Environmental Evaluation of the Health of the Shediac Bay

Final Report

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1 Introduction

1.1 Description of the Shediac Bay Watershed Association

The Shediac Bay Watershed Association (SBWA) was founded in 1999 as a result of growing concerns from local community residents over the ecological health of Shediac Bay. In order to establish a long-term water quality-monitoring program, a community-based association was formed.
The Shediac Bay Watershed Association vision and mission statements are as follows:

Our Vision – Communities working together to foster a healthy ecosystem that will sustain the quality of water for future generations.

Our Mission – The SBWA will accomplish its vision through education and community stewardship.

The Board of Directors includes the following members:

Mr. Armand Robichaud, President	Mr. Gerry Dionne	Ms. Petrina Ferris
Mr. Denis Haché, Vice-President	Mr. Léo-Paul Bourgeois	Mr. Louis Vallée
Mr. David Dunn, Past President	Mr. Claude Léger	Mr. Gilles Thibault
Ms. Helen Hall, Treasurer	Mr. Marc Fougère	Mr. Bill Belliveau
Ms. Frances Kelly, Secretary	Ms. Germaine Gallant	Ms. Sophie Landry
Mr. Pierre Landry	Mr Arthur Melanson	

The Shediac Bay Watershed Association gratefully receives guidance, donations and in-kind support from various organizations and interest groups. SBWA has a database of stakeholders consisting of business owners, industry, foresters, farmers, local residents, cottage owners, recreation boaters and swimmers, conservation groups and community organizations within the Shediac Bay Watershed.

1.2 Overview of the Shediac Bay Watershed

The Shediac Bay Watershed covers 420 km^2 of land area and stretches along 36 km of coastline, from Cap Bimet to Cap de Cocagne (Fig. 1). The Shediac Bay Watershed is composed of two major river systems emptying into Shediac Bay: the Shediac River and the Scoudouc River. The Shediac and the Scoudouc Rivers are characterized by small tributaries covering a watersheds of 201.8 and 143.3 km^2, respectively. The Shediac River is composed of two major water arms. The northern water arm is created by the convergence of the McQuade Brook, the Weisner and the Calhoun Brook. The southern water arm of the Shediac River is the continuation of the Batemans Brook. Water velocity in both rivers is generally weak due to the gentle regional elevation. The watershed boundaries stretch into both Kent and Westmorland County and cross into both Shediac and Moncton.

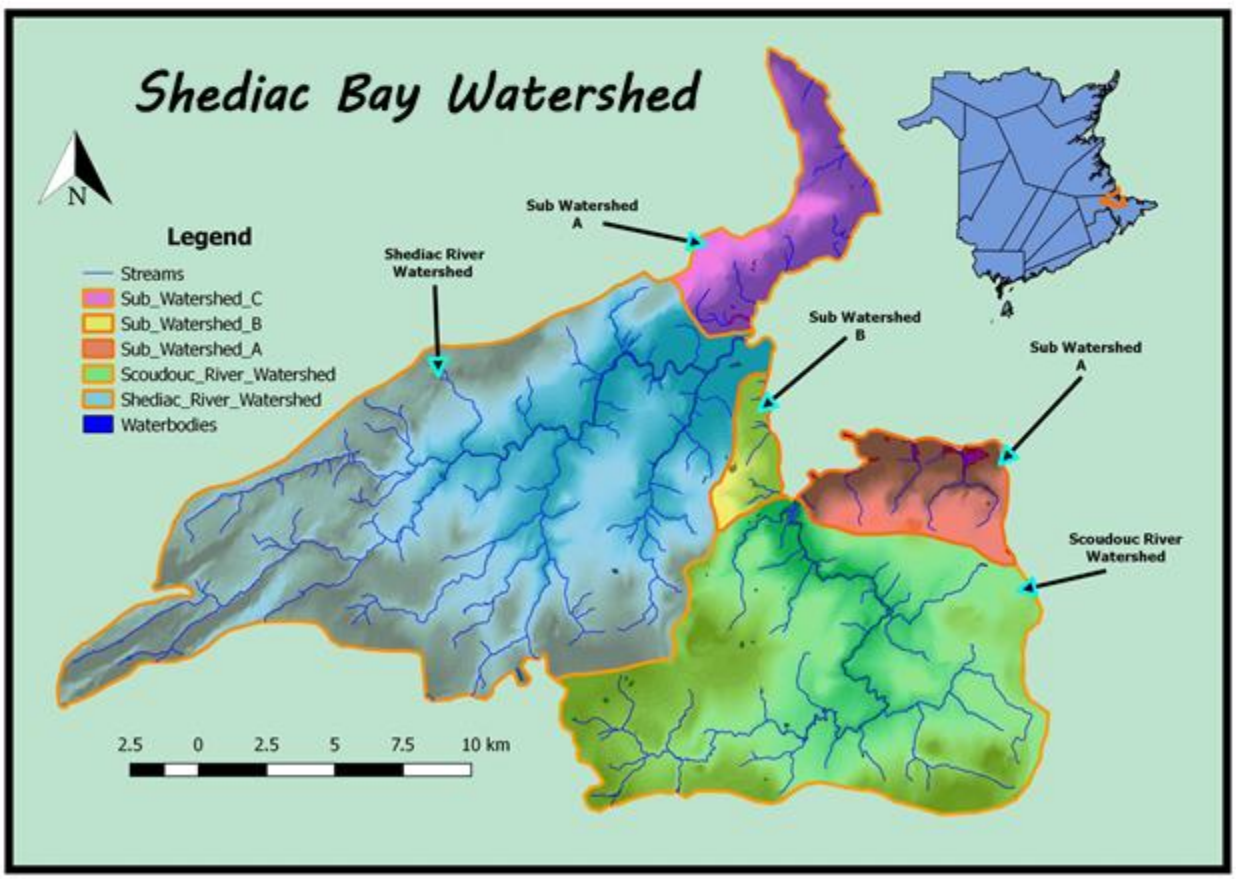

Figure 1: Map of Shediac Bay watershed boundaries and sub-watersheds

1.3 Purpose of project

This project is a continuation of the first phase of an evaluation program to assess water contamination sources and coastal habitats quality of the Shediac Bay.

The Association has been monitoring water quality in the Shediac River and Scoudouc River watersheds since 1999. The freshwater sampling program has been ongoing at the same monitoring stations that were established for the purpose of the development of the NB Water Classification Legislation (2002). Since the beginning of the monitoring program, available funding only allowed for freshwater samplings. Only in recent years has funding been acquired to collect water quality data in the saltwater ecosystems of the watershed. However, other projects have been done in the past that targeted the improvement of water quality in the Shediac Bay, such as the oyster restoration and the septic system replacement programs. For more information on these projects, please visit our website for the full reports; http://www.shediacbayassociation.org/reports-archives/.

In 2015, the SBWA began its "Phase 1" in the Evaluation of the Health of the Shediac Bay project. It began with 7 sampling sites along the coastline of Pointe-du-Chêne, around the mouth of the Scoudouc River and the outer edges of the Shediac River estuary. The sampling continued in 2016 with the addition of 3 new sites. The water sampling was done for E. coli, and was done only once a month (from May to August) due to limited capacity. Although the quantity and frequency of these samplings is inadequate to collect the amount of data needed, it did provide information on where to concentrate our next efforts.

In 2016, a new study was done using "Environmental DNA", or e-DNA, to assess the *source* of the E. coli bacteria that causes water contamination and beach closures. Since E.coli is present in the lower intestines of humans and warm-blooded animals, the source of fecal contamination can be traced back to the species of which it came from by analyzing the DNA of the bacteria. Using this concept and a protocol developed by Vision H2O, water samples were collected at 5 sites in the Shediac Bay, and shipped to a laboratory providing the service. Details of this study are summarized in section 5.0 of this report.

Also in 2016, a partnership was formed with the *Southern Gulf of Saint Lawrence Coalition on Sustainability* to begin the assessment of the eelgrass habitats in the Shediac Bay. The first study site, and monitoring transect, was established in the Scoudouc River estuary, and the second was done in the Shediac River estuary in 2017. These transect are monitored once per year using the SeagrassNet protocol, to measure changes in density of the eelgrass beds due to the threat of the invasive green crab.

Turning the attention toward coastal habitats, a "Marsh Monitoring Program" from Bird Studies Canada began in 2015 to evaluate wetlands for their health and habitat quality for various bird populations. In 2016, staff received training to perform wetland evaluations under the WESP-AC (*Wetland Ecosystem Services Protocol for Atlantic Canada*) evaluation program. The WESP-AC was designed to provide an assessment of the health of both freshwater and saltwater marshes, as well as their ecosystem benefits, functions and services. A report on the WESP-AC assessments for 2016 and 2017 can be found on the SBWA website (Reports and Archives).

As always, public education is always an integral part of all SBWA projects. In recent years, a new website was launched in order to make all project report since 1999 to be publicly available, and to have a solid platform to display educational materials. A collection of interpretation panels have been professionally designed and placed along walking trails and other green spaces around the Town of Shediac. A strong working relationship with teachers in local schools have allowed presentations, activities, and field trips for hundreds of kids and young adults. Annual special events include the beach sweep and tree planting events.

The first phase of any initiative to address water pollution in a watershed must begin with sampling, assessment of land usage and their adjoining buffer zones. Once these studies provides enough data to identify contamination sources, a "Phase 2 Action Plan" can be determined.

2 Water Quality Sampling in Shediac Bay

The SBWA has expanded the water quality sampling program to evaluate the smaller tributaries of the Shediac Bay. These small brooks have never been assessed for water contaminants or evaluated for surrounding land uses and buffer zones. Due to the rise of concern for the health of the Shediac Bay, 11 new sites were added along the coastline from Boudreau-Ouest to Grande-Digue, to assess possible bacterial and contamination sources. All samples are analyzed by RPC Laboratory, and all sample results are sent to the *Department of Environment and Local Government*.

The purpose of the samples taken by the SBWA is to determine priority areas where the association can implement restoration programs such as tree planting along riparian zones. The data is not used to determine the safety of the recreational uses of the bay, such as swimming advisories.

There are many different guideline criteria for determining water quality. For example, Health Canada recommended microbiological guideline values for recreational water quality. The values are based on the presence of fecal indicator bacteria, namely, *Enterococci* for marine water, and *Escherichia coli* for freshwater.

In marine water, the guideline value is set at a geometric mean of 35 enterococci/100 mL when a minimum of 5 samples are collected (average bacterial concentrations of the 5 bottles must be below 35 MPN/100 mL), and the value of a single sample must be below 70 enterococci/100 mL.

In freshwater, the guideline value is set at a geometric mean of 200 E. coli /100 mL when a minimum of 5 samples are collected (average bacterial concentrations of the 5 bottles must be below 200 MPN/100 mL), and the value of a single sample must be below 400 E. coli /100 mL.

For this project, all samples collected are single samples and are analyzed for E. coli, since the small tributaries are freshwater (however, 2 sites are impacted by rising tides, but E. coli can still be used for brackish water). All bacterial data in this report is flagged when levels exceed 400 MPN/100 mL.

Table 1: Guidelines for Health Canada Recreational Water Quality: summary table

Guidelines		
Parameter	Considerations	Guideline
Escherichia coli (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 200 *E. coli* /100 mL ≤ 400 *E. coli* /100 mL
Enterococci (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 35 Enterococci /100 mL ≤ 70 Enterococci /100 mL

3 Methodology

3.1 Water Quality Sampling

Water quality monitoring was conducted once a month from June to October 2017, at 11 new sampling sites in small tributaries along the coast of the Shediac Bay. Water quality sampling was performed using the protocol developed by the New Brunswick Department of Environment. Water samples were not collected after heavy rainfall events.

Basic water quality parameters (DO, temperature, pH, conductivity and salinity) were measured using a new YSI- *Professional Plus* multi-parameter metre. Water samples were sent to *RPC Laboratory* for analysis of *E.coli* and inorganic elements.

The equipment needed to conduct the sampling and collect the habitat data includes; laboratory issued sample bottles, labels, latex or nitrile gloves, clipboard, waterproof paper for field sheets, pencils, waders or rubber boots, GPS, digital camera, YSI (water conditioning metre), metre stick and survey measuring tape.

3.2 Site Information - Small Tributaries of the Shediac Bay

The following describes the sample site information for the 11 new water quality monitoring stations established in 2017.

Table 2: Water Quality Monitoring – Small Streams Site Information

Site ID	Latitude	Longitude	Elevation (m) Google Earth	Brook Name	Location Description
WQ-1	N46°13'24.19"	W64°28'30.36"	10	Unnamed Brook	907 route NB-133, Boudreau-Ouest, Dirt Road after this address, going through the field (sample upstream of the culvert)
WQ-2	N46°13'35.25"	W64°29'48.39"	9	Unnamed Brook	725 route NB-133, Boudreau-Ouest (sample upstream from culvert)
WQ-3	N46°13'18.25"	W64°31'30.94"	13	Unnamed Brook	482 Main st, Shediac, In front of Shediac Bakery (sample upstream of culvert)
WQ-4	N46°13'11.25"	W64°32'56.17"	3	Unnamed Brook	Shediac Town Hall, 290 Main st, sample downstream culvert
WQ-5	N46°13'22.17"	W64°33'58.17"	8	Unnamed Brook	Park at Atkinson Court, walk on Route 133 (sample upstream from culvert)
WQ-6	N46°14'23.90"	W64°34'2.29"	8	Unnamed Brook	Park at Old Mill Rd (Sample upstream from culvert)
WQ-7	N46°14'43.38"	W64°34'7.29"	3	Unnamed Brook	Brook flows between Bay Vista Lodge at 3521 Route 134, Shediac Cape, (sample upstream from culvert)
WQ-8	N46°15'11.99"	W64°34'14.01"	1	Unnamed Brook	In front of Dr. Chiropractor, 3694 Route NB-134, Shediac Cape, (sample upstream of culvert)
WQ-9	N46°16'41.70"	W64°35'13.77"	1	Albert-Gallant Brook	2487 Shediac rd, (sample downstream from culvert due to beaver flooding)
WQ-10	N46°17'8.24"	W64°34'29.13"	3	Unnamed Brook	Brook is after Antoine Rd, Grande-Digue, (sample from upstream of culvert)
WQ-11	N46°17'52.15"	W64°33'18.27"	1	Unnamed Brook	Brook is before on your left of Chemin des Sœurs, Grande-Digue, (sample from upstream of culvert)

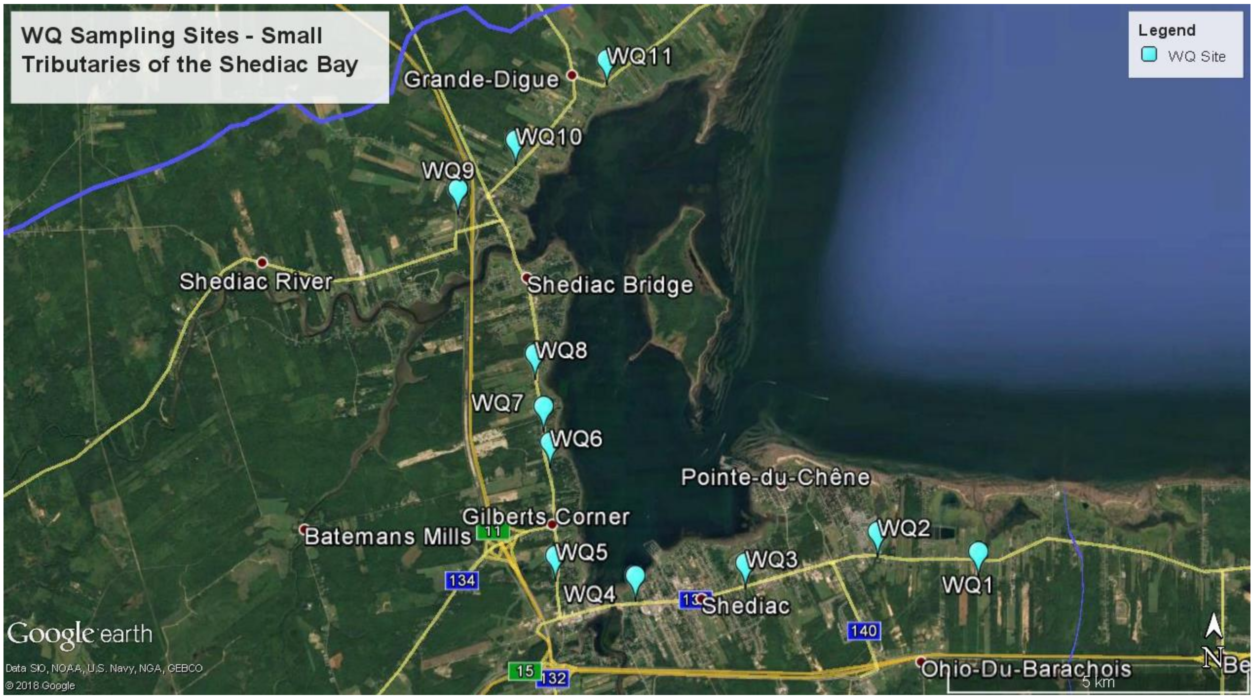

Figure 2: Water Quality Sampling Sites - Small Streams

3.3 Water Quality Parameters

3.3.1 Water Temperature

Water temperature can fluctuate depending on the period of the day and during seasonal changes. Values are influenced by numerous factors such as the tree canopy providing shade, water velocity and depths, presence of cold springs, etc. It is considered that water above 25 or 29 degrees Celsius (°C) tends to be of poor quality because less oxygen can be dissolved. Therefore, water temperature directly influences the dissolved oxygen levels. Water temperatures above 22 °C is said to cause thermal stress to salmonid populations, causing them to stop feeding and search for thermal refugia.

3.3.2 Potential Hydrogen (pH)

The potential hydrogen (pH) level indicates if the water is acidity or basic. It affects how much other substances, such as metals, dissolve in the water. In facts, the pH affects the solubility and toxicity of chemicals and heavy metals in water. Many aquatic organisms are sensitive to changes in pH and may be adversely affected by the pH that is either too high or too low. The pH varies naturally depending on bedrock, climate and vegetation cover, but may also be affected by industrial or other effluents, the exposure of some type of rock (for example during road construction) or drainage from mining operations. According to the CCME's Canadian water quality guidelines, pH should be between 6.5 and 9, as pH levels move away from this range it can stress animal systems and reduce hatching and survival rates in the stream.

3.3.3 Dissolved Oxygen

Dissolved oxygen (DO) represents the concentration of oxygen in gaseous form in the dissolved in the water column. Most of the oxygen in the water comes from the surface atmosphere and is mixed in the water by turbulence and current. The measurement of the concentration of dissolved oxygen in surface waters is essential for measuring changes in water condition and evaluating water quality. It has a direct effect on aquatic life and can be influenced by stream habitat alteration. DO is essential for the survival of fish and many other forms of aquatic life. The temperature limits the amount of oxygen that can dissolve in water, dissolved oxygen varies with temperature and tends to be lower when the water temperature is high. However, temperature is not the only cause of low-oxygen, too many bacteria and an excess amount of biological oxygen demand from the oxygen consumption used by the microorganisms (aerobic bacteria) in the oxidation of organic matter also affects the dissolved oxygen concentrations. According to the Canadian Council of Ministers of the Environment (CCME) Canadian water quality guidelines, the lowest acceptable DO concentration for aquatic life in cold water is 9.5 mg/l for early life stages and 6.5 mg/l for other life stages.

3.3.4 Conductivity

Conductivity is the measurement of the ability of water to pass an electrical current. It is affected by the amount of inorganic dissolved solids (nitrate, chloride, sulfate, sodium, etc.) found in the water. The conductivity level may be influenced by rainwater, agricultural or urban runoff and the geology of the area. There are no set criteria for conductivity levels for water quality, but the US Environmental Protection Agency states that stream conductivity levels ranging between 0.15 and 0.5 mS/cm usually seem to support a good mixed fisheries. Consequently, a higher conductivity level may indicate a higher amount of dissolved material in the water and the presence of contaminants.

3.3.5 Nitrate-Nitrogen

Nitrogen is essential for plant growth, but the presence of excessive amounts in water presents a major pollution problem. Nitrogen compounds may enter water as nitrates or be converted to nitrates from agricultural fertilizers, sewage, industrial and packing house wastes, drainage from livestock feeding areas, farm manures and legumes. The acceptable amount of Nitrate-nitrogen for the protection of aquatic life in freshwater is set at 13 mg/l (NO3).

3.3.6 Phosphates

Phosphates exist in different forms: orthophosphate, metaphosphate and organically compound contains phosphorus. These forms of phosphate occur in living and decomposing plants and animals, as free ions, chemically bonded in aqueous system or mineralized compounds in sediments, soils and rocks. Large amount of phosphate coming from cleaning products (detergents), run off from agricultural and residential fertilizer components can lead to eutrophication. Soil erosion is a major contributor of phosphorus to stream. It is recommended by Environment Canada to apply the Canadian Framework for phosphorus. Trigger ranges are based on the range of phosphorus concentrations in water that define the reference trophic status for a site. Measured phosphorus concentrations should not exceed predefined trigger ranges and should not increase more than 50% over baseline (reference) levels. Total phosphorus levels should be under 0.025 mg/L to maintain its unaffected trophic state.

3.3.7 Escherichia Coli

Escherichia coli (E. coli) is one of many species of bacteria living in the lower intestines of mammals. The presence of E. coli in water is a common indicator of fecal contamination. The acceptable count of E.coli in water is set at 400 MPN/100 ml.

3.3.8 Aluminum

A high concentration of aluminum, due to non-point sources such as rain and snowmelt leaching from watershed soils, can pose a risk to fish in freshwater habitats. For example, ionoregulatory and osmoregulatory complications can develop in fish where aluminum concentrations exceed the CCME recommended guideline of 5 $\mu g \cdot L^{-1}$ when the pH is less than 6.5, and 100 $\mu g \cdot L^{-1}$ when the pH is greater than or equal to 6.5. Furthermore, respiratory problems can occur due to the precipitation of aluminum on the gills, as the positively charged aluminum ion (Al^{3+}) binds with the negatively charged epithelium of the gill.

Many of Atlantic Canada's freshwater habitats naturally contain aluminum concentrations that often exceed CCME guidelines for the protection of aquatic wildlife; however, various fish species are abundant in New Brunswick's rivers. This increased amount of aluminum and other metals is often accompanied by runoff organic carbon due to Atlantic Canada's relatively flat topography and impermeability (Dennis & Clair, 2012). The organic carbon possesses a negatively charged carboxylic functional group, which attracts and binds with the positively charged dissolved aluminum ion. This neutralizes the aluminum ion, rendering it inert and therefore unable to bind with the negatively charged epithelium of the fish gill. Despite this, aluminum ion levels in Atlantic Canada can still reach levels dangerous to fish (Dennis & Clair, 2012).

3.3.9 Iron

Iron enters freshwater habitats in a similar manner to aluminum. Rain and snowmelt leach iron from rocks and watershed soils, and the runoff enters rivers and streams. Anthropogenic sources, such as wastewater and storm water discharges, are also non-point sources of iron in freshwater habitats. A high concentration of iron may cause physiological and/or morphological changes in aquatic plant species (Xing & Liu, 2011).

3.3.10 Copper

Because copper is an essential metal, aquatic organisms have developed methods of copper regulation in the body. Despite this, however, copper toxicity is still possible at high concentrations.

3.3.11 Chloride

Chloride ions (Cl-) in a freshwater habitat are the result of dissolved salts from various sources, and can negatively impact aquatic wildlife sensitive to increased chloride concentration. Although a naturally contributing source of chloride is estuarine backflow from the ocean during rising tide, road salt runoff can also increase chloride concentrations. Since freshwater organisms are generally hyperosmotic, they depend on a low concentration of chloride for proper osmoregulation. A higher concentration of chloride may decrease the ability for freshwater organisms to osmoregulate, affecting endocrine balance, oxygen consumption following long-term exposure, and overall changes in physiological processes. Increased chloride levels may also increase the rigidity in spotted salamander eggs, lowering permeability and in turn, oxygen consumption (Canadian Council of Ministers of the Environment, 2011).

3.3.12 Boron

Boron (B) is ubiquitous in the environment, occurring naturally in the earth's crust and various minerals. Although boron is relatively non-toxic, it may cause sensitivities in some species of fish. Long-term exposure to boron has shown to cause sensitivities in amphibians and water fleas (Canadian Council of Ministers of the Environment, 2009).

3.3.13 Ammonia

Ammonia (NH_3) has many different point and non-point sources, including not only natural causes, but also anthropogenic (e.g. municipal, agricultural, and industrial) causes. Natural sources of ammonia include the decomposition of dead organic matter and waste, gas exchange with the atmosphere, forest fires, animal waste, human breath, discharge of ammonia by biota, and nitrogen fixation processes. Sewage treatment plants and waste burning are examples of municipal sources, whereas intensive farming, ammonia-rich fertilizer spills, and the decomposition of wastes from livestock are examples of agricultural sources. Finally, industrial sources include, but are not limited to, iron and steel mills, fertilizer plants, oil refineries, meat-processing plants, mining, and the fabrication of explosives.

High concentrations of unionized ammonia can result in adverse health effects in freshwater biota. Since unionized ammonia is neutral, it can diffuse across biological membranes more readily than ammonium ion (NH_4^+). A study done by Thurston and Russo (1984) showed that long-term exposure of rainbow trout to ammonia causes pathological lesion formation on the gills and tissue degradation in the kidneys (Canadian Council of Ministers of the Environment, 2010).

3.4 CCME - Canadian Environmental Quality Guidelines (CEQGs)

Table 3: Summary of the CCME Canadian Environmental Quality Guidelines

CCME RECOMMENDED GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (FRESHWATER) SUMMARY							
Parameter	Condition	Value (µg/L)	Condition	Value (µg/L)	Equation Between Conditions	Notes	
Ag	—	—	Long-Term	0.25	—	The following parameters did not have	
Al	pH<6.5	5	pH≥6.5	100	—	CCME recommended guidelines for the	
As	—	—	Upper	5	—	protection of aquatic life and were	
B	Short-Term	29,000	Long-Term	1,500	—	therefore omitted from the table:	
Cd (Short-Term)	HARD<5.3	0.11	HARD>360	7.7	10^(1.016*LOG(HARD)-1.71)	ALK_T	Mg
Cd (Long-Term)	HARD<17	0.04	HARD>280	0.37	10^(0.83*LOG(HARD)-2.46)	Ba	Mn
Cl	Short-Term	640,000	Long-Term	120,000	—	Be	Na
CLRA	Narrative; refer to CCME website for more information.				—	HCO3	NOX
Cu	HARD<82	2	HARD>180	4	0.2*EXP(0.8545*LN(HARD)-1.465)	Bi	Rb
Fe	—	—	Upper	300	—	Br	pH (Sat)
Mo	—	—	Upper	73	—	Ca	Sb
NH3_T	Table; refer to CCME website for more information.				—	CO3	Sn
NH3_Un	—	—	Long-Term	19	—	Co	SO4
Ni	HARD≤60	25	HARD>180	150	EXP(0.76*LN(HARD)+1.06)	COND	Sr
NO2	—	—	Upper	197	—	Cr	TDS
NO3	Short-Term	550	Long-Term	13	—	F	Te
Pb	HARD≤60	1	HARD>180	7	EXP(1.273*LN(HARD)-4.705)	HARD	TKN
Se	—	—	Upper	1	—	K	TOC
Tl	—	—	Upper	0.8	—	Lang_Ind (20°C)	TURB
U	Short-Term	33	Long-Term	15	—	Li	V
Zn	—	—	Upper	30	—		

3.5 Health Canada - Guidelines for Canadian Recreational Water Quality

Table 4: Guidelines for Health Canada Recreational Water Quality: Summary Table

Guidelines		
Parameter	Considerations	Guideline
Escherichia coli (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 200 *E. coli* /100 mL ≤ 400 *E. coli* /100 mL
Enterococci (Primary-Contact Recreation)*	Geometric mean concentration (minimum 5 samples) Single sample maximum concentration	≤ 35 Enterococci /100 mL ≤ 70 Enterococci /100 mL

Source : https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-recreational-water-quality-third-edition/guidelines-canadian-recreational-water-quality-third-edition-page-9.html#a41

3.6 CCME Recommendation Guidelines for the Protection of Aquatic Life (Freshwater)

Table 5: CCME Recommendation Guidelines for the Protection of Aquatic Life (Freshwater)

CCME RECOMMENDED GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE (FRESHWATER) SUMMARY OF OTHER PARAMETERS				
Parameter	Description	Value	Units	Notes
Dissolved O_2	Early life stages, cold water biota†	9.5	mg/L	† The guidelines for dissolved oxygen are divided into four different categories to accommodate the wide range of tolerances exhibited by freshwater species at various life stages, and with warmer or colder temperature preferences.
	Other life stages, cold water biota	6.5	mg/L	
	Early life stages, warm water biota	6.0	mg/L	
	Other life stages, warm water biota	5.5	mg/L	
pH	Lower long-term limit	6.5	—	‡ There is no limit for the protection of aquatic wildlife for E. coli. The limit of 400 MPN/100 mL for the protection of environmental and human health is used instead.
	Upper long-term limit	9.0	—	
E. coli	Upper limit‡	400	MPN/100 mL	

3.7 CCME Guidance framework for Phosphorus

Table 6: CCME Guidance framework for Phosphorus

CCME Guidance Framework for Phosphorus (TP-L)				
Parameter	Description	Value	Units	Notes
TP-L*	Hyper-eutrophic	> 100	µg/L	The CCME recommended guidelines for the protection of aquatic wildlife (freshwater) indicate the concentrations of total phosphorus at which each condition may occur. This does not suggest that a stream with hyper-eutrophic levels of total phosphorus will necessarily exhibit hyper-eutrophic properties, for example.
	Eutrophic	35 – 100	µg/L	
	Meso-eutrophic	20 – 35	µg/L	
	Mesotrophic	10 – 20	µg/L	
	Oligotrophic	4 – 10	µg/L	
	Ultra-oligotrophic	< 4	µg/L	* Total phosphorus level

3.7.1 Terms and Definitions

All data collected during the sampling season has been organized in 3 distinct tables: water chemistry data and E. coli results, nutrient results, and inorganic results. The following provides the terms and definitions of the acronyms used in the data tables.

Table 7: Terms and definitions for water chemistry and bacterial data tables

TERMS AND DEFINITIONS FOR FIELD DATA COLLECTED BY YSI AND LABORATORY SAMPLES		
Parameter	Unit	Definition
Temp	°C	Air and water temperature measured in degrees Celsius
SAL	ppt	Salinity measured in parts per thousand
Dissolved O_2	mg/L, %	Dissolved oxygen measured in milligrams per litre and percentage
E. coli	MPN/100mL	Escherichia coli concentration measured in most probable number per 100 millilitres
ALK_T	mg/L	Total alkalinity measured in milligrams per litre
CLRA	TCU	Water colour measured in true colour units
COND	µS/cm	Conductivity measured in microsiemens per centimetre in the field and laboratory
HARD	mg/L	Hardness measured in milligrams per litre
Lang_Ind (20°C)	—	Langlier index at 20 degrees Celsius
pH	—	Potential of hydrogen measured in the field and laboratory, and the saturation pH at 20 degrees Celsius
Sat (20°C)	—	The pH at which water at 20 degrees Celsius is saturated with calcium carbonate
TDS	mg/L	Total dissolved solids measured in milligrams per litre
TURB	NTU	Water turbidity measured in nephelometric turbidity units

Table 8: Terms and definitions for nutrients data tables

TERMS AND DEFINITIONS FOR NUTRIENT DATA					
Parameter	Unit	Definition	Parameter	Unit	Definition
HCO_3	mg/L	Bicarbonate measured in milligrams per litre	NH_3_Un	µg/L	Ammonia unionized at 20°C measured in micrograms per litre
Br	µg/L	Bromine measured in micrograms per litre	NO_2	µg/L	Nitrite measured in micrograms per litre
Ca	mg/L	Calcium measured in milligrams per litre	NO_3	µg/L	Nitrate measured in micrograms per litre
CO_3	µg/L	Carbonate measured in micrograms per litre	NO_X	µg/L	Nitrite + Nitrate measured in micrograms per litre
Cl	mg/L	Chloride measured in milligrams per litre	SO_4	mg/L	Sulphate measured in milligrams per litre
F	µg/L	Fluoride measured in micrograms per litre	TKN	mg/L	Total Kjedhal nitrogen measured in milligrams per litre
K	mg/L	Potassium measured in milligrams per litre	TN	mg/L	Total nitrogen calculated in milligrams per litre
Mg	mg/L	Magnesium measured in milligrams per litre	TOC	mg/L	Total organic carbon measured in milligrams per litre
Na	mg/L	Sodium measured in milligrams per litre	TP-L	µg/L	Total phosphorus measured in micrograms per litre
NH_3T	µg/L	Total ammonia measured in micrograms per litre	—	—	—

Table 9: Terms and definitions for inorganic data tables

TERMS AND DEFINITIONS FOR HEAVY METAL DATA					
Parameter	Unit	Definition	Parameter	Unit	Definition
Al	µg/L	Aluminum measured in micrograms per litre	Mn	µg/L	Manganese measured in micrograms per litre
As	µg/L	Arsenic measured in micrograms per litre	Mo	µg/L	Molybdenum measured in micrograms per litre
B	µg/L	Boron measured in micrograms per litre	Ni	µg/L	Nickel measured in micrograms per litre
Ba	µg/L	Baryium measured in micrograms per litre	Pb	µg/L	Lead measured in micrograms per litre
Cd	µg/L	Cadmium measured in micrograms per litre	Rb	µg/L	Rubidium measured in micrograms per litre
Co	µg/L	Cobalt measured in micrograms per litre	Sb	µg/L	Antimony measured in micrograms per litre
Cr	µg/L	Chromium measured in micrograms per litre	Sr	µg/L	Strontium measured in micrograms per litre
Cu	µg/L	Copper measured in micrograms per litre	U	µg/L	Uranium measured in micrograms per litre
Fe	µg/L	Iron measured in micrograms per litre	V	µg/L	Vanadium measured in micrograms per litre
Li	µg/L	Lithium measured in micrograms per litre	Zn	µg/L	Zinc measured in micrograms per litre

4 Sampling Results

The following section will describe the water quality data collected at the 11 new sampling sites for the 2017 field season. The surrounding land uses, as visible from aerial imagery from several years of images on Google Earth, are also described for each site. The information is meant to complement the data and provide information on potential causes for contamination.

4.1 WQ-1

This water quality sampling site is located in a residential area in Boudreau-West, and is accessed by a private dirt road (with landowner permission) connected to Route 133. The samples are taken upstream from the culvert of the dirt road. The surrounding land uses includes: agricultural fields, several gravel pits, and the Highway 15. The buffer zones dividing the stream and the farm fields (± 10 hectares, 2 hectares, 1.3 hectares) ranges between 15 and 50 metres in density. There is a good buffer zone that separates the brook and the gravels pits (> 50 m on each side) that should prevent sediment from running off into the water.

The tributary joins the Shediac Bay approximately 1 km downstream of the sampling site. The small stream ends with a small estuary surrounded by a salt marsh. Next to this salt marsh is the Greater Shediac Sewage Commission’s aeration lagoons, as well as a lift station with an outfall discharge pipe at the edge of the estuary. The treated wastewater from the lagoons is discharged further out into the bay, but there is a possibility that contaminants may come into this estuary during incoming tides or storm surges. The water quality station is located higher than the highest tidal zone.

The water sampling results for the site WQ-1, for 2017, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. Total phosphorus levels for long-term eutrophic conditions according to the “CCME Guidance framework for Phosphorus” were in the mesotrophic range (10 - 20 µg/L). Results did not exceed any of the recommended CCME water quality guidelines for inorganics (heavy metals and other elements). Bacterial levels did not exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 10: Water chemistry data and E. coli results for WQ-1, 2017

SITE WQ-1: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	17	16.6	0.13	11.15	—	40.0	35	42	199	288	60.3	-1.13	8.02	7.4	8.5	178.75	137	0.7
17-07-19	22	13.2	0.16	9.44	—	71.2	42	21	1255	335	75.9	-0.88	7.39	7.5	8.4	214.50	163	1.8
17-08-22	20	14.7	0.19	10.58	—	56.3	50	8	311	396	88.5	-0.65	8.26	7.6	8.3	253.50	200	0.4
17-09-20	20	14.5	0.19	9.08	—	24	46	31	319	402	90.8	-0.78	7.97	7.5	8.3	260.00	203	1.0
17-10-18	10	7.8	0.19	11.63	—	32	48	54	268	404	93.2	-0.65	8.26	7.6	8.2	200.00	203	0.4

◥ E. coli sample in June measured in CFU/100 mL

Table 11: Nutrient results for WQ-1, 2017

SITE WQ-1: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	34.9	40	19.1	82	62.5	150	0.76	3.06	26.6	<50	<1	<50	690	690	<1	0.19	0.9	4.4	14
17-07-19	41.9	50	23.6	125	69.4	130	0.93	4.11	31.6	<50	<1	<50	620	620	5	0.2	0.8	3.0	16
17-08-22	49.8	50	27.3	186	88.6	100	1.06	4.93	36.9	<50	<1	<50	840	840	7	0.2	1	1.3	12
17-09-20	45.8	50	28.1	136	94.5	170	1.11	5.00	38.3	160	2	<50	680	680	4	0.2	0.9	4.2	18
17-10-18	47.8	50	28.8	179	97	170	1.25	5.18	38.4	<50	<1	<50	580	580	<1	0.2	0.8	5.8	10

Table 12: Inorganics results for WQ-1, 2017

SITE WQ-1: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	33	<1	8	63	<0.01	<0.1	<1	<1	160	0.8	32	<0.1	<1	<0.1	0.7	<0.1	54	<0.1	33	15	<1	1
17-07-19	26	<1	11	74	<0.01	<0.1	<1	<1	100	0.9	42	0.4	<1	<0.1	0.9	<0.1	67	0.1	33	15	<1	2
17-08-22	10	<1	12	83	<0.01	<0.1	<1	<1	70	1.0	48	<0.1	<1	<0.1	1.1	<0.1	73	<0.1	33	15	<1	2
17-09-20	17	<1	11	94	<0.01	<0.1	<1	<1	120	1.0	44	<0.1	<1	<0.1	1.1	<0.1	86	<0.1	33	15	<1	<1
17-10-18	16	<1	9	88	<0.01	<0.1	<1	<1	130	1.0	33	<0.1	<1	<0.1	1.1	<0.1	84	<0.1	33	15	<1	2

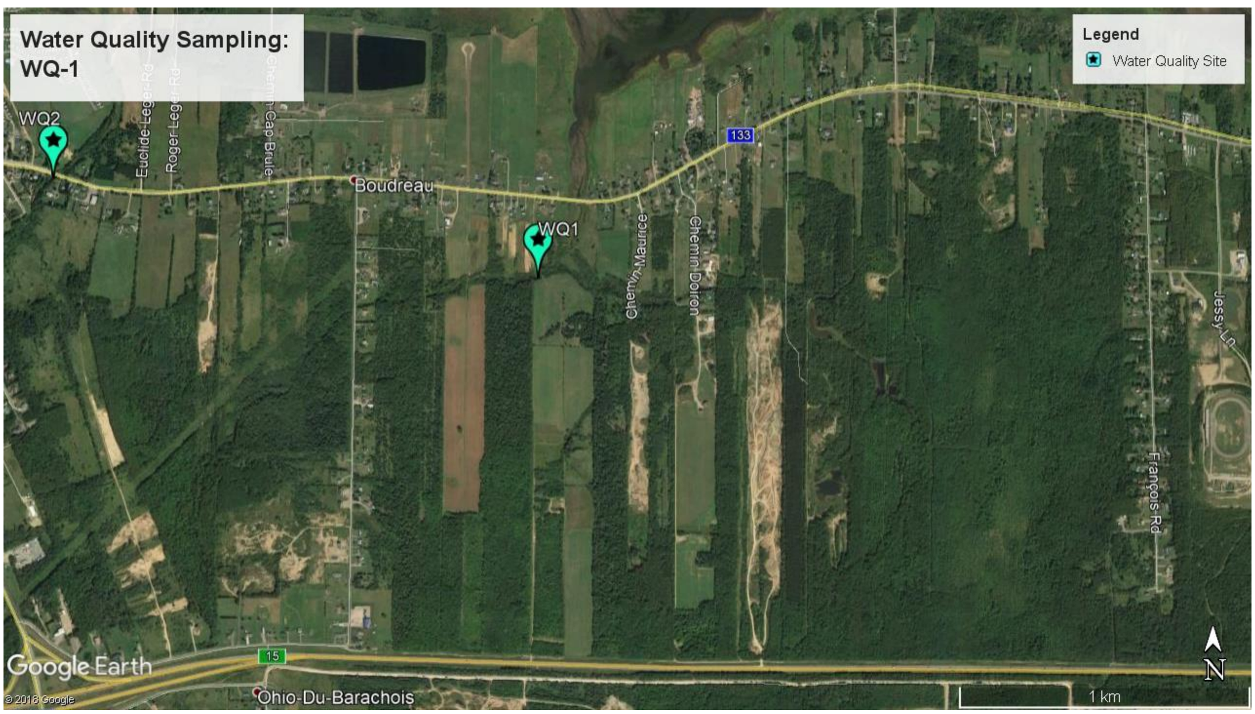

Figure 3: WQ-1 site location and surrounding land uses

4.2 WQ-2

This water quality sampling site is also located in a residential area in Boudreau-West, near the convenience store “Handy Andy’s” on Route 133. The samples are taken upstream of the wooden culvert. The surrounding land uses is mainly residential, roads, and has a drive-in movie theatre upstream (300 m). Below the culvert of Route 133, directly following the sampling site, is the beginning of a provincially regulated freshwater wetland. The freshwater wetland is approximately 170 metres in length before transitioning to a coastal salt marsh at the highest tidal point. Within the salt marsh area is the *Ocean Surf RV Campground*. There are no trees between the campground and the wetland and brook areas, making any buffer zone only made up of wild grasses and shrubs. In the southern part of the campground, the 30-metre buffer zone is respected by the maintenance crew, by not mowing grass past a certain line. However, another part of the campground is built within the buffer zone of the estuary, with camping lots placed along the edges of a rock armoured bank. A partnership was formed with *Ocean Surf* to begin planting trees in the buffer zone, as part of a multi-year goal of enhancing the riparian zone. In 2017, 182 native trees were planted.

The water sampling results for the site WQ-2, for 2017, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. Total phosphorus levels for long-term eutrophic conditions according to the “CCME Guidance framework for Phosphorus” were in the mesotrophic range (10 - 20 µg/L). Results did not exceed any of the recommended CCME water quality guidelines for inorganics (heavy metals and other elements). Bacterial levels did not exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 13: Water chemistry data and E. coli results for WQ-2, 2017

SITE WQ-2: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	17	11.7	0.18	10.49	—	40.0 ◥	56	8	279	380	74.2	-0.67	7.76	7.6	8.3	243.10	189	0.6
17-07-19	23	14.6	0.19	8.5	—	238.2	68	<5	308	391	94.3	-0.39	7.54	7.7	8.1	549.60	196	0.7
17-08-22	21	16.0	0.20	9.74	—	141.4	84	6	337	410	102	-0.17	7.65	7.8	8.0	264.55	215	0.7
17-09-20	20	15.7	0.21	9.04	—	72	78	5	349	429	106	-0.29	7.85	7.7	8	276.25	218	0.8
17-10-18	10	8.2	0.21	9.47	—	69	79	15	299	434	118	-0.34	7.52	7.6	7.9	286.65	229	0.8

◥ E. coli sample in June measured in CFU/100 mL

Table 14: Nutrient results for WQ-2, 2017

SITE WQ-2: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	55.8	80	23.2	209	78.4	160	0.95	3.96	39.5	<50	<1	<50	300	300	7	0.12	0.4	1.7	11
17-07-19	67.7	70	29.1	319	73.4	140	1.11	5.26	36.8	<50	<1	<50	290	290	7	0.1	0.4	1.3	16
17-08-22	83.5	80	31.3	495	77.6	160	1.20	5.92	37.9	<50	<1	<50	310	310	8	0.2	0.5	1.4	18
17-09-20	77.6	80	32.7	366	82.4	180	1.25	6.03	39.9	50	<1	<50	140	140	7	0.1	0.2	1.4	19
17-10-18	78.7	60	36.2	295	93	130	1.45	6.80	36.4	<50	<1	<50	100	100	6	<0.1	<0.2	1.7	10

Table 15: Inorganics results for WQ-2, 2017

SITE WQ-2: HEAVY METALS AND OTHER ELEMENTS																					
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	17	<1	12	99	<0.01	<0.1	<1	<1	80	1.4	59	0.2	<1	<0.1	0.8	<0.1	120	0.2	33	15	<1	<1
17-07-19	19	<1	13	107	<0.01	<0.1	<1	<1	90	1.3	104	0.2	<1	<0.1	1.0	<0.1	131	0.3	33	15	<1	2
17-08-22	12	<1	15	114	<0.01	<0.1	<1	<1	110	1.5	84	0.2	<1	<0.1	1.0	<0.1	146	0.3	33	15	<1	2
17-09-20	15	<1	14	133	<0.01	<0.1	<1	<1	140	1.5	118	0.2	<1	<0.1	1.1	<0.1	174	0.3	33	15	<1	3
17-10-18	8	<1	11	140	<0.01	<0.1	<1	<1	110	1.6	84	0.1	<1	<0.1	1.1	<0.1	162	0.3	33	15	<1	4

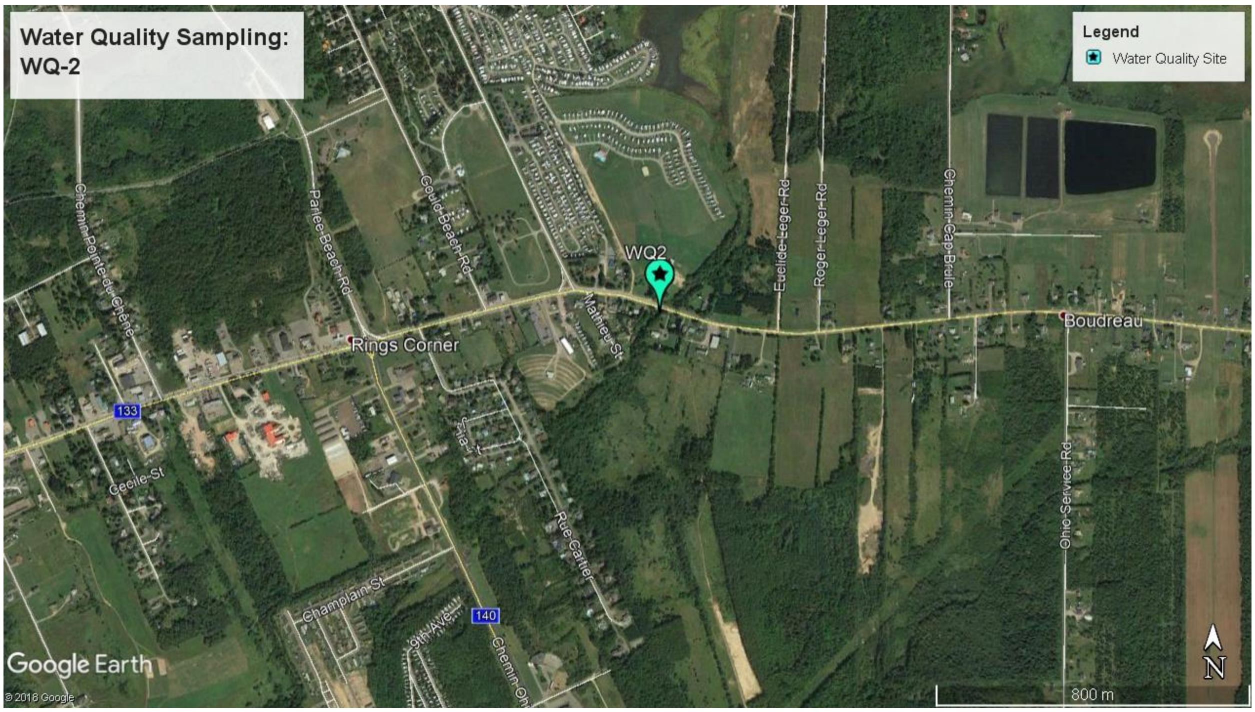

Figure 4: WQ-2 site location and surrounding land uses

4.3 WQ-3

This water quality sampling site is located in a residential and commercial area in the Town of Shediac, directly off Main St., next to the *Shediac Bakery*. The samples are taken upstream of the culvert. The surrounding land uses upstream is mainly a large residential sector, up to the approximate headwaters below Highway 15. It is important to note that for most of the riparian zones along this brook, there are inadequate buffer zones (< 15 m). This unnamed brook reaches the tidal zone approximately 400 metres downstream of the sampling site.

The water sampling results for the site WQ-3, for 2017, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. Total phosphorus levels for long-term eutrophic conditions according to the "CCME Guidance framework for Phosphorus" were in the meso-eutrophic range (20 -35 µg/L). Results did not exceed any of the recommended CCME water quality guidelines for inorganics (heavy metals and other elements). Bacterial levels did exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL), on 1 occurrence; the July sampling. The result was over three times the recommended limit (1299.7 MNP/100 mL).

Table 16: Water chemistry data and E. coli results for WQ-3, 2017

SITE WQ-3: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	18	12.4	0.11	10.96	—	20.0 ◥	63	12	177	238	70.8	-0.40	7.84	7.8	8.2	151.45	121	1.2
17-07-19	23	17.3	0.13	7.81	—	**1299.7**	73	8	235	280	93.4	-0.13	7.75	7.9	8.0	178.75	139	0.4
17-08-22	22	18.4	0.15	9.47	—	15.8	99	12	276	318	104	0.04	7.78	7.9	7.9	206.05	168	0.6
17-09-20	20	17.5	0.19	7.77	—	71	100	10	339	398	117	-0.01	7.86	7.8	7.8	257.40	211	0.5
17-10-18	10	7.7	0.21	7.9	—	10	90	18	298	450	121	-0.25	7.43	7.6	7.9	289.25	234	0.3

◥ E. coli sample in June measured in CFU/100 mL

Table 17: Nutrient results for WQ-3, 2017

SITE WQ-3: NUTRIENT DATA																		
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	62.6	50	23.1	371	31.6	130	1.01	3.19	16.0	<50	<1	<50	430	430	6	0.11	0.5	2.0	19
17-07-19	72.4	50	30.4	541	31.7	130	1.38	4.25	17.1	<50	<1	<50	460	460	7	0.1	0.6	1.9	25
17-08-22	98.2	60	33.8	733	37.1	150	1.73	4.75	20.0	<50	<1	<50	500	500	8	0.2	0.7	2.6	33
17-09-20	99.4	60	38.2	590	61.8	150	1.93	5.26	32.1	<50	<1	<50	390	390	9	0.2	0.6	2.8	35
17-10-18	89.6	50	39.5	335	80	120	2.30	5.52	40.1	<50	<1	<50	<50	<50	11	0.2	0.2	3.4	28

Table 18: Inorganics results for WQ-3, 2017

SITE WQ-3: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	40	<1	9	68	<0.01	<0.1	<1	<1	60	0.9	29	<0.1	<1	<0.1	0.8	<0.1	55	0.4	33	15	<1	<1
17-07-19	22	<1	14	78	<0.01	<0.1	<1	<1	50	0.6	18	0.3	<1	<0.1	1.2	<0.1	64	0.5	33	15	<1	7
17-08-22	16	<1	15	85	<0.01	<0.1	<1	<1	60	0.5	17	0.2	<1	<0.1	1.6	<0.1	70	0.6	33	15	<1	3
17-09-20	48	<1	16	107	0.01	<0.1	<1	1	190	0.5	78	0.2	<1	0.2	1.6	<0.1	87	0.7	33	15	<1	6
17-10-18	26	<1	81	107	<0.01	<0.1	<1	<1	60	0.4	64	0.1	<1	0.2	1.5	<0.1	91	0.6	33	15	<1	7

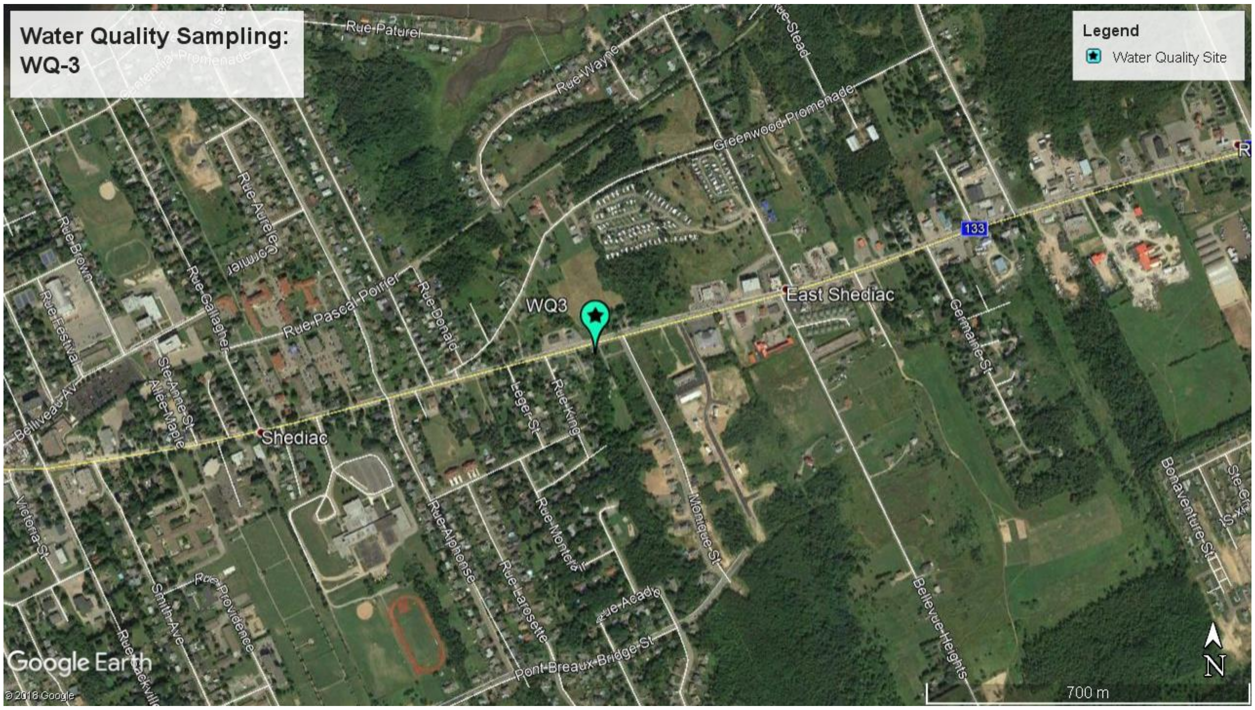

Figure 5: WQ-3 site location and surrounding land uses

4.4 WQ-4

This water quality sampling site is located behind the Town of Shediac's city hall. There is a culvert where this brook exits the underground canal along the edge of the parking lots for Town Hall and *Chez Gabrièle's Inn & Restaurant,* and the sample is taken directly below this culvert. The surrounding land uses for small unnamed brook is mainly residences, business parking lots and roads. A part of this brook is channelled in an underground pipe somewhere along Chelsey Street, before reaching Main Street. Fractures or breaks in the municipal sewer or stormwater pipes could possibly be a source of contamination for this brook. There is also a dog park upstream (600 metres) next to a drainage ditch that connects to this brook. The SBWA built its first rain garden below this dog park, in an effort to capture stormwater runoff from the park and from the surrounding area (parking lot of the *Vestiaire St-Joseph* and Centennial Park). The brook flows into the Shediac Bay approximately 200 metres downstream from the sampling site, and is unaffected by normal tides.

The water sampling results for the site WQ-4, for 2017, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. Total phosphorus levels for long-term eutrophic conditions according to the "CCME Guidance framework for Phosphorus" were in the meso-eutrophic range (20 -35 µg/L). Results did exceed the recommended CCME water quality guidelines for chloride in the months of June and October (157 mg/L & 122 mg/L respectively), exceeding the long-term limit (120 mg/L) but the short-term limit was not exceeded (640 mg/L). The site was also slightly elevated in copper for the month of June (4 µg/L) as the recommendation for copper based on the hardness value of 164 mg/L would be 3.61 µg/L. Even though bacterial levels did not exceed the maximum concentration of E. coli from

Health Canada recreational guideline (≥ 400 MPN/100 mL), bacterial concentration are slightly elevated in June (260 CFU/100 mL*) and July (387.3 MPN/100 mL).

*CFU/100 mL is comparable to MPN/100 mL, both are used in accredited laboratory and correspond to the same measurable scale in terms of concentrations. Both values mean the same thing, the only difference is the method used to analyze the samples.

Table 19: Water chemistry data and E. coli results for WQ-4, 2017

SITE WQ-4: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	18	11.8	0.39	11.02	—	260.0*	100	<5	590	790	164	0.08	7.69	7.8	7.7	507.00	385	0.4
17-07-19	23	14.1	0.30	8.75	—	387.3	120	<5	485	623	170	0.18	7.61	7.8	7.6	399.75	319	0.4
17-08-22	22	15.8	0.27	10.13	—	114.5	130	<5	464	572	163	0.29	7.69	7.9	7.6	366.60	304	0.3
17-09-20	20	15.6	0.31	8.7	—	141	120	<5	520	627	188	0.21	7.78	7.8	7.6	409.50	326	0.3
17-10-18	10	12.2	0.33	9.32	—	10	130	<5	510	676	192	0.25	7.37	7.8	7.5	435.50	355	0.4

* E. coli sample in June measured in CFU/100 mL

Table 20: Nutrient results for WQ-4, 2017

SITE WQ-4: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	99.4	80	51.6	590	157	150	2.63	8.56	79.4	<50	<1	<50	1830	1830	16	0.11	1.9	1.3	22
17-07-19	119	70	52.8	708	102	150	2.25	9.14	54.0	<50	<1	<50	1580	1580	18	0.1	1.7	0.9	24
17-08-22	129	80	49.8	963	93.8	160	2.04	9.40	45.6	<50	<1	<50	1510	1510	17	0.1	1.6	1.0	26
17-09-20	119	70	57.9	708	110	160	2.26	10.6	48.0	<50	<1	<50	1680	1680	16	0.1	1.8	0.9	28
17-10-18	129	90	59.2	766	122	160	2.27	10.7	58.2	<50	<1	<50	1250	1250	18	<0.1	1.2	0.8	22

Table 21: Inorganics results for WQ-4, 2017

SITE WQ-4: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	10	<1	21	234	<0.01	<0.1	<1	4	50	3.2	30	0.3	<1	<0.1	1.8	<0.1	232	0.9	33	15	1	2
17-07-19	33	<1	24	253	<0.01	<0.1	<1	2	80	3.9	39	0.4	<1	0.3	1.7	<0.1	248	1	33	15	1	5
17-08-22	11	<1	24	211	<0.01	<0.1	<1	1	40	4.1	15	0.4	<1	<0.1	1.6	<0.1	238	1	33	15	1	2
17-09-20	36	<1	24	241	<0.01	<0.1	<1	1	100	4.1	36	0.3	<1	0.5	1.8	<0.1	295	1	33	15	1	6
17-10-18	25	<1	27	248	<0.01	<0.1	<1	1	60	5.4	24	0.4	<1	0.1	1.9	<0.1	333	1	33	15	1	6

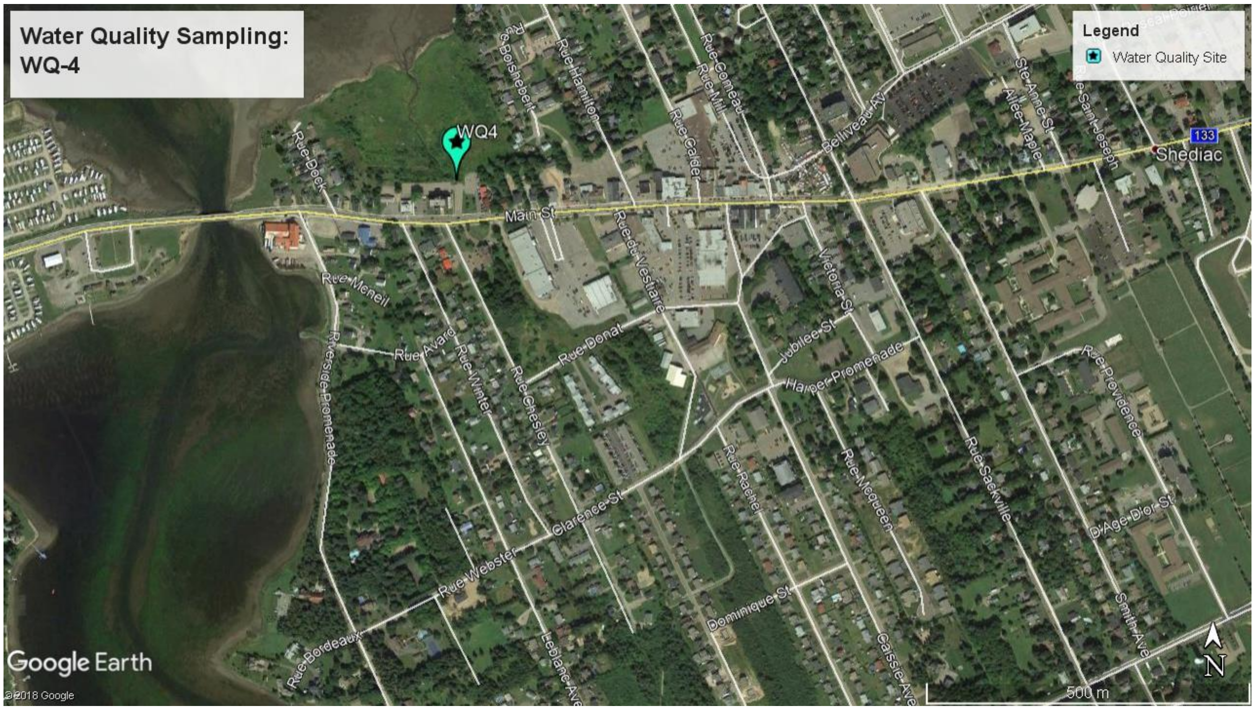

Figure 6: WQ-4 site location and surrounding land uses

4.5 WQ-5

This water quality sampling site is also located off Route 133, past *Guy's Frenchys* heading towards Gilbert's Corner. The stream crosses the road 75 m past Atkinson Court. The samples are taken upstream from the culvert. The sample site is located approximately 90 m from the tidal zone and the beginning of a salt marsh. The surrounding land uses is mainly residential, forested land, and farm fields. The riparian area around the residential properties have little buffer (< 15 m), but this constitutes small sections of the brook. However, there are good buffer zones between the farmlands and the head ponds of this brook; 25 m – 50 m in tree density. There is a thinner buffer zone where the pond discharges into the brook, approximately 20 m between the bank and a field. Another brook joins these ponds upstream, supplying water from the other side of Highway 11, up to Route 134 (Lakeville Road). In this area, there is more cultivated land where the brook passes, but there is no buffer zone visible from aerial imagery. There is no indication that animals, such as cows, are being raised in that field, but the lack of buffer around this brook passing around and through these fields may be impacted by sediment and could explain the higher levels of total phosphorus.

The water sampling results for the site WQ-5, for 2017, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. Total phosphorus levels for long-term eutrophic conditions according to the "CCME Guidance framework for Phosphorus" were in the meso-eutrophic range (20 -35 µg/L). Results did exceed the recommended CCME water quality guidelines for chloride in each sample from June to October, exceeding the long-term limit (120 mg/L), but the short-term limit was not exceeded (640 mg/L).

Bacterial levels did not exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 22: Water chemistry data and E. coli results for WQ-5, 2017

SITE WQ-5: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	19	16.8	0.31	9.41	—	10.0	71	18	540	651	88.2	-0.28	7.94	7.8	8.1	416.00	299	1.4
17-07-19	23	17.9	0.34	7.6	—	24.3	76	9	610	712	104	-0.28	7.78	7.7	8.0	455.00	350	0.8
17-08-22	23	16.7	0.29	9.45	—	64.4	94	9	500	604	101	-0.09	7.78	7.8	7.9	390.00	308	0.6
17-09-20	20	15.1	0.33	9.28	—	32	85	<5	550	671	139	-0.01	7.75	7.8	7.8	435.50	346	0.4
17-10-18	—	8.8	0.37	10.17	—	19	90	11	520	755	132	-0.22	7.46	7.6	7.8	487.50	392	0.7

◥ E. coli sample in June measured in CFU/100 mL

Table 23: Nutrient results for WQ-5, 2017

SITE WQ-5: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	70.5	60	30.1	418	138	140	0.93	3.17	81.8	<50	<1	<50	60	60	<1	0.30	0.4	4.2	34
17-07-19	75.6	50	36.0	356	164	110	1.41	3.54	97.6	<50	<1	<50	60	60	<1	0.2	0.3	2.9	31
17-08-22	93.4	50	35.3	554	132	110	1.49	3.22	77.4	<50	<1	<50	80	80	<1	0.2	0.3	2.1	32
17-09-20	84.5	40	48.9	501	158	100	1.70	4.05	76.5	80	2	<50	<50	<50	4	<0.1	<0.2	1.6	25
17-10-18	89.6	50	46.1	335	182	90	2.32	4.22	96.6	<50	<1	<50	50	50	5	0.2	0.2	2.8	19

Table 24: Inorganics results for WQ-5, 2017

SITE WQ-5: HEAVY METALS AND OTHER ELEMENTS																					
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	10	<1	8	164	<0.01	0.1	<1	<1	260	0.5	678	<0.1	<1	<0.1	1.1	<0.1	80	<0.1	33	15	1	<1
17-07-19	14	<1	10	159	<0.01	0.1	<1	<1	190	0.5	683	<0.1	<1	<0.1	1.4	<0.1	84	<0.1	33	15	1	4
17-08-22	21	<1	13	131	<0.01	<0.1	<1	<1	150	0.4	514	<0.1	<1	0.1	1.5	<0.1	68	0.1	33	15	1	4
17-09-20	12	<1	12	173	<0.01	<0.1	<1	<1	100	0.4	331	<0.1	<1	<0.1	1.5	<0.1	95	0.1	33	15	<1	4
17-10-18	12	<1	10	174	<0.01	<0.1	<1	<1	90	0.4	336	<0.1	<1	<0.1	1.9	<0.1	98	0.1	33	15	<1	8

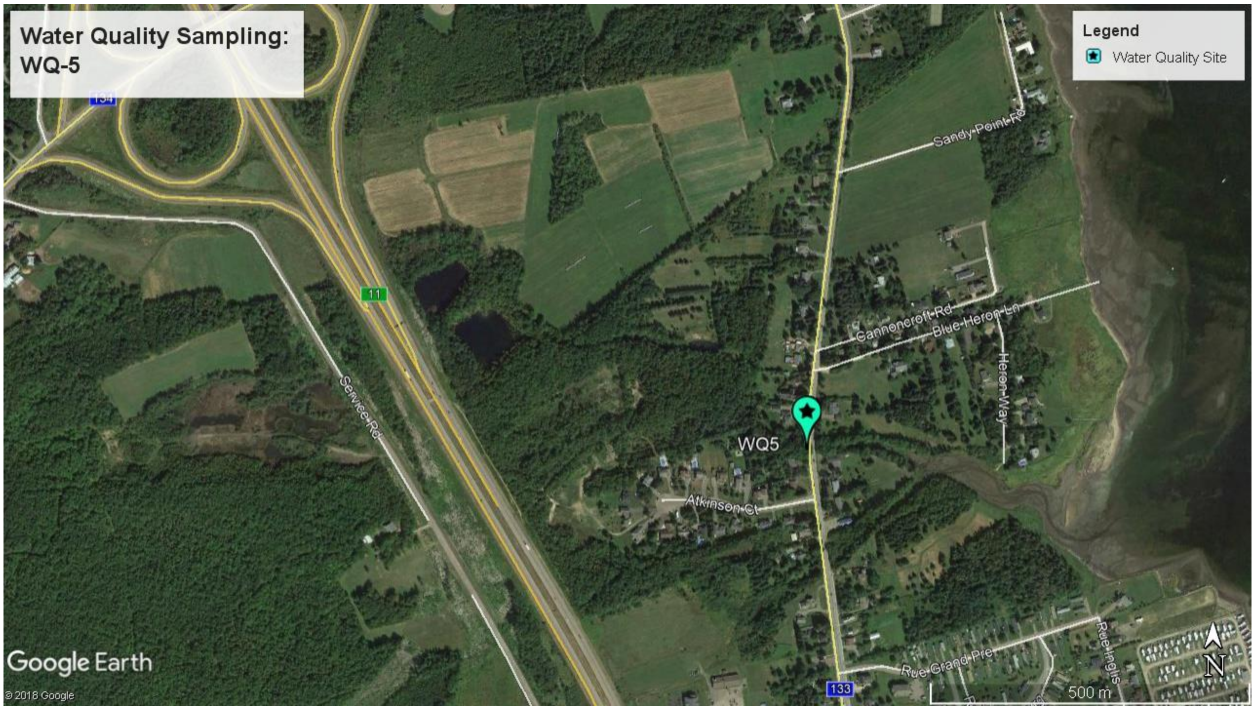

Figure 7: WQ-5 site location and surrounding land uses

4.6 WQ-6

This water quality sampling site is located off Route 134, past the Shediac Cape School, right next to Old Mill Road. The vehicle is parked on Old Mill Road, and the samples are taken downstream of the culvert crossing Route 134, to capture the water coming from both directions; coming from along Old Mill Road and along Route 134. The sample site is located approximately 175 m from the tidal zone. The surrounding land uses includes; residential, active farm fields for cultivation and for cows (as seen on aerial imagery), and a gravel pit. There is very little or no buffer along the brook as it flows through the fields. It is unknown if cows are held in this area on a regular basis, but there are obvious cows tracks that criss-crosses the brook in one particular area and animals visible in aerial views from several years. There is also no buffer between the gravel pit area and the brook. Passed the gravel pit heading upstream is a more forested lot, with healthier riparian zones. The next parcel of land and leading up to the end of the brook near Highway 11 are more cows pastures, as animals, cow tracks and cattle fencing can be seen on aerial imagery. There is more vegetation in the buffer zones in this field, with tree densities ranging from 5 – 30 metres.

The water sampling results for the site WQ-6, for 2017, meet the recommendations for the survival of freshwater aquatic life based on pH, but dissolved oxygen levels fell below 6 mg/L in the months of August and September (4.86 mg/L and 5.85 mg/L respectively). Total phosphorus levels for long-term eutrophic conditions according to the “CCME Guidance framework for Phosphorus” were in the mesotrophic range (10 - 20 µg/L). Results did exceed the recommended CCME water quality guidelines for iron in the sample taken in August; 340 µg/L when the recommendation is 300 µg/L. Bacterial levels did exceed in the sample taken in July; 816.4 MPN/100 mL double the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 25: Water chemistry data and E. coli results for WQ-6, 2017

SITE WQ-6: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	20	14.2	0.21	8.35	—	120.0	77	11	344	434	112	-0.46	7.76	7.5	8.0	282.45	214	0.9
17-07-19	23	14.7	0.20	7.2	—	**816.4**	78	<5	337	421	118	-0.44	7.74	7.5	7.9	273.00	211	0.4
17-08-22	24	15.2	0.16	**4.86**	—	51.2	87	<5	267	329	107	-0.62	7.37	7.3	7.9	214.50	171	0.6
17-09-20	20	14.9	0.14	**5.85**	—	89	78	<5	235	292	105	-0.38	7.74	7.6	8.0	189.15	149	0.5
17-10-18	—	8.9	0.15	6.9	—	125	91	<5	215	310	112	-0.58	7.69	7.3	7.9	201.50	167	1.0

◥ E. coli sample in June measured in CFU/100 mL

Table 26: Nutrient results for WQ-6, 2017

SITE WQ-6: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	76.8	50	35.1	228	81	130	1.26	5.96	34.3	<50	<1	<50	1140	1140	4	0.31	1.4	2.9	17
17-07-19	77.8	50	36.8	231	73.7	110	1.76	6.41	32.7	<50	<1	<50	1520	1520	5	0.3	1.8	1.9	14
17-08-22	86.8	40	33.0	163	44.6	110	2.12	5.99	19.2	<50	<1	<50	1680	1680	5	0.2	1.9	1.3	13
17-09-20	77.7	40	32.2	291	35	110	2.25	5.93	14.4	100	2	<50	1490	1490	4	0.2	1.7	1.3	17
17-10-18	90.8	40	34.4	170	39.9	80	2.27	6.32	15.5	<50	<1	<50	1570	1570	5	0.1	0.7	1.2	17

Table 27: Inorganics results for WQ-6, 2017

SITE WQ-6: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	13	<1	10	95	<0.01	<0.1	<1	<1	120	0.6	76	<0.1	<1	<0.1	1.0	<0.1	75	0.2	33	15	<1	<1
17-07-19	17	<1	12	99	<0.01	<0.1	<1	<1	100	0.6	161	<0.1	<1	<0.1	1.3	<0.1	72	0.1	33	15	<1	4
17-08-22	98	<1	15	99	0.01	0.2	<1	<1	**340**	0.8	406	<0.1	<1	0.6	1.3	<0.1	59	0.2	33	15	<1	4
17-09-20	9	<1	15	96	<0.01	<0.1	<1	<1	140	0.6	321	<0.1	<1	<0.1	1.2	<0.1	60	0.1	33	15	<1	4
17-10-18	57	<1	15	98	<0.01	0.1	<1	<1	230	0.7	349	<0.1	<1	0.2	1.1	<0.1	63	0.1	33	15	<1	3

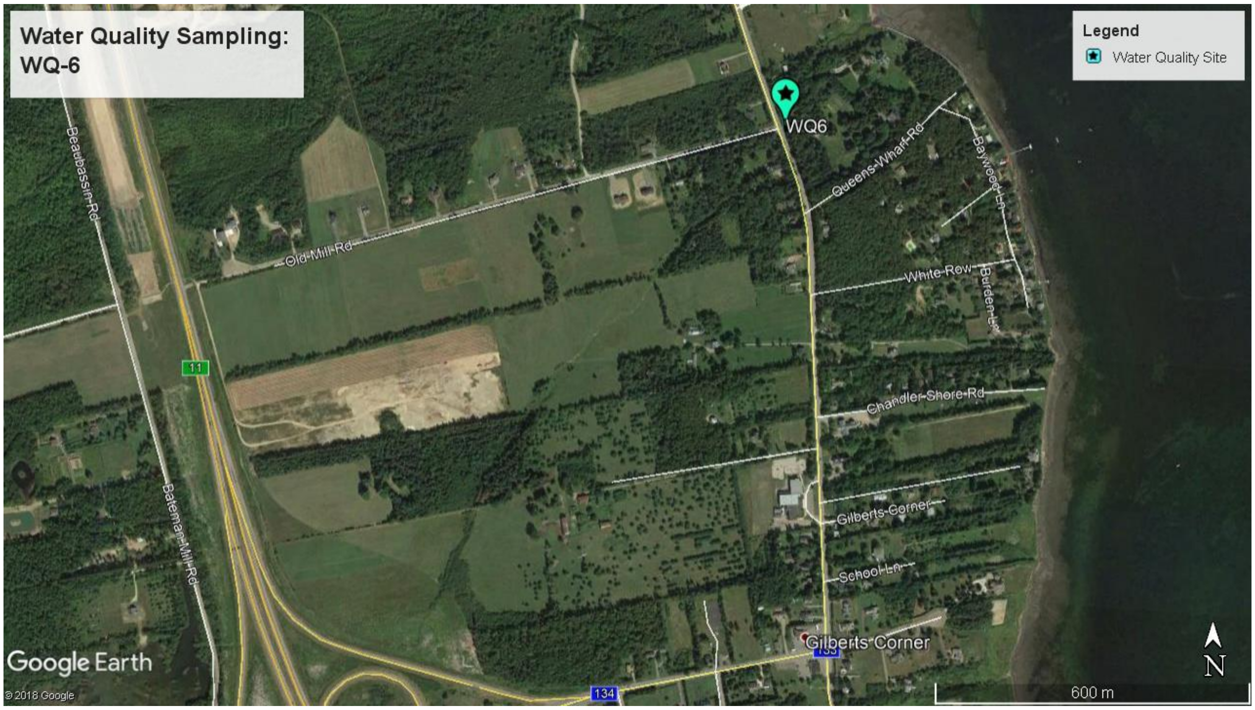

Figure 8: WQ-6 site location and surrounding land uses

4.7 WQ-7

This water quality sampling site is located off Route 134, on the property of *Bay Vista Lodge*. The samples are taken upstream of the culvert crossing the main road. The sample site is located approximately 160 m from the tidal zone and the beginning of a salt marsh. The surrounding land uses is mainly residential the cottages of *Bay Vista*. This brook is very short; the only obvious source of water being a pond (1,700 m^2) approximately 200 m away. The brook does not appear on GeoNB, only a separate brook nearby which flows into the same coastal wetland. This other nearby brook leads up to a gravel pit approximately 550 metres upstream from Route 134, but it is surrounded by forested lots.

The water sampling results for the site WQ-7, for 2017, meet the recommendations for the survival of freshwater aquatic life based on pH, but dissolved oxygen levels fell below 6 mg/L in the months of July, August and September (5.1 mg/L, 4.46 mg/L and 5.85 mg/L respectively). Total phosphorus levels for long-term eutrophic conditions according to the “CCME Guidance framework for Phosphorus” were in the eutrophic range (35 – 100 µg/L). Results did exceed the recommended CCME water quality guidelines for iron and aluminum. Iron is elevated in all samples except August; June (580 µg/L), July (570 µg/L), September (660 µg/L), and October (710 µg/L), when the recommendation is 300 µg/L. Aluminum is elevated in the samples of July (102 µg/L), September (110 µg/L) and October (167 µg/L), when the recommendation is 100 µg/L when the pH value is ≥ 6.5. Bacterial levels did not exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 28: Water chemistry data and E. coli results for WQ-7, 2017

SITE WQ-7: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	22	19.3	0.12	8.24	—	40.0	40	19	224	257	57.1	-0.63	8.19	7.9	8.5	163.80	123	4.1
17-07-19	24	21.7	0.12	5.1	—	172.3	48	11	237	255	65.5	-1.10	7.82	7.3	8.4	164.45	126	4.3
17-08-22	24	20.7	0.12	4.46	—	33.6	55	12	226	247	67.8	-1.03	7.43	7.3	8.3	159.90	126	1.1
17-09-20	—	18.9	0.11	5.85	—	373	46	11	199	226	64.9	-0.92	7.66	7.5	8.4	—	114	3.3
17-10-18	—	9.9	0.10	7.95	—	25	44	12	155	222	64.3	-1.04	7.58	7.4	8.4	141.05	113	8.2

E. coli sample in June measured in CFU/100 mL

Table 29: Nutrient results for WQ-7, 2017

SITE WQ-7: NUTRIENT DATA																		
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	39.7	40	16.8	296	50.3	90	0.64	3.69	22.2	<50	<1	<50	<50	<50	4	0.27	0.3	2.9	38
17-07-19	47.9	40	19.1	90	43.3	100	1.10	4.33	21.6	<50	<1	<50	<50	<50	6	0.4	0.4	2.5	49
17-08-22	54.9	40	19.4	103	39.8	120	1.30	4.69	19.1	80	<1	<50	110	110	7	0.5	0.6	2.5	44
17-09-20	45.8	30	18.7	136	36	110	1.86	4.41	17.5	90	1	<50	<50	<50	6	0.4	0.4	2.0	84
17-10-18	43.9	30	18.6	104	35	80	1.22	4.34	16.5	<50	<1	<50	70	70	9	0.3	0.4	1.6	68

Table 30: Inorganics results for WQ-7, 2017

SITE WQ-7: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	81	<1	5	31	<0.01	0.2	<1	<1	580	1.3	108	<0.1	<1	0.2	0.7	<0.1	44	<0.1	33	15	<1	<1
17-07-19	102	1	6	71	<0.01	0.2	<1	<1	570	1.3	120	<0.1	<1	0.3	0.9	<0.1	53	<0.1	33	15	<1	3
17-08-22	12	<1	7	115	<0.01	<0.1	<1	<	290	1.3	145	<0.1	<1	<0.1	1.1	<0.1	54	<0.1	33	15	<1	5
17-09-20	110	1	7	100	<0.01	0.3	<1	1	660	1.3	441	<0.1	<1	0.5	1.5	<0.1	53	0.1	33	15	1	15
17-10-18	167	<1	6	79	<0.01	0.3	<1	1	710	1.2	178	<0.1	<1	0.8	0.9	<0.1	49	0.1	33	15	1	28

Figure 9: WQ-7 site location and surrounding land uses

4.8 WQ-8

This water quality sampling site is located off Route 134, in front of a chiropractor's office (3694 Route NB-134, Shediac Cape). The site is within the tidal zone, being approximately 75 metres from the outlet into the Shediac Bay. The samples are taken upstream from the culvert. The surrounding land uses includes; residences, farmlands and a chicken farm. The farm fields possess little to no buffer around the lots; mainly wide open fields with little tree line density. There is a settling pond behind the chicken farm buildings, with a thin band of vegetation surrounding it (> 10 m). Observations taken during the sampling includes dark colouration and bad odours in the water.

The water sampling results for the site WQ-8, for 2017, has several parameters that are outside of the range of several recommendations for the survival of freshwater aquatic life. Dissolved oxygen varied greatly, with August, September and October being extremely low (0.12 mg/L, 0.07 mg/L and 4.53 mg/L respectively). The pH value measure by the YSI in October was below 6.5 (6.40), however, when measured by the laboratory, the value is 7.4, and 7.1 when saturated at 20°C. Total phosphorus levels for long-term eutrophic conditions according to the "CCME Guidance Framework for Phosphorus" were in the eutrophic (35 – 100 µg/L) to hyper-eutrophic range (> 100 µg/L).

Results exceeded long term limits for chloride in freshwater in June (160 mg/L) and July (350 mg/L), when the recommendation is 120 mg/L. The short term limits for chloride in freshwater is 640 mg/L, and the results for August, September and October are 14 000 mg/L, 7 120 mg/L and 12 000 mg/L respectively. However, it is very important to note that this site is in a tidal zone and the tide was high at the time of the sample (salinity concentrations 24-27 ppt). There are no recommendations for chloride in saltwater. Iron is elevated in all samples; June (350 µg/L), July (740 µg/L), August (1000 µg/L) September (700 µg/L), and October (2000 µg/L), when the recommendation is 300 µg/L. Aluminum is elevated in the samples of August (110 µg/L), September (141 µg/L) and October (210 µg/L), when the recommendation is 100 µg/L when the pH value is ≥ 6.5. The sample in July exceeded the long-term limit for unionized ammonia (19 µg/L) with a value of 61 µg/L. Boron levels are elevated in August and October; 3440 µg/L and 3000 µg/L respectively when the long term limits are 1500 µg/L.

Bacterial levels exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL) in July and August, where levels exceeded the maximum detection limit of > 2419.6 MPN/100 mL.

Table 31: Water chemistry data and E. coli results for WQ-8, 2017

SITE WQ-8: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	22	21.8	0.58	10.37	—	10.0 ◥	62	15	1070	785	111	0.40	8.47	8.7	8.3	676.00	361	2.6
17-07-19	24	19.3	3.40	6.55	—	**>2419.6**	130	36	5600	1470	194	-0.13	7.55	7.7	7.8	4300.00	753	13.5
17-08-22	24	21.9	26.62	**0.12**	0.05	**>2419.6**	107	18	38970	52400	4680	0.48	7.63	7.5	7.0	27046.50	25200	5.6
17-09-20	—	19.8	24.20	**0.07**	0.80	33	120	20	34090	26300	812	-0.59	6.90	7.2	7.8	—	9670	25.0
17-10-18	10	10.5	24.50	**4.53**	—	32	130	8	28010	45800	4140	0.35	**6.40**	7.4	7.1	25103.00	22200	4.5

◥ E. coli sample in June measured in CFU/100 mL

Table 32: Nutrient results for WQ-8, 2017

SITE WQ-8: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_{3}_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	59.0	650	22.4	2780	**160**	140	4.55	13.3	94.9	<50	<1	<50	200	200	27	0.30	0.5	2.0	**41**
17-07-19	129	1250	35.0	610	**350**	140	9.41	25.9	199	3100	**61**	<50	220	220	48	0.5	0.7	3.7	**680**
17-08-22	107	48800	302	317	**14000**	1650	287	954	7770	470	6	<50	<50	<50	1830	1.2	1.2	0.6	**93**
17-09-20	120	8060	69.6	178	**7120**	1060	51.7	155	1260	730	5	<50	<50	<50	940	2.5	2.5	0.6	**360**
17-10-18	130	40600	258	306	**12000**	1510	258	848	6910	490	5	<50	<100	<1000	1850	0.8	<2	<0.5	**166**

Table 33: Inorganics results for WQ-8, 2017

SITE WQ-8: HEAVY METALS AND OTHER ELEMENTS																				
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	49	<1	55	48	<0.01	<0.1	<1	<1	**350**	2.2	143	0.2	<1	0.2	1.7	<0.1	127	0.2	33	15	1	<1
17-07-19	71	2	105	100	0.04	0.2	<1	2	**740**	5.3	402	0.1	<1	0.7	4.6	<0.1	243	0.3	33	15	3	19
17-08-22	**110**	<50	**3440**	120	<0.5	<5	<50	<50	**1000**	134	650	10	<50	<5	84	<5	5600	<5	33	15	<50	<50
17-09-20	**141**	<5	607	314	<0.05	<0.5	<5	<5	**700**	28.6	151	1	<5	0.9	15.1	<0.5	1260	0.9	33	15	16	12
17-10-18	**210**	<50	**3000**	180	<0.5	<5	<50	<50	**2000**	120	340	8	<50	<5	72	<5	5490	<5	33	15	50	<50

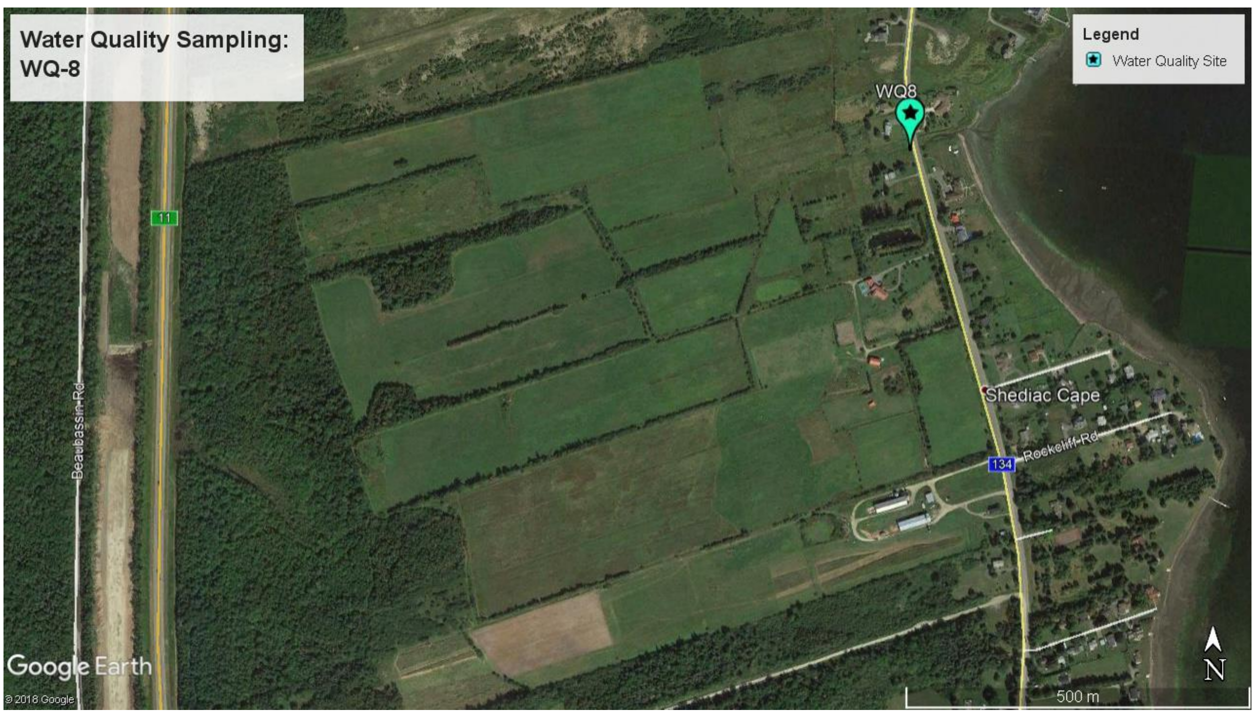

Figure 10: WQ-8 site location and surrounding land uses

4.9 WQ-9

This water quality sampling site is located in the Ruisseau Albert-Gallant, off Babineau Access Road, 320 m after turning to the left off Viaduc Road (turning to the right is Shediac River Road). The samples are taken downstream of the culvert, due to flooding on the other side caused by a beaver dam at the mouth of the culvert, creating conditions unfit for chest waders. The sample site is located approximately 300 m from the tidal zone. The surrounding land uses is mainly residences and large agricultural fields. There is a farming lot (1.2 hectares) along the right side of the brook (looking upstream), with no buffer zone along the total length of its riverbank (100 metres). On the left side of the sampling site are much larger cultivated farm field; 14.6 Hectares and another lot 5.3 Hectares. The drainage from these fields flows down to the ditch along Shediac River Rd. and Babineau Access Rd., and may flow down to the brook's culvert. There are no trees around any of these farm fields. There is also the presence of the large junkyard of *Bastarache's Auto Salvage*, but there is approximately 1 km of forested buffer between the salvage lot and the head ponds of the brook (as delineated on GeoNB).

The water sampling results for the site WQ-9, for 2017, meet the recommendations for the survival of freshwater aquatic life based on pH, but dissolved oxygen levels fell below 6 mg/L in the months of August, September and October (3.59 mg/L, 5.08 mg/L and 5.64 mg/L respectively). Total phosphorus levels for long-term eutrophic conditions according to the "CCME Guidance Framework for Phosphorus" were in the meso-eutrophic (20 -35 µg/L) to eutrophic range (35 – 100 µg/L). Iron is elevated in all samples; June (980 µg/L), July (1230 µg/L), August (1280 µg/L) September (730 µg/L), and October (960 µg/L), when the recommendation is 300 µg/L. Bacterial levels did not exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL).

Table 34: Water chemistry data and E. coli results for WQ-9, 2017

SITE WQ-9: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	25	18.6	0.07	9.47	—	20.0	55	46	125	143	51.0	-0.76	8.04	7.6	8.4	92.30	70	2.8
17-07-19	25	22.2	0.90	6.35	—	55.4	71	30	175	174	68.2	-0.63	8.05	7.5	8.1	118.95	88	5.4
17-08-22	24	19.2	0.10	3.59	—	37.9	91	38	183	203	75.3	-0.69	7.55	7.3	8.0	133.25	107	5.9
17-09-20	—	18.2	0.09	5.08	—	9	75	24	730	196	75.3	-0.57	8.15	7.5	8.1	—	104	2.7
17-10-18	11	9.8	0.14	5.64	—	6	77	23	183	221	79.0	-0.84	8.38	7.2	8.0	174.20	116	5.8

◥ E. coli sample in June measured in CFU/100 mL

Table 35: Nutrient results for WQ-9, 2017

SITE WQ-9: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	54.8	40	17.0	205	8.5	170	0.83	2.08	6.43	<50	<1	<50	<50	<50	<1	0.34	0.3	7.0	32
17-07-19	70.8	50	23.4	210	9	150	0.83	2.38	7.28	<50	<1	<50	<50	<50	<1	0.5	0.5	5.7	59
17-08-22	90.8	40	25.5	170	10	150	1.62	2.82	7.99	120	<1	<50	<50	<50	<1	0.5	0.5	5.2	64
17-09-20	74.8	40	25.6	222	11.2	150	1.44	2.77	7.93	70	<1	<50	<50	<50	7	0.4	0.4	4.4	38
17-10-18	76.9	50	26.9	115	15	120	1.58	2.88	11.6	<50	<1	<50	50	50	9	0.4	0.4	4.0	49

Table 36: Inorganics results for WQ-9, 2017

SITE WQ-9: HEAVY METALS AND OTHER ELEMENTS																					
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	49	2	8	67	<0.01	0.2	<1	<1	980	0.6	676	0.1	<1	0.1	0.9	<0.1	59	<0.1	33	15	<1	2
17-07-19	54	2	10	64	<0.01	0.2	<1	<1	1230	0.7	849	0.1	<1	0.2	1.1	<0.1	63	<0.1	33	15	<1	4
17-08-22	31	2	9	101	<0.01	0.3	<1	<1	1280	0.8	1850	0.2	<1	0.2	2.0	<0.1	80	<0.1	33	15	<1	17
17-09-20	21	1	9	89	<0.01	0.2	<1	<1	730	0.7	927	0.1	<1	<0.1	1.6	<0.1	89	<0.1	33	15	<1	7
17-10-18	34	<1	9	88	<0.01	0.2	<1	<1	960	0.6	1010	<0.1	<1	0.2	1.6	<0.1	88	<0.1	33	15	<1	8

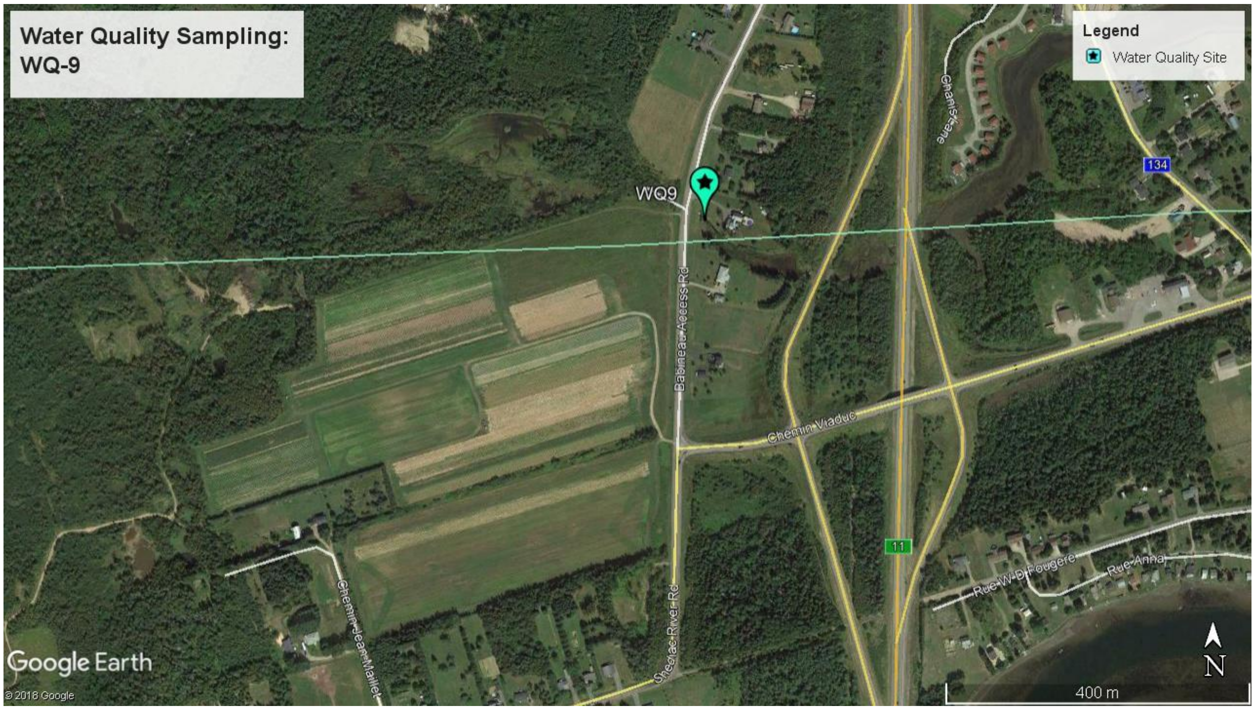

Figure 11: WQ-9 site location and surrounding land uses

4.10 WQ-10

This water quality sampling site is located off Route 530 (Grande-Digue Rd.), 100 m after Chemin Antoine. The samples are taken upstream of the culvert. The sample site is located approximately 130 m from the tidal zone. The surrounding land uses is mainly residences and a possible agricultural fields (> 1 ha.). There is a buffer zone that separates the field and the brook (average 5-15 m in thickness).

The water sampling results for the site WQ-10, for 2017, meet the recommendations for the survival of freshwater aquatic life based on pH, but dissolved oxygen levels fell below 6 mg/L in the months of July, August and October (5.84 mg/L, 4.42 mg/L and 4.05 mg/L respectively). Total phosphorus levels for long-term eutrophic conditions according to the “CCME Guidance Framework for Phosphorus” were in the meso-eutrophic (20 -35 µg/L) to eutrophic range (35 –

100 µg/L)). Iron is elevated only in June (750 µg/L), when the recommendation is 300 µg/L. Aluminum is also slightly elevated June (108 µg/L), when the recommendation is 100 µg/L when the pH value is ≥ 6.5. Bacterial levels exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL) in August and September, where levels exceeded the maximum; 1299.7 MPN/100 mL and > 10 000 MPN/100 mL*.

*Membrane filtration method was used (FFA01) to analyze E. coli, has a maximum detection limit of > 10 000 MPN/100 mL.

Table 37: Water chemistry data and E. coli results for WQ-10, 2017

SITE WQ-10: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	27	19.0	0.06	8.29	—	390.0 ◥	30	100	110	127	36.8	-1.49	8.09	7.3	8.8	80.60	61	2.2
17-07-19	26	20.3	0.13	5.84	—	275.5	53	28	245	270	84.5	-0.81	7.70	7.4	8.2	174.85	129	1.1
17-08-22	26	19.4	0.19	4.42	—	1299.7	69	15	346	388	118	-0.67	7.44	7.3	8.0	250.90	191	0.9
17-09-20	—	17.5	0.18	6.31	—	>10000	62	20	318	362	108	-0.65	7.70	7.4	8.1	240.50	179	1.1
17-10-18	13	9.7	0.23	4.05	—	205	85	15	342	485	142	-0.72	7.59	7.1	7.8	313.95	247	0.6

◥ E. coli sample in June measured in CFU/100 mL

Table 38: Nutrient results for WQ-10, 2017

SITE WQ-10: NUTRIENT DATA																			
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	29.9	40	11.5	56	17	200	0.60	1.97	8.35	<250	<1	<250	<250	<250	2	0.45	0.4	11.3	30
17-07-19	52.9	50	27.0	125	46.4	140	0.95	4.16	16.4	50	<1	<50	230	230	<1	0.4	0.6	5.3	30
17-08-22	68.9	60	37.9	129	78.1	130	1.21	5.75	22.7	110	<1	<50	340	340	1	0.4	0.7	3.5	57
17-09-20	61.8	50	34.6	146	73.9	150	1.94	5.19	22.6	300	3	<50	370	370	<1	0.7	1.1	4.5	62
17-10-18	84.9	60	45.6	100	99.7	120	2.90	6.85	30.6	1480	7	<50	90	90	5	1.6	1.7	3.7	53

Table 39: Inorganics results for WQ-10, 2017

SITE WQ-10: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	108	<1	7	31	<0.01	<0.1	<1	<1	750	0.3	114	<0.1	<1	0.3	1.0	<0.1	39	<0.1	33	15	<1	1
17-07-19	19	<1	12	39	<0.01	<0.1	<1	<1	220	0.3	190	0.1	<1	<0.1	1.5	<0.1	70	<0.1	33	15	<1	9
17-08-22	15	<1	15	45	0.01	0.2	<1	<1	160	0.4	799	0.1	1	<0.1	2.1	<0.1	83	<0.1	33	15	<1	15
17-09-20	23	<1	14	48	0.01	0.2	<1	<1	240	0.3	646	<0.1	<1	0.2	2.8	<0.1	82	<0.1	33	15	<1	15
17-10-18	13	<1	15	68	<0.01	0.2	<1	<1	170	0.4	1630	<0.1	<1	<0.1	4.1	<0.1	102	<0.1	33	15	<1	6

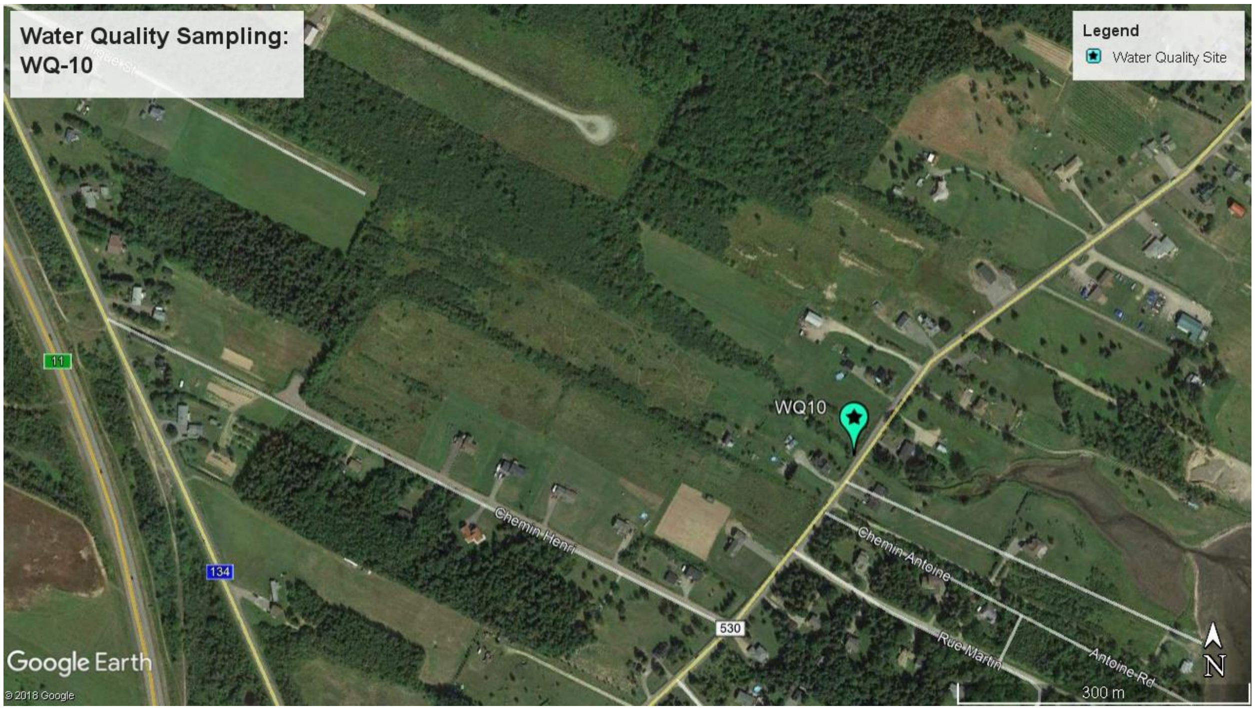

Figure 12: WQ-10 site location and surrounding land uses

4.11 WQ-11

This water quality sampling site is located off Route 530 (Grande-Digue Rd.), just before the Chemin des Soeurs. The samples are taken upstream of the culvert. The sample site is located approximately 80 m from the tidal zone. The surrounding land uses is mainly residential and agricultural farms. The farm lands are made up of various parcels of land, spanning over 58 Hectares of land leading up to the watershed boundary. There is very little evidence of any tree buffer over this area from aerial imagery, except for one forested parcel and a few thin lines of trees along property lines.

The water sampling results for the site WQ-11, for 2017, meets or exceeds all the recommendations for the survival of freshwater aquatic life based on pH and dissolved oxygen. Total phosphorus levels for long-term eutrophic conditions according to the "CCME Guidance Framework for Phosphorus" were in the meso-eutrophic (20 -35 µg/L) to eutrophic range (35 – 100 µg/L). Iron is elevated is all samples; June (660 µg/L), July (630 µg/L), August (1490 µg/L) September (2090 µg/L), and October (530 µg/L), when the recommendation is 300 µg/L. Aluminum is also elevated July (122 µg/L), August (181 µg/L), and September (235 µg/L), when the recommendation is 100 µg/L when the pH value is ≥ 6.5. Bacterial levels exceed the maximum concentration of E. coli from Health Canada recreational guideline (≥ 400 MPN/100 mL) in July (1732.9 MPN/100 mL), August (> 2419.6 MPN/100 mL), September (791 MPN/100 mL) and October (3035 MPN/100 mL)*.

*Membrane filtration method was used (FFA01) to analyze E. coli, has a maximum detection limit of > 10 000 MPN/100 mL.

Table 40: Water chemistry data and E. coli results for WQ-11, 2017

SITE WQ-11: FIELD DATA COLLECTED BY YSI AND LAB SAMPLES																		
Date (yy-mm-dd)	Temp (°C)		SAL (ppt)	Dissolved O_2		E. coli (MPN /100mL)	ALK_T (mg/L)	CLRA (TCU)	COND (µS/cm)		HARD (mg/L)	Lang_Ind (20°C)	pH (pH)			TDS (mg/L)		TURB (NTU)
	Air	Water		(mg/L)	%				Field	Lab			Field	Lab	Sat (20°C)	Field	Lab	
17-06-22	27	19.0	0.07	8.8	—	60.0	45	58	129	148	46.4	-1.02	8.23	7.5	8.5	94.90	71	2.0
17-07-19	29	21.7	0.11	6.03	—	1732.9	72	20	223	238	76.6	-0.53	7.52	7.6	8.1	154.05	121	2.7
17-08-22	26	20.5	0.15	12.22	—	>2419.6	91	32	291	313	93.5	-0.16	7.62	7.8	8.0	203.45	166	14.2
17-09-20	—	18.1	0.15	6.36	—	791	86	39	276	313	98.9	-0.06	7.35	7.9	8	206.05	163	10.2
17-10-18	—	9.4	0.15	10.78	—	3035	87	21	223	314	98.8	-0.46	7.66	7.5	8.0	204.10	163	5.3

E. coli sample in June measured in CFU/100 mL

Table 41: Nutrient results for WQ-11, 2017

SITE WQ-11: NUTRIENT DATA																		
Date (yy-mm-dd)	HCO_3 (mg/L)	Br (µg/L)	Ca (mg/L)	CO_3 (µg/L)	Cl (mg/L)	F (µg/L)	K (mg/L)	Mg (mg/L)	Na (mg/L)	NH_3T (µg/L)	NH_3_Un (µg/L)	NO_2 (µg/L)	NO_3 (µg/L)	NO_X (µg/L)	SO_4 (mg/L)	TKN (mg/L)	TN (mg/L)	TOC (mg/L)	TP-L (µg/L)
17-06-22	44.9	50	14.3	133	12.2	180	1.37	2.6	8.70	<50	<1	<50	180	180	3	0.62	0.8	8.7	47
17-07-19	71.7	50	23.9	268	25.5	110	1.90	4.10	15.7	60	<1	<50	260	260	4	0.4	0.7	3.6	47
17-08-22	90.4	60	28.9	536	42.8	110	2.26	5.18	22.6	<50	<1	<50	130	130	6	0.6	0.7	2.9	102
17-09-20	85.3	50	30.6	637	42.7	140	2.62	5.46	21.3	<50	<1	<50	80	80	5	0.4	0.5	3.2	74
17-10-18	86.7	50	30.5	258	41.7	100	2.22	5.49	21.7	<50	<1	<50	50	50	7	0.2	0.2	2.4	29

Table 42: Inorganics results for WQ-11, 2017

SITE WQ-11: HEAVY METALS AND OTHER ELEMENTS																						
Date (yy-mm-dd)	Al (µg/L)	As (µg/L)	B (µg/L)	Ba (µg/L)	Cd (µg/L)	Co (µg/L)	Cr (µg/L)	Cu (µg/L)	Fe (µg/L)	Li (µg/L)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Pb (µg/L)	Rb (µg/L)	Sb (µg/L)	Sr (µg/L)	U (µg/L)	U_STL (µg/L)	U_LTL (µg/L)	V (µg/L)	Zn (µg/L)
17-06-22	48	<1	13	60	<0.01	0.2	<1	<1	660	0.6	153	0.2	<1	0.2	1.4	<0.1	108	<0.1	33	15	<1	10
17-07-19	122	<1	24	119	0.01	0.3	<1	<1	630	1.1	343	0.2	<1	0.6	2.1	<0.1	241	0.1	33	15	<1	10
17-08-22	181	2	30	153	<0.01	0.3	<1	<1	1490	1.3	540	0.2	<1	0.8	2.4	<0.1	317	0.2	33	15	1	6
17-09-20	235	2	28	192	0.02	0.5	<1	<1	2090	1.5	672	0.1	<1	1.3	2.9	<0.1	365	0.2	33	15	1	13
17-10-18	19	<1	25	149	<0.01	<0.1	<1	<1	530	1.3	163	0.1	<1	<0.1	2.0	<0.1	351	0.2	33	15	<1	5

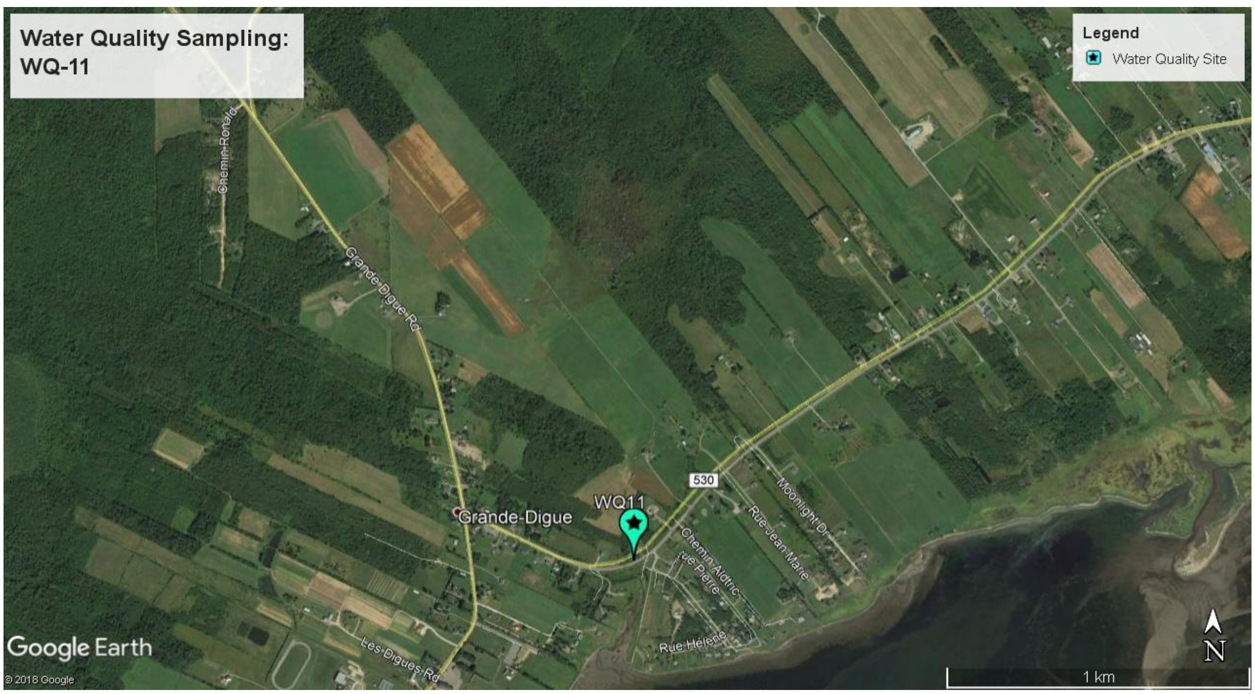

Figure 13: WQ-11 site location and surrounding land uses

4.12 Bacterial Sampling Summary

The bacterial levels in some of the small streams sites shows the need for more investigation around land uses. Valuable data has been collected in 2017 and will be used in the planning of future studies and remediation action plans.

The sites that did not surpass the 400 MPN/100 mL limits in 2017 are; WQ-1, WQ-2, WQ-4, WQ-5, WQ-7 and WQ-9. The sites WQ-3 and WQ-6 both had only one instance of bacterial spike in the month of July. There was no rainfall in the 24 hours prior to the sampling of July. The only occurrence of light rainfall (> 5 mm) in the 24-hour period prior to a sample was for the months of June and September.

Based on the bacterial levels alone, the sites demanding further investigation are; WQ-8, WQ-10 and WQ-11.

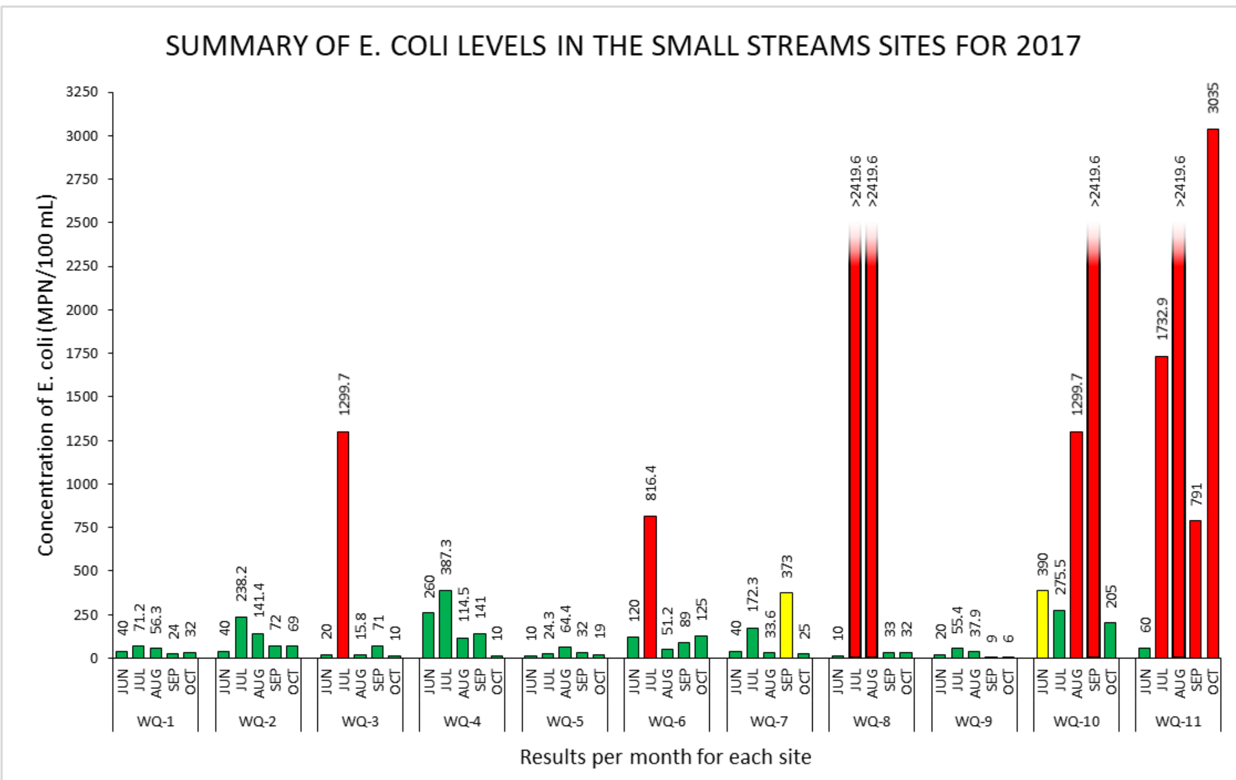

Figure 14: Summary of water quality results for E. coli, small streams sampling 2017

5 Environmental DNA Study

The environmental DNA test, or e-DNA, done in October of 2016 has provided to some very interesting information, but has also led to a lot more questions. When looking for sources of environmental contaminations, usual testing only looks for areas with high concentrations of E. coli or Enterococci. The use of e-DNA is meant to provide information on the *sources* of the bacteria, by analyzing the *DNA* of the bacteria.

E. coli bacteria are present in the large intestines of all warm-blooded animals, including humans. For this reason, E. coli is used as an indicator of fecal contamination in the environment. The DNA sequencing of these bacteria have led to the ability to determine from which animal the bacteria came from, using a technique called “Bacterial Source Tracking” (BST). Using this methodology, funding was received to establish 5 sites along the coast from Boudreau-Ouest to Shediac Bridge, to gather information on the sources of bacteria impacting the Shediac Bay.

The sampling was done following a heavy rainfall over two days (49 mm total), so that the effects of stormwater running off the land could be analyzed. The sampling was done in October, as there were no heavy rainfall events significant enough before that point in the sampling period options (laboratory availability was also a factor).

The sources of E. coli found in the Shediac Bay during this sampling includes; ruminants, dog, pig, gull, and human.

Ruminants are mammals that eat and digest plant-based foods, such as grass. They include cows, sheep, goats, buffalo, deer and several other animals that have specialized stomachs to facilitate the digestion with fermentation. There are several cattle pastures spread out within the watershed. Several of these cattle fields have little buffer zone density. Results for ruminants were positive at the stations; 3, 4 and 5.

What is interesting about dogs, is that it is the only parameter that was positive or could not be ruled out at each of the 5 sites. When considering the number of dogs present in the Town of Shediac, Shediac Bridge, Scoudouc and all other areas within the limits of the watershed, it is logic that uncollected dog excrement from backyards would mix with rainwater and eventually make it to the bay. Dog waste was classified as a non-point source pollutant in 1991 by the Environmental Protection Agency (EPA). One gram of waste can contain 23-million fecal coliform bacteria; that is 10 times more per pound of body weight than a cow produces. The EPA estimates that 2 days’ worth of dog waste from about 100 dogs could contribute enough pollution to close beaches and shell fishing within 20 miles of the watershed areas.

Sources of human E. coli was present Stations 1, 2 and 4; Boudreau-Ouest, Pointe-du-Chêne, and Ruisseau Albert-Gallant in Shediac Bridge. This can be an indication faults in the municipal sewer structures and/or defective septic systems.

There is only one instance where pig E. coli was detected, Station 3, in the mouth of the Scoudouc River. There are no known pig farms in the area, but this result may come from farmers manure treatments of their fields. There was one sample positive for gulls, at the Station 2 near Parlee Beach.

The BST analysis is only able to detect the presence of these sources of bacteria; it does not quantify which sources of coliform are more present than others. This means that it cannot determine how significant each source is in causing bacterial spikes in the Shediac Bay.

Table 43: e-DNA Site Information

Site ID	Latitude	Longitude	Location Description
DNA Station 1	N46°14'15.48"	W64°29'47.27"	East end of Parlee Beach, at the mouth of the small estuary in Boudreau-Ouest, next to The Bluff
DNA Station 2	N 46°14'24.19"	W64°31'4.40"	West end of Parlee Beach, at the mouth of the small brook, North of Pointe-du-Chêne
DNA Station 3	N 46°13'9.73"	W64°33'13.66"	At the mouth of the Scoudouc River, below NB-133
DNA Station 4	N 46°16'46.26"	W 64°34'23.13"	At the mouth of the Ruisseau Albert-Gallant
DNA Station 5	N 46°16'20.81"	W 64°34'29.89"	At the mouth of the Shediac River, below NB-134

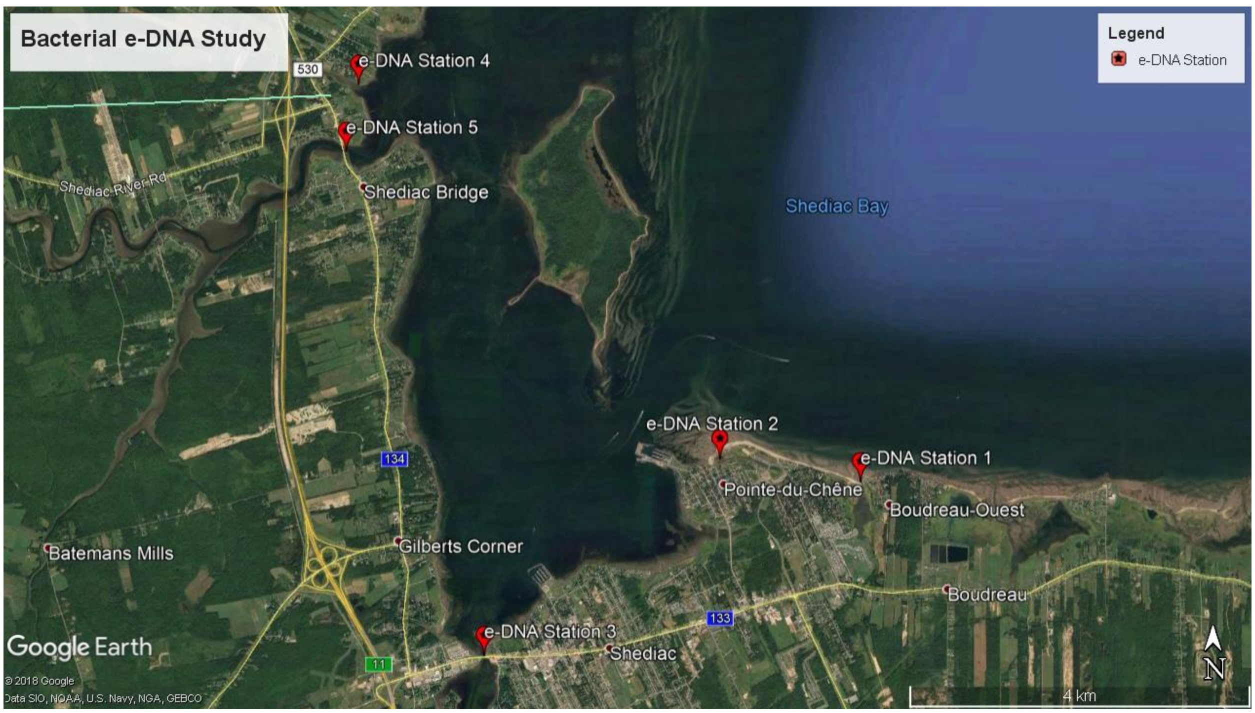

Figure 15: e-DNA Sampling sites

Table 44: e-DNA Study Results of 2016

Bacterial Source Tracking (BST) Results									
Site ID	Total E. coli concentrations (MPN/100 mL)	General *Bacteroides**	Human	Ruminants	Pig	Horse	Dog	Elk	Gull
Station 1	> 1700	+	+	-	-	-	+	-	-
Station 2	> 1700	+	+	-	-	-	+	-	+
Station 3	350	+	-	+	+	-	+	-	-
Station 4	920	+	+	+	-	-	+	-	-
Station 5	79	+	-	+	-	-	?	-	-
Legend: + = detected; - = not detected; ? = uncertain (potential presence; cannot be ruled out)									
QA/QC passed: All negative controls (equipment blank, extraction blank and PCR blank) and the PCR positive control reference tests performed as expected.									

***BACTEROIDE mini primer**
CHARACTERISTICS: The gram-negative Bacteroides spp. or closely related genera are capsulated obligatory anaerobic bacilli that are non-spore forming, pale-staining, and some are motile by flagella, while other taxa are non-motile. They are normally commensal, found in the intestinal tract of humans (mouth, colon, urogenital tract) and other animals.
EPIDEMIOLOGY: Worldwide - *Bacteroides* spp. or closely related genera are part of the normal flora of the gastrointestinal and respiratory tract and the mouth
HOST RANGE: Humans, dogs, cats and other animals.
MODE OF TRANSMISSION: Infection results from displacement of *Bacteroides* spp. or closely related genera from normal mucosal location as a result of trauma such as animal/human bites, burns, cuts, or penetration of foreign objects, including those involved in surgery. There is no evidence that organisms are invasive on their own.
COMMUNICABILITY: Low; human-to-human transmission is possible through clenched-fist wounds and skin penetrating human bites.
RESERVOIR: Present as part of normal flora in of the gastrointestinal tract, the mouth, and other animals.
ZOONOSIS: Yes, skin penetrating animal bites could lead to infection.
SURVIVAL OUTSIDE HOST: *Bacteroides* and like genera have been detected in feces infected water by PCR for at least 2 weeks at 4°C; 4 to 5 days at 14°C; 1 to 2 days at 24°C; and 1 day at 30°C.

6 Discussion

The first disclaimer is that SBWA does not by any means proclaim to be water quality experts. The purpose of this project is to collect samples, organize the data, look at surrounding land uses and buffer zones, then pass on the information to experts. We can point out trends from our limited sampling results, but changes occur so quickly that general patterns are not always evident. Our sampling is simply a snapshot of the results on that collection day. It would be very expensive to monitor water quality changes on a daily or even weekly basis. As a non-profit environmental organization, we do not have the resources or capacity for this. Our goal is to look for gross abnormalities in general patterns and hope to identify possible causes.

Many of the flagged parameters above can have a wide range of negative impacts on various aquatic species when concentrations exceed their threshold of tolerance. This threshold varies depending on species, life stage, and sometimes concentrations of other parameters.

The concentrations for the following metals were below their respective detection limits for all samples at every site. These metals were not included in the above tables; Silver (Ag), Beryllium (Be), Bismuth (Bi), Selenium (Se), Tin (Sn), Tellurium (Te), Thallium (Tl).

Most sites were generally under the limits for E. coli based on Health Canada Recreational Guidelines, except for WQ-3 (1 sample), WQ-6 (1 sample), WQ-8 (2 samples), WQ-10 (2 samples), and WQ-11 (4 samples). Additional samplings of the drainage surrounding WQ-8, 10 and 11 should be done, as some sites have the potential to be very high. In July and August, the RPC laboratory used the Colilert Method as they were waiting for more membrane filters. The maximum detection limit for the Colilert Method is >2419.6 MPN/100 mL. The detection limit for the membrane filtration method has a maximum detection limit of >10 000 MPN/100 mL, and can also be modified with a dilution method to analyze up to >1 Million MPN/100 mL. We saw levels in September and October that were higher than the Colilert method can detect; WQ-10 had one sample at >10 000 MPN/100 mL (Sept.) and WQ-11 had one sample at 3035 MPN/100 mL (Oct.)

All pH levels were found to be within the guidelines; between 6.5 and 9. However, dissolved oxygen was very poor in certain areas during the summer months. With very warm temperatures and very little rainfall in the summer 2017, the water in some of those sampling sites became very warm and stagnant. The presence of bacteria and algae can further decrease the levels of dissolved oxygen available for aquatic life.

Looking at total phosphorous levels, most of our site falls into mesotrophic to eutrophic range. Only one site, WQ-8, had extreme levels of total phosphates that reached the hyper-eutrophic range (> 100 µg/L) as some of its samples had levels of 360 µg/L and 680 µg/L.

Inorganic's results that were over the CCME recommended water quality guideline were mainly iron and aluminum. There were a few instances of copper, boron, chloride and unionized ammonia that also surpassed the limits. The province of New Brunswick is known to have higher levels of naturally occurring aluminum. More investigation ad consultation with experts is needed to interpret the inorganic results.

7 SeagrassNet Eelgrass Monitoring

The SeagrassNet program is a global seagrass monitoring network that monitors the status of seagrasses and the threats to these ecosystems. The program started in 2001, and now includes more than 126 sites in 33 countries. The protocol for the sampling can be found www.seagrassnet.org.

The Southern Gulf of Saint Lawrence Coalition on Sustainability (Coalition-SGSL) has implemented the SeagrassNet program in Atlantic Canada since 2015. They have provided equipment and training to the SBWA for the monitoring program to begin in the Shediac Bay. The first site was established in the estuary of the Scoudouc River in 2016, and a second site was established in the Shediac River estuary in 2017.

The data collected from these annual surveys will serve to measure changes in eelgrass densities in these sensitive habitats. Since the first appearance of the invasive green crab in the Shediac Bay in 2010, population monitoring has shown a trend of constant increase in their numbers. The green crab is an invader is capable of devastating eelgrass habitats. The SeagrassNet program provides a protocol to measure the impacts of the green crab in the Shediac Bay.

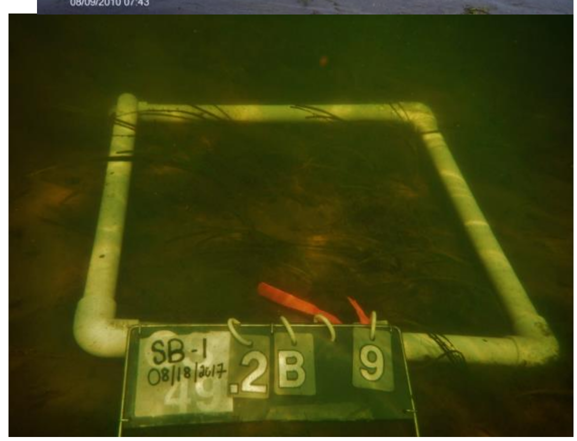

Figure 16: Photo of Shediac Bay, sampling quadrant in the Scoudouc River (Left) and Shediac River (Right) estuaries

7.1 Scoudouc River

The Scoudouc River site is located N46°13'32.3" W 64°33'26.2" in the estuary of Scoudouc River. In total, there have been two surveys conducted at this site to date: the first survey was done on August 3, 2016, and the second survey was done on August 18, 2017.

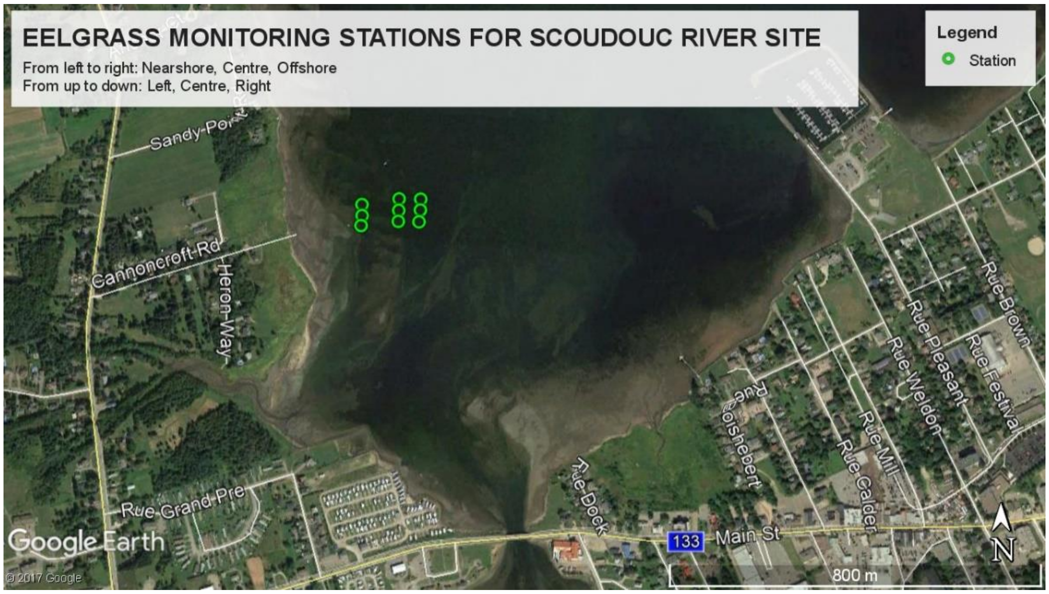

Figure 17: Map of Scoudouc River eelgrass monitoring station

7.2 Shediac River

The Shediac River site is located N 46°16'16.54" W 64°34'23.30" east of the Route 134 bridge. Only one survey has been conducted at this site to date, on August 18, 2017.

Figure 18: Map of Scoudouc River eelgrass monitoring station

7.3 Analysis

Since only the Scoudouc River site was surveyed in 2016, it was the only site used to test for statistical difference in percent cover, shoot density, and canopy height of eelgrass between 2016 and 2017 using an ANOVA (*Analysis Of Variance*) calculation. However, an ANOVA was also used to test for statistical difference in percent cover, shoot density, and canopy height between the Scoudouc River site and the Shediac River site for the year 2017.

7.3.1 Results and Discussion

For the Scoudouc River site, there is no statistical difference in percent cover or canopy height of *Zostera marina* between the years 2016 and 2017; however, there was a significant decrease in shoot density (Figure 19). Although no statistical difference in shoot density was found between near-shore, middle, and offshore stations in the Scoudouc River site, there was difference in percent cover and canopy height; an increase in distance from shore resulted in an increase in canopy height of eelgrass (Figure 20).

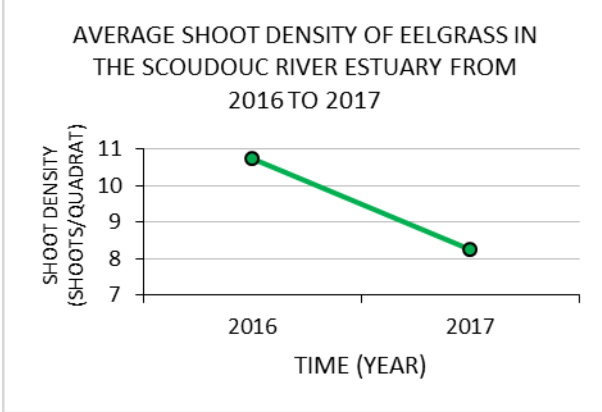

Figure 19: Number of shoots per 25 cm x 25 cm square quadrat between 2016 and 2017 for the Scoudouc River site. A decline in overall average shoot density can be seen over the year.

Between the two sites, all three parameters showed significant difference: percent cover, shoot density, and canopy height of eelgrass in the Scoudouc River site were all higher than those of eelgrass in the Shediac River site (Figure 21).

The Community Aquatic Monitoring Program (CAMP) nutrients results for 2016 showed an increased level of phosphates for the month of August; all samples taken in August were above 35 µg/L, suggesting eutrophic conditions (Canadian Council of Ministers of the Environment, 2004). Furthermore, epiphytes were present on the eelgrass at both sites during time of sampling, indicating that plant growth was being stimulated at that time.

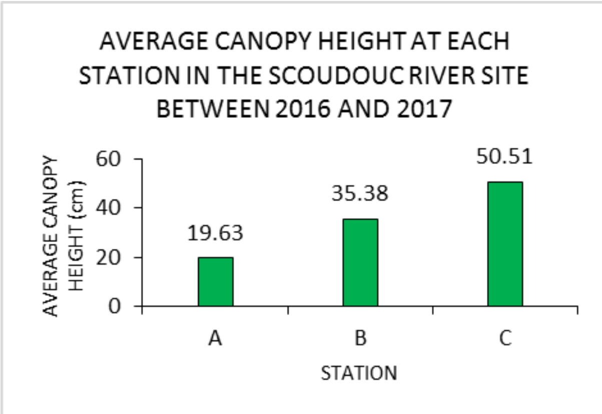

Figure 21: **Average canopy height in 2016 and 2017 for each station at the Scoudouc River site. Station A corresponds to near shore, Station B is in the middle, and Station C is farthest offshore.**

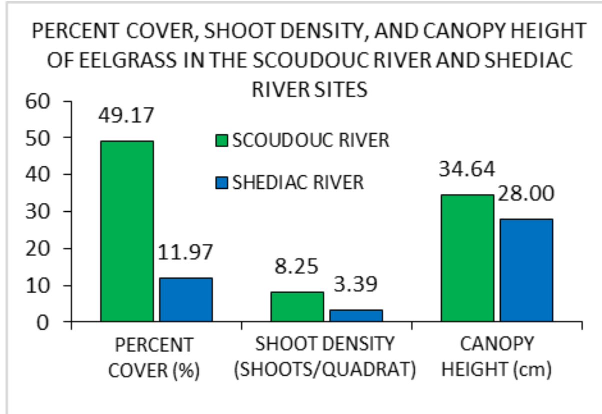

Figure 20: **A comparison of the Scoudouc River site and the Shediac River site examining percent cover, shoot density, and canopy height of the respective eelgrass populations.**

7.4 Eelgrass Conclusion and Recommendations

Initially, an eelgrass restoration plan was established for the Shediac Bay region in 2017. Phase 1 included using a boat with a SONAR device in order to obtain the bathymetric characteristics of the Shediac Bay. However, due to a lack of time and the unavailability of the *Southern Gulf of St. Lawrence Coalition on Sustainability*, who had access to the necessary equipment, the mapping of eelgrass beds was not done. As a result, insufficient data was collected, and an appropriate restoration location could not be determined.

Although some decline was noticed within the eelgrass population in the Scoudouc River site, it is uncertain as to whether this decline is caused by green crab predation or natural factors.

Therefore, it is crucial that eelgrass populations in the Scoudouc River and Shediac River sites continue to be monitored in order to gain valuable information on how the eelgrass population in these regions are being affected by the invasive green crab population. Long-term monitoring of both eelgrass and green crab populations in the Shediac Bay region will aid in determining future courses of action (e.g. green crab removal, eelgrass restoration).

8 Public Education, Outreach and Involvement

8.1 Boater Awareness Program

The Shediac Bay received significant media attention in the last few years related to bacterial contamination and public health safety for swimming. In order to address the causes around this issue, different avenues are being explored.

As a first step into mitigating potential causes of contamination in the bay, an educational program was designed in partnership with Transport Canada and the Shediac Bay Yatch club. A new campaign was designed to promote the use of pump out stations for boaters' sewage management.

Local marinas were contacted to confirm the presence of pump out stations, at the various locations in Southeast NB. Five marinas from Bouctouche to Shediac have pump-out facilities (Bouctouche, Cocagne, Cocagne Cape, Shediac Bay Yatch Club and Pointe-du-Chêne). The only local marina that does not have a pump out station is the Aboiteau Marina in Cap Pelé.

A meeting was held on June 6th with Transport Canada and local marinas. It was discussed at the meeting what type of message could be developed for a pamphlet and poster. The materials were designed during June and July, and were finalized and printed in early August. Summer students then distributed the pamphlets and put up the posters in locations around Southeastern New Brunswick.

The education campaign was done later in the season than was anticipated, and could have had a greater impact if done earlier. However, the materials are now ready to be used early in the 2018 boating season. This program will continue in the coming years with more media outreach and communications.

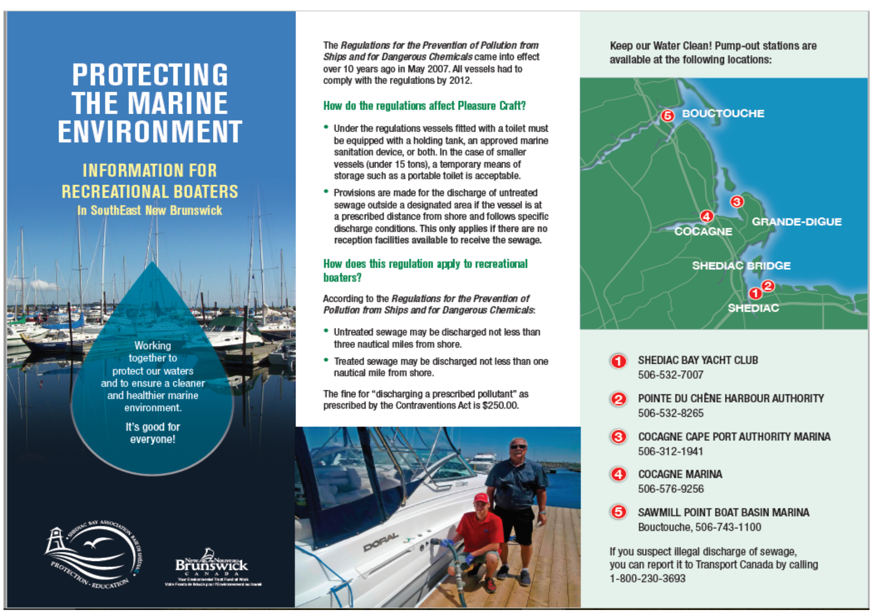

Figure 22: Boater Awareness pamphlet side 1 (English)

Figure 23: Boater Awareness pamphlet side 2 (French)

Figure 24: Boater Awareness Poster

8.2 Beach Sweep

In celebration of World's Oceans Day, a public beach sweep event is organized every year by the SBWA, in partnership with the Town of Shediac. This activity aims to combat marine litter, to raise awareness, and contribute to the protection and conservation of our marine environment in the Shediac Bay. The event was advertised to begin at the Homarus Eco-Centre, at the Pointe-du-Chêne wharf on Saturday, June 10 2017.

It was a beautiful warm sunny day, and 19 volunteers showed up to pick up trash along the coastline of the Town of Shediac. SBWA staff greeted volunteers and provided them with gloves, garbage bags and small handout gifts. The Shediac Tim Hortons donated coffee, hot chocolate, Timbits and "Clean Community" T-shirts.

People were directed to different parts of the coastline in order to cover as much ground as possible. There were designated drop-off points for their garbage bags, which would then be picked up by staff of the Town of Shediac. Our volunteers were then invited to a lunch of subs donated by the Shediac Subway, along with fruit and vegetable platters donated by the Shediac Coop IGA. Special thanks goes out to Oceanside Fitness Gym and Shediac Dixie Lee, for donated gift certificates as prize draws for the volunteers; 2 one month free memberships at the gym, and two 10$ gift cards at Dixie Lee. Other toy prizes were drawn for the children participating in the event.

A trash inventory was done on the 15 large garbage bags brought back to the Homarus Eco-Centre. The following count (Table 1) does not include any of the trash bags deposited at other drop off locations that were collected by the Town. It is not a surprise that the items found in greater quantities includes cigarette buds, food wrappers, plastic bags, Styrofoam, cans, bottle caps, etc. Surprisingly, a 20$ bill was found amongst the rocks of the Pointe-de-Chêne wharf. The cash was donated to the SBWA by the volunteer who found it.

Figure 25: Advertisement poster for Beach Sweep 2017

Based on volunteer feedback, either at lunch or via quick phone call, an estimate of 4.1 km of coastline was cleaned that day.

Table 45: Trash inventory, Beach Sweep 2017

Cigarette butts	250	Plastic Bottles	33	Wood	4	Paper	2
Wrappers	235	Rubber Elastics	30	Metal	4	Life Jacket	2
Plastic Bags	72	Plastics	19	Rope	3	Box	2
Foam (full bag + 59 items)	59	Single	7	Jus box	3	Shorts	1
Cans	59	Pipe	6	Fiberglass	3	Jeans	1
Bottle caps	54	Glass Bottles	5	Sandals	2	Buoys	1
Coffee Cups	53	Bucket	5	Rubber gloves	2	Mooring	1

Figure 26: Annual Beach Sweep June 10, 2017

8.3 Interpretation Panels

For this project, two interpretation panels were professionally designed. The first panel on "Salt Marshes" will be placed along a coastal walking trail passing through a salt marsh, and "Eelgrass" has been placed in a lookout spot in Point-du-Chêne near a park bench. All panels designed by the SBWA are bilingual.

Figure 27: Interpretation panel on Salt Marshes

Figure 28: Interpretation panel on Eelgrass

8.4 Educational Kiosks

8.4.1 Shediac Farmer's Market

An education kiosk was displayed on Sundays at the Shediac Farmer's market, for 10 weeks out of the summer. The main objective was to speak on water conservation and stormwater management, and giveaway water conservation kits and rain barrels. SBWA staff and summer students talked to visitors of all ages on the various other projects of the year. In the summer of 2017, staff spoke to over 1,400 visitors about the watershed group, local environmental issues and projects realized to mitigate these issues. The market kiosk is always a great tool to find people interested in receiving free rain barrels and water conservation kits for their homes.

Figure 29: Shediac Farmer's Market in the Park

8.4.2 Lobster Festival

In partnership with the Homarus Eco-centre, a kiosk was set up for four days at the Shediac Lobster festival from July 5th to July 8th. Our summer students spoke of our projects in the same fashion as the Shediac Farmer's market in the Park.

Figure 30: Shediac Lobster Festival

8.5 Media Outreach

8.5.1 Newsletter

Two bilingual newsletters were produced during the 2017-2018 fiscal year. The newsletter display information and photos on the various projects that the SBWA has been doing in the year. The Association had 250 copies produced for each edition, printed on 100% recycled paper. The newsletters are distributed to various businesses, medical offices, hair salons, and anywhere else that had a waiting area or that was appropriate to leave newsletters for the public to take. The rest were distributed during the Shediac Market, during public presentations and other meetings. The newsletters can be found on the Shediac Bay Watershed Association website.

8.5.2 Socials Medias and Website

The SBWA is working to keep its website and social media up to date, posting photos and short description of activities and projects. The SBWA also attended a conference on social media for non-profit organizations, helping us to develop a social media communications strategy. The association is also working on the development of infographic and fact sheets, being professionally designed, to be posted to the website and social media.

www.shediacbayassociation.org www.facebook.com/#!/shediacbaywatershedassociation

9 Closing Comments

The *Evaluation of the Health of the Shediac Bay* project is a first phase in the development of new projects with the purpose of addressing environmental issue targeting water quality. With the help of sampling results, land use investigation, habitat evaluations and several invaluable partners such as the *Department of Environment and Local Government*, an action plan can be developed to address contamination sources. When dealing with non-point source pollution in a watershed, one cannot be expected to solve the issues of human activities overnight. Problems related stormwater runoff and faults in both private and municipal infrastructure can take several years and even decades to be detected and resolved. Collaborations between environmental groups, businesses, private citizen and government are crucial in the development and implementation of an action plan.

The Global Seagrass Monitoring Network will be useful to determine the state of eelgrass beds in the Shediac Bay. There are many threats to the health and abundance of eelgrass such as nutrients overloads and the invasive green crab.

Continuing the education programs will help the spread of information on best practices and promote citizen stewardship towards the Shediac Bay.

Continuing to perform water quality monitoring is of the utmost importance in making sure our watershed is properly managed. Tracking bacterial sources will help complement remediation works by determining not only where work is needed most, but also if such work is accomplishing its purpose. There’s much work that can be done to improve the environment around Shediac Bay. The association hopes to continue to expand their programs with the help of the Environmental Trust Fund and other partners around the bay.

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Appendix A – WATER CHEMISTRY METHODOLOGY

Table 46: RPC Laboratory Analytical Methods

RPC LABORATORY ANALYTICAL METHODS				
Analyte	Parameter	RPC SOP Number	Method Reference	Method Principle
Ammonia	NH_3T	4.M47	APHA 4500-NH3 G	Phenate Colourimetry
pH	pH	4.M03	APHA 4500-H+ B	pH Electrode - Electrometric
Alkalinity (as CaCO3)	ALK_T	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	Cl	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	F	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	SO_4	4.M45	APHA 4500-SO4 E	Turbidimetry
Nitrate + Nitrite (as N)	NO_X	4.M48	APHA 4500-NO3 H	Hydrazine Red., Derivitization, Colourimetry
Nitrite (as N)	NO_3	4.M49	APHA 4500-NO2- B	Ferrous Ammonium Sulfate Colourimetry
Phosphorus - Total	TP-L	4.M17	APHA 4500-P E	Digestion, Manual Colourimetry
Carbon - Dissolved Organic	TOC	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	TURB	4.M06	APHA 2130 B	Nephelometry
Colour	CLRA	4.M55	APHA 2020 Color (A,C)	Single Wavelength Spectrophotometry
Conductivity	COND	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	—	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

Table 47: RPC Laboratory Analytical Methods for E. coli

RPC LAB ANALYTICAL METHODS FOR E. COLI		
Method	ID	Max Detection Limit
Membrane Filtration	FSA-01	10000 MPN/100 mL
Colilert	FSA-10	2419.6 MPN/100 mL