Water Quality Overview Halifax 2014

Summary of Program Results - Calendar 2014

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Energy & Environment
March 2015

HALIFAX

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Abbreviations & Acronyms

CC	Community Council
CCME	Canadian Council of Ministers of the Environment
DA	Development Agreement
DO	Dissolved Oxygen
HEMDCC	Harbour East – Marine Drive Community Council
MAC	Maximum Allowable Concentration
MPS	Municipal Planning Strategy
NWCC	North West Community Council
RCAP	Rapid Chemical Analysis Program
RWAB	Regional Watersheds Advisory Board
TCU	True Colour Unit
TP	Total Phosphorus
TSS	Total Suspended Solids
WC	Watercourse

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1. Overview

The Halifax Regional Municipality (HRM) conducts, directly or indirectly, water quality monitoring in lakes and streams for four programs each year – beaches, Blue Flag beaches, Development Agreement compliance, and watershed studies. In 2014, HRM contracted monitoring services for a new, limited-term program in support of community planning projects

This report documents the nature, activities, current results, and significant changes of each program for the 2014 calendar year.

2. Beaches

2.1. Origin

HRM Aquatic Services owns and operates a collection of 24 municipal beaches every summer during July and August. To protect the public against waterborne illness, Aquatic Services conducts water quality monitoring within the supervised beach area and manages beaches in accordance with the monitoring results, in addition to other factors beyond the scope of this report. Monitoring is coordinated by HRM's Energy and Environment staff and done in consultation with Halifax Water. This program is performed in accordance with the Guidelines for Canadian Recreational Water Quality, published by Health Canada, and in consultation with staff from Nova Scotia Health and Wellness.

2.2. Program Description

This program collects water samples and tests them to determine the number of indicator microbiological organisms present in a standard volume. Freshwater beaches are tested for E. coli, whereas marine and estuarine beaches are tested for fecal Enterococci. Beaches are re-tested when results exceed 199 and 34 organisms per 100mL, and immediately closed (and retested) when results exceed 399 and 69, respectively. Testing is performed by accredited local commercial laboratories, and results are provided electronically to HRM staff upon their availability, typically within 48 or 72 hours of sample collection for E. coli and Enterococci, respectively.

2.3. Frequency

Each beach is sampled a minimum of once per week for each of the nine weeks during the beach season (July 1 – August 31), and once before the season begins. Additional samples are taken if the first weekly samples exceed microbiological criteria given above.

2.4. History

Halifax began conducting water quality monitoring at its own beaches in 2009. Prior to 2009, Nova Scotia Environment (and its predecessors) conducted water quality monitoring on behalf of HRM.

2.5. Activities 2014

Twenty-two beaches were active in 2014. Saunders Beach, situated on Paper Mill Lake, Bedford, was not in operation this year due to ongoing reconstruction of the dam at the outlet of the lake.

Beach monitoring began one week before the official first day of beach season (July 1st) and continued through the last full week of August for a total of ten sampling weeks. 81 sample collections totalling 512 samples were submitted through the period, including both E. coli and Enterococci samples.

2.6. Results, Observations and Discussion

Halifax beaches experienced 10 beach closures in 2014, as summarized in Table 1. Eight of 22 beaches closed one or more times, and 12 beaches remained open all season long. Only two beaches closed twice – Springfield & Birch Cove – with total closure duration of ten days and six days, respectively. Unlike previous years, there were no precautionary closures of the two Halifax Harbour beaches (Dingle & Black Rock), as no wastewater pumping stations near these beaches overflowed during the summer season. This finding reflects the relatively low number and intensity of precipitation events occurring during the period.

The closures were evenly distributed over the summer, with five occurring in each of July and August. This pattern also varies from that observed in previous years, where more closures were observed in July than August, and several occurred within a few days of one another. Media reporting of beach closure events in 2014 was modest, and simply reported beaches closed and reopened.

Table 1. Summary of Beach Closures 2014.

Beach Name (Watercourse Name)	Date Closed[1]	Date Re-Opened[2]	Closure Duration[3]	Closure reason	Indicator Used[4]	Indicator Concentra'n(s)[5]
Springfield (Springfield Lake)	July 4[a]	July 9	6 days	Test results	E. Coli	350/440; 90/20
Government's Wharf (Musquodoboit Harbour)	July 18	July 23	5 days	Test results	Enterococci	140/150; 5/5
Dingle (North West Arm)	July 24	July 30	6 days	Test results	Enterococci	110/ 10; 10/5
Penhorn (Penhorn Lake)	July 24	July 28	4 days	Test results	E. Coli	700/870; 10/5
Shubie (Lake Charles)	July 30	August 1	2 days	Test results	E. Coli	>2500/>2500; 70/80

Beach Name (Watercourse Name)	Date Closed[1]	Date Re-Opened[2]	Closure Duration[3]	Closure reason	Indicator Used[4]	Indicator Concentra'n(s)[5]
Springfield (Springfield Lake)	August 7	August 11	4 days	Test results	E. Coli	>2500/370; 70/50
Malay Falls (Marshall Flowage)	August 14	August 18	4 days	Test results	E. Coli	>2500/2100; ND/10
Birch Cove (Lake Banook)	August 14	August 18	4 days	Test results	E. Coli	500/>2500; 170/210
Birch Cove (Lake Banook)	August 20	August 22	2 days	Test results	E. Coli	720/420; 200/80
Oakfield (Grand Lake)	August 29*	n/a	3 days	Test results	E. Coli	>2500/>2500

a. The beach closure was originally given as July 7th, as announced on the municipal website. Beach staff actually closed the beach on July 4 at 4:30pm.
1. The date on which the beach was closed by lifeguards. This date may precede the publication of Public Service Announcements of beach closures on the HRM website (www.halifax.ca/.

2. The date on which the beach reopened.
3. Refers to the total number of days on which a beach was closed, including partial days where beaches re-opened the day after they were closed. Tends to overstate the actual closure duration by up to one full day.
4. E. Coli is used for freshwater lakes and Enterococci for ocean / estuarine bodies (ocean, harbour)

5. Two tests are taken per beach at one time; these results are presented as pairs. Closure threshold is 400 (E. Coli) and 70 (Enterococci).

* The latest test results did not permit the re-opening of the beach prior to the end of the 2014 Beach Summer Season (i.e., August 31st).

3. Blue Flag Beach

3.1. Origin

HRM endorsed the goal of achieving a minimum of one Blue Flag Beach in the 2011-2012 Corporate Plan. Regional Council then formally declared the candidacy of HRM as a Blue Flag Community on September 27, 2011, in support of its application for Birch Cove Beach, located on Lake Banook, Dartmouth.

3.2. Program Description

The Blue Flag is an internationally recognized and respected eco-label that is awarded to beaches and marinas. Administered in Canada by Environmental Defence, the flag is bestowed on beaches that have achieved international standards in water quality, environmental management, environmental education, and safety and services.

HRM established a Blue Flag Committee comprised of staff from Halifax, Halifax Water and Clean Foundation to ensure that all criteria are met and opportunities and challenges are addressed. Operationally, the primary Blue Flag requirements are 1) additional water quality monitoring beyond the municipality's standard beach program and 2) the hosting and/or promotion of five environmental education activities. The Blue Flag program provides for significant local flexibility regarding environmental activities. The expansion of program offerings is likely contingent on increased inclusion of community members and/or organizations, directly or through partnership agreements.

3.3. Activities 2014

Halifax was awarded a second Blue Flag for Birch Cove Beach in spring 2014. Staff presented an information report regarding the status of the Blue Flag program to the Environment and Sustainability Standing Committee of Regional Council. The municipality's Blue Flag Beach Committee (the presence and function of which are mandated by Blue Flag criteria) met in both spring and fall 2014 to plan and review the execution of program activities. Municipal staff and program affiliates carried out activities to meet annual program requirements, as follows:

- Lifeguards updated the water quality results on designated signage at Birch Cove Beach;
- Municipal staff updated the Birch Cove Beach page on the Blue Flag Canada website with water quality results and educational activities;
- Five environmental educational or information events were provided to members of the community and targeted members of municipal staff. These activities were put on by staff from Clean Foundation, Nova Scotia Museum of Natural History, Sierra Club of Canada - Atlantic Chapter, as well as Halifax municipal staff of the Findlay Community Centre and Energy & Environment; and
- Municipal staff revised the Halifax.ca Beaches website to enhance existing Blue Flag promotion.

In January 2015, staff submitted an application for the 2015 annual award for Birch Cove Beach.

3.4. Results, Observations and Discussion

Birch Cove Beach retained its Blue Flag status throughout the summer of 2014. The beach remained open for swimming for 55 out of 61 days – about 90% of the season. The beach was sampled 14 times for E. coli and 11 times for Enterococci throughout the summer. As reported in the Beaches section, two samples exceeded the maximum acceptable concentration for E.

Coli as defined by Blue Flag Canada and Health Canada's Guidelines for Canadian Recreational Water Quality. This resulted in two beach closures, of four and two days respectively. Despite these results, water quality met Blue Flag's bathing water criteria for the year due to low bacteria counts observed at other sampling events.

Halifax was visited by representatives from Blue Flag Canada in late August for their annual Control Visit. The Control Report, received in November, confirmed satisfaction with beach operations and Blue Flag criteria and documented only one area for improvement – posting of environmental activities on the designated signage located at the beach. Staff commits to ensure this occurs in 2015.

4. Development Agreements

4.1. Origin

Sections 25 through 31 of the Halifax Regional Municipality Charter refer to the establishment, powers and duties and other functions of Community Councils; Sections 229 & 240 of the Charter refer to Development Agreements, and Sections 227 and 228 refer to the purpose and policy in municipal planning strategies.

The Bedford Municipal Planning Strategy (MPS) establishes the authority for a water quality monitoring program in the Bedford West Secondary Planning Strategy, Policies BW-3 through BW-5.

4.2. Program Description

The requirements for water quality monitoring that are placed on a developer are set through negotiations between the municipality and landowners through a negotiated process which results, upon approval, in a Development Agreement. Those projects that are created subject to the terms of a MPS typically require monitoring within a lake and at its inlets and outlets. Those projects that originate through stormwater management sections of development agreements – and not through an MPS - typically do not require lake monitoring but are instead directed to streams and/or rivers that run through the lands subject to development. Agreements specify the items that must be monitored, the frequency of monitoring and reporting, and the duration of the program. Most often, a pre-construction (or "baseline") sampling event is required, followed by monitoring during the construction phase, and often a concluding period post-construction. If present, this latter period typically lasts for two years following the conclusion of construction activities.

Monitoring reports are typically directed to a specified member of Halifax staff (either a Development Engineer or Environmental Performance Officer), who then forwards the reports on to the Councillor for the area and the respective Community Council. Once reports have reached the agenda for the Community Council and are posted online, copies may also be directed to individuals and groups that have expressed an ongoing interest in the program.

4.3. Agreements in effect requiring water quality monitoring

As of December 31st, 2014, there are four Development Agreements in effect that commit developers to pay for water quality monitoring programs. A summary of these programs is given in Table 2.

Table 2. Summary of monitoring programs conducted through Development Agreements in 2014

Monitoring Program	Developer(s)	Consultant	Program Initiation (Baseline Yr.)	Municipal Planning Strategy (MPS) & Community Council (CC)	Summary, DA Monitoring Requirements
Bedford West* (Bedford)	West Bedford Holdings Ltd., Cresco	SNC Lavalin (contracted to HRM)	Spring 2009	**MPS:** Bedford **CC:** North West	DA Part 5.3: Water Quality Monitoring Plan. Kearney Lake, Papermill Lake + tributaries (11 locations); 3x annually; *Measures***:** general chemistry, microbiological, field measurements, metals (67 total)
Twin Brooks (Middle Sackville)	Numbered Company	McCallum Environmental	Spring 2010	**MPS:** Sackville **CC:** North West	DA Part 7.3 Water Quality Testing; unnamed brooks (4 locations); 3x annually; *Measures***:** general chemistry, microbiological, field measurements, metals, pesticides & herbicides (107 total)
Brunello Estates* (Timberlea)	Brunello Estates	Stantec	Summer 2011	**MPS:** Timberlea/Lakeside/ Beechville; **CC:** Halifax and West	DA Part 2.7.5 Storm Water Management System. Unnamed brooks (max. 7 locations); 10 times annually, *Measures***:** general chemistry, microbiological, field measurements, metals (9, 29 or 49 total)
Lost Creek Village, Phase 5-10; (Beaver Bank)	Lost Creek Village Inc. (Keith & Hugh Barrett)	McCallum Environmental	Summer 2013	**MPS:** Sackville **CC:** North West	DA Part 5.1: Stormwater Management Plans; unnamed brook (2 locations); 12x annually, *Measures*: phosphorus, total suspended solids, turbidity, pH (4 total)

* These developments are multi-phased and are generally expected to take more than one year to complete.

4.4. Activities and Program Notes 2014

As of December 31, 2014, all required water quality monitoring events had been completed. All monitoring events conducted in 2014 have been duly reported to HRM except those of Year 4, Q1 (July - September) & Q2 (October – December), Brunello Estates. The receipt of these latter reports is anticipated before the end of fiscal 2014.

Although the Lost Creek Village development is still active, no construction or monitoring events occurred in 2014.

The Development Agreement for Brunello Estates directed that monitoring reports be submitted to the Halifax Watershed Advisory Board. The Board, however, has ceased operations as it was deemed to have concluded its mandate. Due to this change, municipal staff now directs water quality monitoring reports from the developer to the Halifax and West Community Council for its consideration.

The Bedford West program did not consistently one of the sample stations within Papermill Lake during 2014. This variation from sampling requirements was required to accommodate safety concerns, as lower water levels associated with the Papermill Lake dam reconstruction project made the ground adjacent to this station unstable. Based on a scheduled completion of the dam reconstruction project in spring 2015, staff anticipates that the affected station should be available for sampling during all three seasons in 2015.

4.5. Results, observations & discussion

4.5.1. Bedford West

The water quality monitoring program in Bedford West is dynamic. Originating with nine monitoring locations applicable to sub-areas 3 & 4, additional monitoring sites have been added based on negotiations with developers as new Development Agreements are reached for the construction of more sub-areas of the West Bedford subdivision. As of December 2014, development agreements are in place for 4 of 12 sub-areas and 11 monitoring sites are in effect.

For 2014, consultants reported exceedances for dissolved oxygen (DO), pH, chloride and several metals, at multiple sites over two or three seasons. These exceedances are summarized in Table 3. A review of the exceedances by sites is given in Figure 1.

Exceedances are defined as observed values for measured parameters that fall outside (above or below) guideline values. Guideline values are established by qualified agencies for reference purposes to identify levels that should result in negligible risk to living organisms, their functions, or any interactions that are integral to sustaining ecosystem health and designated resource uses that they support. In the context of this report, the Canadian Council of Ministers of the Environment (CCME) is the agency that has defined guideline values (Canadian Environmental Quality Guidelines - CEQGs) against which most measured parameters are compared. Some parameters are not addressed under CEQGs, and are alternately compared against the Canadian Recreational Water Quality Guidelines (CRWQGs) produced by Health Canada.

The impact of a water quality parameter exceeding a guideline value varies depending on its sensitivity to the parameter and a host of other qualities of the surrounding water. The most severe impact of an exceedance to any organism is death, but a number of sub-lethal effects include changes in the behaviour, physiology, biochemistry, and cell and tissue structures of impacted life forms.

A summary of measured parameters, guideline values, and implications of exceedances is provided below in Table 4.

Reconstruction of the dam at the lower end of Paper Mill Lake began in July 2012, triggering the lowering of water levels and exposure of a significant portion of the lake shoreline to accommodate dam works. No water quality monitoring associated with this work has been required or conducted, so the impact of this project on water quality within Papermill Lake is unknown.

Table 3. Summary of Bedford West Water Quality Measures with Guideline Exceedances from 2014 through 2009.

Measure	# Seasons Exceeded (2014)	# Sites Exceeded					
		2014**	2013	2012	2011	2010	2009
pH	2	6	5	3	8	3	4
Aluminum	3	11	11	11	9	9	8
Arsenic	0	0	0	0	0	0	0
Cadmium	3	11	10	10	5	9	0
Chloride	1	2	1	1	0	0	0
Chromium	1	7	3	1	0	0	0
Copper	0	0	6	1	0	1	0
Dissolved Oxygen	3	10	8	3	9	9	0
Iron	3	5	7	6	7	8	2
Lead	0	0	3	1	0	1	2
Selenium	0	0	0	0	0	0	0
Turbidity	0	0	0	1	0	0	0
Zinc	1	1	0	4	3	0	0
E. Coli	1	1	0	1	1	2	3

* Monitoring was conducted for three seasons in 2014
** Based on all three seasons monitored in 2014

The number of Cadmium exceedances reported from 2009 through 2014 reveals a significant jump since the first year of reporting. Records submitted by the consultant indicate that the minimum detection limit applied by their subcontracted laboratory were insufficient to identify all exceedances in 2009. Consequently, the apparent jump in this statistic may more accurately reflect a change in laboratory practice rather than a change in environmental conditions.

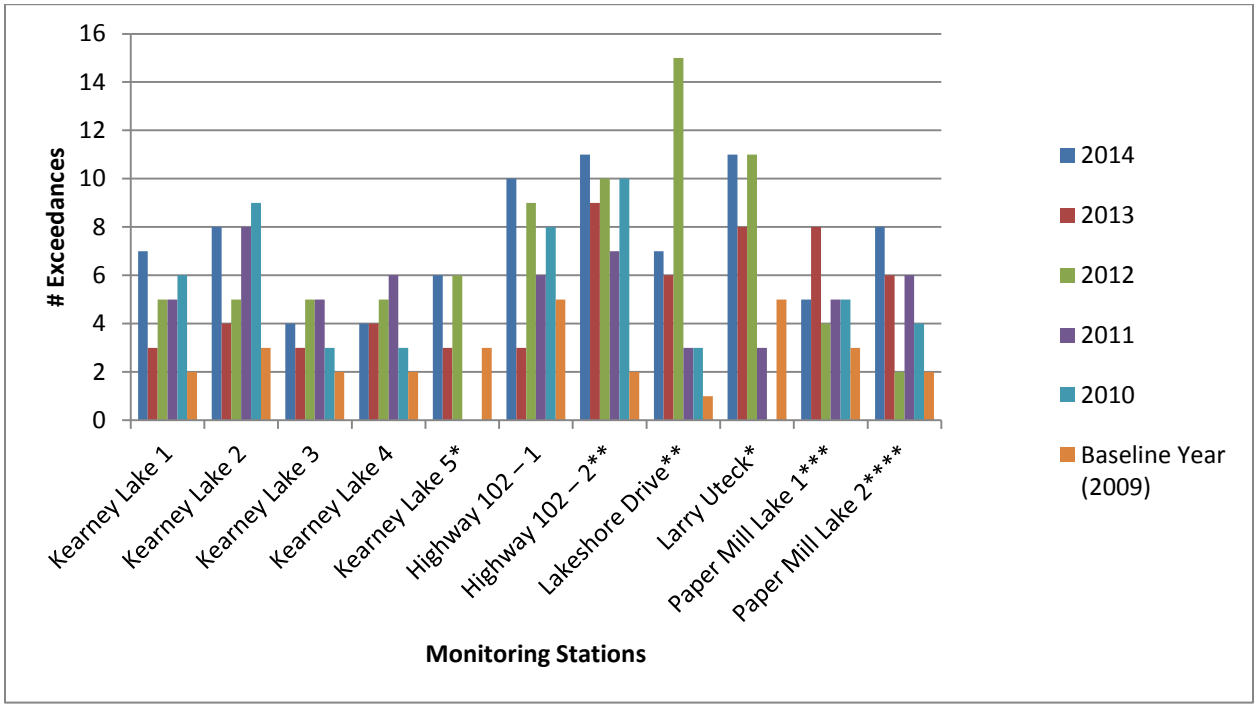


Figure 1. Summary of Bedford West Monitoring Locations with Exceedances in 2014 through 2009 (Baseline Year[1])

[1] Baseline year 2009 for all sites but Kearney Lake 5 & Larry Uteck, for which the baseline year was 2012.

Table 4. Summary of Measured Parameters and Guideline Values for parameters

Parameter	Guideline Value(s)	Notes
pH	6.5 – 9.0	Salmon and trout are typically amongst the most sensitive species. Immature life forms are usually more vulnerable than mature forms.
Aluminum	5 µg/L (< pH 6.5) 100 µg/L (≥ pH 6.5)	Aluminum is more soluble and potential more toxic to aquatic life at acidic pH.
Arsenic	5 µg/L	Arsenic levels in uncontaminated surface waters are generally less than 2µg/L. Arsenic is more available for uptake by plants in low phosphorus conditions.
Cadmium	Short-term: 1.0 µg/L Long-term: 0.09 µg/L	Cadmium toxicity is most impacted by water hardness, but also by alkalinity, pH, dissolved organic matter, temperature and acclimation.
Chloride	Short-term: 640 mg/L Long-term: 120 mg/L	Ambient concentrations are as high as 20-40 mg/L in coastal lakes.
Chromium	n/a for total chromium; Cr (VI) 1.0 µg/L Cr (III) 8.9 µg/L	
Copper	Hardness Value 0 < 82mg/L 2mg/L ≥82 ≤ 180 mg/L $0.2 * e^{\{0.8545[\ln(\underline{hardness})]-1.465\}}$ >180 mg/L 4 mg/L Unknown 2 mg/L	Copper toxicity is strongly related to water hardness (the sum of calcium and magnesium concentrations). Fish, invertebrates, and amphibians are equally sensitive.
Dissolved Oxygen*	ELS OLS Warm Water 6 mg/L 5.5 mg/L Cold Water 9.5 mg/L 6.5 mg/L	Among the most fundamental parameters in water, besides temperature and salinity.
Iron	300 ug/L	Follows numerical limits imposed by other jurisdictions (IJC, Ontario).
Lead	Hardness Value 0 <60mg/L 1mg/L ≥60 ≤ 180 mg/L $0.2 * e^{1.273[\ln(\underline{hardness})]4.705\}}$ >180 mg/L 7 mg/L Unknown 1 mg/L	Lead toxicity is strongly related to water hardness, and is greater in soft water than hard water, both for acute and chronic exposures.
Selenium	1 µg/L	Follows numerical limits imposed by other jurisdictions (IJC)
Turbidity[1]	50 NTU	Established as an aesthetic objective to satisfy most recreational uses
Zinc	30 µg/L	Acute toxicity modified by water hardness.
E. Coli[1]	200 CFU/100mL	For primary body contact recreation

* ELS = Early Life Stages; OLS = Other Life Stages
[1] Guideline source: CRWQG

4.5.2. Brunello Estates

This report presents water quality results obtained from the Annual Summary of Water Quality for Year 3 of the Brunello Estates development project (June 2013 – May 2014). It excludes the results obtained from Q1 & Q2 of Year 4 (June –December 2014), as these were unavailable at the time of report preparation.

During year 3, as in all periods, water quality sampling was limited to watercourses in which construction activities were occurring in the drainage area upstream. For the 2013-2014 construction year, water quality was monitored in five Watercourses (WC) in different quarters (see Table 4). 11 monitoring events occurred during Year 3, which were used to determine quarterly and annual means of selected measures, for comparison to Year 2 and Baseline annual means.

Eight measures were found to exceed guideline values for Watercourses (WC) 6, 7, & 9 in Year 3: pH, aluminum, arsenic, cadmium, chloride, copper, iron, & lead. WC-11 and WC-13 were not monitored for inorganic and metal parameters since the commencement of sampling for these watercourses occurred after the scheduled collection of these measures for the other watercourses. A summary of exceedances observed is presented in Table 5.

All were found in WC 7, but neither arsenic nor lead was found in WC 6. Only three measures exceeded guideline values in the baseline data (arsenic, cadmium & iron), half as many as in Year 2.

Based on measured and inferred data, chloride levels remain low throughout the project area, while water clarity and transparency remained high in both WC-6 & WC-7. E. coli levels rose measurably in WC 6 but not WC 7, although concentrations remain well below the recreational guideline limit of 200 colony-forming units/100mL at both locations. Total Phosphorus (TP) levels are elevated in WC 7 compared to baseline levels, with WC 7 classifying as eutrophic and WC 6 as meso-eutrophic.

Table 5 Summary of Brunello Estates Water Quality Monitoring Completed during Construction Year 3 (July 2013-May 2014). After Stantec 2014. (See Appendix F)

Quarter	# Sampling Events	WC-6	WC-7	WC-9	WC-11	WC-13
1st Quarter	3	3	3	0	0	0
2nd Quarter	3	3	3	2	0	0
3rd Quarter	2	2	2	2	0	0
4th Quarter	3	3	3	3	2	2

Table 6. Summary of Brunello Estates Water Quality Measures with Guideline Exceedances from Baseline through Construction Year 3.

Measures*	Sites Exceeded Construction Year 3	# Sites Exceeded		
		Construction Year 3	Construction Year 2	Baseline Year
pH	WC (7, 9, 11, 13)	4	1	6
Aluminum	WC (6, 7, 9)	3	2	6
Arsenic	WC-9	1	1	0
Cadmium	WC (6, 7, 9)	3	2	6
Chloride	WC 9	1	0	2
Copper	WC (6, 7, 9)	3	1	0
Iron	WC (6, 7, 9)	3	2	6
Lead	WC (6, 7, 9)	3	1	1

* Based on annual mean values; six sites (WC-1, WC-4, WC-6, WC-7, WC-11, & WC-13) were measured in Baseline Year, whereas only sites 6 & 7 were measured in Construction Year 2

The concentration of total phosphorus in watercourses within the Brunello Estates area is increasing over time, typically in a range of 3-6 times the baseline values where data are available. All measured watercourses have undergone a change in trophic level classification since the baseline year; as shown in Table 6 and Figure 2, below.

Table 7. Summary of Brunello Estates Trophic Level Classifications from Baseline through Construction Year 3.

Watercourse	Construction Year 3 - Mean	Construction Year 2 – Mean	Baseline - Mean
WC-6	Eutrophic (0.071 mg/L)	Meso-eutrophic (0.030 mg/L)	Meso-eutrophic (0.023 mg/L)
WC-7	Eutrophic (0.157 mg/L)	Eutrophic (0.054 mg/L)	Mesotrophic (0.024 mg/L)
WC-9	Meso-eutrophic (0.032 mg/L)	n/a	Mesotrophic (concentration n/a)
WC-11	Eutrophic (0.038 mg/L)	n/a	Mesotrophic (0.012 mg/L)
WC-13	Eutrophic (0.043 mg/L)	n/a	Mesotrophic (0.014 mg/L)

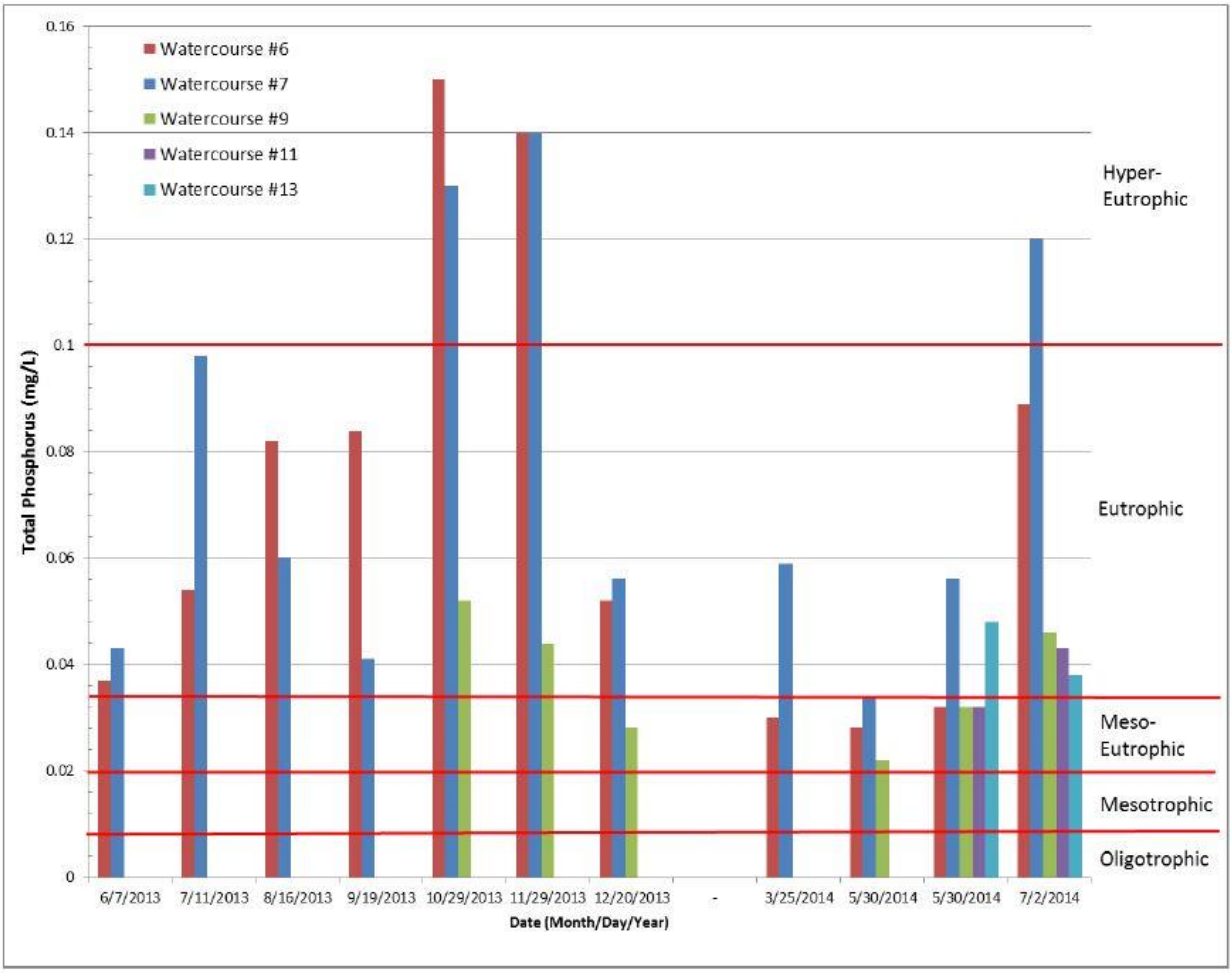


Figure 2. Total Phosphorus of Watercourses measured between June 2013 and July 2014. After Stantec 2014 (See Appendix F).

5. Watershed Studies

5.1. Origin

Watershed studies are conducted in HRM under the authority of HRM Regional Municipal Planning Strategy (Policy E-17 of the original plan (2006), Policy E-23 of the revised plan (2014)). The Watershed Study policy identifies a suite of objectives that studies must meet to enable municipal staff to plan on a watershed basis – that is, plan for community growth where that growth can be accommodated by water quality objectives, and avoid growth where those objectives cannot be met. Watershed studies must be accepted as background for future community planning by applicable Community Councils to be used as intended by municipal staff.

5.2. Program Description

Watershed studies are intended to serve as technical background materials, to be conducted and approved prior to the beginning of secondary planning studies in the same areas. Thirteen objectives were defined in Policy E-17 (RMPS 2006) as mandatory objectives of each study, and a fourteenth objective was added to Policy E-23 (RMPS 2014). Depending on local circumstances, certain watershed studies have also incorporated servicing studies, to determine the extent of central water and/or sewer services that may be required to meet water quality objectives, and an estimate of associated costs.

Water quality monitoring is connected in watershed studies in two distinct ways. Firstly, surface and/or groundwater monitoring is conducted by consultants carrying out the studies to help form the basis of water quality objectives. Secondly, studies are required, through clause (n) of Policy E-23, to recommend monitoring plans to assess whether specific water quality objectives for the watershed are being met.

5.3. Programs in Effect & Activities 2014

Two studies were active during 2014, as identified in Table 7, below.

Table 8. Watershed studies in Effect 2014.

Watershed Study Name	HRM Council Jurisdiction	Consultant	Activity Status*
Preston Area	Harbour East Marine Drive Community Council	AECOM	Complete; Accepted by Community Council
Sandy Lake	North West Community Council	AECOM	Complete; Accepted by Community Council

* As of February 23, 2015

HRM commissioned the Preston Area and Sandy Lake Watershed Studies simultaneously through a single contract to AECOM in mid-2013. Water quality samples were collected in both study areas during four events, held summer 2013, fall 2013, spring 2014 & summer 2014. Three public meetings were held for the Preston Area study, in June and December 2013 as well as September 2014. Two public meetings were held for the Sandy Lake study, in February and October 2014. Both studies were presented twice to the Regional Watersheds Advisory Board for comment.

HEMDCC accepted the Preston Area study in December 2014, and NWCC accepted the Sandy Lake study in February 2015.

5.4. Results, Observations & Discussion

A summary of the surface water quality findings and monitoring study recommendations produced by all completed studies is given below in Table 8.

Table 9. Water Quality Findings and Monitoring Recommendations from HRM Watershed Studies Completed 2014

Study	Water Quality Findings*	Water Quality Monitoring Recommendations
Preston Area	• The study encompassed the Salmon River (SR) and Partridge River (PR) watersheds • SR: Lake Major is oligotrophic; Long Lake is mesotrophic • PR: Whynder Lake eutrophic, Eagle Lake meso-eutrophic; Frog Lake meso-eutrophic; Partridge River outlet: Mesotrophic • Arsenic concentrations exceeding guidelines was found in all communities (drilled wells). • Total Coliforms were present in dug wells in Lawrencetown, Mineville, and East Preston • In each community where homes had positive/problematic Arsenic and Total Coliforms levels, at least some did not have a treatment system in place • Yield issues were observed in each of these communities: Lawrencetown/Mineville, Montague	• Salmon River watershed: Conduct long-term monitoring for Lake Major and Long Lake, 3x/year, • Partridge River watershed: Conduct long-term monitoring for three lakes (Eagle, Frog, & Whynder) ○ Eagle & Frog lakes should be sampled every month for one year, followed by seasonal sampling three times per year in each of spring, summer & fall ○ Whynder Lake should occur seasonally to ass nutrient loads • Conduct follow-up monitoring for three lakes outside Study Area: Nelson, Gammon, & Robinson. • All recommended monitoring programs should assess six

	Gold Mines, and East Preston. • Iron , manganese and chloride were common issues;	parameters/groups: pH, nitrogen compounds, total phosphorus, chloride, e. coli, total suspended solids • Sampling locations for all lakes should be selected to provide a representative sample of the entire water body.

Sandy Lake	• An increasing trend in total phosphorus concentration was observed; this trend is not reflected in the results of water quality modelling for development scenarios
	• Sandy Lake has transitioned from an oligotrophic state to a mesotrophic state over the span of 30 years.
	• Chloride levels in the lakes are low, suggesting few sources in the watershed and that the majority comes from precipitation and dry deposition
	• Sandy Lake is not significantly affected by urban runoff or erosion.
	• If all planned and anticipated developments proceed, total phosphorus (TP) concentrations will exceed the recommended water quality objectives in both lakes
	• Water quality objectives may be met in both lakes if mitigative measures are employed
	  ○ Removal of Uplands Park WWTF
	  ○ Removal of Septic Systems near Sandy Lake
	  ○ Application of Advanced Stormwater Management to future developments
		• The study recommended the adoption of a monitoring plan and schedule first proposed by Stantec in 2009, identifying discrete groups for monitoring effort and a suite of monitoring intervals addressing all groups.
		• Temperature and dissolved oxygen profiles should be collected during each sampling event.
		• Water samples should be collected from 0.5m below the water surface, at mid-depth, and at 1m above the lake bottom.
		• Both discrete and volume-weighted samples should be analyzed.
		• Total phosphorus and chlorophyll a analysis should be performed on all discrete water samples. Volume-weighted samples should be tested for the remaining grouped analytical parameters

* Both studies incorporated surface water monitoring and analysis into their findings. The Preston Area study also incorporated the analysis of subsurface (potable well) samples into its findings, as households and other buildings in this study area rely on on-site wells, not central water services. Lakeshore capacity modelling was incorporated into the Sandy Lake study findings to address anticipated developments within the study area. Such modelling was not

undertaken for the Preston Area study due to the lack of anticipated development in affected communities.

6. Baseline Monitoring for Community Planning

In August 2014, the municipality issued a Request for Proposals (RFP) to solicit water quality monitoring and reporting services. The services requested are required to support future community planning processes to which the municipality committed through the RP+5 process. The solicited service consists of monitoring 38 watercourses in each of spring, summer, and fall during a single calendar year, and will be conducted over a three-year period starting 2015. A summary of the program is provided below in Table 9; subsequent annual reports will present the findings of this program. The contract was issued to SLR Consulting Ltd. in November, 2014.

Table 10. Summary of Community Planning Baseline Water Quality Monitoring Program, 2015-2017

Year	Communities Targeted	# & Names of Watercourses Sampled
2015	Port Wallace, Fall River	(14) A Lake, Beaver Pond, Bell Lake (Dartmouth), Charles Lake, Cranberry Lake, Fenerty Lake, Fletcher's Lake, (Shubenacadie) Grand Lake, Loon Lake, Lake MicMac, Red Bridge Pond, Rocky Lake, Second Lake, and Lake Thomas
2016	Beaver Bank, Porter's Lake,	(11) Barrett Lake, Beaver Bank Lake, Conrod Lake, Duck Pond, Fiddle Lake, Kinsac Lake, Little Lake, Porter's Lake, Thief Lake, Thompson Lake, Tucker Lake
2017	Regional Centre (Dartmouth), Middle Sackville	(13) Albro Lake, Lake Banook, Drain Lake, Little Albro Lake, Little Sackville River, Little Springfield Lake, Lisle Lake, Maynard Lake, Oathill Lake, Penhorn Lake, Sackville River, Springfield Lake, Webber Lake

Conclusion

The municipality conducted four separate programs in 2014 that generate water quality information about certain watercourses throughout its jurisdiction. The type of information generated by each program is driven by their respective needs. As a result, there is a large range in the scope of measures assessed, frequency and location of sampling, as well as the amount and nature of reporting. Results generated and information revealed by these programs

are used to inform program operations and policy directions. Reports generated by these programs are all publicly available on Halifax.ca.

Appendices

Appendix A: Beaches Protocol 2014

Appendix B: Beach Water Quality Summary 2014

Appendix C: Blue Flag Beach Criteria 2014

Appendix D: Blue Flag Control Visit Report, Birch Cove Beach, 2014

Appendix E: Bedford West Monitoring Report Fall 2014

Appendix F: Brunello Estates Monitoring Report (Construction Year 3, annual)

HRM Water Quality Monitoring Procedures & Protocols
Beaches Recreation Program
Summer 2014

This document describes the role of water quality in the operation of HRM's Aquatic Services – Beaches Program.

Beach Management

The HRM Supervised Outdoor Swim (Beaches) program is offered as a public service during the summer months of every year, from July 1 through August 31. This service, offered at 22 locations throughout HRM in 2014 (see Appendix A) is highly valued by our residents, and is one of the signature recreational services available during summer months. Public services offered in natural environments can only be offered when an adequate measure of public safety can be assured. Both freshwater and marine aquatic environments pose potential threats to human health, due to the possibility of contact with various chemicals or biological materials, and physical hazards.

The primary hazard posed by water quality is the potential for contact with microorganisms associated with fecal contamination. The best way to manage this risk is through the effective operation of a water quality monitoring program, including the use of risk awareness measures, appropriate guidelines and standards for collection, handling, analysis, and reporting.

Beach Operation

Beaches are to be open to the public except in the following circumstances:

- Any single test result for a given beach is above the 'automatic close' limit (i.e., based on measured bacterial counts)
- Beach personnel suspect water quality concerns (precautionary – all sites)
- Notification of wastewater treatment plant overflows (precautionary – for Halifax Harbour sites only)

Beach staff responses to circumstances triggering beach closures (test results or overflow notifications) are described later in this protocol.

The opening and closure of beaches to the public is driven by water quality test results. HRM personnel are responsible for the collection, handling and delivery of the samples to the analytical laboratory and associated documentation, and the lab is responsible for confirming documentation and analytical procedures, conducting analytical procedures, and reporting analytical results to HRM staff. HRM and lab staff responsibilities are described separately below.

Water Quality - HRM Front End: Sample Collection, Handling, Delivery & Documentation

Sample collection is the process of obtaining an uncontaminated sample of water from within a supervised beach area. Samples are best collected from the position in the water nearest the greatest concentration of bathers, typically at 1.2 to 1.5 metres deep but varying from beach to beach. At this location, the open bottle should be submerged below the water surface approximately 30 cm, with the open end facing downwards until the bottle has reached 30 cm (1 foot) below the surface. The most important consideration in sample collection is to avoid contaminating the sample. Human skin naturally harbours several varieties of microorganisms, including bacteria, even when freshly washed. If a hand touches the inside of the bottle or the inside of the lid, these bacteria could be transferred to the water sample, and may cause false test results, which could result in unnecessary beach closures, further testing requirements and unnecessary expense.

Beach program supervisors have the option to use telescoping sampling poles to enable them to collect samples from the appropriate locations within the beach while remaining dry on shore – but these poles should only be used if the supervisors can reliably obtain full samples in a single immersion while orienting bottles properly throughout the procedure.

HRM strives to meet the intent of the Canadian Recreational Water Quality Guidelines (Health Canada, 2012), and this protocol has been developed in consultation with the Nova Scotia Department of Health and Wellness (NSDHW). Two water samples will be collected from each beach one time per week, at minimum. This sample frequency enables the calculation of a geometric mean, a type of average that HRM uses for Blue Flag reporting purposes.

Sampling procedures will be the same every week. Every beach will have two monitoring locations (Station A & Station B). For most beaches, where only one parameter is tested, one sample will be collected from each station – meaning that two samples will be obtained from each beach, every week from start to end of the season.

Halifax has beaches in both freshwater and saltwater (marine) environments. Monitoring protocols are identical in these environments, except for two factors, as depicted in Table 1:

Table 1. General Beach Monitoring Indicators and Maximum Concentrations

Beach Type	**Indicator Organism**	**Maximum Allowable Concentration**
Freshwater	E. Coli	399
Marine	Fecal Enterococci	69

Additional monitoring requirements are in effect for Blue Flag beaches (official & candidates alike). In addition to Birch Cove Beach's standard E. Coli testing, one of the two stations (Station A) will also be monitored for Enterococci. Black Rock and Dingle beaches will be monitored, at Station A, for E. Coli, in addition to their standard Enterococci analyses. A summary of all monitoring requirements at all beaches is provided in Appendix B.

Beach Supervisors receive hands-on training on proper sample collection procedures from HRM's water quality coordinator at the start of each beach season. Only Beach Supervisors should collect water samples from supervised beaches. In extenuating circumstances, they may delegate collection to other staff, provided that delegates are informed of proper collection procedures and care is taken to ensure they are followed.

Handling procedures for water samples are intended to ensure safe, secure, and controlled collection of samples from the time they are collected until delivered to the lab. They include proper bottle labelling and storage – including refrigeration. Bottles must be labelled with the following information:

- Date and Time of sample collection
- Sample ID: Beach Name
- Sample Type: FW (Fresh Water) **or** SW (Salt Water)
- Analysis: E. Coli (FW) **or** Enterococci (SW)

The lab prefers water samples to be 10°C or cooler, so freshly collected samples should be immediately placed into a cooler upon return to the vehicle. If electronic coolers are unavailable

or non-functional, Beach Supervisors should immediately make alternate arrangements, such as the use of standard 'picnic' coolers and crushed ice to cool the samples during transport.

The same type of bottle is used for both E. coli and Enterococci samples. This bottle contains a substance, Sodium Thiosulphate ($Na_2S_2O_3$) in crystalline (powder) form. This substance is immaterial to our concerns – it is used as a dechlorination agent for treated drinking water, and consequently does not matter if the powder escapes the bottle upon sample collection. HRM personnel will not come into contact with this material under normal handling procedures. If the material does get onto someone's skin, thorough washing with soap and water is recommended. The Material Safety Data Sheet (MSDS) for Sodium Thiosulphate is given as Appendix C.

Documentation of water samples is critical, because incomplete, inaccurate or false paperwork can lead to confusing, misleading, or useless sample results. In some circumstances, however unlikely, these could result in the bathing public being exposed to unsafe waters under HRM supervision – a condition that HRM strives to avoid.

The primary documentation to be made for water samples is on the Chain of Custody (COC) form supplied by the lab, customized for the HRM Beaches program – see Appendix D. This form requires the following information:

- Field Sample Identification (i.e., Beach name & Station #)
- Matrix (i.e., Fresh Water or Salt Water)
- Date & Time of sample collection
- # and Type of Bottles (per site) – you will need to report each sampling station on its own line (row) *****
- (Identification of Analysis Required) - check either E. coli, Enterococci, or both
- Name of (HRM staff delivering samples), plus date and time of delivery

*** HRM's Blue Flag beaches will all have two samples collected at Station A (one E. Coli, one Enterococci), and one sample collected at Station B (depends). Mark the number of bottles per station accordingly.**

Water samples are only valid for bacteriological analysis within 24 hours of sample collection, so HRM staff must ensure the delivery of all samples to the lab on the same day they are collected. If this is not possible, samples should be stored in a refrigerated environment (either coolers or a dedicated refrigerator) and delivered to the lab as soon as possible the following morning, BEFORE 24 hours has elapsed from the earliest sample collection point the previous day. Samples delivered more than 24 hours after collection are not reliable indicators of water quality, cannot be used to determine the safety of the beach and should be repeated.

<u>Water Quality – Laboratory Back End: Documentation Confirmation, Analysis & Reporting</u>
HRM contracts with only accredited and certified laboratories for the testing of water samples through the Beaches program. These labs apply thorough quality control and assurance programs at all stages of their work, which begins with sample reception. Reception staff are responsible for confirming that the number and type of bottles received match those reported on the COC form, and for following up on any inconsistencies, errors, or uncertainties with the client. Normally this would be the HRM Beach Supervisor who is delivering and signing for the samples at the time of sample submission, but it may also or instead be the primary client contact (i.e., Cameron Deacoff).

Upon satisfactory receipt and confirmation of all samples, the lab conducts the appropriate analysis as requested on the COC. Some labs can conduct analyses for all bacteria on-site, and others sub-contract affiliated (and accredited/certified) labs to analyze bacteria where on-site facilities do not exist.

As indicated in the previous section, samples remain viable for analysis only when delivered to the laboratory within 24 hours of sample collection. It is therefore critical to accurately observe and record the collection time, and to deliver samples less than 24 hours later. The table below identifies the key drop times and corresponding reporting periods for both parameters on a weekly basis.

Table 2. Sample Drop-off Times for Maxxam Labs

Drop-Off Day	**Parameter**	**Preferred Drop Time (same day)**	**Latest Acceptable Drop Time**	**Results Availability Time & Day**
Monday – Thursday	E. coli	4pm @ Bedford; 2pm Burnside	8am (day after sample collected) at Bedford	Noon on Day 2*
Monday – Thursday	Enterococci	1pm ** @ Bedford 11am Burnside	1pm Bedford Day same day of Collection; 11am Burnside same day of collection	Noon on Day 3
Friday	E. coli	3pm (same day)	3pm (same day)	Monday – Noon
Friday	Enterococci	N/A	N/A	N/A
* Please note this is a 24 hour test. If samples are received in the afternoon the results will not be ready by noon the following day; they will be reported by noon on the second day. (i.e., if sample dropped off Monday at 3pm the results will be reported on Wednesday by noon).				
** Enterococci tests are performed in Sydney; samples must be dropped off on the day of collection in Bedford to ensure hold times are met.				
Advance notice for drop-off of samples outside the regular cut-off times should be given with as much notice as possible. During business hours, please contact Mari Kenny 420-0203 ext.: 291 or Leonard Muise ext. 236. After business hours, please contact Jerry Arenovich (Lab Manager) 499-6235, Robyn Edwards, Microbiology Supervisor, 448-4337, or Suzanne Rogers, Customer Services Manager, 209-4055.				

Effective June 2014, lab results from Maxxam Laboratories are sent to the following personnel via email: Cameron Deacoff, Jen Nagle & Rhonda Dea.

Water Quality Results

HRM uses the best available scientific guidance, in consultation with NSDHW and NSE, to determine the bacteria levels at which swimming and other primary contact recreation is safe. This guidance comes from Health Canada, which publishes Guidelines for Canadian Recreational Water Quality. The current edition of these guidelines was published in 2012.

E. coli is recommended as the best indicator of fecal contamination in fresh water, and as a suitable indicator in marine waters. Enterococci is recommended as the best indicator of fecal contamination in salt water, and as a suitable indicator in fresh waters.

A study comparing the management implications of E. Coli vs. Enterococci results was completed in 2012. Consultation with NS Environment based on study results, coupled with enhanced laboratory analytical capacity, has resulted in a change in HRM management

approach. Consequently, HRM uses E. Coli as indicator of water quality for freshwater beaches, and Enterococci as the indicator of water quality for marine / brackish beaches – a practice adopted in 2013. For further clarity, beaches that will now exclusively be managed on the basis of Enterococci results are as follows:

- Black Rock Beach (Halifax)
- Dingle Beach (Halifax)
- Kinap Beach (Porter's Lake)
- Government's Wharf (Musquodoboit Harbour)

HRM Response to Water Quality Results

Lab results are received by HRM Coordinators or Supervisors with the Beach program.

Where E. coli results meet or exceed 200 units, Beach Supervisors should arrange to retest the affected beach as soon as possible and follow the steps outlined in Table 4:

Table 4. Action Items for Excess E. coli Levels

Step #	Action	Person(s) Responsible
1	Notify Manager of Leisure & Aquatic Services	Aquatics Specialist or Beach Supervisor on Office duty
2	Notify staff on affected beach location	Beach Staff
3	Place appropriate signage at site	Lifeguard(s) on site
4	Notify HRM Public Affairs Officer: Jennifer Stairs Office: 490-5940 Cell: 476-5975 Email: stewarj@halifax.ca	Beach Staff
5	Remain on station for at least 7 days for Public Relations	Lifeguard(s) on site
6	Direct all media questions to the Manager of Leisure & Aquatic Services or designate. Staff to maintain "no comment" unless otherwise directed.	All staff
7	Notify NS Environment (Stephen Westhaver or alternate) & NS Department of Health & Wellness (Linda Passerini & Dr. Robin Taylor)	Water Quality Coordinator

In the event of overflows at Halifax Water Pumping Stations or other potential overflow points, Halifax Water has developed a response procedure for Dingle Beach and Black Rock Beach. See Appendix E for this Procedure.

Beach Retesting in Case of Closure

When water sample results are the cause of a beach closure, the beach is automatically re-sampled the next day (or the next possible day) to confirm the results. If results continue to exceed the threshold (≥400), then the beach will remain closed for a minimum of 72 hours before re-sampled. Beaches should remain closed until any single sample result is below 400.

When wastewater (sewage) system overflows are the cause of beach closures, water samples (E. Coli and Enterococci) should be collected one day after the overflow. If the re-tested samples show Enterococci levels of ≥ 70, the beaches should remain closed and the water re-tested. Beaches should remain closed until a both sample results are below 70.

During retesting conditions, Beach Supervisors should consider documenting the following conditions to assist in interpreting water results as necessary:

- Was it raining at the time of collection or at any time during the previous 24 hour period?
- How clear or turbid was the water?
- Were ducks or other waterfowl present? How many?
- Did you see any other possible signs of water contamination, or possible causes?

HRM Beach Program Contacts:

Acting Manager, Leisure & Aquatic Services	Rhonda Dea HRM Recreation – Leisure & Aquatic Services 479.4577 / 476.1761 dear@halifax.ca
Aquatic Supervisor	Jen Nagle HRM Recreation – Leisure & Aquatic Services 490.4515 / 476.0992 naglej@halifax.ca
Water Quality Coordinator	Cameron Deacoff HRM Energy & Environment 490.1926 / 476.0363 deacofc@halifax.ca
Beach Office	(Rotating position – Beach Supervisors) HRM Recreation – Leisure & Aquatic Services 490.5458
Beach Supervisor	Zara Tufts HRM Recreation – Leisure & Aquatic Services 293.5309 tuftsz@halifax.ca
Beach Supervisor	Josh Weagle HRM Recreation – Leisure & Aquatic Services 293.5388 weaglejo@halifax.ca
Beach Supervisor	Danny McNamara HRM Recreation – Leisure & Aquatic Services 293.5334 mcnamard@halifax.ca
Beach Supervisor	Abby Clarke-Caseley HRM Recreation – Leisure & Aquatic Services 293.5286 clarkea@halifax.ca

List of Appendices:

Appendix A.

Halifax Regional Municipality Beach Locations 2014

Area	Beach Name	Civic Address	Community	Associated Lake/Watercourse & Park (if any)
Halifax	Black Rock Beach	5718 Point Pleasant Dr.	Halifax	Halifax Harbour (Point Pleasant Park)
	Dingle Beach	Dingle Rd.	Halifax	Northwest Arm, Halifax Harbour (Fleming Park)
	Campbell Point Beach	187 Lakewood Dr.	Brookside	Hatchet Lake
	Chocolate Beach	2 Melwood Ave.	Halifax	Chocolate Lake
	Cunard Beach	121 Williams Lake Rd.	Halifax	Cunard Pond
	Kearney Beach	Unaddressed - Hamshaw Dr.	Halifax	Kearney Lake
	Kidston Beach	94 Fieldstone St.	Halifax	Kidston Lake
	Long Pond Beach	869 Herring Cove Rd	Herring Cove	Long Pond
Dartmouth	Albro Beach	199 Albro Lake Rd.	Dartmouth	Albro Lake
	Birch Cove Beach	46 Oakdale Cres.	Dartmouth	Lake Banook (Birch Cove Park)
	Penhorn Beach	70 Penhorn Dr.	Dartmouth	Penhorn Lake
	Shubie Beach	30 John Brenton Dr.	Dartmouth	Lake Charles (Shubie Park)
Bedford/Sackville	Kinsmen Beach	31 First Lake Dr.	Sackville	First Lake
	Sandy Beach	115 Smiths Rd.	Bedford	Sandy Lake
	Springfield Beach	Lakeview Ave.	Sackville	Springfield Lake
Eastern Shore	Kinap Beach*	181 Greenough Dr.	West Porters Lake	Porters Lake
	Lake Echo Beach	3170 Highway 7	Lake Echo	Lake Echo
	Mallay Falls*	Lochaber Mines Rd., off Highway 374	Sheet Harbour	East River Sheet Harbour
	Government Wharf*	169 West Petpeswick Rd.	West Petpeswick	Musquodoboit Harbour
	Pleasant Drive Beach	183 Pleasant Dr.	Gaetz Brook	Petpeswick Lake
	Webber's Beach	738 Upper Lakeville Rd.	West Petpeswick	Lake Charlotte
Oakfield	Oakfield Beach	366 Oakfield Park Road	Grand Lake	Grand Lake (Oakfield Provincial Park)

* weekday supervision only

Appendix B.

Beach Monitoring Summary 2014

Blue Flag Beaches

Beach	Water Type	Sample Type	# of Stations	Sample Collection	# Bottles
Birch Cove Beach	Fresh (Lake)	E. coli & Enterococci	2 (A & B)	**Stn A**: E. coli; Enterococci; **Stn B**: E. coli	3
Black Rock Beach	Marine (ocean)	E. coli & Enterococci	2 (A & B)	**Stn A**: E. coli; Enterococci; **Stn B**: Enterococci	3
Dingle Beach	Marine (ocean)	E. coli & Enterococci	2 (A & B)	**Stn A**: E. coli; Enterococci; **Stn B**: Enterococci	3

Other Beaches

Beach	Water Type	Sample Type	# of Stations*	# Bottles / Station	Standard Sample
Albro Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Campbell Point Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Chocolate Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Cunard Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Government Wharf	Marine (ocean)	Enterococci	2 (A & B)	1	1 / week
Kearney Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Kidston Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Kinap Beach	Marine (ocean)	Enterococci	2 (A & B)	1	1 / week
Kinsmen Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Lake Echo Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Long Pond Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Mallay Falls*	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Oakfield Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Penhorn Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Pleasant Drive Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Sandy Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Shubie Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Springfield Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week
Webber's Beach	Fresh (Lake)	E. coli	2 (A & B)	1	1 / week

Appendix C.

No Acid

Anachemia

255 Norman.
Lachine (Montreal), Que
H8R 1A3

Material Safety Data Sheet

EMERGENCY NUMBERS:

(USA) CHEMTREC : 1(800) 424-9300 (24hrs)
(CAN) CANUTEC : 1(613) 996-6666 (24hrs)
(USA) Anachemia : 1(518) 297-4444
(CAN) Anachemia : 1(514) 489-5711

WHMIS	Protective Clothing	TDG Road/Rail
WHMIS CLASS: D-2B		Not controlled under TDG (Canada). PIN: Not applicable. PG: Not applicable.
		

Section I. Product Identification and Uses

Product name	**SODIUM THIOSULFATE, ANHYDROUS**
Chemical formula	Na2S2O3
Synonyms	Sodium hyposulfite, Sodium thiosulfate, AC-8547, 85786
Supplier	Anachemia Canada. 255 Norman. Lachine (Montreal), Que H8R 1A3
Material uses	For laboratory use only.

CI#	Not available.
CAS#	7772-98-7
Code	AC-8547
Formula weight	158.11
Supersedes	

Section II. Ingredients

Name	CAS #	%	TLV
1) SODIUM THIOSULFATE	7772-98-7	100	Not established by ACGIH: ACGIH (Sulfur dioxide) TWA 2 ppm (5.2 mg(SO2)/m3); STEL 5 ppm (13 mg(SO2)/m3)

Toxicity values of the hazardous ingredients

SODIUM THIOSULFATE:
INTRAPERITONEAL (LD50): Acute: 5200 mg/kg (Mouse).

Section III. Physical Data

Physical state and appearance / Odor	Clear to white granules or crystals. Odorless.
pH (1% soln/water)	8.6
Odor threshold	Not available.
Percent volatile	0% at 21°C
Freezing point	Transition at 48°C
Boiling point	Decomposes at >100°C.
Specific gravity	1.66-1.73 (Water = 1)
Vapor density	Not applicable.
Vapor pressure	Not applicable.
Water/oil dist. coeff.	Not available.
Evaporation rate	Not applicable.
Solubility	33% (in H2O)

Section IV. Fire and Explosion Data

Flash point	Not available.
Flammable limits	Not available.
Auto-ignition temperature	Not available.
Fire degradation products	Oxides of sulfur and sodium. Hydrogen sulfide. Sodium sulfide.
Fire extinguishing procedures	Use DRY chemical, carbon dioxide, foam or water spray. Wear adequate personal protection to prevent contact with material or its combustion products. Self contained breathing apparatus with a full facepiece operated in a pressure demand or other positive pressure mode. Disperse vapors with water spray if they have not ignited. Cool containing vessels with flooding quantities of water until well after fire is out.
Fire and Explosion Hazards	The sensitivity to impact is not applicable. The sensitivity to static discharge is not applicable. Heating above 100°C yields a flammable residue sodium sulfide. Contact with oxidizers may cause fire and/or explosion. Emits toxic fumes under fire conditions.

Section V. Toxicological Properties

Routes of entry	Inhalation and ingestion. Eye contact. Skin contact.
Effects of Acute Exposure	May be harmful by ingestion, inhalation, or skin absorption. Irritant.
Eye	May irritate or burn eyes and cause temporary conjunctivitis.
Skin	May cause skin irritation. Aqueous solutions or dust may cause irritation from repeated or prolonged contact.
Inhalation	Dust or mist may cause severe irritation to the respiratory tract. Exposure may cause coughing, chest pains, and difficulty in breathing. If heated to the point where sulfur dioxide gas is driven off, then this gas is highly irritating to the respiratory tract.
Ingestion	May cause gastrointestinal irritation. May cause nausea, vomiting, purging, cyanosis. Doses of 8 g/kg (oral, rat) were non-toxic.

Section V. Toxicological Properties

Effects of Chronic Overexposure	Carcinogenic effects: Not available. Mutagenic effects: Not available. Teratogenic effects: Not available. Toxicity of the product to the reproductive system: Not available. To the best of our knowledge, the chemical, physical, and toxicity of this substance has not been fully investigated.

Section VI. First Aid Measures

Eye contact	Immediately flush eyes with copious quantities of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Seek immediate medical attention.
Skin contact	Immediately flush skin with plenty of water and soap for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash contaminated clothing before reusing.
Inhalation	Remove patient to fresh air. Administer approved oxygen supply if breathing is difficult. Administer artificial respiration or CPR if breathing has ceased. Seek immediate medical attention.
Ingestion	If conscious, wash out mouth with water. Have conscious person drink several glasses of water to dilute. Seek immediate medical attention. Never give anything by mouth to an unconscious or convulsing person.

Section VII. Reactivity Data

Stability	Stable. Conditions to avoid: High temperatures, sparks, open flames and all other sources of ignition, contamination.
Hazardous decomp. products	Not available.
Incompatibility	Oxidizing agents (e.g., nitrates, sodium nitrite, halogens) cause vigorous exothermic reactions. Acids release sulfur dioxide gas. Water-reactive materials such as sodium, cause strong exothermic reaction. Mercury salts, lead, silver, iodides, iodine, mercury.
Reaction Products	Sulfur dioxide gas which is toxic, corrosive, and an oxidizer, is driven off above 100°C leaving, a sodium sulfide residue which is flammable, a strong irritant to skin and tissue and is also incompatible with acids. Hazardous polymerization will not occur.

Section VIII. Preventive Measures

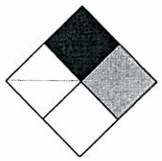
Protective Clothing in case of spill and leak	Wear respirator, chemical safety goggles, rubber boots and heavy rubber gloves.
Spill and leak	Evacuate the area. Sweep up and place in container for disposal. Avoid raising dust. Ventilate area and wash spill site after material pick up is complete. DO NOT empty into drains. DO NOT touch damaged container or spilled material. Avoid run off.
Waste disposal	According to all applicable regulations.
Storage and Handling	Store in a cool place away from heated areas, sparks, and flame. Store in a well ventilated area. Store away from incompatible materials. Do not add any other material to the container. Do not wash down the drain. Do not breathe dust. Keep away from direct sunlight or strong incandescent light. Keep container tightly closed and dry. Manipulate in a well ventilated area or under an adequate fume hood. Avoid raising dust. Handle and open container with care. Minimize dust generation and exposure - use dust mask or appropriate protection. This product must be manipulated by qualified personnel. Do not get in eyes, on skin, or on clothing. Wash well after use. In accordance with good storage and handling practices. Do not allow smoking and food consumption while handling.

Section IX. Protective Measures

Protective clothing	Splash goggles. Impervious gloves, apron, coveralls, and/or other resistant protective clothing. Sufficient to protect skin. If use conditions generate dusts, wear a NIOSH-approved respirator appropriate for those emission levels. Appropriate respirators may be a full facepiece or a half mask air-purifying cartridge respirator with particulate filters, a self-contained breathing apparatus in the pressure demand mode, or a supplied-air respirator. Do not wear contact lenses. Make eye bath and emergency shower available. Ensure that eyewash station and safety shower is proximal to the work-station location.
Engineering controls	Local mechanical exhaust ventilation capable of minimizing dust emissions at the point of use. Do not use in unventilated spaces.

Section X. Other Information

Special Precautions or comments Irritant! Do not breathe dust. Avoid all contact with the product. Avoid prolonged or repeated exposure. Manipulate in a well ventilated area or under an adequate fume hood. Keep away from heat, sparks and flame. Handle and open container with care. Container should be opened only by a technically qualified person.
RTECS NO: XN6472000.



NFPA

Prepared by MSDS Department/Département de F.S.. | **Validated 28-Jul-1999**

Telephone# (514) 489-5711

Appendix D.

Maxxam Analytics
200 Bluewater Road, Suite 105, Bedford, Nova Scotia B4B 1G9 Tel: 902-420-0203 Fax: 902-420-8612 Toll Free: 1-800-565-7227
49 Elizabeth Ave., St John's, NL A1A 1W9 Tel: 709-754-0203 Fax: 709-754-8612 Toll Free: 1-888-492-7227
90 Esplanade, Sydney, NS B1P 1A1 Tel: 902-567-1255 Fax: 902-539-6504 Toll Free: 1-888-535-7770
www.maxxam.ca E-mail: Clientservicesbedford@maxxam.ca

MAXXAM Chain of Custody Record

COC#: Page of

This column for lab use only :

Client Code

Maxxam Job#

Cooler ID	Seal Present	Seal Intact	Temp 1	Temp 2	Temp 3	Average Temp

Integrity YES NO | Integrity/Checklist by:

Labelled by: | Location/Bin#

INVOICE INFORMATION:

Company Name: Halifax Regional Municipality
Contact Name: Cameron Deacoff
Address: PO Box 1749, Halifax, NS B3J 3A5
Email: deacofc@halifax.ca
Ph: 490-1926 / 476-0363 **Fax:** 490-5862

REPORT INFORMATION (if differs from invoice):

Company Name: same
Contact Name:
Address:
Email:
Ph: **Fax:**

PO# 2070665903
Project # / Phase#
ProjectName/Site Location
Quote
Site #
Task Order#
Sampled by

TURNAROUND TIME
Standard ☐
10 day ☐
If RUSH Specify Date:
Pre-schedule rush work
Charge for # Jars used but not submitted

Guideline Requirements/ Detection Limits/ Special Instructions

Send results by email only.
CC results to Jen Nagle & Rhonda Dea

Field Sample Identification	Fresh (FW) or Marine (SW)	Date/Time Sampled	# & type of bottles	E. Coli	Enterococci
1 Black Rock - Station A	SW	July 1, 0930	2	x	x
2 Black Rock - Station B	SW	July 1, 0930	1		x
3 Dingle - Station A	SW	July 1, 0900	1		x
4 Dingle - Station B	SW	July 1, 0900	1	x	
5 Birch Cove - Station A	FW	July 1, 1045	2	x	x
6 Birch Cove - Station B	FW	July 1, 1045	1	x	
7 Chocolate Lake - Station A	FW	July 1, 1000	1	x	
8 Chocolate Lake - Station B	FW	July 1, 1000	1	x	
9 Government's Wharf - Station A	SW	July 1, 1200	1		x
10 Government's Wharf - Station B	SW	July 1, 1200	1		x

RELINQUISHED BY: (Signature/Print) **Date** **Time**

RECEIVED BY: (Signature/Print) **Date** **Time**

White : Maxxam Yellow : Mail Pink : Client

Appendix E.

PROCEDURE FOR RESPONDING TO SEWAGE OVERFLOWS - Where Dingle or Black Rock Beaches may be affected.

Pumping Stations of Concern:

Dingle Tower PS
Chain Rock PS
Armdale PS
Pier A PS

Other Overflow points:

Armdale Roundabout
Jubilee Road
Coburg Road
Fairfield Holding Tank

PROCEDURE:

1. Overflow event occurs, as detected by Halifax Water (HW) Wastewater Collection Services

2. HW Wastewater Collection Services to begin notification.

If an HHSP pumping station overflow occurs, Lewis Stewart or designate will make the contact.

For all other HW infrastructure, the HW on-duty supervisor will make the contact.

HW Operations to notify the following if the overflow event (or the malfunction) lasts for 1 hour or greater, by telephone & email:

a. **HRM Recreation** – to begin shut down of affected beach(es).

Weekdays, call **Jen Nagle, Aquatics Supervisor**
Cell: 476-0992 (best contact number)
Office: 490-4515
naglej@halifax.ca

And

HRM Environmental Performance Officer
Cameron Deacoff
Cell: 476-0363
Office: 490-1926
cameron.deacoff@halifax.ca

* Contact via email only

Weekends, call the **Beach Line** 490-5458

Recreation Supervisors check messages first thing in the morning and in the afternoon.

b. **Halifax Water's Environmental Services Department**
When an overflow event occurs, or if there is any occurrence of malfunctions or shut-downs which result in discharges, HW Operations will notify Halifax Water's Environmental Services Department.

Tony Blouin, Manager, Regulatory Compliance
Phone: (902) 237-0706
Email: blouint@halifaxwater.ca
* Contact via email only

Or Alternates: Environmental Services P2 Group (see Contacts).

Water sampling: In the event of a significant overflow, HRM Beach Supervisors will sample at the relevant beach or beaches as per the attached sampling protocol.

3. HRM Recreation staff will initiate the process of shutting down the beaches.

As per the procedure followed when weekly Nova Scotia Environment (NSE) water sampling reveals high bacterial levels at any of the other HRM supervised beaches: The beach staff clear the water of all swimmers. The Aquatics Supervisor will put the information out to the media (through Corporate Communications), update the HRM website, post signage at the beach and keep staff at the beach for at least a week to prevent swimmers from entering the water. This will continue until testing has confirmed that bacterial levels have fallen to within acceptable limits, as advised by HW Environmental Services.

For Black Rock and Dingle beaches the PSA should list a representative from HRM Beaches and James Campbell, or designate from HW, as contacts on the PSA.

4. HRM Energy & Environment (Cameron Deacoff) will advise NSE and Nova Scotia Dept. of Health and Wellness (NSDHW) that the beach/beaches has/have been shut down and provide any available information on sampling.

Stephen Westhaver (or alternate)
District Manager
NSE Central Region
(902) 424-8183; westhasb@gov.ns.ca

Linda Passerini
Environmental Health Consultant
NSDHW & Protecting Health Unit, CDHA Public Health
(902) 424-2736; linda.passerini@gov.ns.ca

Dr. Robin Taylor
Medical Officer of Health
Capital District Health Authority
(902) 481-5826; Robin.Taylor@cdha.nshealth.ca

Other HW Contact Info:

Supervisors:

Name	Work Phone	Cell	E-mail
Lewis Stewart	490-6116	476-6445	stewarl@halifaxwater.ca
Thoren Pelley	490-4943	476-1420	thorenp@halifaxwater.ca
Chris Weeks	490-4959	476-6823	weeksc@halifaxwater.ca
Tony Makin	490-4960	476-7132	makint@halifaxwater.ca
Dino Amaral	490-6083	476-2525	amarald@halifaxwater.ca
Cedric Williams	490-6729	476-4965	cedricw@halifaxwater.ca

Superintendents:

Name	Office Phone	Cell	E-mail
Danny Patey	490-2004	476-5902	pateyda@halifaxwater.ca
Sheldon Parsons	490-1781	476-6327	parsonsh@halifaxwater.ca
Ken MacDonald	490-4107	229-7270	kenm@halifaxwater.ca

P2 Group:

Name	Office Phone	Cell	Email
Heather Crowell	n/a	222-6689	crowelh@halifaxwater.ca
Kim Fawcett	n/a	476-0556	fawcetk@halifaxwater.ca
Charles Lloyd	n/a	440-8037	lloydc@halifaxwater.ca

Communications:

Name	Office Phone	Cell	E-mail
James Campbell	490-4604	476-5885	campbej@halifaxwatwer.ca

HRM Energy & Environment Sampling Procedure in Event of a CSO/Malfunction/Shutdown Event

Black Rock (Point Pleasant Park) and Dingle (Fleming Park) Beaches

In the event of an overflow/discharge notification from Halifax Water (HW) Wastewater Collection Services, HRM Recreation will close the corresponding beach(es) at the earliest opportunity when the lifeguarding staff is next on duty.

When an overflow/discharge notification is received by HRM Recreation from Halifax Water (HW) Wastewater Collection Services, the role of HRM Recreation is to conduct daily sampling at the closed beach(es) for fecal enterococci and E. coli, in accordance with field monitoring protocols established by HRM Energy & Environment. Field sampling is through grab samples taken at approximately 0.3 metre depth, in water that is approximately 1.0 to 1.5 metres deep. Water samples from this position can best be collected with a sampling pole from shore. When a sampling pole is unavailable, samplers may wade to a water depth of approximately 1 meters. Regardless of method, samplers are to collect 1 sample bottle per parameter per beach. Sampling will commence on the day following a notification (if the notification is issued overnight), or on the day of a notification if the notification is issued during working hours.

Samples are to be delivered to the Maxxam Lab in Halifax, which provides 1 day turnaround for E. coli results, and 3 day turnaround for the Enterococci results.

Daily sampling will continue until a single sample of E. coli falls below the swimming guideline level (200/100mL). When this happens, HRM Energy & Environment will notify HRM Recreation that levels are safe and the beach(es) may re-open.

The HRM Aquatics Supervisor will, through Corporate Communications, put the updated information out to the media and update the HRM website.

HRM Energy & Environment will also notify NSE and NSDHW that beaches are re-opening.
The Aquatics Supervisor will also put the updated information out to the media (through Corporate Communications), update the HRM website and signage at the beaches.

Appendix B. Beach Water Quality Summary 2014

E. coli Results

Beach	Week of June 9	Week of June 23	Week of June 30	Week of July 7	Week of July 14	Week of July 21	Week of July 28	Week of Aug 4	Week of Aug 11	Week of Aug 18	Week of Aug 25
Albro	ND, 30	ND, 30	20, 30	10, 80	10, ND	60, ND	20, 10	ND, 20	ND, 10	180, 130	ND, 30
Birch Cove	ND, ND	20, 10	20, 80	ND, 20	10, 10	40, 40	10, 10	200, 370; 50, 80	500, >2500; 170, 210	720, 420; 200, 80	40, 100
Black Rock	--	--	ND	10	--	ND	ND	110	ND	20	ND
Campbell	--	ND, ND	ND, ND	10, 40	ND, ND	ND, ND	30, 40	ND, 10	10, ND	10, 10	ND, ND
Chocolate	--	20, 10	90, 40	ND, ND	10, ND	20, ND	ND, 10	ND, 10	40, 70	40, 30	30, 30
Cunard	--	ND, 10	10, ND	10, ND	ND, 10	ND, 20	ND, ND	ND, 10	30, 200; 90, 90	10, 20	60, 30
Dingle	--	--	ND	--	ND	ND	10	ND	ND	ND	ND
Kearney	--	20, 10	40, 50	20, 20	20, 10	20, 10	10, 10	30, 80	ND, 20	240, 150; 60, 30	10, 30
Kidston	--	ND, ND	10, ND	ND, ND	10, 10	ND, ND	20, 10	30, 40	ND, ND	50, 30	10, ND
Kinsmen	--	1400, 1000; 150, 110	20, 20	200, 40; 50, 10	20, 50	40, 20	20, 70	70, 170	40, 150	30, 20	150, 190
Lake Echo	--	10, 10	ND, 30	10, 10	30, 50	10, 10	ND, 40	10, ND	10, 10	ND, 20	10, 10
Long Pond	--	ND, ND	120, 160	20, 10	ND, ND	80, 40	ND, 30	20, ND	60, 50	60, 10	ND, ND
Malay Falls	--	10, ND	ND, 30	ND, ND	10, 30	20, 70	ND, 10	ND, ND	>2500, 2100; ND, 10	10, 20	ND, ND
Oakfield	--	20, 10	20, ND	ND, ND	ND, ND	10, ND	10, ND	ND, ND	10, ND	20, ND	>2500, >2500;
Penhorn	--	ND, ND	10, 40	20, 40	ND, 10	700, 870; 10, ND	30, 20	10, ND	20, 30	70, 20	10, 10
Pleasant	--	ND, ND	ND, 20	ND, ND	ND, 40	ND, 20	ND, 20	ND, ND	ND, ND	ND, ND	ND, 10
Sandy	--	ND, 10	10, 30	10, 10	ND, ND	40, 20	ND, ND	10, 10	ND, 10	40, ND	ND, 10
Shubie	--	ND, ND	20, 10	30, ND	40, 20	40, 30	>2500, >2500; 70, 80	20, 10	80, 40	10, 20	ND, ND
Silversides	--	150, 90	60, 20	10, ND	ND, ND	60, 10	50, 10	60, 40	10, ND	20, 20	110, 40
Springfield	--	20, 10	350, 440	90, 20	ND, 10	100, 110	150, 180	320, >2500	10, ND	40, 10	160, 180
Webbers	--	ND, ND	ND, ND	ND, ND	ND, 40	ND, ND	ND, 10	20, 10	130, 360	ND, ND	ND, ND

Enterococci Results

Beach	Week of June 9	Week of June 23	Week of June 30	Week of July 7	Week of July 14	Week of July 21	Week of July 28	Week of Aug 4	Week of Aug 11	Week of Aug 18	Week of Aug 25
Birch Cove	ND	ND	ND	ND	ND	ND	10	20	20	42	ND
Black Rock	NC	ND, ND	ND, 20	10, ND	ND, ND	ND, ND	ND, ND	ND, 20	10, 10	20, 10	ND, ND
Dingle	NC	ND, ND	ND, 10	52, ND; ND	20, ND	110, 10	ND, ND	31, 10	10, ND	ND, ND	ND, 10
Government	NC	ND, 42	10, 10	ND, ND	140, 150	ND, ND	42, 10	ND, ND	50, ND	10, ND	31, ND
Kinap	NC	ND, ND	ND, ND	ND, ND	ND, ND	ND, ND	NC	ND, ND	NC	ND, ND	87, 75

Notes

1. E. Coli results are posted in the following format: (Raw Station A, Raw Station B).
2. Enterococci results are posted in the following format: Raw Station A, Raw Station B
3. Results given as ' ND' indicates that the bacteria was "Not Detected"
4. Results given as 'NC' indicates that no sample was collected during the given period.
5. Laboratory results are based on an Reportable Detection Limit of 10. Geomeans calculated using nondetect results use 1/2 the RDL value, or 5, for those stations
6. Results are posted for the week during which the samples were collected, not the week during which the results were received by HRM
7. When more that one sample set was collected during the week (i.e. due to non-compliant test results etc.), the second set is posted below the first of results.
8. Cells shown in yellow indicate that the geometric mean of test results exceed the warning level threshold. Affected beaches are retested upon receipt of these notifications, but not closed.
9. Cells shown in red indicate that the geometric mean of test results exceed the guidance level. Affected beaches are closed upon receipt of these notifications.

BLUE FLAG BEACH CRITERIA AND EXPLANATORY NOTES 2013

INTRODUCTION

The Blue Flag programme for beaches and marinas is run by the international, non-governmental, non-profit organisation FEE (the Foundation for Environmental Education). The Blue Flag programme was started in France in 1985. It has been operating in Europe since 1987 and in areas outside of Europe since 2001, when South Africa joined. Today, Blue Flag has become a truly global programme with an ever-increasing number of countries participating in the programme.

The Blue Flag programme promotes sustainable development in freshwater and marine areas. It challenges local authorities and beach operators to achieve high standards in the four categories of: water quality, environmental management, environmental education and safety. Over the years, the Blue Flag has become a highly respected and recognised eco-label working to bring together the tourism and environmental sectors at local, regional and national levels.

The explanatory notes given in this document make up the common and shared understanding of the Blue Flag beach criteria and the requirements for the implementation thereof. The explanatory notes provide details on the measurement and management of compliance with the Blue Flag beach criteria.

The criteria are categorised as either imperative or guideline. Most beach criteria are imperative, i.e. the beach must comply with them in order to be awarded Blue Flag accreditation. If they are guideline criteria, it is preferable that they are complied with, but not mandatory.

It must be emphasised that the Blue Flag beach criteria in this document are the minimum criteria. A national programme can choose to have stricter criteria to what is outlined here.

These beach criteria and explanatory notes are to be used by all Blue Flag applicants in order to understand the requirements that must be met before a beach can receive Blue Flag accreditation. For guidance purposes, this document should also prove valuable for the management of those beaches already accredited with Blue Flag status. The beach criteria and explanatory notes also serve as a guide for the National, Regional and International Blue Flag Juries when making decisions about a Blue Flag beach candidate.

During the Blue Flag season the flag must fly at the beach. The flag is both a symbol of the programme being run at the beach but also an indication of compliance. The flag may either be flown 24 hours a day during the Blue Flag season, or only during the hours when the beach meets all the Blue Flag criteria. In the case of the former, there must be adequate signage indicating the time when services (eg life-saving), and facilities (eg toilets) are in operation.

If a beach that has Blue Flag accreditation does not comply with the Blue Flag criteria, the flag may be permanently or temporarily withdrawn from the beach. There are several degrees of non-compliance:

1. A **minor** non-compliance is where there is a problem with only one criterion of minor consequence to the health and safety of the beach user or to the environment. When minor compliance occurs and can be immediately rectified, the flag is not withdrawn and the non-compliance is only registered in the control visit report. If however, a minor compliance

cannot be fixed immediately, the beach is given 10 days in which to comply fully with all criteria. The flag is withdrawn until all problems are rectified and it is noted on the Blue Flag homepage.

2. **Multiple non-compliances** relates to non-compliance of two to three criteria but of minor consequence to the health and safety of the beach user or to the environment. When multiple non-compliances occur, the beach is given 10 days in which to comply fully with all criteria, the flag is withdrawn until all the problems are rectified and the homepage is updated accordingly.
3. **Major** non-compliance is where the beach does not comply with one or several criteria, the result of which can have consequence to the health and safety of the beach user or to the environment, as well as the general perception of the beach and therefore the Programme. When met with major non-compliance, the flag is withdrawn immediately and for the rest of the season. The site is registered as 'withdrawn' on the Blue Flag homepage, and the beach information board should clearly indicate that Blue Flag status has been withdrawn.

In all cases of non-compliance, the National Operator must immediately inform the local authority/beach operator about the observed areas of non-compliance. Information about the reason for a withdrawal of the flag must be posted clearly at the beach. The local authority/beach operator must inform the National Operator of re-compliance with the criteria and present the appropriate documentation needed. The flag can then be raised at the beach again. The National Operator should also consider a follow-up control visit to check that the beach does comply. In the event that the local authority/beach operator does not ensure and document re-compliance with the criteria within 10 days, the National Operator must ensure that the Blue Flag is withdrawn for the rest of the season at the beach.

In the event that conditions on the beach change and the flag has to be temporarily withdrawn, e.g. when climatic events cause damage to the beach or an emergency arises, the beach management must inform the National Operator that the flag has been temporarily withdrawn and the international website must be changed accordingly.

Apart from updating the Blue Flag homepage of the status of the beach, the National Operator must inform the International Coordination about the non-compliance. If the non-compliance is noted at by an international controller, the National Operator has to give feedback to the International Coordination within 30 days.

The applicant for Blue Flag accreditation is the authority charged with responsibility for the beach. This may be a local municipality, private hotel, national park, or private beach operator. A beach may be eligible for Blue Flag accreditation if it is a designated bathing area and it has the necessary facilities and services to comply with the Blue Flag criteria.

A beach must be accessible in order to be eligible for Blue Flag accreditation. It is preferable that beach users be granted free access to a Blue Flag beach, i.e. to use the beach and its facilities without paying a fee. Blue Flag, however, recognises that at some beaches, e.g. private beaches, members of the public are charged a small, reasonable fee to access the beach. Other payments may be levied for services in the area, e.g. for parking or hiring of equipment.

FEE, and the National Operator in a country, reserves the right to refuse or withdraw Blue Flag accreditation from any beach where the local authority/beach operator is responsible for violations of national environmental regulations or otherwise acts in discord with the objectives and spirit of the Blue Flag programme. Blue Flag beaches are subject to announced and/or unannounced control visits by FEE International.

In the event of a first-time applicant, the applicant local authority/beach operator must provide evidence in the application that the beach complied with the imperative water quality criterion for Blue Flag in the season (or year) prior to application for full status. Applications will only be considered from beaches where a minimum of 20 samples have been taken in the previous season(s).

ENVIRONMENTAL EDUCATION AND INFORMATION

Each beach must have at least one Blue Flag information board in place containing all the information as required by the criteria listed below. For long beaches it is recommended to install more than one Blue Flag information board (approximately one every 500 metres). All Blue Flag information boards must follow national standards with respect to information, content and design. These Blue Flag information boards must be in place at all Blue Flag beaches.

Criterion 1. Information about the Blue Flag programme and other FEE eco-label must be displayed.

Information about the Blue Flag programme must be displayed on the Blue Flag information board. The correct Blue Flag logo must be used, in accordance with the FEE branding guidelines. The essence of each of the four categories of the Blue Flag criteria must be explained in this information. The length of the Blue Flag season must also be included.

The information could furthermore be posted at other locations, e.g. at major access points, lifeguard stations, other beach facilities, or in parking areas. Tourist information offices should also have information about the Blue Flag programme.

Contact details for the local, national and international Blue Flag representatives should be posted as well.

In areas of international tourism, it is recommended that the information be provided in relevant languages.

In the event that the flag is temporarily withdrawn, information must be posted at the beach informing the public as to the reasons why the flag was withdrawn.

Blue Flag beaches and marinas should promote the Green Key programme as another eco-label FEE programme with a message such as: “Along with the Blue Flag, the Foundation for Environmental Education also develops another eco-label for accommodations: Green Key. Find more information at: www.green-key.org”

Appendix B provides an example of how the Blue Flag information can be presented.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 2. Environmental education activities must be offered and promoted to beach users.

Environmental education activities promote the aims of the Blue Flag programme by:

- increasing the awareness of, and care for, the local environment by recreational users and residents.
- training personnel and tourist service providers in environmental matters and best practice methods.
- encouraging the participation of local stakeholders in environmental management within the area.

- promoting sustainable recreation and tourism in the area.
- promoting the sharing of ideas and efforts between the Blue Flag programme and other FEE programmes (YRE, LEAF, Eco-Schools and Green Key).

The planned environmental education activities for the coming season must be included in the application documents, as well as a report on activities carried out during the previous Blue Flag season (if applicable).
There must be at least five different activities offered in the municipality or community - preferably during the Blue Flag season. The activities should focus on the environment, environmental issues, Blue Flag issues or sustainability issues. At least some of the activities should be carried out at the beach and have a direct focus on the beach environment.

The education activities should be effective and relevant, and each year, the local authority should re-evaluate the activities that were implemented and work towards constantly improving them.

Where the planned environmental education activities are of interest to, and involve, the general public or beach users these activities must be promoted in good time to inform the public about these opportunities. Such activities could also be promoted on the Blue Flag information board, in other areas in the beach area, in local centres, in newspapers and other media.

The environmental education activities must be clearly disseminated to the public. Preferably, the activities should be posted on the common information board. However, dissemination could be an updatable list posted at the kiosk or clubhouse, an SMS service or other means of communication. Whatever the platform for dissemination is, it has to be stated on the information board where to find out more about the activities.

Local authorities/beach operators are encouraged to implement and/or support sustainable development projects in which public participation is a key element, e.g. Local Agenda 21 initiatives.

If specific sensitive natural areas (including Marine Protected Areas) exist near a Blue Flag beach (e.g. mangroves or sea grass beds), it is strongly recommended that some of the education activities address these sensitive natural areas.

Examples of good educational activities can be downloaded from the internal pages of the Blue Flag international website (www.blueflag.org).

Appendix C provides further background on the environmental education activities.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 3. Information about bathing water quality must be displayed.

Bathing water quality information must be displayed on the Blue Flag information board. It is recommended that a table or figure with easily identifiable symbols that correspond to the results be used. The information should also clearly explain how the water quality results relate to the imperative criteria for water quality, with specific reference to sampling frequency and the conditions under which Blue Flag status can be withdrawn.

The authority in charge of providing the bathing water quality results must do so shortly after the analysis so that the data can be updated regularly. It is the responsibility of the local authority to

ensure that the beach operator/beach management posts the information no later than one month after the sampling date. The complete and detailed data must be made available by the local authority to anybody upon request.
Appendix D provides an example of how this information could be presented.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 4. Information relating to local eco-systems and environmental phenomena must be displayed.

The aim of this criterion is to ensure that beach users are well informed and educated about relevant environmental phenomena (including valuable cultural sites/communities), local ecosystems and any sensitive areas in the surrounding environment so that they are encouraged to learn about and experience the environment in a responsible way.

Where appropriate, information about coastal zone ecosystems, wetland areas, unique habitats or any sensitive natural areas must be displayed at or close to the Blue Flag beach. The information should include details about the natural area and a code of conduct for visitors to the area. If the full information is not available on the Blue Flag information board, there should at least be a short notice on the board informing the public about the nearby sensitive area and where they can find further information.

Relevant environmental information could furthermore be displayed at tourist sites, at the natural areas, or in tourist information offices. The information can be published in tourist brochures, local newspapers or pamphlets created specifically for this purpose. In areas that are visited by a high number of tourists, it is recommended that the information be presented in more than one way, as listed above, and it should be presented in relevant languages.

In the case of sensitive underwater environments, specific information about these areas must be provided for divers and snorkelers.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 5. A map of the beach indicating different facilities must be displayed.

A map showing the boundaries of the Blue Flag beach area and the location of key facilities and services must be posted on the Blue Flag information board. The map should be of good quality, easy to read and properly orientated.

Pictograms should preferably be used.

The required map elements (where applicable) should show the location of:

- "You are here" pointers
- lifeguards or lifesaving equipment
- the area patrolled (for beaches with lifeguards)
- first aid equipment
- telephones
- toilets (including toilets for disabled people)
- drinking water
- car and bicycle parking areas
- authorised camping sites at/near the beach
- recycling facilities
- location of water sampling point(s)

- access points and access for disabled persons
- zoning (swimming, surfing, sailing, boating, etc.) where applicable
- nearby public transport
- footpaths
- demarcation of Blue Flag area
- location of other information boards
- rivers and inflows
- local landmarks (where applicable)
- storm water outlets
- nearby natural sensitive areas, etc.
- direction (North)
- scale bar

For guidelines on the design and suitability of maps of Blue Flag beaches, visit www.blueflag.org.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 6. A code of conduct that reflects appropriate laws governing the use of the beach and surrounding areas must be displayed.

The code of conduct should address the activities of beach users and their conduct on the beach. The beach code of conduct must be displayed on the Blue Flag information board. The information could furthermore be posted at other locations, e.g. at all major entrance points, near to the issue concerned (i.e. a No Diving sign on a pier) or as information at the relevant sites. Internationally recognised symbols, e.g. pictograms should be used wherever possible.

The code of conduct should include rules about the presence of domestic animals, zoning, litter management, the use of vehicles, camping, fires, etc.

Laws governing beach usage and management should be available to the public at the office of the local authority/beach operator.

The period when the lifesaving equipment and/or lifeguards, and first aid are available must be clearly marked on the Blue Flag information boards and at the lifeguard station. An explanation of the emergency flag system in use must also be provided.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

WATER QUALITY

The Blue Flag programme requires that beaches achieve excellent bathing water quality. The bathing water quality standards have been based on the most appropriate international and national standards and legislation.

Blue Flag is an international eco-label and it therefore has one minimum global standard for water quality. The standards described here for bathing water quality for beaches must be adopted unless stricter national standards are already in existence, e.g. testing for total coliform bacteria. In that case, the beach must comply with the more demanding national standards for bathing water quality.

Criterion 7. The beach must fully comply with the water quality sampling and frequency requirements.

A Blue Flag beach must have at least one sampling site and this must be located where the concentration of bathers is highest. In addition, where there are potential sources of pollution, e.g. near streams, rivers or other inlets, storm water outlets, etc. additional samples must be taken at these sites to provide evidence that such inflows do not affect bathing water quality.

Samples for microbiological and physical–chemical parameters must be taken.

Similarly, in the case of inland waters where the water is supplemented by outside sources during dry periods, the water quality of the outside source must meet the Blue Flag bathing water quality standards.

Samples should be taken 30 cm below the water surface except for the mineral oil samples that should be taken at surface level.

How often a sample must be taken?
There must be no more than 30 days between samples during the Blue Flag season. The Blue Flag programme does not accept applications from beaches, irrespective of the length of the Blue Flag season, where less than five samples have been taken. I.e. a minimum of five samples must be taken evenly spread out during the season. The first sample must be taken within 30 days before the official starting date of the Blue Flag season.

When sample results raise concern of a possible increase in levels of pollution, it is recommended to temporarily increase the sampling frequency in order to track any possible pollution incident.

In the event of short-term pollution, one additional sample is to be taken to confirm that the incident has ended. This sample is not part of the set of bathing water quality data. If necessary to replace a discarded sample, an additional sample is to be taken seven days after the end of the short-term pollution. Discounting of samples because of short-term pollution during the last assessment period is allowed for maximum 15% of the total number of samples provided for in the monitoring calendar established for that period, or one sample per bathing season, whichever is the greater. When calculating 15% of the total number of samples provided for that period, the result must be rounded up or down.
The rule is:
Anything lower or equal to ,49 should be rounded down (for example: a result of 2,49 gives a possibility of discounting 2 samples).
Anything higher or equal to ,50 should be rounded up (for example: a result of 2,50 gives a possibility of discounting 3 samples).

Both the original and the re-samples have to be sent as a dispensation case to the International Jury for the evaluation (*see Appendix A on dispensation cases*).

In case of an oil spill, abnormal weather or other extreme factors which can have a serious adverse effect on the quality of the bathing water, the beach manager must temporarily take down the flag and clearly state the reason on the information board. It is recommended that the wording of this information is along the lines: "This beach has recently experienced abnormal weather. Swimming is not recommended at this time due to the possibility of pollution."

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 8. The beach must fully comply with the standards and requirements for water quality analysis.

An independent person, officially authorised and trained for the task, must collect the samples.

An independent laboratory must carry out the analysis of the bathing water samples. The laboratory must be nationally or internationally accredited to carry out microbiological and physical-chemical analyses.

In the event that the sampler or the laboratory is not independent, at the time of application a dispensation must be requested and details provided as to why this is required, e.g. in some cases beaches are substantial distances away from the services necessary to meet this requirement.

Methods of analysis:
In the interest of increased quality and comparability of the bathing water quality data used for the evaluation of candidates for the Blue Flag, FEE finds that methods of analysis that ensure a certain trueness, reproducibility, repeatability and comparability between methods should be used. FEE follows European (CEN) or International (ISO) standards in its recommendations regarding parameters and acceptable methods of analysis.

Water quality results must be given to the National Operator as soon as they are made available but not later than one month after the sample has been taken.

A sampling calendar must be established prior to the start of the bathing season. Sampling must take place no later than four days after the date specified in the sampling calendar unless there are exceptional circumstances preventing this. In such a case, the National Jury must submit the beach as a dispensation case to the International Jury (*see Appendix A for more information on dispensation cases*).

Sampling history:
The water quality results for the previous four seasons must accompany all applications. In order to be eligible for the Blue Flag, the beach must show - through these reports - that the bathing water quality standards were met in the previous seasons.

For new countries or new beaches, results from a minimum of 20 samples taken within the proposed Blue Flag season must be available for Blue Flag accreditation to be considered. The sampling history may be taken in one Blue Flag season in order to be able to apply the following year. The applicant beach may also choose to take fewer samples and wait to apply when 20 samples have been collected (for example taking 10 samples in year 1, 10 more in year 2 and applying in year 3). Remember that a minimum of 5 samples has to be taken per Blue Flag season.

The water quality information of the current season must be posted on the Blue Flag information board, in accordance with Criterion 3. *See Appendix D for a recommendation for presenting water quality information on Blue Flag beaches.*

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 9. No industrial, waste-water or sewage-related discharges should affect the beach area.

A bathing water profile must be compiled for every Blue Flag beach. A bathing water profile includes identification of potential sources of pollution, a description of the physical, geographical and hydrological characteristics of the bathing water, as well as assessment of the potential for cyanobacteria and algae formation.
It is recommended that there should not be any discharge of industrial, urban wastewater or sewage-related discharges into the Blue Flag area or immediate buffer zone/surrounding area. In the event that there are discharge points in the area of the beach, these must be documented at the time of application.

Where identified, combined sewage overflow discharges or other urban/industrial waste water discharges are within, or immediately adjacent to, the proposed award area, information to warn the public that there is an intermittent discharge which could, in the short term, impact the bathing water quality must be provided.

The collection, treatment and discharge of urban wastewater in the community must meet national/ international standards and comply with national/international legislation. For the countries in EU, there are requirements for the treatment and effluent quality given in the EU Urban Waste Water Treatment Directive (91/271/EEC). A number of new EU countries have been granted dispensation from the EU Directive. Regardless of national/ international standards and legislation, this waste-water or any discharges must not negatively affect the environment or compromise the water quality standards of a Blue Flag beach.

Regarding industrial pollution, notification must be given about industrial facilities and plants in the vicinity of the beaches stating their likely influence on the environment. Moreover, the appropriate authorities must confirm in writing that the area is being monitored to ascertain the environmental impacts of nearby industrial facilities and confirm that the facilities do not pose a public health risk or environmental hazard.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 10. The beach must comply with the Blue Flag requirements for the microbiological parameter Escherichia coli (faecal coli bacteria) and intestinal enterococci (streptococci)

The microbiological parameters to be monitored are given below:

Parameter	Coastal and transitional waters Limit values	Inland waters Limit values
Escherichia coli (Faecal Colibacteria)	250 cfu/100 ml	500 cfu/100 ml
Intestinal Enterococci (streptococci)	100 cfu/100 ml	200 cfu/100 ml

- cfu = colony forming units (of bacteria)

Accepted percentile:
For the evaluation of an applicant beach the Blue Flag programme requires 95th percentile compliance of the above limit values. This is in accordance with the EU Bathing Water Directive 2006 as well as the recommendation of the World Health Organisation. The percentile has to be calculated for each parameter and also met for each parameter. For example, if the 95th percentile is below the limit values for Escherichia coli but not for Intestinal Enterococci then the beach cannot be awarded with the Blue Flag.
Details on how to calculate the 95th percentile can be found in Appendix F. A calculation spreadsheet, however, is available on the internal pages of the Blue Flag homepage. All bathing water sample results should be entered into the spreadsheet and the percentiles will be calculated automatically. This sheet should be sent to the International Coordination with the application.

For EU countries implementing the Blue Flag it is imperative that an applicant beach is classified as being 'Excellent'.

As stated previously, discounting of a sample may be considered in case of extreme (weather) conditions. Should this be necessary, applicant beaches must be sent in as dispensation cases. *See Appendix A for further details on dispensation cases.*

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 11. The beach must comply with the Blue Flag requirements for the following physical parameters.

Water quality can also be affected by physical and chemical parameters such as oil and floatables:

- There must be no oil film visible on the surface of the water and no odour detected. On land the beach must be monitored for oil and emergency plans should include the required action to take in case of such pollution.
- There has to be an absence of floatables such as tarry residues, wood, plastic articles, bottles, containers, glass or any other substance.

Immediate action should be taken if abnormal changes are detected. This includes abnormal changes in the colour, transparency and turbidity of the water. Should physical and chemical pollution be detected repeatedly, the Blue Flag must be taken down for the remainder of the season and the beach will not be eligible for the Blue Flag the following year, unless the applicant fulfils the conditions for applying as a dispensation case.
Other tests can be conducted, such as the pH value of the water (its value ranges from 6 to 9 in most bathing waters).

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

ENVIRONMENTAL MANAGEMENT

Criterion 12. The local authority/beach operator should establish a beach management committee.

The beach management committee should be charged with ensuring compliance with all environmental management criteria, including Marine Protected Areas requirements if appropriate. The committee should consist of all relevant stakeholders at the local level. Relevant stakeholders could be a local authority representative, hotel manager, beach manager, lifeguard, educational representative, local NGO, and other stakeholders such as community representatives, special user groups, Marine Protected Area representative, etc.

The beach management committee should co-operate with and support the local authority/beach operator and could institute environmental management systems and conduct environmental audits of the beach and its facilities.

Where appropriate, a beach management committee may operate over a number of Blue Flag beaches within a local authority or an area/region, i.e. there is no need for a separate beach management committee for each individual Blue Flag beach.

IMPERATIVE CRITERION	GUIDELINE CRITERION
	All regions

Criterion 13. The local authority/beach operator must comply with all regulations affecting the location and operation of the beach.

Regulations pertaining to issues relating to coastal zone planning, environmental management, waste-water legislation, environmental legislation, and others must be met for the beach to receive and maintain Blue Flag status. The applicant must assure that the facilities and activities under its responsibility comply with these guidelines and/or regulations. The management of the beach location, facilities, beach operation and immediate surrounding area must comply with official development plans and planning regulations. The legislation may include regulations for land-use planning, sewage/industrial waste effluent discharge, environmental health regulations, conservation plans, operations licenses and permits, etc.

The location of facilities and use of the beach area and its vicinity must be subject to planning guidelines.
This includes environmental impact assessments. At the time of application for Blue Flag status, the applicant authority must provide written evidence from the planning department that all buildings on the beach meet local building regulations.

Existing beach facilities, construction and other use of the beach and its vicinity must be in compliance with laws regulating the use of the coastal zone or freshwater areas, including environmental conservation regulations. The back beach area including dunes, paths, and parking areas must be properly maintained according to coastal zone management principles.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 14. Sensitive area management.

Some sites at/near the Blue Flag beach may be very sensitive and require special management. In these cases, the beach operator is strongly encouraged to consult an appropriate conservation organisation or expert for advice on how to manage these sites. Where areas require special management, at the time of application, the applicant must provide confirmation that this consultation has taken place and that a management plan will be implemented.

However, the sensitivity of certain areas may prevent them from being part of a Blue Flag beach or from having information posted at the beach directing people to the area. An increased number of visitors could endanger wildlife and/or habitats, e.g. using land space for the construction of facilities, parking, paths, etc. As a general rule, Blue Flag accreditation is only given to sites that can demonstrate management of visitors and recreational use that prevents long-term irreversible damage to the local natural environment.

If a Blue Flag beach is in or near a Marine Protected Area, it is necessary to consult with the MPA management in order to ensure compatible ecosystem conservation and biodiversity goals.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 15. The beach must be clean.

The beach and surrounding areas including paths, parking areas and access paths to the beach must be clean and maintained at all times. Litter should not be allowed to accumulate causing these areas to become unsightly or hazardous.

The beach must comply with national guidelines or legislation concerning litter and waste management. Beach cleaning may be mechanical or manual, depending on the size, appearance, and sensitivity of the beach and its surroundings. In high use areas, where possible, occasional mechanical sieving and deep cleaning of the sand should be done to remove small particles such as cigarette butts, etc.

During storm water flows, the outlets and surrounding areas must be kept clean.

When cleaning the beach, this must be done with consideration for local flora and fauna, e.g. where turtles may have buried eggs in the sand. The use of insecticides or chemicals for cleaning the sand or surrounding environment is not allowed. The cleaning of Marine Protected Areas as well as sensitive areas (sand dunes, etc.), must be done in accordance with the laws and advice from the relevant authority.

For information about the management of algal waste and seaweed, refer to criterion 15.

To determine the cleanliness level of the beach, it is recommended that a Beach Litter Measuring system, or similar system, be used. (*See Appendix G for further details*).

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 16. Algae vegetation or natural debris should be left on the beach.

Algal vegetation is generally accepted as referring to seaweed. Seaweed and other vegetation/natural debris are natural components of both freshwater and marine ecosystems. These ecosystems must be considered as living and natural environments and not only as a recreational asset to be kept tidy. Thus, the management of seaweed or other vegetation/natural detritus on the shore should be sensitive to both visitor needs and biodiversity. Natural disposal by tides and waves at the beach is accepted, as long as it does not present a nuisance.

Vegetation should not be allowed to accumulate to the point where it becomes a hazard. Only if it is absolutely necessary should vegetation be removed, and then consideration should be given to disposing of it in an environmentally-friendly way, e.g. through composting or for fertilizer use. Wherever possible, environmental specialists should be consulted regarding the management of algal vegetation on the beach.

In some areas seaweed is dried on the beach for later use as fertilizer or dune stabiliser. While this good practice should not be discouraged it is also necessary to ensure that it does not create a nuisance for beach users.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 17. Waste disposal bins/containers must be available at the beach in adequate numbers and they must be regularly maintained.

Waste disposal bins or litter-bins (preferably with covers) should be of a suitable design and appearance as well as functionality. It is recommended that bins made of environmentally friendly products are used, e.g. bins made of recycled composite plastics or wood.

There should be an adequate number of bins on the beach and they should all be regularly maintained, well secured, and spaced appropriately. Individual bin capacity, the number of users on the beach and how frequently the bins are emptied determine the number and minimum space between bins placed on the beach. During the peak tourist season, the spacing between bins and the frequency at which they are emptied should be increased as necessary.

In summary, when choosing and locating bins, the following factors should be considered:

- Bin capacity
- Environmentally friendly products
- Type and source of litter
- Volume of pedestrian traffic
- Servicing methods and intervals (including peak times)
- Local environment, e.g. winds, high tides, scavenging seagulls
- Accessibility, e.g. height, surface

The collected waste should only be disposed of in licensed facilities that are approved by authorities on the basis of environmental requirements. The duty of the community receiving the Blue Flag is to make sure that the waste is properly disposed.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 18. Facilities for the separation of recyclable waste materials should be available at the beach.

In the event that the community has a local recycling facility then containers must be made available at the beach for these materials, e.g. glass, cans, plastic, paper, etc. The receptacles should be properly designed and managed for the type of waste received, should be emptied regularly, and be well placed for accessibility.

The recycling facilities should accommodate the collection and separation of as many different types of materials as possible.

On application, the local authority/beach operator must indicate whether the local authority has facilities for the recycling of waste. In the event that no such facilities exist, the applicant must apply for a dispensation from this criterion.

Blue Flag encourages all local authorities/beach operators to promote recycling and waste separation at the beach, even if the community does not have a local recycling facility.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 19. An adequate number of toilet or restroom facilities must be provided.

The number of toilets/restrooms available at the beach must reflect the average number of beach visitors during the peak season, the length of the beach and the number and location of major access points.

The toilet or restroom facilities must be easy to locate through signage and through information on the map on the Blue Flag information board.

The presence of showers (on the beach or in the buildings), changing rooms and nappy changing facilities are furthermore encouraged. Restrooms/toilets may also be located in nearby shops, restaurants, cafeterias or other establishments open to the general public. There should also be facilities provided for disabled visitors (see criterion 32).

Toilet or restrooms facilities must be equipped with washbasins, soap and clean towels (paper or cloth) or a hand-dryer.

Access to the toilet/restroom facilities must be safe.

Consideration should also be given to the design and maintenance of these facilities. They should be
well-integrated within the built and natural environment and they must be regularly maintained so as to present a well-maintained appearance and to prevent vandalism of buildings.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 20. The toilet or restroom facilities must be kept clean.

The toilet/restroom facilities must be kept clean at all times. The frequency of checking and cleaning the facilities must reflect the intensity of use. Beaches with a high number of daily visitors must have their facilities checked and cleaned every day or several times a day.

The use of environmentally friendly cleaning materials, soap and towels is recommended.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 21. The toilet or restroom facilities must have controlled sewage disposal.

Sewage or effluent from the toilets must not enter the ground or the water untreated. In villages, communities, or in a municipality with sewage treatment facilities, the toilet facilities must be connected to the municipal sewer.

For facilities located outside of areas serviced by the municipal sewage system and/or remotely located beaches, individual treatment and regularly emptied holding tanks that prevent untreated sewage, effluent or seepage from entering the ground or the water - and which do not adversely affect the environment - are acceptable.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 22. On the beach there will be no unauthorised camping or driving and no dumping.

Unauthorised camping, driving and dumping must be prohibited on the beach. There must be information about these restrictions displayed at the beach (as part of the code of conduct, Criterion 6).

Vehicles (except for those used for the purpose of cleaning and safety, e.g. for moving lifeguard equipment, or emergency vehicles) should not be allowed on Blue Flag beaches. For cases, however, where vehicles cannot be entirely prohibited, it must be adequately justified and they must be properly managed. Areas for driving and parking as well as car-free zones must be designated and whenever the situation requires it, police or traffic guards must control the beach. If vehicles are allowed they should be prohibited from entering the high water zone at any time. The majority of the beach should be designated entirely vehicle-free.

Where there are no physical barriers preventing access to the beach by vehicles and where there are problems with unauthorised vehicles, camping or dumping, bylaws should be put in place to prohibit these activities. Information about these by-laws should be displayed. The use of the beach or its nearby areas as dumps for litter and other waste is not accepted.

In the case of special events that involve the use of vehicles on the beach a special management plan must be drawn up and applied to prevent damage to the ecosystem, as well as risks to beach users. *See Appendix H for guidelines on events on Blue Flag beaches.*

Parking for emergency vehicles must be provided in close proximity to the beach.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 23. Access to the beach by dogs and other domestic animals must be strictly controlled.

On Blue Flag beaches, dogs and pets are permitted in the parking areas, on walkways and promenades in the back beach area only - if permitted by the beach authorities as well as local and national legislation. Animals in these areas must be controlled. It is recommended that a Dog-Free Zone be created to prevent dogs and other animals from entering the main beach and swimming area - this excludes guides dogs for the visually impaired.

If the beach is patrolled by mounted police measures must be taken to ensure that no faecal matter contaminates the beach.

Wherever possible stray animals should be managed and systems should be in place to remove stray animals from the beach. Measures should also be put in place to prevent access to the beach by stray animals. In the event that stray animals are able to access the beach and cannot be controlled, it is recommended that the beach operator/local authority erect signs informing the public as to this fact. It is also recommended that information be displayed informing the public what to do should stray animals be seen on the beach.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 24. All buildings and beach equipment must be properly maintained

Consideration should be given to the appearance of buildings and structures at the beach. They should be well integrated within the natural and built environment, should adhere to design standards and meet environmental and aesthetic requirements.
Equipment on the beach includes facilities or services not discussed in any other criteria, e.g. playgrounds and piers. Equipment must be regularly maintained and checked in order to ensure that it is safe to use. Consideration should be given to: the cleanliness of equipment, its condition, the environmental effects of paint and other materials used for maintaining the equipment/buildings and any potential risk associated with its deterioration and malfunction. Wherever possible, environmentally friendly products should be used.

To prevent access by the public, all construction work or hazardous structures must be fenced off. In the event that construction takes place during the Blue Flag season, all Blue Flag criteria must be met during the period of the construction. Also, the construction activities should not impact on beach users.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 25. Marine and freshwater sensitive habitats (such as Coral reefs or sea grass beds) in the vicinity of the beach must be monitored.

If there is a sensitive habitat (such as coral reef or sea grass beds) located within 500 metres from any part of a Blue Flag beach, a monitoring programme must be established to monitor the health of the habitat (coral reef or sea grass beds) at least once a season.

An expert organisation or relevant authority must be consulted regarding the monitoring and management of this sensitive area.

The “Reef Check” Coral Reef Monitoring Programme could be used. *See Appendix H for further details of the Reef Check monitoring system.*

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions where applicable.	

Criterion 26. A sustainable means of transportation should be promoted in the beach area.

This criterion refers to all actions that

- encourage public and collective transport.
- encourage bicycling, bike renting and facilities for bike parking.
- support plans to organise traffic and reduce the peak traffic periods.
- develop pedestrian access.

The Blue Flag programme encourages the promotion of alternative means of transportation, e.g. beach shuttles, bicycle rental or free bicycles. Such initiatives should be given particular attention in communities with high traffic densities in the beach area or where the beach is located in a sensitive area.
It is recommended that the local authority/beach operator implements a traffic management plan to

reduce traffic volumes and the impact of traffic on land use and air pollution in the Blue Flag and surrounding areas.
It is also recommended that information about the availability of sustainable transportation be made available on the Blue Flag information board.

IMPERATIVE CRITERION	GUIDELINE CRITERION
	All regions

SAFETY AND SERVICES

Criterion 27. An adequate number of lifeguards and/or lifesaving equipment must be available at the beach.

It is recommended that the local authority undertake an official risk assessment of the beach (carried out by the appropriate national authority or body of expertise), and that an appropriate response strategy to the assessment be put in place. FEE is currently working with the International Lifesaving Federation (ILS) to put in place an appropriate system for Blue Flag beaches. It is planned that all Blue Flag beaches will require a risk assessment .

The provision of lifesaving personnel/equipment at a beach should be seen as only one element of an overall strategy that includes information and education.

The presence of lifeguards at a Blue Flag beach is recommended in order to increase the safety level at the beach, especially where there are a high number of beach visitors. There must be an adequate number of lifeguards (a minimum of two) placed at appropriate intervals (not more than 200m recommended) according to the beach characteristics and use. The number of lifeguards must increase according to peak usage.

Lifeguards must have appropriate national or international qualifications. Certificates must be checked prior to employment and must be made available to the National Operator on request.

Lifeguards should only be employed for lifeguarding and not in combination with duties such as water sports, rentals and services, cleaning or other duties.

Lifeguards must be easily recognisable. It is therefore recommended that lifeguards wear the internationally recognised red/yellow uniform. Lifeguards must be provided with appropriate lifesaving equipment.

Bathing areas patrolled by lifeguards should be clearly marked out. The area should be defined on the map, at information points and/or physically on the beach with markers or flags. The following recognised flag zoning can be recommended: red = do not swim when red flag is present, red/yellow = swim in the lifeguard patrolled areas, black/white chequered flags = surfing and water-craft zone only (unless another national flag zoning system already exists).

On beaches with low hazard risks and with few users, lifesaving equipment can replace lifeguards. Lifesaving equipment could include: life buoys, torpedo buoys, hooks, life vests, life rafts, etc. The lifesaving equipment must include access to an emergency phone. The equipment should be regularly inspected and must fulfil national/international guidelines.

Where lifesaving equipment is provided, it should be clearly positioned, visible and located at regular intervals allowing it to be reached quickly from any point on the beach. On beaches without lifeguards, maximum intervals of 100 metres between the equipment are recommended. Lifesaving

equipment must be accompanied by instructions for use and what to do in the event of a rescue.

The period when the lifesaving equipment and/or lifeguards, and first aid are available must be clearly marked on the Blue Flag information boards or at the lifeguard station. An explanation of the emergency flag system in use must be provided.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 28. First aid equipment must be available on the beach.

The first aid may be available by means of a) a lifeguard on site, and/or b) an attended first aid station with trained personnel, and/or c) equipment located in a shop or other beach facilities at the beach, and/or d) directly available to the public on the beach. It is strongly recommended that busy beaches and family beaches have first-aid stations with staff in attendance. First-aid personnel must have appropriate qualifications.

First aid stations should have the following equipment a) adequate first aid stock (basic first aid supplies such as bandages, gloves, disinfectant, plasters, etc.) b) cold water and preferably hot water c) first aid bed d) oxygen cylinder and mask e) immobilizing trauma board (e.g. immobilizing blocks or spider harness) f) other equipment (shark attack pack), etc.

First-aid stations or the location of first-aid equipment must be clearly sign-posted for easy location by beach visitors (including on the map on the Blue Flag information board). See Criterion 5. In addition, the time in which first aid is available must be clearly informed.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 29. Emergency plans to cope with pollution risks must be in place.

The emergency plan should cover a clearly identified procedure, facilitating efficiency in the case of an emergency. An emergency could result from oil spills, hazardous/toxic waste spills entering the beach from the sea, discharge of storm water, hurricanes, algal blooms that could be dangerous, etc. An emergency in this context would be defined as an event which leads to a large scale impact on the beach or bathing water.

In order to quickly address pollution at the local level in co-ordination with local authorities, the following
should be included. The:

- identification of people to contact in case of pollution.
- involvement of all administration services and people necessary to intervene.
- procedure for the protection or evacuation of people if necessary.
- procedure of public warning and information.
- withdrawal of the Blue Flag.

The emergency plan must specify who should be contacted in the case of a pollution incident. A responsible local person must be designated for this position. It must also specify who does what in the case of an emergency, including pollution incidents.

The emergency plan must furthermore prove the compliance with other national legislation in the

area, e.g. a national oil spill contingency plan.

As long as the hazard persists, the public should be informed of the pollution or potential danger by posting information at the beach, at all access points, in the media, tourist offices or other relevant means of communication. If the hazard is in the form of large scale polluted water then the public must be informed that bathing is not safe and the beach should be closed to swimming. If there is any infringement of Blue Flag criteria, and to ensure the integrity of the Blue Flag, the flag must be temporarily withdrawn and information posted on the Blue Flag information board or at the beach. Emergency phone numbers for the police, first aid, and relevant emergency numbers along with the contact details for emergency services, in the event of an oil or toxic chemical spill must be posted at the beach preferably on the Blue Flag information board.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 30. There must be management of different users and uses of the beach so as to prevent conflicts and accidents.

Beaches that support multiple activities must have management plans to prevent accidents and conflicts. This must include zoning for swimmers, surfers, wind surfers and motor craft. At the same time, recreational use of the beach must be managed without negatively impacting the natural environment, the biodiversity of the beach and with consideration for aesthetic issues.

Swimmers should be protected from all sea craft (motor, sail or pedal). Where necessary, zoning through the use of buoys, beacon or signs should be in place. The same should be done for surfing areas. Distinctions should be made between motor craft, paddle or sail craft. The use of these various activities must be separated.

Powerboats and powered craft should operate at least 100-200 metres away from the swimming area. The exact distance is to be determined by the local regulatory agency. Furthermore, patrons who operate powered craft should be provided with guidelines for the use of their craft and the location of different zones.

The relevant authority, for example lifeguards, must enforce the zoning of the different recreational areas in the water. Different activities on the beach must also be clearly marked and zoned.

Consideration should also be given to potential noise impacts from some activities (motorised activities, stereos and kites).

If special events are to be held on the beach then these should be located outside of the main swimming areas. In the case that special activity events prevent the beach from upholding the Blue Flag criteria, then the flag must be withdrawn for the duration of the event. When such an event takes place, users of the beach should be notified through public warnings at the beach and preferably in the local media prior to the event. *See Appendix I for guidelines for events on Blue Flag beaches.*

The beach itself must be managed in accordance with an environmental plan that protects sensitive species and habitats at the beach. This can be achieved through zoning or other preventative actions. In some cases, it may be necessary to restrict, disperse or otherwise manage certain activities. Beaches with sensitive dune habitats must be managed in such a way to protect these sensitive habitats, e.g. protective fences. Recreational activities must be managed to prevent

environmental degradation, e.g. coastal erosion or damage to vegetation as well as to prevent birds and other wildlife, e.g. breeding turtles, from being disturbed.

Some particularly sensitive sites may require careful planning and management. In such cases, evidence must be provided to show that recognised local conservation organisations or groups have been approached and that a management plan has been drawn up.

Besides the use of physical separation of the different users, zoning should be clearly indicated on the map
on the Blue Flag information board and information could also be given at access and entry points (see Criterion 5).

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 31. There must be safety measures in place to protect users of the beach.

The public must have access to Blue Flag beaches without being a client of a certain hotel or beach club. Access to the beach should preferably be free, although at some beaches public access is provided through charging a small and reasonable fee.

Access to the beach must be safe. Beaches that are physically challenging must have facilities for safe access, e.g. secured steps with handrails. Similarly, there should be designated pedestrian crossings on busy roads in the vicinity of the beach.

Beach promenades and steps onto the beach must be complete and in good condition. The car park surface must be in good order. Parking places reserved for the use of disabled persons must be available and must be clearly marked. See Criterion 21 for information related to parking on the beach. Other access paths must also be safe, with regulations for cars and bicycles. Bicycle paths should be encouraged whenever relevant.

Where promenade edges are higher than 2 metres above the beach, warning signs and/or a barrier must be in place to prevent accidents. This is especially important where the beach surface is rocky. Consult criteria 32 regarding access for people with physical disabilities.

Visitors to the beach should be safe while on the beach. Information about safety must be readily available. The times of availability of lifesaving services and first aid must be clearly marked on the Blue Flag information boards or at the lifeguard station. In addition, an explanation of the emergency flag system, if in use, must be provided.

If needed, adequate security must be available at the beach in the form of trained and qualified guards responsible for patrolling. The guards must wear easily identified uniforms and should be able to present their licence as trained security personnel on request.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

Criterion 32. A supply of drinking water should be available at the beach

There should be a potable water source at the beach, e.g. from a fountain, pipe, tap, etc. This source can be in the restroom/toilet block or on the beachfront but it must be protected from contamination by animals.

IMPERATIVE CRITERION	GUIDELINE CRITERION
	All regions

Criterion 33. At least one Blue Flag beach in each municipality must have access and facilities provided for the physically disabled.

It is strongly recommended that all Blue Flag beaches have facilities that allow access by the physically disabled granting them access to the beach, surrounding buildings, and the restroom facilities. It is a Blue Flag requirement that at least one beach in every municipality must provide these facilities. It is a Blue Flag recommendation that at this beach, if possible, there is access to the water.

Access to the beach should be facilitated by access ramps adapted to users with various disabilities. It is recommended that the ramp design and material fit the natural environment and wherever possible, environmentally friendly materials should be used, i.e. recycled composite plastics.

Facilities should be designed for wheelchair and other disabled users and should comply with the ISO Standard Code for Access. The beach must comply with national regulations regarding access and facilities for people with disabilities. In addition, parking areas should have reserved spaces for disabled parking. In the event that access ramps cannot be provided due to the topography, e.g. at steep cliffs, the local authority must apply for a dispensation for this criterion.

If none of the Blue Flag beaches in a local authority can provide access and facilities for the disabled, a request for a dispensation from this criterion must be documented in the application.

IMPERATIVE CRITERION	GUIDELINE CRITERION
All regions	

APPENDIX A: Dispensation cases

All imperative criteria have to be complied with in order to obtain the Blue Flag. In the event of discussions arising out of the National Jury processes and if an applicant has failed to fulfil the imperative criteria, the National Jury could forward a beach to the International Jury as a dispensation case. In the case of an application requiring a dispensation, the National Jury must forward the case to the International Jury with the necessary background documentation and an explanation as to what imperative criteria have not been fulfilled and giving reasons as to why a dispensation is requested.

Dispensation cases may arise when a beach has exceeded the required limit values because of a known, documented incident during the bathing season. Dispensation cases argued on the basis of incidents considered unusual but not atypical of the site are not considered.

The most frequent request for dispensation is caused by exceptional/extreme weather conditions impacting on compliance with the water quality criteria. A National Jury can in such cases give a dispensation to omit a sample if the national authority's controlling bathing water quality regulation has officially approved such a dispensation. Furthermore, an official statement from national weather authorities stating that the weather was exceptional must accompany the request for dispensation.
For EU-member countries: if the request for dispensation of omission of a sample has been approved by the European Commission, and written proof of the European Commissions' approval is provided to the International Coordination, then the case is not considered as a dispensation case.

If an incident of high levels of pollution can be attributed by way of documentary evidence to other issues, such as an accident or another unavoidable incident, it is also possible to forward to the National Jury such a candidate as a dispensation case. The documentation must show that the problem has been rectified and that the pollution was undoubtedly linked to the incident in question.

A beach can apply for dispensation when:

- facilities are under construction at the time of the application but will be finished by the start of the season.

- owing to extreme weather conditions, the imperative criteria on the beach not being met, e.g. signage or walkways, access to the beach has been damaged, etc. However, these must be in place by the start of the season.

- a beach is not accessible by the physically disabled yet it is the only beach in a local authority to run the Blue Flag programme. The beach must present a plan for how and when the beach can fulfil the criterion as a central part of the dispensation application.

- the location of the beach is such that the distance from services renders it unable to meet an imperative criterion, e.g. an accredited laboratory.

APPENDIX B: Information about the Blue Flag programme must be displayed.
[Criterion 1]

THE BLUE FLAG PROGRAMME
This beach has been given Blue Flag accreditation. The Blue Flag is an environmental award, given to communities that make a special effort to manage their coastal/inland water environment and beaches with respect for the local environment and nature. To attain the Blue Flag, the community and its beach operators have to fulfil a number of criteria covering water quality, environmental information and education, safety, service and facilities.

This effort by the local community ensures that you and your family can expect to visit clean and safe environments at selected bathing sites. And it makes sure that the local community maintains a basis for sound development.

Facts about the Blue Flag:
The Blue Flag is awarded by the Foundation for Environmental Education (FEE), a non-governmental environmental organisation and is represented by such national organisations in each of the participating countries.

The Blue Flag is an environmental award for beaches and marinas. Only local authorities or private beach operators can apply for a Blue Flag for beaches. The criteria for Blue Flag beaches cover four main areas: a) Water quality, b) Environmental information and education, c) Environmental management, and d) Safety and services.

The criteria of the Programme are developed over time, so that participating communities have to keep working on solving relevant environmental problems to get the Blue Flag. Blue Flag accreditation is only given for one season at a time and the award is only valid as long as the criteria are fulfilled. When this is not the case, the responsible persons at the local level are obligated to take the Blue Flag down.
The national FEE organisation checks the Blue Flag sites during the season.

You can help the Programme by also taking actions to protect the environment:
Use the litter-bins on the beach - and recycle waste if possible
Use public transport, walk or rent a bike to get to the beach
Obey the beach code of conduct
Enjoy the nature of the beach and its surroundings, and treat it with respect
Choose a holiday destination that cares for its environment - and an environmentally friendly hotel too, if possible. Along with the Blue Flag, the Foundation for Environmental Education also develops another eco-label for accommodations: Green Key. Find more information at: www.green-key.org

Local, National and International Blue Flag responsible parties:
Name and address of the local responsible person, national Blue Flag operator and the International Co-ordination must be posted.

Text to accompany the names and addresses could be the following: “These are the names and addresses of the local, national and international Blue Flag contacts. It will assist the programme, if you could report on how these beaches comply with the Blue Flag standards. In this way you can help ensure that the Blue Flag standard continues to be met.”

APPENDIX C: Guidelines for Environmental Education Activities. [Criterion 2]

Types of Activities

There must be a mixture of different types of environmental educational activities for different user groups, Some activities must be carried out at the beach and have a direct focus on the beach or coastal environment. The different types of activities can be divided into five categories:

Activities for Passive Participation: This could include exhibitions, films, presentations, slide shows, conferences, debates, presentations by international experts, etc.

Activities for Active Participation: This includes guided tours, educational games, theatre/plays, cleaning
days, coast observation days for marine beaches, diving/snorkeling orientation sessions, beach inspections, photography or drawing contests, nature reconstruction projects, green technology projects, “Adopt a Beach” programmes, community coastal monitoring programmes, etc.

Training Activities: This could be training for teachers, beach or marina staff, people in charge of children groups, lifeguards, cleaners, law enforcement officers, specific national training programmes, etc.

Publishing and Media: The production of leaflets, stickers, interpretive signs, postcards, school and municipal newsletters, books, T-shirts, bags, posters, radio broadcasts, etc.

Blue Flag Environmental Information Centre: It is strongly recommended that Blue Flag beaches provide an
Environmental Information Centre (station, kiosk), where specific information about Blue Flag and environmental education issues can be given. Such a centre or place must offer both activities and exhibitions and provide environmental and nature information in order to qualify as an environmental interpretation or education centre. Information about its location and activities must be provided at the beach or in nearby tourist information offices. The centre should be open to and have activities and information for the general public, not only local school children.

Target groups

The activities should target a wide range of different groups. It is important that the local authority, together with other operators in the area, organise a programme to educate and raise awareness within the many different interest groups that influence the use of the local environment. These interest groups could be visitors, locals, tourism employees, fishermen, local industries, etc.
The types, amounts and target groups of activities should match the situation. For example, in a major tourist destination, more than one activity per season should be available to the general public.

Connection with existing programmes

The activities can be part of already existing environmental education programmes, held either on-site or in the local community (Local Agenda 21 activities, Eco-Schools activities, etc). It is also recommended that the local authority work together with local NGOs in setting up educational activities.

Information about Activities
Information about the publicly accessible activities must be made available at the beach and preferably also in tourism newspapers or magazines or posted in tourism offices. The published information should include: what kind of activities, when and where are they going to take place, who they are for, etc.

Not Acceptable
Activities that are not acceptable for meeting this criterion are:
Activities that are done to meet other Blue Flag criteria such as the general cleaning of the beach, waste management, recycling, and posted environmental information otherwise required on the information board (i.e. information on surrounding sensitive environments), etc.
Activities focusing only on tourism without a specific focus on sustainable tourism
Activities otherwise done by the local authority as part of the standard management of health, safety,
transportation or tourism

APPENDIX D: Recommendations for presenting water quality information on Blue Flag beaches. Example of a coastal water beach:
[Criterion 3]

Beach:_____ **Local authority:**_____
Contact person:_____ **Telephone no:**_____

Date											
Escherichiacoli / Faecal coliform											
☺ < 250cfu/100ml											
😐 >250cfu/100 ml											
Intestinal Enterococci / Faecal streptococci											
☺ <100/100 ml											
😐 >100/100 ml											

Blue Flag and bathing water quality	**What do the results mean?**	
This beach has met the Blue Flag water quality standards. The bathing water is continuously monitored for the different types of bacteria shown in the tables. The bathing water is tested at least every 30 days. In the table you can see when the water has been analysed and how many bacteria were found. A small number of bacteria tell you that the water is very clean - a high number of bacteria tell you that the water may be polluted and could contain bacteria from sewage.	**Faecal coliform / E.coli**	**Faecal streptococci / Intestinal enterococci**
	☺ Below 250 *Excellent bathing water*	☺ Below 100
	😐 Above 250 *Is allowed a few times during the season*	😐 Above 100

APPENDIX E: the 95th percentile

The 95th percentile is a calculation method used to obtain the average amount of pollution. In terms of Bathing Water sampling results, the value shows the results that are less than or equal to the limit values 95% of the time. The standards refer to values that would be exceeded less than 5% of the time.

The 95th percentile is derived through the following calculation (based on the explanation in the EU Bathing Water Directive 2006):

1. Take the log10 value of all bacterial enumerations in the data sequence to be evaluated. Zero values cannot be used and should be replaced by a value of 1 (or the minimum value allowed)
2. Calculate the mean of the log10 values (μ)
3. Calculate the standard deviation of the log10 values (σ)
4. The upper 95 percentile is derived from the following equation: antilog (μ + 1,65 σ)
5. The resulting value must be within the limit values as stated above

A calculating spreadsheet is available on the Blue Flag homepage under the Internal Pages as per January 2010.

APPENDIX F: Beach Litter Measuring System – a method of mapping the status of litter on a beach [Criterion 15]

In order to determine the cleanliness on the beach, the Beach Litter Measuring System could be used by
the beach manager or the national coordinator when doing beach monitoring visits.

The system differentiates between bulky litter (>10cm) and fine litter (<10 cm). It takes a closer look at the
amount of litter in defined representative areas on the beach. According to the amount of litter, beaches are
classified into different cleanliness levels (A+ to D). The method combines taking pictures and making
counts.

At a Blue Flag Beach, the cleanliness level should be A+ or A.

Step by step guidance how to define your beach's cleanliness level:

Bulky Litter

1. Define an area of 100m2 (10m x 10m) for your bulky litter count and photo (Choose the dirtiest 100m2 that you can find on the beach)
2. Count the units of bulky litter (>10cm) within the area
3. Take a picture of the area (to keep as proof)
4. Determine the cleanliness level with help of the beach litter indicator (see below)

Fine Litter

1. Define an area of 1m2 for your fine litter count and photo (choose the dirtiest area within the 100m2)
2. Count units of fine litter (<10cm) within the area
3. Take a picture of the area (to keep as proof)
4. Determine the cleanliness level with help of the beach litter indicator (see below)

Beach Litter Indicator

Number of litter units per area	Cleanliness level
0	A+ Very Clean
1-3	A Clean
4-10	B Moderately Clean
11-25	C Dirty
> 25	D Very Dirty

General
1. Keep a record of your measurements (date, time, location, circumstances, weather conditions, cleanliness level(s) bulky litter, cleanliness level(s) fine litter, other comments)
2. Repeat these steps at different locations along the beach if possible
3. Repeat the measurement at different times during a season and different times of the day if

possible
It is important to keep in mind that starting to use this system might require a bit of time in the beginning.
Once you get some exercise or training, it will be a quick, easy and helpful tool.
For a more detailed version of the beach litter indicator, a description of the system, a training CD or for
taking part in a training session, please visit the Blue Flag website or contact the Blue Flag Coordination.
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1 The Beach Litter Measuring System was developed by the Keep Holland Tidy Foundation and the Royal
Dutch Touring Club.

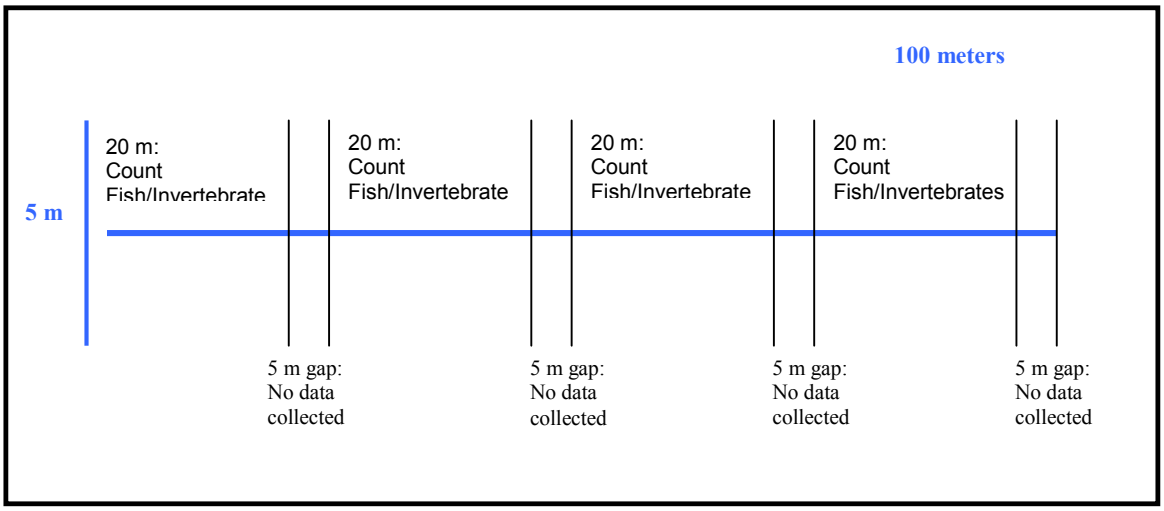
APPENDIX G: Reef Check system for coral reef monitoring [Criterion 25]

Below is a very brief description of the content of the "Reef Check" monitoring programme. For full information about the "Reef Check" system and information about national/international support, please consult http://www.reefcheck.org.

"Reef Check" is designed for use by volunteer non-scientist snorkelers or scuba divers. A local "Reef Check" team should be established with a scientist and a group of snorkelers and divers trained to carry out the analyses. The team members must be skilled at identifying the indicator organisms and substrate categories. It is strongly recommended that the team attend a "Reef Check" training session. If there are already "Reef Check" teams established at the national or local level, these teams can be approached for support.

In order to carry out the monitoring, the following equipment is necessary: a copy of the instruction manual,
indicator organism ID cards/books, GPS, transect lines, underwater paper and water proof pencils/markers,
buoys, plumb line and safety gear.

If possible, the monitoring should take place at two depths: shallow water (2-6 metre depth) and mid-reef (6 - 12 metre depth). Reefs in many areas are however not suitable for monitoring at more than one depth.
A 100 metre transect should be established (preferably parallel to the shore). The transect must be divided
into 4 x 20 metre observation areas divided by 4 x 5 metre gaps. For re-survey, it is important to document or permanently mark the transect start/end points.



The "Reef Check" coral reef monitoring program consists of four types of data collection methods:
1) Site description (environmental conditions and ratings of human impacts) 2) Fish counts
3) Invertebrate counts 4) Substrate type measurements

The site description includes information about: location (overall and exact location), survey time, nearby
population, weather conditions, rating of human impacts on the coral reef and the possible protection of the
coral reef. The substrate survey includes the record of the substrate at points with 0.5 meter intervals along the 4m x 20m transect. The substrate must be classified in one of the following

categories: hard coral, soft coral, recently killed coral, nutrient indicator algae, sponge, rock, rubble, sand, silt/clay or other substrate. In the "Reef Check" manual there is more information about how to conduct the substrate survey and classify the substrate.
The level of coral bleaching, presence of coral disease, presence of litter and coral damage must be noted.

Each region has different indicator fish and invertebrate species that should be counted along the 4m x 20m transect. In the "Reef Check" website and manual, there is more information about the fish and invertebrate species to include in the counting and information about how to conduct the counts. Finally, it is recommended to supplement the survey with photo and/or video documentation.

APPENDIX H: Guidelines for events on Blue Flag beaches [Criterion 30]

Should events be planned for Blue Flag beaches, it is recommended that the local authority/beach operator attempt to find a win-win situation in both hosting the event and maintaining Blue Flag status. Events on Blue Flag beaches are not incompatible with the management of the Blue Flag programme. However, the event should not compromise Blue Flag standards. The Blue Flag should not be dropped simply because an event is planned on the beach.

The decision to allow events to take place on beaches is ultimately the decision of the local authority/beach operator managing that facility and would, as such, be guided by local by-laws and other legislation. Should the local authority be concerned as to potential impacts on Blue Flag standards, early contact and discussion with the National Operator is recommended. It is reiterated that it is the responsibility of the local authority to ensure that Blue Flag standards are met.

If necessary, additional resources, e.g. cleaning staff, portable toilets, etc should be brought in to ensure that the standards do not drop.

Wherever possible, the Blue Flag area should be zoned (this to include the use of buoys – where appropriate – in the water) so that a designated Blue Flag swimming area is still retained and the beach can still fly the flag. It is not recommended that the whole beach be designated to the event.

Wherever possible, every attempt should be made to ensure that all the Blue Flag standards are still met on the beach during the event.

In terms of the criteria of Blue Flag, compliance with all environmental and building legislation also applies to any events and/or the construction of facilities on the beach. This includes the possibility of undertaking Environmental Impact Assessments or producing environmental reports on the impact of the event on the natural surroundings. In this case, permission from the relevant environmental authorities in the region would be necessary.

The public must be given advance warning of any events planned for Blue Flag beaches. This could be in the form of posters or other information at the beach, through announcements in the local media, or on local authority/beach operator websites if appropriate. A notice indicating details of the event, duration of the event, where more information can be obtained, where complaints can be made, etc. must be posted at the beach.

In the event of an activity that takes place on the beach after hours, i.e. for those beaches that withdraw the flag at the end of the day when criterion are no longer being met, the beach operator/local authority must ensure that the beach and the facilities be cleaned and returned to order, before the flag is due to be raised the next morning, even if this means the cleansing teams must work through the night to ensure that the beach is clean once the flag goes up. So, if the flag is normally raised at 08h00 in the morning, the facilities must meet Blue Flag standards by 08h00 in the morning.

It is recommended that the local authority/beach operator consider a fee to be levied on the organisers of events hosted on Blue Flag beaches and that this income be used to make improvements to the beach or within the local area.

Blue Flag Canada
www.BlueFlag.ca

environmental defence
INSPIRING CHANGE

2014 Control Visit Report: Birch Cove Beach

By signing the Blue Flag commitment, the Halifax Regional Municipality has promised to comply with the Blue Flag imperative criteria at Birch Cove Beach. National control visits are conducted during the bathing season to confirm that these criteria are being met. Control visits may be either announced or unannounced.

An announced national control visit was conducted on August 27th, 2014 by Brett Tryon, Blue Flag Program Manager for Environmental Defence. Brett met with Cameron Deacoff, Environmental Performance Officer for the Planning and Development Department at the Halifax Regional Municipality. During the visit, Cameron was interviewed for an upcoming Blue Flag promotional video which we look forward to sharing when it is completed.

Birch Cove Beach was very clean and well maintained. The information boards were impressive, with lots of information about the Blue Flag program, the watershed and the surrounding habitat. Lifeguards were on duty, and the water quality results were easy to find and were up to date. Washrooms were clean and facilities were well maintained.

Although the water quality results were posted, the events section on that sign was not updated. This is likely because the control visit was at the end of the bathing season, and the educational activities had already taken place. It is however, a good idea to post events that happen throughout the year. That could include both activities occurring at the beach as well as activities happening in the community such as lectures or nature walks.

It has been a pleasure working with HRM, and we congratulate you on another Blue Flag season. We will send further instructions for the 2014 application procedure. If you have any questions, please contact Brett Tryon btryon@environmentaldefence.ca 416-323-9521 ext.238.

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Telephone: 902-492-4544
Fax: 902-492-4540

November 21, 2014

Halifax Regional Municipality
Energy and Environment
PO Box 1749
Halifax, Nova Scotia
B3J 3A5

Attention: Mr. Cameron Deacoff

Dear Mr. Deacoff:

RE: Final Report: Water Quality Monitoring Program within Bedford West, Bedford, Nova Scotia – October 2014 Sampling Event

SNC-Lavalin Inc. (SLI) is pleased to submit one (1) electronic copy of the Final Letter Report for the October 2014 Sampling Event of the Bedford West Water Quality Monitoring Program, Bedford, Nova Scotia.

Should you have any questions or require anything further, please contact the undersigned at (902) 468-6230.

Yours truly,

SNC♦LAVALIN INC.

Original Signed

Christa Rafuse, P. Eng
Project Manager

CR/mg

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Table of Contents

1. INTRODUCTION

SNC-Lavalin Inc. (SLI) was retained by the Halifax Regional Municipality (HRM) to conduct a Water Quality Monitoring Program (the program) within Bedford West area.

The purpose of the program is to determine water quality for watersheds impacted by the development in the Bedford West area. The Paper Mill Lake watershed is the primary watershed within the subject area.

The program consists of collecting surface water samples from eleven (11) specified test locations as follows (See Figure 1 - Sample Locations):

- Kearney Lake (KL1, KL2, KL5);
- Kearney Lake Run (KL3, KL4);
- Highway 102 (HWY 102-1);
- Highway 102 (Location: HWY 102-2)
- Lake Shore Drive (Location: LSD);
- Larry Uteck Boulevard (LU);
- Paper Mill Lake (PML1); and
- Paper Mill Lake (PLM2).

The overall purpose of the program is to conduct water quality sampling and testing prior to construction activities to establish baseline conditions, in order to detect any impacts on and/or changes to water quality during and after construction of the development project.

As part of the October 2014 sampling event, this report presents water quality data of the eleven (11) specified test locations.

2. METHODOLOGY

The October 2014 program methodology consisted of one surface water sampling event and laboratory analyses of general chemistry (RCAp), total metals, total phosphorous, total

suspended solids, E. coli bacteria, TKN and chlorophyll-a from the specified test locations. Additionally, standard field parameters (pH, water temperature, dissolved oxygen, conductivity, secchi depth, air temperature, cloud cover, and wildlife sightings) were to be measured at specified sampling locations.

The water samples and field parameter readings were collected from a 1.0 metre depth whenever possible. Site conditions (weather, air temperature, cloud cover, and site accessibility) and field parameters for each sampling location were recorded on a field report.

A new pair of latex gloves was used at each sample location. Surface water samples were collected and placed in clean laboratory-supplied jars and stored in a chilled container together with a chain of custody record for transport to the laboratory. All surface water samples collected were submitted to AGAT Laboratories, located in Dartmouth, NS.

Secchi depth measurements were taken from the shady side of the boat at two sample locations. The secchi disk was lowered in the water until no longer visible. The depth was measured to the nearest tenth of a metre. The disk was raised until visible in the water and the depth was measured. The secchi depth is the midpoint between the two measured depths.

During the October 2014 water sampling event, the Waterra AM100 Aqua Meter and AP800 Aqua Probe were used for collecting water field parameters, such as pH, dissolved oxygen, conductivity and temperature.

With respect to historical field parameter data collection, the following monitors have been used:

a) For the August 2014 water sampling event, the Waterra AM/OO Aqua Meter and AP800 aqua probe were used to collect water field parameters (pH, dissolved oxygen, conductivity and temperature).
b) For the May 2014 water sampling event, the Horiba U-22 parameter monitor was used to collect water field parameters (pH, dissolved oxygen, conductivity and temperature).

c) For 2013-2012 sampling events: Waterra AM100 Aqua Meter and AP800 Aqua Probe were used for collecting water field parameters (pH, dissolved oxygen, conductivity and temperature).
d) For 2011-2010 sampling events: Hach intelliCAL probes were used for collecting for pH, temperature, conductivity and dissolved oxygen (Product Numbers pHC30101, CDC40101 and LDO10101, respectively); and
e) For 2009 sampling events: Oakton Portable Waterproof Meters were used for collecting water field parameters (dissolved oxygen meter 35601 Series; pH and conductivity 35630-00 and 35630-02, respectively).

3. ASSESSMENT OF STANDARDS

The Canadian Council of Ministers of the Environment (CCME) guidelines for water are broken down based on water use including Freshwater Aquatic Life, Marine Water Aquatic Life, Irrigation, Livestock Watering and Aesthetics and Drinking Water. The surface water quality results were compared to the CCME Freshwater Aquatic Life (FWAL) guidelines since the specified sampling locations are located at and/or near adjacent freshwater bodies.

Analytical data for total suspended solids (TSS) and turbidity are compared to the CCME for the Protection of Aquatic Life (CCME Narrative Total Particulate Matter – Table 1 Suspended Sediments and Turbidity, High Flow Conditions, 1999, updated 2002).

For TSS, the guideline value is equal to a maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L. When background is greater than 250 mg/L, the concentration should not increase more than 10% of background levels.

The Health Canada guidelines for Canadian Recreational Water Quality (2012, Third Edition) are presented as reference guidelines. The Canadian Recreational Water Quality guidelines indicate that the clarity of the water should be sufficiently clear such that a Secchi disk is visible at a minimum of 1.2 metres. For turbidity, a limit of 50 Nephelometric

Turbidity Units (NTU) is suggested.

The Nova Scotia Environment Environmental Quality Standards for Surface Water (Notification of Contamination Protocol (PRO-100) July 6, 2013) are presented as reference guidelines (http://www.novascotia.ca/nse/contaminatedsites/protocols.asp).

4. WATER QUALITY RESULTS - OCTOBER 2014

The field parameters data and analytical results such as inorganic, calculated parameters, metals and microbiological are presented in Table 1 – Bedford West Sampling Program Results.

In addition, the field reports are provided in Attachment 1; photographs of each water sampling location are attached in Attachment 2, and laboratory certificates of analysis are enclosed in Attachment 3.

4.1. FIELD OBSERVATIONS

Site conditions were observed at eleven (11) sampling locations. Information was recorded on a Field Data Sheet per station, which included the following information: weather, air temperature, cloud cover, wildlife sightings and site accessibility. Field notes and associated photograph are included in **Attachment 1**, Field Report and **Attachment 2**, Photo-log, respectively.

It should be noted that at station KL1 (Kearney Lake) a potential concern was observed on October 28th, 2014 and immediately reported to the client. However based on the number of dead fish observed (approx.28) by SNC field personnel, it was concluded that a simple dumping of fish was the most likely cause of this issue. As the likelihood of potential water quality sample contamination from these fish was considered low, the monitoring event proceeded as planned.

4.2. FIELD MEASUREMENTS

Standard field parameters were measured at eleven (11) sampling locations. Information was recorded on a Field Data Sheet per station, which included the following information: date, time, sample depth, pH, dissolved Oxygen, secchi depth, water temperature and conductivity. Collected data is included in **Attachment 1**, Field Report.

The dissolved oxygen reading of 4.54 mg/L at HWY 102-1 (dated 2014/10/27) was outside of the applicable CCME FWAL guideline range of 5.5 - 9.5 mg/L.

4.3. LABORATORY ANALYTICAL RESULTS

4.3.1. GENERAL CHEMISTRY

Reported pH below minimum CCME FWAL guideline of 6.5-9pHs as shown in table below:

Reported pH above CCME FWAL guideline of 6.5-9 pH
▪ 6.35 pH at KL1 ▪ 6.06 pH at PLM2 ▪ 5.90 pH at HWY102-1 ▪ 6.40 pH at HYW 102-2 ▪ 6.41 pH at LU

4.3.2. METALS

Analytical results reported three (3) total metals (aluminum, cadmium and iron) concentrations which exceeded the applicable CCME FWAL guidelines as shown in table below. All other metals parameters were reported to be well within the applied CCME FWAL guidelines.

Aluminum concentration above CCME FWAL guideline of 5-100 µg/L	Cadmium concentrations above CCME FWAL guideline of 0.017 µg/L	Iron concentrations above the CCME FWAL guideline of 300 µg/L
▪ 155 µg/L at KL1 ▪ 340 µg/L at KL2 ▪ 105 µg/L at KL3 ▪ 108 µg/L at KL5 ▪ 310 µg/L at HWY102-1 ▪ 216 µg/L at HWY102-2 ▪ 141 µg/L at LSD ▪ 109 µg/L at LU ▪ 141 µg/L at PML-1 ▪ 122 µg/L at PML-2	▪ 0.025 µg/L at KL1 ▪ 0.018 µg/L at KL2 ▪ 0.024 µg/L at KL5 ▪ 0.022 µg/L at HWY102-1 ▪ 0.019 µg/LHWY102-2 ▪ 0.079 µg/L LU ▪ 0.018 µg/L PML-2	▪ 485 µg/L at HWY102-2 ▪ 363 µg/L at LSD

4.3.3. MICROBIOLOGICAL

The E. Coli concentrations were reported to be well within the referenced Health Canada Recreational Water Quality guideline at ten (10) of the eleven (11) water locations. At the LU station, E. Coli concentration was reported above (1730 MPN/100mL) the Health Canada guideline of 400 MPN/100mL.

5. CONCLUSIONS

The October 2014 Bedford West water quality monitoring program was conducted at the eleven (11) water test locations.

It should be noted that the surface water sampling event and laboratory analyses of general chemistry was conducted on Oct 27th, 2014; however due to cloudy conditions a standard field parameter (i.e. secchi depth) was measured on Oct 28th at KL1 location. (See Attachment A – Field Report)

The October 2014 program event included the collection of surface water samples for the analysis of general chemistry, total metals, total phosphorous, total suspended solids, E. Coli, total coliforms and chlorophyll-a, as well as, the collection of standard field parameter data such as pH, water temperature, dissolved oxygen, conductivity, secchi depth, air temperature, cloud cover, and wildlife sightings.

Based on the October 2014 monitoring results (field measurements and laboratory analytical data), and their comparisons with the applicable guidelines the following findings are concluded:

- **Dissolved Oxygen** reading of 4.54 mg/L at HWY 102-1 was outside of the applicable CCME FWAL guideline range of 5.5 - 9.5 mg/L.

- **General Chemistry** concentrations were in general well within the CCME FWAL applicable guidelines for the eleven (11) sampled locations. However, **pH** reported concentrations below CCME FWAL guideline of 6.5-9 pH at five (5) stations as follows: 6.35 pH at KL1; 6.06 pH at PLM2; 5.90 pH at HWY102-1; 6.40 pH at HYW 102-2; and 6.41 pH at LU.

- **Total Aluminum** concentrations exceeding the CCME FWAL guideline of 5-100 µg/L at ten (10) sampling stations as follows: 155 µg/L at KL1; 340 µg/L at KL2; 105 µg/L at KL3; 108 µg/L at KL5; 310 µg/L at HWY102-1; 216 µg/L at HWY102-2; 141 µg/L at LSD; 109 µg/L at LU; 141 µg/L at MPL-1; and 122 µg/L at PML-2.

- **Total Cadmium** concentrations were reported above the CCME FWAL guideline of 0.017 µg/L at seven (7) sampling stations as follows: 0.025 µg/L at KL1; 0.018 µg/L at KL2; 0.024 µg/L at KL5; 0.022 µg/L at HWY102-1; 0.019 µg/LHWY102-2; 0.079 µg/L LU; and 0.018 µg/L PML-2.

- **Total Iron** concentrations were reported above the CCME FWAL guideline of 300 µg/L at two (2) sampling stations as follows: 485 µg/L at HWY102-2 and 363 µg/L at LSD.

- E. Coli concentration at one (1) sampling station was reported above the Health Canada Recreational Water Quality guideline of 400 MPN/100mL. E. Coli concentration at LU reported of 1730 MPN/100mL.

6. LIMITATIONS

The findings of this report are limited to the conditions found at the time of the water sampling event. No assurance can be made that change in conditions may not occur subsequent to this monitoring and assessment of laboratory results, which may have an impact on the parameters surveyed.

This letter report contains professional opinions and findings relating to the data collected in relation to applicable guidelines and not legal opinion. Any use of the water monitoring findings constitutes acceptance of SNC-Lavalin's liability limitations.

N

HWY102-2

HWY102-1

PML2

PAPER MILL LAKE

PML1

KL4

KL3

LSD

KL2

LU

KEARNEY LAKE

KL5

KL1

Legend

- Water Quality Monitoring Test Locations/Sample Identification

0 200 400 800 1,200 1,600

Meters

SNC•LAVALIN

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Certified ISO 9001

HALIFAX REGIONAL MUNICIPALITY

PROJECT: WATER QUALITY MONITORING WITHIN BEDFORD WEST

TITLE: WATER QUALITY MONITORING TEST LOCATIONS

DESIGNED:	CH
DRAWN:	CH
CHECKED:	DH
SCALE:	AS SHOWN
DATE:	10-09-2012
PROJECT #:	510192-0001
DRAWING #:	1

TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Kearney Lake															
Sample Sites						KL1															
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/14	2012/10/10	2013/05/15	2013/08/16	2013/10/16	2014/05/14	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				08:00	11:45	08:30	11:00	13:10	12:00	11:00	14:30	14:00	8:30	11:20	9:50	10:20	11:10	13:30	10:30	14:15	14:55
FIELD DATA																							
Secchi Depth	Meters	--	--	1.2	--	4.1	4.2	5.0	N/A	5.0	4.9	2.4	3.2	2.4	2.35	5.36	N/A	2.50	2.03	2.90	2.36	2.70	2.54
Water Temp	Celsius	0.1	--	--	--	14.0	22.2	16.7	12.9	23.3	8.8	11.5	25.6	15.9	8.9	23.3	15.4	13.2	22.2	14.1	12.7	23.2	12.2
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.77**	8.20	7.00	9.13	7.86	**10.48**	**10.69**	8.22	9.22	8.98	7.93	8.72	**9.76**	8.57	8.30	**15.29**	7.22	8.12
pH	pH	N/A	--	--	--	6.20	6.76	6.67	7.23	7.32	6.61	6.60	6.16	6.04	8.67	6.91	6.32	6.32	8.24	6.35	6.74	7.46	6.44
Specific Conductance	uS/cm	1	--	--	--	263	299	261	248	242	219	288	179	146	277	279	198.1	243	216.5	217.9	547.0	341.0	223.0
INORGANICS																							
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	6	8	8	7	8	6	<5	9	7	24	7	<5	<5	<5	8	30	14	<5
Dissolved Chloride (Cl)	mg/L	1	--	--	120	81	74	64	62	60	55	73	45	33	66	70	50	66	59	48	80	76	46
Colour	TCU	30	--	--	--	18	18	16	26	8	21	28	40	45	50	11	20	11	37	20	13	8	23
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.18	0.09	0.12	0.21	0.16	0.23	0.2	0.11	0.13	0.20	0.09	0.10	0.18	0.14	0.19	0.11	0.11	0.08
Nitrate (N)	mg/L	0.05	--	--	13000	0.18	--	--	0.21	0.16	--	0.2	--	--	0.20	0.09	0.10	0.18	0.14	0.19	0.11	0.11	0.08
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.04	0.03	<0.03	0.03	0.03	<0.03	<0.03	<0.03	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	2.4	2.9	4.7	3.3	3.2	3.1	3.4	5.9	5.5	5.4	2.9	5.2	4.4	4.1	4.3	4.6	2.4	4.4
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	<0.01
pH (Lab)	pH	N/A	--	5.0-9.0	6.5-9	6.94	6.65	6.68	6.91	7.00	6.79	6.52	6.51	6.52	6.7	7.2	6.9	6.78	6.93	6.85	6.72	7.06	**6.35**
Total Calcium (Ca)	mg/L	0.1	--	--	--	9.2	8.5	7.2	7.72	8.66	8.30	7.65	4.82	5.31	6.8	8.4	6.3	7.5	6.6	6.5	8.1	11	6.0
Total Magnesium (Mg)	mg/L	0.1	--	--	--	1.5	1.4	1.2	1.42	1.36	1.30	1.29	0.86	1.06	1.1	1.5	1.5	1.1	1.2	1.2	1.6	1.6	0.9
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	<0.02	<0.02	<0.002	0.009	0.007	0.005	0.008	0.012	0.009	0.037	0.043	0.007	0.007	0.011	0.008	0.011	0.026	0.01
Total Potassium (K)	mg/L	0.1	--	--	--	1.1	0.9	1.3	0.876	0.888	0.901	0.788	0.773	0.871	0.7	0.9	0.9	0.8	0.7	1.1	0.9	1.6	0.7
Total Sodium (Na)	mg/L	0.1	--	--	--	51	46	37	31.8	35.2	33.8	43.7	22.8	19.8	40.1	42.0	29.8	35.8	26.2	31.6	50.2	54.2	37.6
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.6	2.2	2.3	2.9	2.7	2.9	2.8	1.9	2.3	2.4	1.3	2.2	2.5	1.8	2.2	2.0	1.5	1.8
Total Suspended Solids	mg/L	5	--	--	--	1	1	<1	4	17	3	2	2	3	<5	<5	<5	<5	<5	5	<5	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	14	13	12	11	11	11	12	10	8	8	9	9	11	9	9	12	11	7
Turbidity (NTU)	NTU	0.1	--	50	--	0.7	0.8	1.0	1.3	0.6	1	1	1	0.9	2.4	0.8	1.3	1.6	3.3	0.5	2.9	0.7	1.9
Conductivity (uS/cm)	µS/cm	1	--	--	--	310	290	250	240	240	230	290	180	140	246	274	196	259	241	212	290	339	235
Calculated Parameters																							
Anion Sum	me/L	N/A	--	--	--	2.72	2.52	2.23	2.12	2.08	1.91	2.33	1.66	1.27	2.52	2.31	1.60	2.10	1.86	1.71	3.11	2.66	1.45
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	6	8	8	7	8	6	<1	9	7	24	7	<5	<5	<5	8	30	14.00	<5
Calculated TDS	mg/L	1	--	--	--	166	151	131	123	125	118	143	92	77	139	137	98	124	104	103	172	165.00	99
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	2.85	2.57	2.12	1.92	2.10	2.02	2.42	1.33	1.25	2.24	2.41	1.79	2.08	1.61	1.84	2.77	3.09	2.05
Hardness (CaCO3)	mg/L	1	--	--	--	29	27	23	25	27	26	24	16	18	21.5	27.2	21.9	23.3	21.4	21.2	26.8	34.10	18.7
Ion Balance (% Difference)	%	N/A	--	--	--	2.33	0.98	2.53	4.95	0.48	2.80	1.89	11.00	0.79	5.9	2.1	5.3	0.7	7.3	3.4	5.8	7.50	17.2
Langelier Index (@ 20C)	N/A	N/A	--	--	--	-2.68	-2.87	-2.94	-2.72	-2.51	-2.87	NC	-3.18	-3.21	-2.69	-2.63	-3.19	-3.24	-3.14	-3.02	-2.51	-2.36	-3.76
Langelier Index (@ 4C)	N/A	N/A	--	--	--	-2.93	-3.12	-3.19	-2.97	-2.76	-3.12	NC	-3.43	-3.46	-3.01	-2.95	-3.51	-3.56	-3.46	-3.34	-2.83	-2.68	-4.08
Saturation pH (@ 20C)	N/A	N/A	--	--	--	9.62	9.52	9.62	9.63	9.51	9.66	NC	9.69	9.73	9.39	9.83	10.10	10.0	10.1	9.87	9.23	9.42	10.1
Saturation pH (@ 4C)	N/A	N/A	--	--	--	9.87	9.77	9.87	9.88	9.76	9.91	NC	9.94	9.98	9.71	10.2	10.4	10.3	10.4	10.2	9.55	9.74	10.4
Metals (ICP-MS)																							
Total Aluminum (Al)	µg/L	5	5	--	5-100	**230**	--	--	**289**	47.8	--	**338**	--	--	**321**	43	**168**	**191**	**120**	56	**229**	42	**155**
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	16	--	--	18.5	15.9	--	13	--	--	12	15	9	12	7	16	14	20	9
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	8	--	--	11.4	9.1	--	<50	--	--	<5	11	33	6	10	9	7	22	10
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	**0.053**	<0.017	--	**0.056**	--	--	**0.032**	**0.027**	**0.021**	**0.020**	<0.017	0.017	**0.037**	<0.017	**0.025**
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	**6**	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	1	--	--	0.54	<0.40	--	0.79	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	<2	--	--	**5.8**	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	<1	1	1	<1	1
Total Iron (Fe)	µg/L	50	300	--	300	130	--	--	**313**	62	125	177	162	**384**	229	137	195	207	132	92	147	124	168
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	--	--	**10.3**	<0.50	--	<0.50	--	--	<0.5	<0.5	1.9	<0.5	<0.5	<0.5	5.1	<0.5	<0.5
Total Manganese (Mn)	µg/L	2	820	--	--	100	--	--	79.2	57.1	59	78.4	52.3	55.8	48	65	68	73	48	24	48	115	42
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	5	--	--	3.2	<2.0	--	3.2	--	--	<2	<2	2	2	<2	<2	3	<2	3
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	46	--	--	39.1	37.7	--	36	--	--	32	41	32	37	33	30	40	45	26
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<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	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	11	--	--	6.4	<2.0	--	5.4	--	--	8	<2	3	4	2	<2	2	<2	5
Total Uranium (U)	µg/L	0.1	300	--	15	0.1	--	--	0.11	<0.10	--	0.12	--	--	0.1	<0.1	0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	27	--	--	14.4	7.5	11.1	12.1	13.3	9.7	5	<5	11	11	6	5	14	<5	9
MICROBIOLOGICAL																							
Total Coliform	MPN/100mL	1	--	--	--	200	65	--	>250	63	>250	91	>250	--	2420	>2420	1120	1200	866	488	525	1550	>2420
E. coli	MPN/100mL	1	--	400	--	39	24	--	9	15	37	8	**>250**	<100	41	11	17	48	2	7	<1	15	28
Fecal Coliform	MPN/ml	--	--	400	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	0.53	0.79	1.11	1.73	1.47	0.99	0.76	1.44	1.36	0.62	2.3	1.54	1.22	1.40	1.19	0.40	0.41	0.84
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	0.48	0.69	1.17	1.61	1.42	0.81	0.69	1.15	1.14	0.63	2.3	2.16	1.40	1.40	1.19	1.32	0.36	0.8
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	0.9	3.1	0.4	--	0.7	<0.4	1.1	<0.4	0.4

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
" -- " = no guideline available / Not Tested.
CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)
CCME FWAL Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (CCME FWAL calculation equations). The largest guideline value for each respective element range was always used.
Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September 2009)
NSE ESQs for Surface Water = Nova Scotia Environment Environmental Quality Standards for Surface Water (July 2013)
Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.
Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

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TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Kearney Lake															
Sample Sites						KL2															
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/14	2012/10/10	2013/05/15	2013/08/15	2013/10/16	2014/05/14	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				11:00	10:30	10:45	10:15	12:25	10:50	09:30	14:00	13:15	9:50	10:30	10:20	09:10	16:10	14:30	10:45	9:20	14:04
FIELD DATA																							
Secchi Depth	Meters	--	--	1.2	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Temp	Celsius	0.1	--	--	--	16.8	18.2	15.4	13.5	20.4	8.0	9.9	19.1	14.1	7.6	21.8	12.3	10.1	22.9	9.7	11.7	21.1	10.8
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.16**	8.50	5.70	6.28	**4.66**	**9.58**	**9.66**	7.06	8.43	6.47	5.82	7.63	9.37	6.38	7.40	**14.90**	6.95	7.7
pH	pH	N/A	--	--	--	6.33	6.35	6.19	6.61	6.96	6.25	6.77	5.90	5.62	7.72	6.41	6.29	5.75	7.47	5.57	6.60	7.22	5.79
Specific Conductance	uS/cm	1	--	--	--	46	106	89	199	104	75	80	67	54	58	96.6	61.1	77.9	65.3	64.5	188.0	266.0	63.0
INORGANICS																							
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	8	8	8	8	7	<5	<5	7	<5	20	<5	8	<5	<5	<5	29	7	28
Dissolved Chloride (Cl)	mg/L	1	--	--	120	48	48	48	48	25	17	19	14	10	16	20	12	19	21	14	20	17	12
Colour	TCU	30	--	--	--	20	20	20	20	63	95	80	110	120	52	60	94	37	90	71	25	44	168
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.19	0.19	0.19	0.19	0.07	0.06	0.12	0.07	<0.05	0.11	0.08	<0.05	0.12	<0.05	<0.05	0.08	<0.05	<0.05
Nitrate (N)	mg/L	0.05	--	--	13000	0.19	0.19	0.19	0.19	0.07	--	0.12	--	--	0.11	0.08	<0.05	0.12	<0.05	<0.05	0.08	<0.05	<0.05
Nitrite (N)	mg/L	0.05	--	--	60	<0.05	<0.05	<0.05	<0.05	<0.01	--	<0.01	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.03	<0.03	<0.03	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	<0.03	0.04	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	4.3	4.3	4.3	4.3	6.6	9.7	6.5	10	12	8.1	7.1	10.9	7.5	11.1	10.9	6.2	6.6	12.9
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	0.09	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
pH (Lab)	pH	N/A	--	5.0-9.0	6.5-9	6.85	6.85	6.85	6.85	6.78	**6.11**	**6.27**	**6.4**	**6.05**	6.5	6.7	6.5	**6.37**	6.62	**6.34**	6.53	6.87	**6.06**
Total Calcium (Ca)	mg/L	0.1	--	--	--	6.5	6.5	6.5	6.5	4.08	3.55	2.51	2.48	2.21	2.4	3.6	2.9	2.7	2.5	2.4	3.4	4.0	2.4
Total Magnesium (Mg)	mg/L	0.1	--	--	--	1.2	1.2	1.2	1.2	0.98	0.84	0.63	0.64	0.36	0.7	1.0	1.0	0.7	0.5	0.8	1.1	1.0	0.6
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	0.02	0.02	0.02	0.02	0.009	0.009	0.009	0.008	0.013	0.021	0.059	0.013	0.010	0.020	0.029	0.013	0.039	0.03
Total Potassium (K)	mg/L	0.1	--	--	--	1.1	1.1	1.1	1.1	0.634	0.826	0.534	0.497	0.734	0.5	0.7	0.8	0.5	0.5	0.7	0.7	0.9	0.7
Total Sodium (Na)	mg/L	0.1	--	--	--	31.6	31.6	31.6	31.6	14.7	10.6	11.1	7.8	6.9	9.8	14.2	9.5	8.9	7.0	7.9	17.5	14.0	7.6
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.2	2.2	2.2	2.2	4.2	4.7	2.7	4.3	4	2.6	4.0	4.9	2.8	4.4	4.9	2.4	3.3	4.6
Total Suspended Solids	mg/L	5	--	--	--	103	103	103	103	7	<1	<1	<2	<1	<5	<5	<5	<5	135	<5	<5	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	9	9	9	9	<2	<2	<2	<2	<2	3	3	2	4	5	4	4	2	3
Turbidity (NTU)	NTU	0.1	--	50	--	0.5	0.5	0.5	0.5	1.0	1.0	0.4	0.7	0.6	0.5	1.1	1.0	1.9	2.2	1.0	0.9	0.8	1.2
Conductivity (uS/cm)	µS/cm	1	--	--	--	212	212	212	212	100	97	79	66	54	71	91	61	83	69	62	87	94	66
Calculated Parameters																							
Anion Sum	me/L	N/A	--	--	--	0.49	0.82	0.45	0.77	0.85	0.49	0.53	0.53	0.28	0.92	0.63	0.54	0.63	0.70	0.48	1.23	0.66	0.96
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	<1	8	<1	5	7	<1	<1	7	<1	20	<5	8	<5	<5	<5	29	7	28
Calculated TDS	mg/L	1	--	--	--	36	55	35	46	55	38	37	34	25	45	44	34	37	37	31	65	44	44
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	0.71	0.99	0.67	0.74	0.95	0.74	0.68	0.55	0.49	0.65	0.94	0.73	0.63	0.54	0.60	1.07	0.97	0.57
Hardness (CaCO3)	mg/L	1	--	--	--	10	15	10	12	14	12	9	9	8	8.9	13.1	11.4	9.6	8.3	9.3	13.0	14.1	8.5
Ion Balance (% Difference)	%	N/A	--	--	--	18.30	9.39	19.60	1.99	5.56	20.30	12.40	1.85	27.30	17.6	19.7	15.1	0.3	12.9	11.0	7.1	19.1	25.7
Langelier Index (@ 20C)	N/A	N/A	--	--	--	NC	-3.20	NC	-3.44	-3.05	NC	NC	-3.66	NC	-3.37	-3.60	-3.68	-4.05	-3.83	-4.12	-3.04	-3.23	-3.66
Langelier Index (@ 4C)	N/A	N/A	--	--	--	NC	-3.45	NC	-3.70	-3.30	NC	NC	-3.91	NC	-3.69	-3.92	-4.00	-4.37	-4.15	-4.44	-3.36	-3.55	-3.98
Saturation pH (@ 20C)	N/A	N/A	--	--	--	NC	9.78	NC	10.00	9.83	NC	NC	10.10	NC	9.87	10.3	10.2	10.4	10.5	10.5	9.57	10.1	9.72
Saturation pH (@ 4C)	N/A	N/A	--	--	--	NC	10.00	NC	10.30	10.10	NC	NC	10.30	NC	10.2	10.6	10.5	10.7	10.8	10.8	9.89	10.4	10.0
Metals (ICP-MS)																							
Total Aluminum (Al)	µg/L	5	5	--	5-100	**290**	--	--	**175**	**151**	--	**271**	--	--	**209**	**205**	**338**	**256**	**270**	**259**	**205**	**236**	**340**
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	9	--	--	11.7	14.3	--	9.5	--	--	9	11	10	8	<5	13	13	18	9
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	8	--	--	14.7	12.7	--	<50	--	--	6	14	22	6	11	9	11	12	12
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	**0.018**	<0.017	--	<0.017	--	--	<0.017	<0.017	<0.017	<0.017	<0.017	**0.019**	<0.017	<0.017	**0.018**
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	**9**	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	<0.40	<0.40	--	<0.40	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	<2	--	--	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	<1	2	<1	<1	4
Total Iron (Fe)	µg/L	50	300	--	300	250	--	--	227	**403**	238	202	**418**	**358**	154	**541**	**813**	269	**528**	**523**	174	**723**	305
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	--	--	1.01	<0.50	--	<0.50	--	--	<0.5	<0.5	1.1	<0.5	0.5	<0.5	5.8	<0.5	0.5
Total Manganese (Mn)	µg/L	2	820	--	--	26	--	--	43.2	83.3	34.7	12.1	68.4	22.6	17	90	114	24	67	53	33	146	25
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	**0.42**	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	14	--	--	17.8	19.5	--	11.9	--	--	10	18	15	12	9	12	16	17	12
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<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	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	3	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	2	--	--	<2.0	<2.0	--	2.8	--	--	<2	2	3	4	<2	2	2	<2	3
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	8	--	--	5.4	5.3	6.5	<5.0	<5.0	<5.0	<5	<5	7	<5	<5	<5	<5	<5	<5
MICROBIOLOGICAL																							
Total Coliform	MPN/100mL	1	--	--	--	1800	170	--	>250	11	>250	59	>250	--	>2420	1986	>2420	>2420	>2420	>2420	525	>2420	>2420
E. coli	MPN/100mL	1	--	400	--	**1500**	100	--	**>250**	6	6	2	**>250**	<100	3	7	3	12	6	2	<1	18	11
Fecal Coliform	MPN/ml	--	--	400	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	0.82	6.05	1.97	0.73	0.55	0.22	0.44	0.89	0.97	0.53	2.2	0.07	0.62	1.00	0.73	0.13	0.83	0.41
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	0.87	5.97	1.95	0.66	0.54	0.21	0.42	0.73	0.82	0.56	2.2	0.12	0.72	1.00	0.74	0.14	0.86	0.41
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	<0.4	2.2	0.7	--	1.1	<0.4	<0.4	0.4	<0.4

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
" -- " = no guideline available / Not Tested.
CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)
CCME FWAL Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (CCME FWAL calculation equations). The largest guideline value for each respective element range was always used.
Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September, 2009)
NSE ESQs for Surface Water = Nova Scotia Environment Environmental Quality Standards for Surface Water (July 2013)
Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.
Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

SNC·LAVALIN

TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Kearney Lake															
Sample Sites						KL3															
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/14	2012/10/10	2013/05/15	2013/08/16	2013/10/16	2014/05/14	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				09:00	11:00	09:30	11:30	14:12	11:40	10:30	12:20	12:00	10:26	12:20	11:20	9:50	10:00	14:00	11:00	11:50	14:25
FIELD DATA																							
Secchi Depth	Meters	--	--	1.2	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Temp	Celsius	0.1	--	--	--	14.0	21.6	17.3	14.7	23.1	9.9	10.3	21.1	15.5	9	24.5	15.6	11.7	21.5	13.6	11.0	22.7	12.8
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.79**	8.00	8.00	9.26	7.83	**10.35**	**11.06**	8.42	**9.60**	8.89	8.17	7.72	**10.20**	9.20	8.90	5.90	7.87	8.12
pH	pH	N/A	--	--	--	7.27	6.74	6.97	7.27	7.33	6.76	6.83	6.96	6.30	7.68	6.85	6.51	5.86	7.25	6.49	6.55	7.37	6.67
Specific Conductance	uS/cm	1	--	--	--	95	282	246	220	228	199	220	175	161	204	225	177.2	207.3	194.4	210.6	405.0	252.0	208.0
INORGANICS																							
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	<5	7	7	6	7	7	6	7	7	23	6	5	<5	5	7	15	5	6
Dissolved Chloride (Cl)	mg/L	1	--	--	120	66	63	60	55	55	53	56	43	37	50	57	46	54	40	46	58	46	45
Colour	TCU	30	--	--	--	22	20	20	28	12	20	31	38	40	57	15	31	19	23	20	16	13	20
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.14	0.12	0.14	0.24	0.15	0.22	0.24	0.15	0.16	0.19	0.09	0.09	0.21	0.11	<0.05	0.17	0.13	0.13
Nitrate (N)	mg/L	0.05	--	--	13000	0.14	--	--	0.24	0.15	--	0.24	--	--	0.19	0.09	0.09	0.21	0.11	<0.05	0.17	0.13	0.13
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.03	0.04	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	2.6	3.9	4.3	3.6	3.1	3.3	3.8	5.1	5	5.9	3.4	4.9	4.3	4.4	4.6	4.6	2.8	4.5
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	<0.01
pH (Lab)	pH	N/A	--	5.0-9.0	6.5-9	**6.38**	6.67	6.82	6.82	6.99	6.87	6.52	6.5	**6.38**	6.7	7.1	6.9	6.68	6.96	6.86	6.68	6.87	6.59
Total Calcium (Ca)	mg/L	0.1	--	--	--	6.7	7.1	6.8	6.81	7.98	8.29	7.09	4.73	5.63	5.7	6.9	6.0	7.0	5.3	6.8	6.4	7.9	6.8
Total Magnesium (Mg)	mg/L	0.1	--	--	--	1.2	1.2	1.11	1.22	1.28	1.27	1.21	0.83	1.01	1.0	1.2	1.3	1.0	0.9	1.3	1.4	1.2	1.0
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	<0.02	<0.02	0.005	0.005	<0.002	0.003	0.008	0.003	0.012	0.019	0.045	0.007	0.006	0.006	0.012	0.009	0.023	0.15
Total Potassium (K)	mg/L	0.1	--	--	--	0.9	1.1	0.9	0.791	0.837	0.990	0.879	0.681	0.921	0.7	0.9	0.9	0.8	0.6	1.2	0.8	1.1	0.9
Total Sodium (Na)	mg/L	0.1	--	--	--	38	38	35	28.3	33.1	33.0	33.0	20.8	21.3	31.2	34.5	26.37	35.1	20.1	32.1	36.4	39.0	35.3
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.7	2.6	2.6	3.2	2.9	3.2	2.9	2.5	2.6	2.7	2.0	2.6	2.9	2.6	2.7	2.6	1.9	2.4
Total Suspended Solids	mg/L	5	--	--	--	<1	1	1	2	<2	<1	<1	<1	<1	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	11	12	12	10	10	10	9	10	8	7	8	7	7	7	8	9	7	7
Turbidity (NTU)	NTU	0.1	--	50	--	0.7	1.4	0.6	0.3	0.5	0.6	0.6	0.6	0.4	0.8	0.7	1	0.7	2.4	0.4	0.4	0.3	0.9
Conductivity (uS/cm)	µS/cm	1	--	--	--	250	250	240	220	220	220	220	170	160	197	222	182	219	216	204	218	243	216
Calculated Parameters																							
Anion Sum	me/L	N/A	--	--	--	2.11	2.17	2.08	1.90	1.93	1.87	1.90	1.58	1.36	2.03	1.90	1.55	1.68	1.38	1.60	2.14	1.55	1.54
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	<1	7	7	6	7	7	6	7	7	23	6	5	<5	5	7	15	5	6
Calculated TDS	mg/L	1	--	--	--	128	130	123	110	117	116	115	88	82	111	113	91	106	78	100	122	106	100
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	2.12	2.16	1.99	1.69	1.97	1.98	1.92	1.23	1.32	1.77	1.98	1.60	2.00	1.24	1.89	2.07	2.23	2.00
Hardness (CaCO3)	mg/L	1	--	--	--	22	23	22	22	25	26	23	15	18	18.4	22.2	20.3	21.6	16.9	22.3	21.7	24.7	21.1
Ion Balance (% Difference)	%	N/A	--	--	--	0.24	0.23	2.21	5.85	1.03	2.86	0.52	12.50	1.49	6.8	2.1	1.6	8.6	5.5	8.3	1.5	17.9	12.8
Langelier Index (@ 20C)	N/A	N/A	--	--	--	NC	-3.00	-2.89	-2.92	-2.60	-2.73	-3.23	-3.33	-3.35	-2.77	-2.88	-3.21	-3.37	-3.19	-3.05	-2.93	-3.12	-3.39
Langelier Index (@ 4C)	N/A	N/A	--	--	--	NC	-3.25	-3.14	-3.17	-2.85	-2.99	-3.49	-3.58	-3.60	-3.09	-3.20	-3.53	-3.69	-3.51	-3.37	-3.25	-3.44	-3.71
Saturation pH (@ 20C)	N/A	N/A	--	--	--	NC	9.67	9.71	9.74	9.59	9.60	9.75	9.83	9.73	9.47	9.98	10.10	10.0	10.2	9.91	9.61	9.99	9.98
Saturation pH (@ 4C)	N/A	N/A	--	--	--	NC	9.92	9.96	9.99	9.84	9.86	10.00	10.10	9.98	9.79	10.3	10.4	10.4	10.5	10.2	9.93	10.3	10.3
Metals (ICP-MS)																							
Total Aluminum (Al)	µg/L	5	5	--	5-100	259	259	--	**124**	53.5	--	**266**	--	--	**199**	54	**153**	**140**	65	100	**260**	52	**105**
Total Antimony (Sb)	µg/L	2	20	--	--	<2	<2	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	<2	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	13	13	--	15.7	13.2	--	19.1	--	--	18	17	15	19	9	18	17	17	16
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	<2	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	<2	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	9	9	--	7.8	8.7	--	<50	--	--	5	9	17	7	7	10	8	10	12
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	0.019	0.019	--	**0.030**	<0.017	--	**0.046**	--	--	**0.019**	**0.021**	**0.027**	**0.028**	<0.017	<0.017	**0.038**	<0.017	0.017
Total Chromium (Cr)	µg/L	1	1.0	--	1	<1	<1	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	**7**	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	<1	--	<0.40	<0.40	--	<0.40	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	2	2	--	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	<1	1	1	<1	2
Total Iron (Fe)	µg/L	50	300	--	300	523	523	--	73	133	58	136	104	154	137	136	119	131	71	172	137	96	118
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	<0.5	--	0.60	<0.50	--	<0.50	--	--	<0.5	<0.5	0.7	<0.5	<0.5	0.9	3.6	<0.5	<0.5
Total Manganese (Mn)	µg/L	2	820	--	--	53	53	--	36.8	67.1	32.1	41.5	33.1	32.5	25	47	46	37	20	92	41	45	27
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	<2	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	<2	<2	--	2.0	<2.0	--	2.3	--	--	<2	<2	<2	<2	<2	<2	2	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<1	<1	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.1	<0.1	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	12	12	--	33.5	35.9	--	33.2	--	--	25	33	29	33	18	32	31	32	29
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	<0.1	--	<0.10	<0.10	--	<0.10	--	--	<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	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	2	2	--	<2.0	<2.0	--	4.9	--	--	<2	<2	<2	<2	<2	2	3	<2	2
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	<0.1	--	<0.10	<0.10	--	0.11	--	--	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	<2	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	<5	<5	--	9.7	6.9	6.4	9.3	6.6	9.2	<5	<5	8	10	5	7	10	<5	6
MICROBIOLOGICAL																							
Total Coliform	MPN/100mL	1	--	--	--	120	24	--	190	16	58	72	110	--	291	1553	178	345	2420	1300	86	1730	>2420
E. coli	MPN/100mL	1	--	400	--	1	17	--	2	<1	8	5	37	<100	2	<1	3	8	21	<1	<1	<1	13
Fecal Coliform	MPN/ml	--	--	400	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	1.04	1.11	1.18	1.30	1.14	0.51	0.78	1.26	1.24	0.52	1.3	0.81	1.44	2.00	0.65	0.76	0.59	1.23
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	0.94	0.97	1.21	1.09	1.19	0.42	0.67	0.98	1.01	0.55	1.2	1.14	1.62	2.30	0.61	0.69	0.51	1.12
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	<0.4	2.8	<0.4	--	1.3	<0.4	0.6	0.4	0.4

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
" -- " = no guideline available / Not Tested.
CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)
CCME FWAL Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (CCME FWAL calculation equations). The largest guideline value for each respective element range was always used.
Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September, 2009)
NSE ESQs for Surface Water = Nova Scotia Environment Environmental Quality Standards for Surface Water (July 2013)
Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.
Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

SNC·LAVALIN

TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Kearney Lake																Kearney Lake									
Sample Sites						KL4																KL5									
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/14	2012/10/10	2013/05/15	2013/08/16	2013/10/16	2014/05/14	2014/08/14	2014/10/27	2011/10/17	2012/05/01	2012/08/14	2012/10/10	2013/05/15	2013/08/16	2013/10/16	2014/05/14	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				10:00	11:30	10:00	11:20	13:50	11:15	10:10	11:40	11:40	10:16	12:00	11:40	9:41	10:30	14:20	11:15	11:35	14:35	9:40	10:52	13:10	12:10	10:03	10:50	13:45	11:30	13:55	10:45
FIELD DATA																															
Secchi Depth	Meters	--	--	1.2	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Temp	Celsius	0.1	--	--	--	13.4	21.9	17.3	14.5	21.9	9.8	10.1	21.2	15.3	9.0	24.4	15.7	11.7	20.4	13.5	11.0	21.8	12.5	14.7	10.5	26.1	16.6	13.3	22.7	14.7	13.7	22.9	12.8
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.87**	8.10	8.30	9.01	6.27	**10.89**	**10.99**	**8.55**	**9.65**	8.70	7.32	8.87	**10.09**	8.89	**9.60**	**14.50**	5.92	7.52	9.38	7.88	7.90	8.16	**9.67**	8.89	8.60	**15.83**	7.64	7.91
pH	pH	N/A	--	--	--	8.00	6.71	6.94	7.19	6.98	6.07	6.49	6.43	6.02	9.0	6.71	6.77	5.72	7.08	6.41	6.30	7.25	6.55	6.52	7.76	6.69	6.72	6.20	8.57	6.51	6.79	7.86	6.60
Specific Conductance	uS/cm	1	--	--	--	771	262	247	224	226	215	218	172	126	206	225	185.9	207.1	196.2	209.0	273.0	251.0	208.0	112	230	229	189.0	219.5	202.1	212.9	472.0	251.0	211.0
INORGANICS																															
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	5	7	7	6	8	7	5	8	7	22	8	<5	<5	<5	<5	30	5	29	9	21	8	<5	<5	6	5	32	<5	<5
Dissolved Chloride (Cl)	mg/L	1	--	--	120	67	65	60	56	56	53	56	44	37	51	57	46	54	41	47	59	47	48	37	55	57	48	58	44	46	61	47	47
Colour	TCU	30	--	--	--	22	18	20	27	11	20	32	38	43	48	11	20	17	21	20	13	11	28	35	43	10	27	10	22	18	14	11	22
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.15	0.12	0.14	0.23	0.19	0.21	0.23	0.15	0.17	0.19	0.11	0.09	0.20	0.11	0.17	0.25	0.17	0.16	0.17	0.19	0.15	0.83	0.21	0.21	0.25	0.16	0.10	0.16
Nitrate (N)	mg/L	0.05	--	--	13000	0.15	--	--	0.23	0.19	--	0.23	--	--	0.19	0.11	0.09	0.20	0.11	0.17	0.25	0.17	0.16	--	0.19	0.15	0.83	0.21	0.21	0.20	0.16	0.10	0.16
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<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
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	0.05	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.05	<0.03	0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.06
Total Organic Carbon	mg/L	0.5	--	--	--	2.5	2.6	4.0	3.3	2.6	3.1	3.7	6	5.4	7.5	3.2	4.8	4.2	4.5	4.3	4.4	2.1	4.4	4.8	5.8	3.4	4.7	4.0	4.6	7.0	4.3	2.7	4.5
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	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
pH (Lab)	pH	N/A	--	5.0-9.0	6.5-9	6.61	6.75	6.83	6.83	6.93	6.83	6.57	6.57	**6.46**	6.7	7.0	6.9	6.69	6.96	6.85	6.69	6.91	6.85	6.57	6.7	7.1	6.5	6.71	6.93	6.89	6.64	6.84	6.63
Total Calcium (Ca)	mg/L	0.1	--	--	--	6.8	7.7	7.0	6.81	8.00	8.45	6.84	4.93	5.24	5.7	6.8	5.8	6.8	5.1	6.8	6.4	7.9	6.8	5.79	6.1	6.6	5.9	7.1	5.7	6.4	6.5	7.6	7.0
Total Magnesium (Mg)	mg/L	0.1	--	--	--	1.2	1.3	1.2	1.22	1.24	1.31	1.19	0.86	0.99	1.0	1.2	1.2	1.0	0.8	1.2	1.3	1.2	1.0	1.05	1.0	1.1	1.2	1.0	1.0	1.1	1.4	1.2	1.0
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	<0.02	<0.02	<0.002	0.004	<0.002	<0.002	0.007	0.003	0.026	0.022	0.043	0.007	0.006	2.39	0.016	0.022	0.031	0.015	0.009	0.018	0.040	0.006	0.005	0.013	0.010	0.010	0.026	0.14
Total Potassium (K)	mg/L	0.1	--	--	--	1	1	1	0.807	0.905	0.968	0.826	0.733	1.130	0.7	1.0	0.9	0.8	0.6	1.2	0.8	1.1	0.9	0.858	0.7	0.9	0.8	0.8	0.7	1.1	0.8	1.1	0.9
Total Sodium (Na)	mg/L	0.1	--	--	--	39	41	37	28.5	34.3	33.9	32.1	21.5	21.1	31.5	34.5	25.2	31.6	20.1	30.7	35.9	38.6	34.1	22.0	34.6	32.0	27.7	33.6	19.2	31.3	37.5	40.3	38.3
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.7	2.6	2.6	3.1	2.9	3.1	2.9	2.5	2.7	2.7	2.2	2.6	3.0	2.6	2.5	2.6	2.1	2.5	2.5	2.7	2.0	2.4	2.7	2.5	2.5	2.7	2.1	2.5
Total Suspended Solids	mg/L	5	--	--	--	<1	1	<1	<2	<2	<1	2	<1	<2	<5	<5	<5	<5	<5	<5	<5	<5	<5	1	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	11	12	11	10	10	10	9	10	8	7	8	7	7	7	9	9	8	8	9	7	8	8	8	7	8	9	8	8
Turbidity (NTU)	NTU	0.1	--	50	--	0.5	1.0	0.3	0.3	0.2	0.8	0.7	0.7	0.4	0.7	0.4	0.8	0.7	2.6	2.1	1.1	0.6	0.8	0.9	1.1	0.7	0.9	0.7	0.8	0.4	1.1	0.4	0.8
Conductivity (uS/cm)	µS/cm	1	--	--	--	260	250	230	220	230	250	210	170	160	200	224	183	218	218	204	219	241	218	160	215	226	189	232	223	204	228	246	225
Calculated Parameters																															
Anion Sum	me/L	N/A	--	--	--	2.23	2.22	2.09	1.91	1.94	1.85	1.88	1.62	1.36	2.04	1.94	1.45	1.68	1.31	1.53	2.47	1.60	2.11	1.42	2.13	1.95	1.58	1.82	1.52	1.58	2.56	1.50	1.50
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	5	7	7	6	8	7	5	8	7	22	8	<5	<5	<5	<5	30	5	29	9	21	8	<5	<5	6	5	32	<5	<5
Calculated TDS	mg/L	1	--	--	--	132	135	125	111	118	116	113	90	81	111	114	87	103	75	97	132	108	117	84	118	111	96	110	82	98	136	106	103
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	2.16	2.32	2.07	1.70	2.02	2.03	1.86	1.28	1.3	1.78	1.97	1.53	1.84	1.23	1.84	2.04	2.21	1.94	1.36	1.94	1.85	1.64	1.94	1.23	1.81	2.12	2.27	2.14
Hardness (CaCO3)	mg/L	1	--	--	--	22	25	22	22	25	27	22	16	17	18.4	21.9	19.4	21.1	16.0	21.9	21.3	24.7	21.1	19	19.3	21.0	19.7	21.8	18.4	20.5	22.0	23.9	21.6
Ion Balance (% Difference)	%	N/A	--	--	--	1.59	2.20	0.48	5.82	2.02	4.64	0.53	11.70	2.26	6.6	0.8	2.8	4.5	3.2	9.2	9.5	15.8	4.2	2.16	4.7	2.6	2.0	3.2	10.6	6.7	9.4	20.3	17.5
Langelier Index (@ 20C)	N/A	N/A	--	--	--	-3.21	-2.89	-2.84	-2.92	-2.64	-2.75	-3.22	-3.18	-3.31	-2.79	-2.86	-3.22	-3.37	-3.21	-3.21	-2.63	-3.08	-2.45	-3.06	-2.79	-2.77	-3.62	-3.33	-3.11	-3.19	-2.64	-3.17	-3.42
Langelier Index (@ 4C)	N/A	N/A	--	--	--	-3.46	-3.14	-3.09	-3.17	-2.89	-3.00	-3.47	-3.43	-3.56	-3.11	-3.18	-3.54	-3.69	-3.53	-3.53	-2.95	-3.40	-2.77	-3.31	-3.11	-3.09	-3.94	-3.65	-3.43	-3.51	-2.96	-3.49	-3.74
Saturation pH (@ 20C)	N/A	N/A	--	--	--	9.82	9.64	9.67	9.75	9.57	9.58	9.79	9.75	9.77	9.49	9.86	10.10	10.1	10.2	10.1	9.32	9.99	9.30	9.63	9.49	9.87	10.1	10.0	10.0	10.1	9.28	10.0	10.0
Saturation pH (@ 4C)	N/A	N/A	--	--	--	10.1	9.9	9.9	10.0	9.8	9.8	10.0	10.0	10.0	9.8	10.2	10.4	10.4	10.5	10.4	9.64	10.3	9.62	9.88	9.81	10.2	10.4	10.4	10.4	10.4	9.60	10.3	10.4
Metals (ICP-MS)																															
Total Aluminum (Al)	µg/L	5	5	--	5-100	**150**	--	--	**125**	29.2	--	**231**	--	--	**188**	48	**149**	**141**	**106**	**159**	**236**	46	93	--	**222**	52	**154**	**136**	58	61	**224**	53	**108**
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	16	--	--	16.6	17.8	--	18.2	--	--	18	17	16	18	10	19	17	19	16	--	18	16	15	19	9	16	16	17	17
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	6	--	--	8.6	9.1	--	<50	--	--	6	9	16	7	6	9	8	11	11	--	6	9	15	7	7	9	7	6	10
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	**0.031**	<0.017	--	**0.035**	--	--	**0.021**	<0.017	**0.027**	**0.027**	0.017	**0.050**	**0.027**	<0.017	<0.017	--	**0.022**	**0.027**	**0.029**	**0.024**	<0.017	**0.034**	**0.036**	<0.017	**0.024**
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	6	<1	<1	<1	**6**	<1	<1	--	<1	<1	5	<1	<1	<1	**6**	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	<0.40	<0.40	--	<0.40	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	<2	--	--	<2.0	2.4	<2.0	2.3	<2.0	<2.0	<2	<2	4	**9**	<1	1	<1	<1	2	<2.0	<2	<2	<2	<2	<1	1	<1	<1	5
Total Iron (Fe)	µg/L	50	300	--	300	86	--	--	82	51	55	119	109	138	129	118	133	213	144	248	129	55	104	175	160	78	120	111	70	79	111	<50	119
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	--	--	3.23	<0.50	--	<0.50	--	--	<0.5	<0.5	0.8	0.9	<0.5	<0.5	2.6	<0.5	<0.5	--	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	1.9	<0.5	0.5
Total Manganese (Mn)	µg/L	2	820	--	--	51	--	--	34.5	63.5	29.4	38.5	27.2	29.7	23	34	38	34	77	130	34	29	24	35.9	30	14	37	35	13	12	40	18	25
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	3	--	--	2.0	<2.0	--	<2.0	--	--	<2	<2	5	<2	<2	<2	<2	<2	<2	--	<2	<2	5	<2	<2	<2	2	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	34	--	--	33.1	36.7	--	32.7	--	--	25	32	28	32	17	31	31	31	29	--	27	31	29	31	18	31	31	30	30
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<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	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	5	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	4.2	--	--	<2	<2	<2	<2	<2	3	2	<2	<2	--	3	<2	<2	<2	<2	<2	<2	<2	2
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	<0.10	<0.10	--	0.1	--	--	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	14	--	--	10.4	6.9	7	11.3	7.4	7	<5	<5	**68**	21	<5	9	9	<5	<5	9.3	5	<5	**64**	11	7	5	10	<5	10
MICROBIOLOGICAL																															
Total Coliform	MPN/100mL	1	--	--	--	28	58	--	100	16	75	83	95	--	345	>2420	921	548	>2420	770	308	1550	>2420	--	461	613	93	461	308	461	42	629	>2470
E. coli	MPN/100mL	1	--	400	--	4	33	--	1	<1	2	5	39	<100	4	<1	4	6	38	<1	<1	1	8	100	14	2	6	6	6	4	<1	1	17
Fecal Coliform	MPN/ml	--	--	400	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	0.78	1.11	1.06	0.92	0.07	0.50	0.60	1.04	1.31	0.52	0.7	0.55	1.34	1.50	0.40	0.44	0.50	1.03	0.91	0.30	1.2	1.09	1.44	2.20	0.64	0.20	0.61	0.9
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	0.69	0.96	1.11	0.77	0.07	0.41	0.55	0.82	1.07	0.55	0.7	0.74	1.48	1.70	0.39	0.40	0.57	0.95	0.85	0.33	1.0	1.41	1.59	2.40	0.62	0.20	0.54	0.84
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	0.5	<0.4	0.7	--	1.8	1.1	<0.4	<0.4	<0.4	--	<0.4	2.3	1.0	--	0.6	1.1	<0.4	0.5	1.1

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
" -- " = no guideline available / Not Tested.
CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)
CCME FWAL Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (CCME FWAL calculation equations). The largest guideline value for each respective element range was always used.
Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September, 2009)
NSE ESQs for Surface Water = Nova Scotia Environment Environmental Quality Standards for Surface Water (July 2013)
Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.
Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

SNC·LAVALIN

TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Highway 102																	
Sample Sites						HWY102-1																	
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/15	2012/10/11	2013/05/15	2013/08/15	2013/10/16	2014/05/14	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				07:00	12:45	08:00	13:00	10:20	09:00	13:40	11:00	11:00	14:50	11:00	9:50	14:15	12:22	12:30	12:00	10:10	9:30
FIELD DATA																							
Secchi Depth	Meters	--	--	1.2	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Temp	Celsius	0.1	--	--	--	11.8	18.8	15.7	14.9	19.6	7.4	11.4	17.8	14.6	10.7	21.8	13.6	11.7	19.5	8.9	12.1	19.6	10.2
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**11.44**	5.80	**4.34**	8.18	**4.25**	6.05	8.15	**3.88**	**5.34**	5.65	**1.03**	**3.83**	7.55	**3.32**	**3.10**	**12.03**	**2.09**	**4.54**
pH	pH	N/A	--	--	--	7.98	5.35	5.25	6.31	5.26	5.62	5.75	5.77	5.99	8.76	5.73	6.38	6.19	7.10	6.79	6.02	6.63	5.12
Specific Conductance	uS/cm	1	--	--	--	194	153	104	135	106	109	114	108	89	288	225	155.5	226	173.2	234.0	880.0	337	109
INORGANICS																							
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	<5	<5	<5	<5	<5	<5	5	11	8	22	25	15	9	23	20	31	28	30
Dissolved Chloride (Cl)	mg/L	1	--	--	120	24	38	24	32	25	22	24	19	12	58	48	28	53	31	40	65	57	19
Colour	TCU	30	--	--	--	67	68	57	37	89	53	39	65	79	24	65	40	9	65	25	11	31	93
Nitrite + Nitrate	mg/L	0.05	--	--	--	<0.05	<0.05	<0.05	0.69	<0.05	1.2	0.69	0.25	1.2	2.61	0.06	0.43	0.51	<0.05	<0.05	<0.05	<0.05	0.53
Nitrate (N)	mg/L	0.05	--	--	13000	<0.05	--	--	0.69	<0.05	--	0.69	--	--	2.61	0.06	0.43	0.51	<0.05	<0.05	<0.05	<0.05	0.53
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	0.29	<0.05	<0.05	<0.05	<0.05	0.05	0.1	0.07	0.31	0.19	0.04	<0.03	0.05	0.06	<0.03	0.04	0.03
Total Organic Carbon	mg/L	0.5	--	--	--	6.5	10	7.7	4.7	11	6.3	4.5	7.2	7.4	5.5	10.0	7.0	5.1	10.1	17.7	4.1	7.7	9.0
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	<0.01
pH (units)	pH	N/A	--	5.0-9.0	6.5-9	**4.54**	**5.24**	**5.40**	**5.48**	**6.24**	**5.31**	**6.42**	6.55	**6.28**	**6.4**	6.9	6.8	6.86	6.87	6.73	6.56	7.49	**5.90**
Total Calcium (Ca)	mg/L	0.1	--	--	--	1.7	1.8	1.6	4.93	3.34	5.09	4.9	5.21	5.55	12.5	11.7	7.5	11.1	10.5	13.9	7.2	23.3	2.2
Total Magnesium (Mg)	mg/L	0.1	--	--	--	0.3	0.5	0.5	1.08	0.79	1.09	0.91	0.92	1.19	1.7	2.0	1.4	1.4	1.5	2.3	1.6	3.2	0.6
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	0.07	0.14	0.020	0.006	0.007	0.011	0.009	0.012	0.010	0.019	0.039	0.02	0.006	0.021	0.022	0.013	0.038	0.03
Total Potassium (K)	mg/L	0.1	--	--	--	0.5	1.2	0.7	1.140	1.630	1.310	1.100	1.500	1.880	1.6	2.5	1.5	1.3	1.7	2.4	1.2	2.5	0.7
Total Sodium (Na)	mg/L	0.1	--	--	--	15	25	13	15.9	14.5	14.6	14.8	10.2	8.26	36.3	27.7	14.6	30.8	15.0	20.5	39.1	38.7	18.6
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.5	2.2	2.0	1.1	3.8	5.1	2.8	5.2	4.6	4.1	6.1	5.1	3.1	5.1	5.8	1.7	7.1	4.7
Total Suspended Solids	mg/L	5	--	--	--	7	80	2	<2	11	<2	<1	1	<1	9	6	<5	<5	<5	<5	6	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	5	3	3	8	<2	8	10	8	10	14	8	9	12	8	12	10	7	6
Turbidity (NTU)	NTU	0.1	--	50	--	14.0	35	0.9	1.4	1.2	0.6	0.4	0.6	1.1	0.9	1.9	0.9	0.5	1.6	0.5	0.7	1.6	0.9
Conductivity (uS/cm)	µS/cm	1	--	--	--	100	140	92	130	100	110	110	100	88	263	231	143	243	188	218	252	338	112
Calculated Parameters																							
Anion Sum	me/L	N/A	--	--	--	0.77	1.12	0.73	1.11	0.71	0.88	1.03	0.95	0.80	2.55	2.02	1.31	1.96	1.50	1.78	2.66	2.31	1.30
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	<1	<1	<1	<1	<1	<1	5	11	8	22	25	15	9	23	20	31	28	30
Calculated TDS	mg/L	1	--	--	--	50	73	45	67	50	63	65	58	54	150	117	73	117	83	104	143	150	68
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	0.84	1.32	0.74	1.06	0.93	1.02	1.00	0.83	0.80	2.43	6.04	1.19	2.06	1.40	1.87	2.25	3.22	1.04
Hardness (CaCO3)	mg/L	1	--	--	--	6	6	6	17	12	17	16	17	19	38.2	37.5	24.5	33.5	32.4	44.2	24.6	71.4	8.0
Ion Balance (% Difference)	%	N/A	--	--	--	4.35	8.20	0.68	2.30	13.40	7.37	1.48	6.74	0.00	2.6	1.9	4.6	2.4	3.5	2.6	8.4	16.4	11.2
Langelier Index (@ 20C)	N/A	N/A	--	--	--	NC	NC	NC	NC	NC	NC	-3.50	-2.99	-3.36	-2.77	-2.23	-2.72	-2.73	-2.33	-2.41	-2.69	-1.30	-3.85
Langelier Index (@ 4C)	N/A	N/A	--	--	--	NC	NC	NC	NC	NC	NC	-3.75	-3.25	-3.61	-3.09	-2.55	-3.04	-3.05	-2.65	-2.73	-3.01	-1.62	-4.17
Saturation pH (@ 20C)	N/A	N/A	--	--	--	NC	NC	NC	NC	NC	NC	9.92	9.54	9.64	9.17	9.13	9.52	9.59	9.20	9.14	9.25	8.79	9.75
Saturation pH (@ 4C)	N/A	N/A	--	--	--	NC	NC	NC	NC	NC	NC	10.20	9.80	9.89	9.49	9.45	9.84	9.91	9.52	9.46	9.57	9.11	10.1
Metals (ICP-MS)																							
Total Aluminum (Al)	µg/L	5	5	--	5-100	**510**	--	--	**169**	**192**	--	**205**	--	--	**134**	**183**	**146**	86	**145**	**150**	**187**	83	310
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	22	--	--	52.9	36.9	--	37.3	--	--	58	284	42	57	57	80	46	142	17
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	<5	--	--	11.4	10.9	--	<50	--	--	12	18	13	10	10	11	9	14	11
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	**0.043**	<0.017	--	**0.023**	--	--	**0.034**	**0.021**	<0.017	<0.017	<0.017	**0.040**	**0.022**	<0.017	0.022
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	**8**	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	0.50	0.46	--	<0.40	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	2	--	--	3.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	3	<2	<1	2	<1	<1	2
Total Iron (Fe)	µg/L	50	300	--	300	**720**	--	--	146	**637**	150	107	209	219	102	**1380**	255	111	**938**	**446**	147	**820**	290
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	1.6	--	--	2.37	0.56	--	<0.50	--	--	<0.5	0.7	<0.5	<0.5	<0.5	0.6	2.6	<0.5	0.6
Total Manganese (Mn)	µg/L	2	820	--	--	40	--	--	55.3	39.0	67.0	28.1	21.0	31.3	34	79	28	23	45	31	56	122	61
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	11	--	--	29.1	19.7	--	24.3	--	--	48	58	36	52	47	62	38	103	13
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<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	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	6	--	--	<2.0	<2.0	--	3.5	--	--	<2	3	<2	<2	<2	4	2	<2	<2
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	21	--	--	16.4	6.9	6.9	<5.0	<5.0	6.9	<5	6	<5	<5	<5	10	10	<5	7
MICROBIOLOGICAL																							
Total Coliform	MPN/100mL	1	--	--	--	84	>250	--	>250	>250	180	120	180	--	687	>2420	>2420	1550	>2420	1553	120	>2420	>2420
E. coli	MPN/100mL	1	--	400	--	54	**>250**	--	12	17	5	1	78	<100	3	68	145	4	9	5	3	179	3
Fecal Coliform	MPN/ml	--	--	400	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	15.40	19.29	0.70	18.12	1.61	8.45	0.93	0.58	0.69	0.53	2.59	0.81	1.27	14.70	1.99	0.25	1.10	1.22
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	17.50	19.60	0.84	17.62	1.68	7.52	0.84	0.56	0.65	0.59	2.89	1.05	1.45	15.80	2.20	0.82	1.11	1.38
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	1.1	1.3	0.6	--	0.6	0.6	0.7	0.6	<0.4

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
" -- " = no guideline available / Not Tested.
CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)
CCME FWAL Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (CCME FWAL calculation equations). The largest guideline value for each respective element range was always used.
Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September 2009)
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Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.
Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

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TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Highway 102																	
Sample Sites						HWY102-2																	
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/15	2012/10/11	2013/05/15	2013/08/15	2013/10/16	2014/05/14	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				12:30	12:15	12:30	12:40	09:30	12:30	11:20	15:00	15:30	11:20	12:20	10:35	10:40	10:00	10:22	12:15	14:25	10:07
FIELD DATA																							
Secchi Depth	Meters	--	--	1.2	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	N/A
Water Temp	Celsius	0.1	--	--	--	16.7	19.2	16.4	17.2	17.0	8.7	10.8	24.2	15.1	7.8	23.7	14.3	11.5	22.0	10.7	11.4	--	10.4
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.01**	5.90	**4.80**	**4.91**	**2.45**	**2.99**	6.92	7.03	**5.09**	**3.73**	**13.1**	**3.28**	6.30	**1.57**	**4.20**	**10.50**	--	9.25
pH	pH	N/A	--	--	--	6.57	5.71	5.40	6.33	5.86	5.64	6.22	5.89	5.29	7.3	6.37	6.72	6.01	6.92	5.40	5.40	--	5.85
Specific Conductance	uS/cm	1	--	--	--	37	457	162	415	167	101.2	92.2	123.1	96	225	226	159.1	288	188.5	204.4	204.4	--	174
INORGANICS																							
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	<5	<5	7	6	5	<5	<5	5	<5	17	7	<5	6	14	7	30	--	8
Dissolved Chloride (Cl)	mg/L	1	--	--	120	21	82	83	**170**	41	18	21	21	17	63	109	45	71	50	52	113	--	34
Colour	TCU	30	--	--	--	120	190	91	96	160	68	65	98	77	32	100	70	11	61	36	13	--	85
Nitrite + Nitrate	mg/L	0.05	--	--	--	<0.05	<0.05	<0.05	0.10	<0.05	0.62	0.26	1.8	3.2	1.54	<0.05	0.14	0.17	<0.05	<0.05	<0.05	--	0.12
Nitrate (N)	mg/L	0.05	--	--	13000	<0.05	--	--	0.10	<0.05	--	0.26	--	--	1.54	<0.05	0.14	0.17	<0.05	<0.05	<0.05	--	0.12
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	--	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	0.06	<0.05	<0.05	0.20	<0.05	<0.05	0.30	0.08	0.09	<0.03	<0.03	<0.03	0.17	0.09	<0.03	--	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	8.5	13	13	7.2	14	7.4	5.7	9.2	8.4	7.0	15.8	11.2	6.1	10.6	5.1	17.4	--	8.0
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 (units)	pH	N/A	--	5.0-9.0	6.5-9	**5.43**	**5.96**	**6.30**	**6.05**	**6.32**	**5.47**	**5.93**	**6.18**	**5.92**	**5.9**	6.7	6.8	6.61	6.59	**6.34**	7.20	--	**6.40**
Total Calcium (Ca)	mg/L	0.1	--	--	--	1.6	4.0	4.8	7.44	3.84	4.01	3.07	2.22	3.80	7.0	8.4	5.6	7.6	8.5	8.2	14.1	--	9.5
Total Magnesium (Mg)	mg/L	0.1	--	--	--	0.4	0.7	0.9	0.96	0.59	1.00	0.68	0.68	1.38	1.2	1.4	1.2	1.2	1.3	2.2	3.1	--	1.8
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	<0.02	0.04	0.034	0.010	0.028	0.003	0.009	0.019	0.041	0.021	0.054	0.03	0.014	0.028	0.199	0.028	--	0.20
Total Potassium (K)	mg/L	0.1	--	--	--	0.5	0.8	1.1	0.984	0.956	1.390	0.844	1.310	1.880	1.2	1.7	1.6	1.3	1.5	2.5	2.9	--	1.7
Total Sodium (Na)	mg/L	0.1	--	--	--	15	51	55	83.7	32.0	12.1	13.3	13.1	13.3	41.5	63.6	20.4	39.0	19.1	34.5	69.6	--	24.0
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.2	4.4	4.0	3.0	6.4	5.4	2.5	6.5	6.7	4.1	6.9	5.8	1.6	6.2	6.6	1.6	--	5.9
Total Suspended Solids	mg/L	5	--	--	--	<2	58	62	34	27	3	<1	10	14	<5	39	<5	<5	<5	194	34	--	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	<2	3	8	11	<2	7	5	5	8	12	6	10	10	9	10	12	--	8
Turbidity (NTU)	NTU	0.1	--	50	--	0.7	3.8	4.2	2.6	3.1	0.5	0.4	1.2 (1)	3.9	0.6	10.8	2	1.5	3.3	144	1.1	--	1.1
Conductivity (uS/cm)	µS/cm	1	--	--	--	85	290	310	590	160	94	91	100	110	263	403	179	295	203	223	433	--	194
Calculated Parameters																							
Anion Sum	me/L	N/A	--	--	--	0.60	2.37	2.62	5.13	1.27	0.70	0.73	0.91	0.86	2.48	3.34	1.49	2.34	1.88	1.81	4.04	--	1.29
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	<1	<1	7	6	5	<1	<1	5	<1	17	7	<5	6	14	7	30	--	8
Calculated TDS	mg/L	1	--	--	--	42	150	165	282	93	52	48	62	67	143	200	86	135	100	145	235	--	85
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	--	<10
Cation Sum	me/L	N/A	--	--	--	0.81	2.65	2.89	4.17	1.81	0.86	0.82	0.83	0.97	2.32	2.10	1.40	2.24	1.50	3.50	4.17	--	1.76
Hardness (CaCO3)	mg/L	1	--	--	--	6	13	16	23	12	14	11	8	15	22.4	26.7	18.9	23.9	26.6	29.5	48.0	--	31.1
Ion Balance (% Difference)	%	N/A	--	--	--	14.90	5.58	4.90	10.30	17.50	10.30	5.81	4.60	6.01	3.3	3.6	3.1	2.3	11.3	31.7	1.6	--	15.1
Langelier Index (@ 20C)	N/A	N/A	--	--	--	NC	NC	-3.57	-3.72	-3.70	NC	NC	-4.07	NC	-3.63	-3.15	-3.34	-3.33	-2.92	-3.50	-1.80	--	-3.30
Langelier Index (@ 4C)	N/A	N/A	--	--	--	NC	NC	-3.82	-3.97	-3.95	NC	NC	-4.32	NC	-3.95	-3.47	-3.66	-3.65	-3.24	-3.82	-2.12	--	-3.62
Saturation pH (@ 20C)	N/A	N/A	--	--	--	NC	NC	9.87	9.77	10.00	NC	NC	10.30	NC	9.53	9.85	10.10	9.94	9.51	9.84	9.00	--	9.70
Saturation pH (@ 4C)	N/A	N/A	--	--	--	NC	NC	10.10	10.00	10.30	NC	NC	10.50	NC	9.85	10.2	10.5	10.3	9.83	10.2	9.32	--	10.0
Metals (ICP-MS)																							
Total Aluminum (Al)	µg/L	5	5	--	5-100	270	--	--	189	368	--	260	--	--	145	**466**	**259**	**130**	**138**	**2760**	**400**	--	**216**
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	2.1	--	<1.0	--	--	<2	<2	<2	<2	<2	6	<2	--	<2
Total Barium (Ba)	µg/L	5	1000	--	--	20	--	--	53.1	27.7	--	26.6	--	--	49	74	33	44	43	213	381	--	63
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2
Total Boron (B)	µg/L	5	1200	--	1500	<5	--	--	7.9	7.8	--	<50	--	--	10	17	15	9	10	13	11	--	12
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	0.051	<0.017	--	<0.017	--	--	0.037	**0.031**	**0.032**	**0.019**	<0.017	**0.096**	**0.051**	--	**0.019**
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	1.0	--	<1.0	--	--	<1	<1	<1	<1	1	**9**	**2**	--	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	0.66	0.77	--	<0.40	--	--	<1	1	1	<1	1	3	1	--	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	2	--	--	2.0	<2.0	<2.0	<2.0	2.5	2.8	<2	3	3	<2	1	**12**	4	--	2
Total Iron (Fe)	µg/L	50	300	--	300	**880**	--	--	**1380**	**3850**	**303**	229	**897**	**1110**	214	**5210**	**1550**	**383**	**1720**	**28400**	**1660**	--	**485**
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	1.9	--	--	1.61	2.70	--	0.59	--	--	<0.5	5.2	2.1	0.6	0.7	19.4	3.5	--	1.0
Total Manganese (Mn)	µg/L	2	820	--	--	110	--	--	387	135	52.9	40.5	106	176	78	219	207	83	173	327	212	--	93
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	4	2	--	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	<1	<1	<1	<1	<1	<1	--	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	11	--	--	37.4	21.1	--	16.9	--	--	33	45	31	39	40	45	75	--	43
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1
Total Tin (Sn)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2
Total Titanium (Ti)	µg/L	2	--	--	--	4	--	--	<2.0	6.4	--	4.9	--	--	<2	10	4	4	<2	60	9	--	6
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	--	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	2	<2	<2	<2	11	<2	--	<2
Total Zinc (Zn)	µg/L	5	30	--	30	12	--	--	13.6	12.3	9.3	5.5	9	12.5	<5	7	12	12	<5	**46**	**36**	--	17
MICROBIOLOGICAL																							
Total Coliform	MPN/100mL	1	--	--	--	28	>250	--	>250	75	41	110	>250	--	1553	>2420	>2420	2420	1990	>2420	687	--	>2420
E. coli	MPN/100mL	1	--	400	--	4	230	--	9	5	<1	7	**>250**	<100	<1	16	50	111	9	4	<1	--	<1
Fecal Coliform	MPN/ml	--	--	400	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	0.90	82.63	48.17	0.85	16.36	0.25	0.97	4.91	1.9	2.07	21.03	0.33	2.41	1.10	21.62	10.34	--	0.46
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	0.91	81.20	52.50	0.85	17.35	0.23	0.87	4.49	2.15	2.27	17.26	0.50	3.02	1.30	27.02	11.09	--	0.55
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	0.6	1.1	0.5	--	0.7	2.0	15.3	--	<0.4

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
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TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Lake Shore Drive																Larry Uteck Blvd									
Sample Sites						LSD																LU									
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/17	2012/05/01	2012/08/15	2012/10/11	2013/05/15	2013/08/15	2013/10/16	2014/05/15	2014/08/14	2014/10/27	2011/10/17	2012/05/01	2012/08/15	2012/10/11	2013/05/15	2013/08/15	2013/10/16	2014/05/15	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				12:00	09:30	11:45	09:00	11:28	10:00	08:45	13:20	9:00	9:15	13:00	9:10	08:40	15:30	11:55	9:30	12:45	13:30	10:30	15:20	11:30	10:10	14:30	14:30	13:00	11:45	10:45	9:54
FIELD DATA																															
Secchi Depth	Meters	--	--	1.2	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Temp	Celsius	0.1	--	--	--	13.1	16.7	15.3	13.4	21.3	7.3	10.2	21.0	12.0	5.7	25.7	13.4	7.7	20.2	8.8	8.9	--	10.48	11.3	12.8	27.3	14.6	13.9	18.3	10.9	15.0	22.8	10.2
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.84**	5.70	5.50	8.60	**5.41**	8.47	9.44	7.87	8.16	**4.06**	**2.69**	7.58	8.77	7.26	7.60	**14.78**	--	7.22	**4.24**	6.17	8.2	9.04	**10.15**	8.29	**4.50**	**11.96**	8.08	7.55
pH	pH	N/A	--	--	--	7.88	6.74	6.34	6.42	6.64	6.17	7.09	6.88	6.63	8.22	7.16	6.92	5.19	7.28	6.23	7.02	--	6.31	6.07	7.82	6.65	6.78	6.39	7.49	5.45	6.50	7.23	6.17
Specific Conductance	uS/cm	1	--	--	--	723	210	168	218	203	110	146	126	112	62	177.5	116.7	123.6	132.5	147.8	180.0	--	111	203	955	480	262	670	320	845.0	999.0	611.0	371.0
INORGANICS																															
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	13	16	12	13	21	9	9	15	12	21	14	11	8	20	11	35	--	10	12	14	14	14	6	22	7	30	21	<5
Dissolved Chloride (Cl)	mg/L	1	--	--	120	41	34	31	49	45	25	38	27	22	22	33	23	39	32	23	29	--	23	34	**224**	116	52	**190**	99	**258**	**243**	104	70
Colour	TCU	30	--	--	--	32	27	37	20	26	33	32	41	49	13	20	40	10	21	25	9	--	31	94	18	14	18	7	7	19	6	8	18
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.14	0.14	0.06	0.23	0.10	0.12	0.25	0.17	0.09	0.13	0.80	<0.05	0.18	0.20	<0.05	0.09	--	0.11	0.61	1.00	0.64	1.89	1.11	2.57	0.34	1.22	0.47	1.97
Nitrate (N)	mg/L	0.05	--	--	13000	0.14	--	--	0.23	0.10	--	0.25	--	--	0.13	0.80	<0.05	0.18	0.20	<0.05	0.09	--	0.11	--	1.00	0.64	1.89	1.11	2.57	0.34	1.22	0.47	1.97
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<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
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.06	0.03	<0.03	<0.03	<0.03	0.03	0.03	0.04	--	<0.03	0.06	0.04	0.16	<0.03	<0.03	0.04	0.04	0.05	<0.03	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	5.0	3.8	6.8	3.7	6.0	5.3	4.7	7.1	7.5	3.1	8.0	7.7	4.7	6.3	6.9	5.2	--	8.1	11.0	3.7	22.8	4.8	3.1	4.5	2.9	6.9	4.7	4.7
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	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
pH (units)	pH	N/A	--	5.0-9.0	6.5-9	6.69	6.69	6.93	7.10	7.30	6.67	6.72	6.79	6.49	6.2	6.9	6.9	6.94	6.95	**6.49**	**6.47**	--	6.72	**6.43**	6.7	7.2	7.2	6.92	7.11	**6.49**	**6.42**	7.42	**6.41**
Total Calcium (Ca)	mg/L	0.1	--	--	--	6.5	6.9	5.4	7.99	10.5	5.29	5.9	5.14	5.04	2.6	18.1	5.1	6.4	6.0	5.6	5.4	--	5.1	7.63	30.7	22.1	14.5	22.0	17.6	21.8	23.9	27.6	12.6
Total Magnesium (Mg)	mg/L	0.1	--	--	--	1.4	1.6	1.3	1.99	2.14	1.15	1.25	1.19	1.23	0.7	3.3	1.4	1.2	1.4	1.6	1.5	--	1.1	2.34	4.2	3.6	2.2	2.8	2.7	4.0	4.2	3.8	2.2
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	and 400	0.03	0.009	0.018	0.100	0.009	0.018	0.028	0.014	0.022	0.063	0.003	0.007	0.015	0.078	0.100	--	0.03	0.034	0.043	0.036	0.030	0.006	0.027	0.046	0.260	0.028	0.04
Total Potassium (K)	mg/L	0.1	--	--	--	1.2	1.1	1.3	1.180	1.210	1.030	1.070	0.960	1.240	0.6	1.9	1.3	1.2	1.1	1.4	1.1	--	1.1	2.110	3.2	3.6	2.5	2.6	2.8	2.9	3.1	3.7	3.0
Total Sodium (Na)	mg/L	0.1	--	--	--	24	21	18	24.8	26.9	15.2	23.2	14.3	13.8	11.3	18.6	15.2	21.9	26.6	14.6	23.4	--	18.1	22.7	124	62.2	32.3	95.1	51.7	170	147	88.1	62.7
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	3.1	4.2	4.0	3.2	3.4	4.3	2.6	3.9	3.8	3.1	2.9	4.9	2.6	3.9	5.0	2.9	--	4.2	6.9	4.9	0.7	6.3	5.1	8.6	7.0	2.1	2.5	6.9
Total Suspended Solids	mg/L	5	--	--	--	16	98	5	6	110	7	4	77	5	<5	16	19	<5	17	9	51	--	8	13	5	165	<5	<5	<5	<5	626	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	6	4	5	7	3	4	6	4	4	5	5	5	6	7	5	5	--	4	21	26	25	23	26	29	33	29	20	27
Turbidity (NTU)	NTU	0.1	--	50	--	0.6	12	2.5	12	6.2	1	0.6	2.5	1.7	6.7	**283**	2.1	1.1	31.6	**82.6**	6.6	--	1.4	3.3	4.1	23.0	2.3	1.8	1.6	0.7	42.7	10.1	1.6
Conductivity (uS/cm)	µS/cm	1	--	--	--	170	150	140	200	200	110	150	130	110	96	161	110	168	136	105	122	--	125	190	813	482	255	732	433	840	819	605	394
Calculated Parameters																															
Anion Sum	me/L	N/A	--	--	--	1.56	0.82	1.22	1.80	1.77	0.97	1.39	1.14	0.96	1.15	1.37	0.97	1.40	1.46	0.97	1.63	--	0.94	1.69	7.21	4.12	2.36	6.10	4.02	8.13	8.15	3.80	2.68
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	13	8	12	13	21	9	9	15	12	21	14	11	8	20	11	35	--	10	12	14	14	14	6	22	7	30	21	<5
Calculated TDS	mg/L	1	--	--	--	92	55	74	104	107	62	84	66	60	56	163	58	82	87	66	88	--	59	109	426	246	144	347	229	496	477	262	187
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	<10	<10	<10	<10	<10	<10	--	<10	<1	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	1.53	0.99	1.20	1.69	1.94	1.05	1.44	1.02	1.00	0.76	3.59	1.10	1.43	1.62	1.62	1.52	--	1.19	1.70	7.40	4.30	2.43	5.55	3.51	8.90	8.24	5.64	3.64
Hardness (CaCO3)	mg/L	1	--	--	--	22	15	19	28	35	18	20	18	18	9.4	58.8	18.5	20.9	20.7	20.6	19.7	--	17.3	29	94.0	70.0	45.3	66.5	55.1	70.9	77.0	84.6	40.5
Ion Balance (% Difference)	%	N/A	--	--	--	0.97	9.39	0.83	3.15	4.58	3.96	1.77	5.56	2.04	20.7	63.0	6.1	1.0	5.2	25.0	3.4	--	11.8	0.29	1.3	2.2	1.4	4.7	6.8	4.5	0.6	19.4	15.2
Langelier Index (@ 20C)	N/A	N/A	--	--	--	-2.74	-3.20	-2.60	-2.22	-1.71	-2.99	-2.88	-2.64	-3.05	-3.62	-2.30	-2.91	-2.93	-2.55	-3.29	-2.84	--	-3.14	-2.95	-2.32	-1.94	-2.10	-2.60	-1.93	-2.98	-2.38	-1.45	-3.41
Langelier Index (@ 4C)	N/A	N/A	--	--	--	-2.99	-3.45	-2.85	-2.47	-1.96	-3.24	-3.13	-2.89	-3.31	-3.94	-2.62	-3.23	-3.25	-2.87	-3.61	-3.16	--	-3.46	-3.20	-2.64	-2.26	-2.42	-2.92	-2.25	-3.30	-2.70	-1.77	-3.73
Saturation pH (@ 20C)	N/A	N/A	--	--	--	9.43	9.78	9.53	9.32	9.01	9.66	9.60	9.43	9.54	9.82	9.20	9.81	9.87	9.50	9.78	9.31	--	9.86	9.38	9.02	9.14	9.30	9.52	9.04	9.47	8.80	8.87	9.82
Saturation pH (@ 4C)	N/A	N/A	--	--	--	9.68	10.00	9.78	9.57	9.26	9.91	9.85	9.68	9.80	10.10	9.52	10.10	10.20	9.82	10.1	9.63	--	10.2	9.63	9.34	9.46	9.62	9.84	9.36	9.79	9.12	9.19	10.1
Metals (ICP-MS)																															
Total Aluminum (Al)	µg/L	5	5	--	5-100	99	--	--	349	189	--	217	--	--	490	**19200**	**186**	**131**	93	**3420**	**487**	--	141	--	218	**227**	**252**	**107**	**447**	31	**1400**	46	109
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	**8**	<2	<2	<2	<2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	14	--	--	15.3	19.2	--	13.9	--	--	11	86	12	12	7	24	15	--	11	--	225	201	116	133	134	119	185	157	80
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	2	<2	<2	<2	<2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	13	--	--	41.4	21.6	--	<50	--	--	6	24	16	10	15	15	14	--	16	--	11	17	22	10	22	18	22	20	21
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	0.018	<0.017	--	<0.017	--	--	0.029	**1.050**	**0.023**	<0.017	<0.017	**0.073**	**0.032**	--	<0.017	--	0.538	**0.171**	**0.168**	**0.300**	**0.236**	**0.148**	**0.171**	**0.031**	0.079
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	**11**	<1	<1	<1	**2**	<1	--	<1	--	<1	<1	<1	<1	1	<1	<1	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	<0.40	0.88	--	<0.40	--	--	<1	34	<1	<1	<1	1	<1	--	<1	--	<1	1	<1	<1	<1	<1	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	<2	--	--	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	**22**	2	<2	1	**12**	2	--	3	2.9	<2	3	16	2	**6**	2	2	<1	4
Total Iron (Fe)	µg/L	50	300	--	300	180	--	--	**554**	**965**	120	211	**388**	**384**	161	**38900**	**312**	236	254	**4200**	**593**	--	363	**2150**	**347**	**1320**	**500**	194	**890**	157	**2000**	207	229
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	--	--	3.02	0.54	--	<0.50	--	--	0.6	**82.4**	<0.5	<0.5	<0.5	5.2	0.5	--	<0.5	--	0.8	0.7	1.0	<0.5	1.4	<0.5	1.8	<0.5	<0.5
Total Manganese (Mn)	µg/L	2	820	--	--	51	--	--	113	632	22.8	30.2	53.4	38.5	26	13200	67	71	81	124	140	--	60	129	182	485	120	87	89	26	71	182	36
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	13	<2	<2	<2	2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	3	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	**2**	<1	<1	<1	<1	<1	--	<1	--	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	30	--	--	36.3	42.1	--	24.4	--	--	12	82	22	24	24	25	26	--	19	--	112	94	60	93	90	96	116	111	54
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	--	<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	--	--	<2.0	<2.0	--	<2.0	--	--	<2	<2	<2	<2	<2	<2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	<2	--	--	7.2	4.1	--	5.3	--	--	3	405	4	<2	2	36	6	--	3	--	4	3	7	3	11	2	22	<2	3
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	1.6	<0.1	<0.1	<0.1	0.1	<0.1	--	<0.1	--	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	30	<2	<2	<2	2	<2	--	<2	--	<2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	7	--	--	7.2	6.7	<5.0	<5.0	<5.0	5	<5	**110**	7	6	<5	15	<5	--	<5	9	**79**	**92**	**39**	**57**	**49**	26	17	8	23
MICROBIOLOGICAL																															
Total Coliform	MPN/100mL	1	--	--	--	53	>250	--	>250	>250	280	85	>250	--	1414	>2420	>2420	1990	>2420	>2420	1203	--	8	--	>2420	>2420	2420	866	>2420	866	>2420	961	>2420
E. coli	MPN/100mL	1	--	400	--	22	24	--	4	45	6	10	**>250**	<100	2	26	10	10	20	2	<1	--	>2420	<100	<1	2	19	3	86	<1	<1	7	**1730**
Fecal Coliform	MPN/ml	--	--	400	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	1.46	10.70	4.68	1.21	6.64	0.21	1.19	1.93	1.41	1.88	6.62	0.13	<0.50	1.6	2.02	1.91	--	0.32	1.99	2.44	32.52	1.80	1.54	2.30	0.12	99.13	2.54	0.96
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	1.85	11.10	5.62	1.32	7.71	0.19	1.07	1.73	1.18	2.28	7.58	0.22	<0.50	2	2.98	1.91	--	0.33	2.08	2.71	31.31	2.15	1.77	2.50	0.11	98.00	2.51	0.96
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	0.5	3.5	0.5	--	0.7	3.0	1.0	--	<0.4	--	0.4	4.2	0.7	--	0.5	<0.4	1.2	1.7	<0.4

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)

" -- " = no guideline available / Not Tested.

CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)

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Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September, 2009)

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Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.

Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

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TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Paper Mill Lake																
Sample Sites						PML1																
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/15	2012/10/11	2013/05/15	2013/08/15	2013/10/16	2014/05/15	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				13:45	13:00	13:00	13:35	15:15	13:00	13:00	16:50	17:00	12:50	--	10:55	10:51	11:35	10:45	10:30	14:45	12:35
FIELD DATA																						
Secchi Depth	Meters	--	--	1.2	--	3.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Water Temp	Celsius	0.1	--	--	--	15.7	17.1	16.2	13.2	22.7	9.1	10.3	22.1	13.6	8.3	--	14.9	11.6	22.5	12.3	12.1	23.6	12.4
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.56**	8.10	6.90	8.76	7.83	**10.43**	**10.39**	8.17	**9.54**	8.41	--	8.60	**9.98**	7.65	**9.90**	**12.08**	7.49	8.06
pH	pH	N/A	--	--	--	7.39	6.57	6.64	7.06	7.35	5.89	6.28	6.20	6.11	7.58	--	6.63	6.39	7.20	6.32	6.60	7.42	6.60
Specific Conductance	uS/cm	1	--	--	--	561	279	223	265	234	125	177	174	106	366	--	186.4	215.1	199.0	250.5	431.0	263.0	210.0
INORGANICS																						
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	6	7	7	7	9	5	6	7	7	20	--	<5	<5	6	7	31	7	7
Dissolved Chloride (Cl)	mg/L	1	--	--	120	39	64	58	67	61	24	44	43	18	55	--	45	57	57	48	63	50	46
Colour	TCU	30	--	--	--	54	15	21	19	12	57	32	38	65	38	--	29	8	15	11	17	10	30
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.49	0.10	0.17	0.42	0.27	0.66	0.55	0.15	0.62	0.22	--	0.14	0.21	0.18	0.18	0.22	0.24	0.18
Nitrate (N)	mg/L	0.05	--	--	13000	0.49	--	--	0.42	0.27	--	0.55	--	--	0.22	--	0.14	0.21	0.18	0.18	0.22	0.24	0.18
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<0.05	--	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	0.06	--	<0.03	<0.03	0.04	<0.03	0.04	<0.03	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	6.5	3.6	4.7	0.7	3.3	6.7	4.6	5	8.3	5.7	--	5.3	4.2	4.1	5.1	4.0	2.0	4.4
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 (units)	pH	N/A	--	5.0-9.0	6.5-9	**6.36**	6.75	6.79	6.63	7.04	6.58	6.54	6.83	6.67	6.6	--	6.8	6.71	6.92	6.88	6.66	7.00	6.64
Total Calcium (Ca)	mg/L	0.1	--	--	--	4.5	6.9	6.4	8.37	9.02	5.90	6.02	4.99	4.64	6.0	--	6.0	6.8	6.6	6.9	6.9	9.1	7.0
Total Magnesium (Mg)	mg/L	0.1	--	--	--	0.6	1.1	1.0	1.25	1.22	0.82	0.98	0.89	0.85	1.0	--	1.1	1.0	0.9	1.5	1.3	1.4	1.0
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	<0.02	<0.02	0.002	0.018	0.002	<0.002	0.014	0.011	0.030	0.019	--	0.03	0.006	0.007	0.047	0.012	0.030	0.02
Total Potassium (K)	mg/L	0.1	--	--	--	0.9	0.9	0.9	1.160	1.060	1.340	1.230	0.771	1.430	0.8	--	1.0	0.8	1.0	1.5	0.9	1.3	0.9
Total Sodium (Na)	mg/L	0.1	--	--	--	25	38	34	35.2	40.2	18.4	26.8	22.8	13.7	33.6	--	29.8	35.3	28.5	32.2	38.1	41.6	33.7
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	4.5	2.6	2.8	3.8	3.4	5.9	3.7	2.6	5.4	2.9	--	3.2	2.8	2.6	2.6	2.5	2.3	2.7
Total Suspended Solids	mg/L	5	--	--	--	<2	3	9	7	<2	<1	1	<2	5	9	--	6	<5	<5	23	6	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	13	11	11	13	12	12	12	10	12	7	--	10	8	10	10	10	8	8
Turbidity (NTU)	NTU	0.1	--	50	--	0.4	0.5	0.6	8.2	0.9	0.5	0.6	1	1.2	0.7	--	1	0.7	1.1	19.2	1.4	0.9	1.5
Conductivity (uS/cm)	µS/cm	1	--	--	--	170	250	230	260	250	130	180	170	100	214	--	179	227	218	209	230	261	224
Calculated Parameters																						
Anion Sum	me/L	N/A	--	--	--	1.51	2.18	1.99	2.34	2.15	1.09	1.62	1.56	0.92	2.11	--	1.49	1.79	1.95	1.71	2.62	1.73	1.62
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	6	7	7	7	9	5	6	7	7	20	--	<5	<5	6	7	31	7	7
Calculated TDS	mg/L	1	--	--	--	93	129	118	137	134	75	100	90	63	117	--	95	110	109	115	140	117	102
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	--	<10	<10	<10	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	1.40	2.11	1.89	2.11	2.33	1.20	1.58	1.35	0.95	1.89	--	1.78	2.00	1.69	2.56	2.18	2.45	1.94
Hardness (CaCO3)	mg/L	1	--	--	--	14	22	20	26	28	18	19	16	15	19.1	--	19.5	21.1	20.2	23.4	22.6	28.5	21.6
Ion Balance (% Difference)	%	N/A	--	--	--	3.78	1.63	2.58	5.17	4.02	4.80	1.25	7.22	1.60	5.5	--	9.0	5.5	7.0	19.8	9.2	17.0	9.2
Langelier Index (@ 20C)	N/A	N/A	--	--	--	-3.57	-2.90	-2.94	-2.96	-2.43	-3.25	-3.27	-2.94	-3.13	-2.91	--	-3.31	-3.35	-3.07	-3.03	-2.61	-2.79	-3.26
Langelier Index (@ 4C)	N/A	N/A	--	--	--	-3.82	-3.15	-3.19	-3.21	-2.68	-3.50	-3.53	-3.19	-3.38	-3.23	--	-3.63	-3.67	-3.39	-3.35	-2.93	-3.11	-3.58
Saturation pH (@ 20C)	N/A	N/A	--	--	--	9.93	9.65	9.73	9.59	9.47	9.83	9.81	9.77	9.80	9.51	--	10.10	10.1	9.99	9.91	9.27	9.79	9.90
Saturation pH (@ 4C)	N/A	N/A	--	--	--	10.20	9.90	9.98	9.84	9.72	10.10	10.10	10.00	10.10	9.83	--	10.40	10.4	10.3	10.2	9.59	10.1	10.2
Metals (ICP-MS)																						
Total Aluminum (Al)	µg/L	5	5	--	5-100	**260**	--	--	**665**	45.9	--	**233**	--	--	**177**	--	**306**	**141**	**103**	**3920**	**305**	**129**	142
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	--	<2	<2	<2	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	--	<2	<2	<2	2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	23	--	--	35.3	24.4	--	26.6	--	--	22	--	19	20	12	40	23	23	18
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	--	<2	<2	<2	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	<2	<2	<2	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	8	--	--	11.3	8.6	--	<50	--	--	6	--	9	6	8	9	8	13	11
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	**0.032**	<0.017	--	<0.017	--	--	<0.017	--	**0.066**	**0.021**	**0.018**	**0.430**	<0.017	**0.020**	<0.017
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	--	<1	<1	<1	**3**	<1	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	0.96	<0.40	--	<0.40	--	--	<1	--	2	<1	<1	9	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	<2	--	--	2.0	<2.0	<2.0	4.0	<2.0	2.3	<2	--	<2	<2	1	**6**	1	<1	2
Total Iron (Fe)	µg/L	50	300	--	300	140	--	--	**837**	89	161	141	**315**	**528**	137	--	**742**	130	205	**5300**	239	296	182
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	--	--	1.73	<0.50	--	<0.50	--	--	<0.5	--	0.9	<0.5	<0.5	**13.5**	0.9	<0.5	<0.5
Total Manganese (Mn)	µg/L	2	820	--	--	17	--	--	142	68.9	41.3	14.4	128	62.4	48	--	214	33	58	693	54	260	49
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	<2	<2	<2	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	2	<2	<2	9	<2	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	--	<1	<1	<1	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	18	--	--	36.3	37.1	--	25	--	--	26	--	30	31	25	34	35	37	30
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Tin (Sn)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	<2	<2	<2	<2	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	<2	--	--	7.8	<2.0	--	3.9	--	--	<2	--	4	<2	<2	65	4	<2	3
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	0.1	--	<0.1	<0.1	<0.1	0.6	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	<2	<2	<2	10	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	8	--	--	10.0	5.4	5.7	6.3	6.2	5.4	<5	--	13	8	<5	**62**	<5	<5	6
MICROBIOLOGICAL																						
Total Coliform	MPN/100mL	1	--	--	--	200	73	--	>250	>250	>250	85	>250	--	411	--	2420	866	1730	1011	613	2420	>2420
E. coli	MPN/100mL	1	--	400	--	33	45	--	19	**>250**	2	2	34	<100	2	--	20	12	4	6	6	10	10
Fecal Coliform	MPN/ml	--	--	400	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	0.62	2.31	0.57	0.82	1.12	0.07	2.85	0.86	0.15	1.03	--	0.69	1.17	1.10	5.07	0.67	0.64	0.91
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	0.64	2.21	0.64	0.74	1.04	0.06	2.75	0.76	0.15	1.10	--	0.91	1.37	1.10	6.39	0.65	0.65	0.87
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	<0.4	--	0.4	--	0.4	0.8	0.4	0.4	<5

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
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TABLE 1: BEDFORD WEST SAMPLING PROGRAM

October 2014	Units	RDL	NSE ESQs for Surface Water (Reference)	Health Canada Guideline for Recreational Water Quality (Reference)	CCME Guideline FWAL (Applied)	Paper Mill Lake																	
Sample Sites						PML2																	
Sampling Date	yyyy-mm-dd	--				2009/06/29	2009/08/13	2009/10/01	2010/05/31	2010/08/24	2010/11/01	2011/05/13	2011/08/14	2011/10/16	2012/05/01	2012/08/15	2012/10/11	2013/05/15	2013/08/15	2013/10/16	2014/05/15	2014/08/14	2014/10/27
Sampling Time	hh:mm	--				13:15	13:40	13:45	14:30	16:20	13:00	12:40	16:20	16:15	13:16	--	--	13:40	10:45	11:20	11:00	9:20	8:30
FIELD DATA																							
Secchi Depth	Meters	--	--	1.2	--	2.8	2.2	2.3	N/A	3.0	2.0	2.2	2.3	2.2	2.35	--	--	3.20	--	N/A	N/A	N/A	3.1
Water Temp	Celsius	0.1	--	--	--	14.8	24.2	19.7	17.8	25.3	10.1	10.9	23.1	15.2	11.6	--	--	14.8	--	12.6	14.4	21.1	12.1
Dissolved Oxygen	mg/L	0.01	--	--	5.5-9.5	**10.20**	8.30	8.40	8.78	8.09	**10.58**	**9.88**	8.7	8.94	7.75	--	--	9.26	--	8.90	**12.44**	6.95	7.92
pH	pH	N/A	--	--	--	6.36	6.82	6.84	7.09	7.39	6.53	6.31	6.67	6.13	8.61	--	--	6.49	--	6.13	6.50	7.22	5.92
Specific Conductance	uS/cm	1	--	--	--	267	264	241	237	234	201	159	173	156	231	--	--	234	--	250.5	966.0	266.0	215.0
INORGANICS																							
Total Alkalinity (as CaCO3)	mg/L	5	--	--	--	5	7	7	6	8	7	<5	8	7	21	--	--	<5	--	8	32	10	26
Dissolved Chloride (Cl)	mg/L	1	--	--	120	63	63	58	62	58	50	44	43	34	55	--	--	63	--	64	**245**	50	42
Colour	TCU	30	--	--	--	22	17	19	20	13	23	35	38	48	39	--	--	18	--	8	6	7	31
Nitrite + Nitrate	mg/L	0.05	--	--	--	0.14	0.07	0.09	0.19	0.11	0.23	0.33	0.14	0.22	0.24	--	--	0.22	--	<0.05	0.13	0.18	0.18
Nitrate (N)	mg/L	0.05	--	--	13000	0.14	--	--	0.19	0.11	--	0.33	--	--	0.24	--	--	0.22	--	<0.05	0.13	0.18	0.18
Nitrite (N)	mg/L	0.05	--	--	60	<0.01	--	--	<0.01	<0.01	--	<0.01	--	--	<0.05	--	--	<0.05	--	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	--	--	19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.03	--	--	0.03	--	0.23	0.05	0.03	<0.03
Total Organic Carbon	mg/L	0.5	--	--	--	3.6	2.6	4.5	3.2	3.4	3.6	4	6	5.6	5.9	--	--	4.4	--	4.0	2.7	2.4	5.8
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
pH (units)	pH	N/A	--	5.0-9.0	6.5-9	6.50	6.81	6.82	6.66	7.02	6.83	**6.37**	6.60	6.60	6.6	--	--	6.68	--	6.73	7.13	7.04	6.77
Total Calcium (Ca)	mg/L	0.1	--	--	--	6.1	7.1	6.1	7.17	7.69	7.96	5.30	4.76	5.04	6.1	--	--	6.7	--	7.7	19.2	8.8	6.9
Total Magnesium (Mg)	mg/L	0.1	--	--	--	1.1	1.1	1.1	1.25	1.17	1.20	0.93	0.86	0.90	1.0	--	--	1.0	--	1.4	1.7	1.4	1.0
Total Phosphorus (1M depth)	mg/L	0.006	--	--	--	<0.02	<0.02	0.002	0.010	0.002	<0.002	0.009	0.009	0.007	0.025	--	--	0.006	--	0.026	0.011	0.026	0.02
Total Potassium (K)	mg/L	0.1	--	--	--	0.9	1.0	0.9	0.984	0.900	1.020	0.861	0.801	0.968	0.8	--	--	0.8	--	1.3	1.4	1.2	1.1
Total Sodium (Na)	mg/L	0.1	--	--	--	35	40	34	31.1	35.1	30.8	25.7	21.3	20.9	34.6	--	--	37.5	--	42.0	133	42.6	33.9
Reactive Silica (SiO2)	mg/L	0.5	--	--	--	2.6	2.5	2.3	2.6	2.3	3.3	2.9	2.5	3	2.8	--	--	2.7	--	4.2	2.4	2.3	2.9
Total Suspended Solids	mg/L	5	--	--	--	2	3	<1	15	<2	11	<1	8	<1	<5	--	--	<5	--	<5	16	<5	<5
Dissolved Sulphate (SO4)	mg/L	2	--	--	--	11	11	11	10	10	10	9	10	9	7	--	--	9	--	11	27	7	7
Turbidity (NTU)	NTU	0.1	--	50	--	0.8	0.7	0.6	1.0	0.8	0.4	0.4	3.4	0.5	0.7	--	--	1	--	3.3	2.6	0.7	1
Conductivity (uS/cm)	µS/cm	1	--	--	--	240	250	230	230	230	210	170	170	150	213	--	--	254	--	277	777	273	212
Calculated Parameters																							
Anion Sum	me/L	N/A	--	--	--	2.11	2.17	1.99	2.07	2.01	1.77	1.46	1.58	1.30	2.13	--	--	1.98	--	2.19	8.12	1.77	1.86
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	5	--	--	--	5	7	7	6	8	7	<1	8	7	21	--	--	<5	--	8	32	10	26
Calculated TDS	mg/L	1	--	--	--	123	131	117	120	120	110	91	89	79	119	--	--	119	--	137	448	118	109
Carb. Alkalinity (calc. as CaCO3)	mg/L	10	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<10	--	--	<10	--	<10	<10	<10	<10
Cation Sum	me/L	N/A	--	--	--	1.94	2.23	1.88	1.88	2.03	1.86	1.48	1.28	1.27	1.94	--	--	2.09	--	2.55	6.96	2.47	1.95
Hardness (CaCO3)	mg/L	1	--	--	--	20	22	20	23	24	25	17	15	16	19.3	--	--	20.8	--	25.0	54.9	27.7	21.3
Ion Balance (% Difference)	%	N/A	--	--	--	4.20	1.36	2.84	4.81	0.50	2.48	0.68	10.50	1.17	4.8	--	--	2.8	--	7.5	7.7	16.5	2.2
Langelier Index (@ 20C)	N/A	N/A	--	--	--	-3.33	-2.83	-2.93	-3.06	-2.55	-2.80	NC	-3.18	-3.17	-2.89	--	--	-3.39	--	-3.08	-1.73	-2.61	-2.57
Langelier Index (@ 4C)	N/A	N/A	--	--	--	-3.59	-3.08	-3.18	-3.31	-2.80	-3.05	NC	-3.43	-3.42	-3.21	--	--	-3.71	--	-3.40	-2.05	-2.93	-2.89
Saturation pH (@ 20C)	N/A	N/A	--	--	--	9.83	9.64	9.75	9.72	9.57	9.63	NC	9.78	9.77	9.49	--	--	10.1	--	9.81	8.86	9.65	9.34
Saturation pH (@ 4C)	N/A	N/A	--	--	--	10.10	9.89	10.00	9.97	9.82	9.88	NC	10.00	10.00	9.81	--	--	10.4	--	10.1	9.18	9.97	9.66
Metals (ICP-MS)																							
Total Aluminum (Al)	µg/L	5	5	--	5-100	**130**	--	--	**1030**	55.8	--	**202**	--	--	**189**	--	--	**131**	--	**107**	**181**	52	**122**
Total Antimony (Sb)	µg/L	2	20	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	--	--	<2	--	<2	<2	<2	<2
Total Arsenic (As)	µg/L	2	5.0	--	5	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	--	--	<2	--	<2	<2	<2	<2
Total Barium (Ba)	µg/L	5	1000	--	--	16	--	--	23.0	12.2	--	23	--	--	22	--	--	22	--	37	50	27	19
Total Beryllium (Be)	µg/L	2	5.3	--	--	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<2	--	--	<2	--	<2	<2	<2	<2
Total Bismuth (Bi)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	--	<2	--	<2	<2	<2	<2
Total Boron (B)	µg/L	5	1200	--	1500	5	--	--	8.2	8.8	--	<50	--	--	6	--	--	6	--	9	7	13	11
Total Cadmium (Cd)	µg/L	0.017	0.01	--	0.017	<0.3	--	--	**0.037**	<0.017	--	**0.028**	--	--	**0.023**	--	--	**0.039**	--	**0.060**	**0.062**	**0.019**	**0.018**
Total Chromium (Cr)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	--	--	<1	--	<1	<1	<1	<1
Total Cobalt (Co)	µg/L	1	10	--	--	<1	--	--	0.65	<0.40	--	<0.40	--	--	<1	--	--	<1	--	2	<1	<1	<1
Total Copper (Cu)	µg/L	1	2	--	2.0-4.0	<2	--	--	3.3	<2.0	<2.0	<2.0	<2.0	<2.0	<2	--	--	<2	--	**1380**	1	<1	2
Total Iron (Fe)	µg/L	50	300	--	300	100	--	--	**1090**	151	76	143	**699**	181	178	--	--	181	--	**1760**	264	**316**	134
Total Lead (Pb)	µg/L	0.5	1	--	1.0-7.0	<0.5	--	--	2.39	<0.50	--	<0.50	--	--	<0.5	--	--	<0.5	--	**49.7**	0.7	<0.5	<0.5
Total Manganese (Mn)	µg/L	2	820	--	--	58	--	--	159	81.0	28.0	33.8	88.6	30.6	22	--	--	87	--	866	206	278	24
Total Molybdenum (Mo)	µg/L	2	73	--	73	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	--	<2	--	<2	<2	<2	<2
Total Nickel (Ni)	µg/L	2	25	--	25-150	2	--	--	2.2	<2.0	--	<2.0	--	--	<2	--	--	<2	--	3	<2	<2	<2
Total Selenium (Se)	µg/L	1	1.0	--	1	<2	--	--	<1.0	<1.0	--	<1.0	--	--	<1	--	--	<1	--	<1	<1	<1	<1
Total Silver (Ag)	µg/L	0.1	0.1	--	0.1	<0.5	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	--	--	<0.1	--	0.1	<0.1	<0.1	<0.1
Total Strontium (Sr)	µg/L	5	21000	--	--	30	--	--	34.7	32.8	--	25.7	--	--	27	--	--	31	--	35	68	37	29
Total Thallium (Tl)	µg/L	0.1	0.8	--	0.8	<0.1	--	--	<0.10	<0.10	--	<0.10	--	--	<0.1	--	--	<0.1	--	<0.1	<0.1	<0.1	<0.1
Total Tin (Sn)	µg/L	2	--	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	--	<2	--	3	<2	<2	<2
Total Titanium (Ti)	µg/L	2	--	--	--	<2	--	--	21.3	<2.0	--	3.6	--	--	<2	--	--	<2	--	2	3	<2	<2
Total Uranium (U)	µg/L	0.1	300	--	15	<0.1	--	--	0.10	<0.10	--	<0.10	--	--	0.1	--	--	<0.1	--	<0.1	<0.1	<0.1	<0.1
Total Vanadium (V)	µg/L	2	6	--	--	<2	--	--	<2.0	<2.0	--	<2.0	--	--	<2	--	--	<2	--	<2	<2	<2	<2
Total Zinc (Zn)	µg/L	5	30	--	30	12	--	--	18.3	<5.0	5.8	6.6	7.5	10	8	--	--	11	--	**762**	<5	<5	5
MICROBIOLOGICAL																							
Total Coliform	MPN/100mL	1	--	--	--	49	40	--	>250	46	97	64	>250	--	261	--	--	1410	--	411	291	517	>2420
E. coli	MPN/100mL	1	--	400	--	10	31	--	69	<1	6	17	**>250**	<100	1	--	--	12	--	2	<1	3	16
Fecal Coliform	MPN/ml	--	--	400	--	--	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chlorophyll A - Acidification method	µg/L	0.05	--	--	--	1.15	1.36	0.59	3.50	1.54	0.53	0.55	2.48	1.33	0.76	--	--	1.18	--	0.25	0.99	0.48	0.72
Chlorophyll A - Welschmeyer method	µg/L	0.05	--	--	--	1.22	1.33	0.66	3.39	1.51	0.42	0.51	2.26	1.13	0.76	--	--	1.34	--	0.27	1.13	0.44	0.7
Total Kjeldahl Nitrogen as N	mg/L	0.4	--	--	--	--	--	--	--	--	--	--	--	--	<0.4	--	--	--	--	1.7	<0.4	0.4	<5

Notes:

RDL = Recordable Detection Limit (represents most recent sampling event RDL)
" -- " = no guideline available / Not Tested.
CCME FWAL = Canadian Council of Ministers of the Environment Freshwater Aquatic Life Guideline for the protection of the environment and ecological receptors (last updated 2011)
CCME FWAL Guidelines for Aluminum, Lead, Copper and Nickel vary based on reported pH and water hardness (CCME FWAL calculation equations). The largest guideline value for each respective element range was always used.
Health Canada Guideline for Recreational Water Quality = Health Canada Guidelines for Canadian Recreational Water Quality - Draft (September, 2009)
NSE ESQs for Surface Water = Nova Scotia Environment Environmental Quality Standards for Surface Water (July 2013)
Bold = Parameter concentration exceeds CCME FWAL Guideline - Present Result.
Bold = Parameter concentration exceeds CCME FWAL Guideline - Previous Result.

SNC·LAVALIN

ATTACHMENT 1
Field Reports

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5	
Client:	Halifax Regional Municipality		
Site: Kearney Lake		**Site ID: KL1**	
Watercourse: Kearney Lake		**Location:** Kearney Lake Road	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:			
GPS Coordinates:	20T 0445718E, 4948496N (UTM, NAD83)		
SNC Field Personnel:	Ghislain Pitre		

Site Conditions

Weather:	Cloudy
Air Temperature:	10°C
Cloud Cover:	Yes
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Off Kearney Lake Road

Field Parameter Data

	Remarks
Date (d.m.y):	**27/10/2014**
Time (hh:mm):	14:55
Sample Depth (m):	1.0
pH:	6.44
Dissolved Oxygen (mg/L):	8.12
Secchi Depth (m):	2.54 **(Date: 28/10/2014)**
Water Temperature (degrees Celsius):	12.24
Conductivity (µs/cm):	223

Additional Comments / Notes

Field parameters data and water samples were collected from this location on Oct 27th, 2014. Due to cloudy weather, secchi disk measurement was collected at this sample location on Oct 28th, 2014.

A potential concern was observed; however it was concluded that probable someone dumped the death fish at this location. Based on the number of fish observed (approx.28) by SNC field personnel, it was concluded that a simple dumping of death fish was the most likely cause of this issue. As the likelihood of potential water quality sample contamination from these fish was considered low, the monitoring event proceeded as planned. The observation and associated photograph are included in the report.

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake	**Site ID: KL2**	
Watercourse: Kearney Lake	**Location:** Kearney Lake Road	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0443942E, 4949803N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Cloudy
Air Temperature:	9
Cloud Cover:	Yes
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Via Lake Dr. off Hammonds Plains Rd

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	14:04
Sample Depth (m):	1.0
pH:	5.79
Dissolved Oxygen (mg/L):	7.70
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	10.77
Conductivity (µs/cm):	63

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake Run	**Site ID: KL3**	
Watercourse: Kearney Lake Run	**Location:** Kearney Lake Road	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0444390E, 4950406N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Cloudy
Air Temperature:	10°C
Cloud Cover:	Yes
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Walking through the woods off Kearney Lake Road

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	14:25
Sample Depth (m):	0.5
pH:	6.67
Dissolved Oxygen (mg/L):	8.12
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	12.83
Conductivity (µs/cm):	208

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Kearney Lake Run	**Site ID: KL4**	
Watercourse: Kearney Lake Run	**Location:** Kearney Lake Road	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0444463E, 4950571N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Cloudy
Air Temperature:	10°C
Cloud Cover:	Yes
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Via walking path off Kearney Lake Road

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	14:35
Sample Depth (m):	0.5
pH:	6.55
Dissolved Oxygen (mg/L):	7.52
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	12.52
Conductivity (µs/cm):	208

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 9
Client:	Halifax Regional Municipality	
Site: Kearney Lake	**Site ID: KL5**	
Watercourse: Kearney Lake	**Location:** Kearney Lake Road	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 4949142E, 445280N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Sunny
Air Temperature:	11°C
Cloud Cover:	Partially
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Along Kearney Lake Road

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	10:45
Sample Depth (m):	1.0
pH:	6.60
Dissolved Oxygen (mg/L):	7.91
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	12.84
Conductivity (µs/cm):	211

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Highway 102	**Site ID: HWY 102-1**	
Watercourse: Marsh area	**Location:** Highway 102, south of exit 3	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0444708E, 4951644N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Sunny
Air Temperature:	9°C
Cloud Cover:	No
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Off Highway 102

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	9:30
Sample Depth (m):	1.0
pH:	5.11
Dissolved Oxygen (mg/L):	4.54
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	10.20
Conductivity (µs/cm):	109

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Highway 102	**Site ID: HWY 102-2**	
Watercourse: Marsh area	**Location:** HWY 102, south of exit 3	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0444829E, 4951778N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Sunny
Air Temperature:	11°C
Cloud Cover:	No
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Off Highway 102

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	10:07
Sample Depth (m):	0.5
pH:	5.85
Dissolved Oxygen (mg/L):	9.25
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	10.35
Conductivity (µs/cm):	174

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Lake Shore Drive	**Site ID: LSD**	
Watercourse: Marsh @ Lakeshore Dr.	**Location:** Kingswood Subdivision	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0442583E, 4950431N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Sunny
Air Temperature:	10°C
Cloud Cover:	Partially
Wildlife Sightings:	Yes (Deer)
Site Accessibility: Yes, Accessible	Via Lakeshore Drive in Kingswood Subdivision

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	13:30
Sample Depth (m):	0.5
pH:	6.31
Dissolved Oxygen (mg/L):	7.22
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	10.48
Conductivity (µs/cm):	111

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 9
Client:	Halifax Regional Municipality	
Site: Larry Uteck Blvd.	**Site ID: LU**	
Watercourse: Pond	**Location:** Larry Uteck off-ramp	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 4949816E, 445042N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Sunny
Air Temperature:	12°C
Cloud Cover:	No
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	From Larry Uteck Blvd. off-ramp, Halifax-bound

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	9:54
Sample Depth (m):	1.0
pH:	6.17
Dissolved Oxygen (mg/L):	7.55
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	10.18
Conductivity (µs/cm):	371

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Paper Mill Lake	**Site ID: PML1**	
Watercourse: Paper Mill Lake	**Location:** Moirs Mill Subdivision	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0445129E, 4951154N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Sunny
Air Temperature:	11°C
Cloud Cover:	Yes (some)
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Via French Mast Lane in Moirs Mill Subdivision

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	12:35
Sample Depth (m):	1.0
pH:	6.60
Dissolved Oxygen (mg/L):	8.06
Secchi Depth (m):	N/A
Water Temperature (degrees Celsius):	12.37
Conductivity (µs/cm):	210

Additional Comments / Notes

FIELD REPORT – OCTOBER 2014

Project:	Water Quality Monitoring - Bedford West	**Sub-Area(s):** 2, 3, 4, 5
Client:	Halifax Regional Municipality	
Site: Paper Mill Lake	**Site ID: PML2**	
Watercourse: Paper Mill Lake	**Location:** Moirs Mill Subdivision	
Monitoring Well ☐Pumping Well ☒ Surface Water ☐Spring/Seep ☐Discharge Pipe ☐Other:		
GPS Coordinates:	20T 0445363E, 4951740N (UTM, NAD83)	
SNC Field Personnel:	Ghislain Pitre	

Site Conditions

Weather:	Overcast
Air Temperature:	8°C
Cloud Cover:	Yes
Wildlife Sightings:	No
Site Accessibility: Yes, Accessible	Via Lake Dr., off Hammonds Plains Rd.

Field Parameter Data

	Remarks
Date (d.m.y):	27/10/2014
Time (hh:mm):	8:30
Sample Depth (m):	1
pH:	5.92
Dissolved Oxygen (mg/L):	7.92
Secchi Depth (m):	3.08
Water Temperature (degrees Celsius):	12.10
Conductivity (µs/cm):	215

Additional Comments / Notes

ATTACHMENT 2

Site Photographs

Photo 1a: KL1, Kearney Lake sample location

Photo 1b: KL1, Kearney Lake (potential concern)

Photo 2: KL2, Kearney Lake sample location

Photo 3: KL3, Kearney Lake sample location

Photo 4: KL4, Kearney Lake sample location

Photo 5: KL5, Kearney Lake sample location.

Photo 6: HWY102-1 sample location

Photo 7: HWY102-2 sample location

Photo 8: LSD, Lake Shore Drive sample location.

Photo 9: LU, Larry Uteck off-ramp sample location

Photo 10: PML1, Paper Mill Lake sample location

Photo 11: PML2, Paper Mill Lake sample location

ATTACHMENT 3

Laboratory Certificates of Analysis

AGAT Laboratories

11 Morris Drive, Unit 122
Dartmouth, Nova Scotia
CANADA B3B 1M2
TEL (902)468-8718
FAX (902)468-8924
http://www.agatlabs.com

CLIENT NAME: SNC-LAVALIN
5657 SPRING GARDEN RD, SUITE 200
HALIFAX , NS B3J3R4
(902) 492-4544

ATTENTION TO: Christa Rafuse

PROJECT: 510192-0001 Bedford West

AGAT WORK ORDER: 14X907730

MICROBIOLOGY ANALYSIS REVIEWED BY: Laura Baker, Inorganics Data Reporter

WATER ANALYSIS REVIEWED BY: Jason Coughtrey, Inorganics Supervisor

DATE REPORTED: Nov 06, 2014

PAGES (INCLUDING COVER): 13

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (902) 468-8718

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

Total Coliforms and E.coli (MPN)

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

		SAMPLE DESCRIPTION:		KL-1	KL-2	KL-3	KL-4	KL-5	LSD	HWY-102-1	HWY-102-2
		SAMPLE TYPE:		Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:		10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999298	5999327	5999348	5999355	5999365	5999375	5999388	5999398
E. Coli (MPN)	MPN/100 mL		1	28	11	13	8	17	8	3	<1
Total Coliforms (MPN)	MPN/100 mL		1	>2420	>2420	>2420	>2420	>2420	>2420	>2420	>2420

		SAMPLE DESCRIPTION:		PML-1	PML-2	LU
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999415	5999422	5999430
E. Coli (MPN)	MPN/100 mL		1	10	16	1730
Total Coliforms (MPN)	MPN/100 mL		1	>2420	>2420	>2420

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Original Signed

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Metals (Total)

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

SAMPLE DESCRIPTION:				KL-1	KL-2	KL-3	KL-4	KL-5	LSD	HWY-102-1	HWY-102-2
SAMPLE TYPE:				Water	Water	Water	Water	Water	Water	Water	Water
DATE SAMPLED:				10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999298	5999327	5999348	5999355	5999365	5999375	5999388	5999398
pH				6.35	6.06	6.59	6.85	6.63	6.72	5.90	6.40
Reactive Silica as SiO2	mg/L		0.5	1.8	4.6	2.4	2.5	2.5	4.2	4.7	5.9
Chloride	mg/L		1	46	12	45	48	47	23	19	34
Fluoride	mg/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulphate	mg/L		2	7	3	7	8	8	4	6	8
Alkalinity	mg/L		5	<5	28	6	29	<5	10	30	8
True Color	TCU		5	23	168	20	28	22	31	93	85
Turbidity	NTU		0.1	1.9	1.2	0.9	0.8	0.8	1.4	0.9	1.1
Electrical Conductivity	umho/cm		1	235	66	216	218	225	125	112	194
Nitrate + Nitrite as N	mg/L		0.05	0.08	<0.05	0.13	0.16	0.16	0.11	0.53	0.12
Nitrate as N	mg/L		0.05	0.08	<0.05	0.13	0.16	0.16	0.11	0.53	0.12
Nitrite as N	mg/L		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03	<0.03	<0.03	<0.03	0.06	<0.03	0.03	<0.03
Total Organic Carbon	mg/L		0.5	4.4	12.9	4.5	4.4	4.5	8.1	9.0	8.0
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	37.6	7.6	35.3	34.1	38.3	18.1	18.6	24.0
Total Potassium	mg/L		0.1	0.7	0.7	0.9	0.9	0.9	1.1	0.7	1.7
Total Calcium	mg/L		0.1	6.0	2.4	6.8	6.8	7.0	5.1	2.2	9.5
Total Magnesium	mg/L		0.1	0.9	0.6	1.0	1.0	1.0	1.1	0.6	1.8
Total Phosphorous	mg/L		0.02	0.02	0.02	0.02	<0.02	0.02	0.03	0.03	0.03
Bicarb. Alkalinity (as CaCO3)	mg/L		5	<5	28	6	29	<5	10	30	8
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10	<10	<10	<10	<10	<10	<10
Hydroxide	mg/L		5	<5	<5	<5	<5	<5	<5	<5	<5
Calculated TDS	mg/L		1	99	44	100	117	103	59	68	85
Hardness	mg/L			18.7	8.5	21.1	21.1	21.6	17.3	8.0	31.1
Langelier Index (@20C)	NA			-3.76	-3.66	-3.39	-2.45	-3.42	-3.14	-3.85	-3.30
Langelier Index (@ 4C)	NA			-4.08	-3.98	-3.71	-2.77	-3.74	-3.46	-4.17	-3.62
Saturation pH (@ 20C)	NA			10.1	9.72	9.98	9.30	10.0	9.86	9.75	9.70
Saturation pH (@ 4C)	NA			10.4	10.0	10.3	9.62	10.4	10.2	10.1	10.0
Anion Sum	me/L			1.45	0.96	1.54	2.11	1.50	0.94	1.30	1.29

Original Signed

Certified By:

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http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Metals (Total)

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

Parameter	Unit	G / S	RDL	KL-1 Water 10/27/2014 5999298	KL-2 Water 10/27/2014 5999327	KL-3 Water 10/27/2014 5999348	KL-4 Water 10/27/2014 5999355	KL-5 Water 10/27/2014 5999365	LSD Water 10/27/2014 5999375	HWY-102-1 Water 10/27/2014 5999388	HWY-102-2 Water 10/27/2014 5999398
Cation sum	me/L			2.05	0.57	2.00	1.94	2.14	1.19	1.04	1.76
% Difference/ Ion Balance (NS)	%			17.2	25.7	12.8	4.2	17.5	11.8	11.2	15.1
Total Aluminum	ug/L		5	155	340	105	93	108	141	310	216
Total Antimony	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Arsenic	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Barium	ug/L		5	9	9	16	16	17	11	17	63
Total Beryllium	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Bismuth	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Boron	ug/L		5	10	12	12	11	10	16	11	12
Total Cadmium	ug/L		0.017	0.025	0.018	0.017	<0.017	0.024	<0.017	0.022	0.019
Total Chromium	ug/L		1	<1	<1	<1	<1	<1	<1	<1	<1
Total Cobalt	ug/L		1	<1	<1	<1	<1	<1	<1	<1	<1
Total Copper	ug/L		1	1	4	2	2	5	3	2	2
Total Iron	ug/L		50	168	305	118	104	119	363	290	485
Total Lead	ug/L		0.5	<0.5	0.5	<0.5	<0.5	0.5	<0.5	0.6	1.0
Total Manganese	ug/L		2	42	25	27	24	25	60	61	93
Total Molybdenum	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Nickel	ug/L		2	3	<2	<2	<2	<2	<2	<2	<2
Total Selenium	ug/L		1	<1	<1	<1	<1	<1	<1	<1	<1
Total Silver	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Strontium	ug/L		5	26	12	29	29	30	19	13	43
Total Thallium	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Titanium	ug/L		2	5	3	2	<2	2	3	<2	6
Total Uranium	ug/L		0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Vanadium	ug/L		2	<2	<2	<2	<2	<2	<2	<2	<2
Total Zinc	ug/L		5	9	<5	6	<5	10	<5	7	17

Original Signed

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Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Metals (Total)

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: PML-1	PML-2	LU
				SAMPLE TYPE: Water	Water	Water
				DATE SAMPLED: 10/27/2014	10/27/2014	10/27/2014
				5999415	5999422	5999430
pH				6.64	6.77	6.41
Reactive Silica as SiO2	mg/L		0.5	2.7	2.9	6.9
Chloride	mg/L		1	46	42	70
Fluoride	mg/L		0.1	<0.1	<0.1	<0.1
Sulphate	mg/L		2	8	7	27
Alkalinity	mg/L		5	7	26	<5
True Color	TCU		5	30	31	18
Turbidity	NTU		0.1	1.5	1	1.6
Electrical Conductivity	umho/cm		1	224	212	394
Nitrate + Nitrite as N	mg/L		0.05	0.18	0.18	1.97
Nitrate as N	mg/L		0.05	0.18	0.18	1.97
Nitrite as N	mg/L		0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L		0.03	<0.03	<0.03	<0.03
Total Organic Carbon	mg/L		0.5	4.4	5.8	4.7
Ortho-Phosphate as P	mg/L		0.01	<0.01	<0.01	<0.01
Total Sodium	mg/L		0.1	33.7	33.9	62.7
Total Potassium	mg/L		0.1	0.9	1.1	3.0
Total Calcium	mg/L		0.1	7.0	6.9	12.6
Total Magnesium	mg/L		0.1	1.0	1.0	2.2
Total Phosphorous	mg/L		0.02	0.03	0.03	0.03
Bicarb. Alkalinity (as CaCO3)	mg/L		5	7	26	<5
Carb. Alkalinity (as CaCO3)	mg/L		10	<10	<10	<10
Hydroxide	mg/L		5	<5	<5	<5
Calculated TDS	mg/L		1	102	109	187
Hardness	mg/L			21.6	21.3	40.5
Langelier Index (@20C)	NA			-3.26	-2.57	-3.41
Langelier Index (@ 4C)	NA			-3.58	-2.89	-3.73
Saturation pH (@ 20C)	NA			9.90	9.34	9.82
Saturation pH (@ 4C)	NA			10.2	9.66	10.1
Anion Sum	me/L			1.62	1.86	2.68

Original Signed

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

Standard Water Analysis + Metals (Total)

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: PML-1 SAMPLE TYPE: Water DATE SAMPLED: 10/27/2014 5999415	PML-2 Water 10/27/2014 5999422	LU Water 10/27/2014 5999430
Cation sum	me/L			1.94	1.95	3.64
% Difference/ Ion Balance (NS)	%			9.2	2.2	15.2
Total Aluminum	ug/L		5	142	122	109
Total Antimony	ug/L		2	<2	<2	<2
Total Arsenic	ug/L		2	<2	<2	<2
Total Barium	ug/L		5	18	19	80
Total Beryllium	ug/L		2	<2	<2	<2
Total Bismuth	ug/L		2	<2	<2	<2
Total Boron	ug/L		5	11	11	21
Total Cadmium	ug/L		0.017	<0.017	0.018	0.079
Total Chromium	ug/L		1	<1	<1	<1
Total Cobalt	ug/L		1	<1	<1	<1
Total Copper	ug/L		1	2	2	4
Total Iron	ug/L		50	182	134	229
Total Lead	ug/L		0.5	<0.5	<0.5	<0.5
Total Manganese	ug/L		2	49	24	36
Total Molybdenum	ug/L		2	<2	<2	<2
Total Nickel	ug/L		2	<2	<2	<2
Total Selenium	ug/L		1	<1	<1	<1
Total Silver	ug/L		0.1	<0.1	<0.1	<0.1
Total Strontium	ug/L		5	30	29	54
Total Thallium	ug/L		0.1	<0.1	<0.1	<0.1
Total Tin	ug/L		2	<2	<2	<2
Total Titanium	ug/L		2	3	<2	3
Total Uranium	ug/L		0.1	<0.1	<0.1	<0.1
Total Vanadium	ug/L		2	<2	<2	<2
Total Zinc	ug/L		5	6	5	23

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Original Signed

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

TP (Water)

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

		SAMPLE DESCRIPTION:		KL-1	KL-2	KL-3	KL-4	KL-5	LSD	HWY-102-1	HWY-102-2
		SAMPLE TYPE:		Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:		10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999298	5999327	5999348	5999355	5999365	5999375	5999388	5999398
Total Phosphorus	mg/L		0.006	0.013	0.025	0.148	0.015	0.135	0.031	0.031	0.201

		SAMPLE DESCRIPTION:		PML-1	PML-2	LU
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999415	5999422	5999430
Total Phosphorus	mg/L		0.006	0.021	0.018	0.039

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Original Signed

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

CLIENT NAME: SNC-LAVALIN

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

TSS, TKN

DATE RECEIVED: 2014-10-27

DATE REPORTED: 2014-11-06

		SAMPLE DESCRIPTION:		KL-1	KL-2	KL-3	KL-4	KL-5	LSD	HWY-102-1	HWY-102-2
		SAMPLE TYPE:		Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:		10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999298	5999327	5999348	5999355	5999365	5999375	5999388	5999398
Total Kjeldahl Nitrogen as N	mg/L		0.4	0.4	<0.4	0.4	<0.4	1.1	<0.4	<0.4	<0.4
Total Suspended Solids	mg/L		5	<5	<5	<5	<5	<5	8	<5	<5

		SAMPLE DESCRIPTION:		PML-1	PML-2	LU
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		10/27/2014	10/27/2014	10/27/2014
Parameter	Unit	G / S	RDL	5999415	5999422	5999430
Total Kjeldahl Nitrogen as N	mg/L		0.4	0.8	<0.4	<0.4
Total Suspended Solids	mg/L		5	<5	<5	<5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Original Signed

Certified By:

AGAT Laboratories

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Quality Assurance

CLIENT NAME: SNC-LAVALIN

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

Water Analysis

RPT Date: Nov 06, 2014			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Standard Water Analysis + Metals (Total)															
pH	5998984		7.64	7.57	0.9%	<	101%	80%	120%	NA	80%	120%	NA	80%	120%
Reactive Silica as SiO2	1	5999348	2.4	2.4	0.0%	< 0.5	103%	80%	120%		80%	120%	94%	80%	120%
Chloride	6000358		13	14	5.4%	< 1	99%	80%	120%	NA	80%	120%	NA	80%	120%
Fluoride	6000358		0.3	0.3	0.0%	< 0.1	88%	80%	120%	NA	80%	120%	80%	80%	120%
Sulphate	6000358		4	5	0.0%	< 2	99%	80%	120%	NA	80%	120%	94%	80%	120%
Alkalinity	5998984		50	49	1.6%	< 5	83%	80%	120%	NA	80%	120%	NA	80%	120%
True Color	1	6000035	<5	<5	0.0%	< 5	105%	80%	120%		80%	120%		80%	120%
Turbidity	1	6001427	3.9	4	2.5%	< 0.1	85%	80%	120%		80%	120%		80%	120%
Electrical Conductivity	5998984		196	192	2.0%	< 1	87%	80%	120%	NA	80%	120%	NA	80%	120%
Nitrate as N	6000358		0.15	0.18	0.0%	< 0.05	90%	80%	120%	NA	80%	120%	87%	80%	120%
Nitrite as N	6000358		<0.05	<0.05	0.0%	< 0.05	98%	80%	120%	NA	80%	120%	89%	80%	120%
Ammonia as N	1	5999430	<0.03	<0.03	0.0%	< 0.03	97%	80%	120%		80%	120%	88%	80%	120%
Total Organic Carbon	1		15.0	15.2	1.3%	< 0.5	102%	80%	120%		80%	120%	94%	80%	120%
Ortho-Phosphate as P	1	5999348	<0.01	<0.01	0.0%	< 0.01	103%	80%	120%		80%	120%	103%	80%	120%
Total Sodium	1028201		29.8	29.4	1.4%	< 0.1	108%	80%	120%	107%	80%	120%	103%	70%	130%
Total Potassium	1028201		1.3	1.3	0.0%	< 0.1	110%	80%	120%	106%	80%	120%	96%	70%	130%
Total Calcium	1028201		17.7	18.0	1.7%	< 0.1	103%	80%	120%	98%	80%	120%	108%	70%	130%
Total Magnesium	1028201		1.95	1.92	1.6%	< 0.1	100%	80%	120%	98%	80%	120%	101%	80%	120%
Total Phosphorous	1028201		0.04	0.04	0.0%	< 0.02	113%	80%	120%	110%	80%	120%	96%	70%	130%
Bicarb. Alkalinity (as CaCO3)	5998984		50	49	1.6%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Carb. Alkalinity (as CaCO3)	5998984		<10	<10	0.0%	< 10	NA	80%	120%	NA	80%	120%	NA	80%	120%
Hydroxide	5998984		<5	<5	0.0%	< 5	NA	80%	120%	NA	80%	120%	NA	80%	120%
Total Aluminum	1028201		< 5	< 5	0.0%	< 5	101%	80%	120%	102%	80%	120%	91%	70%	130%
Total Antimony	1028201		< 2	< 2	0.0%	< 2	93%	80%	120%	94%	80%	120%	98%	70%	130%
Total Arsenic	1028201		4	4	0.0%	< 2	98%	80%	120%	95%	80%	120%	90%	70%	130%
Total Barium	1028201		12	11	8.7%	< 5	97%	80%	120%	94%	80%	120%	104%	70%	130%
Total Beryllium	1028201		< 2	< 2	0.0%	< 2	109%	80%	120%	104%	80%	120%	104%	70%	130%
Total Bismuth	1028201		< 2	< 2	0.0%	< 2	106%	80%	120%	94%	80%	120%	101%	70%	130%
Total Boron	1028201		53	51	3.8%	< 5	110%	80%	120%	100%	80%	120%	100%	70%	130%
Total Cadmium	1028201		0.042	0.035	18.2%	< 0.017	99%	80%	120%	95%	80%	120%	98%	70%	130%
Total Chromium	1028201		< 1	< 1	0.0%	< 1	110%	80%	120%	111%	80%	120%	100%	70%	130%
Total Cobalt	1028201		< 1	< 1	0.0%	< 1	111%	80%	120%	109%	80%	120%	96%	70%	130%
Total Copper	1028201		1	4		< 1	113%	80%	120%	110%	80%	120%	94%	70%	130%
Total Iron	1028201		< 50	< 50	0.0%	< 50	103%	80%	120%	99%	80%	120%	95%	70%	130%
Total Lead	1028201		< 0.5	< 0.5	0.0%	< 0.5	103%	80%	120%	103%	80%	120%	104%	70%	130%
Total Manganese	1028201		90	90	0.0%	< 2	99%	80%	120%	99%	80%	120%	102%	70%	130%
Total Molybdenum	1028201		19	19	0.0%	< 2	97%	80%	120%	92%	80%	120%	106%	70%	130%
Total Nickel	1028201		< 2	< 2	0.0%	< 2	112%	80%	120%	110%	80%	120%	97%	70%	130%
Total Selenium	1028201		< 1	< 1	0.0%	< 1	104%	80%	120%	98%	80%	120%	92%	70%	130%

AGAT Laboratories

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Quality Assurance

CLIENT NAME: SNC-LAVALIN
PROJECT: 510192-0001 Bedford West
SAMPLING SITE:

AGAT WORK ORDER: 14X907730
ATTENTION TO: Christa Rafuse
SAMPLED BY:

Water Analysis (Continued)

RPT Date: Nov 06, 2014			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Total Silver	1028201		< 0.1	< 0.1	0.0%	< 0.1	101%	80%	120%	97%	80%	120%	99%	70%	130%
Total Strontium	1028201		94	91	3.2%	< 5	100%	80%	120%	100%	80%	120%	100%	70%	130%
Total Thallium	1028201		< 0.1	< 0.1	0.0%	< 0.1	100%	80%	120%	103%	80%	120%	105%	70%	130%
Total Tin	1028201		< 2	< 2	0.0%	< 2	95%	80%	120%	96%	80%	120%	98%	70%	130%
Total Titanium	1028201		< 2	< 2	0.0%	< 2	108%	80%	120%	105%	80%	120%	100%	70%	130%
Total Uranium	1028201		3.52	3.62	2.8%	< 0.1	100%	80%	120%	98%	80%	120%	120%	70%	130%
Total Vanadium	1028201		< 2	< 2	0.0%	< 2	111%	80%	120%	111%	80%	120%	100%	70%	130%
Total Zinc	1028201		< 5	< 5	0.0%	< 5	111%	80%	120%	109%	80%	120%	87%	70%	130%
TSS, TKN															
Total Kjeldahl Nitrogen as N	1	5999298	0.4	0.5	22.2%	< 0.4	108%	80%	120%		80%	120%	97%	80%	120%
Total Suspended Solids	1	5999298	<5	<5	0.0%	< 5	99%	80%	120%		80%	120%	109%	80%	120%
TP (Water)															
Total Phosphorus	5999298	5999298	0.013	0.014	7.4%	< 0.006	93%	90%	110%	98%	90%	110%	109%	80%	120%

Original Signed

Certified By:

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Method Summary

CLIENT NAME: SNC-LAVALIN

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Microbiology Analysis			
E. Coli (MPN)	MIC-121-7000	Based on SM 9223B	INCUBATOR
Total Coliforms (MPN)	MIC-121-7000	Based on SM 9223B	INCUBATOR

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Method Summary

CLIENT NAME: SNC-LAVALIN

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
pH	INOR-121-6001	SM 4500 H+B	PC-TITRATE
Reactive Silica as SiO2	INORG-121-6028	SM 4110 B	COLORIMETER
Chloride	INORG-121-6005	SM 4110 B	IC
Fluoride	INORG-121-6005	SM 4110 B	IC
Sulphate	INORG-121-6005	SM 4110 B	IC
Alkalinity	INORG-121-6001	SM 2320 B	PC-TITRATE
True Color	INORG-121-6014	EPA 110.2	NEPHELOMETER
Turbidity	INORG-121-6022	SM 2130 B	NEPHELOMETER
Electrical Conductivity	INOR-121-6001	SM 2510 B	PC-TITRATE
Nitrate + Nitrite as N	INORG-121-6005	SM 4110 B	CALCULATION
Nitrate as N	INORG-121-6005	SM 4110 B	IC
Nitrite as N	INORG-121-6005	SM 4110 B	IC
Ammonia as N	INORG-121-6003	SM 4500-NH3 G	COLORIMETER
Total Organic Carbon	INORG-121-6026	SM 5310 B	TOC ANALYZER
Ortho-Phosphate as P	INORG-121-6005	SM 4110 B	COLORIMETER
Total Sodium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Potassium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Calcium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Magnesium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Phosphorous	MET-121-6104 & MET-121-6105	SM 3125	ICP/MS
Bicarb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC-TITRATE
Carb. Alkalinity (as CaCO3)	INORG-121-6001	SM 2320 B	PC-TITRATE
Hydroxide	INORG-121-6001	SM 2320 B	PC-TITRATE
Calculated TDS	CALCULATION	SM 1030E	CALCULATION
Hardness	CALCULATION	SM 2340B	CALCULATION
Langelier Index (@20C)	CALCULATION	CALCULATION	CALCULATION
Langelier Index (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 20C)	CALCULATION	CALCULATION	CALCULATION
Saturation pH (@ 4C)	CALCULATION	CALCULATION	CALCULATION
Anion Sum	CALCULATION	SM 1030E	CALCULATION
Cation sum	CALCULATION	SM 1030E	CALCULATION
% Difference/ Ion Balance (NS)	CALCULATION	SM 1030E	CALCULATION
Total Aluminum	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Antimony	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Arsenic	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Barium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Beryllium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Bismuth	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Boron	MET121-6104 & MET-121-6105	SM 3125	ICP/MS

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Method Summary

CLIENT NAME: SNC-LAVALIN

AGAT WORK ORDER: 14X907730

PROJECT: 510192-0001 Bedford West

ATTENTION TO: Christa Rafuse

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Total Cadmium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Chromium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Cobalt	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Copper	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Iron	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Lead	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Manganese	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Molybdenum	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Nickel	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Selenium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Silver	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Strontium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Thallium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Tin	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Titanium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Uranium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Vanadium	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Zinc	MET121-6104 & MET-121-6105	SM 3125	ICP/MS
Total Phosphorus	INOR-93-6022	SM 4500-P B & E	SPECTROPHOTOMETER
Total Kjeldahl Nitrogen as N	INOR-121-6020	SM 4500 NORG D	COLORIMETER
Total Suspended Solids	INOR-121-6024, 6025	SM 2540C, D	GRAVIMETRIC

Dalhousie University
Department of Oceanography
Halifax, N.S.
B3H 4R2

30-Oct-14 AGAT Laboratories, 11 Morris Dr. Unit 122, Dartmouth, NS, B3B 1M2

Attention: Lisa Johnston
Re: Determination of chlorophyll a in algae by fluorescence

AGAT Job#: 14X907730
Req#: 96721

Acidification Technique:

Sample ID	Chl a (µg/L)
5999298	0.84
5999327	0.41
5999348	1.23
5999355	1.03
5999365	0.90
5999375	0.32
5999388	1.22
5999398	0.46
5999415	0.91
5999422	0.72
5999430	0.96

Welschmeyer Technique:

Sample ID	Chl a (µg/L)
5999298	0.80
5999327	0.41
5999348	1.12
5999355	0.95
5999365	0.84
5999375	0.33
5999388	1.38
5999398	0.55

phone: (902)494-6663 **fax: (902)494-2039**

5999415	0.87
5999422	0.70
5999430	0.96

- **CHl a = chlorophyll a**
- **An underestimation of chl a occurs by the fluorescence acidification technique in the presence of Chl b. Since chl b containing chlorophytes are often present in freshwater ecosystems another technique (welschmeyer) was also employed.**
- **Reference for Welschmeyer technique Limnol. Oceanogr., 39(8) 1994, 1985-1992**

Received: 28-Oct-14
Completed: 30-Oct-14

Original Signed

Jessica Miller

phone: (902)494-6663 **fax: (902)494-2039**

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Chain of Custody Record

Turnaround Time Required (TAT)

Regular TAT 5 to 7 working days ☑
Rush TAT 24 to 48 hours ☐
48 to 72 hours ☐
Date Required: _____

Report To

Company: SNC Lavalin
Contact: Christa Rafuse
Address: 40 Fielding Avenue, Dartmouth, NS, B3B1E4
Phone: +1 (902) 468-6230 Fax: +1 (902) 468-786
PO#:
AGAT Quotation: 12-761
Client Project Name/#: 510192-0001 Bedford West

Report Information

1. Name: Maria Gutierrez
Email: Maria.Gutierrez@snclavalin.com
2. Name: Christa Rafuse
Email: christa.rafuse@snclavalin.com

Report Format

☐ Single Sample per page
☑ Multiple Samples per page
☑ Excel Format Included

Laboratory Use Only

Arrival Condition: ☑ Good ☐ Poor (see notes)
Arrival Temperature: 9°
AGAT Job Number: 14X907730
Notes:

Invoice To Same Yes ☑ / No ☐

Company:
Contact:
Address:
Phone: Fax:
PO#/Credit Card #:

Regulatory Requirements (Check):

☐ List Guidelines on Report ☐ Do not List Guidelines on Report
☐ PIRI
☐ Tier 1 ☐ Res ☐ Pot ☐ Coarse
☐ Tier 2 ☐ Com ☐ N/Pot ☐ Fine
☐ Gas ☐ Gas ☐ Lube
☐ CCME
☐ Industrial ☐ CDWQ ☐ Other
☐ Commercial ☐ NSDFOSP
☐ Res/Park ☐ HRM 101
☐ Agricultural ☐ Storm Water
☐ FWAL ☐ Waste Water
☐ Sediment

Sample Identification	Sample Matrix	Date/Time Sampled	Comments – Site/Sample Info. Sample Containment	Microtox	CCME PHC BTEX/F1-F4	Metals	AB Class II Landfill	Detailed Salinity	Routine Potability	Standard Water + Metals	Low Level Total Phosphorus	TSS & TKN	E.Coli (MPN)	Chlorophyll A	Number of Containers	Preserved (Y/N)	Hazardous (Y/N)	Lab Sample #
KL-1	WATER	Oct 27, 2014								✓	✓	✓	✓	✓				
KL-2	WATER	"								✓	✓	✓	✓	✓				
KL-3	WATER	"								✓	✓	✓	✓	✓				
KL-4	WATER	"								✓	✓	✓	✓	✓				
KL-5	WATER	"								✓	✓	✓	✓	✓				
LSD	WATER	"								✓	✓	✓	✓	✓				
HWY-102-1	WATER	"								✓	✓	✓	✓	✓				
HWY-102-2	WATER	"								✓	✓	✓	✓	✓				
PML-1	WATER	"								✓	✓	✓	✓	✓				
PML-2	WATER	"								✓	✓	✓	✓	✓				
LU	WATER	"								✓	✓	✓	✓	✓				
	WATER									✓	✓	✓	✓	✓				

Samples Relinquished by (print name & sign):	Date	Samples Received by (Print name & sign):	Date	Special Instructions	Page ___ of ___
Ghislain Pitre	Oct 27, 2014	Chris Deamel	Oct 27/14		
Samples Relinquished by (print name & sign):	Date	Original Signed	Date 15:20		NO:
Samples Relinquished by (print name & sign):	Date	Samples Received by (Print name & sign):	Date		

ANNUAL SUMMARY OF WATER QUALITY FOR YEAR 3 OF CONSTRUCTION MONITORING

Prepared for:
Brunello Estates
Suite 202, 2000 Barrington Street
Halifax, NS B3J 3K1

Prepared by:
Stantec Consulting Ltd.
102 - 40 Highfield Park Drive
Dartmouth, NS B3A 0A3

Stantec Project No. 121510734

October 6, 2014

Sign-off Sheet

This document entitled ANNUAL SUMMARY OF WATER QUALITY FOR YEAR 3 OF CONSTRUCTION MONITORING was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Brunello Estates (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Original Signed

Prepared by _____
(signature)

Greg Piorkowski, Ph.D.

Original Signed

Reviewed by _____
(signature)

Elizabeth Kennedy, M.Sc., P.Geo

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LIST OF APPENDICES

1.0 INTRODUCTION

Brunello Estates is currently constructing an 18-hole golf course and residential development between Lakeside and Timberlea in Halifax, Nova Scotia. The property is bordered by Highways 3 and 103 (Figure 1). Further information regarding the development can be found at www.brunelloestates.com. All watercourses and associated fish habitat within the project area have been identified and is described in the aquatic assessment report titled "Brunello Estates – Stream Assessments in Preparation for an Application for Watercourse Alteration" (Stantec 2009a).

A water quality monitoring plan (WQMP) was developed for Brunello Estates by Stantec (2009b). The WQMP is based on information contained within the Halifax Regional Municipality's Water Quality Monitoring Functional Plan and was accepted by the Halifax Area Watershed Advisory Board (HWAB) in February 2011. The Brunello Estates WQMP was initiated at the onset of development and has been carried out according to the approved plan over the course of construction activities. This report summarizes the water quality characteristics of watercourses adjacent to construction activity occurring in the third year of development as compared to baseline conditions and regulatory guidelines application to the protection of freshwater aquatic

2.0 SURVEY METHODOLOGY

2.1 WATER QUALITY MONITORING FRAMEWORK

The water quality monitoring framework for Brunello Estates is detailed in the *Brunello Estates Water Quality Monitoring Plan* (Stantec 2011), which outlines a prescriptive monitoring program to assess potential impacts of urban development on freshwater resources adjacent to construction activities within the Brunello Estates development. Within the approved plan, basic water quality parameters are monitored monthly except during winter freeze-up (January to March) where only one monitoring event takes place. Basic water quality is assessed through Group 1 parameters and additional, more specific, parameters are monitored quarterly (Group 2) and semi-annually (Group 3). A generic schedule of water quality sampling occurring annually throughout the development lifetime is provided in Table 1. Water quality parameters belonging to Group 1, Group 2 and Group 3 are listed in Table 2.

Table 1 Water Quality Monitoring Schedule

June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Group 1	Group 1	Group 3	Group 1	Group 1	Group 2	Group 1	Group 2 (one winter event)			Group 3	Group 1

Table 2 Grouped Water Quality Parameters Assessed in Monitored Watercourses

Group 1	Group 2	Group 3
Laboratory Analysis	**Group 1** parameters plus;	**Group 1 and 2** parameters plus;
Total Suspended Solids	Potassium	Antimony
Turbidity	Sodium	Arsenic
Total Phosphorous	Calcium	Barium
E.coli	Magnesium	Beryllium
Colour	Hardness (as $CaCO_3$)	Bismuth
	TDS	Boron
In Situ Measurements	Alkalinity (as $CaCO_3$)	Cadmium
pH	Bicarbonate (as $CaCO_3$)	Chromium
Conductivity	Carbonate (as $CaCO_3$)	Cobalt
Dissolved Oxygen	Sulphate	Lead
Water Temperature	Reactive Silica	Molybdenum
	Nitrate-Nitrite	Nickel
Observations	Ammonia	Selenium
Cloud Cover	Turbidity	Silver
Ice Depth	Color	Strontium
Date & Time	Total Organic Carbon	Thallium
Air Temperature	Iron	Tin
48 h precipitation	Copper	Titanium
	Manganese	Uranium
	Zinc	Vanadium

Permanent sample locations were chosen for each watercourse based on their proximity to proposed construction activities surrounding the watercourses, the identified habitat described in the aquatic assessment report (Stantec 2009a), and connectivity of the watercourses to larger systems. In total, six locations were chosen to be monitored over the course of development, all of which are streams or brooks (*i.e.* lotic systems). Three of the monitored watercourses drain into Governors Lake (WC 1, 2 and 6), and two of the monitored watercourses drain into Nine Mile River (WC-11 and WC-13). The remaining two watercourses (WC-4 and WC-7) predominantly drain connecting wetlands. The water quality monitoring locations are illustrated in Figure 1.

2.2 LOCATION AND DATES OF SAMPLING IN YEAR 3 OF CONSTRUCTION

Water quality monitoring in Year 3 was limited to those watercourses in which construction activities were occurring in upstream drainage areas. In the beginning of Year 3 (June 2013 – July 2014), construction activities were limited to the central portions of the development in areas draining to watercourses WC-6 and WC-7. Development expanded in October 2013 to the area draining WC-9 and in May 2014 to areas draining to WC-11 and WC-13. Accordingly, water quality sampling was performed throughout Year 3 only at WC-6 and WC-7. The dates and schedule of water quality sampling is listed in Table 3.

Table 3 Dates of Water Quality Sampling for Watercourses Monitored in Year 3 of Construction

Quarter	Date	WC-6	WC-7	WC-9	WC-11	WC-13
1st Quarter	June 7, 2013	•	•			
	July 11, 2013	•	•			
	August 16, 2013	•	•			
2nd Quarter	September 19, 2013	•	•			
	October 29, 2013	•	•	•		
	November 29, 2013	•	•	•		
3rd Quarter	December 11, 2013	•	•	•		
	March 25, 2014	•	•	•		
4th Quarter	April 28, 2014	•	•	•		
	May 30, 2014	•	•	•	•	•
	July 2, 2014	•	•	•	•	•

3.0 WATER QUALITY RESULTS

3.1 METEOROLOGICAL CONDITIONS

The timing of monitoring events was chosen to correspond with periods of weather typical to the season in which the monitoring occurred with periods of elevated rainfall and drought conditions avoided (if possible). Meteorological conditions observed during and prior to sampling are identified in Table 4.

Table 4 Meteorological Conditions for the Year 3 Sampling Dates

Quarter	Date	Conditions	Air Temperature (°C)	48 h Antecedent Precipitation (mm)
1st Quarter	June 7, 2013	Overcast / light rain	11	0.0
	July 11, 2013	Drizzle / fog	19	4.0
	August 16, 2013	Sunny	18	0.0
2nd Quarter	September 19, 2013	Mainly clear	12	0.0
	October 29, 2013	Mainly clear	1	13.7
	November 29, 2013	Sunny	-5	80.7
3rd Quarter	December 11, 2013	Mainly clear	-5	14.5
	March 25, 2014	Mostly cloudy	-7	Trace
4th Quarter	April 28, 2014	Fog / light rain	5	17.0
	May 30, 2014	Cloudy	13	0.0
	July 2, 2014	Mostly cloudy	22	Trace

3.2 WATER QUALITY OBSERVATIONS

3.2.1 Watercourse #6 (WC-6)

In the first quarter of year three, water quality was observed to have no unusual odour, colour or turbidity, except in August when water was slightly turbid. However, in the second quarter, low to moderate turbidity and brown colour was noted for all three events. In September of Q2, the silt fence adjacent to the watercourse was noted to be at capacity, and was promptly replaced upon notification of Brunello Estates. Elevated turbidity levels corresponded to higher precipitation in October and November 2013. No unusual colour or turbidity was noted in the third quarter, but brown, turbid water was observed in May of Q4 and silt deposition on the streambed was noted in July 2014.

3.2.2 Watercourse #7 (WC-7)

No unusual odour, colour or turbidity was observed in the first and third quarters of Year 3. However, brown coloured stream water with moderate to high turbidity was observed during the October and November sampling events in Q2, again corresponding to periods of higher precipitation. Low to moderate turbidity and brown colouration was again observed in the April and July sampling events of Q4.

3.2.3 Watercourse #9 (WC-9)

The water quality in WC-9 was generally clear and tea-coloured with no unusual odour, colour or turbidity, except for the October and November events of Q2 where low to moderate turbidity was observed. These events corresponded to periods of elevated precipitation and runoff.

3.2.4 Watercourse #11 (WC-11)

The WC-11 sampling location was difficult to located in the May sampling event of Q4 due to low flow conditions; the watercourse was present as a series of stagnant pools. Small amounts of flow and interconnection between the pools was observed in the July sampling event. The water appeared clear and tea-coloured in both sampling events.

3.2.5 Watercourse #13 (WC-13)

At the onset of sampling in May of Q4, the water in WC-13 appeared brown with moderate turbidity, but was clear and tea-coloured with no unusual odour or turbidity in the July event of Q4.

3.3 WATER QUALITY ANALYTICAL RESULTS

3.3.1 Group 1 Parameters

During Year 3 of monitoring (June 2013 – July 2014) water samples were collected monthly with the exception of the third quarter (December to March) where only two samples were collected due to winter conditions and stream freeze-up occurring between these months. The parameters from Group 1 (Table 1) were sampled every event, and Group 2 and Group 3 parameters were sampled quarterly and semi-annually, respectively, as described in Table 2. Tables 5 through 9 present the quarterly and annual means for Group 1 water quality parameters during Year 3 of construction contrasted against applicable regulatory guidelines and the baseline mean collected in spring 2011. Baseline data is attached in Tables A-1 and A-2 and Year 3 monitoring data is included in Tables A-3 to A-10.

Graphical representations of select Group 1 water quality parameters (pH, specific conductivity, TSS, turbidity, TP and *E. coli*) are attached in Figures 2 through 7. Where applicable the graphs indicate the parameter specific guideline value(s) for the Protection of Aquatic Life from the Canadian Council for the Ministers of the Environment (CCME FAL). Other parameters from Group 1 such as water temperature and dissolved oxygen are not included in the graphical representations as they are diurnally variable and the single point in time sampling regime reduces the efficacy of graphical interpretation.

Table 5 Watercourse 6 – Annual and Quarterly Average Values of Group 1 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Year 3 – Q1 Mean[1]	Year 3 – Q2 Mean[1]	Year 3 – Q3 Mean[1]	Year 3 – Q4 Mean[1]	Baseline Mean[1]	Year 2 – Annual Mean[1]
pH[2]	-	6.66	6.55	7.38	6.38	*6.43*	**6.68**
Specific Conductivity[2]	µS/cm	147	104	238	240	*240*	**177**
Total Phosphorous	µg/L	58	125	41	50	*23*	**71**
Total Suspended Solids	mg/L	10	24	6	7	*2*	**12**
Turbidity	NTU	22.8	77.7	13.5	18.5	*0.9*	**36.1**
Color	TCU	95	92	35	52	*111*	**69**
Dissolved Oxygen[2]	mg/L	8.10	9.73	9.25	8.80	*7.15*	**8.94**
Dissolved Oxygen[2]	%	72	83	78	78	*59*	**78**
E. coli	MPN/100 mL	62	40	ND	27	*3*	**35**

[1] One half RDL value used for calculation of average where one or more samples were reported as non-detectable.
[2] Measured In-situ

Table 6 Watercourse 7 – Annual and Quarterly Average Values of Group 1 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Year 3 – Q1 Mean[1]	Year 3 – Q2 Mean[1]	Year 3 – Q3 Mean[1]	Year 3 – Q4 Mean[1]	Baseline Mean[1]	Year 2 – Annual Mean[1]
pH[2]	-	5.68	5.89	6.38	6.48	*4.59*	**6.08**
Specific Conductivity[2]	µS/cm	42	29	41	71	*55*	**46**
Total Phosphorous	µg/L	67	104	58	70	*16*	**76**
Total Suspended Solids	mg/L	3	26	655	5	*1*	**154**
Turbidity	NTU	1.9	84.5	45.5	33.3	*2*	**40.9**
Color	TCU	333	205	105	187	*189*	**218**
Dissolved Oxygen[2]	mg/L	6.13	8.30	9.30	8.38	*7.20*	**7.91**
Dissolved Oxygen[2]	%	56	73	75	74	*62*	**71**
E. coli	MPN/ 100 mL	4	ND	ND	13	*ND*	**5**

1 One half RDL value used for calculation of average where one or more samples were reported as non-detectable.
[2] Measured In-situ

Table 7 Watercourse 9 – Annual and Quarterly Average Values of Group 1 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Year 3 – Q1 Mean[1]	Year 3 – Q2 Mean[1]	Year 3 – Q3 Mean[1]	Year 3 – Q4 Mean[1]	Baseline Mean[1]	Year 2 – Annual Mean[1]
pH[2]	-	-	5.98	5.64	5.19	*4.62*	**5.55**
Specific Conductivity[2]	µS/cm	-	123	265	469	*316*	**312**
Total Phosphorous	µg/L	-	48	28	33	*20*	**37**
Total Suspended Solids	mg/L	-	4	4	3	*1*	**3**
Turbidity	NTU	-	32	7.6	7.0	*0.5*	**14.3**
Color	TCU	-	270	71	98	*144*	**118**
Dissolved Oxygen[2]	mg/L	-	9.05	9.95	9.02	*7.55*	**9.29**
Dissolved Oxygen[2]	%	-	72	78	82	66	**78**
E. coli	MPN/ 100 mL	-	33	10	356	9	**108**

[1] One half RDL value used for calculation of average where one or more samples were reported as non-detectable.
[2] Measured In-situ

Table 8 Watercourse 11 – Annual and Quarterly Average Values of Group 1 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Year 3 – Q1 Mean[1]	Year 3 – Q2 Mean[1]	Year 3 – Q3 Mean[1]	Year 3 – Q4 Mean[1]	Baseline Mean[1]	Year 2 – Annual Mean[1]
pH[2]	-	-	-	-	3.84	*4.19*	**3.84**
Specific Conductivity[2]	µS/cm	-	-	-	33	*45*	**33**
Total Phosphorous	µg/L	-	-	-	38	*12*	**38**
Total Suspended Solids	mg/L	-	-	-	5	*1*	**5**
Turbidity	NTU	-	-	-	3.2	*0.5*	**3.2**
Color	TCU	-	-	-	137	*160*	**137**
Dissolved Oxygen[2]	mg/L	-	-	-	2.90	*9.14*	**2.90**
Dissolved Oxygen[2]	%	-	-	-	23	*74*	**23**
E. coli	MPN/ 100 mL	-	-	-	ND	*ND*	**ND**

1 One half RDL value used for calculation of average where one or more samples were reported as non-detectable.
[2] Measured In-situ

Table 9 Watercourse 13 – Annual and Quarterly Average Values of Group 1 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Year 3 – Q1 Mean[1]	Year 3 – Q2 Mean[1]	Year 3 – Q3 Mean[1]	Year 3 – Q4 Mean[1]	Baseline Mean[1]	Year 2 – Annual Mean[1]
pH[2]	-	-	-	-	5.42	*5.51*	**5.42**
Specific Conductivity[2]	µS/cm	-	-	-	64	*76*	**64**
Total Phosphorous	µg/L	-	-	-	43	*14*	**43**
Total Suspended Solids	mg/L	-	-	-	3	6	**3**
Turbidity	NTU	-	-	-	16.4	*1.1*	**16.4**
Color	TCU	-	-	-	82	99	**82**
Dissolved Oxygen[2]	mg/L	-	-	-	6.13	*7.8*	**6.13**
Dissolved Oxygen[2]	%	-	-	-	58	69	**58**
E. coli	MPN/ 100 mL	-	-	-	3	*ND*	**3**

[1] One half RDL value used for calculation of average where one or more samples were reported as non-detectable.
[2] Measured In-situ

3.3.2 Group 2 and 3 Parameters

In addition to the monthly sampling of Group 1 parameters, Group 2 and Group 3 parameters were sampled quarterly and semi-annually, respectively, as outlined in Table 2. During Year 3 of construction monitoring, Group 2 and 3 parameters were analyzed only for watercourses WC-6, WC-7, and WC-9. The commencement of sampling for watercourses WC-11 and WC-13 occurred after the scheduled Group 2 and Group 3 water quality measures were collected for the other watercourses. Key water quality parameters were chosen for presentation from the Group 2 and Group 3 parameters based on the availability of CCME FAL guidelines, including:

- Dissolved chloride
- Nitrate
- Nitrite
- Select metals (Al, As, Cd, Cu, Fe, Pb, Ni, Se, Ag, Tl, Zn)

Tables 10 to 12 indicate the number of samples, sample ranges, mean values, baseline means, guideline values and the frequency of guideline exceedances for each key parameter in

Groups 2 and 3. Tabular representation was chosen over graphical representation as the number of samples for each parameter is limited to two to four sampling events per year.

Table 10 Watercourse 6 – Annual and Quarterly Average Values of Select Group 2 and 3 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Number of Samples (n)	Year 3 - Range	Year 3 – Mean[1]	Baseline	CCME FAL	Frequency of Guideline Exceedance
Chloride	mg/L	4	24 – 95	54	*58*	**120**	*0*
Nitrate		4	0.44 - 1.6	<0.050	*0.31*	**13**	*0*
Nitrite		2	<0.010	<0.010	<0.010	**0.6**	*0*
Aluminum	µg/L	2	970 – 2600	1785	*158*	**100**	*1.0*
Arsenic		2	1.5 – 3.7	2.6	*<1.0*	**5**	*0*
Cadmium		2	0.033 – 0.05	0.042	*0.04*	**0.017**	*1.0*
Copper		4	<2.0 – 6.4	4.0	*<2.0*	**2**	*0.75*
Iron		4	1000 – 5600	2698	*237*	**300**	*1.0*
Lead		2	0.9 – 2.3	1.6	*<0.5*	**1**	*0.5*
Nickel		2	<2.0 – 2.5	<2.0	*<2.0*	**25**	*0*
Selenium		2	<1.0	<1.0	*<1.0*	**1**	*0*
Silver		2	<0.10	<0.10	*<0.1*	**0.1**	*0*
Thallium		2	<0.10	<0.10	*<0.1*	**0.8**	*0*
Zinc		4	9.3 – 17	12.1	*5.5*	**30**	*0*

[1] One half RDL value used for calculation of average where one or more samples were reported as non-detectable.

Table 11 Watercourse 7 – Annual and Quarterly Average Values of Select Group 2 and 3 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Number of Samples (n)	Year 3 - Range	Year 3 – Mean[1]	Baseline	CCME FAL	Frequency of Guideline Exceedance
Chloride	mg/L	4	7 - 9	8	*7*	**120**	*0*
Nitrate		4	<0.05	<0.05	*0.21*	**13**	*0*
Nitrite		2	<0.01	<0.01	*<0.01*	**0.6**	*0*
Aluminum	µg/L	2	829 - 2500	1665	*235*	**100**	*1.0*
Arsenic		2	2.1 - 4.1	3.1	*<1.0*	**5**	*0*
Cadmium		2	0.036 – 0.073	0.055	*0.065*	**0.017**	*1.0*
Copper		4	2.9 – 7.7	4.9	*<2.0*	**2**	*1.0*
Iron		4	1700 – 7400	3618	*402*	**300**	*1.0*
Lead		2	1.5 – 1.98	1.74	*0.58*	**1**	*1.0*
Nickel		2	<2.0	<2.0	*<2.0*	**25**	*0*
Selenium		2	<1.0	<1.0	*<1.0*	**1**	*0*
Silver		2	<0.1	<0.1	*<0.1*	**0.1**	*0*
Thallium		2	<0.1	<0.1	*<0.1*	**0.8**	*0*
Zinc		4	6.7 - 26	14	*6.5*	**30**	*0*

[1] One half RDL value used for calculation of average where one or more samples were reported as non-detectable.

Table 12 Watercourse 9 – Annual and Quarterly Average Values of Select Group 2 and 3 Water Quality Parameters in Year 3 of Construction

Parameter	Unit	Number of Samples (n)	Year 3 – Range	Year 3 – Mean[1]	Baseline	CCME FAL	Frequency of Guideline Exceedance
Chloride	mg/L	3	33 - 140	94	*105*	**120**	*0.33*
Nitrate		3	0.08 – 0.12	0.11	*0.08*	**13**	*0*
Nitrite		2	<0.01	<0.01	*<0.01*	**0.6**	*0*
Aluminum	µg/L	1	1100	1100	*410*	**100**	*1.0*
Arsenic		1	33	33	*<1.0*	**5**	*1.0*
Cadmium		2	0.069	0.069	*0.11*	**0.017**	*1.0*
Copper		3	2.1 – 3.4	2.8	*<2.0*	**2**	*1.0*
Iron		3	830 – 2800	1517	*515*	**300**	*1.0*
Lead		1	1.4	1.4	*0.6*	**1**	*1.0*
Nickel		1	<2.0	<2.0	*<2.0*	**25**	*0*
Selenium		1	<1.0	<1.0	*<1.0*	**1**	*0*
Silver		1	<0.1	<0.1	*<0.1*	**0.1**	*0*
Thallium		1	<0.1	<0.1	*<0.1*	**0.8**	*0*
Zinc		3	12 - 20	16	*12.7*	**30**	*0*

[1] One half RDL value used for calculation of average where one or more samples were reported as non-detectable.

4.0 DISCUSSION

The results of the water chemistry sampling and *in-situ* water quality measurements are discussed below in comparison to the relevant Canadian Council of the Ministers of the Environment (CCME) Guidelines for the Protection of Freshwater Aquatic Life (CCME FAL) and Recreational Water Quality Guidelines (RWQG).

4.1 GROUP 1 PARAMETERS

4.1.1 Acidity

The annual mean pH for WC-6 (6.8) falls within the range recommended for the protection of aquatic life. The mean pH for WC-7 (6.1), WC-9 (5.6), WC-11 (3.8) and WC-13 (5.4) are below CCME FAL guidelines. CCME FAL recommends a pH range of 6.5 to 9.5 pH units to maintain fish health as low pH values reduce the ability of certain species to spawn and hinder tissue development in juveniles (CCME 2006). However, the mean pH is similar to conditions observed during the baseline sampling events and elsewhere within Nova Scotia. Watercourse 11 exhibits lower mean pH (3.8) than the other monitoring sites likely due to this watercourse draining peatlands which are naturally more acidic than forest soils.

During baseline fish habitat assessments it was determined that no fish habitat was present within WC-6, WC-7, WC-11 and WC-13 and therefore the recommended CCME FAL pH range is utilized

as a reference value. The fish habitat near the WC-9 sampling location has the potential to support small-bodied fish species such as minnows and stickleback therefore the guideline is more applicable. Although the pH range of the streams is below the CCME FAL guidelines, Nova Scotia has naturally acidic streams and viable fish communities have been observed in pH ranges of 5.6 – 6.3 with fish density declines occurring below pH of 5.5 (Lacroix 1987). Stantec personnel in Nova Scotia routinely observe high density fish communities in streams with pH levels similar to or more acidic than those measured in the watercourses of Brunello Estates.

4.1.2 Trophic Status

Trophic status is a general measure of the nutrient accumulation within a waterbody. The CCME Canadian Guidance Framework for the Management of Freshwater Systems has developed trophic levels based on ranges of phosphorous concentrations. A body of water is usually classified as being in one of four classes (oligotrophic, mesotrophic, meso-eutrophic or eutrophic) ranging from low to high trophic status. Watercourses with extreme trophic indices may also be considered hyperoligotrophic or hypereutrophic.

Concentrations of phosphorus found in all watercourses monitored during year three of construction monitoring (WC-6, WC-7, WC-9, WC-11 and WC-13) were elevated as compared to the baseline monitoring results. Based on the CCME framework, the trophic status of the watercourses monitored during each quarter and as an annual average of year three are indicated in Table 13.

Table 13 Brunello Estates – Year 3 Quarterly and Annual Trophic Levels

Watercourse	Baseline	Year 3 – Q1	Year 3 – Q2	Year 3 – Q3	Year 3 – Q4	Year 3 – Mean
WC-6	Meso-eutrophic	Eutrophic	Hyper-eutrophic	Eutrophic	Eutrophic	Eutrophic
WC-7	Mesotrophic	Eutrophic	Hyper-eutrophic	Eutrophic	Eutrophic	Eutrophic
WC-9	Mesotrophic	-	Eutrophic	Mesotrophic	Meso-eutrophic	Meso-eutrophic
WC-11	Mesotrophic	-	-	-	Eutrophic	Eutrophic
WC-13	Mesotrophic	-	-	-	Eutrophic	Eutrophic

The results for all watercourses indicate an increase in total phosphorus concentrations and trophic status when compared to the baseline results. In particular, WC-6 and WC-7 experienced substantial increases in total phosphorus, corresponding to the increase in suspended solids throughout the year. WC-9 experienced more moderate increases in nutrients, elevating from mesotrophic to meso-eutrophic status. Both WC-11 and WC-13 elevated from mesotrophic to eutrophic, indicating phosphorus accumulation at these locations.

4.1.3 Particulate Matter

Water clarity and transparency of the streams in Brunello Estates were measured by visual observations and the concentrations of total suspended solids (TSS) and turbidity in the water samples. TSS is a direct measure of the weight of solids in the water and is used to directly indicate the quantity of sediment in the water column, whereas turbidity is a measure of light refraction by the water matrix. CCME FAL recommends a maximum TSS increase of 25 mg/L from background levels for short term exposure (STE; 24 h) and 5 mg/L over background levels for longer term exposures (LTE; 24 h to 30 days). A maximum turbidity increase over background levels of 8 NTU for STE and 2 NTU increase for LTE is also recommended in CCME FAL. The interpreted guidelines for each monitoring location are presented in the attached data tables. With respect to the analytical values, mean TSS or turbidity over the quarterly monitoring period are compared to the respective LTE guideline, and individual TSS and turbidity values for each sampling event are compared against the STE guideline.

Over the course of the annual monitoring period, individual samples exceeded the interpreted STE limits for TSS on four events at WC-6 and three events at WC-9, but no other watercourse exceeded their respective STE limit for TSS. The interpreted LTE limits for TSS were exceeded for quarters Q1 and Q2 at WC-6, and quarters Q2 and Q3 at WC-7. The LTE limits for TSS were not exceeded at WC-9, WC-11 and WC-13.

The interpreted STE limits for turbidity were exceeded in nine of eleven events at WC-6, seven of eleven events at WC-7, three of seven events at WC-9, and one of two events at WC-13. The interpreted STE limit for turbidity was not exceeded at WC-11. The interpreted LTE guidelines for turbidity were exceeded during all quarters at each monitoring location, except for Q1 at WC-7. The turbidity values coincide with site visit observations where brown, turbid water and evidence of erosion from nearby developments were noted.

4.1.4 Microbiological Water Quality

E. coli is a type of fecal bacteria found in the intestinal tract of warm-blooded animals and is used as an indicator of fecal contamination. Fecal contamination has little effect on aquatic habitats and the primary reason for its monitoring is related to human health; the CCME recreational water quality guideline of 200 CFU/100 mL was adopted for the Brunello water quality monitoring plan. During baseline monitoring, *E. coli* concentrations within the streams of Brunello Estates development were detectable in watercourses WC-6 and WC-9, but were below guideline values. During Year 3 of construction monitoring, *E. coli* was detectable at six of eleven sampling events at WC-6, three of eleven events at WC-7, six of seven events at WC-9 and one of two events at WC-13, but only exceeded guidelines at WC-9 during the July 2014 sampling event (890 CFU/100 mL). The source of *E. coli* measured in the three streams cannot be assigned, but likely are attributed to wildlife or pets. Watercourse 9 is located nearest to existing residential development and the higher levels of *E. coli* at this location may be due to fecal contamination from pets or human wastes via stormwater runoff.

4.2 GROUP 2 AND 3 PARAMETERS

Group 2 and 3 water quality parameters were analyzed only at WC-6, WC-7 and WC-9 due to the timing of the sampling events outlined in Tables 1 and 2. At WC-6 and WC-7, guidelines were frequently exceeded fro aluminum, cadmium, copper, iron and lead. However, aluminum and cadmium exceeded guidelines at baseline sampling as well. At WC-9, water quality guidelines for chloride, aluminum, arsenic, cadmium, copper, iron and lead were frequently exceeded, and aluminum, cadmium, and iron exceeded guidelines during baseline sampling. The increased prevalence of aluminum and iron likely reflect the increases in suspended particulates in these watercourses, as they are constituents of soil material that may have eroded into the waterbody. Increases in other metals may be associated with surface runoff and higher incidences of suspended colloidal and particulate matter as well. The high chloride observed in WC-9 is likely related to the use of road salt in this watercourse, which is influenced to a greater extent by historical residential development.

5.0 SUMMARY

The results provided in this report represent the annual water quality summary for Year 3 for the construction monitoring program, which occurred between May 2013 and July 2014. During this monitoring year, total phosphorus was elevated and trophic levels were increased for all monitored watercourses. The elevated total phosphorous and trophic level may be related to an increase in particulate matter, particularly in regard to turbidity, reported during this year at all monitoring sites. The observed increase in heavy metals typical of soil material in the waterbodies may also be related to higher incidences of colloidal material transported to the water column through runoff. Increases in particulate matter at WC-6, WC-7, WC-9 and WC-13 are believed to be directly related to construction activities during this period, as supported by visual evidence of erosion and sedimentation during site visits. Consequently, the effectiveness of the measures being taken to prevent sediment loading should be assessed at these locations. This data report was created to provide Brunello Estates a brief overview of the water quality observed during the third year of monitoring as compared to the baseline results and applicable regulatory guidelines.

Appendix A

Water Quality Summary Tables

Table A1: Brunello Estates Water Chemistry (Baseline)

RESULTS OF ANALYSES OF WATER			Watercourse #1			Watercourse #6			Watercourse #7					Watercourse #11			Watercourse #13			CCME FAL
Date		**dd/mm/yy**	**3/31/2011**	**5/17/2011**	**6/21/2011**	**3/31/2011**	**5/17/2011**	**6/21/2011**	**3/31/2011**	**5/17/2011**	**6/21/2011**	**7/21/2011**	**8/28/2011**	**3/31/2011**	**5/17/2011**	**6/21/2011**	**3/31/2011**	**5/17/2011**	**6/21/2011**	
Calculated Parameters	**Units**	**RDL**																		
Anion Sum	me/L	N/A	4.90	1.96	2.23	3.05	1.39	2.21	0.200	0.250	0.213	-		0.180	0.140	0.157	0.970	0.160	0.432	
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1	ND	ND	ND	ND	6	ND	ND	ND	ND	-		ND	ND	ND	ND	ND	ND	
Calculated TDS	mg/L	1	287	121	166	190	88	89	17	22	32	-		17	14	22	61	16	28	
Carb. Alkalinity (calc. as CaCO3)	mg/L	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	-		ND	ND	ND	ND	ND	ND	
Cation Sum	me/L	N/A	4.72	2.10	2.2	3.19	1.50	2.23	0.310	0.410	0.389	-		0.280	0.280	0.29	0.800	0.280	0.42	
Hardness (CaCO3)	mg/L	1	38	12	23	43	18	22	3	5	4	-		3	2	4	11	4	7	
Ion Balance (% Difference)	%	N/A	1.87	3.45	3.5	2.24	3.81	4.21	21.6	24.2	26.2	-		21.7	33.3	40.6	9.60	27.3	32.5	
Langelier Index (@ 20C)	N/A		NC	NC	NC	NC	-3.50	NC	NC	NC	NC	-		NC	NC	NC	NC	NC	NC	
Langelier Index (@ 4C)	N/A		NC	NC	NC	NC	-3.75	NC	NC	NC	NC	-		NC	NC	NC	NC	NC	NC	
Nitrate (N)	mg/L	0.05	0.12	-	0.07	0.45	-	0.21	ND	-	0.15	-		ND	-	0.05	0.79	-	0.15	13
Saturation pH (@ 20C)	N/A		NC	NC	NC	NC	9.83	NC	NC	NC	NC	-		NC	NC	NC	NC	NC	NC	
Saturation pH (@ 4C)	N/A		NC	NC	NC	NC	10.1	NC	NC	NC	NC	-		NC	NC	NC	NC	NC	NC	
Inorganics																				
Total Alkalinity (Total as CaCO3)	mg/L	5	ND	ND	ND	ND	6	ND	ND	ND	ND	-		ND	ND	ND	ND	ND	ND	
Dissolved Chloride (Cl)	mg/L	1	160	67	88	97	42	36	7	8	7	-		6	5	4	28	5	9	
Colour	TCU	5	31	190	211	35	170	130	88	240	220	210		80	220	180	15	93	190	
Nitrate + Nitrite	mg/L	0.05	0.12	0.05	0.07	0.45	0.26	0.21	ND	0.27	0.15	-		ND	ND	0.05	0.79	0.08	0.05	
Nitrite (N)	mg/L	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	-		ND	ND	ND	ND	ND	ND	0.06
Nitrogen (Ammonia Nitrogen)	mg/L	0.05	0.08	ND	ND	0.23	ND	ND	ND	ND	ND	-		ND	ND	ND	ND	ND	ND	69.7 - 153
Total Organic Carbon ©	mg/L	0.5	3.9	14	10	3.8	12	5.7	7.9	17	8.9	-		6.7	18	12	2.5	9.6	14	
Orthophosphate (P)	mg/L	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	-		ND	ND	ND	ND	ND	ND	
pH	pH	N/A	**4.76**	**5.13**	**4.98**	6.53	**6.33**	**6.45**	**4.40**	**4.42**	**4.96**	-		**4.28**	**4.27**	**4.45**	**6.19**	**4.63**	**5.12**	6.5 - 9.0
Total Phosphorus	mg/L	0.002	0.014	0.017	0.015	0.022	0.025	0.022	0.016	0.019	0.014	0.046		0.010	0.015	0.011	0.015	0.012	0.016	
Reactive Silica (SiO2)	mg/L	0.5	5.1	3.5	2.3	7.4	4.9	4.8	3.5	3.6	3.4	-		6.0	4.3	4.4	5.8	4.5	4.7	
Total Suspended Solids	mg/L	2	1	1	2	ND	4	ND	1	2	ND	2		ND	ND	ND	7	7	5	
Dissolved Sulphate (SO4)	mg/L	2	12	3	5	13	3	5	ND	ND	ND	-		ND	ND	ND	6	ND	ND	
Turbidity	NTU	0.1	0.4	0.5	0.5	0.8	1.1	0.7	0.5	6.5	0.5	0.5		0.4	0.4	0.5	2.1	0.7	0.5	
Conductivity	uS/cm	1	590	250	340	370	170	180	47	52	67	-		48	42	44	120	38	57	
Microbiological	**Units**																			
Escherichia coli	CFU/100mL	1.0	9	11	8	ND	37	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	200
Field Measurements	**Units**																			
Water Temperature	°C	0.01	4.94	10.73	13.01	2.73	10.19	13.74	4.15	10.73	13.61	15.61	16.81	2.49	8.31	9.89	6.69	8.74	9.05	
pH	pH	0.01	**4.67**	**4.31**	**4.89**	**5.08**	**5.54**	**5.45**	**4.23**	**4.31**	**4.89**	**4.8**	**4.75**	**4.41**	**3.96**	**4.2**	7.47	**4.26**	**4.81**	6.5 - 9.0
Specific Conductivity	µS/cm	1	580	49	320	376	169	176	51	49	42	59	67	51	42	41	136	37	55	
Dissolved Oxygen	mg/L	0.01	9.27	6.69	6.7	10.28	8.02	8.54	8.69	6.69	6.21	4.97	5.08	10.03	8.64	8.74	8.73	7.86	6.86	5.5
Dissolved Oxygen	%	0.1	72.7	60.2		75.7	71.5		66.6	60.2	59.7	50	51.9	73.6	73.6		71.2	67.5		
Total Dissolved Solids	g/L	0.001	0.377	0.032	0.208	0.241	0.11	0.115	0.033	0.032	0.027	0.038	0.043	0.033	0.027	0.026	0.09	0.024	0.036	
Air Temperature	°C	1	10	17	17	10	17	17	10	17	17	20	25	10	17	17	10	17	17	

Values in bold exceed CCME FAL/Recreational guidelines

Table A2: Brunello Estates Water Quality - Metals (Baseline)

RESULTS OF ANALYSES OF WATER

Metals	Units	RDL	Watercourse #1			Watercourse #4			Watercourse #6			Watercourse #7			Watercourse #11			Watercourse #13			CCME FAL
Date		dd/mm/yy	3/31/2011	5/17/2011	6/21/2011	3/31/2011	5/17/2011	6/21/2011	3/31/2011	5/17/2011	6/21/2011	3/31/2011	5/17/2011	6/21/2011	3/31/2011	5/17/2011	6/21/2011	3/31/2011	5/17/2011	6/21/2011	
Calculated Parameters	**Units**	**RDL**																			
Total Aluminum (Al)	ug/L	5.0	**421**	-	**398**	**467**	-	**376**	**173**	-	**143**	**285**	-	**185**	**382**	-	**222**	**540**	-	**476**	100
Total Antimony (Sb)	ug/L	1.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Arsenic (As)	ug/L	1.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	5
Total Barium (Ba)	ug/L	1.0	51.7	-	48.3	94.7	-	67	31.8	-	28	5.8	-	4.2	7.3	-	1.8	15.9	-	2.3	
Total Beryllium (Be)	ug/L	1.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Bismuth (Bi)	ug/L	2.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Boron (B)	ug/L	50	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Cadmium (Cd)	ug/L	0.017	**0.132**	-	**0.082**	**0.277**	-	**0.135**	**0.040**	-	ND	**0.065**	-	ND	**0.103**	-	**0.023**	**0.062**	-	**0.032**	0.017
Total Calcium (Ca)	ug/L	100	11400	3690	5870	21900	6830	7830	12600	5370	5500	695	1010	1211	382	344	392	3080	780	890	
Total Chromium (Cr)	ug/L	1.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Cobalt (Co)	ug/L	0.40	0.84	-	0.56	0.76	-	0.66	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Copper (Cu)	ug/L	2.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	2
Total Iron (Fe)	ug/L	50	261	**724**	**560**	150	**519**	**330**	113	**374**	223	177	**803**	226	228	**499**		**430**	207	110	300
Total Lead (Pb)	ug/L	0.50	0.65	-	0.55	ND	-	ND	ND	-	ND	0.58	-	ND	0.61	-	ND	**1.68**	-	0.98	1
Total Magnesium (Mg)	ug/L	100	2290	742	560	3710	1110	1225	2720	1120	1342	415	488	465	369	293	273	825	379	521	
Total Manganese (Mn)	ug/L	2.0	189	41.0	39.8	233	42.5	50	10.8	15.4	8.9	37.6	70.9	59.8	23.3	15.0	17.4	36.1	29.3	31.2	
Total Molybdenum (Mo)	ug/L	2.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Nickel (Ni)	ug/L	2.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	25
Total Phosphorus (P)	ug/L	100	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Potassium (K)	ug/L	100	1190	772	770	1770	1110	1087	1300	923	877	477	1000	678	497	557	500	802	487	521	
Total Selenium (Se)	ug/L	1.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	1
Total Silver (Ag)	ug/L	0.10	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	0.1
Total Sodium (Na)	ug/L	100	89600	41500	39600	175000	87100	69900	52500	25400	28600	4290	5270	4780	3600	3440	3300	12500	3730	3300	
Total Strontium (Sr)	ug/L	2.0	49.3	-	48.7	88.4	-	64.4	53.1	-		4.6	-	2.6	3.9	-	2.8	15.4	-	7.8	
Total Thallium (Tl)	ug/L	0.10	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	0.8
Total Tin (Sn)	ug/L	2.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Titanium (Ti)	ug/L	2.0	ND	-	ND	ND	-	ND	2.0	-	ND	2.6	-	ND	3.3	-	2.3	11.6	-	4.2	
Total Uranium (U)	ug/L	0.10	ND	-	ND	ND	-	ND	0.24	-	ND	0.17	-	ND	ND	-	ND	0.58	-	ND	
Total Vanadium (V)	ug/L	2.0	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	ND	-	ND	
Total Zinc (Zn)	ug/L	5.0	18.1	9	11.1	15.0	6.7	5.8	5.3	6.1	5.2	5.7	7.3	ND	ND	5	5.2	5.2	ND	ND	30

Values in bold exceed CCME FAL guidelines

Table A3 Brunello Estates Water Chemistry (General Chemistry)

RESULTS OF ANALYSES OF WATER			Watercourse #6												CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter			
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	4/28/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	**Units**	**RDL**													
Anion Sum	me/L	N/A	-	-	1.640	-	-	1.16	-	-	3.19	2.090	-		
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	19	-	-	9.1	-	-	12	10	-		
Calculated TDS	mg/L	1.0	-	-	114.0	-	-	86.0	-	-	190	130	-		
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	ND	-	-	ND	-	-	ND	ND	-		
Cation Sum	me/L	N/A	-	-	2.000	-	-	1.47	-	-	3.05	2.210	-		
Hardness (CaCO3)	mg/L	1.0	-	-	35	-	-	24	-	-	42	31	-		
Ion Balance (% Difference)	%	N/A	-	-	9.9	-	-	11.8	-	-	2.24	2.79	-		
Langelier Index (@ 20C)	N/A		-	-	-1.96	-	-	-2.86	-	-	-2.54	-2.53	-		
Langelier Index (@ 4C)	N/A		-	-	-2.22	-	-	-3.11	-	-	-2.79	-2.78	-		
Nitrate (N)	mg/L	0.050	-	-	0.48	-	-		-	-	-	0.44	-		13
Saturation pH (@ 20C)	N/A		-	-	9.09	-	-	9.6	-	-	9.2	9.37	-		
Saturation pH (@ 4C)	N/A		-	-	9.35	-	-	9.85	-	-	9.45	9.62	-		
Inorganics	**Units**														
Total Alkalinity (Total as CaCO3)	mg/L	5.0	-	-	20	-	-	9.1	-	-	12	10	-		
Dissolved Chloride (Cl)	mg/L	1.0	-	-	37	-	-	24	-	-	95	58	-		120
Colour	TCU	50	76	**130**	79	120	-	64	50	-	19	47	38	70	
Nitrate + Nitrite	mg/L	0.050	-	-	0.48	-	-	1.6	-	-	0.57	0.44	-	-	
Nitrite (N)	mg/L	0.010	-	-	ND	-	-		-	-	-	ND	-	-	0.06
Nitrogen (Ammonia Nitrogen)	mg/L	0.050	-	-	ND	-	-	ND	-	-	ND	ND	-	-	69.7 - 153
Total Organic Carbon	mg/L	5.0	-	-	9.4	-	-	8.9	-	-	3.9	6.6	-	-	
Orthophosphate (P)	mg/L	0.010	-	-	0.013	-	-	ND	-	-	ND	ND	-	-	
pH	pH	N/A	-	-	7.13	-	-	6.74	-	-	6.66	6.84	-	-	6.5 - 9.0
Total Phosphorus	mg/L	0.002	0.037	0.054	0.082	0.084	0.15	0.14	0.052	-	0.03	0.028	0.032	0.089	
Reactive Silica (SiO2)	mg/L	0.50	-	-	11	-	-	7.8	-	-	7.7	7.2	-	-	
Total Suspended Solids	mg/L	1.0	2.6	12	14	29	22	20	8.2	-	4.1	5.6	6	10	STE: 27.0; LTE: 7.0
Dissolved Sulphate (SO4)	mg/L	2.0	-	-	8.4	-	-	9.4	-	-	11	9.5	-	-	
Turbidity	NTU	0.10	-	7.5	38.0	40	73	120.0	14.0	-	13	**12.0**	9.4	**34.0**	STE: 10.0; LTE: 4.0
Conductivity	uS/cm	1.0	-	-	190	-	-	130		-	370	250	-	-	
Microbiological	**Units**														
Escherichia coli	CFU/100mL	1.0	6	40	140.0	ND	100	20.0	ND	-	ND	ND	ND	80	200
Field Measurements	**Units**														
Water Temperature	°C	0.01	8.5	14.8	15.4	12.7	7.2	5.4	2	-	5.5	5.3	8.6	16.2	
pH	pH	0.01	**6.48**	7.18	**6.32**	**6.34**	6.7	6.62	6.8	-	7.95	7.95	5.58	5.6	6.5 - 9.0
Specific Conductivity	µS/cm	1	183	153	106	123	104	86	202	-	274	247	156	317	
Dissolved Oxygen	mg/L	0.01	9.7	7.1	7.5	8.7	11.4	9.1	8.1	-	10.4	10.4	6.6	9.41	5.5 Minimum
Dissolved Oxygen	%	0.1	-	69	75	82	94	72	75	-	81	81	57	97	
Total Dissolved Solids	g/L	0.001	0.116	0.093	0.095	0.076	0.066	0.066	0.094	-	0.247	0.124	0.147	0.206	
Air Temperature	°C	1	-	-	-	-		-3	-4	-	-5	5	10	18	

Values in bold exceed CCME FAL/Recreational guidelines

Table A4 Brunello Estates Water Chemistry (Metals)

RESULTS OF ANALYSES OF WATER			Watercourse #6												CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter			
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	4/28/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	Units	RDL													
Total Aluminum (Al)	ug/L	5.0	-	-	**2600**	-	-	-	-	-	**-**	970	-	-	100
Total Antimony (Sb)	ug/L	1.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Arsenic (As)	ug/L	1.0	-	-	**3.7**	-	-	-	-	-	**-**	1.5	-	-	5
Total Barium (Ba)	ug/L	1.0	-	-	34.1	-	-	-	-	-	-	24	-	-	
Total Beryllium (Be)	ug/L	1.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Bismuth (Bi)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Boron (B)	ug/L	50	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Cadmium (Cd)	ug/L	0.017	-	-	**0.05**	-	-	**-**	-	-	**-**	0.033	-	-	0.017
Total Calcium (Ca)	ug/L	100	-	-	9230	-	-	6000	-	-	13000	9400	-	-	
Total Chromium (Cr)	ug/L	1.0	-	-	3.1	-	-	-	-	-	-	ND	-	-	
Total Cobalt (Co)	ug/L	0.40	-	-	1.04	-	-	**-**	-	-	-	ND	-	-	
Total Copper (Cu)	ug/L	2.0	-	-	**3.2**	-	-	**5.4**	-	-	ND	6.4	-	-	2
Total Iron (Fe)	ug/L	50	-	-	**2890**	-	-	**5600**	-	-	**1000**	**1300**	-	-	300
Total Lead (Pb)	ug/L	0.50	-	-	**2.3**	-	-	-	-	-	**-**	0.9	-	-	1
Total Magnesium (Mg)	ug/L	100	-	-	2840	-	-	2100	-	-	2600	1900	-	-	
Total Manganese (Mn)	ug/L	2.0	-	-	96.3	-	-	130	-	-	54	34	-	-	
Total Molybdenum (Mo)	ug/L	2.0	-	-	ND	-	-	**-**	-	-	-	ND	-	-	
Total Nickel (Ni)	ug/L	2.0	-	-	2.5	-	-	-	-	-	-	ND	-	-	25
Total Phosphorus (P)	ug/L	100	-	-	ND	-	-	**-**	-	-	-	ND	-	-	
Total Potassium (K)	ug/L	100	-	-	2340	-	-	2500	-	-	1700	1600	-	-	
Total Selenium (Se)	ug/L	1.0	-	-	ND	-	-	**-**	-	-	-	ND	-	-	1
Total Silver (Ag)	ug/L	0.10	-	-	ND	-	-	-	-	-	-	ND	-	-	0.1
Total Sodium (Na)	ug/L	100	-	-	26400	-	-	17000	-	-	49000	35000	-	-	
Total Strontium (Sr)	ug/L	2.0	-	-	37.2	-	-	-	-	-	-	35	-	-	
Total Thallium (Tl)	ug/L	0.10	-	-	ND	-	-	-	-	-	-	ND	-	-	0.8
Total Tin (Sn)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Titanium (Ti)	ug/L	2.0	-	-	87.4	-	-	-	-	-	-	26	-	-	
Total Uranium (U)	ug/L	0.10	-	-	0.93	-	-	-	-	-	-	0.51	-	-	
Total Vanadium (V)	ug/L	2.0	-	-	4.3	-	-	-	-	-	-	ND	-	-	
Total Zinc (Zn)	ug/L	5.0	-	-	ND	-	-	17	-	-	9.3	10	-	-	30

Values in bold exceed CCME FAL guidelines

Table A5 Brunello Estates Water Chemistry (General Chemistry)

RESULTS OF ANALYSES OF WATER			Watercourse #7											CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter			
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	4/28/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	**Units**	**RDL**													
Anion Sum	me/L	N/A	-	-	0.260	-	-	0.200	-	-	0.24	0.22	-	-	
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	ND	-	-	ND	-	-	ND	ND	-	-	
Calculated TDS	mg/L	1.0	-	-	26	-	-	31	-	-	26	21	-	-	
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	ND	-	-	ND	-	-	ND	ND	-	-	
Cation Sum	me/L	N/A	-	-	0.500	-	-	0.76	-	-	0.57	0.43	-	-	
Hardness (CaCO3)	mg/L	1.0	-	-	6	-	-	11	-	-	7.7	5.9	-	-	
Ion Balance (% Difference)	%	N/A	-	-	31.6	-	-	58.3	-	-	40.7	32.3	-	-	
Langelier Index (@ 20C)	N/A		-	-	NC	-	-	NC	-	-	NC	NC	-	-	
Langelier Index (@ 4C)	N/A		-	-	NC	-	-	NC	-	-	NC	NC	-	-	
Nitrate (N)	mg/L	0.050	-	-	ND	-	-	-	-	-	-	ND	-	-	13
Saturation pH (@ 20C)	N/A		-	-	NC	-	-	NC	-	-	NC	NC	-	-	
Saturation pH (@ 4C)	N/A		-	-	NC	-	-	NC	-	-	NC	NC	-	-	
Inorganics	**Units**														
Total Alkalinity (Total as CaCO3)	mg/L	5.0	-	-	ND	-	-	ND	-	-	ND	ND	-	-	
Dissolved Chloride (Cl)	mg/L	1.0	-	-	9	-	-	7	-	-	8.4	7.9	-	-	120
Colour	TCU	50	240	480	280	260	-	150	130	-	79	110	200	250	
Nitrate + Nitrite	mg/L	0.050	-	-	ND	-	-	ND	-	-	ND	ND	-	-	
Nitrite (N)	mg/L	0.010	-	-	ND	-	-		-	-	-	ND	-	-	0.06
Nitrogen (Ammonia Nitrogen)	mg/L	0.050	-	-	ND	-	-	ND	-	-	ND	ND	-	-	69.7 - 153
Total Organic Carbon	mg/L	5.0	-	-	22 (1)	-	-	12	-	-	6.6	11	-	-	
Orthophosphate (P)	mg/L	0.010	-	-	0.021	-	-	0.011	-	-	ND	ND	-	-	
pH	pH	N/A	**-**	-	**4.85**	**-**	-	**5.08**	-	-	**5.33**	**5.01**	-	**-**	6.5 - 9.0
Total Phosphorus	mg/L	0.002	0.043	0.098	0.06	0.041	0.13	0.14	0.056	-	0.059	0.034	0.056	0.12	
Reactive Silica (SiO2)	mg/L	0.50	-	-	6	-	-	5.5	-	-	3.7	2.7	-	-	
Total Suspended Solids	mg/L	1.0	3.2	3.4	ND	ND	21	31	1300	-	11	5.6	3.5	7	STE: 27.0; LTE: 7.0
Dissolved Sulphate (SO4)	mg/L	2.0	-	-	ND	-	-	ND	-	-	ND	ND	-	-	
Turbidity	NTU	0.10	2.1	1.9	1.8	3.5	100	150	34	-	57	**23.0**	**10.0**	**67.0**	STE: 10.0; LTE: 4.0
Conductivity	uS/cm	1.0	-	-	46	-	-	44	-	-	42	38	-	-	
Microbiological	**Units**														
Escherichia coli	CFU/100mL	1.0	ND	10	2	ND	ND	ND	ND	-	ND	ND	ND	40	200
Field Measurements	**Units**														
Water Temperature	°C	0.01	8.9	16	17.4	14.1	7.7	5	1.1	-	5.9	5.9	7.9	18.1	
pH	pH	0.01	**5.52**	7.18	**4.34**	**5.36**	**6.08**	**6.24**	6.73	**-**	**6.02**	**6.02**	6.92	6.51	6.5 - 9.0
Specific Conductivity	µS/cm	1	42	41	44	29	35	23	50	-	31	31	25.1	156	
Dissolved Oxygen	mg/L	0.01	7.3	5	6.1	8.9	9.5	6.5	8.2	-	10.4	10.4	8.4	6.35	5.5 Minimum
Dissolved Oxygen	%	0.1	-	53	59	88	80	52	67	-	83	83	71	69	
Total Dissolved Solids	g/L	0.001	0.02	0.022	0.02	0.018	0.017	0.018	0.021	-	0.015	0.015	0.013	0.99	
Air Temperature	°C	1	-	-	-	-	-	-3	-4	-	-5	5.6	10	18	

Values in bold exceed CCME FAL/Recreational guidelines

Table A6 Brunello Estates Water Chemistry (Metals)

RESULTS OF ANALYSES OF WATER			Watercourse #7											CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter			
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	4/28/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	Units	RDL													
Total Aluminum (Al)	ug/L	5.0	-	-	**829**	-	-	**-**	-	-	**-**	2500	-	-	100
Total Antimony (Sb)	ug/L	1.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Arsenic (As)	ug/L	1.0	-	-	**4.1**	-	-	**-**	-	-	**-**	2.1	-	-	5
Total Barium (Ba)	ug/L	1.0	-	-	11.3	-	-	-	-	-	-	17	-	-	
Total Beryllium (Be)	ug/L	1.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Bismuth (Bi)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Boron (B)	ug/L	50	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Cadmium (Cd)	ug/L	0.017	-	-	**0.073**	-	-	-	-	-	-	0.036	-	-	0.017
Total Calcium (Ca)	ug/L	100	-	-	1370	-	-	1500	-	-	1300	1200	-	-	
Total Chromium (Cr)	ug/L	1.0	-	-	1.2	-	-	-	-	-	-	1.9	-	-	
Total Cobalt (Co)	ug/L	0.40	-	-	0.79	-	-	-	-	-	-	0.78	-	-	
Total Copper (Cu)	ug/L	2.0	-	-	ND	-	-	**7.7**	-	-	**4**	2.9	-	-	2
Total Iron (Fe)	ug/L	50	-	-	**1770**	-	-	**7400**	-	-	**3600**	1700	-	-	300
Total Lead (Pb)	ug/L	0.50	-	-	**1.98**	-	-	-	-	-	-	1.5	-	-	1
Total Magnesium (Mg)	ug/L	100	-	-	634	-	-	1800	-	-	1100	690	-	-	
Total Manganese (Mn)	ug/L	2.0	-	-	96.6	-	-	200	-	-	130	110	-	-	
Total Molybdenum (Mo)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Nickel (Ni)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	ND	-	-	25
Total Phosphorus (P)	ug/L	100	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Potassium (K)	ug/L	100	-	-	1320	-	-	2800	-	-	2100	1300	-	-	
Total Selenium (Se)	ug/L	1.0	-	-	ND	-	-	-	-	-	-	ND	-	-	1
Total Silver (Ag)	ug/L	0.10	-	-	ND	-	-	-	-	-	-	ND	-	-	0.1
Total Sodium (Na)	ug/L	100	-	-	6080	-	-	4400	-	-	5100	4800	-	-	
Total Strontium (Sr)	ug/L	2.0	-	-	8.4	-	-	-	-	-	-	7	-	-	
Total Thallium (Tl)	ug/L	0.10	-	-	ND	-	-	-	-	-	-	ND	-	-	0.8
Total Tin (Sn)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	ND	-	-	
Total Titanium (Ti)	ug/L	2.0	-	-	11.6	-	-	-	-	-	-	64	-	-	
Total Uranium (U)	ug/L	0.10	-	-	0.82	-	-	-	-	-	-	0.66	-	-	
Total Vanadium (V)	ug/L	2.0	-	-	ND	-	-	-	-	-	-	3.3	-	-	
Total Zinc (Zn)	ug/L	5.0	-	-	6.7	-	-	26	-	-	15	10	-	-	30

Values in bold exceed CCME FAL guidelines

Table A7 Brunello Estates Water Chemistry (General Chemistry)

RESULTS OF ANALYSES OF WATER			Watercourse #9											CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter		
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	5/30/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	**Units**	**RDL**													
Anion Sum	me/L	N/A	-	-	-	-	-	0.920	-	-	4.32	3.190	-	-	
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	-	-	-	ND	-	-	ND	ND	-	-	
Calculated TDS	mg/L	1.0	-	-	-	-	-	67	-	-	260	190	-	-	
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	-	-	-	ND	-	-	ND	ND	-	-	
Cation Sum	me/L	N/A	-	-	-	-	-	1.290	-	-	4.33	3.170	-	-	
Hardness (CaCO3)	mg/L	1.0	-	-	-	-	-	10	-	-	33	22	-	-	
Ion Balance (% Difference)	%	N/A	-	-	-	-	-	16.7	-	-	0.12	0.31	-	-	
Langelier Index (@ 20C)	N/A		-	-	-	-	-	NC	-	-	NC	NC	-	-	
Langelier Index (@ 4C)	N/A		-	-	-	-	-	NC	-	-	NC	NC	-	-	
Nitrate (N)	mg/L	0.050	-	-	-	-	-		-	-	-	0.12	-	-	13
Saturation pH (@ 20C)	N/A		-	-	-	-	-	NC	-	-	NC	NC	-	-	
Saturation pH (@ 4C)	N/A		-	-	-	-	-	NC	-	-	NC	NC	-	-	
Inorganics	**Units**														
Total Alkalinity (Total as CaCO3)	mg/L	5.0	-	-	-	-	-	ND	-	-	ND	ND	-	-	
Dissolved Chloride (Cl)	mg/L	1.0	-	-	-	-	-	33	-	-	**140**	110	-	-	120
Colour	TCU	50	-	-	-	-	-	270	100	-	42	82	63	150	
Nitrate + Nitrite	mg/L	0.050	-	-	-	-	-	0.079	-	-	0.12	0.12	-	-	
Nitrite (N)	mg/L	0.010	-	-	-	-	-	-	-	-	-	ND	-	-	0.06
Nitrogen (Ammonia Nitrogen)	mg/L	0.050	-	-	-	-	-	ND	-	-	0.068	ND	-	-	69.7 - 153
Total Organic Carbon	mg/L	5.0	-	-	-	-	-	14 (1)	-	-	4	6.9	-	-	
Orthophosphate (P)	mg/L	0.010	-	-	-	-	-	0.011	-	-	ND	ND	-	-	
pH	pH	N/A	**-**	-	**-**	**-**	-	**5.35**	-	-	**5.11**	**5.07**	-	**-**	6.5 - 9.0
Total Phosphorus	mg/L	0.002	-	-	-	-	0.052	0.044	0.028	-	ND	0.022	0.032	0.046	
Reactive Silica (SiO2)	mg/L	0.50	-	-	-	-	-	5	-	-	4.6	4	-	-	
Total Suspended Solids	mg/L	1.0	-	-	-	-	3	4.8	3.6	-	ND	1.6	3	4.5	STE: 26.0; LTE: 6.0
Dissolved Sulphate (SO4)	mg/L	2.0	-	-	-	-	-	ND	-	-	11	10	-	-	
Turbidity	NTU	0.10	-	-	-	-	30.0	34.0	6.3	-	9	8.5	4.8	7.7	STE: 8.5; LTE: 2.5
Conductivity	uS/cm	1.0	-	-	-	-	-	120	-	-	520	370	-	-	
Microbiological	**Units**														
Escherichia coli	CFU/100mL	1.0	-	-	-	-	ND	100	10	-	10	150	30	890	200
Field Measurements	**Units**														
Water Temperature	°C	0.01	-	-	-	-	6.7	4.1	2.3	-	5	5	13.2	15.2	
pH	pH	0.01	**-**	**-**	**-**	**-**	**6.02**	**5.95**	**5.9**	**-**	**5.38**	**5.38**	**5.28**	**4.91**	6.5 - 9.0
Specific Conductivity	µS/cm	1	-	-	-	-	144	102	156	-	373	373	442	591	
Dissolved Oxygen	mg/L	0.01	-	-	-	-	10.2	7.9	9.4	-	10.5	10.5	8.7	7.85	5.5 Minimum
Dissolved Oxygen	%	0.1	-	-	-	-	84	60	74	-	82	82	84	80	
Total Dissolved Solids	g/L	0.001	-	-	-	-	0.089	0.062	-	-	0.184	0.184	0.262	3.79	
Air Temperature	°C	1	-	-	-	-	-	-3	-3	-	-5	4.5	10	18	

Values in bold exceed CCME FAL/Recreational guidelines

Table A8 Brunello Estates Water Chemistry (Metals)

RESULTS OF ANALYSES OF WATER				Watercourse #9													CCME FAL
Sampling Period				Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter				
Date			mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	4/28/2014	5/30/2014	7/2/2014		Guidelines
Calculated Parameters		Units	RDL														
Total Aluminum (Al)	Total Aluminum (Al)	ug/L	5.0	-	-	-	-	-	-	-	-	-	1100	-	-		100
Total Antimony (Sb)	Total Antimony (Sb)	ug/L	1.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Arsenic (As)	Total Arsenic (As)	ug/L	1.0	-	-	-	-	-	-	-	-	-	ND	-	-		5
Total Barium (Ba)	Total Barium (Ba)	ug/L	1.0	-	-	-	-	-	-	-	-	-	33	-	-		
Total Beryllium (Be)	Total Beryllium (Be)	ug/L	1.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Bismuth (Bi)	Total Bismuth (Bi)	ug/L	2.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Boron (B)	Total Boron (B)	ug/L	50	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Cadmium (Cd)	Total Cadmium (Cd)	ug/L	0.017	-	-	-	-	-	-	-	-	-	0.069	-	-		0.017
Total Calcium (Ca)	Total Calcium (Ca)	ug/L	100	-	-	-	-	-	2500	-	-	10000	6900	-	-		
Total Chromium (Cr)	Total Chromium (Cr)	ug/L	1.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Cobalt (Co)	Total Cobalt (Co)	ug/L	0.40	-	-	-	-	-	-	-	-	-	0.65	-	-		
Total Copper (Cu)	Total Copper (Cu)	ug/L	2.0	-	-	-	-	-	**3.4**	-	-	ND	2.1	-	-		2
Total Iron (Fe)	Total Iron (Fe)	ug/L	50	-	-	-	-	-	**2800**	-	-	**830**	920	-	-		300
Total Lead (Pb)	Total Lead (Pb)	ug/L	0.50	-	-	-	-	-	-	-	-	-	1.4	-	-		1
Total Magnesium (Mg)	Total Magnesium (Mg)	ug/L	100	-	-	-	-	-	1000	-	-	1900	1300	-	-		
Total Manganese (Mn)	Total Manganese (Mn)	ug/L	2.0	-	-	-	-	-	80	-	-	160	120	-	-		
Total Molybdenum (Mo)	Total Molybdenum (Mo)	ug/L	2.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Nickel (Ni)	Total Nickel (Ni)	ug/L	2.0	-	-	-	-	-	-	-	-	-	ND	-	-		25
Total Phosphorus (P)	Total Phosphorus (P)	ug/L	100	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Potassium (K)	Total Potassium (K)	ug/L	100	-	-	-	-	-	1400	-	-	1200	1200	-	-		
Total Selenium (Se)	Total Selenium (Se)	ug/L	1.0	-	-	-	-	-	-	-	-	-	ND	-	-		1
Total Silver (Ag)	Total Silver (Ag)	ug/L	0.10	-	-	-	-	-	-	-	-	-	ND	-	-		0.1
Total Sodium (Na)	Total Sodium (Na)	ug/L	100	-	-	-	-	-	22000	-	-	83000	61000	-	-		
Total Strontium (Sr)	Total Strontium (Sr)	ug/L	2.0	-	-	-	-	-	-	-	-	-	28	-	-		
Total Thallium (Tl)	Total Thallium (Tl)	ug/L	0.10	-	-	-	-	-	-	-	-	-	ND	-	-		0.8
Total Tin (Sn)	Total Tin (Sn)	ug/L	2.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Titanium (Ti)	Total Titanium (Ti)	ug/L	2.0	-	-	-	-	-	-	-	-	-	22	-	-		
Total Uranium (U)	Total Uranium (U)	ug/L	0.10	-	-	-	-	-	-	-	-	-	0.23	-	-		
Total Vanadium (V)	Total Vanadium (V)	ug/L	2.0	-	-	-	-	-	-	-	-	-	ND	-	-		
Total Zinc (Zn)	Total Zinc (Zn)	ug/L	5.0	-	-	-	-	-	12	-	-	20	15	-	-		30

Values in bold exceed CCME FAL guidelines

Table A9 Brunello Estates Water Chemistry (General Chemistry)

RESULTS OF ANALYSES OF WATER			Watercourse #11											CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter			
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	4/28/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	**Units**	**RDL**													
Anion Sum	me/L	N/A	-	-	-	-	-	-	-	-	-	-	-	-	
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Calculated TDS	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Cation Sum	me/L	N/A	-	-	-	-	-	-	-	-	-	-	-	-	
Hardness (CaCO3)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Ion Balance (% Difference)	%	N/A	-	-	-	-	-	-	-	-	-	-	-	-	
Langelier Index (@ 20C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Langelier Index (@ 4C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Nitrate (N)	mg/L	0.050	-	-	-	-	-	-	-	-	-	-	-	-	13
Saturation pH (@ 20C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Saturation pH (@ 4C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Inorganics	**Units**														
Total Alkalinity (Total as CaCO3)	mg/L	5.0	-	-	-	-	-	-	-	-	-	-	-	-	
Dissolved Chloride (Cl)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	120
Colour	TCU	50	-	-	-	-	-	-	-	-	-	-	63	210	
Nitrate + Nitrite	mg/L	0.050	-	-	-	-	-	-	-	-	-	-	-	-	
Nitrite (N)	mg/L	0.010	-	-	-	-	-	-	-	-	-	-	-	-	0.06
Nitrogen (Ammonia Nitrogen)	mg/L	0.050	-	-	-	-	-	-	-	-	-	-	-	-	69.7 - 153
Total Organic Carbon	mg/L	5.0	-	-	-	-	-	-	-	-	-	-	-	-	
Orthophosphate (P)	mg/L	0.010	-	-	-	-	-	-	-	-	-	-	-	-	
pH	pH	N/A	-	-	-	-	-	-	-	-	-	-	-	-	6.5 - 9.0
Total Phosphorus	mg/L	0.002	-	-	-	-	-	-	-	-	-	-	0.032	0.043	
Reactive Silica (SiO2)	mg/L	0.50	-	-	-	-	-	-	-	-	-	-	-	-	
Total Suspended Solids	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	3	6.5	STE: 26.0; LTE: 6.0
Dissolved Sulphate (SO4)	mg/L	2.0	-	-	-	-	-	-	-	-	-	-	-	-	
Turbidity	NTU	0.10	-	-	-	-	-	-	-	-	-	-	4.8	1.6	STE: 8.4; LTE: 2.4
Conductivity	uS/cm	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Microbiological	**Units**														
Escherichia coli	CFU/100mL	1.0	-	-	-	-	-	-	-	-	-	-	ND	ND	200
Field Measurements	**Units**														
Water Temperature	°C	0.01	-	-	-	-	-	-	-	-	-	-	7.4	15.9	
pH	pH	0.01	-	-	-	-	-	-	-	-	-	-	**4.03**	**3.64**	6.5 - 9.0
Specific Conductivity	µS/cm	1	-	-	-	-	-	-	-	-	-	-	24.8	42	
Dissolved Oxygen	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	2.8	2.99	5.5 Minimum
Dissolved Oxygen	%	0.1	-	-	-	-	-	-	-	-	-	-	14	31	
Total Dissolved Solids	g/L	0.001	-	-	-	-	-	-	-	-	-	-	0.013	0.027	
Air Temperature	°C	1	-	-	-	-	-	-	-	-	-	-	10	18	

Values in bold exceed CCME FAL/Recreational guidelines

Table A10 Brunello Estates Water Chemistry (General Chemistry)

RESULTS OF ANALYSES OF WATER			Watercourse #13											CCME FAL
Sampling Period			Year 3 - First Quarter			Year 3 - Second Quarter			Year 3 - Third Quarter			Year 3 - Fourth Quarter			
Date		mm/dd/yyyy	6/7/2013	7/11/2013	8/16/2013	9/19/2013	10/29/2013	11/29/2013	12/20/2013	-	3/25/2014	5/30/2014	5/30/2014	7/2/2014	Guidelines
Calculated Parameters	**Units**	**RDL**													
Anion Sum	me/L	N/A	-	-	-	-	-	-	-	-	-	-	-	-	
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Calculated TDS	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Carb. Alkalinity (calc. as CaCO3)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Cation Sum	me/L	N/A	-	-	-	-	-	-	-	-	-	-	-	-	
Hardness (CaCO3)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Ion Balance (% Difference)	%	N/A	-	-	-	-	-	-	-	-	-	-	-	-	
Langelier Index (@ 20C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Langelier Index (@ 4C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Nitrate (N)	mg/L	0.050	-	-	-	-	-	-	-	-	-	-	-	-	13
Saturation pH (@ 20C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Saturation pH (@ 4C)	N/A		-	-	-	-	-	-	-	-	-	-	-	-	
Inorganics	**Units**														
Total Alkalinity (Total as CaCO3)	mg/L	5.0	-	-	-	-	-	-	-	-	-	-	-	-	
Dissolved Chloride (Cl)	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	-	-	120
Colour	TCU	50	-	-	-	-	-	-	-	-	-	-	72	91	
Nitrate + Nitrite	mg/L	0.050	-	-	-	-	-	-	-	-	-	-	-	-	
Nitrite (N)	mg/L	0.010	-	-	-	-	-	-	-	-	-	-	-	-	0.06
Nitrogen (Ammonia Nitrogen)	mg/L	0.050	-	-	-	-	-	-	-	-	-	-	-	-	69.7 - 153
Total Organic Carbon	mg/L	5.0	-	-	-	-	-	-	-	-	-	-	-	-	
Orthophosphate (P)	mg/L	0.010	-	-	-	-	-	-	-	-	-	-	-	-	
pH	pH	N/A	-	-	-	-	-	-	-	-	-	-	-	-	6.5 - 9.0
Total Phosphorus	mg/L	0.002	-	-	-	-	-	-	-	-	-	-	0.048	0.038	
Reactive Silica (SiO2)	mg/L	0.50	-	-	-	-	-	-	-	-	-	-	-	-	
Total Suspended Solids	mg/L	1.0	-	-	-	-	-	-	-	-	-	-	2.5	4	STE: 31.3; LTE: 11.3
Dissolved Sulphate (SO4)	mg/L	2.0	-	-	-	-	-	-	-	-	-	-	-	-	
Turbidity	NTU	0.10	-	-	-	-	-	-	-	-	-	-	**25.0**	7.8	STE: 9.1; LTE: 3.1
Conductivity	uS/cm	1.0	-	-	-	-	-	-	-	-	-	-	-	-	
Microbiological	**Units**														
Escherichia coli	CFU/100mL	1.0	-	-	-	-	-	-	-	-	-	-	ND	10	200
Field Measurements	**Units**														
Water Temperature	°C	0.01	-	-	-	-	-	-	-	-	-	-	9.2	15.3	
pH	pH	0.01	-	-	-	-	-	-	-	-	-	-	**5.84**	**5.01**	6.5 - 9.0
Specific Conductivity	µS/cm	1	-	-	-	-	-	-	-	-	-	-	43.1	84	
Dissolved Oxygen	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	6.2	6.06	5.5 Minimum
Dissolved Oxygen	%	0.1	-	-	-	-	-	-	-	-	-	-	54	62	
Total Dissolved Solids	g/L	0.001	-	-	-	-	-	-	-	-	-	-	0.052	0.055	
Air Temperature	°C	1	-	-	-	-	-	-	-	-	-	-	10	18	

Values in bold exceed CCME FAL/Recreational guidelines

Appendix B

Figures

AUTHOR: C.Shupe	DATE: February 1, 2010	BRUNELLO ESTATES	FIGURE NO.: **Figure 1**
APPROVED BY: H. Aubrey	SCALE: 1:10,000	**Sample Locations for Brunello Estates Water Quality Monitoring Plan**	Stantec
Brunello Estates	COORDINATE SYSTEM: UTM NAD 83 ZONE 20		

X:\Projects\NovaScotia\104xxxx\1049385_Brunello_Estates\Mapping\MXD\ReportFigures\Fig_XX_Field_Delin_Streams_May2009.mxd

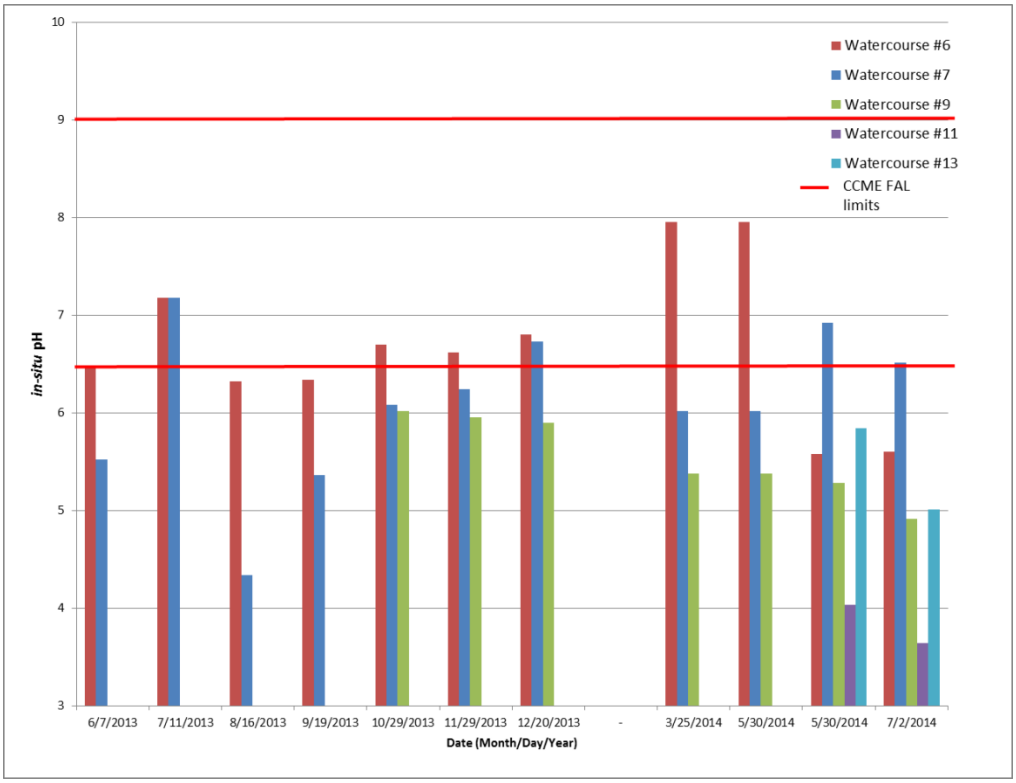

Figure 2. In situ pH of Watercourses Monitored Between June 2013 and July 2014

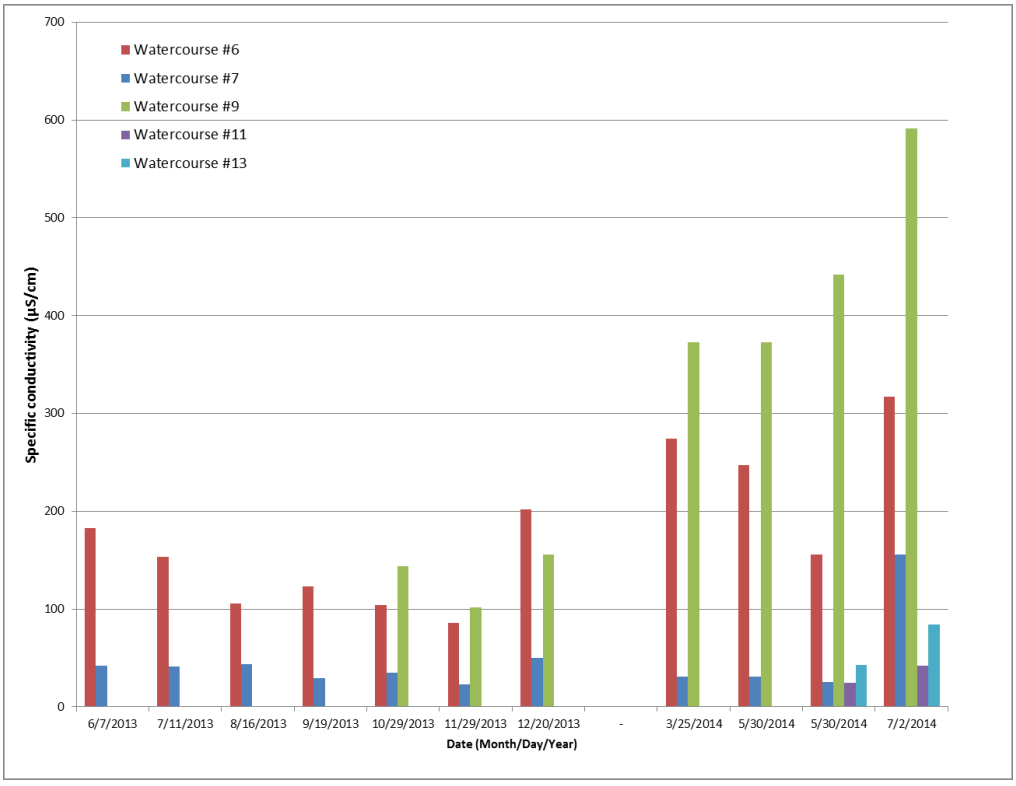

Figure 3. Specific Conductivity of Watercourses Monitored Between June 2013 and July 2014

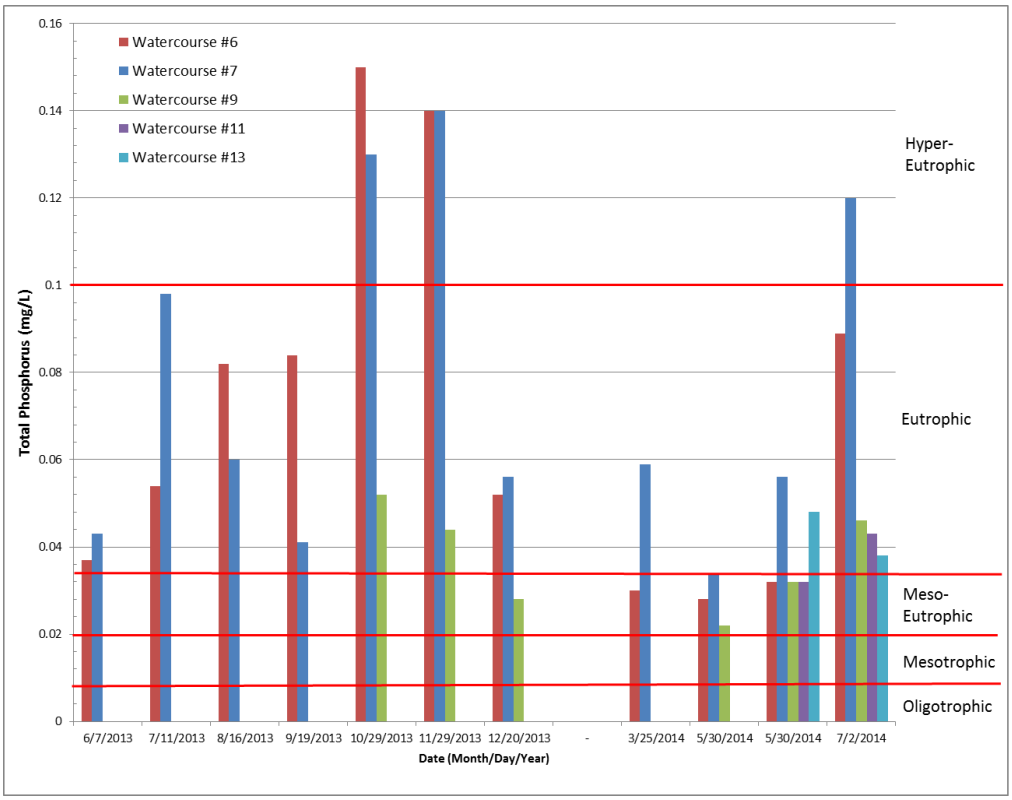

Figure 4. Total Phosphorus of Watercourses Monitored Between June 2013 and July 2014

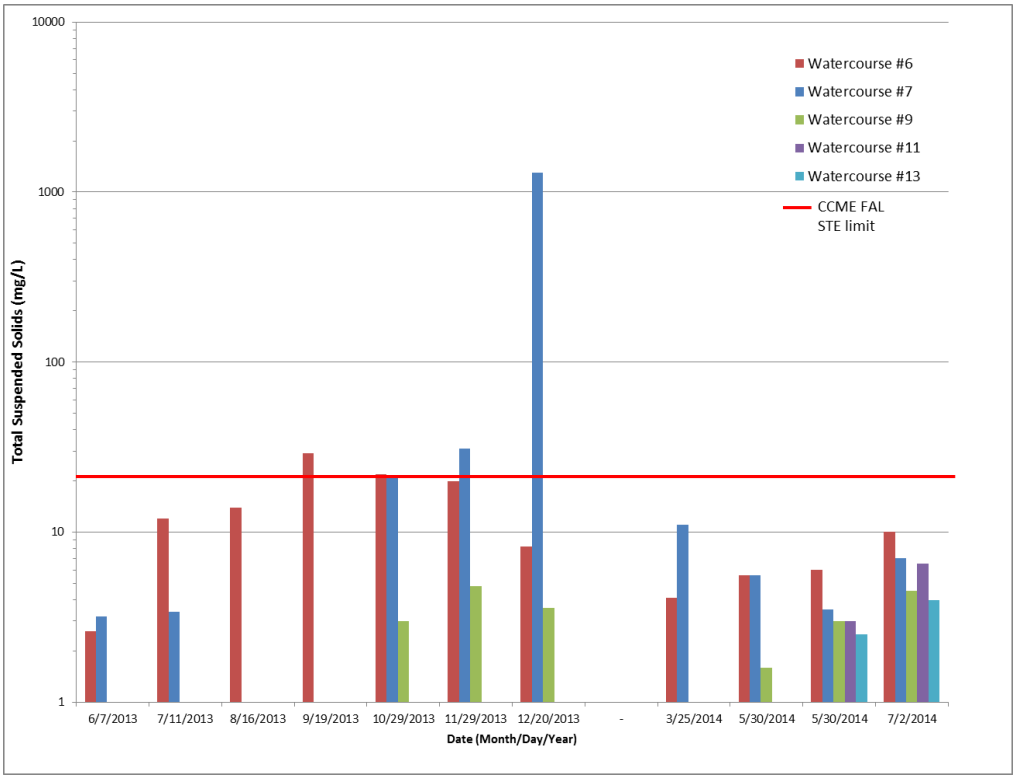

Figure 5. Total Suspended Solids of Watercourses Monitored Between June 2013 and July 2014

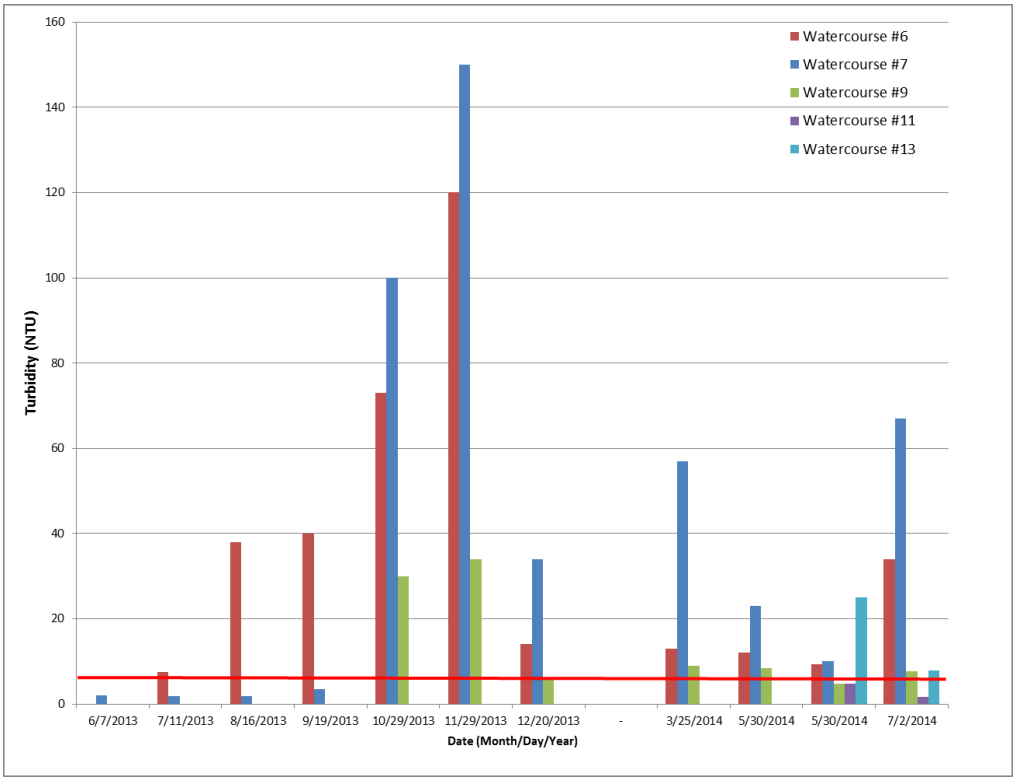

Figure 6. Turbidity of Watercourses Monitored Between June 2013 and July 2014

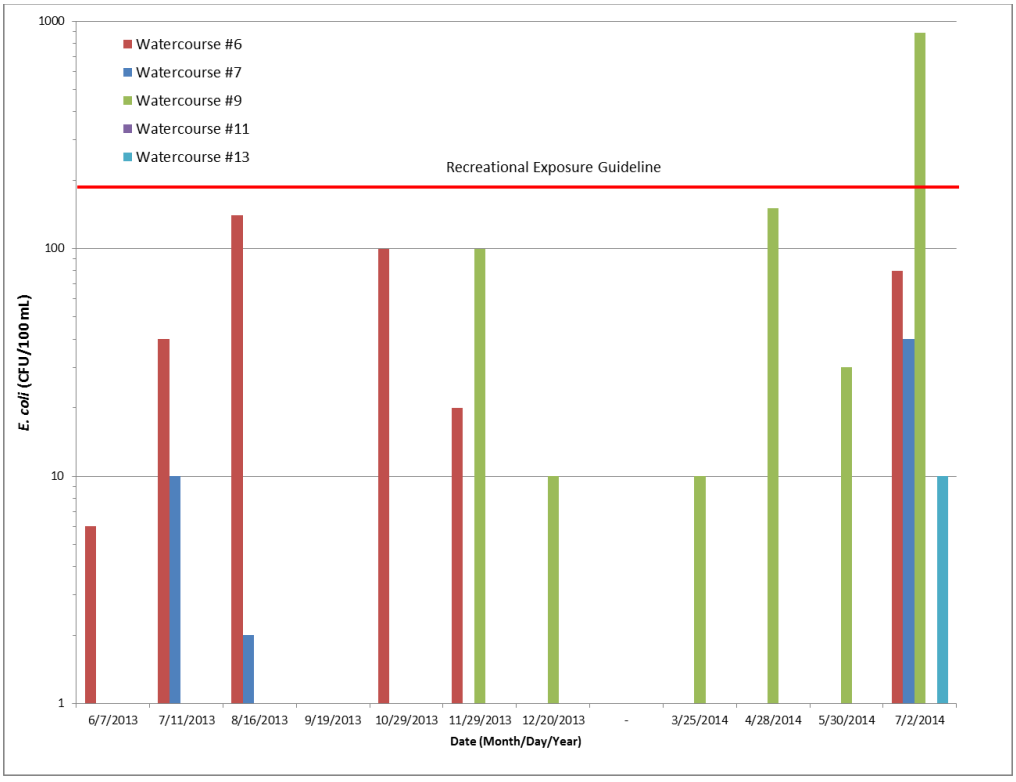

Figure 7. Waterborne *E. coli* in Watercourses Monitored Between June 2013 and July 2014