2020 Water Quality Report, Canton, Massachusetts

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Background

The Neponset River Watershed Association (NepRWA) has been collecting water quality data in Canton and throughout the Neponset River watershed since 1996. Samples are collected by volunteers through the Community (formerly Citizen) Water Monitoring Network (CWMN) and by NepRWA staff through the Hot Spot program. Data gathered by the CWMN volunteers are used to track the health of the Neponset River and its tributaries, and to locate pollution sources (hot spots) for follow-up sampling. There are eight permanent CWMN stations within and bordering the town of Canton; two on Pequit Brook, one on Pecunit Brook, one on Ponkapoag brook, one on Beaver Meadow Brook, one on Massapoag Brook, one on the East Branch of the Neponset River, and one on the Neponset River (Figure 1). Waterbodies in Canton are tested for *Escherichia coli* (*E.coli*), total phosphorus, pH, dissolved oxygen, and temperature once per month between May and October. Sites EAB010, MPB088, NER125, POB040, and PQB036 are also tested for ortho-phosphate and ammonia. The parameters discussed in this report are limited to those that are tested at every site

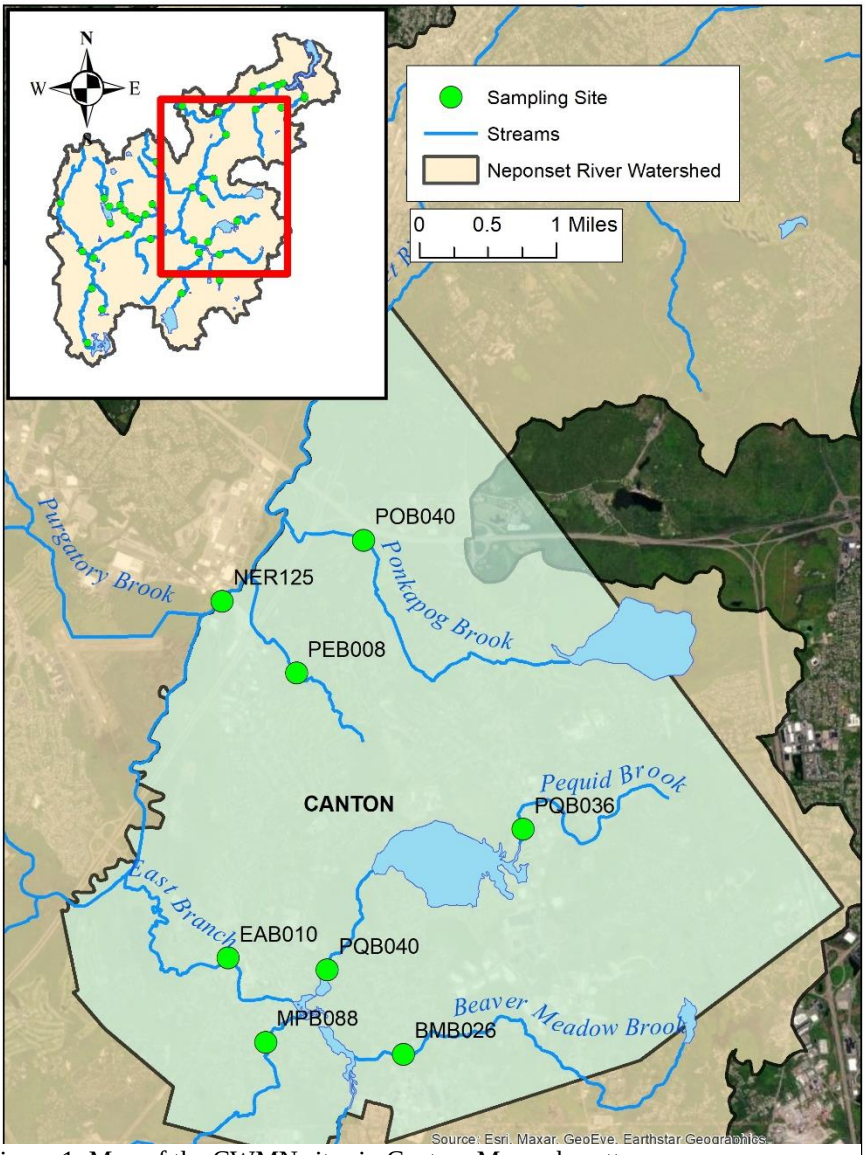

Figure 1: Map of the CWMN sites in Canton, Massachusetts.

including *E. coli*, total Phosphorus, pH, and dissolved oxygen. The raw water quality data are available upon request.

The concentration of *E. coli* bacteria is used to assess a waterbody's safety for "contact recreation" through activities such as swimming, fishing, boating, and wading. The presence of *E. coli* is evidence of fecal contamination and is an indicator of the likely presence of other, more dangerous, pathogens associated with human and animal waste. The most common sources of *E. coli* include improper disposal of pet waste in streets, lawns, and catch basins. Additional common sources include sewer or septic system malfunctions and discharges of organic wastes from household or commercial garbage. Wildlife waste also contains *E. coli*, however elevated concentrations from wildlife are typically associated with human activities, such as feeding ducks. Management interventions to reduce *E. coli* loads can include education on pet waste disposal, proper management of solid waste, frequent cleaning of catch basins, filtration stormwater best management practices (BMPs) to reduce the runoff that reaches a waterbody, and rapid identification and repair of sewage leaks and spills.

Phosphorus is a required plant nutrient that is often the "limiting nutrient" in freshwater ecosystems. Therefore, the concentration of available phosphorus in a freshwater waterbody will often control the rate of aquatic plant growth (the other required nutrients are typically present at proportionately higher levels). *Excess* phosphorus creates *excess* biomass, especially algae, in a process called eutrophication. When the excess plants and algae die, the process of decomposition consumes dissolved oxygen, and in extreme cases dissolved oxygen levels get too low to support aquatic animals such as fish. Other impacts of eutrophication include unattractive and smelly algal blooms and destruction of underwater plant communities through reduced light penetration. Elevated phosphorus concentrations can cause *harmful* algal blooms (HABs), such as cyanobacteria that produce toxins harmful to people. Phosphorus sources can include wet (from rain) or dry (from sprinklers) weather runoff from parking lots, streets/gutters, and lawns. These surfaces contain phosphorus from fertilizers, organic matter (leaves, grass clippings), soil, garbage, and pet waste. Interestingly, phosphorus can also accumulate on these surfaces from atmospheric deposition. Illegal dumping of organic matter such as leaves in or near waterways or catch basins is a common problem. Poorly maintained

septic systems, illicit discharges of sewage, and naturally occurring dead aquatic plant materials are additional sources.

The pH of a waterbody is a measure of how much free hydrogen ion (H+) is present in the water—a lot of free hydrogen ion leads to acidity (low pH) and low amounts of free hydrogen ion leads to more basic conditions (high pH). Water that is too acidic or too basic can be toxic to aquatic life. The pH is influenced by bedrock characteristics, groundwater seepage, acid rain, or heavy loading of tannin rich leaves/needles.

Adequate concentrations of dissolved oxygen (DO) are necessary to support fish, amphibians, mollusks, aquatic insects, and other invertebrate species. Many environmental drivers impact the DO levels in a water body. For example, cooler water temperatures sustain higher levels of DO, which is why there is often a seasonal trend in DO concentration: low levels in the warm months and higher levels in the colder months. Rapid mixing and turbulence (such as riffles or step pools) also result in high levels of DO due to atmospheric mixing. Alternatively, large amounts of decaying organic matter consume dissolved oxygen as microorganisms degrade the organic matter and lower levels of DO result. Excessive phosphorous that causes eutrophic conditions is also closely associated with low dissolved oxygen levels because it drives plant growth and subsequent decomposition. In thermally stratified lakes, oxygen deficient conditions can occur in the deeper portions of the water where there is no atmospheric mixing and no photosynthesis (the two sources of DO in aquatic systems). In the summer, ponds and lakes typically have warmer surface waters and thus lower surface DO concentrations. Management interventions that can increase DO levels include increasing riparian shading to maintain lower water temperatures, removing obsolete dams, reducing excessive water diversions, and reducing decaying organic matter though the reduction of phosphorous runoff and other drivers of eutrophication.

Results and Discussion

Monthly sampling events occur on predetermined days each month, which means the weather is not a criterion in determining when to collect the water quality data. However, rain events can significantly alter the concentrations of various parameters by washing bacteria, nutrients, and other chemicals from land surfaces into the river. In 2020, five sampling days

occurred during dry periods and just one sampling date occurred during a wet period. A wet period is defined as greater than 0.1 inches of precipitation within the 48-hour period preceding a sampling event. As shown in Table 1, 2020 had more sampling events occur during dry weather since 2016 when all six sampling events occurred during dry weather. The implication of this result is that any improvements in certain parameters like *E. coli* may be a result from the disproportionate sampling during dry weather as opposed to real changes in water quality or real changes in the frequency of sewage spills.

Table 1: The number of water quality sampling days that occurred during dry or wet weather since year 2010.

Year	Dry (days)	Wet (days)
2010	5	1
2011	3	3
2012	2	4
2013	5	1
2014	4	2
2015	4	2
2016	6	0
2017	4	2
2018	3	3
2019	3	3
2020	5	1

Escherichia coli (E. coli)

In Massachusetts there are two criteria that define acceptable levels of *E.coli* in Class B waterbodies (waterbodies that support wildlife, swimming, and boating, but not drinking). In Class B waters, no single sample shall exceed 235 Colony Forming Units (CFU) per 100 ml (the single sample standard), and/or the geometric mean of at least 5 samples taken within the same season shall not exceed 126 CFU/100ml (the seasonal standard).

In 2020 maximum *E. coli* levels at six of the eight sampling sites exceeded the 235 cfu/100mL single sample limit (Table 2). The highest levels were observed at the two sites on Pequid Brook. Minimum *E. coli* levels were acceptable at all eight sites. The seasonal standard was above the acceptable limit at just three sites: POB040, PQB036, PQB040 (Table 2). The sites on Beaver Meadow Brook and on the Neponset River approached the seasonal

limit, but were below the threshold. Two sites (BMB026 and EAB010) fully complied with the *E. coli* standard for the duration of 2020.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the eight sampling sites in Canton, MA, year 2020. N=6 for each site except PEB008 and PQB036 where N = 5 and N = 4, respectively. Units are in cfu/100ml. Bold rows were sites with *E. coli* levels that failed the single sample limit at least once. An * means the seasonal sample limit was surpassed. Note that the Massachusetts DEP requires a minimum of five samples so the value at PQB036 would not be used in regulation.

CWMN Site	Maximum	Average	Minimum	Geometric Mean
BMB026	175	130	41	118
EAB010	201	113	52	96
MPB088	**318**	**108**	**20**	**69**
NER125	**313**	**145**	**63**	**123**
PEB008	**780**	**245**	**20**	**110**
POB040	**573**	**226**	**20**	**156***
PQB036	**594**	**310**	**41**	**217***
PQB040	**2910**	**988**	**10**	**385***

During the wet weather event in 2020 only Pequid brook (PQB040) and Ponkapog Brook (POB040) had levels that were greater than 235cfu/100ml, but note that no *E. coli* sample was collected at PQB036 or PEB008 on this day. Previous years indicate that wet weather at these sites can result in elevated *E. coli* levels. It is important to note that even during dry weather many of the sites exceed the single sample standard. In 2020, of the five sampling events that occurred in dry weather, at least one sample exceeded the standard at Massapog Brook, the Neponset River, Pecunit Brook, Ponkapog Brook and Pequid Brook. The maximum dry weather water sample levels in 2020 ranged from 175 cfu/100ml, at Beaver Meadow Brook, to 2910 cfu/100ml, at Pequid Brook.

Wet weather events were generally associated with higher *E. coli* levels in past years at all the sampling sites in Canton (Figure 2). Interestingly in 2020, the maximum *E. coli* levels were observed during dry weather at five of the six sites where samples were collected in both weather conditions (but it is important to note that there were 5 dry weather sampling events in 2020 and just one wet sampling event) (Table 3).

Table 3: The maximum *E. coli* levels from samples in 2020 in wet and dry weather. N = 1 for wet weather and N = 5 for dry weather (except N = 4 for PQB036 and N = 5 at PEB008). NA signifies *E. coli* samples were not collected. Bolded values indicate the higher of the two *E. coli* levels.

Site	Dry	Wet
BMB026	**175**	160
EAB010	**201**	63
MPB088	**318**	108
NER125	**313**	63
PEB008	780	NA
POB040	246	**573**
PQB036	594	NA
PQB040	**2910**	1720

Pequid Brook appears to have the greatest problem with *E. coli* of any of the streams in Canton in 2020. Site PQB040 had highly elevated *E. coli* levels during one dry weather sampling event and the one wet weather sampling event. Additionally, a majority of the dry weather sampling events revealed elevated concentrations, suggesting a systemic problem at this site with *E. coli* even in dry weather. Because we only sampled once during wet weather we cannot say if there is a systemic problem during rain events. At this site in 2018 and 2019 wet weather sampling did result in high *E. coli* levels, which suggests a systemic problem during rain events. The site on Ponkapog Brook (POB040) also had *E. coli* concentrations above the single sample threshold during the rain event, but not by as much as PQB040.

Despite elevated wet weather *E. coli* concentrations in the two previous years, the levels on Beaver Meadow brook, the east branch Neponset River, Neponset River, and Massapoag Brook in 2020 during the one rain event were lower and below the single sample standard.

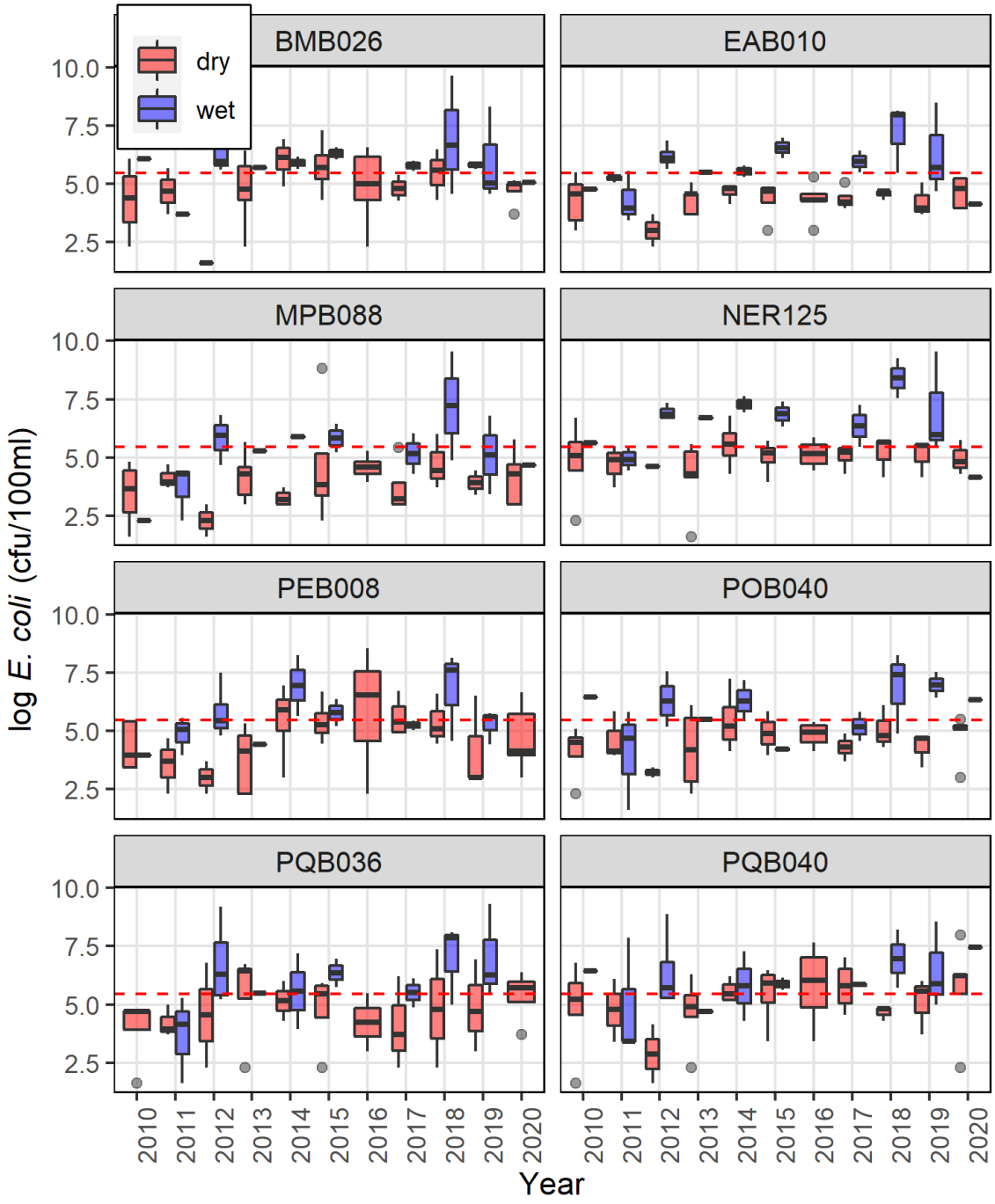

Figure 2: *E. coli* levels at the eight sampling sites in Canton from years 2010 to 2020 – note the log scale, which allows exponential data to be viewed more easily. The plot shows levels grouped by weather (blue = wet, red = dry). The red dashed line at y = log(235) shows the single sample maximum acceptable threshold. Boxplot statistics: The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the largest value no further than 1.5 * IQR from the hinge (where IQR is the inter-quartile range, or distance between the first and third quartiles). The lower whisker extends from the hinge to the smallest value at most 1.5 * IQR of the hinge. Data beyond the end of the whiskers are called "outlying" points and are plotted individually.

Phosphorus

The state of Massachusetts does not provide numerical phosphorus standards for classification of water quality impairments. Instead, the Massachusetts Department of Environmental Protection (MassDEP) uses a narrative standard that considers the EPA gold book Phosphorus standard, dissolved oxygen levels, excessive primary producer growth, or other indictors of a phosphorus problem. The EPA gold book standard identifies an average of at least three samples exceeding 0.1mg/l as the upper threshold for flowing waters and 0.05mg/l for streams entering a lake/reservoir. We considered four sites in Canton to be flowing waters and four sites to be entering a lake or reservoir (Table 4). Dissolved oxygen and excess primary producer growth, like algal blooms, are used as evidence that the Phosphorus levels are causing an impact to the stream ecology.

In 2020, three sites in Canton had seasonal averages that were above the EPA standard: BMB026, PQB036, and PQB040. These three sites are considered to be sites where the stream is entering a lake or reservoir with the 0.05mg/l threshold (Table 4). The other five sampling sites were below the threshold – these include all four flowing water sites and one additional site entering a lake or reservoir.

Table 4: The maximum, average, and minimum values of total phosphorus recorded during 2020 at the 8 sampling sites in Canton. Bolded rows have a seasonal average that exceed the EPA gold book standard for total Phosphorus. N=6 for each site except PEB008 where N = 5.

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)	Standard (mg/l)
BMB026	**0.2**	**0.08**	**0.03**	**0.05**
EAB010	0.08	0.05	0.03	0.1
MPB088	0.07	0.04	0.03	0.05
NER125	0.14	0.07	0.03	0.1
PEB008	0.1	0.08	0.05	0.1
POB040	0.15	0.09	0.04	0.1
PQB036	**0.19**	**0.1**	**0.02**	**0.05**
PQB040	**0.09**	**0.06**	**0.03**	**0.05**

The levels of total Phosphorus in 2020 at the flowing water sites do not appear to be concerning except at site POB040 (Figure 3). At site POB040, total Phosphorus levels exceeded the 0.1mg/l threshold twice in 2020 (TP = 0.15mg/l and TP = 0.13mg/l in August and July,

respectively) and the last three years have had elevated concentrations compared to previous years. While TP levels at site PEB008 are below the upper threshold, the mean value has increased since 2015 and is approaching the limit. Alternatively, the levels of total Phosphorus at the sites with the more stringent standard did not comply with the standard at three of the four sites. Pequit Brook appears to have the largest problem with total Phosphorus levels (Figure 4). Site PQB036 water samples have had levels greater than the standard at a majority of sampling events since 2012. At site PQB040 total Phosphorus levels appear to be increasing annually since 2017 after decreasing from year 2010. Total Phosphorus levels Beaver Meadow Brook were above the threshold during five of the six sampling events in 2020 and levels are elevated compared to many previous years.

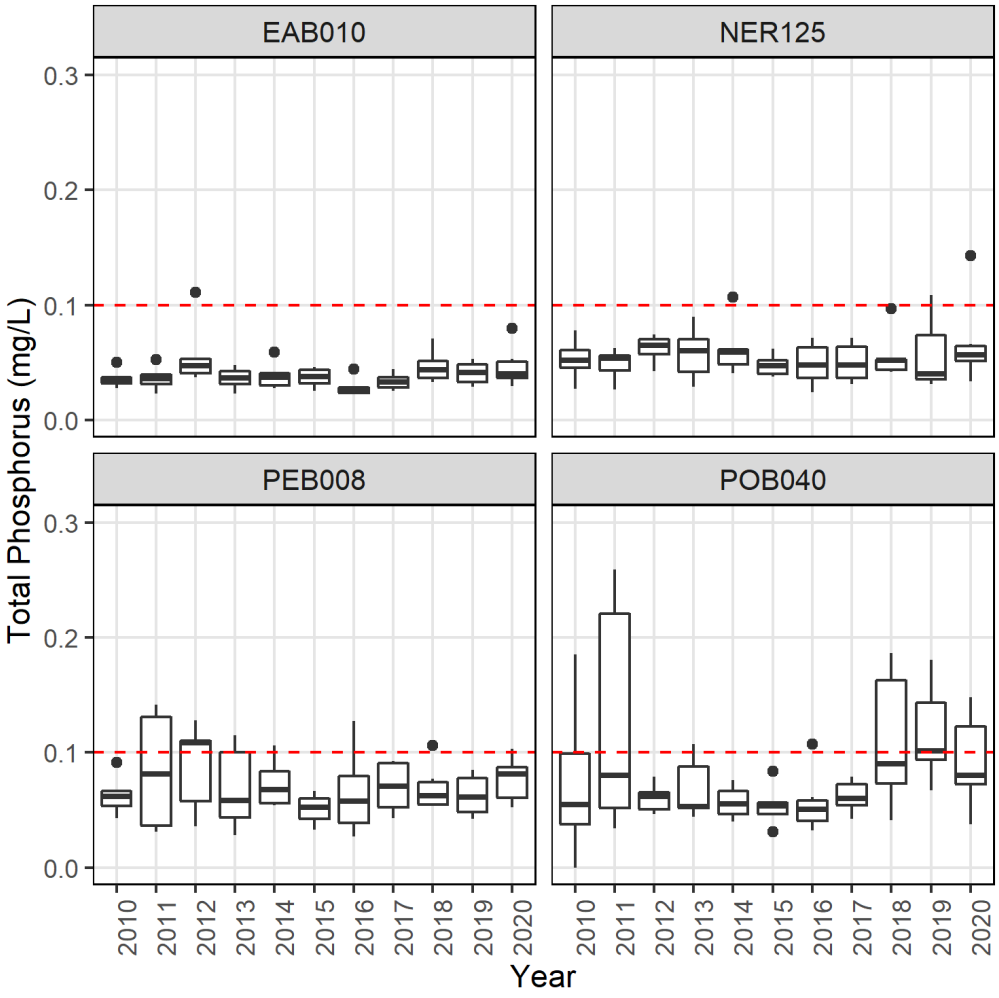

Figure 3: Total phosphorus levels at the four flowing water sites in Canton from year 2010 to 2020. The red dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 2. **Note two outliers have been removed from POB040 to better view the data (2011 = 0.58mg/l and 2018 = 0.45mg/l)**.

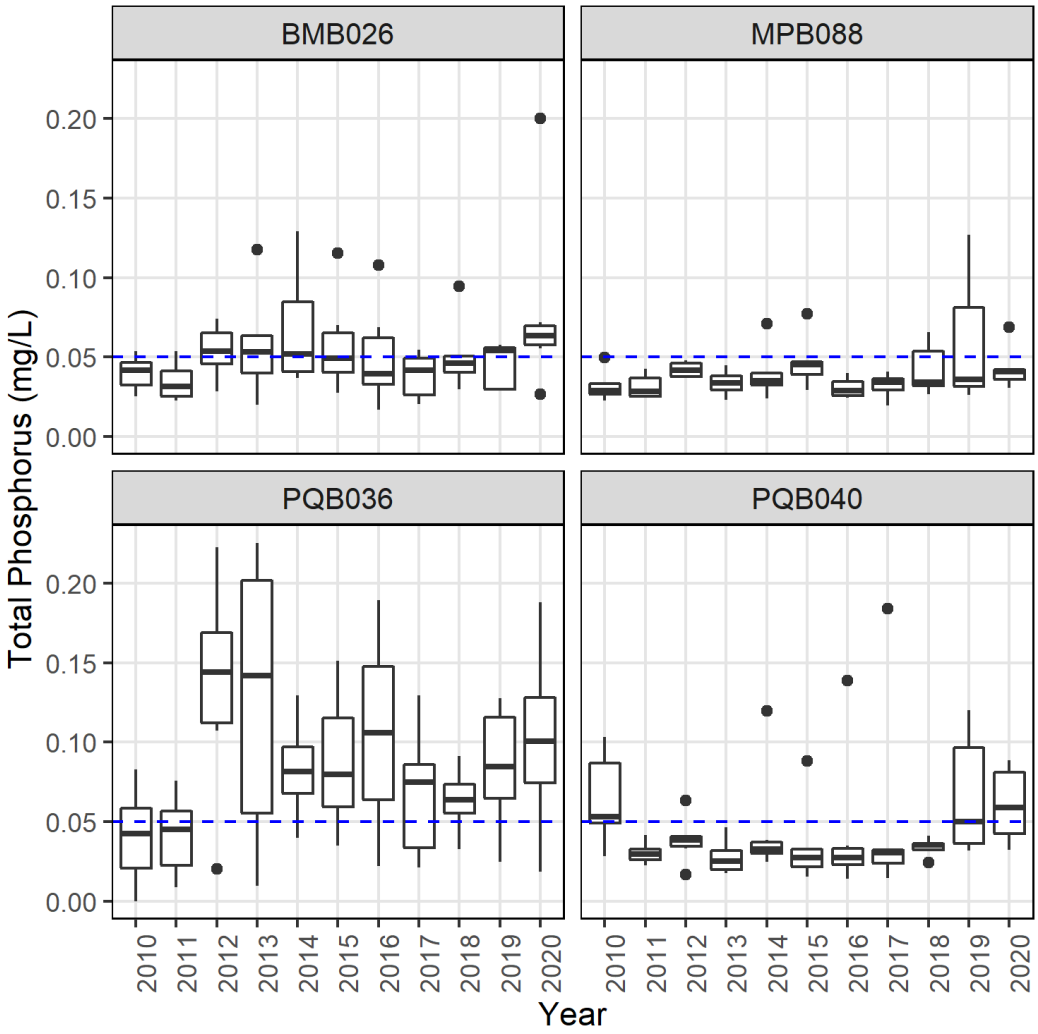

Figure 4: Total phosphorus levels at the four stream sites that are entering a lake or reservoir in Canton from year 2010 to 2020. The blue dashed line is at 0.05mg/l. Boxplot statistics are the same as Figure 2. Note that the y-axis range is different than Figure 4.

It is important to note that the Massachusetts DEP asks for additional information to help identify a problem with total Phosphorus, such as primary producer data. While we do not have primary producer data at these sites, many sites in Canton have a strong negative correlation between total Phosphorus levels and dissolved oxygen levels (Table 5), which can be a symptom of eutrophication. The strongest correlations are observed at PQB036, followed by BMB026 and NER125. Data from CWMN sampling shows that dissolved oxygen levels are dangerously low in past years and in 2020 at PQB036 (Figure 6), which makes it a more likely candidate as a stream impaired by total Phosphorus.

Table 5: Correlation coefficient (R^2) between total Phosphorus levels and dissolved oxygen levels at the eight sites in Canton, MA using data from 2010 - 2020.

Site	R^2
PQB036	-0.49
BMB026	-0.45
NER125	-0.36
POB040	-0.25
PQB040	-0.23
PEB008	-0.14
MPB088	-0.12
EAB010	0.04

pH

The state of Massachusetts considers a pH range of 6.5 to 8.3 to be healthy for waterbodies in the state. All sampling events in Canton met the pH standard in year 2020 except three sites, BMB026 (pH = 6.33), PEB008 (pH = 6.46), and PQB036 (pH = 6.46), which were slightly more acidic than the standard allows for (Figure 5) In past years, PQB036 is the only site that has low pH levels (all samples in 2015 and 2017) in past years, but levels improved in 2019 and 2020. No sites had any water samples that were above the upper threshold.

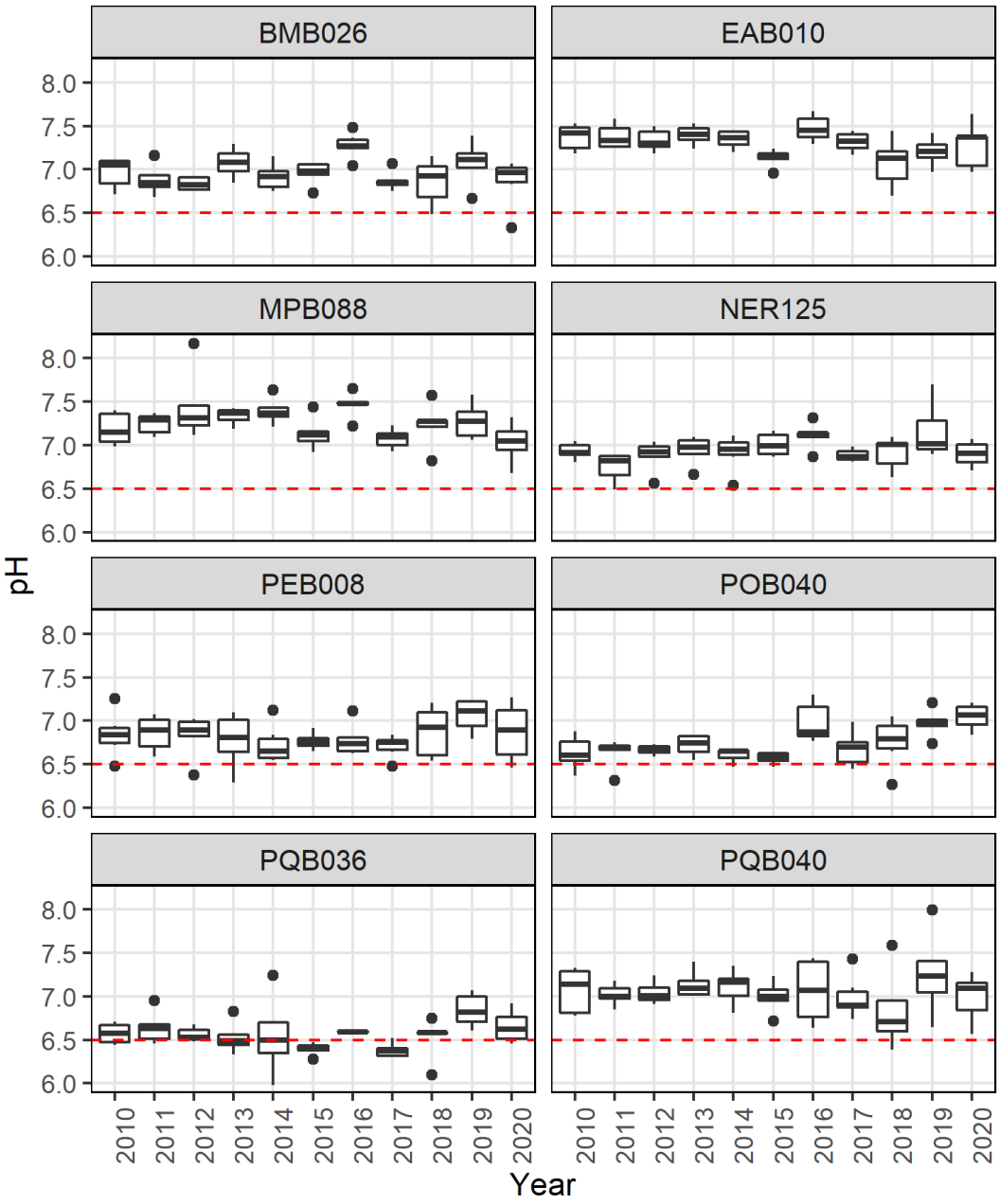

Figure 5: The pH levels at the eight sites in Canton for years 2010 through 2020. Boxplots statistics are the same as Figure 2. The red dashed line is at pH = 6.5, the lowest allowable pH level in Massachusetts.

Dissolved Oxygen:

The state of Massachusetts considers DO levels below 5 mg/L to be stressful to all aquatic organisms and 6mg/L to be stressful to certain species of fishes that require colder water.

August 2020 levels of DO at four sites were lower than the mean August values, BMB026, EAB010, MPB088, and NER125 (Figure 6). The largest drop in DO was at site NER125, which had hypoxic conditions in August of 2020 (DO = 0.73mg/L) compared to the six year mean value of DO = 4.0mg/l. Hypoxic waters have low oxygen levels (less than 2mg/l) and cannot support many aquatic species. Additionally, levels of DO at site NER125 were below the 5mg/l threshold for most of the sampling season except in May.

Dissolved oxygen levels at site PQB036 (the upper site on Pequid Brook) have been very low in past years and were again in 2020. DO levels at this site in 2020 started at 4.80mg/l in May, but ranged from 0.35mg/l to 1.40mg/l for the remainder of the sampling season (excluding August when no sample was taken), which suggests hypoxic conditions for the duration of the summer and early Fall. Interestingly, in past years, the DO levels in October were higher than levels in the summer months, but in 2020 the lowest value was observed (DO = 0.35mg/l), which can be considered anoxic, or having no dissolved oxygen.

Of the sites sampled, the Massachusetts Division of Fisheries and Wildlife considers Ponkapog Brook to be a cold-water fish resource, which means that levels should remain above 6 mg/l (but important to note that MassDEP has not designated this stream as a cold-water fishery for purposes of the MA Water Quality Standards). Site POB040 is on Ponkapog brook

and values in June (DO = 5.2mg/l), August (DO = 4.54mg/l), and September (DO = 5.85mg/l) were less than this more stringent threshold.

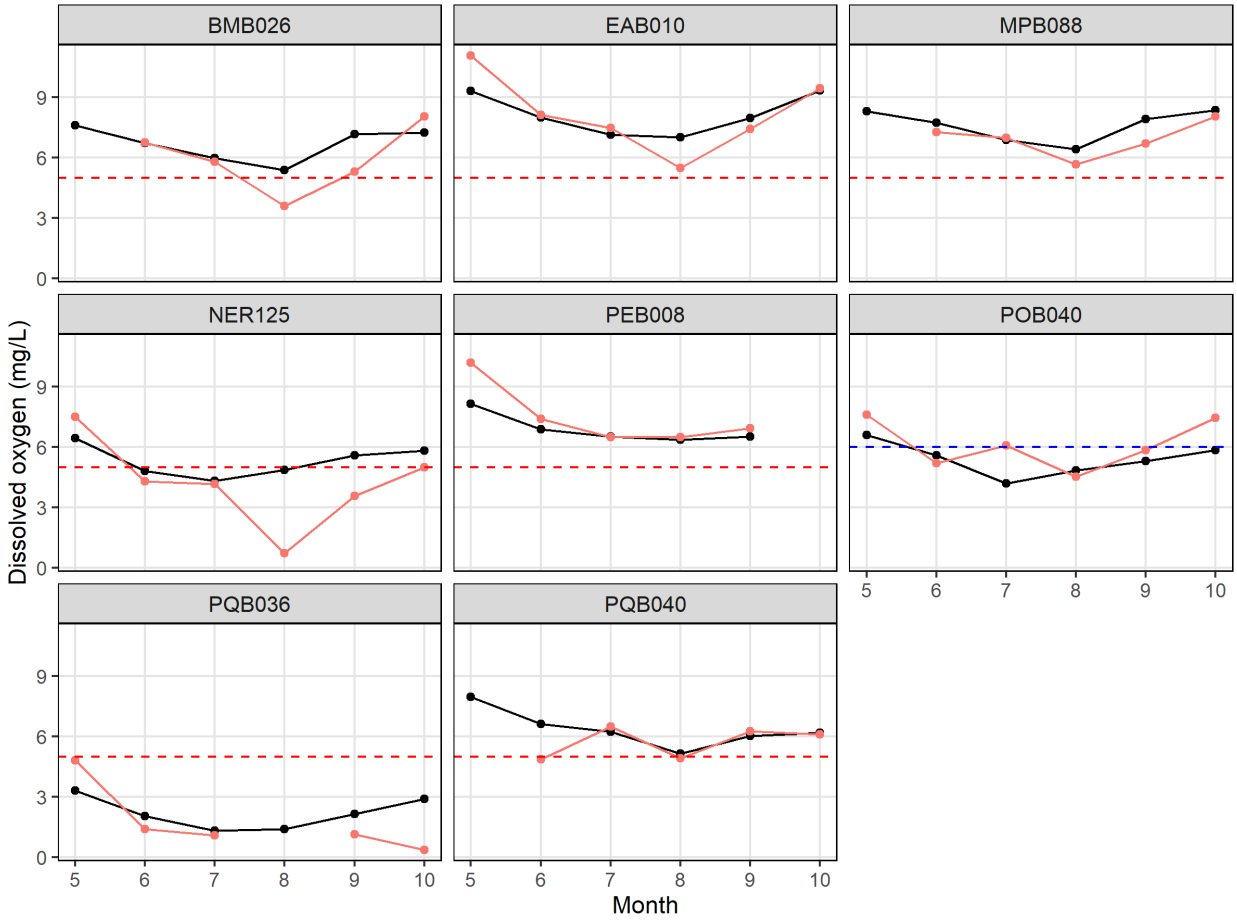

Figure 6: Monthly dissolved oxygen levels at each of the eight sites in Canton. The black line shows the mean monthly value from 2010 to 2019 and the red line shows the 2020 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l.

Conclusion

The water quality data that we collect through the CWMN program is used to inform our messaging to the public and follow up site visits to sites to investigate problems (hot spot sampling). Table 6 details our recommendations and items to discuss with the Town.

Table 6: Major parameters of concern by site with recommendations on first steps to address the problem. * signifies a critical problem. DO = Dissolved oxygen.

Site	Parameter	Recommendation
PQB036	DO*	• Reduce nutrient loads and organic content • Evaluate flow rates and shading throughout the summer and fall

	TP*	• Sample for primary producers (algae, Chlor a) and survey for overgrowth of aquatic plants in stream and at Reservoir pond • Identify sources of TP
NER125	DO*	• Evaluate flow rates and shading in August • Evaluate loads of organic matter
POB040	DO	• Reduce nutrient loads • Assess shading and flow rates during the summer months
	TP	• Identify sources and cause for increase • Assess aquatic plant growth
	E coli	• Conduct bacterial source identification survey
PQB040	TP	• Identify sources and cause for increase • Sample for primary producers in Forge Pond
	E. coli	• Identify source of peak levels during dry weather and the consistent high levels during the other dry weather sampling events. • Identify sources of wet weather elevated levels. Sample during more rain events to increase the sample size of wet weather and determine if the elevated levels in 2020 are a continuing issue or a one-time event.
BMB026	TP	• Identify new sources that could have led to increase in 2020 • Sample for primary producers in Bolivar Pond
PEB008	TP	• Identify sources and cause for increase
	E coli	• Source identification