2023 Water Quality Report, Canton, Massachusetts

Prepared by Sean McCanty, Ph.D.
River Restoration Director
Neponset River Watershed Assocation

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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. As part of the Community Water Monitoring Network (CWMN), volunteers collect monthly water samples annually from May to October. Data gathered by the CWMN volunteers are used to track the health of the Neponset River and its tributaries, inform the public about threats to human health and wildlife, 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

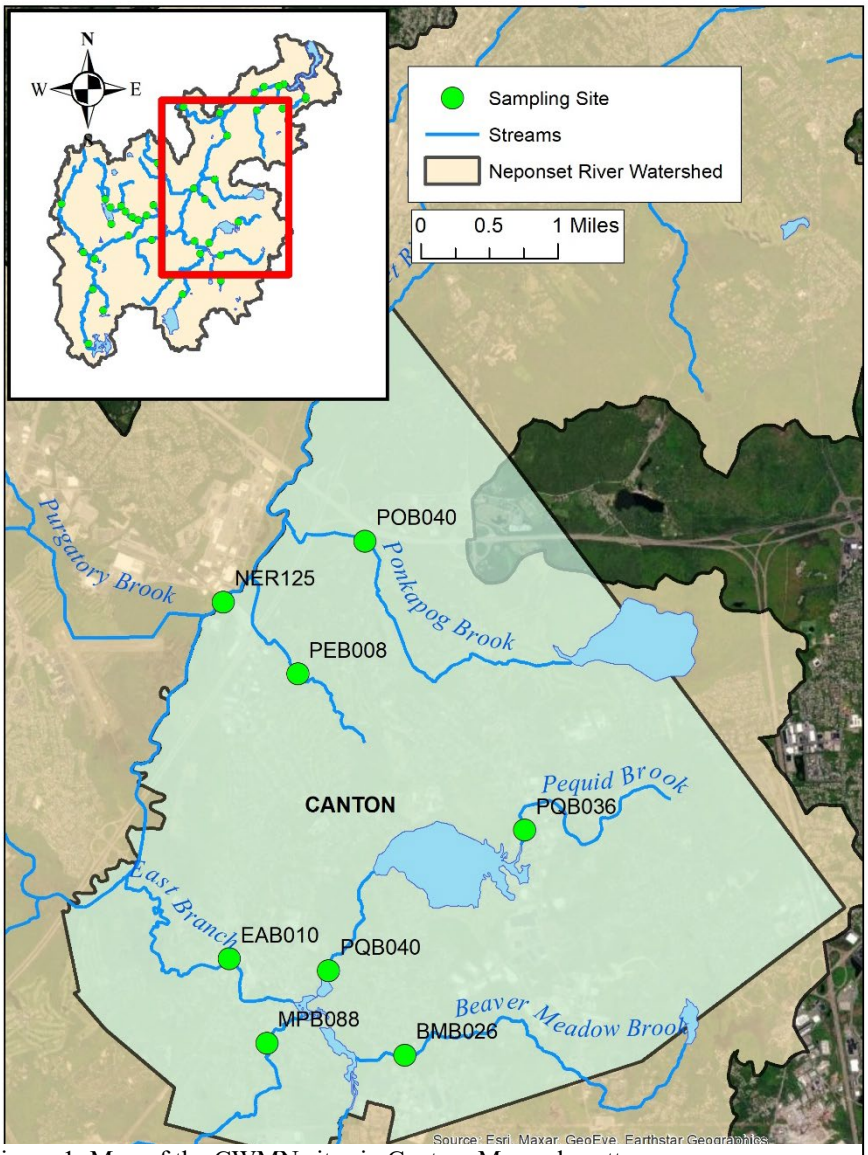

Figure 1: Map of the CWMN sites in Canton, Massachusetts.

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

E. coli bacteria concentration is used by NepRWA and the Commonwealth to assess a waterbody's safety for "contact recreation" through activities such as swimming (primary contact) and boating (secondary contact). The presence of *E. coli* is not necessarily hazardous itself, but it provides evidence of fecal contamination and is an indicator that other, more dangerous, pathogens associated with human and animal waste might be present. The most common source of excess *E. coli* in our watershed is the 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,* so some amount of *E. coli* in waterbodies is normal. However, elevated concentrations from wildlife are typically due to human activities, such as feeding ducks or large populations of geese. 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 or infiltration 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. This means that plants and algae will grow until the lack of phosphorus limits them. 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, leading to a process called eutrophication. When these excess plants and algae die, the process of decomposition by bacteria and other decomposers consumes dissolved oxygen from the water. 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 loss of underwater plant communities due to reduced light penetration in turbid and algae-rich waters. Elevated phosphorus concentrations can also cause *harmful* algal blooms (HABs), where toxins are produced by the algae. A notable culprit is cyanobacteria, which produce toxins harmful to people and pets as well as wildlife.

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, from fine dust particles and aerosols. 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 acidic the water is, with low pH meaning the water is more acidic than neutral, and high pH meaning it is more basic or alkaline. Water that is too acidic or too basic can be toxic to aquatic life. The pH is influenced by soil and bedrock characteristics, groundwater seepage, acid rain, carbon dioxide in the atmosphere, 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 can sustain higher concentrations 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 increase levels of DO due to atmospheric mixing. Aquatic plants also generate oxygen via photosynthesis during daytime hours. Alternatively, large amounts of decaying organic matter consume dissolved oxygen as microorganisms degrade the organic matter and lower levels of DO result, particularly in overnight hours when decomposition is not offset by active photosynthesis. 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 withdrawals / diversions, and reducing decaying organic matter though the reduction of phosphorous runoff and other drivers of eutrophication.

Results and Discussion

Monthly sampling events occur rain or shine on the second Thursday of the month during the sampling season. This means that weather is not a criterion in determining when to collect water quality data. This allows our sampling program to address the different conditions that occur in our waterbodies in wet vs. dry weather. Rain events result in significant increases in street runoff via stormwater and overland flow into our rivers, which can significantly alter the concentrations of bacteria, nutrients, and other chemicals. In 2023, two sampling days occurred during wet periods and four sampling days occurred during dry periods, matching the 10-year average, while overall the region experienced above average precipitation. 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, the wet/dry ratio of sampling events can vary substantially year-to-year, and may not always reflect drought or flood years. For example, 2021 and 2020 had all but one sampling event occur in dry weather, despite being a drought and flood year respectively. This variability in wet weather sampling suggests we should be cautious in any improvements or changes in parameters, especially for *E. coli*, as the relative improvement may reflect wet vs. dry dynamics more than real improvements to water quality or changes in the frequency of sewage spills. As climate change shifts precipitation patterns, a change in sample collection or weighting may be needed to track water quality changes.

Table 1: The number of water quality sampling days that occurred during dry or wet weather since year 2013.

Year	Dry (days)	Wet (days)
2013	5	1
2014	4	2
2015	4	2
2016	6	0
2017	4	2
2018	3	3
2019	3	3
2020	5	1
2021	5	1
2022	2	4
2023	4	2

Escherichia coli (E. coli)

In Massachusetts, the criteria that defines acceptable levels of *E.coli* in Class B waterbodies (waterbodies that support wildlife, swimming, and boating, but not drinking) was formerly set by a single sample maximum (235 Colony Forming Units (CFU) per 100 mL) and geometric mean calculation (not to exceed 126 CFU/100mL). State level assessment of bacterial impairment now have criteria set by both a statistical value threshold (<10% of samples should exceed 410 CFU/100mL) and a rolling geometric mean calculation (not to exceed 126 CFU/100mL in 20% of windows). Because NepRWA's sampling is performed monthly rather than weekly, and the purpose of these reports is to provide meaningful historic comparison, the new criteria will not be applied in this report. For sites in Canton, this means no single sample should exceed 235 CFU/100 mL (the single sample standard), nor should the geometric mean of at least 3 sequential samples taken within the same season exceed 126 CFU/100mL (the seasonal standard). For ease of interpretation and for historic comparison, NepRWA calculates the geometric mean on the whole sampling season (6 sampling events).

In 2023 maximum *E. coli* levels at seven sampling sites exceeded the 235 CFU/100mL single sample limit and four exceeded the 126 CFU/100mL seasonal average (Table 2). The highest levels were observed at Massapoag Brook, which had more than 40 times the threshold values for single sample maximum. Pequit Brook experienced the worst seasonal geomean for the year. Minimum *E. coli* levels were acceptable at all eight sites and East Branch met bacterial standards throughout the season. The seasonal standard was low at the two sites on the "mainstem" of the river, NER125 and EAB010 (Table 2). This suggests the largest issues are with the tributaries in Canton. Combined with data from 2021, which showed all tributary sites above state guidelines in summer dry weather as well, it appears that Canton tributaries are experiencing both runoff and potential sewage related issues.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the eight sampling sites in Canton, MA, year 2023. N=6 for each site. Units are in cfu/100ml. Bold rows and values were sites with *E. coli* levels that failed the single sample limit at least once. An * means the seasonal sample limit was surpassed.

CWMN Site	Maximum	Average	Minimum	Geometric Mean
BMB026	**301**	110	51	84
EAB010	187	93	52	81
MPB088*	**9800**	**1753**	10	**174**
NER125	**3870**	**706**	10	96
PEB008	**4350**	**939**	10	118
POB040*	**3450**	**654**	63	**165**
PQB036*	**3870**	**1474**	20	**404**
PQB040*	**959**	**280**	41	**164**

Table 3: The maximum *E. coli* levels from samples in 2023 in wet and dry weather. N = 2 for wet weather and N = 4 for dry weather. Bolded values indicate *E. coli* levels above state criteria, and bolded sites names reflect sites above the criteria even in dry conditions.

Site	Dry	Wet
BMB026	85	**301**
EAB010	187	110
MPB088	189	**9800**
NER125	85	**3870**
PEB008	74	**4350**
POB040	156	**3450**
PQB036	**2380**	**3870**
PQB040	187	**959**

Wet weather events were generally associated with higher *E. coli* levels in past years at all the sampling sites in Canton, with the exception of 2020 (Figure 2). While this is unusual, because of the low sample size of wet weather that year (N=1), it may represent outlier data. For the 2023 data, the wet/dry patterns follow the typical trends for most sites.

Pequit Brook appears to have the greatest problem with *E. coli* for the streams in Canton in 2023. In both wet and dry weather, Pequit Brook was well above the state criteria, with wet weather samples higher than in the last ten years and dry weather values were the worst recorded since 2020 (Figure 2). However, all Canton tributaries have had recurrent problems with both single station maximums and seasonal averages, suggesting a systemic problem at these sites with *E. coli*. In 2022, Pecunit Brook experienced the worst results, including high

dry weather concentrations. The shift in site outcomes suggests a systematic approach, rather than site specific might yield greater results. While E. coli is a concern at all Canton sites, the number of high *E. coli* counts in the smaller brooks raises particular concerns about the health of these tributaries.

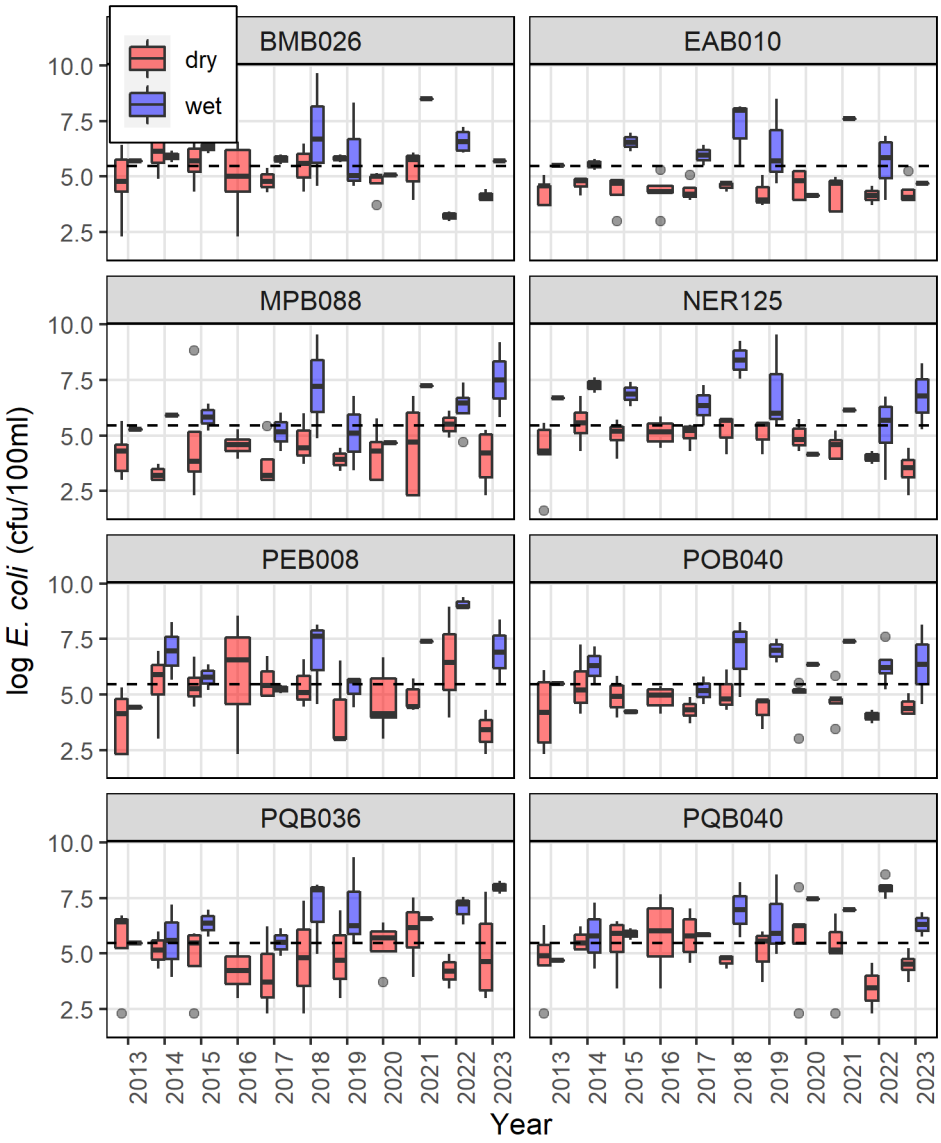

Figure 2: *E. coli* levels at the eight sampling sites in Canton from years 2013 to 2023 – note the log scale, which allows exponential data to be viewed more easily. The plot shows levels grouped by weather (blue = wet, red = dry). The black dashed line shows the single sample maximum acceptable threshold (235 CFU/100mL). The lower and upper bounds of each box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends to the largest value or no further than 1.5 * the range between these two quartiles. Similarly, the lower whisker extends from the hinge to the smallest value or 1.5 * this interquartile range. Data beyond the end of the whiskers are “outlying" points and are plotted individually.

Phosphorus

The Commonwealth of Massachusetts does not currently provide numerical standards for classification of water quality impairments by phosphorus alone. Instead, the Massachusetts Department of Environmental Protection (MassDEP) uses a narrative standard that considers the EPA gold book standard for phosphorus alongside dissolved oxygen levels and excessive primary producer growth. 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 phosphorus levels are causing an impact to the stream ecology.

In 2023, only one Canton site had a seasonal phosphorus average above the EPA standards, Pequit Brook at Del Pond Dr. However, MPB088, POB040, PQB036, and PQB040 all had maximums above the phosphorus threshold and PQB040 had an average that equaled the standard (Table 4). POB040 was the only flowing site with a maximum above the threshold.

Table 4: The maximum, average, and minimum values of total phosphorus recorded during 2023 at the 8 sampling sites in Canton. Sites broken out into flowing waters or those entering a lake or reservoir. Bolded rows have a seasonal average that exceed the EPA gold book standard for total phosphorus. N=6 for each site.

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)	Standard (mg/l)
Flowing				
EAB010	0.05	0.03	0.02	0.1
NER125	0.09	0.06	0.03	0.1
PEB008	0.10	0.07	0.04	0.1
POB040	0.12	0.07	0.03	0.1
Entering Reservoir				
BMB026	0.05	0.04	0.02	0.05
MPB088	0.08	0.04	0.02	0.05
PQB036	0.09	**0.06**	0.02	0.05
PQB040	0.07	0.05	0.03	0.05

The levels of total phosphorus in 2023 at the flowing water sites do not appear to be concerning (Figure 3). However, in the past few years, site POB040 has had total phosphorus levels above the threshold multiple times, as it did this year. Similarly, Pecunit Brook had elevated

phosphorus levels last year relative to the last decade, which combined with the bacteria data discussed above makes more investigation at these sites merited.

In contrast, the levels of total phosphorus at the sites with the more stringent standard did not comply with the standard at one of the four sites. Pequit Brook appears to have the largest problem with total phosphorus levels, particularly at PQB036. However, three of the four sites showed a decline or no change relative to previous years (Figure 4). Site PQB036 water samples have had concerning phosphorus levels during a majority of sampling events since 2013. At site PQB040 total phosphorus levels appeared to be increasing annually since 2017, yet the last 3 years showed a stabilization.

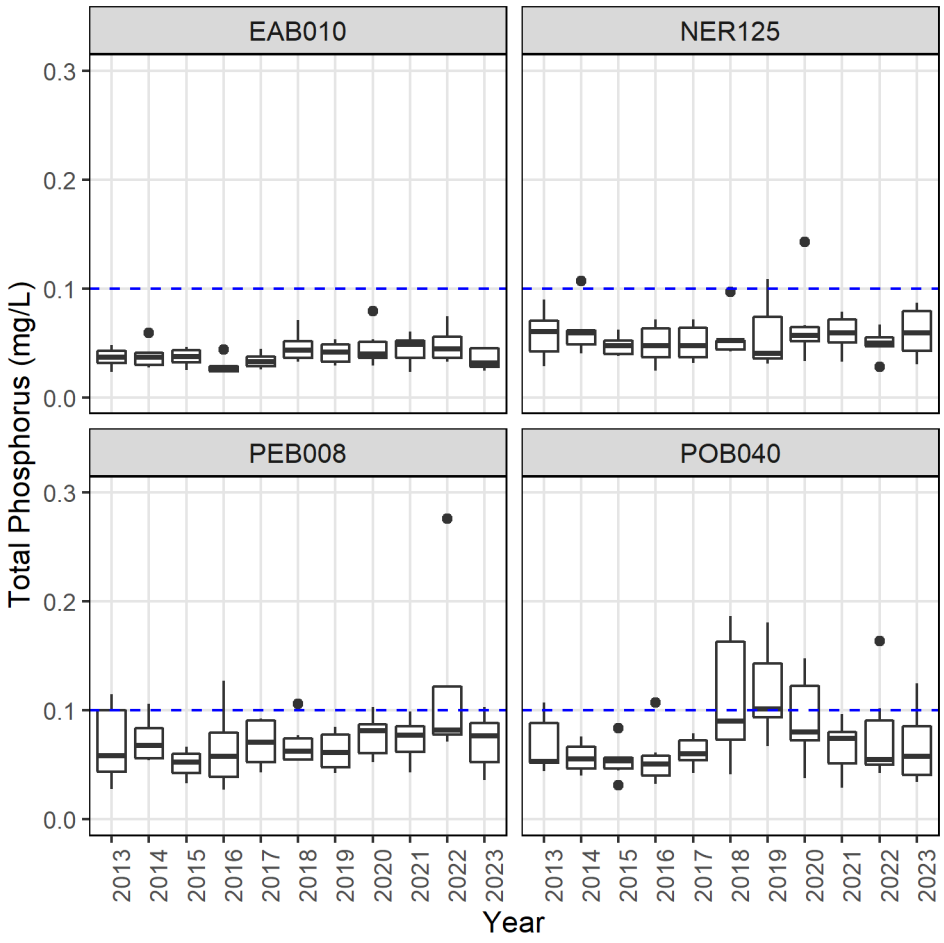

Figure 3: Total phosphorus levels at the four flowing water sites in Canton from year 2013 to 2023. The blue dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 2.

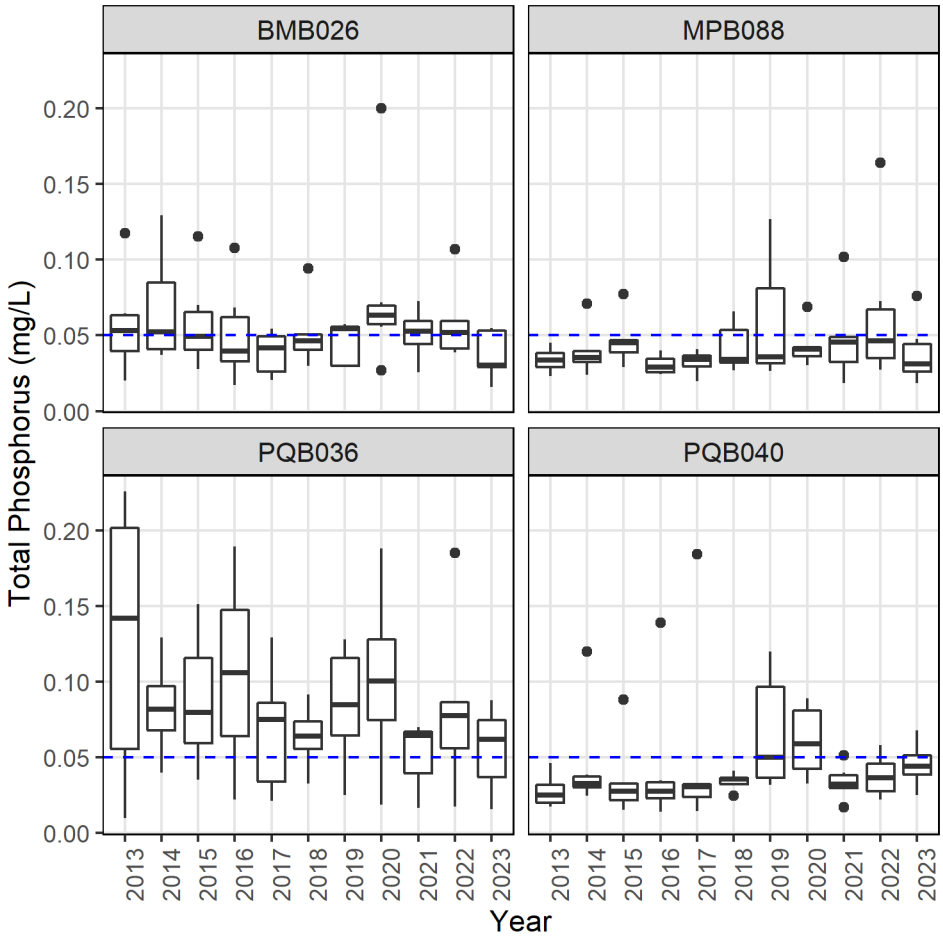

Figure 4: Total phosphorus levels at the four stream sites that are entering a lake or reservoir in Canton from year 2013 to 2023. The blue dashed line is at 0.05mg/l. Boxplot statistics are the same as Figure 2. Note that the y-axis range is different than Figure 3.

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 POB040, and PEB008.

Table 5: Correlation coefficient (r) between total Phosphorus levels and dissolved oxygen levels at the eight sites in Canton, MA using data from 2013 - 2023.

Site	r
PQB036	-0.49
POB040	-0.45
PEB008	-0.33
NER125	-0.32
BMB026	-0.2
MPB088	-0.17
PQB040	-0.17
EAB010	-0.03

pH

The Commonwealth of Massachusetts considers a pH range between 6.5 and 8.3 SU (standard units) to be healthy for waterbodies in the state. All sites in Canton failed to meet the pH standard in 2022 for at least one sampling events, possibly due to low flow conditions in the drought (Figure 5). However, in 2023, these segments appear to have recovered. Such largescale change at multiple sites in Canton, and seen across the watershed, is likely drought related, but these values should be closely monitored over the next few years, especially as extreme weather becomes more common.

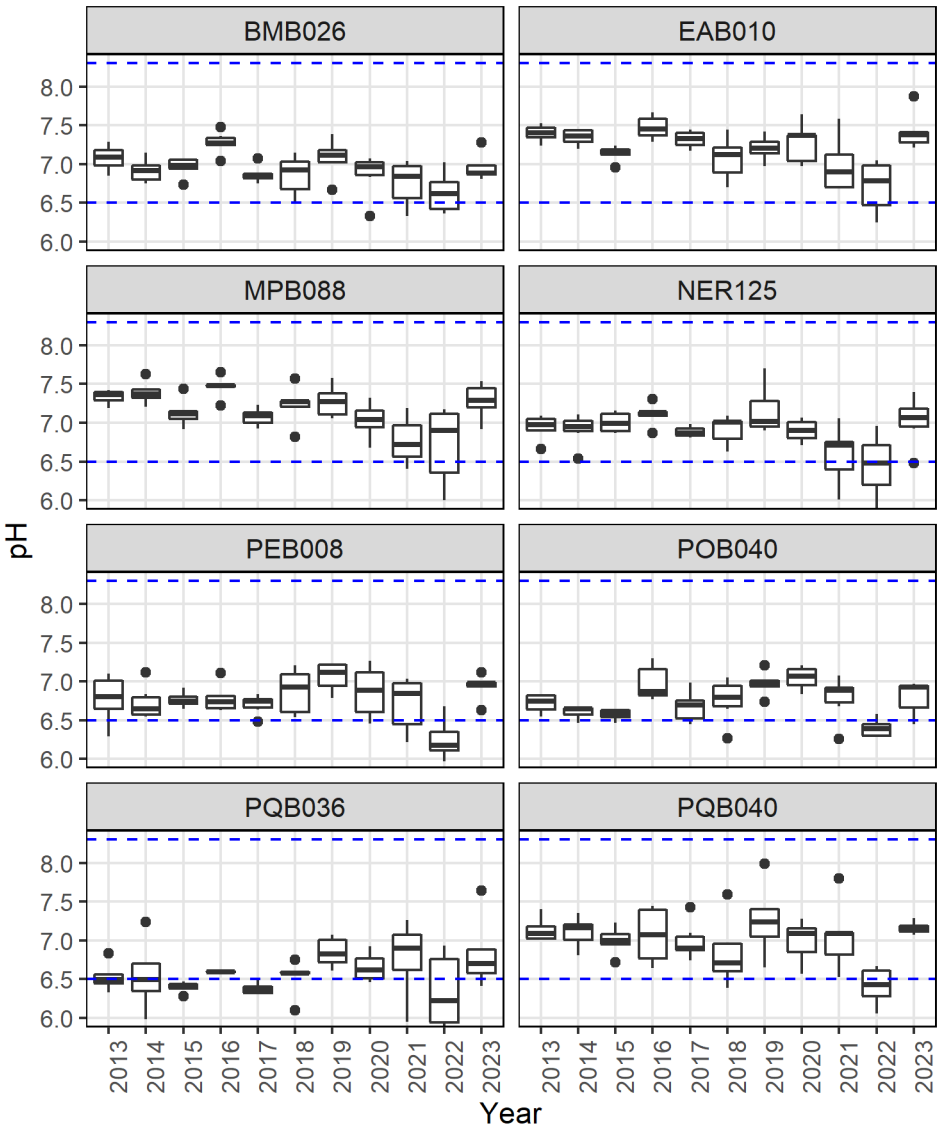

Figure 5: The pH levels at the eight sites in Canton for years 2013 through 2023. Boxplots statistics are the same as Figure 2. The blue dashed lines are at pH = 6.5 and pH=8.3, the criteria range for pH level in Massachusetts.

Dissolved Oxygen:

The Commonwealth of Massachusetts considers DO levels below 5 mg/L to be stressful to all aquatic organisms and 6 mg/L to be stressful to certain species of fishes that require colder water. Ponkapoag Brook is listed as a Coldwater Fish Resource by the Massachusetts Division of Fisheries and Wildlife, so we apply the 6 mg/l threshold for this site and the 5mg/l threshold elsewhere. However, it is important to note that the Massachusetts DEP does not recognize Ponkapoag Brook as a cold-water fishery stream and they are therefore not regulated as such under the Surface Water Quality Standards.

Levels of DO at three sites were lower than the thresholds at some point during the sampling season, with only EAB010, MPB088, NER125, PEB008 and PQB040 consistently meeting standards (Figure 6). NER125, PEB008, and POB040, all dipped below their respective criteria during the prior sampling year, but only slightly, which suggests a small margin of error for negative impacts to oxygen. BMB026 and PQB036 experienced the worst dissolved oxygen values, with nearly all samples below the state criteria and with four and one sampling events with hypoxic conditions (<3mg/l), which cannot support many aquatic species. It is not surprising that PQB036 also had the strongest negative correlation between phosphorus levels and dissolved oxygen, suggesting eutrophication may be playing a role here. Finally, BMB026's low values follow from 2022 where it had highly variable dissolved oxygen values, dipping into borderline hypoxic conditions several times over the year. Both BMB026 and PQB036 merit further DO investigations to determine causes and potential solutions to hypoxia.

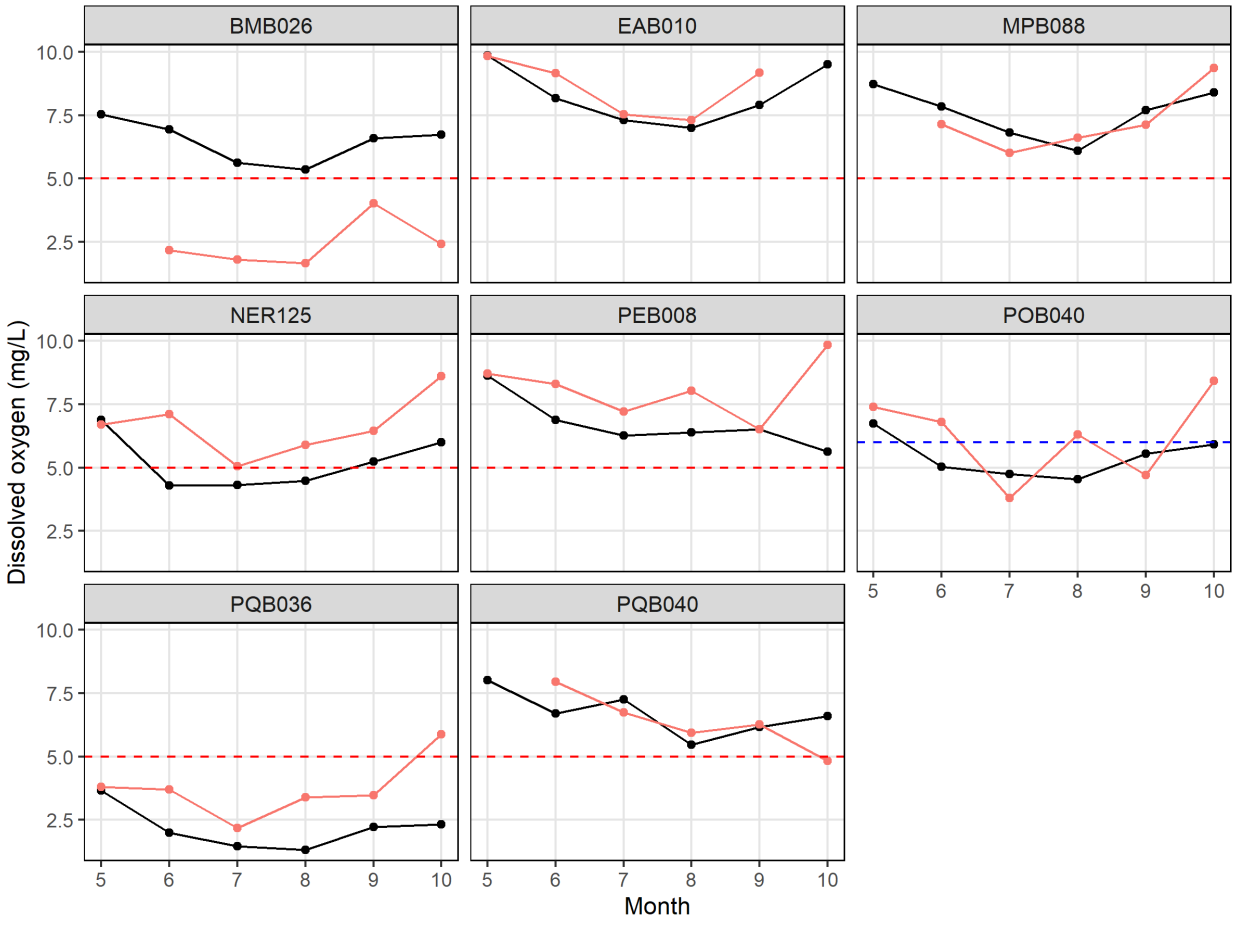

Figure 6: Monthly dissolved oxygen levels at each of the eight sites in Canton. The black line shows the mean monthly value from 2013 to 2022 and the red line shows the 2023 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l (Ponkapoag Brook only).

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 **Pequit Brook @ Del Pond Dr.**	DO*	• Reduce nutrient loads and organic content • Evaluate ways to increase flow rates and shading throughout the summer and fall • Consider continuous monitoring of DO with loggers to identify key changes over time
	TP*	• Sample for primary producers (algae, Chlorophyll-a) and survey for overgrowth of aquatic plants in stream and at Reservoir Pond • Identify sources of TP (runoff or inflows)
	E. coli	• Identify source of persistent issues with bacteria, including during dry weather (possible sewage contamination) • Conduct bacterial source identification survey, possibly including species ID • Compare bacterial testing from Reservoir Pond for potential loading concerns
NER125 **Neponset River @ Dedham St Bridge**	DO*	• Evaluate flow rates and shading in summer • Evaluate loads of organic matter, consider minor dredging or aeration to promote decomposition if sediment depth limits flow
POB040	DO	• Reduce nutrient loads • Assess shading and flow rates during the summer months

Ponkapoag Brook @ Elm St	TP	• Identify sources and any changes that may have resulted in lower TP this year • Assess aquatic plant growth via survey
PQB040 **Pequit Brook @ Sherman St.**	TP	• Identify sources and cause for increase • Sample for primary producers in Forge Pond
	E. coli	• Identify source of peak levels 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 **Beaver Meadow Brook @ Pine St.**	*E. coli*	• Identify wet weather sources of bacteria, develop BMPs to intercept high runoff flows
PEB008 **Pecunit Brook @ Elm St.**	TP	• Identify sources and cause for increases
	E. coli	• Identify highly elevated 2022 bacteria source, potentially follow up with source identification tracking for both dry and wet weather sources. • Develop wet weather runoff interception (BMPs)
MPB088 **Massapoag Brook @ Walnut St.**	*E. coli*	• Determine cause of consistently high bacteria loads in both wet and dry weather 2022.
EAB010 **East Branch @ Neponset St.**	*E. coli*	• Determine best interventions to divert wet weather runoff to limit high bacteria loads.