality monitoring program							Halifax Water’s ra		
	Note: RWQ - Raw Water Quality (Reference);																														

Sample Name				LMG4 (20812)				LMG4 (20812)				LMG5 (20813)			LMG5 (20813)							LMG5 (20813)									
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Soldier Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake
Sample Location Descriptions			Units	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	Lake Gullies Bro	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	458366.81	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82
Northing	-	-	-	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4958208.23	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	16-Nov-11	Dec-11	28-Oct-09	30-Nov-09	14-Dec-09	Jan-10	Feb-10	Mar-10	22-Apr-10	18-May-10	17-Jun-10	28-Jul-10	Aug-10	9-Sep-10	3-Nov-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11
Sampling Time	-	-	hh:mm	-	-	-	-	-	-	11:58	-	10:09	11:00	9:31	-	-	-	11:05	9:44	10:01	10:36	-	12:12	12:26	-	-	-	-	-	-	-
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	-	8.6	-	6.36	5.57	0.73	-	-	-	7.84	11.48	17.29	18.85	-	18.36	6.67	-	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	-	14	11.64	11.51	13.16	15.81	-	-	-	11.32	10.26	9.63	8.87	-	9.05	12.18	-	-	-	-	-	-	-
% Air Saturation	-	-	%	-	-	-	-	-	-	119.9	98.84	93.3	104.6	110.3	-	-	-	95.2	94.1	100.3	95.4	-	96.3	99.5	-	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	4.3	4.79	4.3	4.2	4.35	-	-	-	4.42	4.54	4.32	4.27	-	4.42	4.46	-	-	-	-	-	-	-
Specific Conductance	-	-	uS/cm	-	-	-	-	-	-	30	31.00	33	34	33	-	-	-	28	26	27	27	-	35	37	-	-	-	-	-	-	-
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	-	0.77	0.69	0.59	0.52	0.83	-	-	-	0.57	0.6	0.5	0.62	-	0.4	0.51	-	-	-	-	-	-	-
INORGANICS																															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	-	3	-	-	-	-	-	-	-	4	-	-	-	-	5	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	-	-	-	-	-	<0.05	-	<0.05	<0.05	<0.05	-	-	-	<0.05	<0.05	<0.05	<0.05	-	<0.05	<0.05	-	-	-	-	-	-	-
Nitrite (N)	-	60.00	mg/L	-	-	-	-	-	-	<0.01	-	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	-	9.7	-	12	11	9.5	-	-	-	8.5	6.3	7.4	10	-	8.8	12	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.707	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.383	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	-	-	-	-	-	-	0.014	-	<0.02	<0.02	<0.02	-	-	-	<0.02	0.002	0.005	0.004	-	0.007	0.007	-	-	-	-	-	-	-
Total Phosphorus Detection Limits												<0.02	<0.02	<0.02				<0.02													
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.223	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.32	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	-	-	-	-	-	-	<1	-	<1	1	<1	-	-	-	<1	<1	23	<2	-	<1	<1	-	-	-	-	-	-	-
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																															
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	314	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.017	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.47	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	501.00	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.61	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	59.20	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.3	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.3	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL																															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	-	-	-	-	-	<1	-	<1	1	<1	-	-	-	<1	1	<1	<1	-	3	ND	-	-	-	-	-	-	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	w water quality monitoring program				Halifax Water's raw water quality monitoring program							Halifax Water's raw water quality monitoring program							Halifax Water's raw water quality monitoring program							Halifax Water's ra		
	Note: RWQ - Raw Water Quality (Reference);																														

Sample Name				LMG5 (20813)				LMG5 (20813)			LMG6 (20814)					LMG6 (20814)								LMG6 (20814)							
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Spider Lake	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major
Sample Location Descriptions			Units	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	ider Lake Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I	t Barren Brook I
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	459389.82	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31
Northing	-	-	-	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4956656.04	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	16-Nov-11	Dec-11	28-Oct-09	30-Nov-09	14-Dec-09	27-Jan-10	Feb-10	18-Mar-10	22-Apr-10	18-May-10	17-Jun-10	28-Jul-10	Aug-10	9-Sep-10	3-Nov-10	30-Nov-10	17-Dec-10	26-Jan-11	Feb-11	31-Mar-11	2-May-11	27-May-11	24-Jun-11
Sampling Time	-	-	hh:mm	-	-	-	-	-	12:15	-	13:07	12:45	11:15	11:30	-	15:00	11:00	11:02	11:06	11:55	-	13:24	12:49	10:10	10:57	11:00	-	14:15	13:45	11:04	10:46
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	8.85	-	6.48	6.1	1.65	0.25	-	4.65	5.84	8.47	12.03	19.07	-	18.75	6.07	2.24	2.66	-0.02	-	6.04	9.03	13.32	15
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	14.68	11.65	11.99	12.65	15.1	15.21	-	12.04	11.71	10.91	10.09	9.2	-	9.31	12.81	10.95	12.97	12.08	-	6.31	10.04	9.04	7.58
% Air Saturation	-	-	%	-	-	-	-	-	126.5	-	97.5	101.9	108.1	104.8	-	93.5	93.8	93.2	93.7	99.3	-	99.9	103.1	79.7	95.5	82.6	-	50.7	86.9	86.4	75.2
pH	5.0-9.0	6.5-9	pH	-	-	-	-	-	4.33	4.36	4.97	4.34	4.4	5.72	-	5.44	4.47	4.41	4.25	5.86	-	5.64	5.17	5.08	4.31	5.04	-	5.4	5.32	5.63	5.34
Specific Conductance	-	-	uS/cm	-	-	-	-	-	32	31.20	49	40	40	60	-	67	36	35	33	53	-	74	64	66	90	85	-	79	64	62	49
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	1.23	0.64	0.33	0.31	0.31	1.16	-	0.4	0.31	0.53	0.46	1.08	-	0.47	0.48	0.84	-	1.36	-	0.38	0.65	0.45	0.73
INORGANICS																															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	4	-	-	-	-	-	-	15	5	-	-	-	-	17	-	-	22	18	-	18	15	-	10	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	-	-	-	-	<0.05	-	<0.05	<0.05	<0.05	0.05	-	0.1	<0.05	0.06	<0.05	0.09	-	0.18	<0.05	0.05	<0.05	0.09	-	0.09	<0.05	<0.05	<0.05
Nitrite (N)	-	60.00	mg/L	-	-	-	-	-	<0.01	-	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	11	-	8.8	8.6	6.7	5.4	-	6.2	7	5.8	7.8	11	-	7.1	9.3	5.6	5.8	6.4	-	4.1	6.2	6.4	9.3
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.93	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.812	-	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	-	-	-	-	-	0.014	-	<0.02	<0.02	<0.02	0.02	-	<0.02	<0.02	0.003	0.002	0.022	-	0.016	0.008	0.008	0.015	0.018	-	0.021	0.009	0.014	0.019
Total Phosphorus Detection Limits											<0.02	<0.02	<0.02			<0.02	<0.02														
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.543	-	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.84	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	-	-	-	-	-	1	-	<1	<1	<1	<1	-	<1	<1	1	<2	<2	-	<1	<1	<1	<1	<2	-	ND	3	<1	<1
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																															
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	233	-	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.5	-	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.7	-	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.6	-	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.017	-	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.59	-	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	974.00	-	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.50	-	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	140.00	-	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.2	-	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL																															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	-	-	-	-	3	-	4	<1	<1	<1	-	<1	<1	<1	1	<1	-	<1	3	2	<1	<1	-	<1	3	1	1
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	w water quality monitoring program				Halifax Water's raw water quality monitoring program								Halifax Water's raw water quality monitoring program								Halifax Water's raw water quality monitoring program							
	Note: RWQ - Raw Water Quality (Reference);																														

Sample Name				LMG6 (20814)						LMG6A (2707C)		LMG6A (2707C)								LMG6A (2707C)								LMG6A (2707C)		LMG7 (		
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major
Sample Location Descriptions			Units	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook In	t Barren Brook I	e Drainage or N	e Drainage or N	e Drainage or N
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	461144.31	461144.31	461144.31	461144.31	461144.31	461144.31	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	461127.44	464483.94	464483.94	464483.94
Northing	-	-	-	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4953178.08	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4952861.28	4951734.46	4951734.46	4951734.46
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		29-Jul-11	26-Aug-11	28-Sep-11	27-Oct-11	16-Nov-11	9-Dec-11	23-Jan-12	24-Feb-12	30-Mar-12	30-Apr-12	31-May-12	28-Jun-12	30-Jul-12	29-Aug-12	25-Sep-12	30-Oct-12	29-Nov-12	14-Dec-12	29-Jan-13	26-Feb-13	19-Mar-13	18-Apr-13	29-May-13	24-Jun-13	31-Jul-13	20-Aug-13	29-Oct-09	30-Nov-09	14-Dec-09
Sampling Time	-	-	hh:mm	11:50	11:55	11:50	9:45	13:19	8:50	12:00	11:15	9:36	11:27	9:16	9:39	9:39	9:54	8:51	9:32	9:35	9:24	10:00	9:36	9:32	9:26	10:30	10:46	9:52	9:31	10:59	14:15	12:55
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																													
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	12.9	20.1	14.14	8.03	8.92	4.71	0.01	0.34	3.38	7.5	11.92	16.45	17.45	16.75	14.38	11.69	2.05	1.14	-	0.03	0.04	6.77	13.12	18.43	19.91	18.02	6.57	7.1	2.15
Dissolved Oxygen	-	5.5-9.5	mg/L	-	9.47	10.69	11.98	14.36	11.2	12.77	13.94	12.3	11.57	10.07	8.1	7.61	6.52	7.79	8.65	11.20	11.83	-	9.59	10.63	8.01	10.21	8.45	7.51	7.55	9.28	7.63	10.94
% Air Saturation	-	-	%	-	104.4	104.1	101.2	124	87.1	87.3	96.3	92.3	96.5	93.3	82.9	79.5	67.1	76.2	79.7	81.1	83.5	-	65.5	72.8	65.6	97.1	90	82.4	79.8	70.5	64	81.3
pH	5.0-9.0	6.5-9	pH	6.10	6.34	5.84	5.45	5.34	4.94	4.94	5.17	5.08	4.94	5.06	5.01	5.14	5.33	4.76	6.14	5.81	5.16	-	4.55	5.25	6.57	6.81	5.72	5.63	5.66	6	5.89	5.71
Specific Conductance	-	-	uS/cm	57	53	64	43	40	43	69	59	72	59	60	60	55	68	43	56	59	53	-	100	85	81	74	66	55	61	284	256	115
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	1.03	0.98	0.85	0.97	0.89	2.00	0.49	0.99	0.49	0.61	0.76	1.09	1.02	2.51	0.80	1.44	0.51	0.63	-	0.55	0.53	0.38	0.33	0.49	1.01	0.95	2.41	2.38	5.08
INORGANICS																																
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	8	6	8	-	-	-	-	-	-	-	-	-	-	-	-	-	25	20	20	-	-	-	-	-	56	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	0.07	0.14	0.12	<0.05	<0.05	<0.05	0.13	0.053	0.082	<0.05	<0.05	<0.05	0.061	0.099	<0.05	<0.05	0.052	0.14	-	0.11	0.071	<0.05	<0.05	<0.05	0.064	-	0.17	0.07	0.11
Nitrite (N)	-	60.00	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	0.01	0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	9.5	13	8.1	10	11	9.4	3.7	4.3	3.8	7	6.3	11	10	9.8	14	8	5.5	8.7	-	3	3.9	3.9	5.9	9.1	13	-	2.3	2.4	3.1
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	1.95	-	2.24	-	-	-	-	-	-	-	-	-	2.17	-	1.96	-	-	-	-	-	-	-	-	-	1.98	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	0.795	-	1.02	-	-	-	-	-	-	-	-	-	0.923	-	0.7	-	-	-	-	-	-	-	-	-	0.823	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.031	0.03	0.015	0.012	0.014	0.02	0.011	0.011	0.008	0.005	0.009	0.016	0.022	0.025	0.022	0.001	0.007	0.012	-	0.01	0.012	<0.02	0.01	0.009	0.017	-	<0.02	<0.02	0.03
Total Phosphorus Detection Limits																									<0.02					<0.02	<0.02	
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	0.397	-	0.559	-	-	-	-	-	-	-	-	-	0.387	-	0.463	-	-	-	-	-	-	-	-	-	0.419	-	-	-	-
Total Sodium (Na)	-	-	mg/L	7.48	-	8.02	-	-	-	-	-	-	-	-	-	6.99	-	5.11	-	-	-	-	-	-	-	-	-	7.09	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	1	<1	<1	<2	1	1	<2	1.8	<1	1.6	1.4	<1	1	1.4	<1	1.4	<1	<1	-	<1	<1	<1	<1	<1	<1	-	8.00	5.00	12.00
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																
Total Aluminum (Al)	-	5-100	µg/L	218	-	175	-	-	-	-	-	-	-	-	-	268	-	391	-	-	-	-	-	-	-	-	-	355	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	25.8	-	23.8	-	-	-	-	-	-	-	-	-	29.5	-	20.6	-	-	-	-	-	-	-	-	-	27.5	-	-	-	-
Total Barium (Ba)	-	-	µg/L	3.7	-	3.2	-	-	-	-	-	-	-	-	-	5.9	-	6.6	-	-	-	-	-	-	-	-	-	5.7	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Total Boron (B)	-	-	µg/L	<5	-	<5	-	-	-	-	-	-	-	-	-	<5	-	<5	-	-	-	-	-	-	-	-	-	<5	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	0.331	-	<0.017	-	-	-	-	-	-	-	-	-	0.094	-	0.045	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	0.41	-	0.52	-	-	-	-	-	-	-	-	-	1.66	-	0.83	-	-	-	-	-	-	-	-	-	1.35	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	654.00	-	662.00	-	-	-	-	-	-	-	-	-	904.00	-	626.00	-	-	-	-	-	-	-	-	-	1150.00	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	<0.50	-	<0.50	-	-	-	-	-	-	-	-	-	0.56	-	0.53	-	-	-	-	-	-	-	-	-	0.52	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	70.40	-	135.00	-	-	-	-	-	-	-	-	-	354.00	-	134.00	-	-	-	-	-	-	-	-	-	272.00	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	-	-	-	-	<1	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	9.3	-	10	-	-	-	-	-	-	-	-	-	10.7	-	8.8	-	-	-	-	-	-	-	-	-	9.8	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-
Total Tin (Sn)	-	-	µg/L	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	3.8	-	2.5	-	-	-	-	-	-	-	-	-	3.3	-	<2	-	-	-	-	-	-	-	-	-	2.9	-	-	-	-
Total Uranium (U)	-	-	µg/L	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	-	-	-	-	<0.1	-	-	-	-
Total Vanadium (V)	-	-	µg/L	2.2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	-	-	-	-	<2	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	<5	-	<5	-	-	-	-	-	-	-	-	-	5.7	-	14	-	-	-	-	-	-	-	-	-	<5	-	-	-	-
MICROBIOLOGICAL																																
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	24	2	<1	<1	<1	2	<1	<1	<1	1	8	41	12	6	13	<1	2	<1	-	<1	1	2	<1	<1	10	-	1	<1	<1
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																																
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	Halifax Water's raw water quality monitoring program								Halifax Water's raw water quality monitoring program								Halifax Water's raw water quality monitoring program								Halifax Water's raw water quality monitoring				
	Note: RWQ - Raw Water Quality (Reference);																															

Sample Name				20815)			LMG7 (20815)									LMG7 (20815)									LMG7 (20815)										
Lake Name	**CCME Guideline (RWQ)**	**CCME Guidelines (FWAL)**	**Units**	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major
Sample Location Descriptions				Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94
Northing	-	-	-	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		27-Jan-10	25-Feb-10	12-Mar-10	21-Apr-10	13-May-10	23-Jun-10	21-Jul-10	20-Aug-10	21-Sep-10	29-Oct-10	18-Nov-10	2-Dec-10	24-Jan-11	Feb-11	17-Mar-11	18-Apr-11	27-May-11	24-Jun-11	29-Jul-11	26-Aug-11	Sep-11	27-Oct-11	16-Nov-11	9-Dec-11	23-Jan-12	24-Feb-12	30-Mar-12	30-Apr-12	31-May-12	28-Jun-12	30-Jul-12	29-Aug-12
Sampling Time	-	-	hh:mm	10:40	12:10	11:08	11:00	14:20	14:20	11:14	10:38	10:22	10:24	10:07	10:22	9:50	-	9:53	9:20	13:26	13:15	13:10	11:10	-	11:25	14:59	11:00	11:25	10:55	11:20	13:37	11:09	11:27	11:20	11:37
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																																
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	1.41	1.76	2.08	9.59	11.12	13.3	16.54	17.01	13.27	11.49	9.34	7.53	2.56	-	4.83	4.59	13.26	13.42	10.6	17.4	-	8.7	10.08	5.44	1.1	4.71	3.38	9.28	11.69	14.98	16.03	16.51
Dissolved Oxygen	-	5.5-9.5	mg/L	8.23	7.5	6.6	6.37	1.42	4.04	4.87	1.11	2.11	5.34	6.49	3.1	5.97	-	6.85	3.76	4.44	3.51	-	2.29	-	5.02	2.33	7.7	6.65	11.2	7.66	6.57	6.76	7.39	8.48	5.57
% Air Saturation	-	-	%	58.6	53.9	47.8	55.9	12.9	38.6	49.9	11.5	20.2	49.1	56.6	25.9	43.8	-	53.4	29.2	42.4	33.6	-	24	-	43.2	20.7	61	46.9	87.1	57.5	57.3	62.4	73.3	86.0	57.1
pH	5.0-9.0	6.5-9	pH	6	6.36	6.27	6.19	6.23	6.23	6.16	5.97	6.18	5.5	5.82	5.84	6.47	-	5.84	6.06	6.29	6.09	6.33	6.13	-	6.28	6.31	6.29	5.97	4.94	5.94	5.91	6.06	5.72	5.72	5.70
Specific Conductance	-	-	uS/cm	356	331	336	155	352	335	190	313	311	327	266	238	218	-	159	259	252	277	210	318	-	228	1143	174	192	43	246	311	256	261	210	244
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	2.59	1.65	1.01	1.57	4.15	4.96	9.03	3.57	18.2	7.35	3.67	3.21	0.56	-	1.71	0.51	2.33	5.48	8.92	19.6	-	8.34	4.2	3.37	4.83	2.17	1.75	3.53	5.74	14.8	13.8	12.8
INORGANICS																																			
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	72	72	66	-	76	-	-	-	-	53	-	67	-	64	-	-	-	-	-	-	-	-	27	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	0.13	<0.05	0.07	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	0.12	-	0.07	0.06	0.06	<0.05	<0.05	<0.05	-	<0.05	<0.05	0.06	<0.05	<0.05	0.066	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite (N)	-	60.00	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	1.8	3.8	3.4	3.3	4.7	3.9	4.9	6	5.1	3.5	4.6	2.6	3.2	-	4.2	2.7	3.8	4.7	9.6	12	-	3.9	3.5	3	2.3	3.4	2.7	3.5	4.1	5.8	5	5.5
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	7.85	-	8.41	-	-	-	-	-	7.13	-	-	7.53	7.08	9.34	-	-	-	-	-	-	-	-	-	6.1	6.88	6.72
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	1.86	-	1.86	-	-	-	-	-	1.73	-	-	1.81	1.69	2.17	-	-	-	-	-	-	-	-	-	1.56	1.65	1.66
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	<0.02	0.02	<0.02	<0.02	0.019	0.019	0.017	0.017	0.023	0.022	0.02	0.015	0.025	-	0.029	0.013	0.016	0.028	0.03	0.025	-	0.022	0.027	0.025	0.025	0.025	0.016	0.008	0.018	0.019	0.034	0.025
Total Phosphorus Detection Limits				<0.02		<0.02	<0.02																												
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	1.14	-	2.64	-	-	-	-	-	1.85	-	-	0.93	1.03	1.47	-	-	-	-	-	-	-	-	-	1.81	1.61	2.32
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	38.80	-	49.30	-	-	-	-	-	39.60	-	-	35.50	28.00	31.70	-	-	-	-	-	-	-	-	-	34.40	33.20	30.40
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	7.00	3.00	8.00	4.00	15.00	13.00	17.00	180.00	19.00	12.00	6.00	3.00	ND	-	9.00	2.00	7.00	14.00	47.00	36.00	-	16.00	9.00	7.00	8.40	9.20	7.50	6.00	15.00	30.00	30.00	38.00
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																			
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																			
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	51.2	-	60.7	-	-	-	-	-	236	-	-	52.5	105	86.5	-	-	-	-	-	-	-	-	-	50.9	61.5	56.5
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	<1	-	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	<1	<1	<1
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	2.3	-	2.4	-	-	-	-	-	<1	-	-	2	3.8	4	-	-	-	-	-	-	-	-	-	2.3	3	3.8
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	21.3	-	21.3	-	-	-	-	-	14.8	-	-	17	17.9	20.1	-	-	-	-	-	-	-	-	-	14	14.5	15.7
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	<1	-	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	<1	<1	<1
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	<2	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	9	-	10	-	-	-	-	-	<5	-	-	<5	<5	<5	-	-	-	-	-	-	-	-	-	<5	<5	<5
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	<0.017	-	<0.017	-	-	-	-	-	0.068	-	-	0.034	0.053	<0.017	-	-	-	-	-	-	-	-	-	0.384	0.061	0.361
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	<1	-	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	<1	<1	<1
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	2.35	-	1.22	-	-	-	-	-	3.39	-	-	2.07	2.56	3.89	-	-	-	-	-	-	-	-	-	0.71	1.16	0.59
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	3.1	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	9450.00	-	16100.00	-	-	-	-	-	4180.00	-	-	9090.00	20400.00	30100.00	-	-	-	-	-	-	-	-	-	8480.00	11700.00	13700.00
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	<0.50	-	<0.50	-	-	-	-	-	<0.50	-	-	<0.50	<0.50	<0.50	-	-	-	-	-	-	-	-	-	<0.50	<0.50	<0.50
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	1610.00	-	1400.00	-	-	-	-	-	866.00	-	-	1420.00	2160.00	3450.00	-	-	-	-	-	-	-	-	-	927.00	1200.00	869.00
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	<2	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	6.1	-	<2	-	-	-	-	-	7.0	-	-	2.8	<2	2.7	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	<1	-	<1	-	-	-	-	-	<1	-	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	<1	<1	<1
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	<0.1	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	24.9	-	23.4	-	-	-	-	-	17.8	-	-	20.9	19.2	24.3	-	-	-	-	-	-	-	-	-	17.7	19.2	19.8
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	<0.1	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	<2	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	2.4	-	-	2.6	4.7	<2	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	<0.1	-	<0.1	-	-	-	-	-	<0.1	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	<2	-	<2	-	-	-	-	-	<2	-	-	<2	<2	<2	-	-	-	-	-	-	-	-	-	<2	<2	<2
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	6.9	-	9.7	-	-	-	-	-	18.0	-	-	10.9	5.4	21	-	-	-	-	-	-	-	-	-	7.9	7.2	15.2
MICROBIOLOGICAL																																			
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	<1	<1	<1	<1	<1	5	25	1	5	<1	<1	<1	<1	-	<1	<1	<2	9	9	2	-	<1	<1	<1	<1	<1	<1	<1	<1	4	12	8
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																																			
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	program			Halifax Water's raw water quality monitoring program									Halifax Water's raw water quality monitoring program									Halifax Water's raw water quality monitoring program										
	Note: RWQ - Raw Water Quality (Reference);																																		

Sample Name				LMG7 (20815)						LMG7 (20815)					
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)	Units	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major	Lake Major
Sample Location Descriptions				Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N	Drainage or N
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream	Stream
Easting	-	-	-	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94	464483.94
Northing	-	-	-	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46	4951734.46
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		25-Sep-12	30-Oct-12	29-Nov-12	14-Dec-12	29-Jan-13	26-Feb-13	19-Mar-13	18-Apr-13	29-May-13	24-Jun-13	31-Jul-13	20-Aug-13
Sampling Time	-	-	hh:mm	10:42	11:03	11:03	10:53	11:30	11:15	11:23	11:18	11:53	12:13	11:17	11:06
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-												
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	14.49	12.25	3.34	2.41	-	1.08	0.76	6.35	14.08	16.31	17.09	16.11
Dissolved Oxygen	-	5.5-9.5	mg/L	7.72	8.01	11.12	14.04	-	7.68	7.89	6.72	7.85	6.33	4.42	5.49
% Air Saturation	-	-	%	75.8	74.7	83.4	102.7	-	54.2	55.2	54.5	76.3	64.6	45.9	55.8
pH	5.0-9.0	6.5-9	pH	5.45	5.62	5.33	5.02	-	5.23	5.46	5.73	5.87	6	6.19	6.11
Specific Conductance	-	-	uS/cm	267	187	181	184	-	325	354	154	248	230	201	104
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	3.98	8.19	2.29	2.29	-	2.63	3.35	1.4	1.74	2.51	12.2	8.8
INORGANICS															
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	78	81	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	0.064	0.095	0.011	0.13	-	0.091	0.098	0.14	<0.05	<0.05	<0.05	-
Nitrite (N)	-	60.00	mg/L	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	4.7	4.2	2.6	2.5	-	2.4	2.1	2.5	3.2	4.7	6.4	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	7.32	6.51	6.01	5.77	-	-	-	6.47	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	1.71	1.75	1.65	1.61	-	-	-	1.63	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.023	0.008	0.008	0.009	-	0.008	0.017	0.018	0.017	0.009	0.022	-
Total Phosphorus Detection Limits															
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	1.65	2.86	2.05	2.07	-	-	-	2.70	-	-	-	-
Total Sodium (Na)	-	-	mg/L	35.60	23.00	19.60	21.70	-	-	-	33.80	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	9.60	13.00	4.40	4.40	-	3.40	<1	<1	1.80	3.40	13.00	-
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters															
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)															
Total Aluminum (Al)	-	5-100	µg/L	335	69.1	24.5	46.2	-	-	-	32.2	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	<1	<1	<1	<1	-	-	-	<1	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	1.3	2.3	1.2	<1	-	-	-	<1	-	-	-	-
Total Barium (Ba)	-	-	µg/L	15.3	12.9	11.4	12.3	-	-	-	15.6	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	<1	<1	<1	<1	-	-	-	<1	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	<2	<2	<2	<2	-	-	-	<2	-	-	-	-
Total Boron (B)	-	-	µg/L	<5	<5	<5	<5	-	-	-	<5	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	0.313	0.256	<0.017	0.024	-	-	-	0.155	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	<1	<1	<1	<1	-	-	-	<1	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	3.11	0.83	0.61	0.86	-	-	-	0.53	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	3.5	<2	<2	<2	-	-	-	<2	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	3300.00	7450.00	4450.00	3990.00	-	-	-	2660.00	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	<0.50	<0.50	<0.50	<0.50	-	-	-	<0.50	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	562.00	770.00	803.00	798.00	-	-	-	589.00	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	<2	<2	<2	<2	-	-	-	<2	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	<2	<2	<2	<2	-	-	-	<2	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	<1	<1	<1	<1	-	-	-	<1	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	18.3	17.5	16.3	15.3	-	-	-	17.7	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	-	-	-	-
Total Tin (Sn)	-	-	µg/L	<2	<2	<2	<2	-	-	-	<2	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	<2	3	<2	<2	-	-	-	<2	-	-	-	-
Total Uranium (U)	-	-	µg/L	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	-	-	-	-
Total Vanadium (V)	-	-	µg/L	<2	<2	<2	<2	-	-	-	<2	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	20.9	51.6	14.9	11.4	-	-	-	15.1	-	-	-	-
MICROBIOLOGICAL															
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	16	5	<1	<1	-	<1	<1	<1	<1	13	10	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS															
Biochemical Oxygen Demand	-	-	(mg/L)	-	-	-	-	-	-	-	-	-	-	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	Halifax Water's raw water quality monitoring program						Halifax Water's raw water quality monitoring program					
	Note: RWQ - Raw Water Quality (Reference);														

Sample Name	North Preston WWTF			North Preston WWTF								
Lake Name	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake
Sample Location Descriptions	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
Easting	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Northing	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Applicable Watershed	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	4-Jan-12	10-Jan-12	12-Jan-12	13-Jan-12	17-Jan-12	24-Jan-12	3-Feb-12	7-Feb-12	14-Feb-12	23-Feb-12	28-Feb-12	1-Mar-12
Sampling Time	-	-	-	-	-	-	-	-	-	-	-	-
Sampled By / Data Source	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA												
Depth	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	-	-	-	-	-	-	-	-	-	-	-	-
% Air Saturation	-	-	-	-	-	-	-	-	-	-	-	-
pH	6.18	6.00	-	6.44	6.19	6.68	6.94	6.96	7.05	6.67	6.98	6.97
Specific Conductance	-	-	-	-	-	-	-	-	-	-	-	-
TDS	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	-	-	-	-	-	-	-	-	-	-	-	-
INORGANICS												
Total Alkalinity (as CaCO3)	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	-	-	-	-	-	-	-	-	-	-
Colour	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (N)	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	2.20	2.10	2.50	-	4.20	3.00	1.50	2.10	1.60	1.00	2.00	1.40
Nitrogen TKN - water (as N)	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	0.38	0.20	0.22	-	0.19	0.26	0.21	0.20	0.28	0.25	0.24	0.27
Total Phosphorus Detection Limits												
Total Phosphorus (1M depth)	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	15.00	8.00	8.00	-	6.50	3.60	5.60	5.20	3.00	7.20	5.60	4.60
Dissolved Sulphate (SO4)	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters												
Anion Sum	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)												
Total Aluminum (Al)	-	-	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	-	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	-	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	-	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	-	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	-	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	-	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	-	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	-	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	-	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	-	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	-	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	-	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	-	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL												
Total coliform	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	< 100	< 100	< 100	-	< 1.0	< 100	< 100	< 1.0	< 100	< 100	< 100	< 100
Chlorophyll A - Acidification method	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS												
Biochemical Oxygen Demand	5.00	< 5	4.60	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 2.0	4.80	2.70
Disolved Organic Carbon	-	-	-	-	-	-	-	-	-	-	-	-
Source	Halifax Water 's 2012/2013 Effluent Data			Halifax Water 's 2012/2013 Effluent Data								

Sample Name	North Preston WWTF								
Lake Name	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake
Sample Location Descriptions	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-
Sample Type	SW	SW	SW	SW	SW	SW	SW	SW	SW
	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
Easting	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Northing	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Applicable Watershed	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	6-Mar-12	19-Mar-12	21-Mar-12	27-Mar-12	29-Mar-12	3-Apr-12	5-Apr-12	17-Apr-12	25-Apr-12
Sampling Time	-	-	-	-	-	-	-	-	-
Sampled By / Data Source	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA									
Depth	-	-	-	-	-	-	-	-	-
Secchi Depth	-	-	-	-	-	-	-	-	-
Temp	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	-	-	-	-	-	-	-	-	-
% Air Saturation	-	-	-	-	-	-	-	-	-
pH	6.89	6.50	-	6.99	6.77	6.57	7.52	7.19	6.56
Specific Conductance	-	-	-	-	-	-	-	-	-
TDS	-	-	-	-	-	-	-	-	-
Salinity	-	-	-	-	-	-	-	-	-
Turbidity	-	-	-	-	-	-	-	-	-
INORGANICS									
Total Alkalinity (as CaCO3)	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	-	-	-	-	-	-	-
Colour	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	-	-	-	-	-	-	-	-
Nitrite (N)	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	1.20	0.78	0.68	0.60	0.58	0.75	0.50	0.45	0.42
Nitrogen TKN - water (as N)	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	-	-	-	-	-	-	-
pH (Lab)	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	-	-	-	-	-	-	-
Total Phosphorus	1.10	0.91	0.23	0.72	0.36	0.22	0.21	0.30	1.10
Total Phosphorus Detection Limits									
Total Phosphorus (1M depth)	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	-	-	-	-	-	-	-
Total Suspended Solids	12.00	22.00	6.20	27.00	18.00	6.00	4.20	5.60	24.00
Dissolved Sulphate (SO4)	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	-	-	-	-	-	-	-
Calculated Parameters									
Anion Sum	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)									
Total Aluminum (Al)	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL									
Total coliform	-	-	-	-	-	-	-	-	-
E. Coli	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	-	-	-	-	-	-	-
Fecal Coliform	100.00	< 100	-	< 100	< 100	< 100	< 10	< 100	< 100
Chlorophyll A - Acidification method	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	-	-	-	-	-	-	-
ORGANICS									
Biochemical Oxygen Demand	4.30	5.60	2.40	7.10	5.20	2.40	2.00	< 5.0	6.70
Disolved Organic Carbon	-	-	-	-	-	-	-	-	-
Source	Halifax Water 's 2012/2013 Effluent Data								

Sample Name				North Preston WWTF									North Preston WWTF									North Preston WWTF								North Preston WWTF						
Lake Name	**CCME Guideline (RWQ)**	**CCME Guidelines (FWAL)**		Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake
Sample Location Descriptions			**Units**	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
Easting	-	-	-	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Northing	-	-	-	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		30-Apr-12	3-May-12	8-May-12	15-May-12	17-May-12	30-May-12	8-Jun-12	13-Jun-12	19-Jun-12	25-Jun-12	27-Jun-12	4-Jul-12	10-Jul-12	12-Jul-12	17-Jul-12	24-Jul-12	14-Aug-12	16-Aug-12	21-Aug-12	22-Aug-12	23-Aug-12	28-Aug-12	6-Sep-12	12-Sep-12	18-Sep-12	20-Sep-12	25-Sep-12	2-Oct-12	4-Oct-12	12-Oct-12	16-Oct-12	31-Oct-12	2-Nov-12
Sampling Time	-	-	hh:mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Wate	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																																	
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Air Saturation	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	6.88	7.21	6.80	6.02	6.47	6.61	6.56	7.09	6.57	6.26	6.76	7.09	6.21	6.64	6.56	6.50	6.56	6.30	6.76	6.69	-	6.72	6.86	6.04	6.56	6.26	6.48	6.10	6.26	6.36	6.46	7.02	6.38
Specific Conductance	-	-	uS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INORGANICS																																				
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (N)	-	60.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	2.30	0.21	0.41	1.20	1.20	0.75	0.42	0.46	0.83	0.92	1.10	0.19	0.18	0.22	0.15	0.14	0.23	0.39	3.30	-	3.10	4.70	0.44	0.26	0.39	0.29	0.29	0.55	2.10	0.34	0.33	0.61	0.50
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.30	0.21	0.24	0.28	0.32	0.44	0.55	0.52	0.83	0.86	0.69	0.47	0.49	0.51	0.71	0.62	0.52	0.77	0.29	-	0.26	0.28	0.42	0.24	0.23	0.18	0.40	0.20	0.20	0.19	0.15	0.17	0.23
Total Phosphorus Detection Limits																																				
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	9.20	3.80	2.00	3.40	1.80	3.60	4.00	2.60	3.70	3.60	3.60	< 1.0	1.00	2.60	2.60	2.80	3.60	1.60	7.60	-	6.00	2.80	4.40	7.40	3.50	3.40	9.00	3.40	3.80	5.00	2.40	3.50	5.20
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																				
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																				
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL																																				
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100		< 100	< 100	100.00	200.00	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																																				
Biochemical Oxygen Demand	-	-	(mg/L)	2.30	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	2.80	< 5.0	3.90	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	Halifax Water 's 2012/2013 Effluent Data									Halifax Water 's 2012/2013 Effluent Data									Halifax Water 's 2012/2013 Effluent Data								Halifax Water 's 2012/2013 Effluent Data						
	Note: RWQ - Raw Water Quality (Reference);																																			

Sample Name						North Preston WWTF									North Preston WWTF									North Preston WWTF									No			
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake
Sample Location Descriptions			Units	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
Easting	-	-	-	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Northing	-	-	-	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		7-Nov-12	14-Nov-12	21-Nov-12	28-Nov-12	3-Dec-12	12-Dec-12	18-Dec-12	19-Dec-12	14-Jan-13	16-Jan-13	21-Jan-13	25-Jan-13	28-Jan-13	29-Jan-13	7-Feb-13	8-Feb-13	15-Feb-13	20-Feb-13	25-Feb-13	1-Mar-13	5-Mar-13	14-Mar-13	18-Mar-13	20-Mar-13	3-Apr-13	11-Apr-13	19-Apr-13	23-Apr-13	25-Apr-13	2-May-13	6-May-13	8-May-13	14-May-13
Sampling Time	-	-	hh:mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water
FIELD DATA		x	-																																	
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
% Air Saturation	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	7.39	6.75	6.68	7.11	9.32	6.34	6.20	6.30	6.95	7.13	6.99	8.05	6.99	7.09	7.25	7.67	6.47	7.46	9.86	7.02	6.78	6.50	7.69	7.44	12.29	7.55	6.66	6.49	6.73	5.71	6.36	8.05	6.97
Specific Conductance	-	-	uS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INORGANICS																																				
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite (N)	-	60.00	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	0.33	0.21	0.71	0.70	4.00	0.22	1.80	2.20	6.50	3.80	7.30	6.40	4.20	3.30	5.70	4.10	2.60	2.70	4.20	4.30	6.00	0.46	1.90	2.90	2.00	1.20	0.41	0.51	0.34	0.27	0.16	0.15	2.60
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.17	0.16	0.25	0.19	0.98	0.33	0.40	1.00	0.26	0.25	0.67	0.51	0.20	0.19	0.25	0.21	0.40	0.36	0.23	0.33	0.71	0.24	0.20	0.14	0.76	0.19	0.13	0.23	0.26	0.26	0.21	0.24	0.80
Total Phosphorus Detection Limits																																				
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	5.40	3.80	3.80	4.30	11.00	11.00	7.80	10.00	4.60	8.40	15.00	7.90	3.70	4.20	6.60	3.00	9.00	5.80	3.80	5.70	8.00	5.20	3.40	2.00	6.00	3.40	2.20	1.40	1.60	2.60	2.80	3.20	5.40
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters																																				
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)																																				
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL																																				
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	30.00	< 10	< 10	< 100	< 10	10.00	< 10	< 10	< 10	< 10	< 10	< 10	< 10	10.00	< 10	900.00	< 10	< 1.0	< 10	< 10	< 1.0	< 10	1.00	< 10
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ORGANICS																																				
Biochemical Oxygen Demand	-	-	(mg/L)	< 5.0	< 5.0	3.60	< 5.0	18.00	< 5.0	5.20	12.00	5.70	5.10	10.00	13.00	< 5.0	3.40	< 5.0	< 5.0	5.20	7.40	5.90	< 5.0	17.00	< 5.4	< 5.0	< 5.0	4.40	< 5.0	< 5.0	< 5.0	< 5.0	4.30	2.80	3.20	< 5.3
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-			Halifax Water 's 2012/2013 Effluent Data									Halifax Water 's 2012/2013 Effluent Data									Halifax Water 's 2012/2013 Effluent Data									Halifax Wat			
	Note: RWQ - Raw Water Quality (Reference);																																			

Sample Name				rth Preston WWTF					North Preston WWTF					
Lake Name	CCME Guideline (RWQ)	CCME Guidelines (FWAL)		Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake	Winder Lake
Sample Location Descriptions			Units	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston	North Preston
Lab or Field QA/QC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sample Type	-	-	-	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
				Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent	Effluent
Easting	-	-	-	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Northing	-	-	-	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
Applicable Watershed	-	-	-	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston	Preston
Sampling Date	-	-		22-May-13	14-Jun-13	17-Jun-13	18-Jun-13	20-Jun-13	25-Jun-13	3-Jul-13	5-Jul-13	9-Jul-13	17-Jul-13	23-Jul-13
Sampling Time	-	-	hh:mm	-	-	-	-	-	-	-	-	-	-	-
Sampled By / Data Source	-	-	-	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Water	Halifax Wate	Halifax Wate	Halifax Wate	Halifax Water	Halifax Water
FIELD DATA		x	-											
Depth	-	-	Meters	-	-	-	-	-	-	-	-	-	-	-
Secchi Depth	1.20	-	Meters	-	-	-	-	-	-	-	-	-	-	-
Temp	-	-	Celsius	-	-	-	-	-	-	-	-	-	-	-
Dissolved Oxygen	-	5.5-9.5	mg/L	-	-	-	-	-	-	-	-	-	-	-
% Air Saturation	-	-	%	-	-	-	-	-	-	-	-	-	-	-
pH	5.0-9.0	6.5-9	pH	7.04	6.71	6.80	7.20	6.58	6.46	6.51	7.69	6.62	6.31	7.14
Specific Conductance	-	-	uS/cm	-	-	-	-	-	-	-	-	-	-	-
TDS	-	-	g/L	-	-	-	-	-	-	-	-	-	-	-
Salinity	-	-	ppt	-	-	-	-	-	-	-	-	-	-	-
Turbidity	50	-	NTU	-	-	-	-	-	-	-	-	-	-	-
INORGANICS														
Total Alkalinity (as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Alkalinity	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Dissolved Chloride (Cl)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Colour	-	-	TCU	-	-	-	-	-	-	-	-	-	-	-
Nitrite + Nitrate	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Nitrate (N)	-	13000.00	mg/L	-	-	-	-	-	-	-	-	-	-	-
Nitrite (N)	-	60.00	mg/L	-	-	-	-	-	-	-	-	-	-	-
Nitrogen (Ammonia Nitrogen)	-	19.00	mg/L	0.14	2.70	1.40	1.90	0.14	0.33	0.66	0.76	2.60	-	-
Nitrogen TKN - water (as N)	-	-		-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Orthophosphate (as P)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
pH (Lab)	5.0-9.0	6.5-9	pH	-	-	-	-	-	-	-	-	-	-	-
Total Calcium (Ca)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Magnesium (Mg)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Dissolved Phosphorus	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	-	-	mg/L	0.30	0.22	0.20	0.17	0.12	0.27	0.45	0.28	0.24	-	-
Total Phosphorus Detection Limits														
Total Phosphorus (1M depth)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus (Deep)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Potassium (K)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Sodium (Na)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Reactive Silica (SiO2)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	-	-	mg/L	3.60	3.40	3.40	3.40	3.40	4.20	7.40	4.20	4.60	-	-
Dissolved Sulphate (SO4)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Lab Turbidity (NTU)	50.00	-	NTU	-	-	-	-	-	-	-	-	-	-	-
Conductivity (uS/cm)	-	-	µS/cm	-	-	-	-	-	-	-	-	-	-	-
Calculated Parameters														
Anion Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-
Bicarb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Calculated TDS	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Carb. Alkalinity (calc. as CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Cation Sum	-	-	me/L	-	-	-	-	-	-	-	-	-	-	-
Hardness (CaCO3)	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Ion Balance (% Difference)	-	-	%	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-
Langelier Index (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 20C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-
Saturation pH (@ 4C)	-	-	N/A	-	-	-	-	-	-	-	-	-	-	-
Metals (ICP-MS)														
Total Aluminum (Al)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Antimony (Sb)	-	5-100	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Arsenic (As)	-	5.00	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Barium (Ba)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Beryllium (Be)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Bismuth (Bi)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Boron (B)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Cadmium (Cd)	-	0.02	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Chromium (Cr)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Cobalt (Co)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Copper (Cu)	-	2.0-4.0	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Iron (Fe)	-	300.00	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Lead (Pb)	-	1.0-7.0	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Manganese (Mn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Molybdenum (Mo)	-	73.00	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Nickel (Ni)	-	25-150	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Selenium (Se)	-	1.00	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Silver (Ag)	-	0.10	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Strontium (Sr)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Thallium (Tl)	-	0.80	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Tin (Sn)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Titanium (Ti)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Uranium (U)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Vanadium (V)	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Total Zinc (Zn)	-	30.00	µg/L	-	-	-	-	-	-	-	-	-	-	-
MICROBIOLOGICAL														
Total coliform	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-
E. Coli	-	-	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	400	MPN/100mL	-	-	-	-	-	-	-	-	-	-	-
Fecal Coliform	-	-	CFU/100 ml	< 10	< 10	< 10	10.00	1.00	< 10	< 1.0	< 1.0	< 10	< 1.0	< 10
Chlorophyll A - Acidification method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A - Welschmeyer method	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Chlorophyll A	-	-	µg/L	-	-	-	-	-	-	-	-	-	-	-
Pheophytin A	-	-	µg chl eq/L	-	-	-	-	-	-	-	-	-	-	-
ORGANICS														
Biochemical Oxygen Demand	-	-	(mg/L)	4.30	< 5.0	< 5.0	< 5.0	< 5.0	2.80	5.60	5.10	5.00	-	-
Disolved Organic Carbon	-	-	mg/L	-	-	-	-	-	-	-	-	-	-	-
Source	-	-	-	er 's 2012/2013 Effluent Data					Halifax Water 's 2012/2013 Effluent Data					
	Note: RWQ - Raw Water Quality (Reference);													

Appendix B

Water Quality Evaluation

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1. Lake Chemistry and Water Quality

1.1 Lake Chemistry

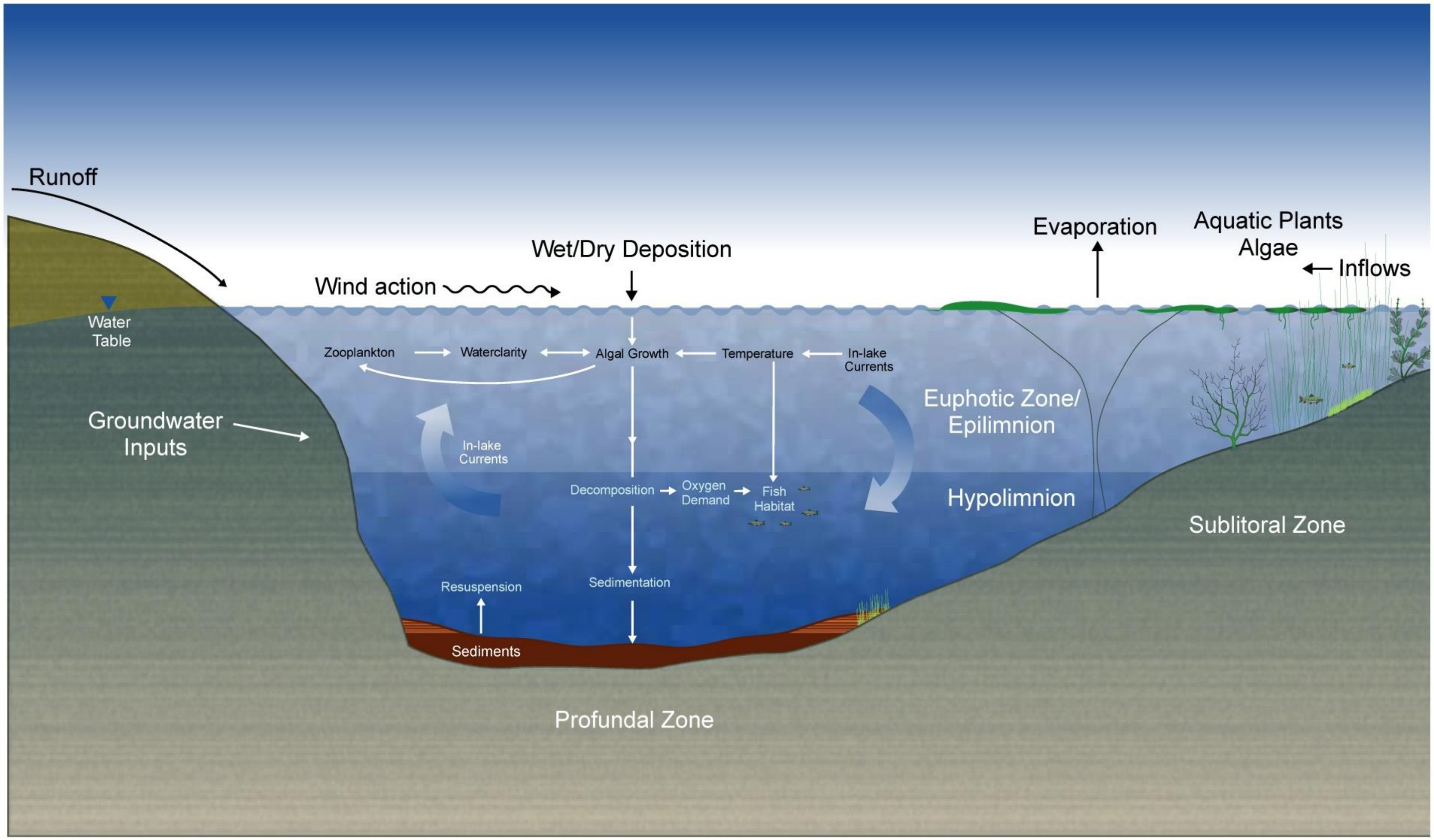
Lakes are central ecological and hydrological components of most watersheds. Lake chemistry is a function of the inflow of surface waters (and hence upstream activities), groundwater discharge to the lake, deposition to the lake surface from the atmosphere, and the deposition and re-suspension of lake bottom sediments. All these processes are modified by the interaction of biological, physical, and chemical activities or processes within the lake. The processes and functions that are important to understanding lake chemistry are illustrated in **Figure B-1.**

Large lakes may have complex water quality patterns due to diverse and chemically distinct inflows from creeks and rivers combined with complex basin shapes. Water circulation through the lake is a core physical process that controls lake water quality. Lake water circulation results from currents generated from inflows, wind, and currents that result when water masses within the lake have different densities. Density currents most commonly occur in response to water masses of different temperatures within a lake.

Deeper lakes in temperate climates undergo a seasonal cycle of thermal stratification, which creates gradients of temperature and dissolved oxygen within the lake. When a lake is of uniform temperature, water is easily circulated throughout its entire depth by wind-driven mixing. This is referred to as “lake overturn” and occurs in the spring and the autumn when lakes warm or cool to approximately 4°C, the temperature at which water is most dense. At this temperature, surface waters sink to the bottom and wind action promotes mixing of the entire water column, exposing the waters to the atmosphere and re-oxygenating the lake. As the lake warms in the summer (or cools in the winter) a density gradient is re-established, with less dense waters at the surface. Throughout much of the year, a deep lake is thermally stratified due to either heating or cooling at the surface. The boundary between warm and cold waters in a lake is called the “thermocline”, and is governed by the water clarity (depth of solar penetration) and the depth to which waters are mixed by the wind. The thermocline isolates water below from the water above such that no further mixing or turnover occurs after stratification. As a result, oxygen concentrations can be depleted, becoming anoxic (< 0.5 mg/L dissolved oxygen) in the deep waters of lakes (hypolimnion) during the summer and winter as decomposition of organic matter consumes the oxygen in the water. This has implications for aquatic life that require oxygen to live, and may also result in the production of toxic compounds, and the release of phosphorus from the sediments to the overlying water. The reduced oxygen concentrations persist in the hypolimnion until the next period of lake overturn, at which time the entire water column is again mixed. At this time, phosphorus accumulated in the hypolimnion is mixed with the surface waters of the lake.

Lake ice cover is another important physical process. On larger lakes, ice generally forms later than in small lakes due to the greater heat storage of larger water bodies, but will remain in place until spring. Once ice is formed, the lake water is isolated from oxygen exchange with the atmosphere and from mixing by the wind. As a result, no oxygen replenishment occurs and the lake may become anoxic under ice cover. The length of ice cover can significantly influence the water quality of the lake. Within the Preston Area, ice cover on lakes is typically of short duration and so winter oxygen depletion is less common than in more continental climates.

Figure B-1. Lake Processes



LEGEND

Schematic Diagram of Lake Processes
that Influence Water Quality

Schematic
Cross-Section

Designed By:	DLS	Drawn By:	SBB
Checked By:	DLS	Approved By:	DLS
Date Issued:	November 2013	Project No.:	60303077

AECOM

FIGURE
B-1

N:\Projects\2004\41255\2005\Final\Images\Fig3.2

1.2 Water Quality

There is no single or simple measure of water quality. Surface waters naturally contain a wide variety of dissolved and suspended substances, and human activities inevitably add to this mixture. As a result, researchers have developed various approaches to measuring water quality. A single water sample may be tested for a few substances, or for a few hundred, depending on the objectives or concerns at the time of the study. Scientists may also study aquatic organisms and the bottom sediments of lakes and rivers to help assess the overall quality of freshwater systems.

Among the many substances found in water, specific indicators of water quality include:

a) ***Physical Characteristics*** such as temperature, dissolved oxygen, colour, Dissolved Organic Carbon (DOC), Total Suspended Solids (TSS) and turbidity. Temperature and dissolved oxygen are largely driven by lake morphometry (shape and structure of the lake basin) and climate but dissolved oxygen can be altered by excessive nutrient load and the introduction of oxygen demanding substances to a lake. Colour and DOC are governed by the organic content of water and result from the decomposition of vegetation in a lake and its watershed. Lakes with a large amount of wetland in their watershed will have high levels of colour and DOC while lakes that are groundwater dominated will have lower concentrations. TSS and turbidity are added by particles of soil or algal cells in the water column that reduce water clarity. They are indicators of urban runoff, algal growth and, indirectly, light transmission through the water column since light stimulates algae populations.

b) ***Chemical Characteristics****:*

1. ***General Water Chemistry:***
   Alkalinity, pH, total hardness, conductivity, anions (chlorides, sulphide, and iron), and cations (calcium, magnesium, and sodium) help to characterize and differentiate each lake. They generally reflect the characteristics of geology and soils in the watershed of a lake, and the relative importance of groundwater (which is more highly mineralized) and surface water (which is less mineralized). The pH is a measure of the acidity or alkalinity of a water body. Lower alkalinity waters (pH<7) typifies the Preston area watershed lakes. The higher levels of alkalinity “buffer” or protect a water body against changes in pH from the addition of acidic substances such as sulphate from acid rain or sulphide minerals in bedrock. Hardness and conductivity measure the concentration of dissolved minerals while anions and cations indicate the specific ions making up the mineral content. Concentrations of these parameters are generally stable in surface water, and need not be sampled frequently in order to characterize a lake.

2. ***Trace Metals****:*
   Metal concentrations including lead (Pb), cadmium (Cd), iron (Fe), copper (Cu), and zinc (Zn) reflect the geology of a watershed. At high concentrations metals can impair aquatic life and therefore may be considered pollutants. They can also be added to lakes by industrial processes, urban runoff and land use practices such as landfilling. Concentrations of these parameters in surface water are typically stable over the short to medium term, and need not be sampled frequently. In the urban environment, many trace metals are found to be associated with particulate materials, such as soil and grit particles. As such, they can be partially managed by stormwater management practices that also remove solids. Measurements of TSS therefore helps to interpret metals concentrations.

3. ***Nutrients****:*
   Total phosphorus (TP), total kjeldahl nitrogen (TKN), ammonia (NH_3), nitrate (NO_3), and dissolved organic carbon (DOC) describe the nutrient characteristics of a lake. Phosphorus and nitrogen forms of nutrients are critical water quality indicators because of nutrient enrichment in urban lakes and their role in

stimulating changes in water clarity and nuisance algae growth, which may include toxic cyanobacteria. Nutrient sources to urban lakes include septic systems, urban runoff that contains organic matter, dog and bird feces, and fertilizer residues. Phosphorus can also be released from the sediments of a lake if the sediments lack oxygen. The photosynthetic pigment in algae, chlorophyll, is not a nutrient, but is used as an indicator of algal response to lake nutrients.

4. ***Bacteria**:*
   Bacterial counts are good indicators of problems related to urban runoff such as discharges from storm sewers, overflows or by-passes from sanitary sewers and sewage treatment facilities, as well as cross-connections between sanitary and storm sewers and inputs from wildlife and domestic animals. Bacterial counts may increase as a result of urbanization and development and thus they are important indicators of general lake system health. Lake Major is the only lake within the study area that is a source of public water supply.

1.3 Trophic Status and Nutrients

The term “trophic status” is used to describe biological productivity within a lake. Trophic status depends on the amount of nutrients available to enhance plant growth, including floating algae called phytoplankton. Algae are important to the overall ecology of the lake because they are the base of the food chain, providing food for zooplankton (microscopic invertebrate animals, which are, in turn, food for other organisms, including fish. Excessive productivity or plant growth is visible as degraded water clarity, algae and weed accumulation on shore and decreased oxygen concentrations in the water column.

In most lakes, phosphorus is the nutrient in shortest supply and its absence acts to limit the production of aquatic life. When present in excess, phosphorus stimulates algal blooms and can result in reduced water clarity and reduced oxygen concentrations in deep lake waters.

Lakes become naturally enriched in nutrients over long periods of time in a process known as eutrophication. Where the amount of phosphorus in a lake is enriched by human activity this process is accelerated and is termed cultural enrichment or cultural eutrophication. Nutrients can come from many sources, such as fertilizers applied to suburban lawns, golf courses, and agricultural fields, deposition from the atmosphere, erosion of soil containing nutrients, urban runoff and sewage treatment plant discharges.

The trophic status of a lake can be determined by measuring nutrient concentrations (phosphorus and nitrogen), algal density (either directly as algal biomass or indirectly as chlorophyll *α* and, in some lakes, water clarity. Although water clarity is influenced by soil particles, colour, and dissolved organic carbon, it is also an indication of biological productivity. The more productive a lake is the greater the algal growth and therefore the less clear the water becomes.

Lakes with few nutrients and low productivity are referred to as “oligotrophic”. They are typically clear water lakes with sparse plant life, high oxygen levels in deep waters and low fish production. In contrast, lakes with higher nutrient concentrations and high productivity are referred to as “eutrophic”. They have abundant plant life, including algae. Lakes with an intermediate productivity are called “mesotrophic” and generally combine the qualities of oligotrophic and eutrophic lakes.

Classification of lake trophic status into oligotrophic, mesotrophic or eutrophic, although somewhat subjective, provides a simplified framework for lake management and a point of reference for lake managers. There are many means of classifying lake trophic status but all are based on measurements of trophic status indicators such as phosphorus concentration, algal concentration or water clarity. These indicators are used to assign lakes to a category based on the values measured. Environment Canada (CCME 2004) provided the following classification (**Table 1**) of trophic status for lakes and rivers, as taken from Vollenweider and Kerekes (1982) and Dodds *et al.* (1998).

Table 1. Trophic Status Based Trigger Ranges for Canadian Waters (CCME, 2004)

Trophic Status	Trigger Ranges for Total Phosphorus (µg/L)	
	Lakes	Rivers and Streams
Ultra-oligotrophic	<4	-
Oligotrophic	4-10	<25
Mesotrophic	10-20	25-75
Meso-eutrophic	20-35	-
Eutrophic	35-100	>75
Hypereutrophic	>100	-

2. Establishing Water Quality Objectives

2.1 Introduction

One of the principal objectives of the watershed study is to evaluate existing water quality conditions and recommend water quality objectives for the main lakes within the watershed. The water quality objectives are based upon a scientific understanding of the Preston Area and widely accepted standards of water quality. These recommended water quality objectives will be used by HRM to establish the acceptable standards that HRM and the public agree will achieve the long term management goals for the Preston Area.

2.2 Water Quality Indicators

Suburban development within the Preston Area may require removal and transformation of forested and natural areas for residential and commercial developments. Given this, a short list of critical parameters or water quality indicators used to establish water quality objectives was derived based on those parameters most likely to be negatively affected by development within the watershed. Deterioration of these parameters will negatively affect recreational use, aquatic life and passive enjoyment or aesthetics of these lakes.

The parameters most likely to be negatively influenced as a result of these land use changes are: **total phosphorus, nitrate, ammonia, total suspended solids, chloride and *E. coli*.** Given their sensitivity to development, these parameters were selected as “indicators” upon which to base water quality objectives. Other parameters such as metals, oil and grease, chlorophyll *α*, and nitrogen, may also increase due to development in the watershed; however, watershed management and implementation of mitigation measures to reduce development impacts to the “indicator parameters” will also limit the changes to all of these parameters. For example, metals concentrations may increase in the watershed but it is likely that the metals will be associated with the transport of suspended solids to the lake as a result of clearing and construction activities in the watershed and increased runoff as a result in increased surface hardening. Consequently, management of suspended sediment within the lake will not only help reduce phosphorus concentrations but also metals. Nevertheless, to avoid a large number of water quality objectives that need to be monitored through expensive water quality monitoring programs, we have restricted setting water quality objectives to the few variables that we think will provide protection of the watershed while focusing the monitoring efforts. There may be, at some time in the future, a need to undertake more specialized monitoring programs and to set specific water quality objectives to individual lakes or even parts of lakes. An example of this might be in relation to impacts from specific developments or land use changes that may warrant targeted investigation such as a new quarry development, forestry operations or housing development. However, at the present time it is essential to implement a focussed and effective water quality management program based on these selected water quality indicators using their associated objectives and early warning values.

Table 2. Changes to Water Quality Parameters from Watershed Development

Water Quality Parameter	Effect of Development	Rationale for inclusion as Indicator Parameter
TP	Increase from fertilizer runoff, stormwater runoff, waste water treatment plant (WWTP) by-passes and overflows, septic systems	Increases in phosphorus can increase growth of algae and aquatic plants which can in turn reduce water clarity and dissolved oxygen
NO_3	Increase from fertilizer runoff, WWTP by-passes and overflows, septic systems, urban runoff, stormwater discharge.	Increases in nitrate can increase growth of algae and aquatic plants which can in turn reduce water clarity and dissolved oxygen
Ammonia	Increase from fertilizer runoff, WWTP by-passes and overflows, urban runoff, effluents from some industrial and commercial activities	Un-ionized ammonia is a portion of ammonia that can be toxic to aquatic life at elevated concentrations
TSS	Increase from deforestation, construction activities, gravel operations, WWTP bypasses and overflows, and stormwater runoff from urban areas/hard surfaces	Increases in suspended solids can reduce water clarity, alter habitat, and interfere with feeding, physiological and behavioural in fish and affect benthic production and periphyton communities.
Chloride	Increase due to spray from road salting practices, stormwater runoff, WWTP bypass overflows, and long-range transport	Increases chloride results in increased salinity, thereby affecting the ability of some organisms to osmoregulate (affecting endocrine balance, oxygen consumption, and physiological processes (Holland et al., 2010)).
E. coli	Increase due to septic systems, WWTP bypass overflows, and stormwater runoff	An indicator of fecal contamination in recreational water

2.3 Review of Water Quality Guidelines and Objectives from Other Jurisdictions

The province of Nova Scotia has not yet developed comprehensive water quality objectives (WQOs) for the lakes and rivers in the province although WQOs have been recommended for specific lakes. When developing water quality objectives for the Preston Area, the guidelines and objectives from other jurisdictions were consulted for direction. The Canadian Water Quality Guidelines (CWQG) provides a benchmark for a consistent level of protection across Canada. The CWQG are derived according to a nationally endorsed scientific protocol, in which all components of the aquatic ecosystem are considered using the available scientific data in association with reviews and guidelines developed in other jurisdictions (e.g., United States Environmental Protection Agency (USEPA), Netherlands, and European Union). The CWQG "are set at such values to as to protect all forms of aquatic life and all aspects of the aquatic life cycles". They are conservative values, set at levels to protect the most sensitive forms of aquatic life.

National standards for parameters in surface waters in the USA have been developed by the USEPA. The USEPA standards are widely used benchmarks based on leading edge scientific research. The USEPA has developed a strategy to address nutrient enrichment of waterbodies that includes the use of regional and waterbody– type approach to set nutrient criteria. The state of Vermont, which has developed comprehensive water quality objectives in association with USEPA guidelines, was selected for comparison as it has similarities with Nova Scotia with respect to latitude, climate and geology. **Table 3** summarizes the CWQG, USEPA, and Vermont water quality guidelines and standards for the key indicator parameters identified for the Preston Area.

Table 3. Water Quality Guidelines and Standards from Canada, USEPA and Vermont

Parameter	CWQG	USEPA	Vermont
TP	Trophic Status Approach	• Ecoregion Based Approach	• Lake specific – maximum increase of 1 mg/L
NO_3	• 13 mg NO_3/L	• n/a	• 5.0 mg/L as NO_3-N
Un-ionized Ammonia	• 0.019 mg/L	• Temperature/pH dependent	• EPA values
TSS	• Short term exposure: 25 mg/L increase • Long term exposure: 5 mg/L increase	• <10 % of the seasonal value	• Water Class dependent
Chloride	• 120 mg/L (chronic toxicity guideline) • 640 mg/L (acute toxicity guideline)	• 230 mg/L chronic concentration (CC) • 860 mg/L maximum concentration (MC)	• n/a
E. coli	• 2000 *E. coli*/L[1] (geometric mean of 5 samples)	• 126 *E. coli*/100 mL (geometric mean of 5 samples)	• Water Class dependent

Note: 1. Health Canada Guidelines for Recreational Water Quality

All indicator parameters, with the exception of total phosphorus, have definitive CWQG limits. The concentrations of these parameters are unlikely to be affected by local geology, but are responsive to land use within the watershed.

2.4 Review of Water Quality Guidelines and Objectives for Total Phosphorus

Currently there are no national guidelines for phosphorus, although several provinces have developed their own guidelines or objectives. The development of national guidelines has been hindered by the need to consider the following factors that affect the nature of phosphorus as a pollutant:

a) It is non-toxic and is a required and limiting nutrient in fresh water, such that small increases stimulate aquatic productivity;
b) The natural or baseline water quality and trophic status for lakes varies extensively across Canada;
c) The detrimental effects of phosphorus are indirect, resulting from algal growth and oxygen depletion, and so there is a lot of variation in phosphorus concentrations associated with observed effects;
d) The effects of phosphorus on primary biological production are modified by natural factors that attenuate light (i.e., Dissolved Organic Carbon or turbidity). These factors can mask the effects of increased phosphorus by reducing the biological response normally associated with elevated phosphorus concentrations;
e) The effects of phosphorus on surface water are partially aesthetic (i.e., decreased water clarity), and so determination of thresholds of effect is somewhat subjective; and
f) Phosphorus concentrations can vary substantially in surface water, as a result of season, differences between river and lake systems and as a result of natural factors in the landscape such as geology, soils and wetlands.

These factors have been accommodated in the guidelines developed by several provinces. Provincial total phosphorus water quality guidelines vary from 5-15 μg/L in British Columbia to 50 μg/L in Alberta (**Table 4**) and reflect, in part, the differences in natural water quality across Canada.

Table 4. Provincial Water Quality Objectives for Total Phosphorus (µg/L)

	Lakes	Rivers
British Columbia	5-15	
Alberta	50	
Manitoba	25	50
Ontario	10, 20	30
Quebec	Background + 50% increase (upper limits of 10 and 20 µg/L)	

2.4.1 Canadian Guidance Framework for Phosphorus

Environment Canada (CCME 2004) developed a framework for the management of phosphorus. The framework offers a tiered approach where phosphorus concentrations should i) not exceed predefined “trigger ranges”; and ii) not increase more than 50% from the baseline or reference condition. The trigger ranges are based on the range of phosphorus concentrations in water that define the reference trophic status for a site. If the defined range is met or exceeded then management action is “triggered”, to assess the problem, determine its causes and implement solutions. For lakes and rivers, trophic status classifications have been developed as ranges of phosphorus concentrations which reflect the fact that not all lakes respond in a clear and precise manner. Environment Canada (CCME 2004) provided a classification of trophic status for lakes and rivers (see Table 1) as adapted from Vollenweider and Kerekes (1982) and Dodds *et al.* (1998).

Appendix C

North Preston Wastewater Treatment Facility Process Description

North Preston Wastewater Treatment Facility
Process Description

Influent Flow (Sewage)

Influent flow is received from five lift stations located throughout the community. The influent enters a grit tank which allows the heavier materials, such as, rocks and gravels to settle out and be later removed, via pumper truck, and disposed of off-site. It then flows into an, automatic, fine mesh Screen where the lighter materials, paper and plastics etc., are collected and removed via an auger which dewaters and deposits it in a trash bin, this is disposed of, off site. From here the flow enters the Equalization Tank (EQ Tank) which contains two medium capacity lift pumps. These two pumps facilitate an equalized (consistent) flow volume to enter the treatment process.

Treatment Process

The Treatment Process consists of two Continuous fill Sequence Batch Reactors (SBRs), with chemical addition of Alum and Caustic Soda for phosphorus removal and pH control/nitrification. The entire system is operated through a PLC (Programmable Logic Control) which utilizes an assortment of motorized valves, solenoids and pumps (liquid and air) to treat the sewage to produce high quality effluent. The SBRs can operate on a timed or dissolved oxygen cycle, whichever the Operations Tech chooses to use, either method is very effective in treating sewage. There are four sequences per cycle; Aerated Fill, Fill Settle, Decant Fill and Anoxic/Static Fill. An entire cycle takes approximately 6 hours to complete, depending upon the volume of sewage entering the facility. The more volume the shorter the sequences and cycle, this is a program built into the PLC to allow for total treatment of all sewage entering the system. The shorter cycle does not inhibit the ability of the treatment process to achieve compliance with NSE (Nova Scotia Environment). The SBRs contain several fine bubble diffusers which receive air supplied via, an Aerazen air blower. This distributes oxygen throughout the SBR's biomass to maintain a dissolved oxygen content of between 2 and 5 mg/l for optimum performance. The Biomass contains microscopic organisms which feed on the waste from the sewage to produce; water, CO2, a quantity of waste and more organisms. It is essential to maintain the biomass and control its volume, through wasting, via pumps contained within the SBRs. The waste cycle is programmed in the PLC to be done at predetermined times throughout the day. The wasted sludge is pumped to an aerated holding tank for further treatment and storage. It is removed from the tank on a scheduled routine, via pumper truck, and taken to the Aero Tech WWTF for dewatering and further treatment.

UV (Ultra Violet) Disinfection System

After the SBR has completed the Aerated Fill sequence the Fill Settle sequence begins. During this time the Biomass separates into two parts, the settled sludge and the clear liquid which floats on top called Supernatant or Effluent. After approximately 60 minutes the PLC automatically switches to Decant Fill sequence. This allows the treated liquid (Supernatant) to flow from the SBR, via automatic valves, through pipe work to the UV disinfection system where ultraviolet light destroys pathogenic (disease causing) orgamisms are destroyed. The UV system is a Trojan 3000, this is a single bank of 9 modules containing 4 UV bulbs each, for a total of 36 bulbs. After the supernatant has been disinfected in the UV system, it flows into the, two stage, managed wetland which contains nutrient (phosphorus and ammonia) consuming reeds. The reeds further enhance the quality of the treated sewage before it flows into Whynder Lake, via nonpoint source distribution, along the entire length of the second stage wetland.

Quality Control

The treatment quality is tested a minimum of five times per month through in house analysis and outside, private lab, analysis. This testing is for process control purposes and to ensure the treatment of the wastewater is compliant with applicable regulations.