2019 Parlee Beach and Shediac Bay Watershed Water Quality Results

Final Report
Fredericton, NB
Project # TAE1989002

27-Feb-20

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27-Feb-20

Dr. Don Fox
Manager, Water Science
NB Department of Environment & Local Government
20 McGloin Street, Marysville Place
Fredericton, NB   E3B 5H1

Dear Dr. Fox,

Re: Final Report: 2019 Parlee Beach and Shediac Bay Watershed Water Quality Results

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood), is pleased to submit this final report to Environment & Local Government.

Please contact us at your convenience with any comments or questions.

Sincerely,

**Wood Environment & Infrastructure Solutions,
a Division of Wood Canada Limited**

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Prepared for:
NB Department of Environment & Local Government
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27-Feb-20

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List of Acronyms

AG   Agricultural
FIB   Fecal Indicator Bacteria
FW   Freshwater
M   Marine
MPN   Most Probable Number
SW   Stormwater
Wood   Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited

1.0   Introduction

1.1   Purpose

Wood Environment & Infrastructure Solutions, a Division of Wood Canada Limited (Wood), has been retained by New Brunswick Environment & Local Government to interpret and report on the 2019 Parlee Beach and Shediac Bay Watershed Water Quality Results. This document presents a review of the Parlee Beach water quality data for 2019 as well as the data collected as part of the Shediac Bay Watershed monitoring program. Areas of concern within the watershed will be outlined and the data will be compared to 2017 and 2018 data as appropriate.

1.2   Regional Setting

Shediac Bay is situated in South-Eastern New Brunswick as illustrated at Figure 1.1. Shediac Bay. Parlee Beach, one of the most popular tourist attractions in the Province, is situated on the southern shore of the Bay.
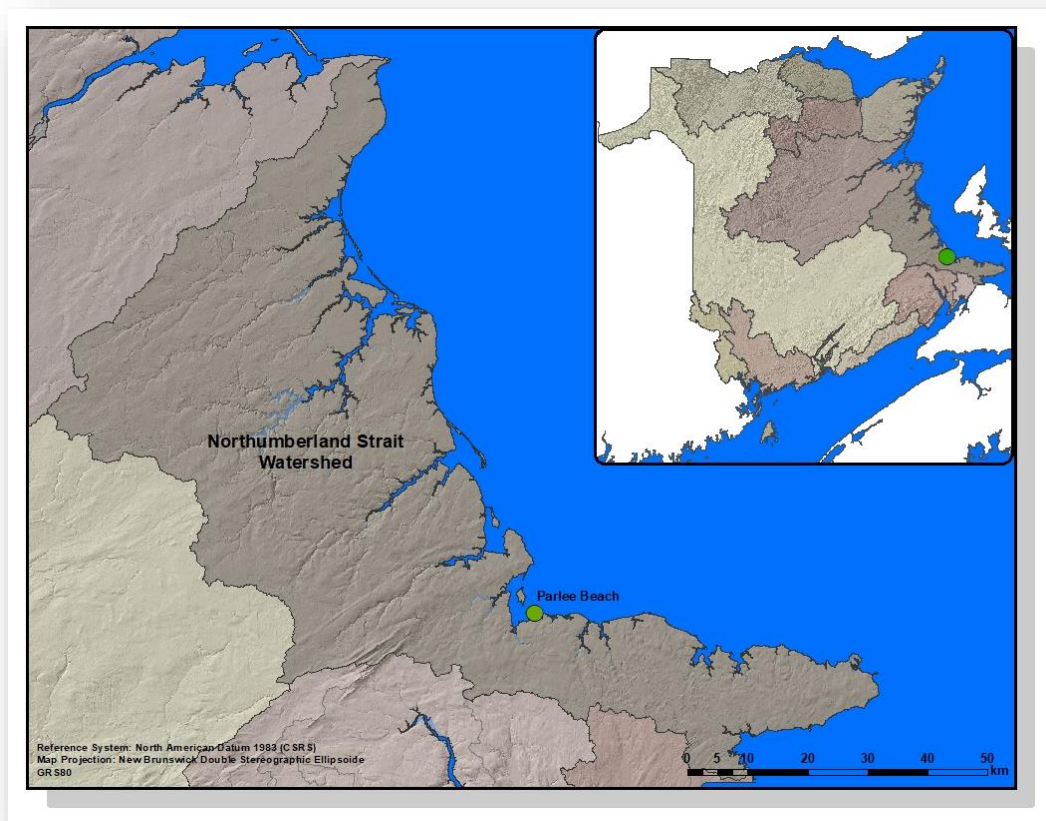
Figure 1.1   Parlee Beach and Shediac Bay

2.0 Watershed Reconnaissance Survey and Water Sampling Program

2.1 Overview

This section presents the results of the Watershed Reconnaissance Survey and Water Sampling Program for 2019. The monitoring plan design, developed by Independent Environmental Services (2017), is described in "Parlee Beach Water Quality Monitoring Plan for 2017". The same monitoring locations and methods have been used for the past three year. The sampling procedures are consistent, and the 2019 results can be compared to the previous two years. For 2019, the earliest monitoring date and the latest monitoring dates (June 12 to October 18) and the swimming season (approximately late May to early September) indicate that monitoring has been conducted over a similar time frame for the past three years and is longer than the swimming season.

In 2019, monitoring was conducted at 24 monitoring stations, identified as follows:

- Five (5) agricultural sites – areas that might be influenced by livestock operations or horticultural activity.

- Ten (10) freshwater sites - small local tributaries that may be influenced by a range of local bacteria sources such as small on-site sewage disposal systems, stormwater inputs, or runoff from fields.

- Nine (9) stormwater sites - small natural drainage channels and local stormwater outfalls.

The locations of the monitoring stations are presented in Figure 2.1.
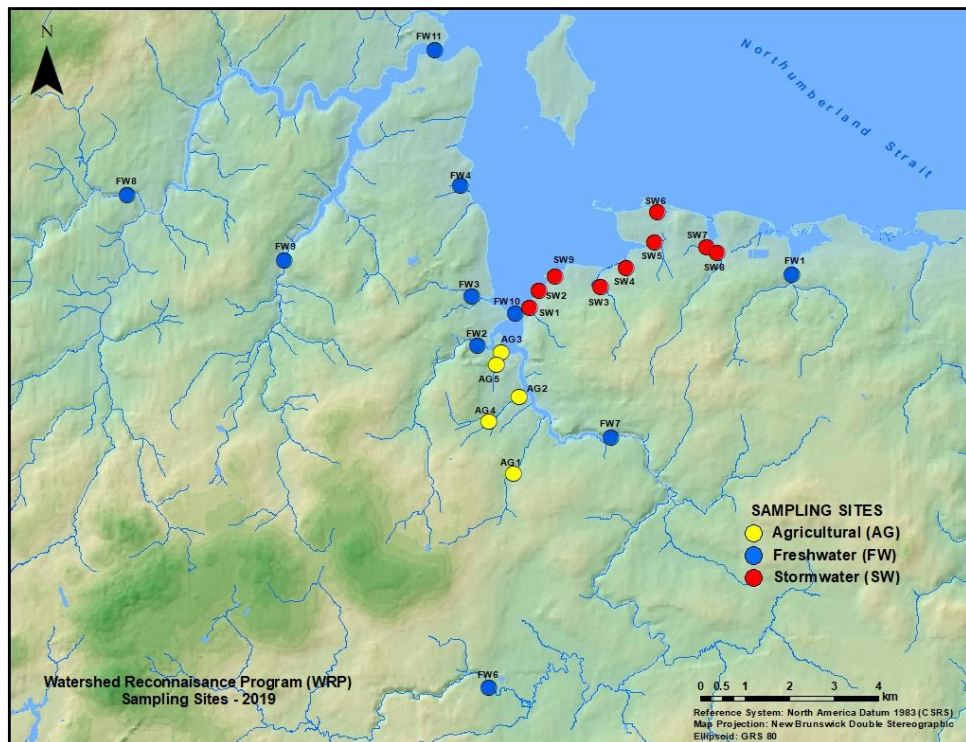
Source: ELG 2019

Figure 2.1   Shediac Watershed Monitoring Stations 2019

2.2   Results – Agriculture Sites

2.2.1 2019 Results

The 2019 test results for the five (5) Agriculture sites are shown in Figure 2.2. Twenty-five (25) sampling events occurred (i.e., twenty-five (25) samples each for E. coli, and enterococcus) between June 12 and October 18, 2019.

The number of exceedances of the single-sample-maximum guideline value of 400 MPN/100 ml for E. coli, and 70 MPN/100 ml for enterococcus is presented in Table 2.1

Table 2.1   Agriculture Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2019

Monitoring Station	Sampling Events	Exceedances: Single-Sample Maximum Guideline Value	
		E. coli	Enterococcus
AG1	5	2 (40%)	4 (80%)
AG2	5	5 (100%)	4 (80%)
AG3	5	2 (40%)	4 (80%)
AG4	5	2 (40%)	5 (100%)
AG5	5	2 (40%)	4 (80%)
Total	25	13 (52%)	21 (84%)

For E. coli, the single-sample-maximum guideline value of 400 MPN/100 ml was exceeded on two (2) of five (5) sampling events at AG1; all five (5) sampling events at AG2; and two (2) of five (5) sampling events at AG3, AG4 and AG5. The highest E. coli value in 2019 was 5172 MPN/100 m exhibited at AG2 on September 25; the lowest value was 10 MPN/100 m at AG3 on three dates: June 12, July 15 and August 19. For all five (5) sampling sites, the single-sample-maximum guideline value was exceeded for 52% of the sample events.

For enterococcus, the single-sample-maximum guideline value of 70 MPN/100 ml was exceeded on four (4) of five (5) sampling events at AG1, AG2, AG3 and AG5; and all five (5) sampling events at AG4. The highest enterococcus value in 2019 was 7270 MPN/100 m exhibited at AG5 on September 25; the lowest value was 10 MPN/100 m at AG3, on June 12. For all five (5) sites, the single-sample-maximum guideline value was exceeded for 84% of the samples.

2.2.2 Comparison to 2018 Results

The 2018 test results are presented in Table 2.2. In 2018, only AG1, AG2 and AG3 were sampled. The single-sample-maximum guideline value of 400 MPN/100 ml for E. coli was exceeded for 77.8% of sampling events at all three sites. For enterococcus, the single-sample-maximum guideline value of 70 MPN/100 ml was exceeded for 94.4% of sampling events at all three sites. A comparison of these results with 2019 could indicate an improvement in water quality although the limited number of samples precludes a determination of a definite trend.

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For E. coli, very high values occurred at all three sites on October 24, 2018. The highest enterococcus value in 2018 was 15531 MPN/100 m at AG1 on October 24; the lowest value was 98 MPN/100 m at AG1, on July 19. Considering only AG1, AG2 and AG3, in 2019 there were five (5) fewer E. coli exceedances, and five (5) fewer enterococcus exceedances than in 2018.

Overall, these data suggest a modest reduction in guideline exceedances at these three sites between 2018 and 2019.

Table 2.2   Agriculture Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2018

Monitoring Station	Sampling Events	Exceedances: Single-Sample Maximum Guideline Value	
		E. coli	Enterococcus
AG1	6	4 (66.6%)	5 (83.3%)
AG2	6	6 (100%)	6 (100%)
AG3	6	4 (66.6%)	6 (100%)
Total	18	14 (77.8%)	17 (94.4%)

2.2.3 Temporal Distribution

An indication of the change in values over the 2019 monitoring season can be gleaned from Figure 2.2. Except for AG3, all sites exhibit the highest values during the September 25 sampling event. Site AG3 exhibits the highest values on October 18. The values decline noticeably on the following sampling event on October 18 for sites AG1, AG2 and AG4. For AG5, the decline in October is relatively modest.

The 2019 data indicate that there continue to be high concentrations of fecal indicator bacteria (FIB) along the Scoudouc River and its tributaries. These values generally increase with time over the summer suggesting that the high FIB concentrations are likely caused by runoff from agricultural operations near the watercourses.

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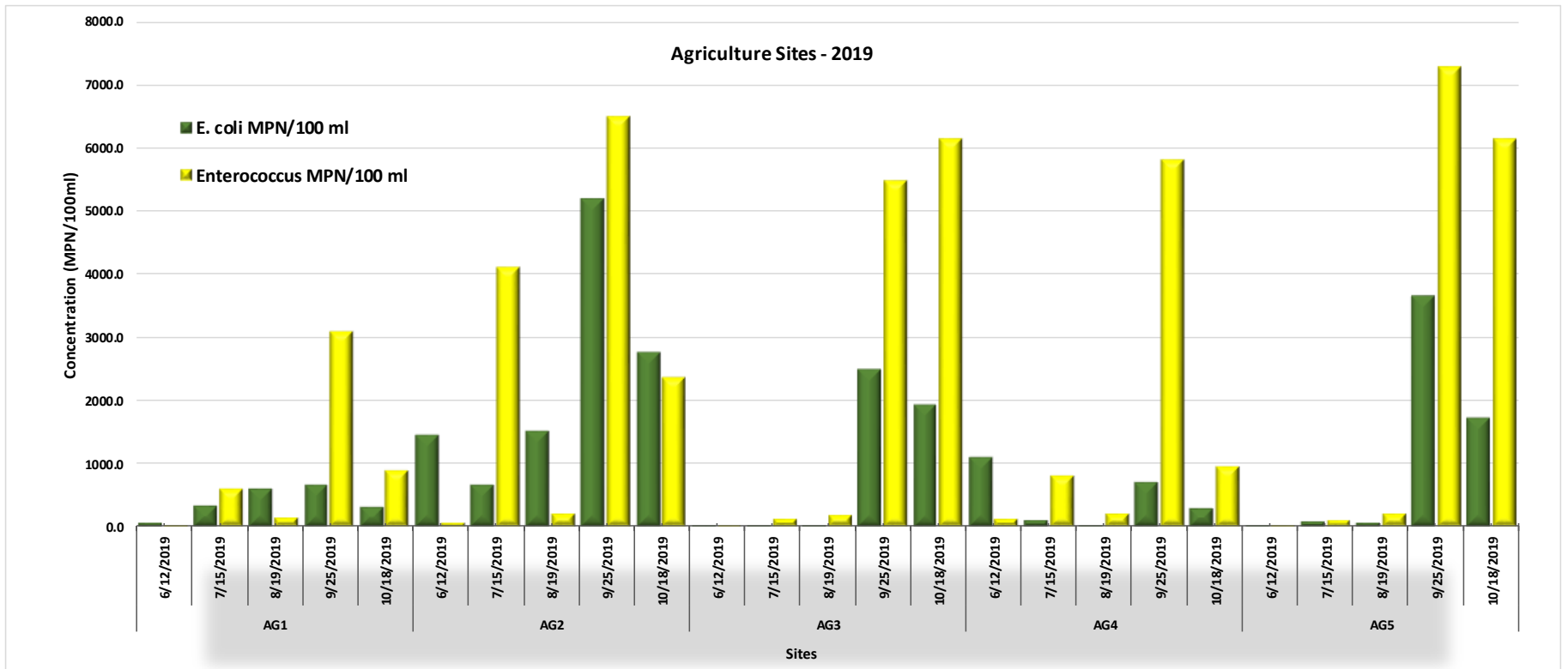
Figure 2.2   Agriculture Sites

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2.3   Results – Fresh Water Sites

2.3.1 2019 Results

The 2019 test results for ten (10) Fresh Water sites are shown in Figures 2.3a and 2.3b. In 2019, the monitoring station FW5 was not sampled due to difficult access conditions. In 2019, fifty (50) sampling events occurred between June 12 and October 18.

The number of exceedances of the single-sample-maximum guideline value for E. coli, and enterococcus is presented in Table 2.3.

Table 2.3   Fresh Water Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2019

Monitoring Station	Sampling Events	Exceedances: Single-Sample-Maximum Guideline Value	
		E. coli	Enterococcus
FW1	5	1 (20%)	4 (80%)
FW2	5	0	4 (80%)
FW3	5	1 (20%)	4 (80%)
FW4	5	1 (20%)	4 (80%)
FW6	5	0	3 (60%)
FW7	5	1 (20%)	3 (60%)
FW8	5	2 (40%)	3 (60%)
FW9	5	2 (40%)	3 (60%)
FW10	5	1 (20%)	4 (80%)
FW11	5	3 (60%)	3 (60%)
Total	50	12 (24%)	35 (70%)

For E. coli, excepting FW2 and FW6 which had no exceedances, all sites exhibit between one (1) and three (3) exceedances, the most frequent of which occur at FW 11 (60% exceedances). For all ten (10) sites, the single-sample-maximum guideline value was exceeded for 24% of the sample events.

For enterococcus, all sites exhibit exceedances for between 60% and 80% of the sampling events. FW6 is at the outer reaches of the watershed suggesting there are contamination sources quite remote from Shediac Bay. The sites FW2, FW3 and FW4 along the western shore of Shediac Bay at Gilbert's Corner and Shediac Cape suggest that surface water runoff into the creeks discharging into the Bay are a possible source of contamination. Values for FW8 and FW9, located at the upper reaches of the Shediac River (where there is agricultural activity), and at FW10, located at the mouth of the Scoudouc River, could be explained by surface water runoff in the immediate vicinity or due to high concentration values exhibited in the Scoudouc River as exhibited at the AG stations. For all ten (10) sites, the single-sample-maximum guideline value was exceeded for 70% of the sample events.

The highest E. coli value in 2019 was 2481 MPN/100 ml exhibited at FW3 on September 25; the lowest value was 10 MPN/100 ml at FW10 and FW11 on June 12. The highest enterococcus value in 2019 was 4611 MPN/100 ml exhibited at FW11 on September 25; the lowest value was 4 MPN/100 ml at FW8 on June 12.

2.3.2 Comparison to 2017 - 2018 Results

The 2018 and 2017 test results are presented in Table 2.4a and 2.4b, respectively. In 2018, the single-sample-maximum guideline value of 400 MPN/100ml for E. coli was exceeded for 32.1% of sampling events. For

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enterococcus, the single-sample-maximum guideline value of 70 MPN/100 ml was exceeded for 80.4% of sampling events. In 2017, the single-sample-maximum guideline value for E. coli was exceeded for 16.4% of sampling events. For enterococcus, the single-sample-maximum guideline value was exceeded for 63.6% of sampling events.

For E. coli in 2019 there were fewer exceedances than in 2018, but more than in 2017. The same situation holds for enterococcus; in 2019 there were fewer exceedances than in 2018, but more than in 2017. However, these data are not strictly comparable due to differences in sampling times and the number of sampling events. More data will be required in order to determine a discernable trend.

Table 2.4a **Fresh Water Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2018**

Monitoring Station	Sampling Events	Exceedances: Single-Sample-Maximum Guideline Value	
		E. coli	Enterococcus
FW1	6	1 (16.6%)	5 (83.3%)
FW2	6	1 (16.6%)	6 (100%)
FW3	6	2 (33.3%)	6 (100%)
FW4	6	2 (33.3%)	6 (100%)
FW5	4	1 (25%)	1 (25%)
FW6	4	1 (25%)	4 (100%)
FW7	4	1 (25%)	3 (75%)
FW8	4	2 (50%)	2 (50%)
FW9	4	2 (50%)	2 (50%)
FW10	6	3 (50%)	4 (66.6%)
FW11	6	2 (33.3%)	2 (33,3%)
Total	56	18 (32.1%)	45 (80.4%)

Table 2.4b **Fresh Water Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2017**

Monitoring Station	Sampling Events	Exceedances: Single-Sample-Maximum Guideline Value	
		E. coli	Enterococcus
FW1	6	1 (16.6%)	6 (100%)
FW2	6	2 (33.3%)	6 (100%)
FW3	5	2 (40%)	3 (60%)
FW4	5	1 (20%)	4 (80%)
FW5	4	0	1 (25%)
FW6	5	1 (20%)	5 (100%)
FW7	4	0	2 (50%)
FW8	4	0	2 (50%)
FW9	4	0	1 (25%)
FW10	6	1 (16.6%)	3 (50%)
FW11	6	1 (16.6%)	2 (33,3%)
Total	55	9 (16.4%)	35 (63.6%)

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2.3.3 Temporal Distribution

An indication of the change in values over the 2019 monitoring season can be gleaned from Figure 2.3a and 2.3b. All sites except FW2 exhibit the highest values during the September 25 sampling event. Site FW2 exhibits the highest values on October 18. The values decline modestly on the following sampling event on October 18.

The 2019 data indicate that there continue to be high concentrations of FIB in the watershed. These values generally increase with time over the summer suggesting that runoff from agricultural operations and urban activity near the water courses is a potential source of contamination.
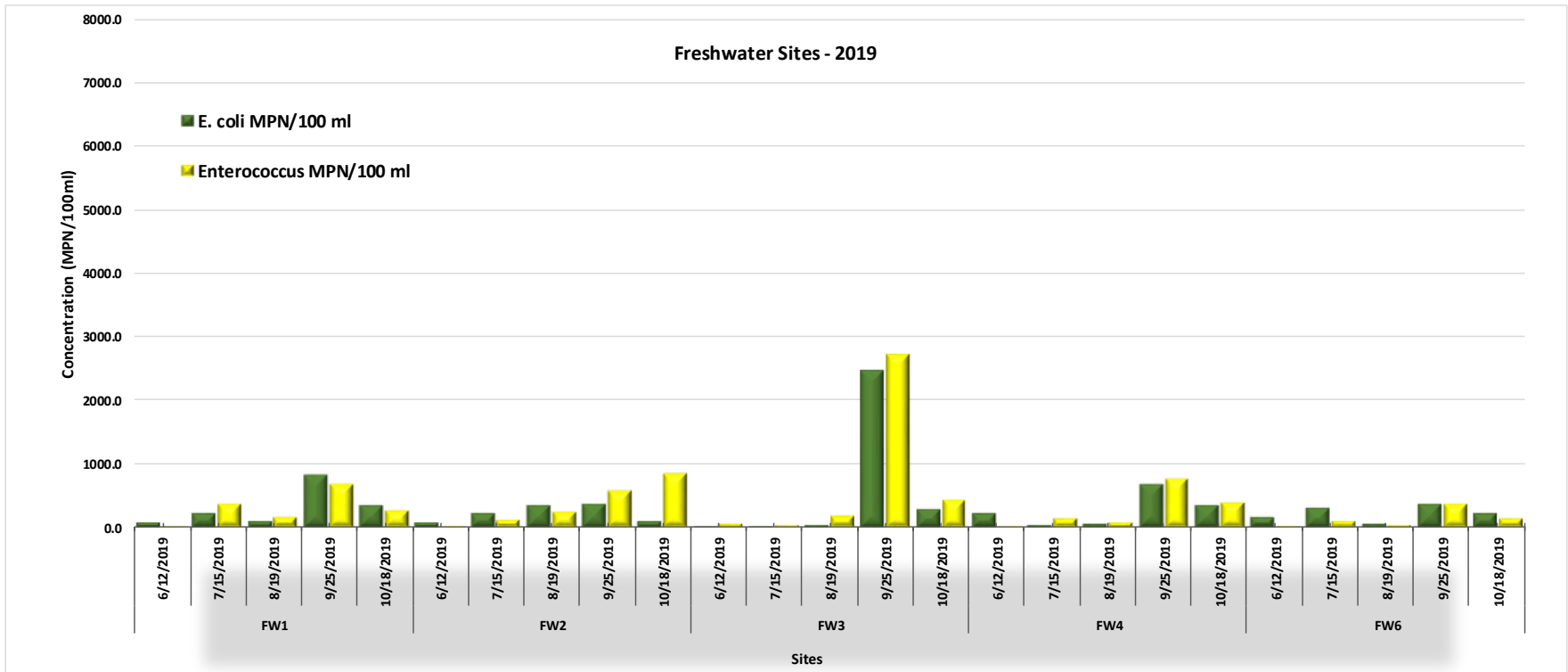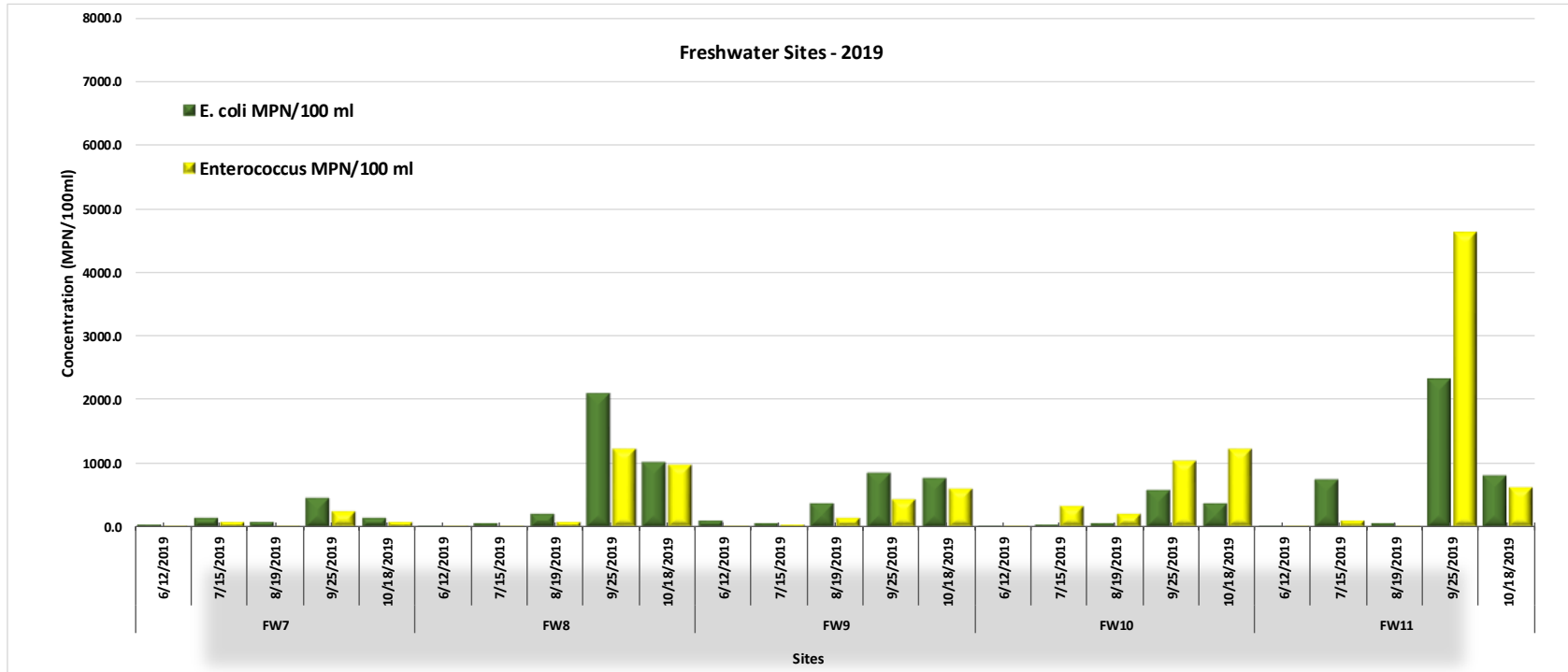
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Figure 2.3a   Fresh Water Sites (FW1 – FW5)

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Figure 2.3b   Fresh Water Sites (FW6 – FW11)

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2.4   Results – Stormwater Sites

2.4.1 2019 Results

The 2019 test results for the nine (9) Stormwater sites are shown in Figures 2.4a and 2.4b. In 2019, forty-five (45) sampling events occurred between June 12 and October 18.

The number of exceedances of the single-sample-maximum guideline value for E. coli and enterococcus is presented in Table 2.5

Table 2.5   Stormwater Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2019

Monitoring Station	Sampling Events	Exceedances: Single-Sample-Maximum Guideline Value	
		E. coli	Enterococcus
SW1	5	2 (40%)	4 (80%)
SW2	5	4 (80%)	5 (100%)
SW3	5	3 (60%)	4 (80%)
SW4	5	3 (60%)	4 (80%)
SW5	5	1 (20%)	2 (40%)
SW6	5	4 (80%)	5 (100%)
SW7	5	4 (80%)	4 (80%)
SW8	5	3 (60%)	5 (100%)
SW9	5	0	3 (60%)
Totals	45	24 (53.3%)	36 (80%)

For E. coli, all sites exhibit exceedances except SW9. Three (3) sites (SW2, SW6, SW7) exhibit exceedances of 80%. SW6 is in Pointe-du-Chêne close to Parlee Beach. The exceedances are likely due to surface water runoff from the (primarily) residential streets and properties in the area. The lowest number of exceedances is at SW5, located in South Cove of Shediac Harbour. For all nine (9) sites, the single-sample-maximum guideline value was exceeded for 53.3% of the sample events.

For enterococcus, exceedances vary between 40% and 100%. Three (3) sites (SW2, SW6, SW8) exhibit exceedances of 100%. Again, SW6 is in Pointe-du-Chêne close to Parlee Beach. Again, the lowest number of exceedances is at SW5, located in South Cove of Shediac Harbour. For all nine (9) sites, the single-sample-maximum guideline value was exceeded for 80% of the sample events.

The highest E. coli value in 2019 was 10462 MPN/100 ml exhibited at SW2 on July 15; the lowest value was 10 MPN/100 ml at SW6 on June 19. The highest enterococcus value in 2019 was 24196 MPN/100 ml exhibited at SW2 on July 15 and at SW6 on October 18; the lowest value was 4 MPN/100 ml at SW9 on June 12.

2.4.2 Comparison to 2017 - 2018 Results

The 2018 and 2017 test results are presented in Table 2.6a and 2.6b, respectively (SW9 was not sampled in 2017).

In 2018 there were forty-seven (47) sampling events. The single-sample-maximum guideline value for E. coli was exceeded for 51.1% of the sampling events. For enterococcus, the single-sample-maximum guideline value was exceeded for 91.5% of the sampling events.

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In 2017 there were forty-three (43) sampling events. The single-sample-maximum guideline value for E. coli was exceeded for 37.2% of the sampling events. For enterococcus, the single-sample-maximum guideline value was exceeded for 86% of the sampling events.

These data over the three seasons are not strictly comparable due to many variables involved: occurrence and concentration of source, rainfall events, randomness in which sampling events are carried out and the number of sampling events. For E. coli, the number of exceedances in 2018 was higher than in 2017; there was little change between 2018 and 2019. For enterococcus, the number of exceedances in 2018 was higher than in 2017; followed by a decline in 2019 of 11.5 percentage points.

Table 2.6a   Stormwater Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2018

Monitoring Station	Sampling Events	Exceedances - Single-Sample-Maximum Guideline Value	
		E. coli	Enterococcus
SW1	6	6 (100%)	6 (100%)
SW2	5	3 (60%)	5 (100%)
SW3	6	6 (100%)	6 (100%)
SW4	6	3 (50%)	6 (100%)
SW5	6	1 (16.6%)	6 (100%)
SW6	3	1 (33.3%)	2 (66.6%)
SW7	3	1 (33.3%)	3 (100%)
SW8	6	1 (16.6%)	6 (100%)
SW9	6	2 (33.3%)	3 (50%)
Totals	47	24 (51.1%)	43 (91.5%)

Table 2.6b   Stormwater Sites Frequency of Exceedances Single-Sample-Maximum Guideline Value 2017

Monitoring Station	Sampling Events	Exceedances - Single-Sample-Maximum Guideline Value	
		E. coli	Enterococcus
SW1	6	4(66.6%)	4(66.6%)
SW2	6	1 (16.6%)	5 (83.3%)
SW3	6	5 (83.3%)	6 (100%)
SW4	6	2 (33.3%)	6 (100%)
SW5	6	2 (33.3%)	4 (66.6%)
SW6	3	0	2 (66.6%)
SW7	4	0	4 (100%)
SW8	6	2 (33.3%)	6 (100%)
Total	43	16 (37.2%)	37 (86.0%)

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2.4.3 Temporal Distribution

An indication of the change in values for the SW sites over the 2019 monitoring season can be gleaned from Figure 2.4a and 2.4b. As with the other monitoring sites, values tend to spike on the September 25 sampling event and fall off thereafter. SW2, located southwest of the Shediac bay Yacht Club, exhibits very high values during the June and July sampling events. SW6 exhibits high values during August, September (towards the end of the swimming season) and October. The highest enterococcus value (24196 MPN/100 ml) recorded at any monitoring site in 2019 was at SW2 in July and at SW6 (close to Parlee Beach) in October.
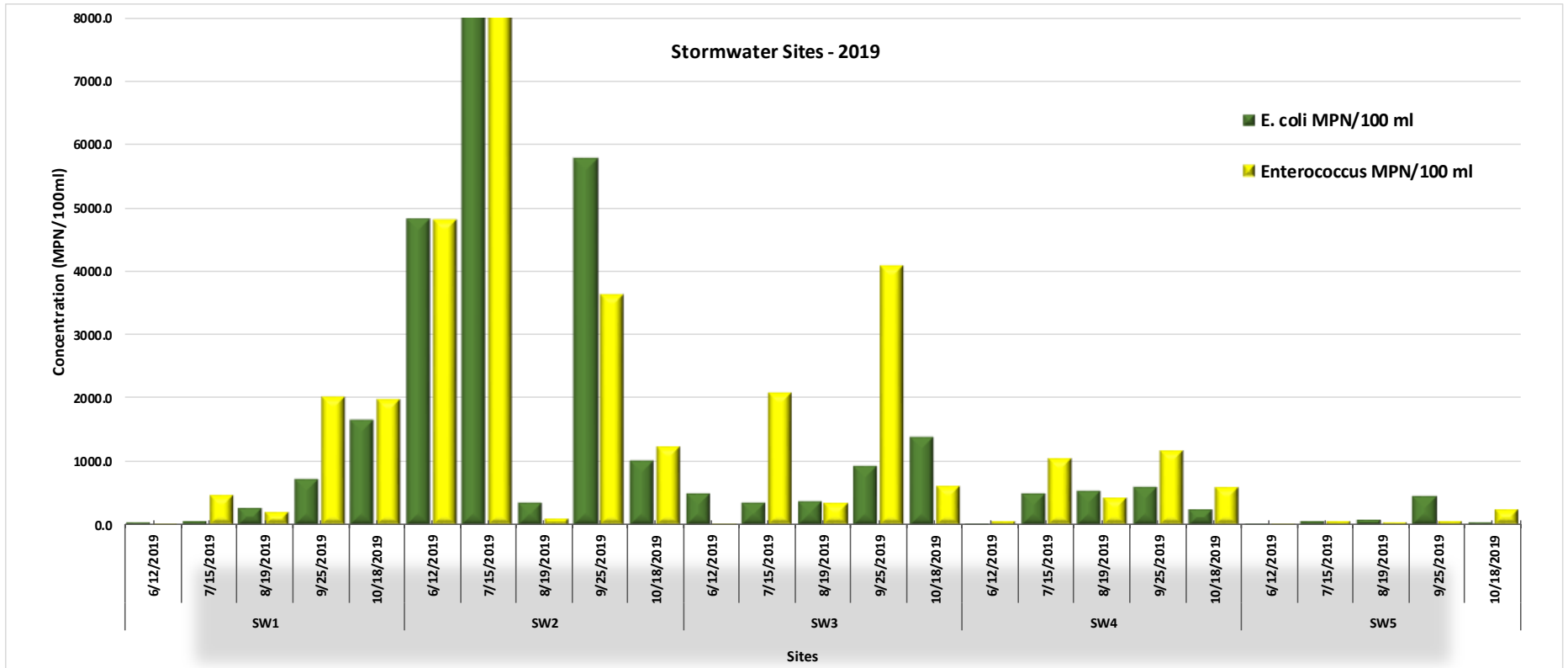
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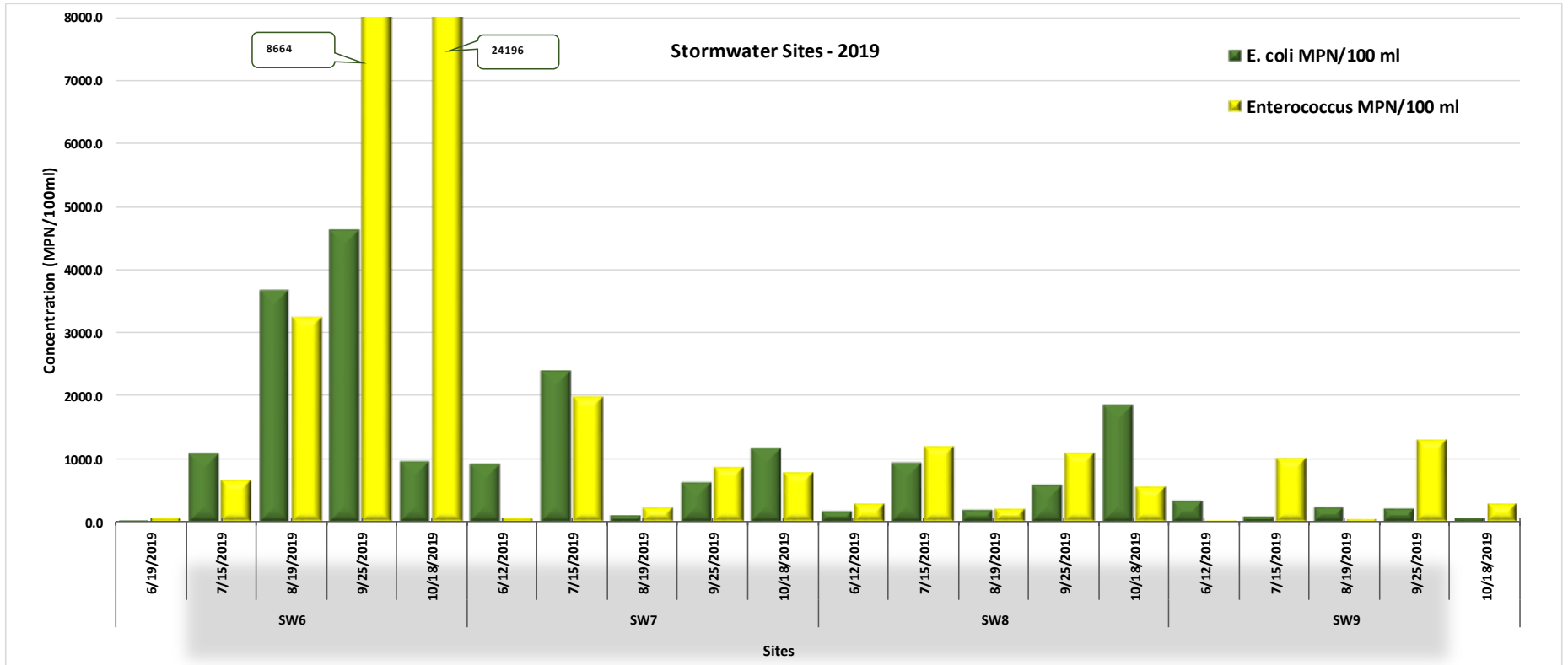**Figure 2.4a   Stormwater Sites (SW1 – SW5)**

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Figure 2.4b   Stormwater Sites (SW6 – SW9)

2.5   Summary Analysis

2.5.1 Single-sample-maximum guideline value exceedances

The number of exceedances of the single-sample-maximum guideline value for E. coli and enterococcus by monitoring category, as well as all sampling events, is presented in Table 2.7 for the 2017 – 2019 seasons. The results for the samples at the Marine monitoring locations in 2017 and 2018 have been excluded from the analysis.

Table 2.7   Exceedances of Single-Sample-Maximum Guideline Value 2017-2019

Monitoring Category	Sampling Events			Exceedances - Single-Sample-Maximum Guideline Value					
	2017	2018	2019	E. coli			Enterococcus		
				2017	2018	2019	2017	2018	2019
AG	18	18	25	9 (50%)	14 (77.8%)	13 (52%)	17 (94.4%)	17 (94.4%)	21 (84%)
FW	55	56	50	9 (16.4%)	18 (32.1%)	12 (24%)	35 (63.6%)	45 (80.4%)	35 (70%)
SW	43	47	45	16 (37.2%)	24 (51.1%)	24 (53.3%)	37 (86%)	43 (91.5%)	36 (80%)
Total	116	121	120	34 (29.3%)	56 (46.3%)	49 (40.8%)	89 (76.7%)	105 (86.8%)	92 (76.7%)

For the three (3) seasons, the general observations are as follows:

E. coli

- AG sites: no discernable trend, highest value in 2018; 2017 and 2019 values are relatively similar.

- FW sites: no discernable trend, highest value in 2018; 2019 value higher than in 2017.

- SW sites: marked increase from 2017 to 2018; 2018 and 2019 values are relatively similar.

- All monitoring categories: trend in increasing exceedances with 2019 value higher than in 2017 by about eleven (11) percentage points.

Enterococcus

- AG sites: decline in the number of exceedances from 2017 to 2019 by about ten (10) percentage points.

- FW sites: no discernable trend, highest value in 2018; 2019 value higher than in 2017 by about six (6) percentage points.

- SW sites: no discernable trend, highest value in 2018; 2019 value lower than in 2017 by about six (6) percentage points.

- All monitoring categories: no discernable trend with 2019 values the same as in 2017.

These data indicate that there are widespread and elevated sources of FIB in the watershed. Over the three (3) seasons, there has been an increase in the number of exceedances of the guideline values. However, caution in interpreting these data is warranted as the sampling times and weather conditions were different between the years. More data will be required in order to determine a discernable trend.

2.5.2   Trend Analysis of Selected Monitoring Stations 2017-2019

The number of guideline value exceedances does not necessarily indicate a fulsome depiction of the situation over time. Accordingly, the Mann-Kendall Trend Test was applied to three (3) monitoring station sample results (AG2, FW3, and SW6) which exhibited the highest values in 2019 compared to other monitoring stations in the same category. The results of this analysis are shown in Figures 2.5a – 2.5f which illustrate the individual sample results and the calculated trend line. The observations are as follows:

AG2: No discernable trend for E. coli or for enterococcus.

FW3: No discernable trend for E. coli or for enterococcus.

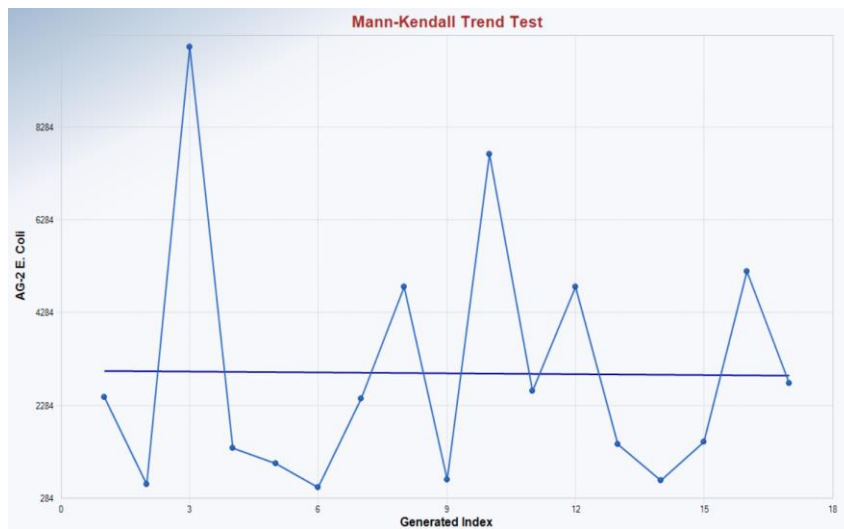SW6: Increasing trend for both E. coli and enterococcus.
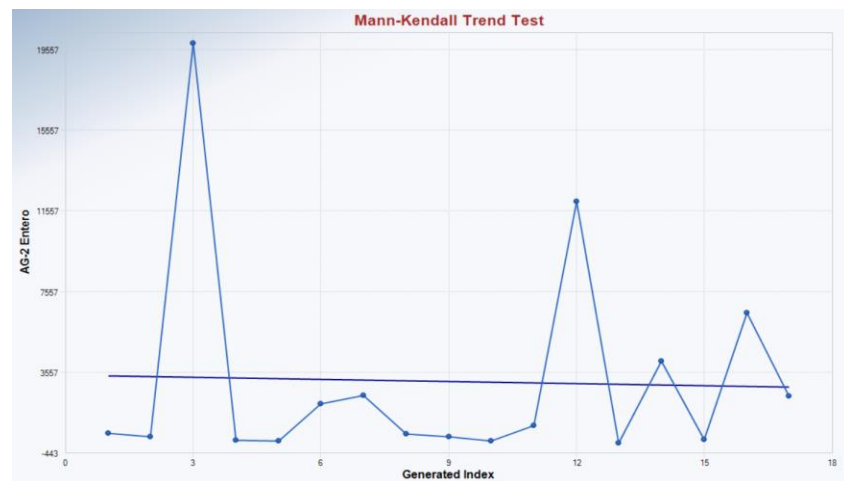

Figure 2.5a   AG2 - E. coli

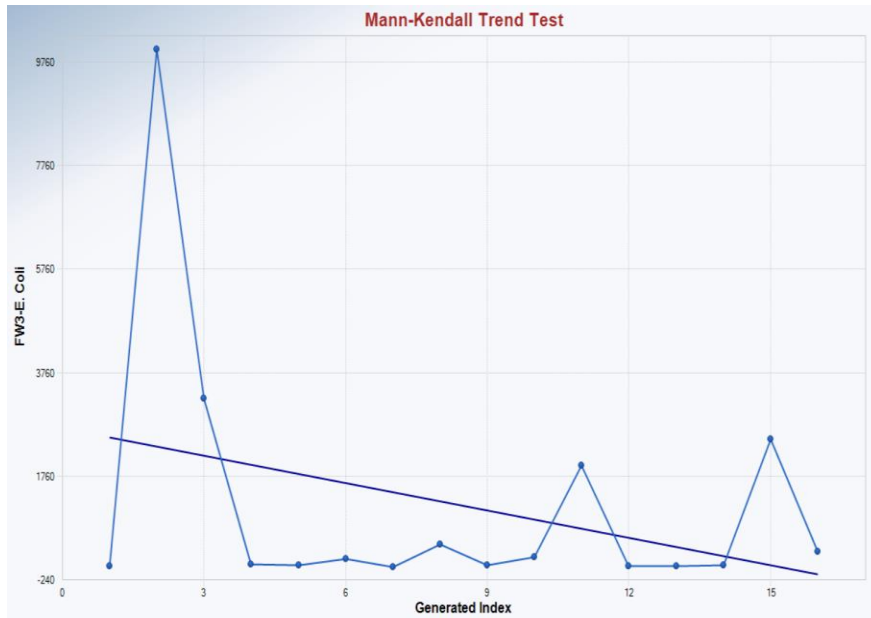
Figure 2.5b   AG2 - Enterococcus

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Figure 2.5c   FW3 - E. coli
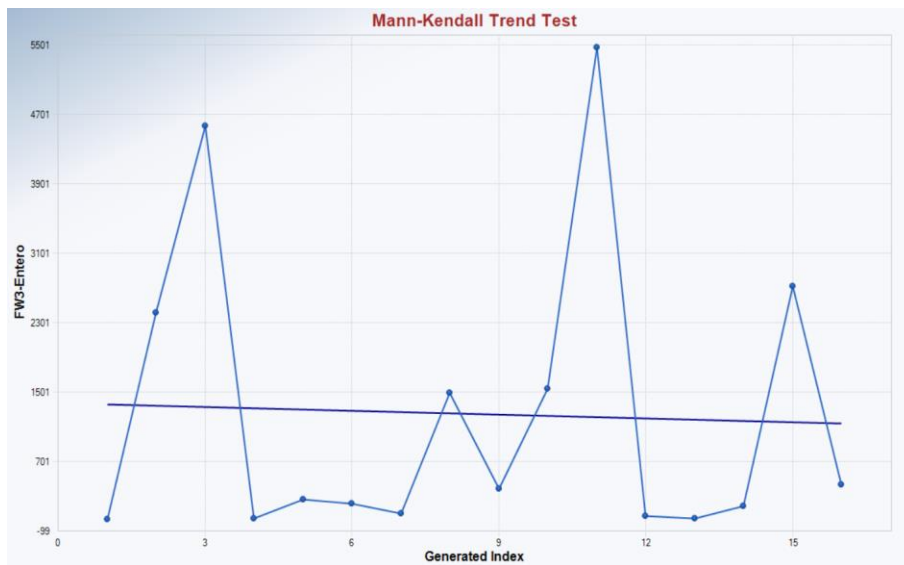
Figure 2.5d   FW3 - Enterococcus
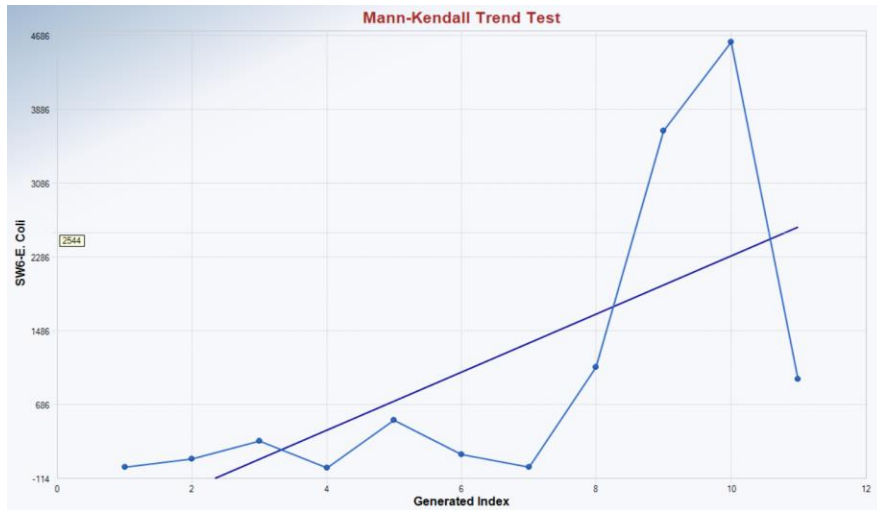
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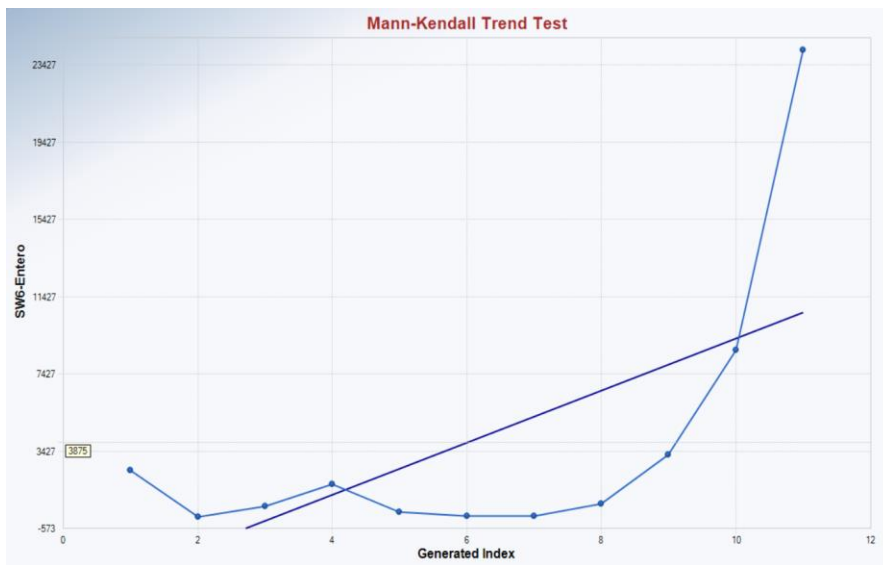**Figure 2.5e   SW6 - E. coli**

Figure 2.5f   SW6 - Enterococcus

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2.5.3 Geometric Mean for E. coli

Figures 2.6a, 2.6b and 2.6c, present a graphic representation of the geometric mean for E. coli for the years 2019, 2018, and 2017, respectively. The size of the circle at each site is proportional to the geometric mean value as indicated in the legend. For all three (3) years, sources of bacteria are distributed throughout the watershed. The legend values are slightly different between the years so precise comparisons are tenuous. However, from a visual perspective the higher values do not exhibit significant change over the years.
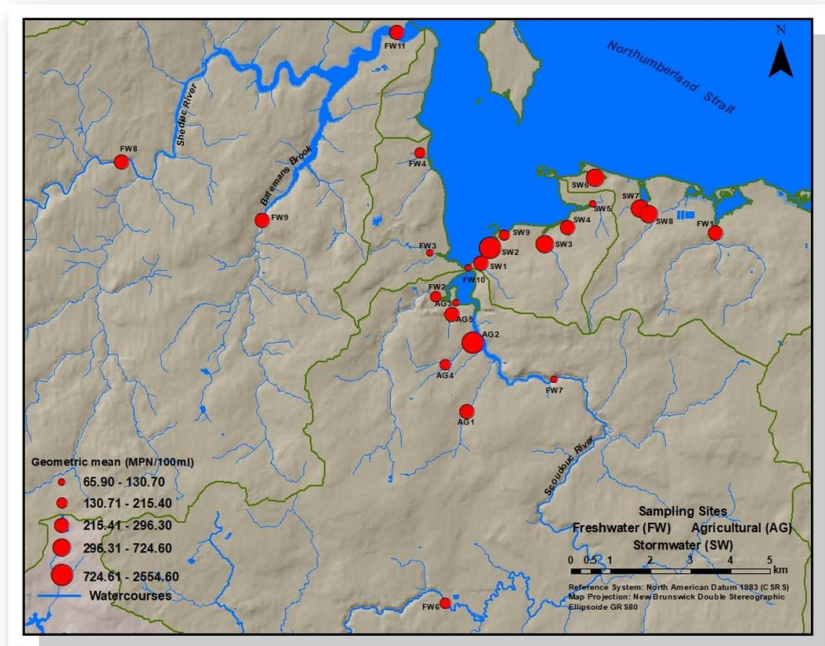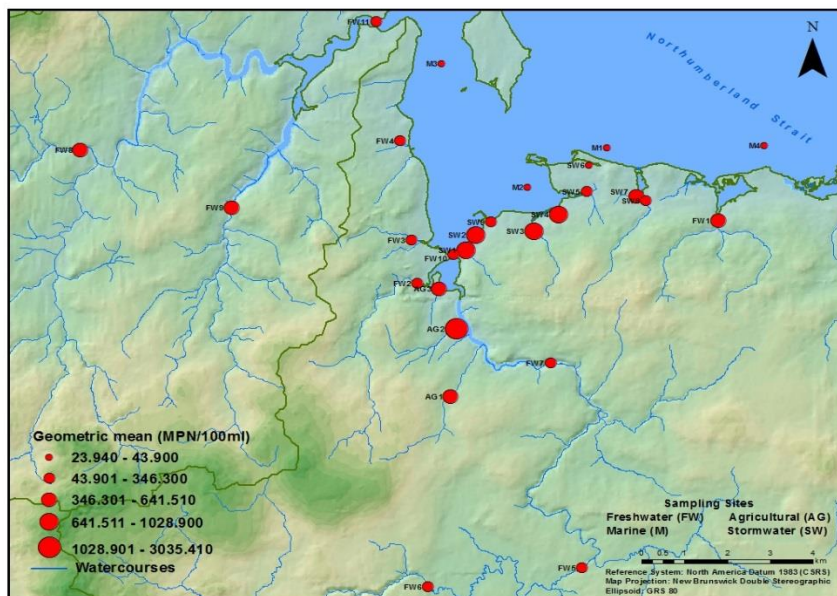

Figure 2.6a   E. coli Geometric Mean 2019

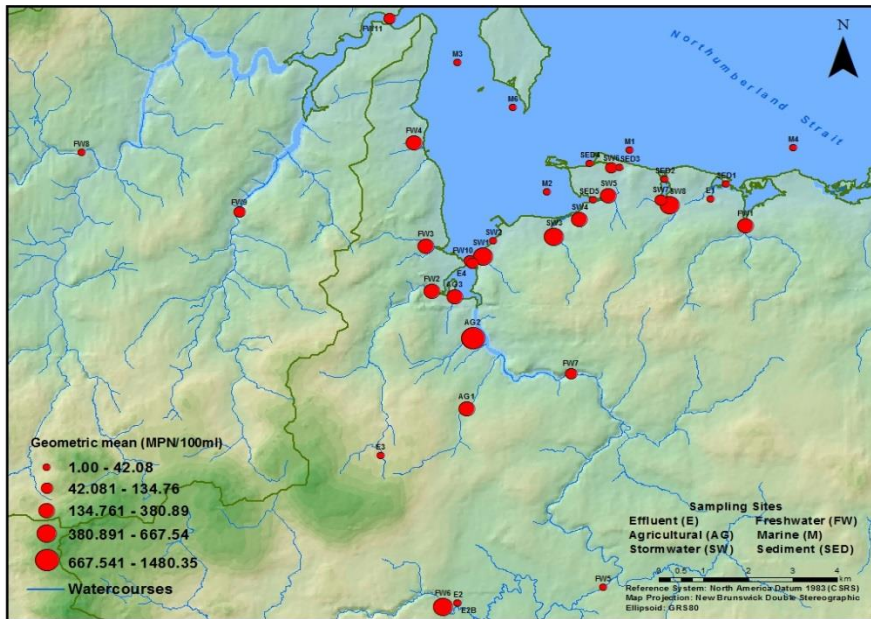**Figure 2.6b   E. coli Geometric Mean 2018**

Figure 2.6c   E. coli Geometric Mean 2017

3.0   Water Quality at Parlee Beach

3.1   Test Results – Single Samples

In 2019, water samples were collected daily (unless hindered by weather) from May 23 to September 9, from the five (5) stations located equidistant along the beach as prescribed in the 2017 Water Quality Monitoring Protocol. During the season, water samples were collected on one hundred and seven (107) days, resulting in one thousand and seventy (1,070) samples for E. coli and enterococcus.

During 2019, for E. coli, there were two samples of 400 MPN/100 ml, equaling the single-sample-maximum guideline value of 400 MPN/100 ml on June 30. There were no exceedances of the geometric mean of 200 MPN/100 ml. This result can be compared to 2018 when there were no exceedances of either the single-sample-maximum guideline value or the geometric mean.

During 2019, for enterococcus, the single-sample-maximum guideline value of 70 MPN/100 ml was exceeded on twenty-seven (27) occasions, occurring over thirteen (13) beach days (days when swimming is open to the public), as presented in Table 3.1. A percentage of 44.4% of exceedances occur during the month of August, when temperatures are usually high, and beachgoers are numerous. This result can be compared to 2018 when the single-sample-maximum guideline value was exceeded on twenty-five (25) occasions and 72% of exceedances occurred during the month of August.

Table 3.1   Enterococcus Exceedances Single-Sample-Maximum Guideline Value 2019

Date	Beach Monitoring Station	Single-Sample-Maximum 70 MPN/100 ml
June 3	2	75
June 21	1	583
	4	74
June 23	1	85
June 30	1	108
	3	171
	4	160
	5	75
July 19	1	132
July 29	5	85
August 11	1	373
	2	74
August 13	2	85
August 14	1	86
	5	504
August 15	3	86
August 27	2	86
	3	183
August 30	1	355
	2	134
	3	96
	4	84
September 9	1	85
	2	160
	3	158
	4	226
	5	161

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3.2   Geometric Mean

For enterococcus, in 2019, the geometric mean of 35 MPN/100 ml was exceeded on eight (8) occasions, as presented in Table 3.2. Fifty percent (50%) of exceedances occur during the month of August. This closely mirrors the results for 2018 when the geometric mean was exceeded on eight (8) occasions, and 62.5% of exceedances occurred during the month of August.

Table 3.2   Enterococcus Exceedances Geometric Mean Guideline Value 2019

Date	Geometric Mean Maximum 35 MPN/100 ml
June 21	80.8
June 23	44.8
June 30	102.9
August 11	38.6
August 14	46.8
August 27	39.7
August 30	119.3
September 9	150.9

3.3   Swimming Advisories

In 2017 and 2018 swimming advisories were issued if there was an exceedance of the geometric mean for E. coli or enterococcus, or if there was ten (10) mm of rainfall over the previous twenty-four (24) hours. In 2019 swimming advisories were only issued due to a sample result. During 2019, there were twelve (12) swimming advisories issued. During 2018, there were twenty-seven (27) swimming advisories issued, and during 2017 there were twenty-three (23) swimming advisories issued. These data are not comparable because of the change in criteria.

3.4   Summary – All Samples

During 2019 samples were collected for one hundred and seven (107) days, resulting in one thousand and seventy (1,070) samples (one sample each for E. coli and enterococcus at each of the five stations). In total 97.3% of all samples met the guideline values.

During 2018, there were 136 sampling days and 1,360 samples, of which 98.2% met the guideline values. In 2017, 1,452 samples were collected, of which 98.6% met the guideline values. There has been no statistically significant change in water quality at Parlee Beach.

3.5   Precipitation and Geometric Mean of Bacteria Counts

The literature suggests that intense rainfall events increase surface water runoff, which may negatively affect water quality at swimming beaches. In 2017 the relationship between rainfall and the geometric mean of bacteria counts was evaluated and it was determined that there was no readily discernable, consistent correlation between these parameters.

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Figures 3.1a to 3.1d illustrate the relationship between rainfall and the geometric mean of E coli. for the months of June to September 2019. There are fourteen (14) occurrences when rainfall exceeds ten (10) mm in a 24-hour period. Eight (8) occurrences are followed by a "spike" in E. coli geometric mean, with a lag time varying from two (2) to four (4) days. Six (6) occurrences do not result in any elevated values in the E. coli geometric mean. Upon this level of analysis and with an occurrence of approximately 50%, we cannot conclude decisively if there is a relationship between rainfall and the geometric mean of E coli.

Figures 3.1e to 3.1h illustrate the relationship between rainfall and the geometric mean of enterococcus for the months of June to September 2019. There are fourteen (14) occurrences when rainfall exceeds ten (10) mm in a 24-hour period. Eight (8) occurrences are followed by a "spike" in enterococcus geometric mean, with a lag time varying from one (1) to three (3) days. Six (6) occurrences do not result in any elevated values in the enterococcus geometric mean. Upon this level of analysis and with an occurrence of approximately 50%, we cannot conclude decisively if there is a relationship between rainfall and the geometric mean of enterococcus.

In this regard, the findings and conclusions of the Report Evaluation of Predictive Modeling for Parlee Beach, FUSS & O'NEIL, March 31, 2019 are worth noting:

"Even when rainfall values are above 10 mm, Enterococcus concentrations are more likely than not to be below the recreational water quality criteria. In addition, it is notable that elevated rainfall is more likely to be a predictor from July to September, although this is also a time when exceedances of the water quality criteria are likely to occur, regardless of rainfall amount." (Section 3.4; page 51)

"An antecedent rainfall amount of 10 mm has not been demonstrated to be a reliable predictor of microbial water quality at Parlee Beach, based on data collected during the 2017 and 2018 beach seasons."   (Section 3.5; page 56)
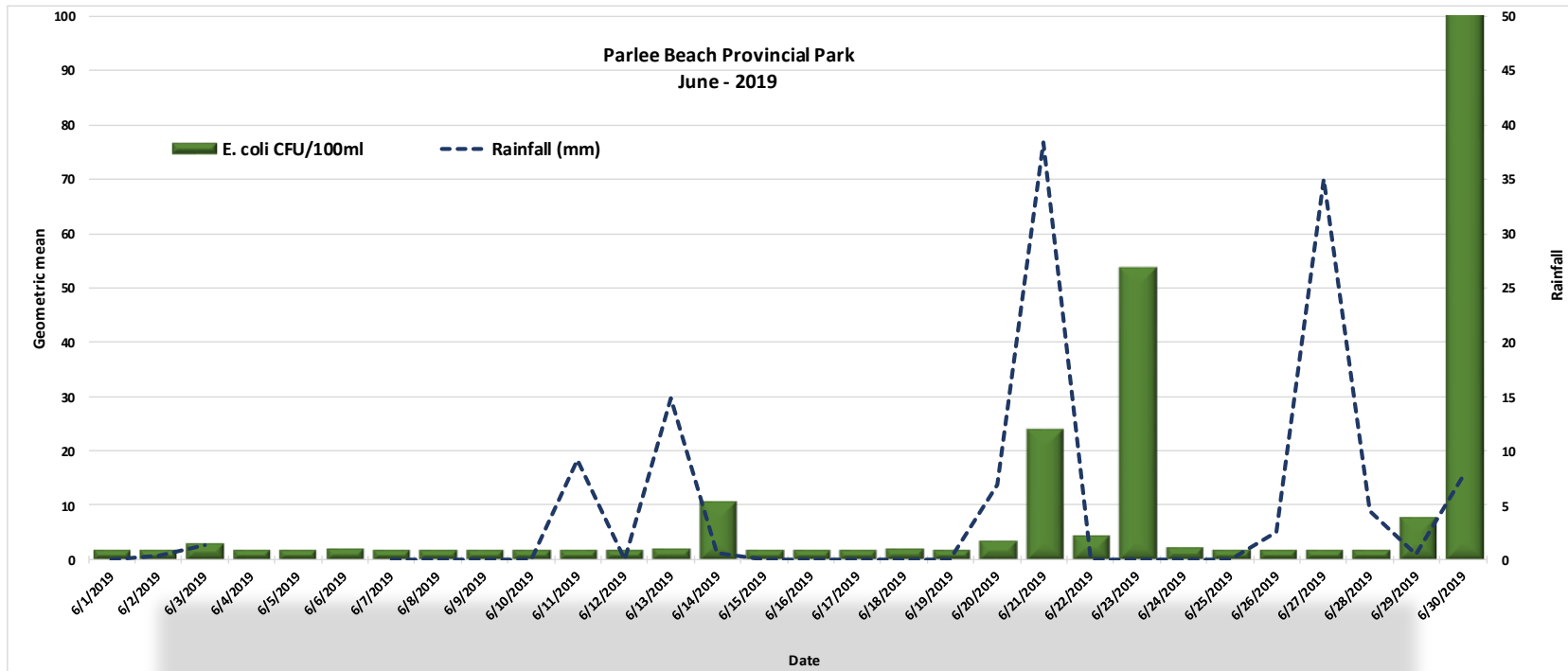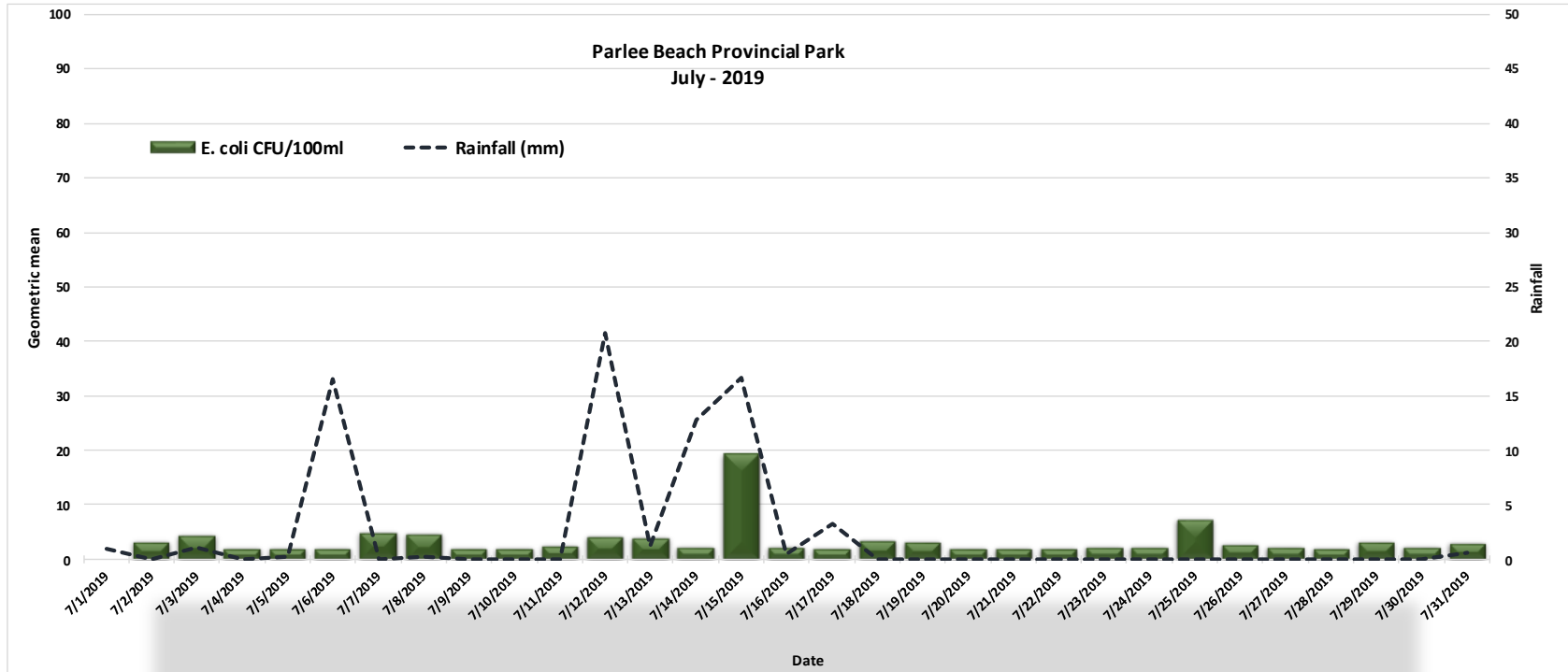
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Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website

Figure 3.1a   Rainfall and E. coli GM – June 2019
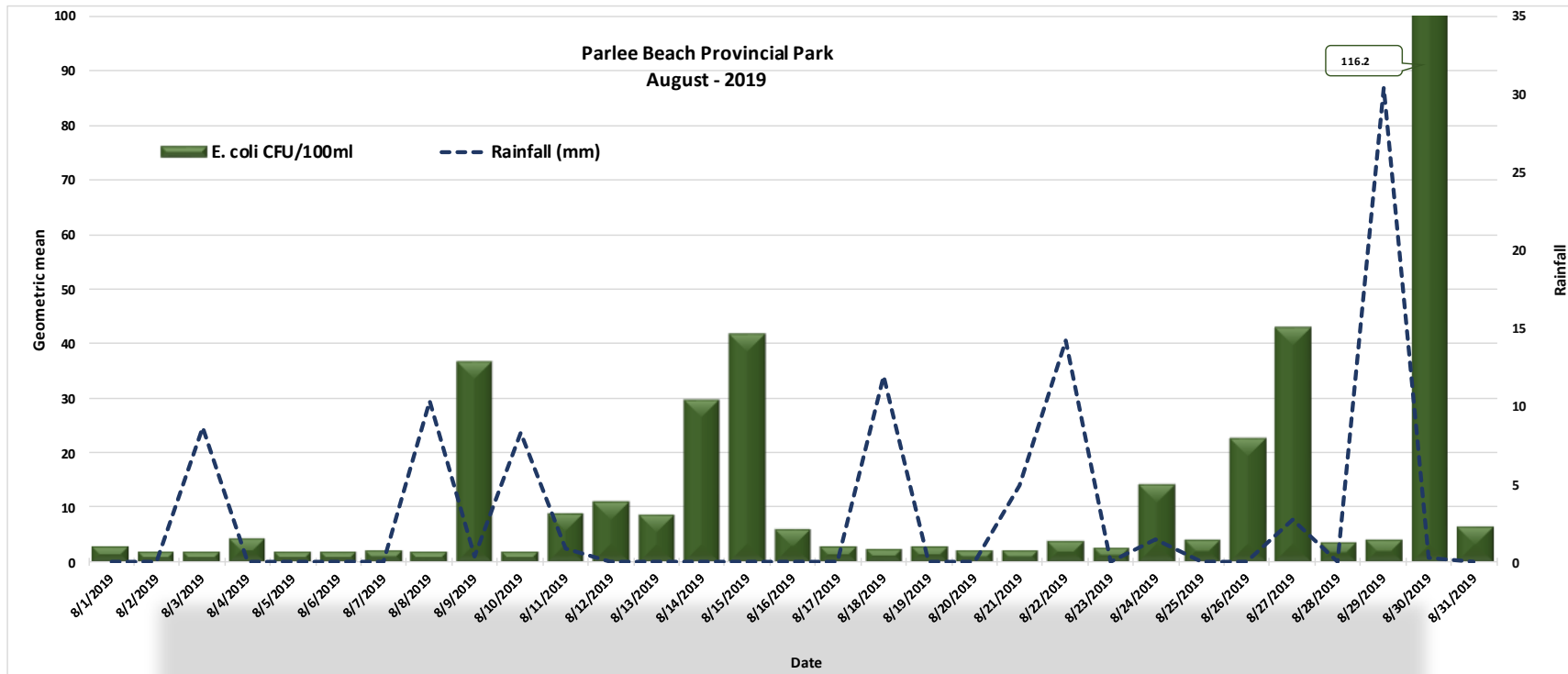
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Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website
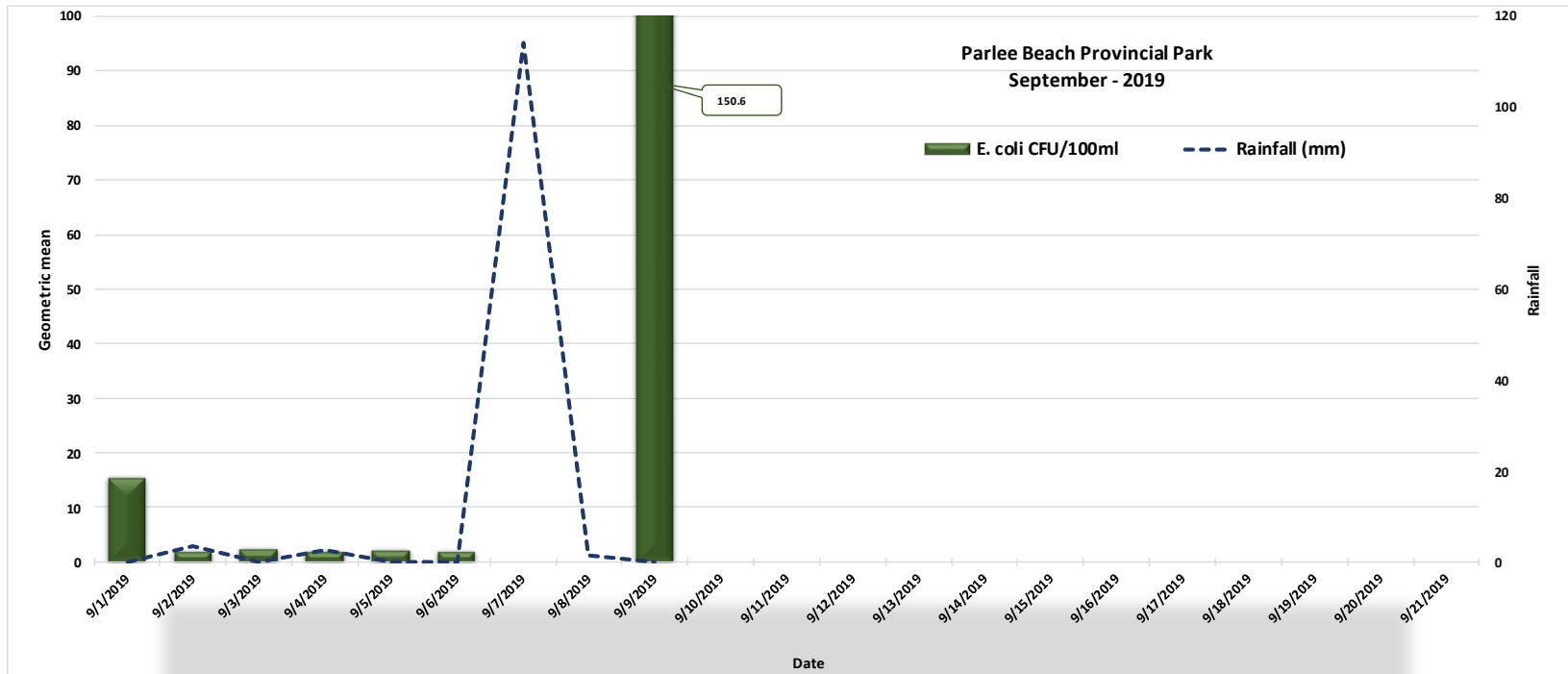
Figure 3.1b   Rainfall and E. coli GM – July 2019

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Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website
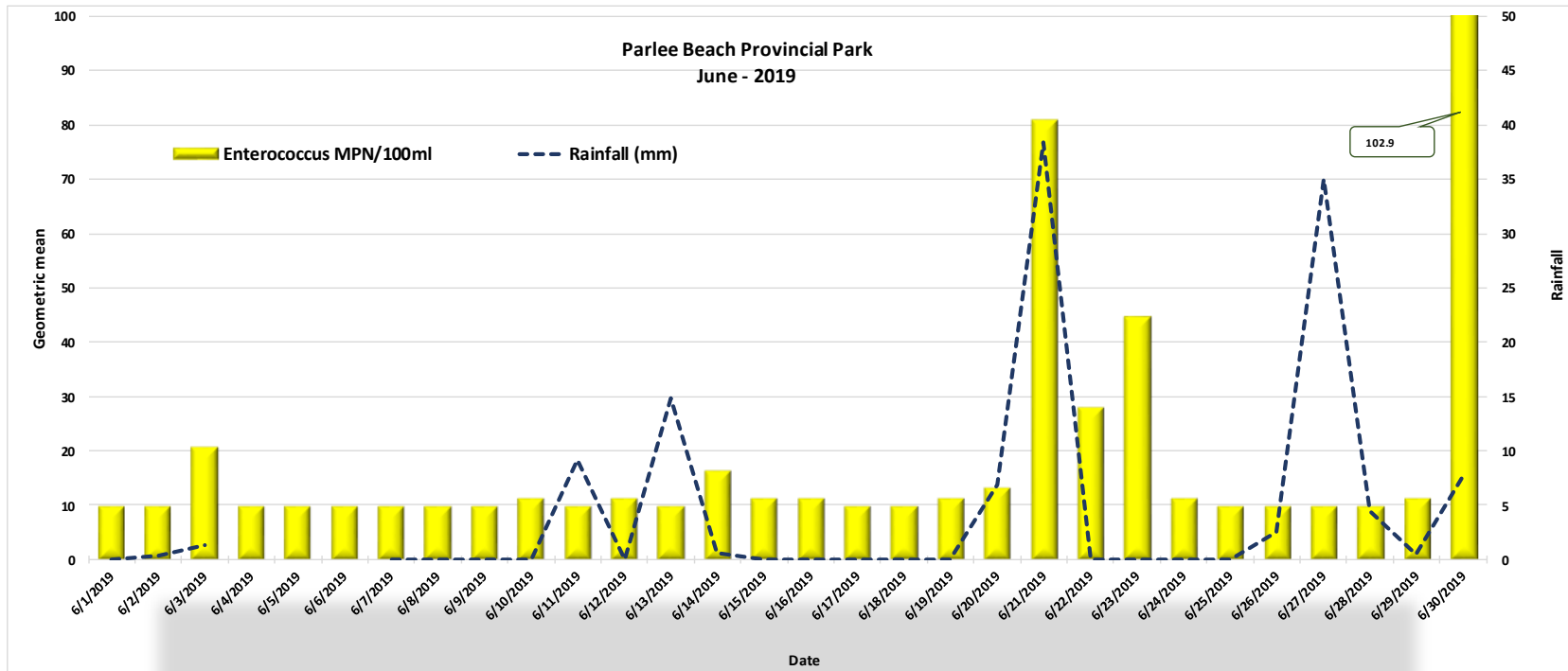
Figure 3.1c   Rainfall and E. coli GM – August 2019

Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website
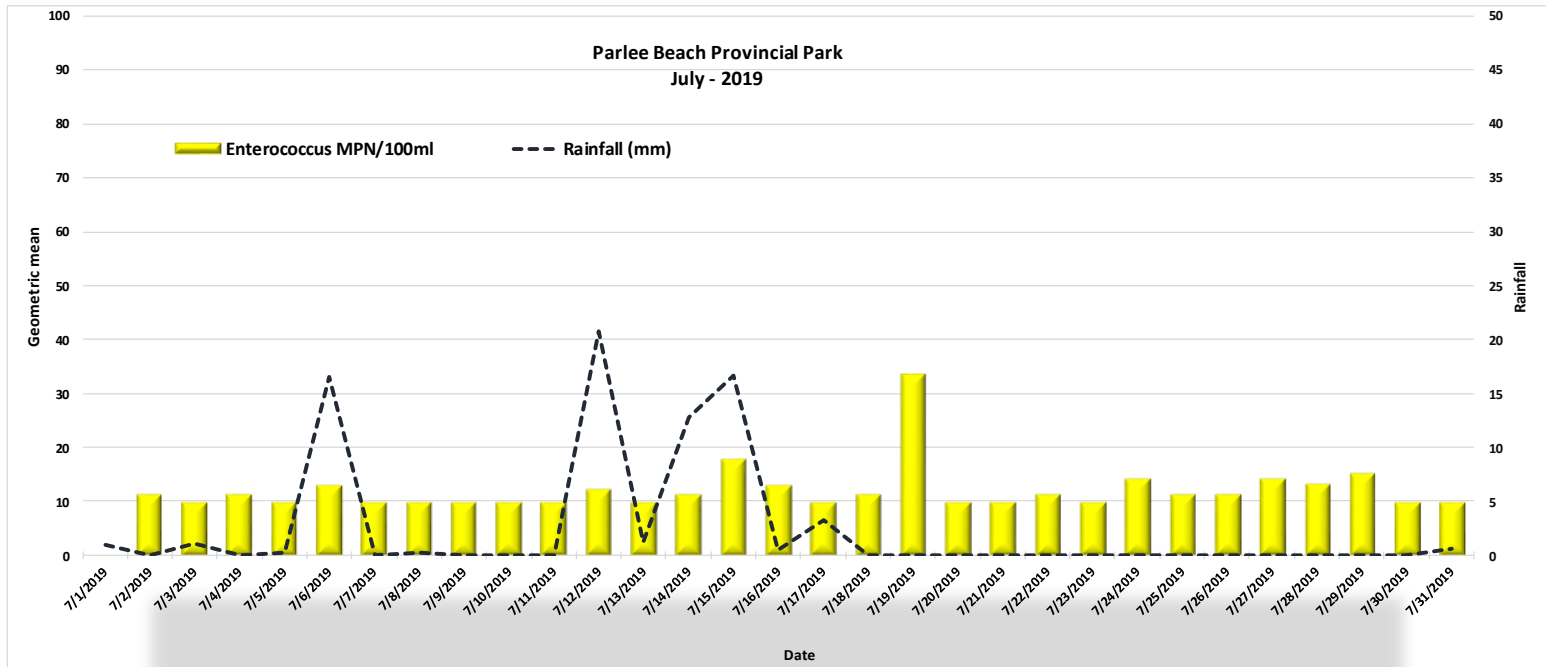
Figure 3.1d   Rainfall and E. coli GM – September 2019

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Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website

Figure 3.1e   Rainfall and Enterococcus GM – June 2019

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Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website

Figure 3.1f   Rainfall and Enterococcus GM – July 2019

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Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website
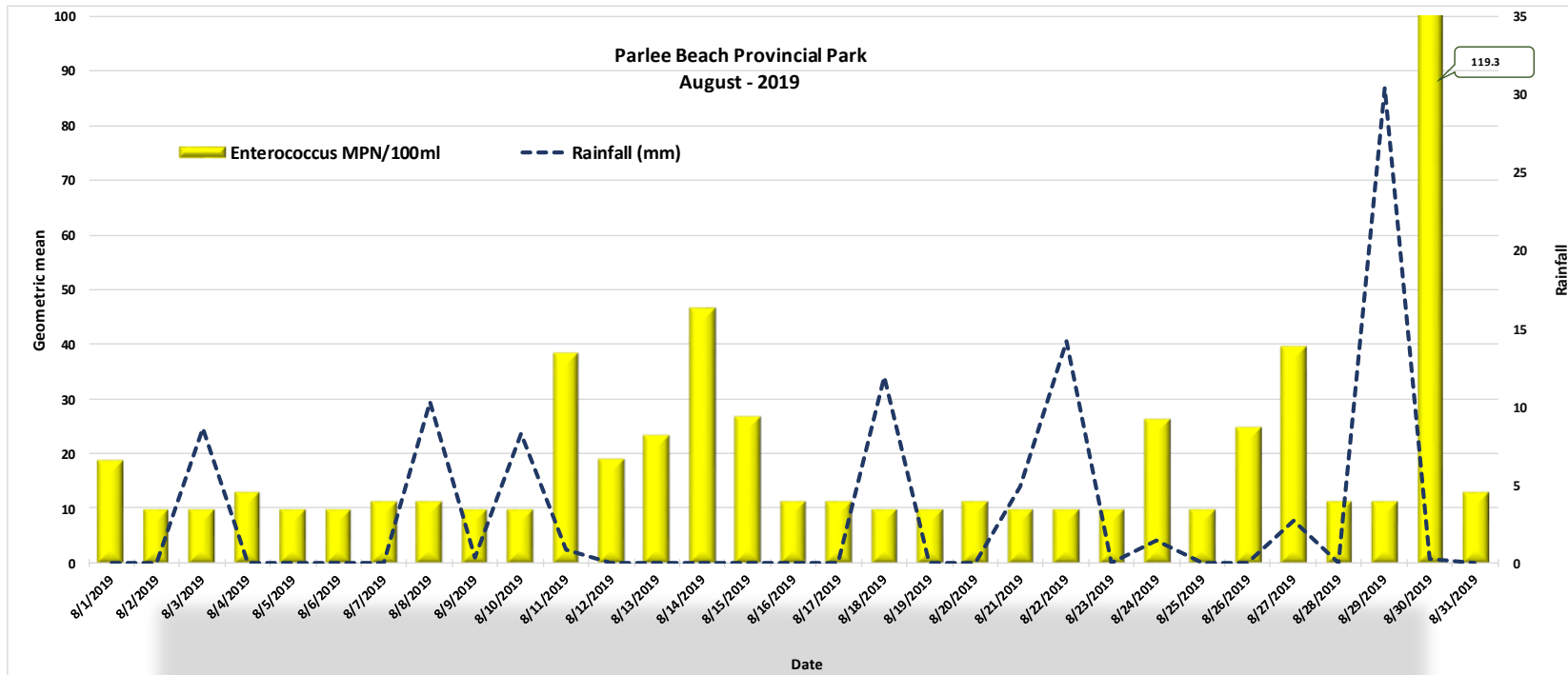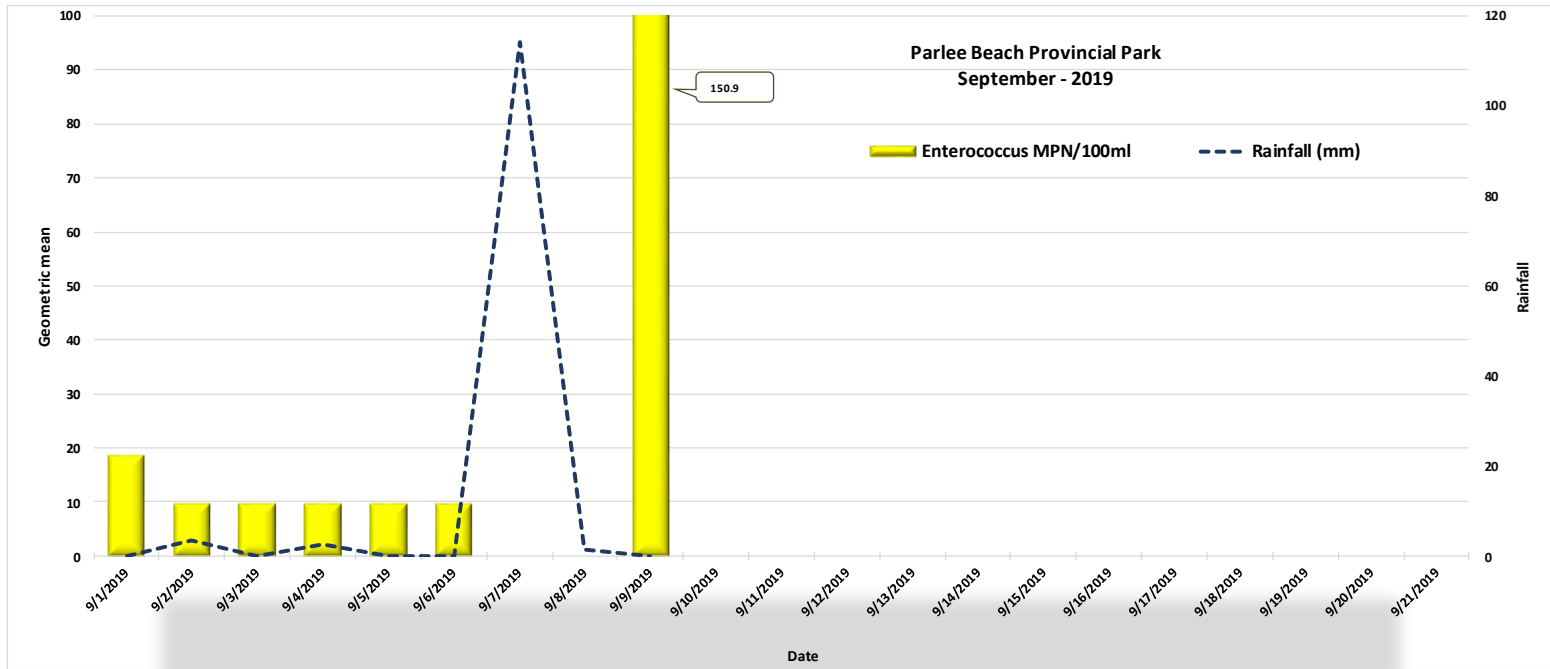
Figure 3.1g   Rainfall and Enterococcus GM – August 2019

Source: Bacteria concentration - Provincial Park Beach website Rainfall Bouctouche ECCC - MSC website

Figure 3.1h   Rainfall and Enterococcus GM – September 2019

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3.6   Wind and Bacteria Counts

In 2017, wind diagrams by month for 30 years of data over the period 1985 to 2015 were reviewed and indicated that during the swimming season (late May to early September), the prevailing winds come from the south and (primarily) the southwest. An evaluation of the relationship between wind direction and the geometric mean of bacteria counts from June to October 2017 indicated a relatively consistent correlation between these parameters. The data suggested that when the wind is blowing from the southwest (between 180 and 270 degrees), water quality at Parlee Beach is acceptable. But when the wind shifts to the northwest (between 270 and 360 degrees) there is often an increase in bacteria values.

During 2018, wind direction and speed data were collected at Parlee Beach Weather Station 51. The conclusion was most of the time, the wind blows from the West or West-South-West, consistent with the findings in 2017.

During 2019, wind speed and direction data were again collected at Station 51 and the results are displayed at Figures 3.2a to 3.2e for the months June to October 2019. The dominant wind direction during all months is West-South-West. However, during August, about 10% of the wind direction is from the West-North-West and West with an increased in wind speed to 11-20 km/hr. During September, about 8% of the wind direction is from the North-North-West also at a wind speed of 11-20 km/hr. These are the months when the bacteria counts are elevated relative to the data for the entire summer. These data corroborate the 2017 and 2018 findings that wind direction generally from the North-West is coincident with higher E. coli and enterococcus counts.
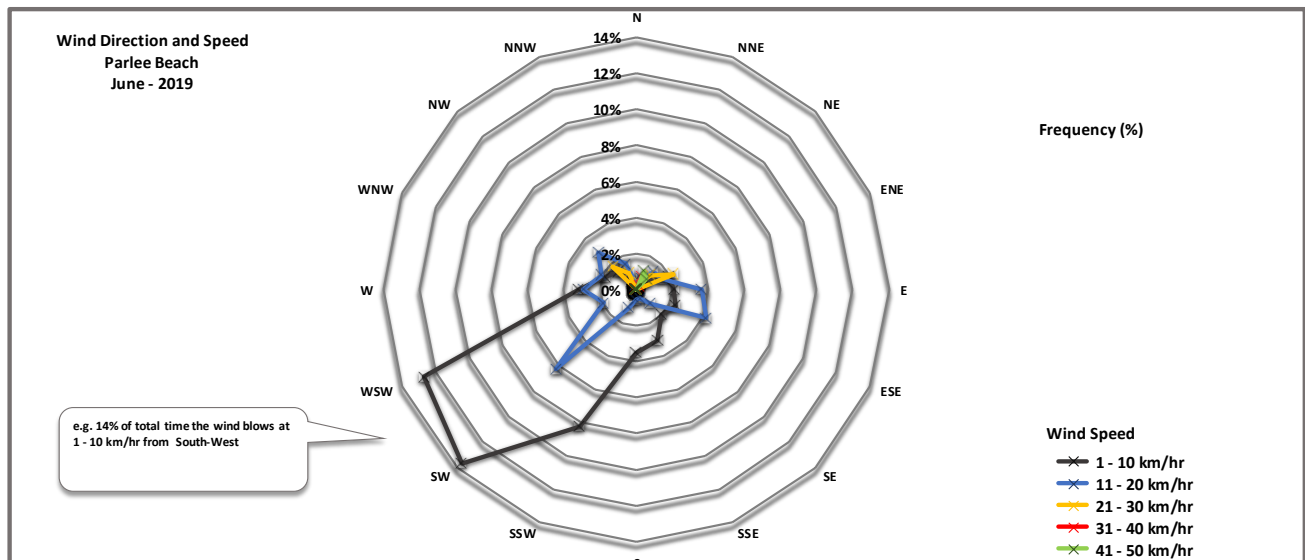

Figure 3.2a   Wind Direction and Speed – June 2019
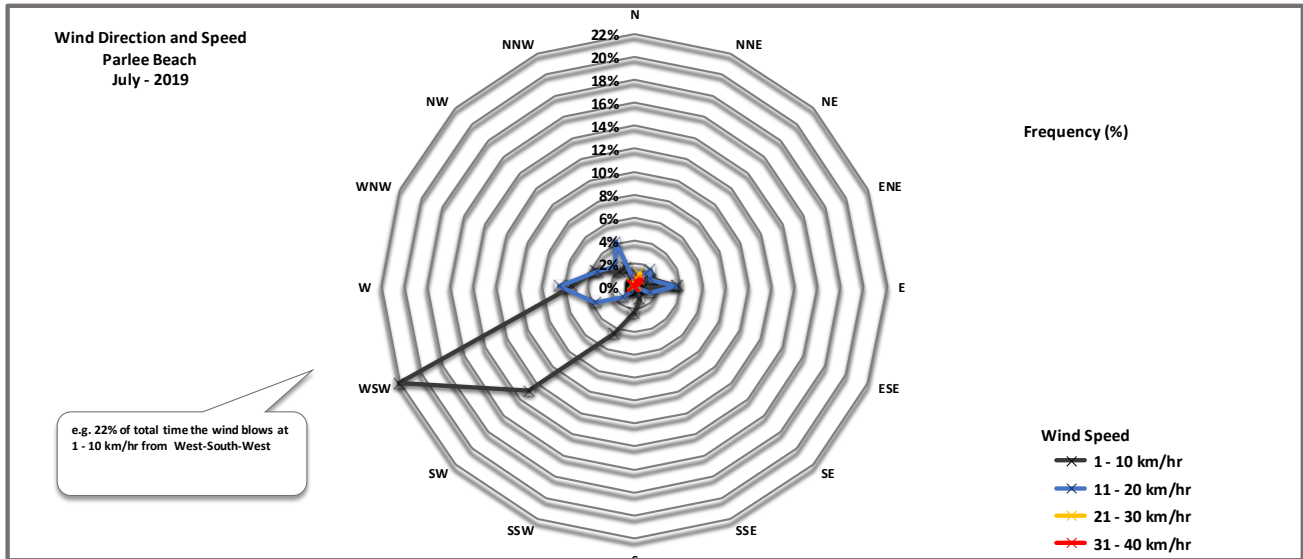
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Figure 3.2b   Wind Direction and Speed – July 2019
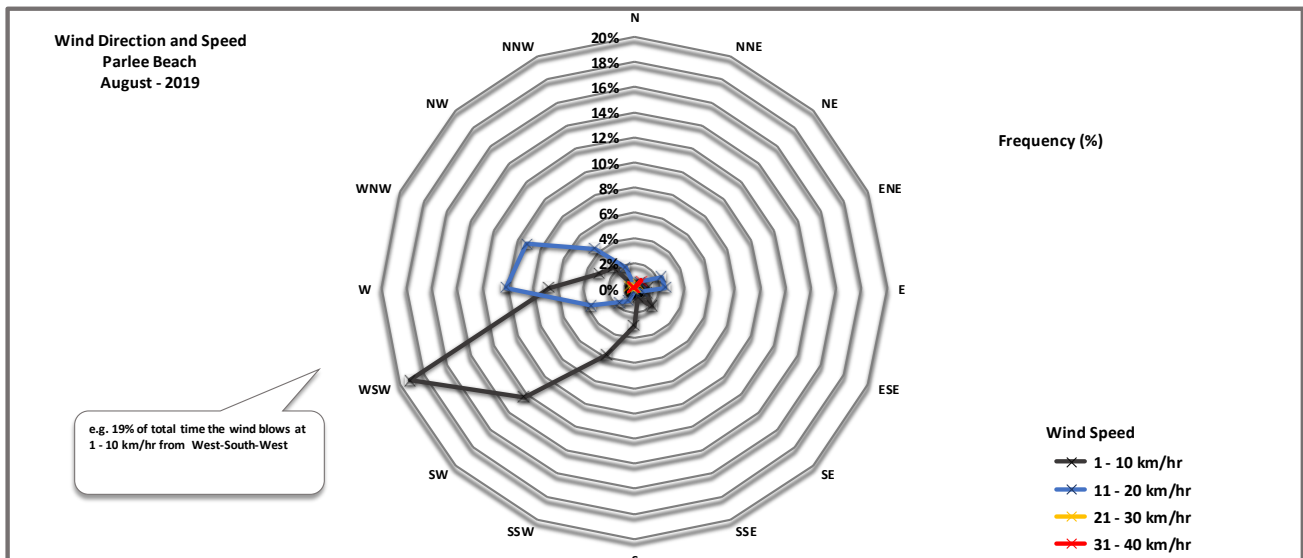

Figure 3.2c   Wind Direction and Speed – August 2019
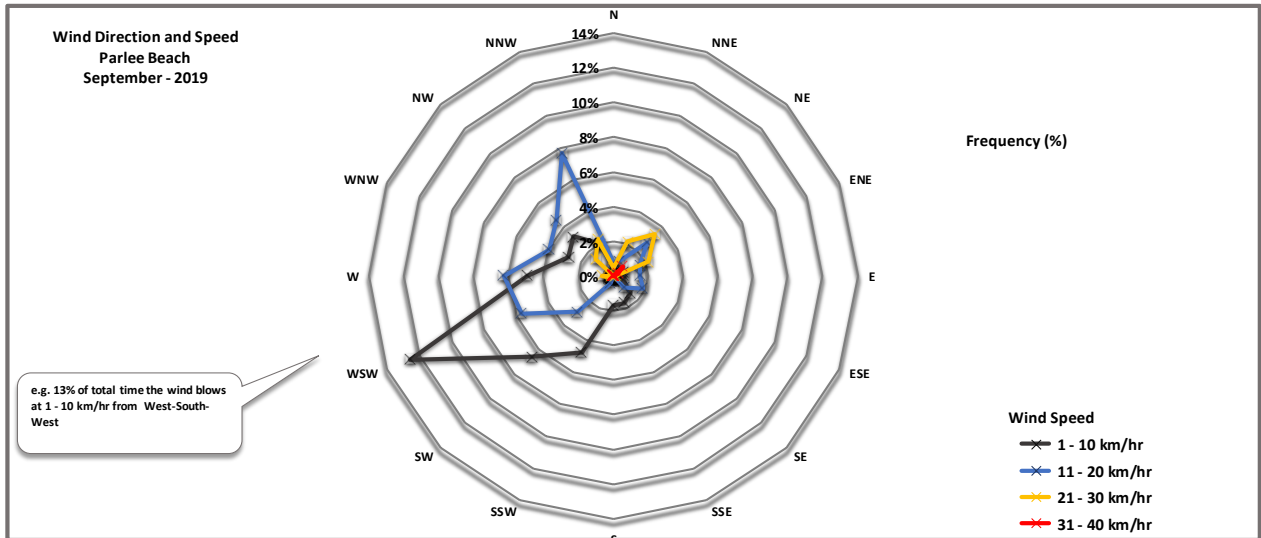
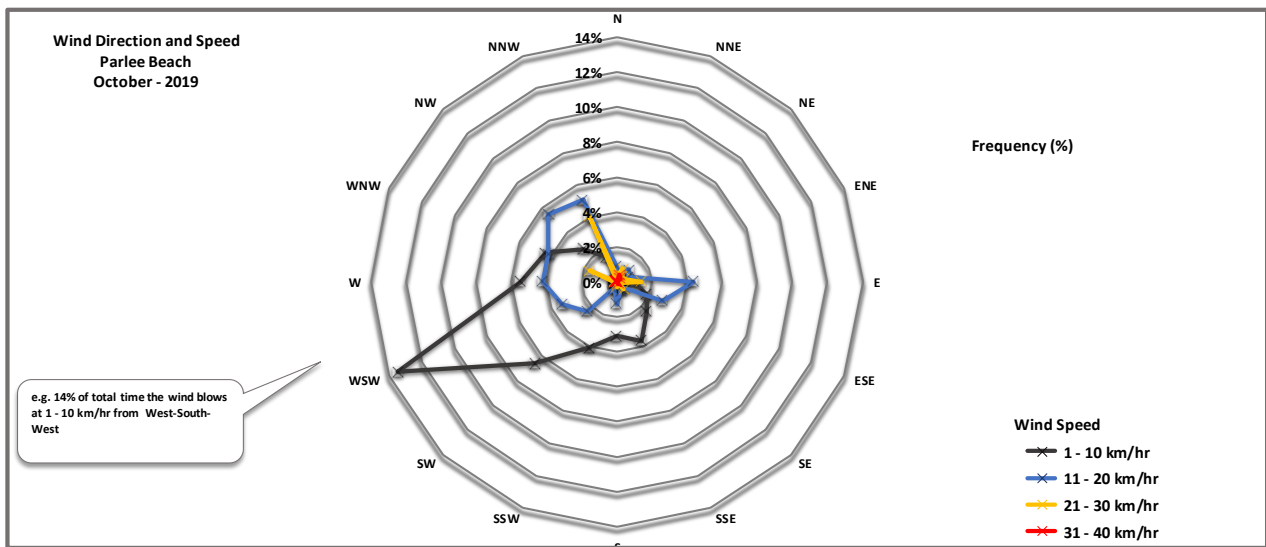**Figure 3.2d   Wind Direction and Speed – September 2019**

Figure 3.2e   Wind Direction and Speed – October 2019

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4.0   Conclusions

Based on an assessment of the 2019 data and information, the conclusions of the 2017 Parlee Beach Water Quality Steering Committee continue to be valid.

For 2019, the conclusions are as follows:

- Based on the samples collected in 2019, concentrations of E. coli and enterococcus in the waters at Parlee Beach are significantly lower than the values stated in the Guidelines for Canadian Recreational Water Quality. In total 97.3% of the one thousand and seventy (1,070) samples collected met the guideline values.

- Based on the samples collected in 2019, high concentrations of E. coli and enterococcus continue to exist throughout the Shediac Bay Watershed. In 2019 for all monitoring categories, 40.8% of E. coli samples and 76.7% of enterococcus samples, exceeded the Single-Sample-Maximum Guideline Value.

- The water quality in the Shediac Bay Watershed does not appear to be improving over time. For all monitoring categories, over 2017 to 2019, the percentage of samples exceeding the Single-Sample-Maximum Guideline Value is increasing. However, the Mann-Kendall Trend Test indicate that for individual sample results there is for the most part no discernable trend apart from monitoring station SW6 (close to Parlee Beach) which exhibits a noticeable increase over time.

- Based on the temporal distribution of the 2019 sample results there is a discernable degradation in water quality over June to September. It would appear reasonable to conclude that surface water run-off from agriculture and urban areas are important contributors to the sources of contamination.

- It is difficult to conclude decisively if there is a relationship between rainfall and the geometric mean of E coli or the geometric mean of enterococcus for Parlee Beach data because the evidence is inconsistent. The highest FIB occurrences and pathways require further analysis.

- There is compelling evidence for a relationship between a North-West wind and bacteria values at Parlee Beach. This does not necessarily mean that wind causes elevated values. If the wind direction truly plays a role in the migration of the bacteria, this could be further investigated as the wind direction change seems to be related to the fall period. Consideration could be given to extending the monitoring season into October and early November (when there are strong North-West winds) as this would help to improve understanding of the mechanism of bacteria migration to Parlee Beach.

- To improve water quality in the Shediac Bay Watershed and reduce "No Swimming Advisories", at Parlee Beach, the bacteria sources which exist throughout the Watershed should be addressed.

5.0   Closing

This report represents an interpretation and analysis of data collected in the Shediac Bay Watershed, and graphics prepared by the New Brunswick Department of Environment and Local Government. This document is intended to be a stand-alone report that provides a fulsome understanding of the water quality conditions in Shediac Bay and at Parlee Beach. The supporting data are available upon request.

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