Water Quality Monitoring in the Rockport-Dorchester Area
2020 Water Quality Report

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- And countless others for supporting EOS in establishing the Chignecto Watersheds Committee and starting up a long-term water quality monitoring program

Executive Summary

During 2020, water quality measurements were taken from 12 sites across the Rockport-Dorchester Area of New Brunswick. In-situ measurements, consisting of pH, temperature, conductivity, dissolved oxygen, total dissolved solids and salinity were taken from June to September using a Hanna Multiparameter Meter. Water samples were collected from June to September and sent to the RPC Laboratory in Moncton for analysis. Additionally, chlorophyll-*a* was measured from June to August and analyzed in the ACME laboratory at Mount Allison University. This water quality report compiles and summarizes these results, which will be used as a baseline of water quality moving forward.

The objective of this report is to establish a baseline of water quality in the Rockport-Dorchester Area, with the intention to continue with a long-term water quality monitoring program. This data will help us gain a better understanding of our watersheds and could lead to the undertaking of any necessary restoration or protection activities, ultimately ensuring healthy watersheds, sustainable ecosystems and resilient communities. This knowledge could also be used to educate the public on local watershed issues and how they connect to climate change in our region.

The water quality results were compared to Canadian Council of Ministers of the Environment (CCME) water quality guidelines, Environment Canada guidelines, and Health Canada Recreational Guidelines. While we could speculate on some of the potential causes for variations between sites and fluctuation in parameter concentrations, this is just the first year of data collection in our monitoring program. More years of data are required to look at trends and relationships within the water quality data.

Water temperature remained below the recommended Environment Canada guideline of 20°C across all sites in August and September. Six sites exceeded 20°C in June and two sites exceeded 20°C in July. July and August had 11 sites below the CCME dissolved oxygen concentration guideline of 6.5 mg/L, while June had seven and September had five sites. Low oxygen in July and August corresponds with the two hottest months according to local air temperature data. In-situ water pH was consistently within CCME guidelines of 6.5 – 9 for all sites. Despite being sampled at low tide, five tidally influenced sites still had brackish water as indicated by high concentrations of specific conductivity, TDS, sodium (Na) and chloride (Cl). Three sites were brackish from June to September, and two sites were brackish in September.

E. coli levels surpassed the Health Canada Recreational Guidelines at two sites in June, six sites in July and August, and three sites in September. Most of our samples were eutrophic (35 – 100 μg/L) to hyper-eutrophic (> 100 μg/L) status as indicated by CCME Canadian Trigger Ranges for total phosphorus. August and September had 11 sites above 35 μg/L, July had 10, and June had eight. Chlorophyll-*a* was measured for the first time with four sites showing highest concentrations in June, three sites in July, and five sites in August. Two surface water chemistry measures, analyzed by RPC, were above

CCME guidelines consisting of chloride (Cl) at five sites and ammonia (un-ionized at 20°C) at two sites. A number of Surface water metals were also above CCME guidelines consisting of aluminum (Al) at 10 sites, boron (B) at three sites, iron (Fe) at 11 sites, and lead (Pb) and cadmium (Cd) at one site.

Overall, EOS had a very successful year of water quality monitoring that provided valuable baseline data for the Rockport-Dorchester Area. EOS Eco-Energy recommends that the knowledge gaps in the Chignecto watersheds continue to be addressed through our long-term water quality monitoring plan.

Introduction

EOS Eco-Energy is an environmental not-for-profit organization based out of Sackville, New Brunswick. EOS Eco-Energy is dedicated to community-based solutions to reducing and adapting to climate change in the Tantramar region of southeast New Brunswick. In 2017 EOS formed the Chignecto Watersheds Committee, a committee dedicated to the long-term sustainability and resiliency of our local environment and preparing our communities for the combined impacts of climate and land use change by promoting watershed awareness through public education, conducting long-term inland water monitoring, and performing subsequent restoration and protection activities. Members include representatives of Ducks Unlimited Canada, NatureNB, professors & research groups from Mount Allison University, the local planning commission, Fort Folly Habitat Recovery, and Chignecto Soil & Crop Association. This wide range of expertise provides the capacity, mentorships, partnerships, networks, and volunteer bases to be successful in establishing a long-term monitoring program. Having a long-term monitoring program will help us maintain healthy, productive aquatic environments that will continue to ensure dependable, safe, high quality water to recreational, agricultural, municipal, and industrial users. Thus, this project will ultimately contribute to the overall health of the environment and quality of life of New Brunswickers.

In 2020-2021 EOS' long-term water quality monitoring program extended to 12 sites in Rockport-Dorchester. In-situ measurements, consisting of pH, temperature, conductivity, dissolved oxygen, total dissolved solids and salinity were taken from June to September using a Hanna Multiparameter Meter. Water samples were collected from June to September and sent to the RPC Laboratory in Moncton for analysis. Chlorophyll-a analyses were also performed for the first time on water samples at the Mount Allison University ACME laboratory from June to August. Monitoring results are summarized in this report and will serve as baseline water quality measures moving forward.

Objective

The objective of this report is to establish a baseline of water quality throughout Rockport-Dorchester, with the intention to continue with a long-term water quality monitoring program. This data will help us gain a better understanding of our watersheds and could lead to the undertaking of any necessary restoration or protection activities, ultimately ensuring healthy watersheds, sustainable ecosystems and resilient communities. This knowledge could also be used to educate the public on local watershed issues and how they connect to climate change in our region.

Methodology

Water quality samples were collected from 12 sampling sites throughout the Rockport-Dorchester area once a month from June to September 2020. The water sampling was performed according to the New Brunswick Department of Environment and Local Government protocols. Water samples at tidally influenced sites were always sampled at low-tide to ensure that we were sampling freshwater that would be representative of what is happening further upstream in the watershed. Water samples were sent to RPC Laboratory in Moncton for surface water quality parameters and *E. Coli* analysis. Sterile sample bottles were provided by RPC prior to sampling to ensure no sample contamination occurred. Collected samples were stored in a cooler at ~ 4ºC until they were transported to RPC at the end of the sampling day.

Water samples were also collected and stored in a cooler at ~ 4ºC until they were brought to the Mount Allison University ACME lab to be filtered via vacuum filtration. The samples were filtered using GF/F filters that were frozen until analyses at the end of the summer. The volume of filtration varied based on how much water was required to see colour on the filter. Because of this, the analyses were performed in triplicate or duplicate depending on the volume of sample required when filtering. The chlorophyll-a analysis was performed using a Turner Trilogy Fluorometer, Chlorophyll-a non-acidification module. The standard operating procedure was adapted by Dr. Justin Liefer and can be found in Appendix 1. Following analyses, the results were corrected for the sample volume and averaged for each sample.

In-situ water quality parameters consisting of pH, temperature, dissolved oxygen, conductivity, salinity, and total dissolved solids, were collected using a Hanna Multiparameter Meter from the 12 sampling sites. The Hanna Meter was calibrated prior to each field outing. Due to issues with our Hanna Meter, some substitutions had to be made for our in-situ monitoring. In August our conductivity sensor stopped working, so we used handheld probes for conductivity/TDS (Oakton PCTSTestr 50 Pocket Tester) and for salinity (Water Rangers kit). Due to the tidal influence, a few of our streams had an ionic content that exceeded the detection limit of our probes for conductivity and TDS, so we were only able to take a salinity measurement. However, RPC provides in-lab measurements of both of these parameters, so we will still have the in-lab data. In September our dissolved oxygen probe also stopped working, so in addition to the handheld probes, we had to supplement our in-situ monitoring with CHEMets dissolved oxygen kits from our Water Rangers kits.

Study Area

The Rockport-Dorchester area covers ~150 km^2 of land area. It is a part of the larger Inner Bay of Fundy Watershed, where all the water ultimate flows into the Bay of Fundy (Figure 1). The watershed boundaries the Petitcodiac River Watershed covered by Petitcodiac Watershed Alliance to the west/northwest, and the Tantramar River Watershed to the north/northeast. Land-use in the Rockport-Dorchester Watershed is primarily forested with agricultural and forestry activities, and residential development in Dorchester (Figure 2). There is also a Nature Conservancy Canada, Johnson Mills Shorebird Interpretation Centre, and Fundy Biosphere Reserve.

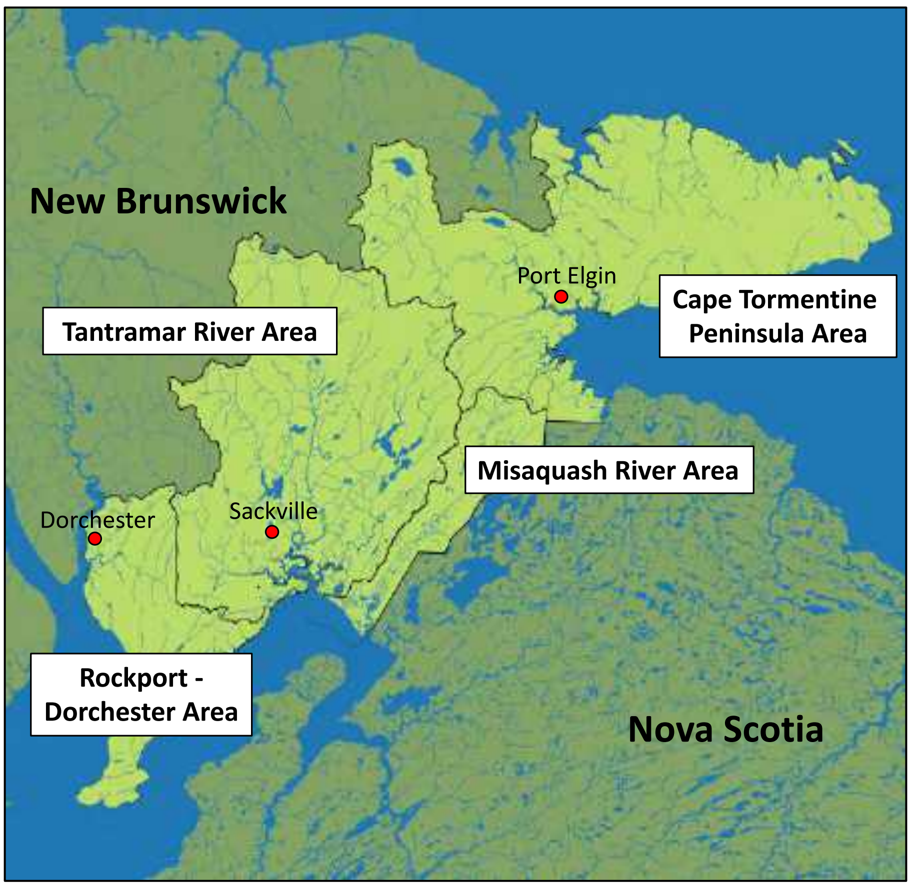


Figure 1: Map of Chignecto Watersheds with Rockport-Dorchester (Source: J Campbell)

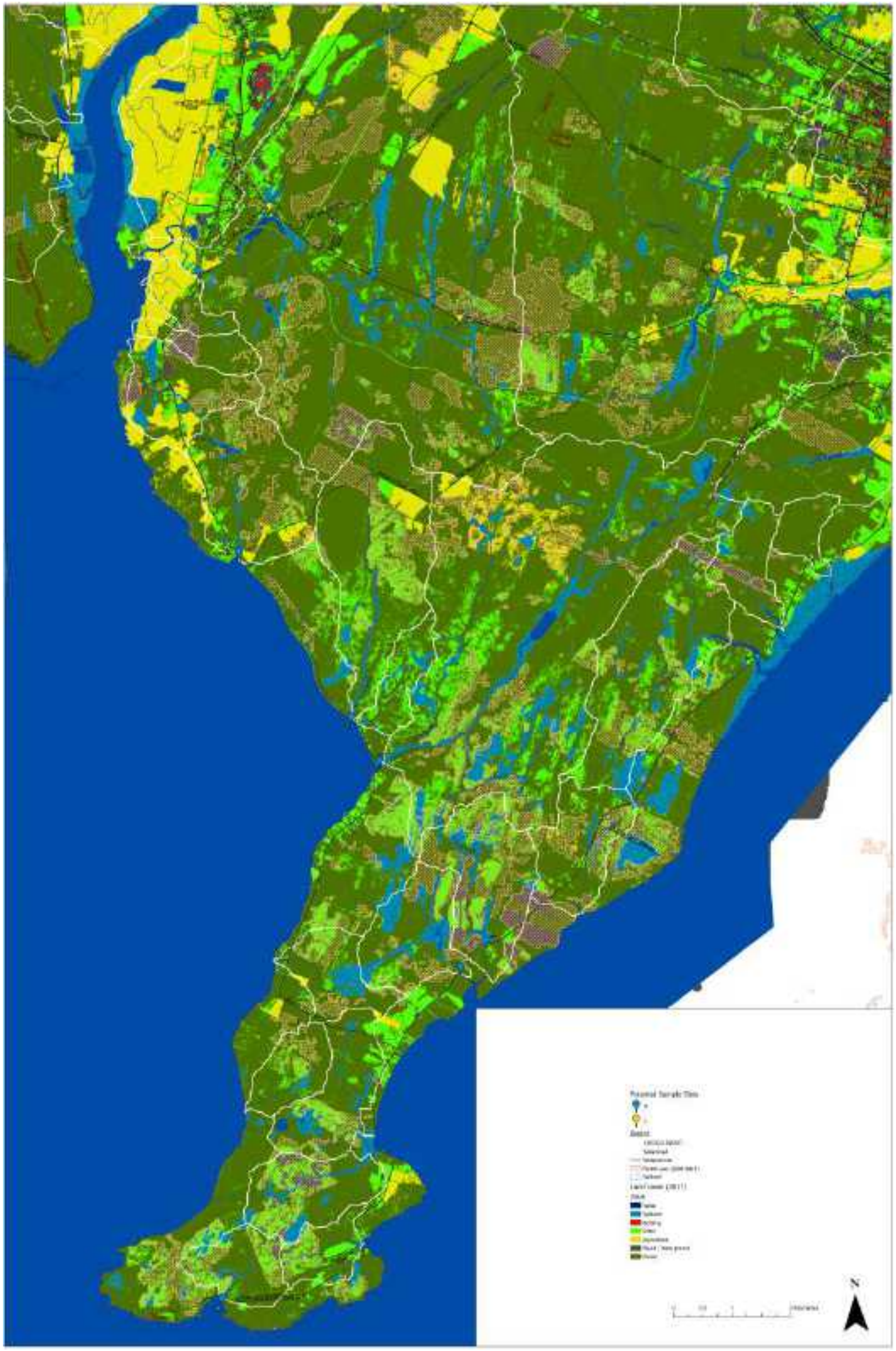


Figure 2: Land-use Map of the Rockport-Dorchester Watersheds (Source: James Bornemann)

Sampling Sites

Water quality samples were collected from 12 sampling sites throughout the Rockport-Dorchester area once a month from June to September 2020 (Table 1, Figure 3).

Table 1: Water Quality Sampling Sites

Station Name	Latitude	Longitude	Location Description
Wood Creek	45.8578	-64.3611	Upstream of aboideau, ~150m SW from bottom of Westcock Marsh Rd.
Harvey Creek	45.7793	-64.4662	Just upstream of culvert under Route 935, 2.4km from Lower Rockport Rd.
Pecks Cove Creek	45.7482	-64.4910	~30m downstream of bridge located 1.8km down Lower Rockport Road
Slacks Cove Creek	45.7254	-64.5259	~50m SE of small parking lot at Slacks Cove beach, on Lower Rockport Road
Johnson Creek	45.8092	-64.4816	~500m NE off Route 935, just below stream branching off to North Brook
Len Buck Brook	45.8141	-64.4944	Just upstream from culvert under Route 935, 2.7km SE of Shorebird Centre
Tower Brook	45.8397	-64.5182	Just upstream from culvert under Route 935, ~300m NW of Ralph Stiles Rd.
Palmers Creek	45.8829	-64.5255	Just downstream from culvert under Route 935, ~900m SW of Water St.
Robbs Brook	45.9043	-64.5235	800m down Station St., just before the brook crosses under the CN railway
Penitentiary Road Creek	45.9143	-64.5264	Just upstream from culvert, 650m up Pent Rd. off Penitentiary Rd.
Two Mile Brook	45.8817	-64.4871	Just upstream of culvert at Route 106, 1km SE of Cherry Burton Rd.
Three Mile Brook	45.8747	-64.4684	Just upstream of culvert at Route 106, 2.7km SE of Cherry Burton Rd.

Figure 3: Map of Rockport-Dorchester Watershed Sampling Sites (Source: KN Croucher)

Site Descriptions

Wood Creek

Figure 4: Looking Upstream Wood Creek in Source August 2020 (Source: KN Croucher)

Wood Creek starts up near British Settlement Rd., running east under Route 935 and finally emptying into the Cumberland basin through an aboideau in the dykes at the end of Old Hospital Road. Land-use is primarily forest, with some agriculture and grass spread around the creek's sub-watershed. There is also a large patch of forest loss (2000-2019) in the watershed and some other smaller patches scattered around. The stream bottom & banks were very silty and muddy. The riparian area had soft, muddy tidally influenced banks that transformed over the summer as the grasses grew higher and higher. Samples were collected at the bottom of a grassy hill, upstream of the aboideau from the south bank. At the lower reaches of the creek where we sampled were surrounded by grassy fields with livestock (Figure 4). June water levels were very low; however, water levels were notably higher in July and August following some rain in the week prior to sampling.

Harvey Creek

Figure 5: Looking at Beaver Dam Upstream Harvey Creek in September 2020 (Source: KN Croucher)

Harvey Creek runs southeast under Route 935 through a culvert that became progressively more clogged by woody debris over the course of the sampling season, resulting in almost stagnant water in August. Samples were collected downstream of the beaver dam (Figure 5), on the north side of Route 935 upstream of the culvert. The creek ultimately empties into the Cumberland Basin further downstream. While there is some forest remaining, the land-use of the creek catchment is primarily forest loss, with a significant loss of forest occurring between 2017 & 2019. There is grass where the forest loss is for a lot of areas and there is some forest in the watershed. Lot of woody debris was present upstream & downstream of the sampling site. There was a beaver dam upstream. The riparian area was quite healthy with the banks covered in a mixture of trees, grasses, and shrubs. There was emergent vegetation present when water levels were low. In July & August there was brown, fuzzy algae mats on the bottom of the creek. Over the course of our sampling we saw lots of frogs and even a beaver once at this site.

Pecks Cove Creek

Figure 6: Looking Upstream Pecks Cove Creek in September 2020 (Source: KN Croucher)

Pecks Cove Creek was the 2nd longest watercourse we measured. We sampled downstream of the bridge on Lower Rockport Road where all of its branches converge (Figure 6). There is a pile of crushed stone on the south bank that provides some sturdy footing to access the creek. The creek is tidally influenced at this point which is very noticeable with its steep, muddy banks, and the silty substrate of the creek. The creek is surrounded by a wide floodplain of grasses. Looking upstream, this watercourse is heavily deforested with only a small buffer area along the watercourse. Otherwise, the primary land-use is forest.

Slacks Cove Creek

Figure 7: Looking Upstream Slacks Cove Creek in August 2020 (Source: KN Croucher)

Slacks Cove Creek is a small creek in Lower Rockport that flows under Lower Rockport Road and ultimately into Slacks Cove. This creek is surrounded by forest as well as forest loss (approximately 60% forested, 40% deforested). The areas with forest loss are mostly grass now and exist along the lower and upper reaches of the creek. The sample site was densely covered by vegetation consisting of conifers, alder, ferns and grass (Figure 7). The water was very clear with rocky substrate and exposed mossy rocks. There was slight undercutting and exposed roots on the shorelines. We sampled upstream to the east of Slacks Cove beach.

Johnson Creek

Figure 8: Looking Upstream Johnson Creek in August 2020 (Source: KN Croucher)

Johnson Creek is a 3rd order stream, with multiple adjoining streams upstream, & is the 2nd largest stream within this watershed. We sampled just downstream of the North Brook confluence (East Brook also joins Johnson Creek further upstream) just before the creek becomes tidally influenced as it flows into the Bay of Fundy. Land-use within the creek catchment is primarily forest. There are deforested patches scattered throughout the watershed with large areas in the lower and upper reaches, occupying approximately 1/5 of the watershed. There is a large area of agriculture in the upper reaches. There is also a lot of grass spread around the watershed, mostly concentrated at the lower reaches. The banks surrounding the sample site were primarily grass covered with some rocks and mud (Figure 8). In July, algae growth was noted on the mud surrounding the creek.

Len Buck Brook

Figure 9: Looking Upstream Len Buck Brook in August 2020 (Source: KN Croucher)

Len Buck Brook is another tidally influenced brook flowing through a culvert under Route 935 into the Bay of Fundy. The brook has wide, grassy floodplains (Figure 9). The land-use is primarily forest and grass. There is an area of forest loss (2000-2019) in the upper reaches, approximately 1/3 of the watershed. There is some agriculture in the headwaters. The banks were steep, muddy and slightly undercut around the sampling site. We sampled just upstream of the Route 935 culvert. In July, algae was growing on the banks of the brook.

Tower Brook

Figure 10: Looking Upstream Tower Brook in September 2020 (Source: KN Croucher)

Tower Brook is another tidally influenced brook that flows under Route 935 into the Bay of Fundy. Land-use surrounding the brook is primarily forest, with deforestation scattered around with a large area around the upper reaches, occupying approximately ¼ of the watershed. There are areas of agriculture mainly around the lower reaches and some grass spread throughout the watershed. We sampled just upstream of the Route 935 culvert. The brook has a large floodplain and its banks were sloped and mostly covered with grass and goldenrod and some exposed mud (Figure 10).

Palmers Creek

Figure 11: Looking Downstream Palmers Creek in June 2020 (Source: KN Croucher)

Palmers Creek is the only 4th order stream (with a number of adjoining streams upstream) within the watershed. Three Mile Brook, Sterling Brook, and Two Mile Brook flow into Ayers Brook which joins Back Brook to form Palmers Pond. Palmers Pond and Fox Brook then flow into Palmers Creek. We sampled just downstream of the culvert where Palmers Creek runs under Route 935. This is a popular fishing site which was evident with beer cans and garbage surrounding the creek. The banks were rocky with vegetation coming up through the rocks and surrounded by grass, shrubs, and deciduous trees (Figure 11). The land-use in this catchment is primarily forest with patches of agriculture in the upper reaches as well as an area surrounding the lower reaches. There are also some large patches of deforestation throughout the watershed. Buildings and pavement also occupy some of the watershed area. Below our sampling site, agriculture surrounds the creek before it flows into the Bay of Fundy.

Robbs Brook

Figure 12: Looking Upstream Robbs Brook in July 2020 (Source: KN Croucher)

Robbs Brook starts upland in Dorchester, surrounded by commercial and institutional land-use with some forested area before crossing under Cape Road and flowing through agricultural fields. We sampled just before the brook crosses under the CN railway through a concrete culvert from 1943. The bank where we accessed the brook to sample was quite loose with silt and gravel, otherwise the shorelines were heavily vegetated with grass, shrubs, and deciduous trees (Figure 12). There was lots of emergent and floating vegetation in the brook throughout the summer. In July, algae growth was noted upstream and brown algae mats were visible at the bottom of the brook.

Penitentiary Road Creek

Figure 13: Looking Upstream Penitentiary Road Brook in July 2020 (Source: KN Croucher)

Penitentiary Road Creek flows under Penitentiary Road. This site was primarily chosen due to agriculture being the main land-use. July and onwards the vegetation surrounding the brook was thriving (Figure 13). We saw lots of frogs and minnows in the brook when sampling. The bottom of the brook was very silty and our boots would sink in when sampling. The banks were grassy with alder and bayberry shrubs. The culvert downstream was blocked by sticks. Due to the low water levels this summer, there was emergent vegetation in the brook and the brook has very low flow. This spot seemed to be a popular birding site as we saw people birding a few times while sampling and also saw a lot of bobolink and tree swallows.

Two Mile Brook

Figure 14: Looking Upstream Two Mile Brook in August 2020 (Source: KN Croucher)

Two Mile Brook starts up near Lower Fairfield Road and flows under Cherry Burton Road and Route 106 before entering Ayers Brook. The brook is mostly surrounded by forest and grass, with a few patches of agriculture. There is a large area of deforestation and agriculture east of this brook before Back Brook. We sampled just upstream of the culvert crossing under Route 106. The brook was silty on the bottom. The banks were covered in a variety of grasses, shrubs, and trees (Figure 14). This a popular fishing spot and we saw lots of tadpoles while sampling.

Three Mile Brook

Figure 15: Looking Upstream Three Mile Brook in June 2020 (Source: KN Croucher)

Three Mile Brook flows under Route 106 into Ayers Brook. It is Primarily surrounded by forest with some agriculture and grass patches in the upper reaches. There is also a large area of forest loss at the lower reaches. We sampled just above the culvert at Route 106. The banks were mainly covered in grass with some exposed mud & undercutting occurring (Figure 15). In August & September, the water was so low that soil and vegetation were emerging in the middle of the brook and we had to walk a little further upstream to reach a suitable sample site. We saw lots of little minnows in the brook over the course of the field season.

Results & Discussion

In-situ water quality measurements and water samples were taken from 12 sites across Rockport-Dorchester from June to September. In-situ measurements for six parameters were collected using a Hanna Multiparameter Meter from the 12 sites resulting in 288 data points. Water samples were analyzed at the RPC Laboratory in Moncton. The lab analyzed samples for 55 parameters for each sample site resulting in 2640 data points. Additionally, chlorophyll-*a* analyses were run on samples collected from the 12 sites from June to August, resulting in 36 data points. In total, 2964 data points were collected over the course of the field season.

We compared our current baseline results to CCME recommended guidelines for the protection of aquatic life (freshwater) (http://st-ts.ccme.ca/en/index.html), Health Canada Guidelines for Recreational Activities (Health Canada, 2012), and Environment Canada guidelines from a Canadian Environmental Sustainability Indicators (CESI) report (Environment Canada, 2011) (Table 2, 3, 4).

Table 2: Recommended Guidelines for the Protection of Aquatic Life (Freshwater) for In-Situ Parameters, E. coli, Total Phosphorus and Chlorophyll-a

Recommended Guidelines for the Protection of Aquatic Life (Freshwater) for In-Situ Parameters, E. coli, Total Phosphorus and Chlorophyll-a			
Parameter	**Condition**	**Concentration**	**Source**
Temperature	Upper Limit	20°C	Environment Canada 2011
pH	Long Term	6.5-9.0	CCME
Dissolved Oxygen (Warm)	Warm Water Biota Early Life Stages	6.0 (mg/L)	CCME
	Warm Water Biota Other Life Stages	5.5 (mg/L)	
Dissolved Oxygen (Cold)	Cold Water Biota Early Life Stages	9.5 (mg/L)	
	Cold Water Biota Other Life Stages	6.5 (mg/L)	
Specific Conductivity	-	-	-
TDS	-	-	-
Salinity	-	-	-
E. coli	Upper Limit	400 E. coli/100 ml	Health Canada 2012
TP	Oligotrophic	4-10 (µg/L)	CCME
	Mesotrophic	10-20 (µg/L)	
	Meso-eutrophic	20-35 (µg/L)	
	Eutrophic	35-100 (µg/L)	
	Hyper-eutrophic	>100 (µg/L)	
Chlorophyll-*a*	-	-	-

Table 3: CCME Recommended Guidelines for the Protection of Aquatic Life (Freshwater) for RPC Surface Water Chemistry Parameters

CCME Recommended Guidelines for the Protection of Aquatic Life (Freshwater) for RPC Surface Water Chemistry Parameters				
Parameter	**Condition**	**Concentration**	**Condition**	**Concentration**
Na	-	-	-	-
K	-	-	-	-
Ca	-	-	-	-
Mg	-	-	-	-
Alkalinity (as CaCO3)	-	-	-	-
Cl	Short Term	640 (mg/L)	Long Term	120 (mg/L)
F	-	-	-	-
SO_4	-	-	-	-
Br	-	-	-	-
Ammonia (as N)	-	-	-	-
Ammonia (Un-ionized @ 20°C)	-	-	Upper Limit	0.019 (mg/L)
Nitrate and Nitrite (as N)	-	-	-	-
NO_2 (as N)	-	-	-	0.06 (mg/L)
NO_3 (as N)	Short Term	550 (mg/L)	Long Term	13 (mg/L)
N-Total	-	-	-	-
TOC	-	-	-	-
Colour	-	-	-	-
Conductivity	-	-	-	-
pH	-	-	Long Term	6.5-9.0
Turbidity	-	-	-	-
Bicarbonate (as $CaCO_3$)	-	-	-	-
Carbonate (as $CaCO_3$)	-	-	-	-
Hardness (as $CaCO_3$)	-	-	-	-
TDS	-	-	-	-
Saturation pH (20°C)	-	-	-	-
Langelier Index (20°C)	-	-	-	-

Table 4: CCME Recommended Guidelines for the Protection of Aquatic Life (Freshwater) for RPC Surface Water Metal Parameters

CCME Recommended Guidelines for the Protection of Aquatic Life (Freshwater) for RPC Surface Water Metal Parameters				
Parameter	**Condition**	**Concentration**	**Condition**	**Concentration**
Al	pH < 6.5	5 (µg/L)	pH ≥ 6.5	100 (µg/L)
Sb	-	-	-	-
As	-	-	Upper Limit	5 (µg/L)
Ba	-	-	-	-
Be	-	-	-	-
Bi	-	-	-	-
B	Short Term	29,000 (µg/L)	Long Term	1,500 (µg/L)
Cd	Short Term HARD < 5.3 mg/L	0.11 (µg/L)	Long Term HARD < 17 mg/L	0.04 (µg/L)
	Short Term HARD ≥ 5.3 to ≤ 360 mg/L	Equation = 10^{1.016(log[hardness]) – 1.71}	Long Term HARD ≥ 17 to ≤ 280 mg/L	Equation = 10^{0.83(log[hardness]) – 2.46}
	Short Term HARD > 360 mg/L	7.7 (µg/L)	Long Term HARD > 280 mg/L	0.37 (µg/L)
Cr	-	-	-	-
Co	-	-	-	-
Cu	-	-	HARD < 82 mg/L	2 (µg/L)
	-	-	HARD ≥ 82 to ≤ 180 mg/L	Equation = 0.2 * e^{0.8545[ln(hardness)]-1.465}
	-	-	HARD > 180 mg/L	4 (µg/L)
Fe	-	-	Upper Limit	300 (µg/L)
Pb	-	-	HARD ≤ 60 mg/L	1 (µg/L)
	-	-	HARD > 60 to ≤ 180 mg/L	Equation = e^{1.273[ln(hardness)]-4.705}
	-	-	HARD >180 mg/L	7 (µg/L)
Li	-	-	-	-
Mn	-	-	-	-
Mo	-	-	Upper Limit	73 (µg/L)
Ni	-	-	HARD ≤ 60 mg/L	25 (µg/L)
	-	-	HARD > 60 to ≤ 180 mg/L	Equation = e^{0.76[ln(hardness)]+1.06}
	-	-	HARD > 180 mg/L	150 (µg/L)
Rb	-	-	-	-
Se	-	-	Upper Limit	1 (µg/L)
Ag	-	-	Upper Limit	0.25 (µg/L)
Sr	-	-	-	-
Te	-	-	-	-
Tl	-	-	Upper Limit	0.8 (µg/L)
Sn	-	-	-	-
U	Short Term	33 (µg/L)	Long Term	15 (µg/L)
V	-	-	-	-
Zn	-	-	Upper Limit	30 (µg/L)

In-Situ Water Quality Measurements

In-situ water quality measurements were collected using a Hanna Multiparameter Meter at the 12 sample sites, from June to September. Unlike 2018 and 2019, no measurements were collected in May and October due to COVID-19 restrictions and equipment malfunction with the Hanna Multiparameter Meter. In-situ water quality measurements are presented as monthly data to capture seasonal variation.

Temperature

Water temperature is dependent on a number of factors including geographic location, season, time of day, velocity, width and depth of the waterbody, riparian vegetative cover, and anthropogenic impacts. Temperature is also a very important water quality parameter as it impacts a number of other chemical, biological, and physical processes in the aquatic environment. For example, higher water temperature means less oxygen can be dissolved. According to Environment Canada recommended guidelines, water temperatures of streams should not exceed 20°C (Environment Canada, 2011). Long-term exposure to temperatures greater than 24°C is lethal to salmonid species. There is also a CCME guideline that states that human activity should not induce temperature changes of +/- 1°C from natural levels.

June had the highest surface water temperatures with an average of 19.8°C across all sites, and had six sites exceed 20°C. July had an average of 18.4°C with two sites exceeding 20°C. August and September had no sites exceeding 20°C, and average surface water temperatures were 17.4°C and 7.0°C, respectively. June likely had the highest surface water temperatures partly due to the air temperature at the time of sampling, and low precipitation for the month. The sampling day for June had the highest average daily temperature of 23.2°C, compared to July with 21.5°C, August with 15.4°C, and September with 7.1°C (Appendix 2, Figure 22). June was also a very dry month with a total rainfall of 24.7mm (Appendix 3, Figure 23). Overall, 2020 had the least amount of precipitation, measured monthly from April to September, over the last seven years (Appendix 3, Figure 24). Low precipitation can decrease water levels and velocity, making waterbodies more vulnerable to higher surface water temperatures.

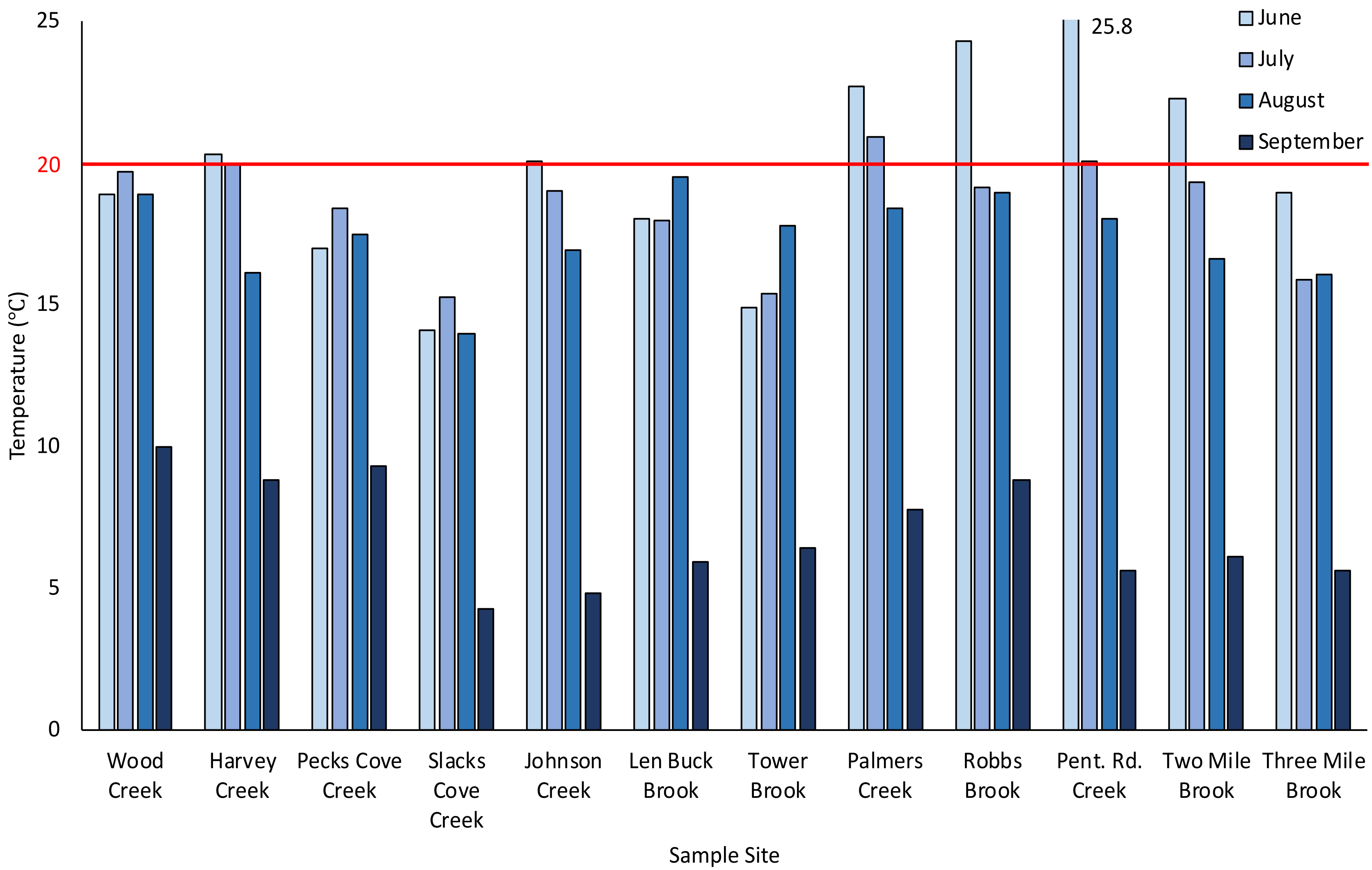
Palmers Creek and Penitentiary Road Creek were above 20°C in June and July (Figure 16). Penitentiary Road Creek also surpassed 24°C in June with 25.8°C (Figure 16). Palmers Creek is a 4th order stream that is downstream from Palmers Pond, where outflow is expected to have relatively warm temperatures. Penitentiary Road Creek had low water levels throughout the season and very low flow with limited shading due to agricultural land use which could lead to increased surface water temperatures.

Harvey Creek, Johnson Creek, Robbs Creek, and Two Mile Brook were all above 20°C for the month of June (Figure 16). Robbs Brook also surpassed 24°C in June with 24.3°C.

All streams have forestry, agricultural, and/or residential land-use that could increase surface water temperatures through reduced riparian cover. Additionally, Harvey Creek has a beaver dam upstream reducing water velocity. Johnson Creek is also a 3rd order stream that is downstream from Johnson Lake where outflow is expected to have relatively warm temperatures.

Wood Creek, Pecks Cove Creek, Slacks Cove Creek, Len Buck Brook, Tower Brook and Three Mile Brook all remained under 20°C for the sampling season (Figure 16).

Figure 16: Monthly Water Temperature Measured In-Situ Using Hanna Multiparameter Meter with 20°C Guideline

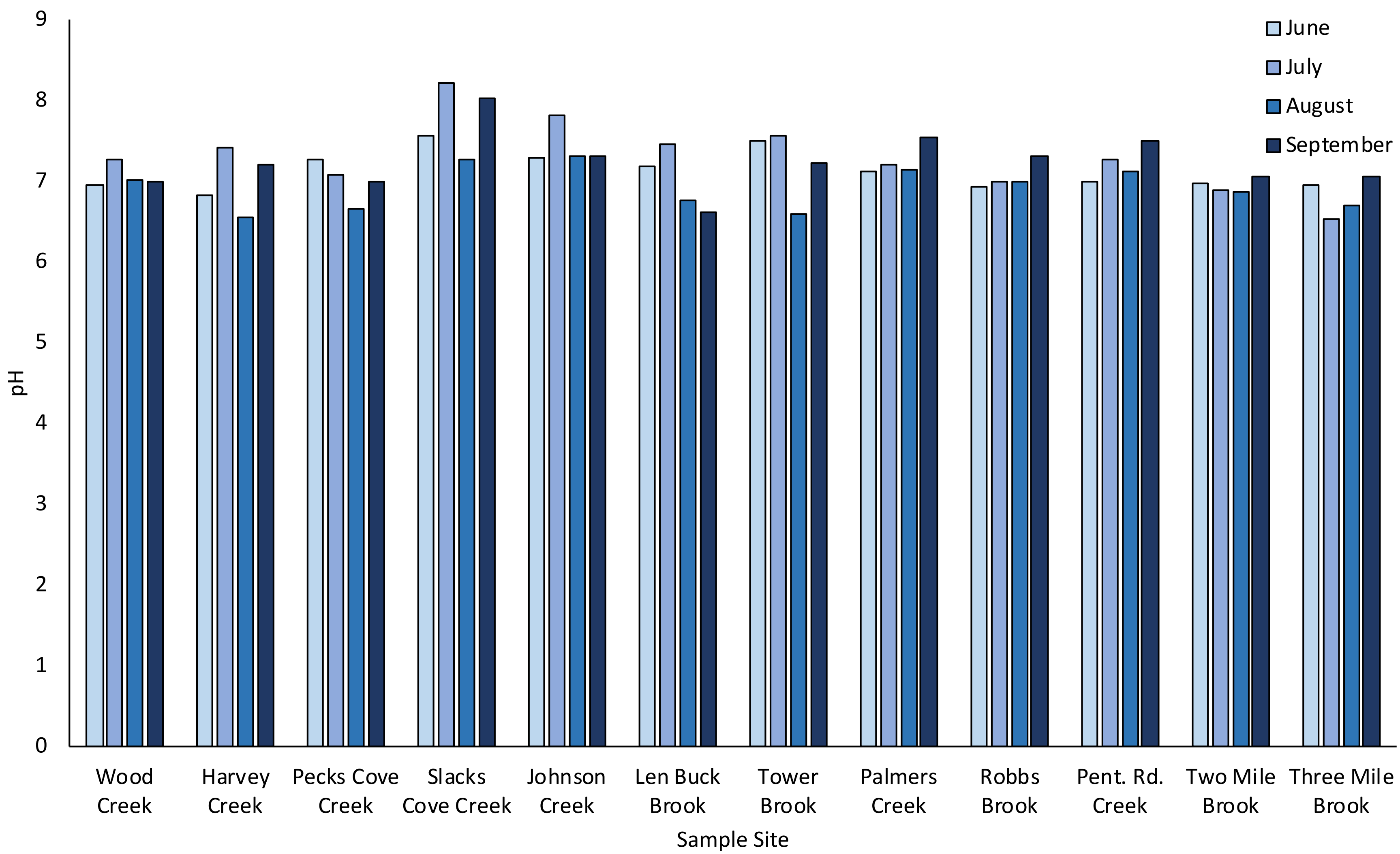


pH

pH is a measure of acidity or alkalinity of the water. It is a logarithmic measurement of free hydrogen ions in solution. The pH scale is from 0 to 14, with a pH of 7 being neutral, < 7 acidic, and > 7 basic. According to the CCME guidelines, the ideal pH for surface water to support aquatic life is between 6.5 and 9.0. According to Health Canada's Recreational Guidelines, the recommended pH is 5.0 to 9.0. pH of surface water can be influenced by a number of factors including surficial geology, acid rain, wastewater effluent, sewer overflows from septic tanks, and agricultural runoff.

In-situ pH measurements for all sites taken between June and September were within CCME guidelines of 6.5 and 9.0 (Figure 17). The lowest measurement was 6.54 from Three Mile Brook and the highest measurement was 8.22 from Slacks Cove Creek (Figure 17).

Figure 17: Monthly Water pH Measured In-Situ Using Hanna Multiparameter Meter



Dissolved Oxygen (DO)

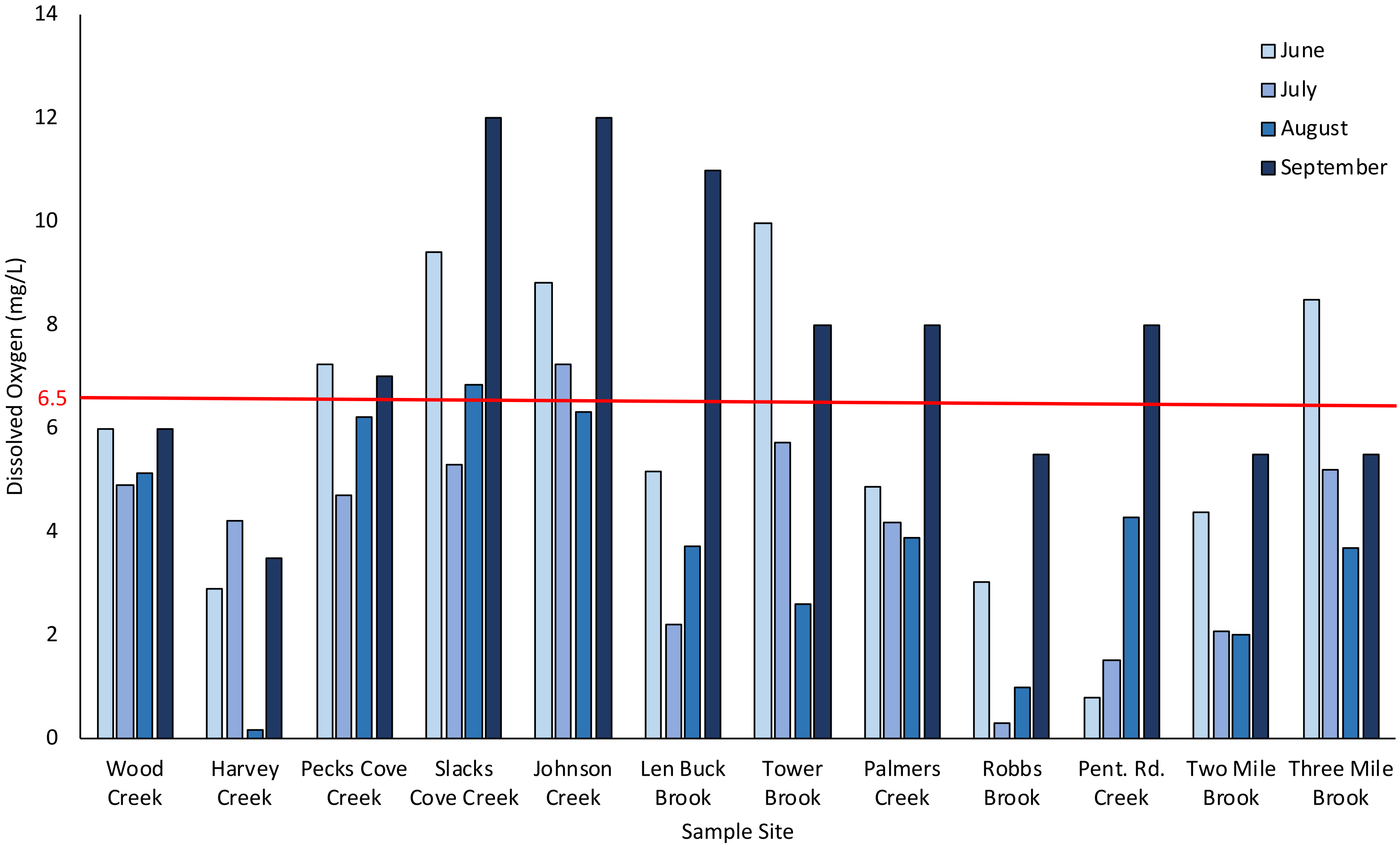
Dissolved oxygen (DO) is the amount of oxygen dissolved in the water that is available for aquatic life. The CCME recommended guideline for the protection of aquatic life for cold water biota is 6.5 mg/L for life stages other than the early stages of life. As the temperature of a waterbody increases, the amount of dissolved oxygen in the water decreases. This is evident in our results as the highest number of sites with DO concentrations below the water quality guidelines occurs in July and August, the two hottest months according to our temperature data (Appendix 2, Figure 22). All but one site for July (Johnson Creek) and one site for August (Slacks Cove Creek) were below the guideline (Figure 18). Seven sites were below the guideline in June and five sites were below the guideline in September.

Four sites had consistently low DO levels, below the CCME recommended guideline of 6.5 mg/L from June to September. Sites included Wood Creek with DO ranging from 4.89 to 6 mg/L, Harvey Creek from 0.15 to 4.22 mg/L, Robbs Brook from 0.3 to 5.5 mg/L, and Two Mile Brook from 2.01 to 5.5 mg/L (Figure 18). Four Sites were below the guideline for three out of four sample months. Three of these sites were below the guideline in June, July, and August. Sites included Len Buck Brook with DO from June to August ranging from 2.21 to 5.15 mg/L, Palmers Creek from 3.87 to 4.88 mg/L, and Penitentiary Road Creek from 0.79 to 4.82 mg/L (Figure 18). Three Mile Brook was below the guideline for July, August, and September with DO ranging from 3.68 to 5.5 mg/L (Figure 18). Lastly, two sites were below the guideline for one month. Slacks Cove creek was 5.3 mg/L in July, and Johnson Creek was 6.31 mg/L in August (Figure 18).

Concentrations of DO below 3 mg/L are considered hypoxic conditions, while water with DO < 0.5 mg/L is considered anoxic. Anoxic conditions can lead to an increase in release of phosphorus from sediments, resulting in algae blooms. Six sites were hypoxic and two sites were anoxic (Figure 18). Harvey Creek was hypoxic in June and anoxic in August. Penitentiary Road Creek was hypoxic in June and July. Len Buck Brook was hypoxic in July. Two Mile Brook was hypoxic in July and August. Tower Brook was hypoxic in August. Lastly, Robbs Brook was anoxic in July and hypoxic in August.

In general, it was a dry summer and sites experienced low water levels and, in some cases, stagnant water. Low DO concentrations can be due to slow moving or stagnant water, which may explain why most sites experienced low DO. Harvey Creek also experienced reduced water velocity due to a beaver dam and woody debris that likely contributed to water becoming stagnant in August.

Figure 18: Monthly Dissolved Oxygen Measured In-Situ Using Hanna Multiparameter Meter with 6.5 mg/L Cut Off



Specific Conductivity, Total Dissolved Solids & Salinity

Specific conductivity (µS/cm) is a measure of the ability of water to carry an electrical current. Conductivity is dependent on the quantity of dissolved inorganic solids (ions, e.g. sodium, chloride, nitrate, phosphate, etc.) and temperature. Conductivity in streams is typically based off of the surficial geology. Intertidal plains and salt marshes have clay, silt, some fine sand, minor peat and organic sediments; all of which can increase conductivity, total dissolved solids, and salinity in our watershed. Specific conductivity means that the conductivity is adjusted as if the sample had been taken at a reference temperature (usually 25^{o}C) so that conductivity can be compared across samples taken at different water temperatures. There is no water quality guideline for conductivity.

Total dissolved solids (TDS) is a measure of the quantity of dissolved solids within the water. TDS occurs naturally in water from sources such as algae, dead organic matter, and particulates from rock or soil. Since the dissolved solids are typically ions, TDS is directly related to conductivity. CCME does not have recommended guideline for the protection of aquatic life for TDS. However, high levels of TDS can impact turbidity, clarity and colour of water, which when increased can lead to low DO levels (sometimes even anoxic conditions) due to the turbidity preventing sunlight from reaching aquatic plants.

Salinity is the concentration of dissolved salt ions (e.g. salt, NaCl, dissolved into a sodium ion (Na^+) and chloride ion (Cl^-)). As it is related to conductivity and TDS, there are no water quality guidelines to compare our results too and the potential sources of salinity are the same as TDS and conductivity.

In-situ water quality measurements for specific conductivity, TDS, and salinity were not reliably captured due to equipment malfunctions with the Hanna Multiparameter Meter. However, RPC surface water chemistry results below (Tables 7 to 30), list specific conductivity, TDS, sodium (Na), and chloride (Cl) concentrations. Findings from the RPC results indicated three tidally influenced sites consisting of Wood Creek, Pecks Cove Creek, and Len Buck Brook, which had brackish water when they were sampled, despite samples being taken at low tide. These sites displayed high levels of specific conductivity, TDS, sodium (Na), and chloride (Cl) concentrations (Table 7, 11, 17). Alternatively, saltwater intrusion due to sea level rise could be occurring resulting in groundwater fed streams to be fed with brackish water. Further investigation is required. Johnson Creek and Tower Brook are also tidally influenced sites that had elevated specific conductivity, TDS, sodium (Na) and chloride (Cl) in September, with concentrations increasing from June to September (Table 15, 19).

RPC Surface Water Chemistry Results

In addition to our in-situ measurements, water quality grab samples were taken to be analyzed at RPC Moncton. This section of the results provides a by site description of the surface water quality results from RPC. We have chosen to also highlight *E. Coli* and Total Phosphorous as they are particularly a concern in our watershed. We also analyzed our water samples from June – August for Chlorophyll-*a* for the first time at Mount Allison University.

E. Coli

Escherichia coli (E. coli) is the most appropriate indicator of faecal contamination in fresh recreational waters. The presence of these fecal indicators could mean there are other disease-causing pathogens present, such as bacteria, viruses, and parasites. Although many strains of coliform bacteria are harmless, certain strains (e.g. *E. coli* 0157:H7) may cause illness. The results were then compared to the Guidelines for Canadian Recreational Water Quality. Water is safe for swimming when bacteria levels are below the guidelines, which Health Canada based off of risk management decisions which evaluated the potential health risks and the benefits of recreational water use for physical activity and enjoyment. For the case of our sampling, a single-sample was taken at each location from June to September, so we compared samples to the single-sample maximum guidelines of less than or equal to 400 E. coli/100mL (Table 5). Every time you take a water sample it is just a snapshot of the water quality at that location at that point in time. This is why an average of multiple samples taken from different locations along a beach is typically used for evaluating water quality. This is also why long-term monitoring is valuable as you can look at the natural variations in water quality and see the trends over time to get an idea of what is expected.

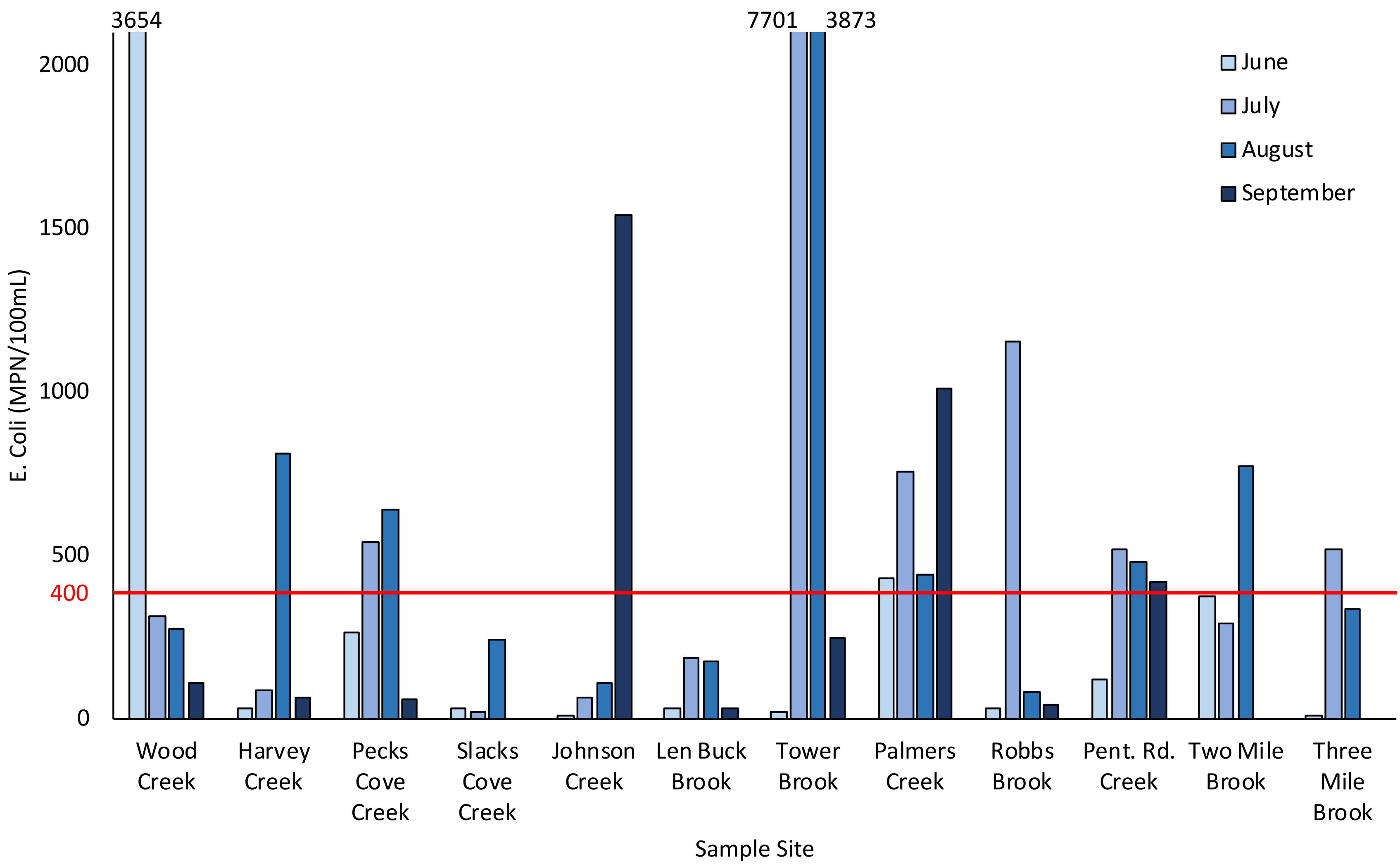
Table 5: Canadian Recreational Water Quality Guidelines

Enterococci	***E. coli***
A geometric mean of most recent five samples equal to or less than 35 enterococci/100 ml	A geometric mean of most recent five samples equal to or less than 200 E. coli/100 ml
A single-sample maximum equal to or less than 70 enterococci/100 ml	A single-sample maximum equal to or less than 400 E. coli/100 ml

The single sample maximum guideline of 400 E. coli/100 ml was exceeded at 10 out of 12 sites. July and August had six sites exceed the guideline, June had two sites, and September had three sites (Figure 19). July and August were the two hottest months of the sample season and water levels were noted to be quite low which could have led to higher concentrations (Appendix 2, Figure 22). Eight out of the 10 sites also have agricultural land use in the watershed that could be a contributing factor to higher concentrations.

One site, Palmers Creek, was consistently above the guideline from June to September (Figure 19). The highest measurement for Palmers Creek was from September with 1012 E. coli/100 ml. One site was above the guideline for three out of four sample months (Figure 19). Penitentiary Road Creek was above the guideline from July to September, and the highest measurement was from July with 521 E. coli/100 ml. Two sites were above the guideline for two out of four sample months (Figure 19). Pecks Cove Creek and Tower Brook were above the guideline in July and August. The highest measurement was taken in August for Pecks Cove Creek with 643 E. coli/100 ml, and July for Tower Brook with 7701 E. coli/100 ml. Six sites were above the guideline for one out of four sample months, consisting of Wood Creek, Harvey Creek, Johnson Creek, Robbs Brook, Two Mile Brook, and Three Mile Brook (Figure 19). The guideline was exceeded in June for Wood Creek with 3654 E. coli/100 ml, in July for Robbs Brook with 1153 E. coli/100 ml and Three Mile Brook with 521 E. coli/100 ml, in August for Harvey Creek with 813 E. coli/100 ml and Two Mile Brook with 771 E. coli/100 ml, and September for Johnson Creek with 1539 E. coli/100 ml. Lastly, Slacks Cove Creek and Len Buck Brook were the only two sites that did not have any of the four samples exceed concentrations (Figure 19).

Figure 19: Monthly E. Coli with 400 MPN/100mL Guideline



Total Phosphorus (TP)

Phosphorus is a component of many important nutrient compounds used by plants, such as phosphates. Phosphorus is also the limiting nutrient for algal growth which can lead to eutrophication. Total phosphorus can range to ultra-oligotrophic (very low, < 4 μg/L TP) to hyper-eutrophic (very high, > 100 μg/L TP) (Table 11). Total phosphorus measures both organic and inorganic phosphates in the surface water. Phosphorus can be present naturally due to geological formations or decomposing organic matter. It is usually adsorbed by sediments. Phosphorus can also enter waterways from fertilizer runoff, manure storage, wastewater treatment effluent, and leaching septic systems.

Table 6: Total phosphorus trigger ranges for Canadian lakes and rivers (Source: CCME)

Trophic Status	Canadian Trigger Ranges Total phosphorus ($\mu g \cdot L^{-1}$)
Ultra-oligotrophic	< 4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hyper-eutrophic	> 100

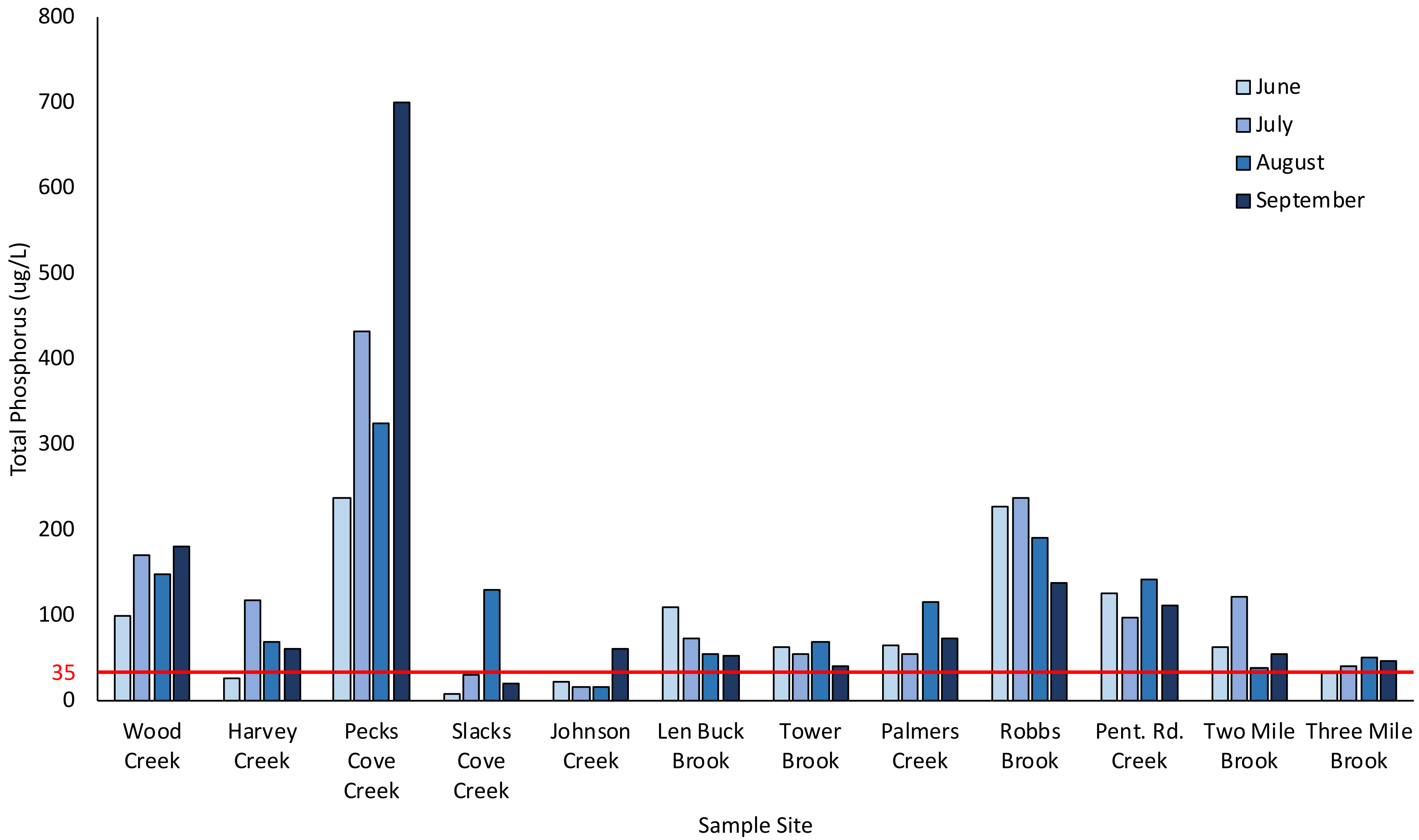
Samples ranged from oligotrophic (4-10 μg/L) to hyper-eutrophic (> 100 μg/L) status from June to September, according to the CCME Canadian Trigger Ranges for Total Phosphorous (Table 6). However, most sample sites were eutrophic (35 – 100 μg/L) to hyper-eutrophic status, with TP concentrations exceeding 35 μg/L (Figure 20). August and September had 11 sites exceed 35 μg/L, July had 10 sites, and June had nine sites.

Eight of 12 sites were consistently above 35 μg/L, consisting of Wood Creek, Pecks Cove Creek, Len Buck Brook, Tower Brook, Palmers Creek, Robbs Brook, Penitentiary Road Creek, and Two Mile Brook (Figure 20). Three of these sites were consistently hyper-eutrophic status consisting of Wood Creek, Pecks Cove Creek, and Penitentiary Road Creek (Figure 20). The highest concentrations of TP for Wood Creek and Pecks Cove Creek were in September with 180 μg/L and 700 μg/L, respectively. The highest concentration for Robbs Brook was in July with 237 μg/L. Five sites were consistently eutrophic (35 μg/L – 100 μg/L) to hyper-eutrophic status consisting of Len Buck Brook, Tower Brook, Palmers Creek, Penitentiary Road Creek, and Two Mile Brook (Figure 20). The highest concentrations for Len Buck Brook and Two Mile Brook were in July with 109 μg/L and 122 μg/L, respectively. The highest concentrations were measured in August for Tower Brook with 68 μg/L, Palmers Creek with 115 μg/L, and Penitentiary Road Creek with 142 μg/L.

Two sites were above 35 μg/L for three out of four sample months (Figure 20). Harvey Creek and Three Mile Brook were above 35 μg/L from July to September. Harvey Creek was meso-eutrophic to hyper-eutrophic status, and the highest concentration was measured in July with 117 μg/L. Three Mile Brook, was meso-eutrophic (20 μg/L – 35 μg/L) to eutrophic status, and the highest concentration was measured in August with 50 μg/L (Figure 20)

Two sites were above 35 μg/L for one out of four sample months (Figure 20). Slacks Cove Creek was above 35 μg/L in August with 129 μg/L and was oligotrophic to hyper-eutrophic. Johnson Creek was above 35 μg/L in September with 60 μg/L and was mesotrophic (10 μg/L – 20 μg/L) to eutrophic status.

Figure 20: Monthly Total Phosphorous with 35µg/L Cut Off

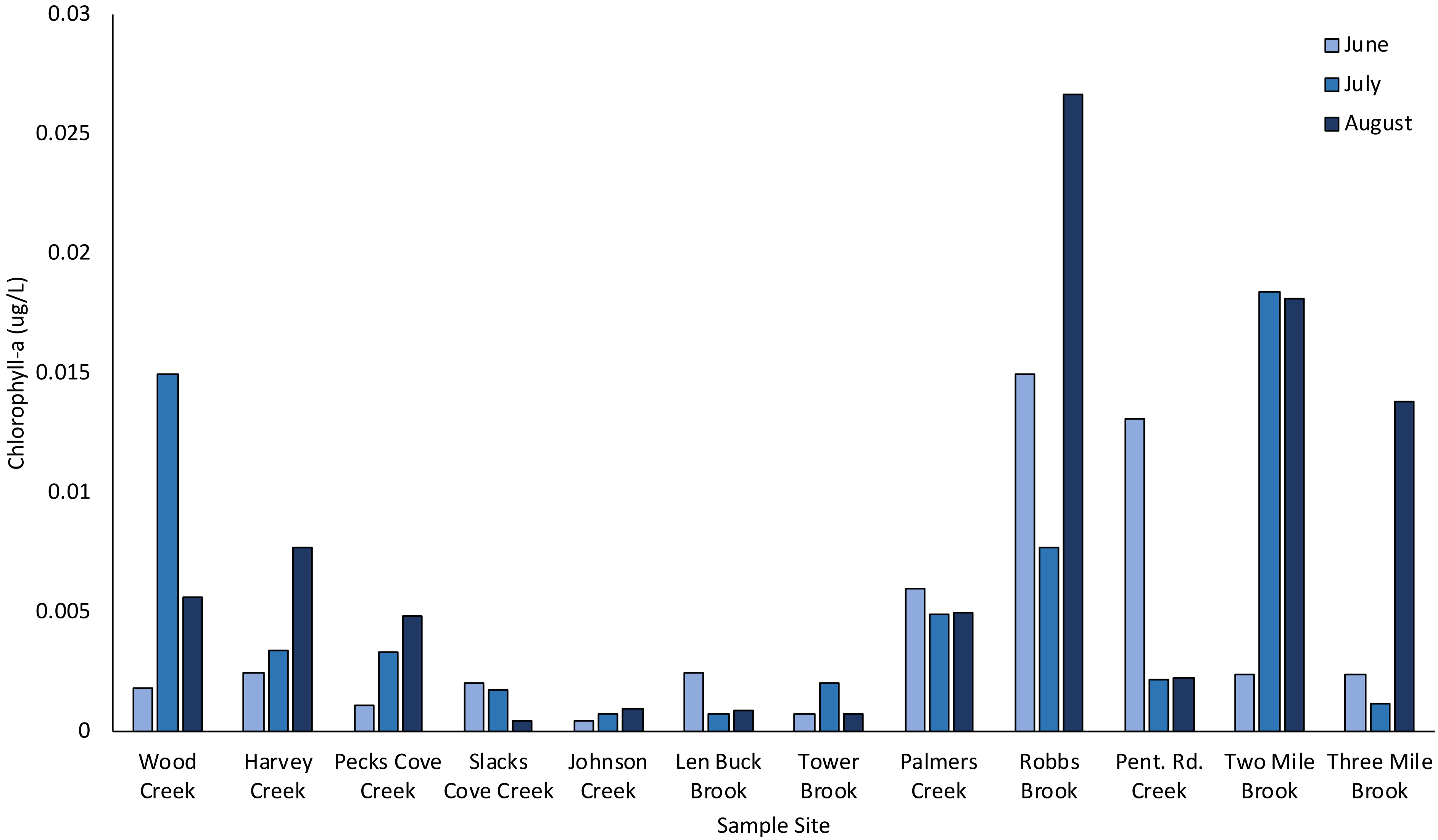


Chlorophyll-*a*

Chlorophyll-*a* (chl-*a*) is a green pigment found in plants and algae that is needed for photosynthesis, and can be used as a measure of algal biomass. Algae is a critical component in the food web, and provides habitat for aquatic insects and fish. But too much algae can lead to declining dissolved oxygen and in some cases harmful algal blooms. Algae biomass can increase under excess nutrients consisting of phosphorus and nitrogen. Additional factors that can affect algae biomass and the likelihood of an algal bloom include surface water temperatures, water levels and velocity, and food web alterations through over fishing and invasive species. Monitoring chl-*a* is important for understanding algae levels and potential impacts in the watershed. There are no water quality guidelines for chl-*a*.

Chl-*a* measurements were taken in June, July and August. Chl-*a* measurements were highest in June for four sites including Slacks Cove Creek with 0.002 μg/L, Len Buck Brook with 0.0024 μg/L, Palmers Creek with 0.006 μg/L, and Penitentiary Road Creek with 0.013 μg/L (Figure 21). Measurements were highest in July for three sites including Wood Creek with 0.015 μg/L, Tower Brook with 0.002 μg/L, and Two Mile Brook with 0.018 μg/L (Figure 21). Measurements were highest in August for five sites including Harvey Creek with 0.008 μg/L, Pecks Cove Creek with 0.005 μg/L, Johnson Creek with 0.001 μg/L, Robbs Brook with 0.027 μg/L, and Three Mile Brook with 0.014 μg/L (Figure 21).

Figure 21: Monthly Chlorophyll-a (μg/L)



Surface Water Quality by Sample Site

Wood Creek

Wood Creek chloride (Cl) concentrations exceeded the CCME freshwater guidelines for protection of aquatic life (short-term = 640 mg/L and long-term = 120 mg/L) across all months ranging from 4560 mg/L to 17000 mg/L (Table 7).

Table 7: Wood Creek Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	2670	104	142	346	83	4560	0.88	730	17	0.12	0.002	< 0.05	< 0.05
2020-07-27	7710	291	325	930	100	13000	1.53	1830	46	0.06	0.001	< 0.05	< 0.05
2020-08-26	10100	380	388	1230	110	17000	1.65	2500	65	< 0.05	< 0.001	< 0.05	< 0.05
2020-09-21	9780	352	299	1210	110	15600	1.63	2640	61.1	0.13	0.002	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	< 1	7	11	22700	7.6	20.5	82.7	0.309	1780	8610	7.6	-0.05
2020-07-27	< 0.05	0.5	3.4	6	44600	7.7	33.3	99.5	0.469	4640	24200	7	0.67
2020-08-26	< 0.05	< 0.2	2	< 5	58900	7.7	7.6	109	0.516	6030	31700	6.8	0.93
2020-09-21	< 0.05	0.5	2.5	< 5	53600	7.6	46.1	110	0.41	5730	30000	6.9	0.69

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) across all months ranging from 420 µg/L to 710 µg/L (Table 8). Boron (B) exceeded the CCME long-term guideline of 1500 µg/L in July with 3300 µg/L, August with 4300 µg/L, and September with 4340 µg/L (Table 8). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) in June and September with 1600 µg/L and 2000 µg/L, respectively (Table 8). The remaining highlighted results in table 8 (arsenic (As), cadmium (Cd), copper (Cu), iron (Fe), lead (Pb), selenium (Se), silver (Ag), thallium (Tl), and zinc (Zn)) require further sampling. The samples were diluted prior to analysis due to their high ionic content, leading to results that were below the reporting limit and not quantified. The CCME guideline for As is an upper limit of 5 µg/L, Cd is 0.37 µg/L with a hardness of > 280 mg/L, Cu is 4 µg/L with a hardness > 180 mg/L, Pb is 7 µg/L with a hardness of > 180 mg/L, Se upper limit is 1 µg/L, Ag upper limit is 0.25 µg/L, Tl upper limit is 0.8 µg/L, and Zn upper limit is 30 µg/L.

Table 8: Wood Creek Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	420	< 2	< 20	140	< 2	< 20	1180	0.3	< 20	< 2	< 20	1600	< 2	45
2020-07-27	500	< 10	< 100	< 100	< 10	< 100	3300	< 1	< 100	< 10	<100	< 2000	< 10	130
2020-08-26	500	< 10	< 100	< 100	< 10	< 100	4300	< 1	< 100	< 10	<100	< 2000	< 10	170
2020-09-21	710	< 5	< 50	60	< 5	< 50	4340	< 0.5	< 50	< 5	< 50	2000	< 5	164

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	920	4	< 20	33	< 20	< 2	2090	< 2	< 2	< 2	< 2	< 20	< 20
2020-07-27	300	< 10	< 100	90	< 100	< 10	5700	< 10	< 10	< 10	< 10	< 1	< 1
2020-08-26	100	10	< 101	120	< 100	< 10	7700	< 10	< 10	< 10	< 10	< 1	< 1
2020-09-21	450	11	< 50	110	< 50	< 5	7490	< 5	< 5	< 5	< 5	<50	< 50

Harvey Creek

Harvey Creek ammonia (un-ionized at 20ºC) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (upper limit = 0.019 mg/L) in August with 0.65 mg/L (Table 9).

Table 9: Harvey Creek Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	11.6	1.12	10.6	1.72	38	21.2	0.22	< 1	0.1	0.07	< 0.001	< 0.05	< 0.05
2020-07-27	15.5	1.48	14.5	2.2	55	29.6	0.13	< 1	0.14	0.11	0.001	< 0.05	< 0.05
2020-08-26	26.9	2.37	21.1	3	63	59.5	0.09	0.09	< 1	0.34	0.65	0.006	< 0.05
2020-09-21	22.3	1.7	15	2.22	42	46.6	0.11	4	0.22	0.31	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	0.05	10.4	60	142	7.1	5.5	37.9	0.045	33.6	86	8.7	-1.62
2020-07-27	< 0.05	0.6	10.6	78	194	7.4	6.9	54.9	0.13	45.3	115	8.4	-1.04
2020-08-26	< 0.05	0.9	12.7	100	304	7.4	24.1	62.8	0.148	65	184	8.2	-0.84
2020-09-21	< 0.05	0.8	8.5	75	237	6.8	16.7	42	0.025	46.6	136	8.6	-1.75

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) in August with 149 µg/L and September with 106 µg/L (Table 10). Iron (Fe) concentrations exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 2290 to 13200 µg/L (Table 10). One lead (Pb) measurement also exceeded the CCME guideline (hardness ≤ 60 mg/L = 1 µg/L) in July with 4 µg/L (Table 10).

Table 10: Harvey Creek Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	88	< 0.1	< 1	163	< 0.1	< 1	9	0.02	< 1	1.7	< 1	2290	0.5	1.3
2020-07-27	47	< 0.1	1	182	< 0.1	< 1	10	0.01	< 1	1.5	< 1	2940	4	1.6
2020-08-26	149	< 0.1	3	305	< 0.1	< 1	12	0.04	< 1	3.6	< 1	13200	0.9	2.5
2020-09-21	106	< 0.1	1	171	< 0.1	< 1	14	0.02	< 1	1.6	< 1	5440	0.6	1.6

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	3120	0.4	< 1	3.2	< 1	< 0.1	145	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2020-07-27	4270	3	< 1	4.3	< 1	< 0.1	208	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1
2020-08-26	5790	0.1	1	6.7	< 1	< 0.1	456	< 0.1	< 0.1	< 0.1	< 0.1	1	5
2020-09-21	2220	0.1	< 1	4.1	< 1	< 0.1	271	< 0.1	< 0.1	1	< 0.1	< 1	3

Pecks Cove Creek

Pecks Cove Creek chloride (Cl) concentrations exceeded the CCME freshwater guidelines for protection of aquatic life (short-term = 640 mg/L and long-term = 120 mg/L) across all months ranging from 11000 mg/L to 16200 mg/L (Table 11). The ammonia (un-ionized at 20ºC) concentration in August also exceeded the CCME guideline (upper limit = 0.019 mg/L) with 0.11 mg/L (Table 11).

Table 11: Pecks Cove Creek Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	6450	259	223	780	128	11000	1.42	1680	41.5	0.07	< 0.001	< 0.05	< 0.05
2020-07-27	7330	282	317	891	140	12600	1.51	1890	44	0.11	0.002	< 0.05	< 0.05
2020-08-26	7060	274	299	867	120	13000	1.35	1.35	1750	47	0.11	0.001	< 0.05
2020-09-21	9800	355	434	1260	130	16200	1.54	2600	63.8	0.07	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	0.6	4.2	19	50000	7.4	40	128	0.302	3770	20500	7.1	0.25
2020-07-27	< 0.05	0.6	4.2	8	39000	7.6	102	139	0.522	4460	23400	6.9	0.69
2020-08-26	< 0.05	0.4	4.4	10	42700	7.4	61.3	120	0.283	4320	23300	7	0.39
2020-09-21	< 0.05	0.5	3.4	< 5	53800	7.4	41.4	130	0.306	6270	30700	6.7	0.74

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) across all months ranging from 620 µg/L to 800 µg/L (Table 12). Boron (B) exceeded the CCME long-term guideline of 1500 µg/L across all month ranging from 2950 to 4240 µg/L (Table 12). Iron concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 2000 to 4000 µg/L (Table 12). The remaining highlighted results in table 12 (arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), selenium (Se), silver (Ag), thallium (Tl), and zinc (Zn)) require further sampling. The samples were diluted prior to analysis due to their high ionic content, leading to results that were below the reporting limit and not quantified.

Table 12: Pecks Cove Creek Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	670	< 5	< 50	70	< 5	< 50	2950	< 0.5	< 50	< 5	< 50	2000	< 5	110
2020-07-27	800	< 10	< 100	< 100	< 1	< 100	3400	< 1	< 100	< 10	< 100	3000	< 10	130
2020-08-26	800	< 10	< 100	< 100	< 1	< 100	3200	< 1	< 100	< 10	< 100	4000	< 11	130
2020-09-21	620	< 5	< 50	90	< 5	< 50	4240	< 0.5	< 50	< 5	< 50	2000	< 5	163

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	1000	6	< 50	79	< 50	< 5	5000	< 5	< 5	< 5	< 5	< 50	< 50
2020-07-27	1000	< 10	< 100	90	< 100	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 100
2020-08-26	1200	< 10	< 100	90	< 100	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 100
2020-09-21	940	7	< 50	112	< 50	< 5	8030	< 5	< 5	< 5	< 5	< 50	< 50

Slacks Cove Creek

Slacks Cove Creek had no measurements above guidelines (Table 13, 14).

Table 13: Slacks Cove Creek Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	9.56	0.69	13.8	2.34	45	14	0.2	2	0.06	< 0.05	< 0.001	0.24	< 0.05
2020-07-27	11.2	0.94	18.6	2.84	64	14.6	0.12	< 1	0.07	0.06	0.002	0.15	< 0.05
2020-08-26	12.1	1.16	18.7	2.99	65	14.5	0.1	6	0.08	< 0.05	< 0.001	0.24	< 0.05
2020-09-21	12.4	0.96	24.4	3.19	81	14.1	0.12	5	0.06	0.05	0.002	0.13	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	0.24	0.3	0.5	19	148	7.8	1.3	44.7	0.265	44.1	76	8.5	-0.74
2020-07-27	0.15	0.4	5.3	19	173	8	1.2	63.4	0.596	58.1	94	8.3	-0.27
2020-08-26	0.24	0.3	5.9	25	187	7.8	2.1	64.6	0.383	59	103	8.3	-0.46
2020-09-21	0.13	0.3	2.7	6	209	7.9	0.2	80.4	0.6	74.1	113	8.1	-0.16

Table 14: Slacks Cove Creek Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	27	< 0.1	< 1	39	< 0.1	< 1	11	< 0.01	< 1	< 0.1	< 1	190	< 0.1	1.4
2020-07-27	14	< 0.1	< 1	39	< 0.1	< 1	13	< 0.01	< 1	< 0.1	< 1	150	< 0.1	1.7
2020-08-26	29	< 0.1	< 1	43	< 0.1	< 1	16	0.02	< 1	< 0.1	< 1	300	< 0.1	1.6
2020-09-21	5	< 0.1	< 1	36	< 0.1	< 1	13	< 0.01	< 1	< 0.1	< 1	60	< 0.1	2.1

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	125	< 0.1	< 1	1.3	< 1	< 0.1	42	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 1
2020-07-27	115	< 0.5	< 1	1.9	< 1	< 0.1	540	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 1
2020-08-26	310	0.2	< 1	2.3	< 1	< 0.1	62	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 1
2020-09-21	62	0.1	< 1	1.4	< 1	< 0.1	64	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1

Johnson Creek

Johnson Creek chloride (Cl) concentrations exceeded the CCME freshwater guidelines for protection of aquatic life, exceeding short-term (640 mg/L) and long-term (120 mg/L) guidelines in September with 2120 mg/L, and the long-term (120 mg/L) guideline in August with 344 mg/L (Table 15).

Table 15: Johnson Creek Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	51.1	1.71	18.6	3.64	25	82.8	0.24	33	0.17	< 0.05	< 0.001	0.1	< 0.05
2020-07-27	38.8	1.11	22.3	2.27	32	66.4	0.15	36	0.09	< 0.05	< 0.001	< 0.05	< 0.05
2020-08-26	202	5.18	55.3	12.1	31	344	0.16	113	0.6	< 0.05	< 0.001	0.06	< 0.05
2020-09-21	1180	37.3	88.7	147	36	2120	0.42	310	7.2	< 0.05	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	0.1	0.4	7.5	39	39	7.5	2.7	24.9	0.074	61.4	215	8.7	-1.22
2020-07-27	< 0.05	0.3	7.2	37	350	7.4	2.6	31.9	0.075	65	195	8.5	-1.13
2020-08-26	0.06	< 0.2	5.9	19	1430	7.6	3.7	30.9	0.116	188	757	8.3	-0.66
2020-09-21	< 0.05	0.3	4.5	9	7320	7.2	14.6	35.9	0.053	827	3910	8.2	-0.97

One aluminum (Al) measurement exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) in September with 220 µg/L (Table 16). Iron concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) in June with 310 µg/L, July with 360 µg/L, and September with 500 µg/L (Table 16). One selenium (Se) measurement highlighted in August requires further sampling as the samples were diluted prior to analysis due to their high ionic content, leading to results that were below the reporting limit and not quantified (Table 16).

Table 16: Johnson Creek Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	93	< 0.1	< 1	106	< 0.1	< 1	20	0.01	< 1	0.2	< 1	310	0.3	1.6
2020-07-27	37	< 0.1	< 1	73	< 0.1	< 1	15	0.02	< 1	< 0.1	< 1	360	0.1	1.3
2020-08-26	59	< 0.2	< 2	151	< 0.2	< 2	54	< 0.02	< 2	< 0.2	< 2	220	< 0.2	2.7
2020-09-21	220	< 0.1	< 1	140	< 0.1	< 1	490	0.2	< 1	< 0.1	< 1	500	< 0.1	16

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	209	0.2	< 1	2.1	< 1	< 0.1	144	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1
2020-07-27	473	0.1	< 1	1.6	< 1	< 0.1	169	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 1
2020-08-26	197	0.2	< 2	4.2	< 2	< 0.2	420	< 0.2	< 0.2	< 0.2	< 0.2	< 2	< 2
2020-09-21	410	< 0.1	< 1	14	< 1	< 0.1	1100	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1

Len Buck Brook

Len Buck Brook chloride (Cl) concentrations exceeded the CCME freshwater guidelines for protection of aquatic life, exceeding short-term (640 mg/L) and long-term (120 mg/L) guidelines in June with 1340 mg/L, August with 775 mg/L and September with 11300 mg/L, and long-term (120 mg/L) guideline in July with 609 mg/L (Table 17).

Table 17: Len Buck Brook Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	777	29.6	43.7	95.5	46	1340	0.42	210	4.8	< 0.05	< 0.001	< 0.05	< 0.05
2020-07-27	332	13.7	26.8	41.6	47	609	0.19	91	1.98	< 0.05	< 0.001	0.06	< 0.05
2020-08-26	393	16.6	30.8	51.5	47	775	0.2	123	2.46	< 0.05	< 0.001	< 0.05	< 0.05
2020-09-21	6580	235	299	827	86	11300	1.26	1440	41.4	< 0.05	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	< 0.4	2	8	4840	7.6	26.2	45.8	0.171	502	2530	8.3	-0.72
2020-07-27	0.06	0.2	2.6	13	2150	7.5	14.3	46.8	0.139	238	1150	8.4	-0.93
2020-08-26	< 0.05	< 0.2	3.2	21	2660	7.5	3.8	46.8	0.139	289	1420	8.4	-0.89
2020-09-21	< 0.05	0.3	2.9	20	35500	7.2	11.7	85.9	0.128	4150	20700	7.2	0.01

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) across all months ranging from 173 µg/L to 280 µg/L (Table 18). Boron (B) exceeded the CCME long-term guideline of 1500 µg/L in September with 2960 µg/L (Table 18). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 600 to 1000 µg/L (Table 18). The remaining highlighted results in table 18 (arsenic (As), copper (Cu), selenium (Se), silver (Ag), thallium (Tl), and zinc (Zn)) require further sampling. The samples were diluted prior to analysis due to their high ionic content, leading to results that were below the reporting limit and not quantified.

Table 18: Len Buck Brook Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	280	< 1	< 10	100	< 10	< 1	340	< 0.1	< 10	< 1	< 10	700	< 1	13
2020-07-27	173	< 0.5	< 5	97	< 0.5	< 5	158	< 0.05	< 5	< 0.5	< 5	600	0.5	6.3
2020-08-26	207	< 0.5	< 5	97	< 0.5	< 5	182	< 0.05	< 5	1.3	< 5	900	< 0.5	6.5
2020-09-21	240	< 5	< 50	130	< 50	< 5	2960	< 0.5	< 50	< 5	< 50	1000	< 5	104

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	540	< 1	< 10	10	< 10	< 1	660	< 1	< 1	< 1	< 1	< 10	< 10
2020-07-27	343	0.9	< 5	5.4	< 5	< 0.5	347	< 0.5	< 0.5	< 0.5	< 0.5	< 5	< 5
2020-08-26	689	< 0.5	< 5	6.6	< 5	< 0.5	441	< 0.5	< 0.5	< 0.5	< 0.5	< 6	7
2020-09-21	1590	6	< 50	75	< 50	< 5	5230	< 5	< 5	< 5	< 5	< 50	< 50

Tower Brook

Tower Brook chloride (Cl) concentrations exceeded the CCME freshwater guideline for protection of aquatic life, exceeding the short-term (640 mg/L) and long-term (120 mg/L) guidelines in September with 4510 mg/L, and short-term (120 mg/L) guideline in July with 160 mg/L, and August with 363 mg/L (Table 19).

Table 19: Tower Brook Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	44.1	2.37	11	6.06	34	78.4	0.08	14	0.27	< 0.05	< 0.001	0.2	< 0.05
2020-07-27	85.7	3.97	13.6	11.3	39	160	0.09	25	0.52	< 0.05	< 0.001	0.13	< 0.05
2020-08-26	204	7.96	20.9	27.6	39	363	0.13	60	1.29	< 0.05	< 0.001	0.23	< 0.05
2020-09-21	2680	95.8	132	338	60	4510	0.77	660	16.6	< 0.05	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	0.2	0.3	2.1	13	382	7.5	18.2	33.9	0.101	52.4	180	8.8	-1.3
2020-07-27	0.13	0.3	3.5	24	652	7.4	6.9	38.9	0.092	80.5	328	8.7	-1.29
2020-08-26	0.23	< 0.2	3.1	21	1400	7.2	7.3	38.9	0.058	166	713	8.6	-1.37
2020-09-21	< 0.05	0.3	3	16	16200	7	5.8	59.9	0.056	1720	8460	7.8	-0.82

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) across all months ranging from 134 µg/L to 230 µg/L (Table 20). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 440 to 1000 µg/L (Table 20). The remaining highlighted results in table 20 require further sampling (arsenic (As), copper (Cu), selenium (Se), silver (Ag), and thallium (Tl)). The samples were diluted prior to analysis due to their high ionic content, leading to results that were below the reporting limit and not quantified.

Table 20: Tower Brook Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	137	< 0.1	< 1	104	< 0.1	< 1	29	0.04	< 1	0.2	< 1	440	0.6	2.3
2020-07-27	134	< 0.1	< 1	117	< 0.1	< 1	48	0.06	< 1	0.2	< 1	540	0.6	3
2020-08-26	161	< 0.2	< 2	121	< 0.2	< 2	99	0.06	< 2	0.7	< 2	880	0.6	5.5
2020-09-21	230	< 2	< 20	140	< 2	< 20	1180	0.2	< 20	< 2	< 20	1000	< 2	46

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	181	0.2	< 1	1.7	< 1	< 0.1	101	< 0.1	< 0.1	< 0.1	0.3	1	12
2020-07-27	314	0.2	< 1	2.5	< 1	< 0.1	138	< 0.1	< 0.1	< 0.1	0.3	1	15
2020-08-26	462	0.3	< 2	4.2	< 2	< 0.2	262	< 0.2	< 0.2	< 0.2	0.3	< 2	14
2020-09-21	1300	< 2	< 20	30	< 20	< 2	2240	< 2	< 2	< 2	< 2	< 20	30

Palmers Creek

Palmers Creek had no measurements above guidelines with the exception of two metals (Table 21, 22).

Table 21: Palmers Creek Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	10.9	0.83	5.28	1.61	21	19.6	0.19	< 1	0.05	0.08	< 0.001	0.08	< 0.001
2020-07-27	14.5	0.9	6.9	1.98	23	25.2	0.07	4	0.05	< 0.05	< 0.001	< 0.05	<0.05
2020-08-26	19	1.29	8.41	2.58	29	35.6	0.1	3	0.07	< 0.05	< 0.001	< 0.05	<0.05
2020-09-21	20.9	1.17	8.99	2.61	29	40	0.11	4	0.07	< 0.05	< 0.001	< 0.05	<0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	0.08	0.5	5.1	25	115	7.2	8.2	21	0.031	19.8	59	9.3	-2.07
2020-07-27	< 0.05	0.4	5.4	24	133	7.3	7.7	22.9	0.043	25.4	74	9.1	-1.82
2020-08-26	< 0.05	< 0.2	4.1	14	179	7.3	9.1	28.9	0.054	31.6	93	8.9	-1.65
2020-09-21	< 0.05	0.2	3.6	13	185	7.2	15.9	28.9	0.043	33.2	101	8.9	-1.72

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) across all months ranging from 135 µg/L to 174 µg/L (Table 22). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 480 to 740 µg/L (Table 22).

Table 22: Palmers Creek Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	141	< 0.1	< 1	128	< 0.1	< 1	9	0.02	< 1	0.4	< 1	610	0.7	0.9
2020-07-27	135	< 0.1	< 1	105	< 0.1	< 1	11	0.01	< 1	0.2	< 1	480	0.4	1
2020-08-26	161	< 0.1	< 1	134	< 0.1	< 1	13	0.01	< 1	0.4	< 1	600	0.8	1
2020-09-21	174	< 0.1	< 1	118	< 0.1	< 1	15	0.01	< 1	0.4	< 1	740	0.8	1

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	1160	0.1	< 1	1.8	< 1	< 0.1	54	< 0.1	< 0.1	< 0.1	< 0.1	< 1	3
2020-07-27	524	0.1	< 1	1.6	< 1	< 0.1	68	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1
2020-08-26	921	0.1	< 1	2.1	< 1	< 0.1	97	< 0.1	< 0.1	< 0.1	< 0.1	1	3
2020-09-21	780	0.1	< 1	1.7	< 1	< 0.1	98	< 0.1	< 0.1	< 0.1	< 0.1	< 1	4

Robbs Brook

One Robbs Brook pH measurement was outside the CCME freshwater guideline for protection of aquatic life (6.5-9.0) in September with 0.3 (Table 23). This result is an outlier and is likely an error, as pH measured in the field, on the same day was 7.3 (Figure 17).

Table 23: Robbs Brook Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	31	1.86	37.9	4.6	94	63.6	0.26	< 1	0.11	< 0.05	< 0.001	< 0.05	< 0.05
2020-07-27	27	1.65	39.9	4.01	93	65.6	0.14	< 1	0.09	0.05	< 0.001	< 0.05	< 0.05
2020-08-26	37.3	3.83	51.6	6.11	120	98.5	0.11	1	0.16	< 0.05	< 0.001	< 0.05	< 0.05
2020-09-21	41.6	4.22	54.6	6.05	100	111	0.14	6	0.15	< 0.05	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	0.5	9.4	69	425	7.2	21.2	93.9	0.14	114	211	7.8	-0.64
2020-07-27	< 0.05	0.5	7.9	38	392	7.4	16.3	92.8	0.219	116	208	7.8	-0.42
2020-08-26	< 0.05	0.4	8	29	540	7.2	33.1	120	0.178	154	286	7.6	-0.42
2020-09-21	< 0.05	0.7	7.5	16	545	0.3	21	99.8	0.187	161	295	7.7	-0.38

Aluminum (Al) concentrations exceeded the CCME freshwater guidelines for protection of aquatic life for pH ≥ 6.5 (100 µg/L) in August with 135 µg/L, and for pH < 6.5 (5 µg/L) in September with 61 µg/L (Table 24). However, September Al concentrations likely do not exceed the guideline with pH presumably being incorrect. Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 2560 to 4980 µg/L (Table 24).

Table 24: Robbs Brook Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	71	0.1	3	221	< 0.1	< 1	25	< 0.01	< 1	0.3	< 1	4980	0.3	2.4
2020-07-27	24	< 0.1	2	296	< 0.1	< 1	20	< 0.01	< 1	0.2	< 1	3990	1	2.3
2020-08-26	135	< 0.1	3	273	< 0.1	< 1	5	< 0.01	< 1	0.6	< 1	5430	0.8	3.3
2020-09-21	61	< 0.1	2	227	< 0.1	< 1	5	< 0.01	< 1	0.3	< 1	2560	0.5	3

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	529	0.6	< 1	1.8	< 1	< 0.1	220	< 0.1	< 0.1	< 0.1	0.2	< 1	1
2020-07-27	812	0.2	< 1	1.5	< 1	< 0.1	216	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 1
2020-08-26	816	0.5	< 1	3.4	< 1	< 0.1	320	< 0.1	< 0.1	< 0.1	0.2	< 1	< 1
2020-09-21	343	0.6	< 1	3.5	< 1	< 0.1	303	< 0.1	< 0.1	< 0.1	0.4	< 1	2

Penitentiary Road Brook

Penitentiary Road Brook had no measurements above guidelines with the exception of two metals (Table 25, 26).

Table 25: Penitentiary Road Brook Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	32	0.92	36.5	2.68	97	57	0.24	< 1	0.08	0.05	< 0.001	< 0.05	< 0.05
2020-07-27	35.5	1.05	36.7	2.45	100	65.3	0.13	5	0.07	< 0.05	< 0.001	< 0.05	< 0.05
2020-08-26	31	1.83	38.7	2.46	100	61.8	0.1	3	0.08	0.1	< 0.001	< 0.05	< 0.05
2020-09-21	37.2	2.26	38.9	2.79	90	70.3	0.12	9	0.09	< 0.05	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	0.5	8.4	88	401	7.6	23.3	96.6	0.361	102	204	7.8	-0.24
2020-07-27	< 0.05	0.4	6.5	41	400	7.4	8.1	99.8	0.236	102	216	7.8	-0.42
2020-08-26	< 0.05	0.3	4.9	32	389	7.4	7.7	99.8	0.236	107	207	7.8	-0.4
2020-09-21	< 0.05	0.5	4.2	10	415	7.4	19.2	89.8	0.212	109	222	7.8	-0.45

Aluminum (Al) concentrations exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) in June with 950 µg/L (Table 26). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 1450 to 4320 µg/L (Table 26).

Table 26: Penitentiary Road Brook Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	950	< 0.1	2	324	< 0.1	< 1	14	< 0.01	< 1	0.7	< 1	4320	0.2	1.4
2020-07-27	16	< 0.1	1	270	< 0.1	< 1	15	< 0.01	< 1	0.2	< 1	1860	< 0.1	1.5
2020-08-26	24	< 0.1	< 1	254	< 0.1	< 1	10	< 0.01	< 1	0.3	< 1	1450	< 0.1	1.4
2020-09-21	61	< 0.1	2	227	< 0.1	< 1	5	< 0.01	< 1	0.6	< 1	2020	0.8	1.6

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	2350	0.7	< 1	1.3	< 1	< 0.1	216	< 0.1	< 0.1	< 0.1	0.3	< 1	2
2020-07-27	556	0.3	< 1	1.3	< 1	< 0.1	233	< 0.1	< 0.1	< 0.1	< 0.1	< 1	< 1
2020-08-26	436	0.3	< 1	2	< 1	< 0.1	235	< 0.1	< 0.1	< 0.1	0.2	< 1	< 1
2020-09-21	235	0.2	< 1	2.3	< 1	< 0.1	256	< 0.1	< 0.1	< 0.1	0.3	1	5

Two Mile Brook

Two Mile Brook had no measurements above guidelines with the exception of two metals (Table 27, 28).

Table 27: Two Mile Brook Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	50.4	1.25	12.6	3.07	49	85.4	0.22	< 1	0.07	0.08	< 0.001	< 0.05	< 0.05
2020-07-27	7.89	1.14	9.78	2.77	59	12.4	0.16	< 1	0.05	0.08	< 0.001	< 0.05	< 0.05
2020-08-26	44.1	1.42	12.1	2.62	50	78.5	0.13	< 1	0.12	0.26	0.002	< 0.05	< 0.05
2020-09-21	42	1.49	12.5	2.67	45	75.1	0.12	< 1	0.12	0.1	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	< 0.05	0.5	9.7	61	414	6.9	4.4	49	0.037	44.1	201	8.6	-1.68
2020-07-27	< 0.05	0.7	13.7	125	144	7.1	8.6	58.9	0.07	35.8	97	8.6	-1.47
2020-08-26	< 0.05	0.6	9.7	106	349	7.3	8.9	49.9	0.094	41	187	8.6	-1.28
2020-09-21	< 0.05	0.6	8.3	81	328	6.9	10.1	45	0.034	42.2	174	8.6	-1.71

One cadmium (Cd) measurement exceeded the CCME freshwater guideline for protection of aquatic life (hardness of 44.1 mg/L = 0.08 µg/L) in June with 0.2 µg/L (Table 28). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 1600 to 3680 µg/L (Table 28).

Table 28: Two Mile Brook Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	82	< 0.1	1	291	< 0.1	< 1	8	0.2	< 1	1.6	< 1	1600	0.6	1.6
2020-07-27	48	< 0.1	2	387	< 0.1	< 1	7	0.02	< 1	2.6	< 1	3680	0.5	0.5
2020-08-26	39	< 0.1	2	285	< 0.1	< 1	12	0.05	< 1	1.3	< 1	2520	0.4	2.5
2020-09-21	66	< 0.1	1	210	< 0.1	1	13	0.02	< 1	0.7	< 1	1840	0.5	2.6

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	718000	0.4	3	2.2	< 1	< 0.1	122	< 0.1	< 0.1	< 0.1	< 0.1	< 1	4
2020-07-27	9710	0.4	1	2.3	< 1	< 0.1	92	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2020-08-26	5370	0.3	2	2.7	< 1	< 0.1	138	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2
2020-09-21	2890	0.3	1	2.5	< 1	< 0.1	147	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2

Three Mile Brook

Three Mile Brook had no measurements above guidelines with the exception of two metals (Table 29, 30).

Table 29: Three Mile Brook Surface Water Chemistry

Date (yyyy-mm-dd)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Alkalinity (as CaCO3) (mg/L)	Cl (mg/L)	F (mg/L)	SO_4 (mg/L)	Br (mg/L)	Ammonia (as N) (mg/L)	Un-ionized @ 20ºC (mg/L)	Nitrate and Nitrite (as N) (mg/L)	NO2 (as N) (mg/L)
2020-06-24	21.4	1	4.32	1.27	10	42.3	0.17	< 1	0.03	< 0.05	< 0.001	0.16	< 0.05
2020-07-27	19	1.12	4.59	1.21	13	35.8	0.1	3	0.03	< 0.05	< 0.001	< 0.05	< 0.05
2020-08-26	14	1.38	4.1	1.12	15	27.1	0.08	< 1	0.03	< 0.05	< 0.001	0.06	< 0.05
2020-09-21	8.11	1.18	3.19	0.94	14	12.2	0.09	< 1	0.02	< 0.05	< 0.001	< 0.05	< 0.05

Date (yyyy-mm-dd)	NO3 (as N) (mg/L)	N-Total (mg/L)	TOC (mg/L)	Colour (TCU)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Bicarbonate (as $CaCO_3$) (mg/L)	Carbonate (as $CaCO_3$) (mg/L)	Hardness (as $CaCO_3$) (mg/L)	TDS (calc) (mg/L)	Saturation pH (20°C)	Langelier Index (20°C)
2020-06-24	0.16	0.4	6	58	174	6.6	85	10	0.004	16	85	9.7	-3.09
2020-07-27	< 0.05	0.3	5.9	51	140	6.9	3.1	13	0.01	16.4	80	9.5	-2.65
2020-08-26	0.06	< 0.2	4.3	53	118	7	6.5	15	0.014	14.8	64	9.5	-2.53
2020-09-21	< 0.05	< 0.2	3.4	41	74	6.8	9.3	14	0.008	11.8	39	9.6	-2.85

One aluminum (Al) concentration exceeded the CCME freshwater guideline for protection of aquatic life (pH ≥ 6.5 = 100 µg/L) in June with 128 µg/L (Table 30). Iron (Fe) concentrations also exceeded the CCME guideline (upper limit = 300 µg/L) across all months ranging from 880 to 1700 µg/L (Table 30).

Table 30: Three Mile Brook Surface Water Metals

Date (yyyy-mm-dd)	Al (µg/L)	Sb (µg/L)	As (µg/L)	Ba (µg/L)	Be (µg/L)	Bi (µg/L)	B (µg/L)	Cd (µg/L)	Cr (µg/L)	Co (µg/L)	Cu (µg/L)	Fe (µg/L)	Pb (µg/L)	Li (µg/L)
2020-06-24	128	< 0.1	< 1	281	0.2	< 1	6	0.04	< 1	1	< 1	1680	0.6	2
2020-07-27	66	< 0.1	< 1	190	0.1	< 1	6	0.03	< 1	0.8	< 1	1040	0.4	2.2
2020-08-26	98	< 0.1	< 1	181	< 0.1	< 1	7	0.03	< 1	2.6	< 1	1700	0.8	2
2020-09-21	93	< 0.1	< 1	81	< 0.1	< 1	7	0.01	< 1	0.5	< 1	880	0.8	1.8

Date (yyyy-mm-dd)	Mn (µg/L)	Mo (µg/L)	Ni (µg/L)	Rb (µg/L)	Se (µg/L)	Ag (µg/L)	Sr (µg/L)	Te (µg/L)	Tl (µg/L)	Sn (µg/L)	U (µg/L)	V (µg/L)	Zn (µg/L)
2020-06-24	179	0.3	4	2.3	< 1	< 0.1	41	< 0.1	< 0.1	< 0.1	< 0.1	< 1	4
2020-07-27	137	< 0.1	3	2.5	< 1	< 0.1	44	< 0.1	< 0.1	< 0.1	< 0.1	< 1	1
2020-08-26	402	< 0.1	3	2.9	< 1	< 0.1	45	< 0.1	< 0.1	< 0.1	< 0.1	1	3
2020-09-21	88	0.5	1	2.4	< 1	< 0.1	37	< 0.1	< 0.1	< 0.1	< 0.1	< 1	2

Conclusions and Recommendations

During the 2020 field season we collected water quality measures from 12 sites throughout the Rockport-Dorchester Watershed. The water quality results were compared to Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic health, Environment Canada guidelines, and Health Canada Guidelines for Recreational Activities. While we could speculate on some of the potential causes for variations between sites and fluctuation in parameter concentrations, this is just the first year of data collection in our monitoring program for this watershed. More years of data are required to look at the natural variations in water quality, potential impacts from climate change and to see trends over time to get an idea of what is expected. As mentioned previously, every time a water sample is taken it is only a snapshot of the water quality at that location at that point in time. This is also why long-term monitoring is so important.

Surface water temperatures remained below the recommended Environment Canada guideline of 20°C across all sites in August and September. In June, six sites exceeded the recommended temperature of 20°C including Palmers Creek, Penitentiary Road Creek, Harvey Creek, Johnson Creek, Robbs Creek, and Two Mile Brook. Palmers Creek and Penitentiary Road Creek were the only two sites to exceed 20°C in July. Penitentiary Road Creek and Robbs Brook also had very high surface water temperatures in June that were greater than 24°C, which can be lethal to salmon species under long-term exposure. These higher temperatures could be attributed to lower water levels and slower moving water with there being very low precipitation over the course of the sample season.

In-situ water pH was within CCME guidelines (6.5 – 9) at all sites and for all sample months.

The highest number of sample sites having dissolved oxygen concentrations below the CCME guideline of 6.5 mg/L occurred in July and August with 11 sites. Johnson Creek was the only site above 6.5 mg/L in July, and Slacks Cove Creek was the only site above 6.5 mg/L in August. Low DO in July and August corresponds with the two hottest sample months according to our temperature data, as dissolved oxygen decreases with increased temperature. Seven sites were below the guideline in June, consisting of Wood Creek, Harvey Creek, Len Buck Brook, Palmers Creek, Robbs Brook, Penitentiary Road Creek, and Two Mile Brook. Five sites were below the guideline in September consisting of Wood Creek, Harvey Creek, Robbs Brook, Two Mile Brook, and Three Mile Brook. Four sites had consistently low DO levels, below the recommended guideline consisting of Wood Creek, Harvey Creek, Robbs Brook, and Two Mile Brook.

There are no water quality guidelines for conductivity, TDS, and salinity. Despite being sampled at low tide from June to September, our tidally influenced sites consisting of Wood Creek, Pecks Cove Creek and Len Buck Brook still had brackish water when they were sampled. Johnson Creek and Tower Brook also had brackish water in September. This resulted in these sites displaying high levels of specific conductivity, TDS, sodium (Na) and chloride (Cl) concentrations.

The highest number of samples exceeding the guideline for E. Coli based on the single-sample maximum according to the Canadian Recreational Water Quality Guidelines occurred in July and August, with 6 sites. July sites consisted of Pecks Cove Creek, Tower Brook, Palmers Creek, Robbs Brook, Penitentiary Road Creek and Three Mile Brook. August sites consisted of Harvey Creek, Pecks Cove Creek, Tower Brook, Palmers Creek, Penitentiary Road Creek and Two Mile Brook. June had two sites exceeding the guideline consisting of Wood Creek and Palmers Creek. September had three sites exceeding the guideline consisting of Johnson Creek, Palmers Creek, and Penitentiary Road Creek. Palmers Creek was the only site consistently above the guideline. Slacks Cove Creek and Len Buck Brook were the only sites consistently below the guideline.

From June to September total phosphorus levels were frequently above 35 μg/L, as ~ 83% of samples were eutrophic (35 – 100 μg/L) to hyper-eutrophic status (> 100 μg/L). August and September had the greatest number of samples within eutrophic to hyper-eutrophic status, with all sample sites except Johnson Creek in August and Slacks Cove Creek in September above 35 μg/L. July had 10 sites within eutrophic to hyper-eutrophic status with only Johnson Creek and Slacks Cove Creek below 35 μg/L. June had eight sites within eutrophic to hyper-eutrophic status with only Harvey Creek, Slacks Cove Creek, Johnson Creek, and Three Mile Brook below 35 μg/L. Wood Creek, Pecks Cove Creek, and Penitentiary Road Creek were consistently hyper-eutrophic status from June to September. No sites were consistently below eutrophic status from June to September. As a key nutrient that can lead to an increase in algae growth and decrease in DO in our waterways, this is a parameter that we would like to look into further.

Chlorophyll-*a* was measured for the first time. Concentrations were highest in June for four sites consisting of Slacks Cove Creek, Len Buck Brook, Palmers Creek, and Penitentiary Road Creek. Concentrations were highest in July for three sites consisting of Wood Creek, Tower Brook, and Two Mile Brook. Concentrations were highest in August for five sites consisting of Harvey Creek, Pecks Cove Creek, Johnson Creek, Robbs Brook, and Three Mile Brook.

Two surface water chemistry measures analyzed by RPC were above CCME guidelines. Chloride (Cl) was above the guideline at five tidally influenced sites consisting of Wood Creek, Pecks Cove Creek, Johnson Creek, Len Buck Brook, and Tower Brook. Ammonia (un-ionized at 20^{o}C) was also above the guideline at two sites consisting of Harvey Creek and Pecks Cove Creek. Five surface water metals were above CCME guidelines. Aluminum (Al) was above the guideline at all sites excepts Slacks Cove Creek and Two Mile Brook. Boron (B) was above the guideline at three sites consisting of Wood Creek, Pecks Cove Creek, and Len Buck Brook. Iron (Fe) was above the guideline at all sites except Slacks Cove Creek. Lead (Pb) was above the guideline at Harvey Creek. Lastly, cadmium (Cd) was above the guideline at Two Mile Brook. Slacks Cove Creek was our most pristine site and had no RPC surface water chemistry or metal results exceeding any water quality guidelines. A number of samples were diluted prior to analysis due to their high ionic content, leading to results that were below the reporting limit and not quantified.

Overall, EOS had a very successful year of water quality monitoring that provided us with valuable baseline data that can be used to ensure the health of the Rockport-Dorchester Area. Water quality monitoring has given us the opportunity to better understand our watershed and the opportunity to have it documented. This project was a great first step towards building a long-term water quality monitoring program within the watershed. As we continue to collect more data we will be able to see trends in the water quality and develop a better understanding of what the "normal" water quality is in our waterways as well as how climate change may impact them.

EOS Eco-Energy recommends that the knowledge gaps in our watersheds continue to be addressed through our long-term water quality monitoring plan. We would also like to expand our knowledge of our watersheds through the collection of CABIN data, hydrological data, riparian health data, and fish & habitat data. EOS believes that this program should return to the Tantramar River Watershed in 2021-22, that was last sampled in 2018, to obtain a second year of information about the state of water quality within the watershed. This is our next step in building a long-term water quality monitoring program within the Inner Bay of Fundy and Northumberland Strait Watersheds.

References

Environment Canada (2011). Technical guidance document for Water Quality Indicator practitioners reporting under the Canadian Environmental Sustainability Indicators (CESI) initiative 2008. Catalogue No En4-138/2010E-PDF. Retrieved from www.canada.ca/en/environment-climate-change/services/environmental-indicators/water-quality-canadian-rivers.html.

Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines (CEQG) Summary table. Retrieved December 2020 from http://st-ts.ccme.ca/en/index.html

Health Canada (2012). Guidelines for Canadian Recreational Water Quality, Third Edition. Water, Air and Climate Change Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. Catalogue No H129-15/2012E. Retrieved from 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

Appendix 1 – Chlorophyll-*a* Methodology

MTA ACME Lab - Fluorometric Chlorophyll *a* Protocol
Revised June 2020

Based on: Welschmeyer 1994, *Limnology and Oceanography*, with modification of extraction solvent according to Shoaf and Lium 1976, *Limnology and Oceanography*. See the MacIntyre and Cullen 2005 reference provided below for validation of this protocol as compared to similar methods.
Instrument: Turner Trilogy Fluorometer, Chlorophyll a Non-acidification Module
Protocol by: Justin Liefer

NOTE: Extraction solvent, waste containers, glass vials, beakers, Pasteur pipets, a vial rack and lab wipes will be provided by the ACME Lab for external users who are paying for analyses on a per sample basis. This protocol assumes the user has received training and approval from the ACME Lab and has prepared samples of an appropriate mass and water content that are in capped glass vials (e.g. 20ml scintillation vials) or polypropylene centrifuge tubes. Centrifugation is needed for sediment, plant tissue, or any samples containing large amounts of suspended particulate material. **Contact the ACME Lab (jliefer@mta.ca) for questions about centrifuge access, sample preparation, or additional information about this protocol.**

Chemicals and Prepared Reagents Needed (See Appendix for recipes and stocks)

- Acetone:DMSO Extraction solvent (3:2 mixture, 90% acetone and DMSO)

Materials and Equipment

- Glass test tubes (12 x 75mm)
- Rack for glass vials
- Solvent-safe bottle-top dispensette
- Small glass beaker
- Solvent waste container
- Pasteur pipets
- Bulb for Pasteur pipets
- Lint-free lab wipes (e.g. Kim Wipes)
- Spray bottled containing 70% ethanol
- Nitrile gloves
- Lab coat
- Safety glasses
- Vortex mixer (optional)
- 15ml polypropylene (Falcon) or glass centrifuge tubes (optional)
- Centrifuge for 15ml tubes (optional)

Protocol

Log Entry and Sample Extraction

1. On the Trilogy Fluorometer Log next to the fluorometer, start a new entry by recording the date, your name, your supervisor (if you are an external user), the type of samples you are analyzing (filters, sediments, etc.), the volume of extraction solvent (per sample) you will use for most of your samples, and the number of samples you are analyzing.
2. To stage your samples for extraction, make sure you have a rack or appropriate box for your samples, something to protect them from light (like a sheet of aluminum foil) and another rack with a cover to protect from light in which you place samples after you have added extraction solvent.
3. In the ACME Lab fume hood, there is a 1 liter amber glass bottle containing Chl *a* extraction solvent (3:2 mixture of 90% acetone:DMSO) with a dispensette attached to it and a beaker labelled "Chl a solvent waste". Make sure the dispensette is set to 5ml (default setting) or to whatever extraction volume you intend to use.
4. Prime the dispensette by pumping solvent into the waste beaker until a continuous stream of solvent comes out of the spout (i.e. no bubbles are seen). This should take 3-4 pumps. Pump the dispensette by **GENTLY** lifting it all the way up and **GENTLY** pressing all the way down. Dump out the beaker of solvent into the large 4 liter amber glass waste bottle in the ACME Lab fume hood labelled for water, acetone, and DMSO.
5. Make sure the light in the fume hood is off.
6. Dispense 5ml of extraction solvent into each of your sample containers. If working with wet samples (i.e. not freeze-dried). You should only have a portion of your samples (~10-12) in the hood at a time, with the rest being kept frozen in a freezer or on ice. After solvent is added to a container, cap it tightly and mix the sample by inverting it several times or mixing it for 2-3 seconds on a vortex mixer. Place samples in a rack and take care to protect them from light.
7. Place samples in the dark at room temperature for 30 minutes. Repeat mixing and place samples back in the dark for another 30 minutes.
8. When ~10 minutes of sample extraction is remaining, turn on the Trilogy fluorometer using the switch on the back of the instrument. You will see a screen telling you to select a module. Select "Chl-NA". Allow the fluorometer to warm-up for at least 10 minutes before beginning any analyses.
9. For sediment, plant tissue, or any samples containing large amounts of suspended particulate material, centrifuge the samples for 2-5 min. at 4,000 RPM using the Eppendorf 5702 centrifuge near the fluorometer. The exact centrifuge time and speed need for a given sample type will vary and should be tested before-hand.

Sample Analysis

10. Once the fluorometer has completed its 10-minute warm-up, open the fluorometer, remove the sample vial holder and insert the solid state Chl *a* standard in the small blue box above the fluorometer. Insert the standard all the way into the slot with the rounded tab facing up and towards the back of the fluorometer.
11. Make sure the fluorometer is in Raw Fluorescence mode. You can toggle between Raw Fluorescence and Direct Concentration mode by pressing the "Mode" key.
12. Close the fluorometer, press the Measure key, and record the fluorescence value for the solid standard on the fluorometer log sheet.
13. Remove the solid standard and re-insert the sample vial holder.
14. Working with one sample at a time and protecting the other samples from light, transfer ~1-2ml of sample extract to a glass test tube using a Pasteur pipet. The amount of sample extract

added to the test tube should enough such that the level of the extract in the tube is near the top of the sample vial holder.

15. Wipe the outside of the test tube containing sample extract with laboratory wipes to make sure it is free of dirt or solvent residue.
16. Place the test tube in the sample vial holder, close the fluorometer lid and press the Measure key. The fluorescence value (in "rfu" or Raw Fluorescence Units) will appear on the screen. Record the value in your notebook. If a sample has a fluorescence value >1500, it should be diluted with Chl a extraction solvent and remeasured. This dilution and re-analysis should be done within 3 hours of initial extraction.
17. Discard the Pasteur pipet you used in the glass waste near the fluorometer.
18. After measurement, place the tube contain sample extract in the tube rack in the ACME Lab fume hood.
19. Repeat measurement for all remaining samples.
20. When all measurements are completed, turn off the fluorometer using the switch on the back on the instrument. Dump out all used extraction solvent into the large 4 liter amber glass waste bottle in the ACME Lab fume hood labelled for water, acetone, and DMSO.
21. Wipe up any spills of solvent in the fume hood or near the fluorometer using paper towel and 70% ethanol. Wipe any solvent residue off of the outside of the solvent dispensing bottle and dispensette. Discard your used empty vials in the glass waste near the fluorometer.
22. Remove all of your sample materials from the fume hood and near the fluorometer. Make sure the rack for measurement vials is placed near the fluorometer.
23. Make sure the box of Pasteur pipets is closed, the box of measurement vial is covered with foil, that there is still a box of lab wipes near the fluorometer and that all other waste (wipes, foil, etc.) are disposed of and any materials you brought into the lab (for external users) are removed.
24. For ACME lab users, do not discard glass scint vials or 15ml centrifuge tubes used for sample extraction. Any remaining solid material in these containers should be discarded and the containers should be thoroughly rinsed with DI water, set out to dry, and designated for Chl *a* analysis use only when put away.

Data Analysis and Quantification

Users who have been trained in the ACME Lab and provide with this protocol also have access to the file named "Chl *a* Processing Template – ACME Lab". This sheet provides the current calibration equation, which can be used to convert the relative fluorescence units (RFUs) that were recorded to units of µg Chl *a* / liter extraction solvent. Make sure that you are using an up to date version of this sheet or have the most recent calibration information in order to properly quantify samples.

<u>Appendix</u>

Preparation of Chlorophyll *a* extraction solvent (3:2 mixture, 90% acetone:DMSO)

<u>Reagents and materials</u>

- Acetone, HPLC-grade
- Dimethyl sulfoxide (DMSO), HPLC-grade
- Ultrapure water
- 1L glass graduated cylinder
- 250ml glass graduated cylinder

- 4L amber glass bottle (previously used for acetone or some other pure, volatile solvent and now completely clean and dry)

Procedure

1. Use the 1L graduated cylinder to add 1600ml of DMSO to the 4L bottle
2. Without rinsing out DMSO, use the same 1L graduated cylinder to add 2000ml of acetone to the 4L bottle
3. Use the 250ml graduated cylinder to add 160ml of acetone to the 4L bottle
4. Use the 250ml graduated cylinder to add 240ml of water to the 4L bottle
5. Cap the 4L bottle tightly and shake well to mix

Method Background:

Chlorophyll *a* (Chl *a*) is the most abundant photosynthetic pigment in nearly all plants and microalgae. Though Chl *a* is present in cyanobacteria as well, phycobilins can often be the more abundant pigments in this taxa. In addition to the value of measuring a key component of the photosynthetic apparatus, Chl *a* concentrations or relative fluorescence of Chl *a* can be an index of microalgal biomass. As such, these Chl *a* measurements can be used as a quick and simple way to track growth and determine growth rate of microalgal cultures in steady-state balanced growth.

Principle of Method:

We use fluorometry to measure both *in vitro* Chl *a* concentration in extracts of algal samples as well *in vivo* measurements of Chl *a*. When blue light is absorbed by Chl *a*, some of this absorbed light energy is lost as heat and the remaining energy is reemitted and as lower energy (longer wavelength) red light. Our particular fluorometry technique is based on the method of Welschmeyer (1994), in which the fluorometer utilizes narrow pass filters to control the excitation wavelength that induces fluorescence and the wavelength of emitted light that is detected. This allows targeted measurement of Chl *a* with minimal interference from similar compounds such as Chl *a* precursors or degradation products or Chlorophyll *b*. Aside from it's selectivity for Chl *a,* this method also has the advantage of being extremely sensitive since the emitted fluorescence signal is greatly amplified by a photo-multiplier tube (PMT) in the fluorometer.

Our method of extracting Chl *a* is based on Shoaf and Lium (1975), in which 3:2 mixture of 90% Acetone:DMSO is added to samples and placed in the dark for 30 minutes at room temperature. This method of extraction has been consistently been shown to produce nearly identical extraction yields as the more common method of extraction in 90% acetone for 24 hours at 20°C. The combination of the Shoaf and Lium (1976) extraction method and the Welschmeyer (1994) fluorescence technique has been shown to produce the most accurate measurements of Chl *a* in microalgal samples, based on comparison to benchmark measurements made by high performance liquid chromatography (HPLC) (MacIntyre and Cullen 2005).

Sample Collection tips:

- Microalgal samples can be collected by **pelleting** (if applicable), **filtration** onto GF/F grade glass fiber or membrane filters, or **direct injection**.
- A wide variety of membrane filters are potentially compatible with the extraction solvent, but white polycarbonate filters are the most common alternative to GF/F filters and these have shown no interference with Chl *a* measurements. Black polycarbonate filters should be avoid as they allow extraction of a substance that creates a high background fluorescence.

- **Direct injection** involves pipetting a microalgal liquid culture sample into a vial then immediately adding extraction solvent. This liquid-liquid extraction also performs well, but the ratio of liquid culture to extraction solvent should 1:25 or ideally 1:50 and higher to avoid interference by seawater. It may also be preferable to freeze liquid samples before extraction as one freeze-thaw cycle will disrupt cell membranes and possibly allow more efficient extraction.
- Samples should be stored in glass vials with non-reactive caps (e.g. foil or PTFE-lined) or 15ml polypropylene centrifuge tubes (in the case of pellets) so that the subsequent extraction can be performed in this storage container.
- Our methods are highly sensitive, so it is best to collect a small amount of biomass per sample (i.e. 5-15 ug of biomass dry weight) so that extracts do not have to be diluted prior to measurement.

References:

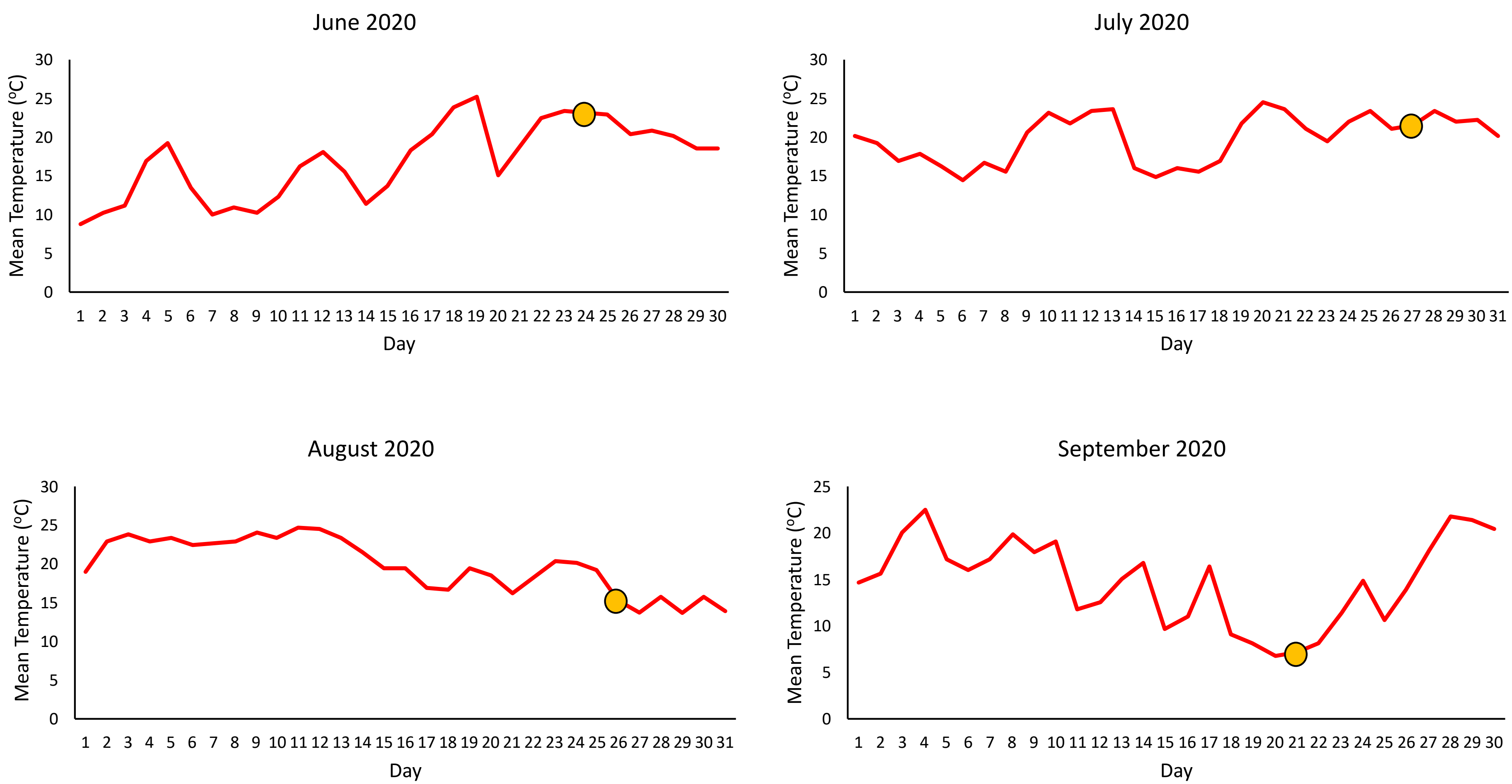
Shoaf, WT, Lium BW (1976) Improved extraction of chl a and b from algae using Dimethyl sulfoxide. Limnology and Oceanography **21**: 926-928.

Welschmeyer NA (1994) Fluorometric analysis of Chlorophyll-a in the presence of Chlorophyll-b and pheopigments. Limnology and Oceanography **39**: 1985-1992.

MacIntyre HL, Cullen JJ (2005) Using Cultures to Investigate The Physiological Ecology of Microalgae. In: Andersen, R. editors, Algal Culturing Techniques: Elsevier Academic Press. pp-287-325.

Appendix 2 – Daily Mean Temperatures During Sampling Season

Figure 22: Daily Temperature (ºC) for June to September 2020 from Environment Canada, Station 8103202, Greater Moncton Romeo Leblanc Intl A. Note: yellow dots indicate sampling day



Appendix 3 – Daily and Total Monthly Precipitation in Dorchester

Figure 23: Daily Precipitation (mm) from April to September for 2020 from Dorchester CoCoRaHS Site CAN-NB-16

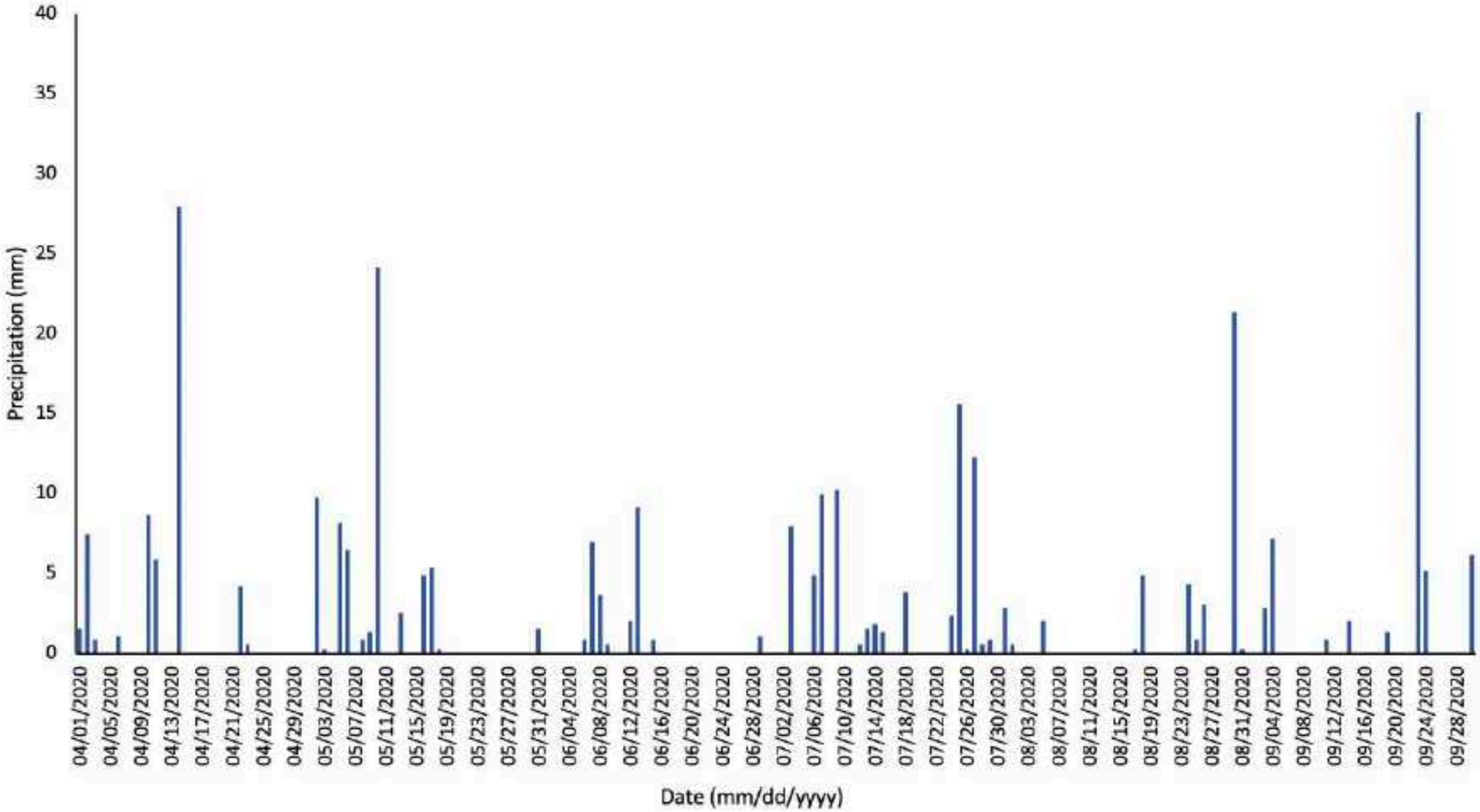
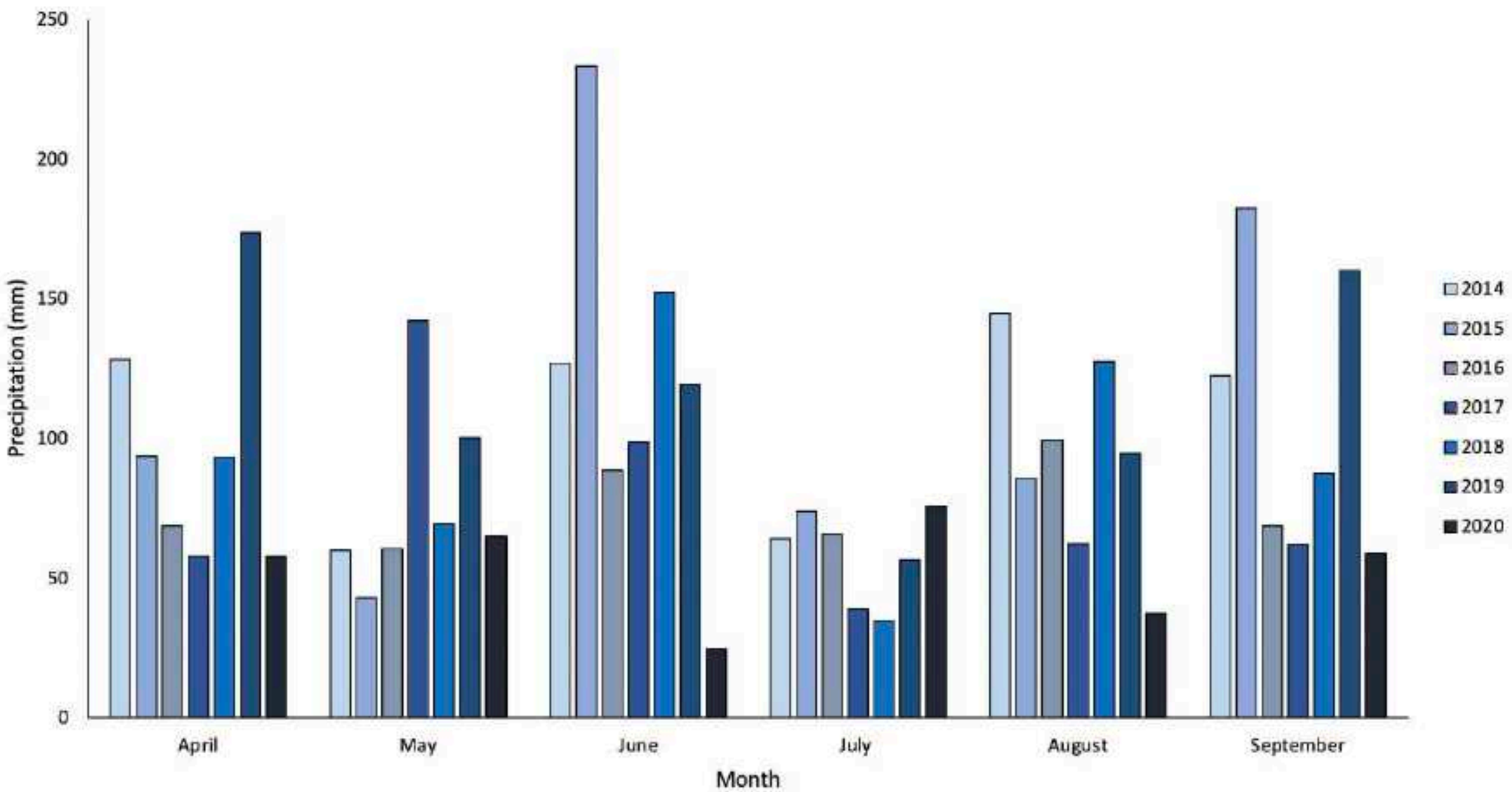


Figure 24: Monthly Precipitation (mm) from April to September for 2014-2020 from Dorchester CoCoRaHS Site CAN-NB-16



Appendix 4 – Data Tables

Table 31: Monthly Water Temperature Measured In-Situ Using Hanna Multiparameter Meter

Sample Site	June	July	August	September
Wood Creek	18.87	19.69	18.86	10
Harvey Creek	20.29	19.91	16.1	8.8
Pecks Cove Creek	17	18.42	17.46	9.3
Slacks Cove Creek	14.11	15.28	13.97	4.3
Johnson Creek	20.03	19.02	16.94	4.8
Len Buck Brook	18.05	17.97	19.53	5.9
Tower Brook	14.92	15.4	17.79	6.4
Palmers Creek	22.68	20.91	18.38	7.8
Robbs Brook	24.32	19.11	18.98	8.8
Pent. Rd. Creek	25.84	20.08	18.03	5.6
Two Mile Brook	22.27	19.35	16.64	6.1
Three Mile Brook	18.98	15.87	16.08	5.6

Table 32: Monthly Water pH Measured In-Situ Using Hanna Multiparameter Meter

Sample Site	June	July	August	September
Wood Creek	6.95	7.27	7.02	6.99
Harvey Creek	6.82	7.42	6.56	7.2
Pecks Cove Creek	7.26	7.08	6.65	7
Slacks Cove Creek	7.57	8.22	7.27	8.03
Johnson Creek	7.28	7.81	7.30	7.30
Len Buck Brook	7.18	7.45	6.76	6.62
Tower Brook	7.5	7.56	6.59	7.23
Palmers Creek	7.11	7.21	7.15	7.54
Robbs Brook	6.94	7	6.99	7.3
Pent. Rd. Creek	7	7.27	7.13	7.5
Two Mile Brook	6.97	6.89	6.86	7.06
Three Mile Brook	6.96	6.54	6.69	7.05

Table 33: Monthly Dissolved Oxygen (mg/L) Measured In-Situ Using Hanna Multiparameter Meter

Sample Site	June	July	August	September
Wood Creek	6	4.89	5.13	6
Harvey Creek	2.89	4.22	0.15	3.5
Pecks Cove Creek	7.22	4.69	6.21	7
Slacks Cove Creek	9.41	5.3	6.83	12
Johnson Creek	8.8	7.25	6.31	12
Len Buck Brook	5.15	2.21	3.72	11
Tower Brook	9.98	5.73	2.59	8
Palmers Creek	4.88	4.17	3.87	8
Robbs Brook	3.03	0.3	0.98	5.5
Pent. Rd. Creek	0.79	1.53	4.28	8
Two Mile Brook	4.36	2.08	2.01	5.5
Three Mile Brook	8.5	5.2	3.68	5.5

Table 34: Monthly E. Coli (MPN/100mL)

Sample Site	June	July	August	September
Wood Creek	3654	316	278	110
Harvey Creek	30	86	813	63
Pecks Cove Creek	262	540	643	62
Slacks Cove Creek	31	20	241	< 10
Johnson Creek	10	63	110	1539
Len Buck Brook	31	185	179	31
Tower Brook	20	7701	3873	246
Palmers Creek	432	754	441	1012
Robbs Brook	31	1153	85	41
Pent. Rd. Creek	120	521	480	422
Two Mile Brook	373	295	771	41
Three Mile Brook	10	521	336	183

Table 35: Monthly Total Phosphorus (P-Total) (μg/L)

Sample Site	June	July	August	September
Wood Creek	100	170	148	180
Harvey Creek	27	117	68	60
Pecks Cove Creek	238	432	325	700
Slacks Cove Creek	7	30	129	20
Johnson Creek	23	17	17	60
Len Buck Brook	109	72	54	52
Tower Brook	62	54	68	41
Palmers Creek	65	54	115	73
Robbs Brook	228	237	190	138
Pent. Rd. Creek	126	98	142	111
Two Mile Brook	62	122	38	54
Three Mile Brook	33	40	50	46

Table 36: Monthly Chlorophyll a (Chl-a) (μg/L)

Sample Site	June	July	August
Wood Creek	0.00181258	0.014954775	0.005651854
Harvey Creek	0.00244421	0.003395225	0.007699561
Pecks Cove Creek	0.00109809	0.003318545	0.004803539
Slacks Cove Creek	0.00204684	0.001740305	0.000449632
Johnson Creek	0.00046066	0.000706697	0.000961669
Len Buck Brook	0.00242576	0.000743951	0.000894224
Tower Brook	0.00070341	0.002015695	0.000730096
Palmers Creek	0.00595987	0.004883012	0.00499237
Robbs Brook	0.01495478	0.007701815	0.026624745
Pent. Rd. Creek	0.01309912	0.002186986	0.002244465
Two Mile Brook	0.00238612	0.018375642	0.018120201
Three Mile Brook	0.00238215	0.001167595	0.01383474