2023 Water Quality Report, Milton, Massachusetts

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Background

The Neponset River Watershed Association (NepRWA) has been collecting water quality data both in Milton 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 ten permanent CWMN stations within and bordering the Town of Milton: three on Pine Tree Brook, three on Unquity Brook and four on the Neponset River (Figure 1). Waterbodies in Milton are tested for *Escherichia coli* (*E.coli*), total phosphorus, pH, dissolved oxygen, and temperature. NER150, NER200, and PTB047 are also tested for ortho-phosphate, total nitrogen, and ammonia. The parameters discussed in this report are limited to those that are tested at every site including *E. coli*, total Phosphorus, pH, and dissolved oxygen. The raw water quality data are available upon request.

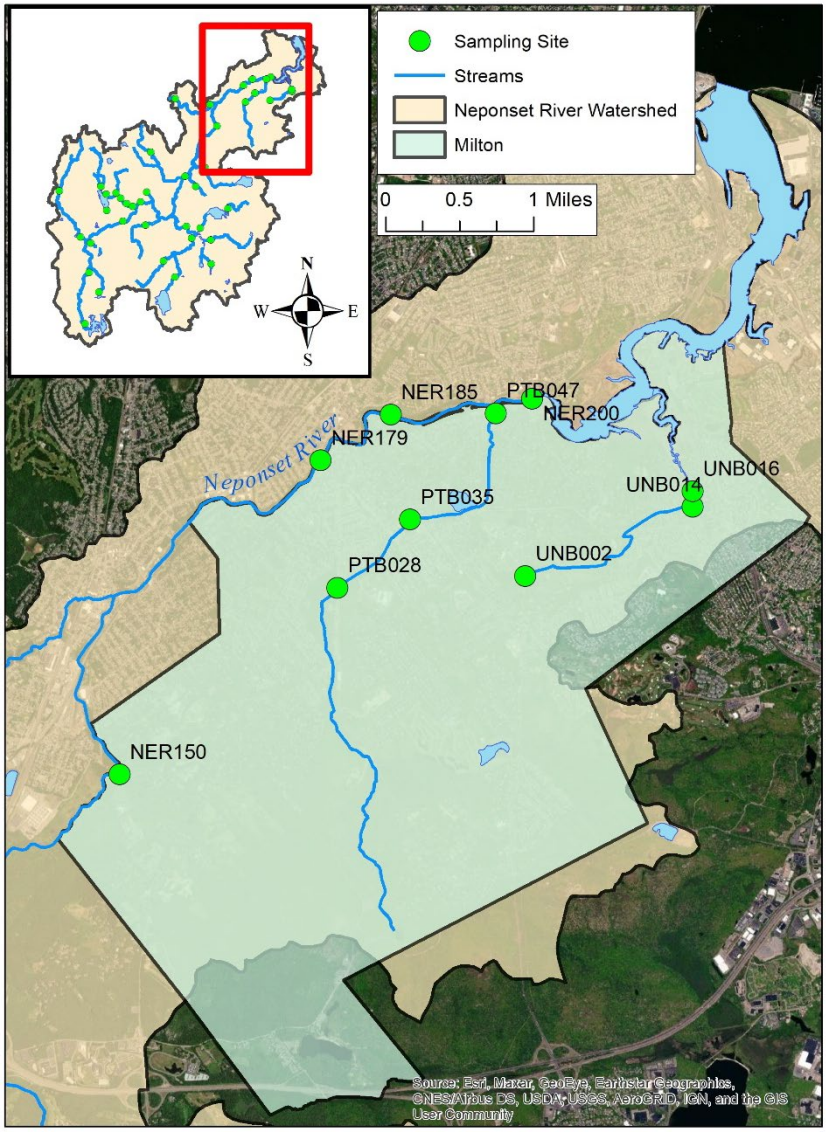

Figure 1: Map of the CWMN sites in Milton, Massachusetts.

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 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. 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 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. In particular, the 2022 drought influence in Milton was severe, with UNB002 being too dry to sample in two events, and PTB028 being too low to sample once.

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 Milton, 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 all ten of the sampling sites exceeded the 235 CFU/100mL single sample limit and the 126 CFU/100mL seasonal geometric average was exceeded at seven (Table 2). This marks slight improvement over 2022, when all 10 sites failed to meet the seasonal standard. The highest seasonal levels were observed in Pine Tree Brook and Unquity Brook, with the exception of the most upstream site on Pine Tree Brook (PTB028). In comparison to last year, no site in Milton exceeded the single sample maximum for its minimum value, although UNB002 nearly did. Broadly speaking, the mainstem of the Neponset sites faired better than either tributary, however the most downstream sites (NER185 and NER200) failed to meet the seasonal standard.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the ten sampling sites in Milton, MA, year 2023. Due to drought low flows, some samples were unable to be collected.

Sampling Site	Maximum	Average	Minimum	Geometric Mean	Samples
NER150	**2760**	**509**	10	82	**6**
NER179	**717**	212	31	97	**5**
NER185	**537**	221	41	**149**	**6**
NER200	**738**	217	30	**128**	**6**
PTB028	**1210**	**280**	31	106	**6**
PTB035	**794**	**543**	52	**390**	**5**

PTB047	**2100**	**623**	131	**364**	**6**
UNB002	**7700**	**2119**	228	**945**	**5**
UNB014	**4880**	**1102**	63	**408**	**6**
UNB016	**1110**	**496**	63	**323**	**5**

In 2023 there were four dry weather events that were sampled, with wet weather sampling only in August and September. Almost all sites showed the highest bacteria values for these two wet weather events (Figures 2-4). However, PTB035 had nearly identical values in the dry sampling in June. Interpretation of the wet weather data is made difficult by the confounding influence of seasonal changes over the year and the additional influence of intense rain throughout the summer, which may have routinely washed surface bacteria into waterways, even before dry samples were taken.

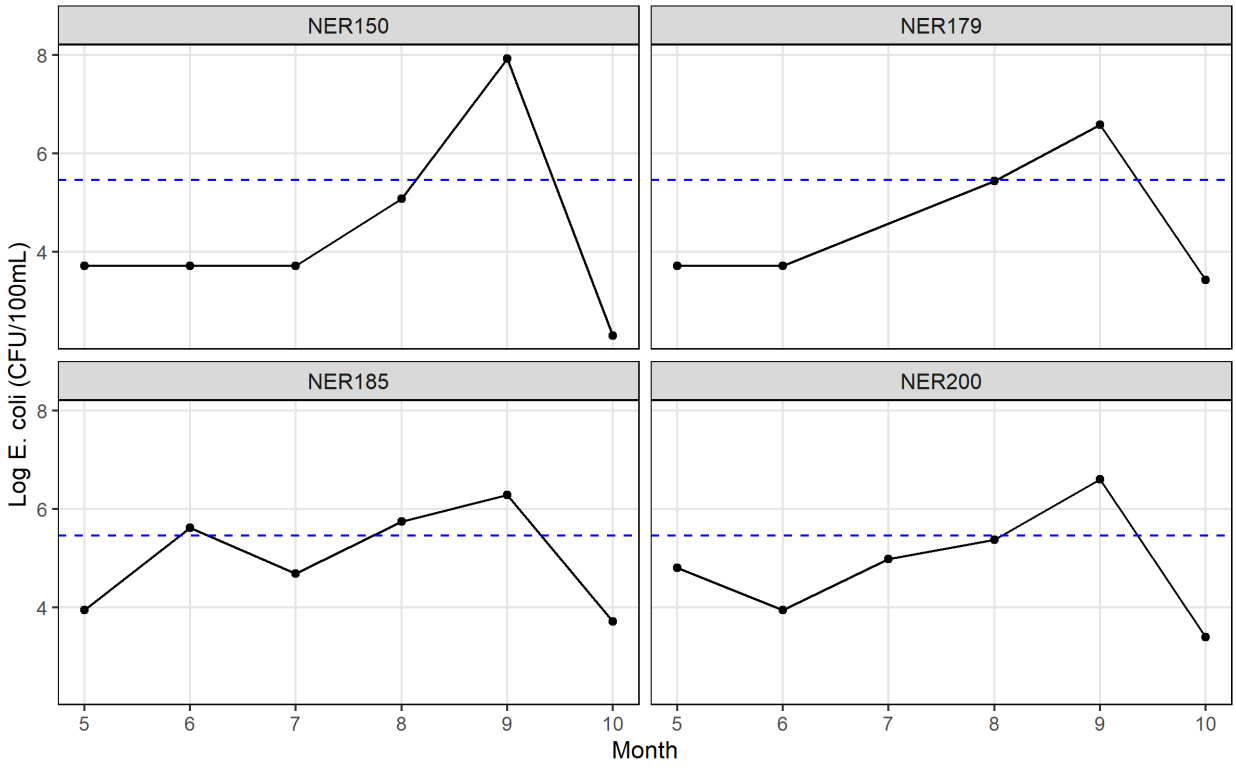

Figure 2: *E.coli* values at the Milton Neponset sampling sites for the 2023 year by sampling month. Black lines represent log-scaled *E. coli* values, with the dashed blue line representing the single sample maximum standard (235 CFU/100mL)

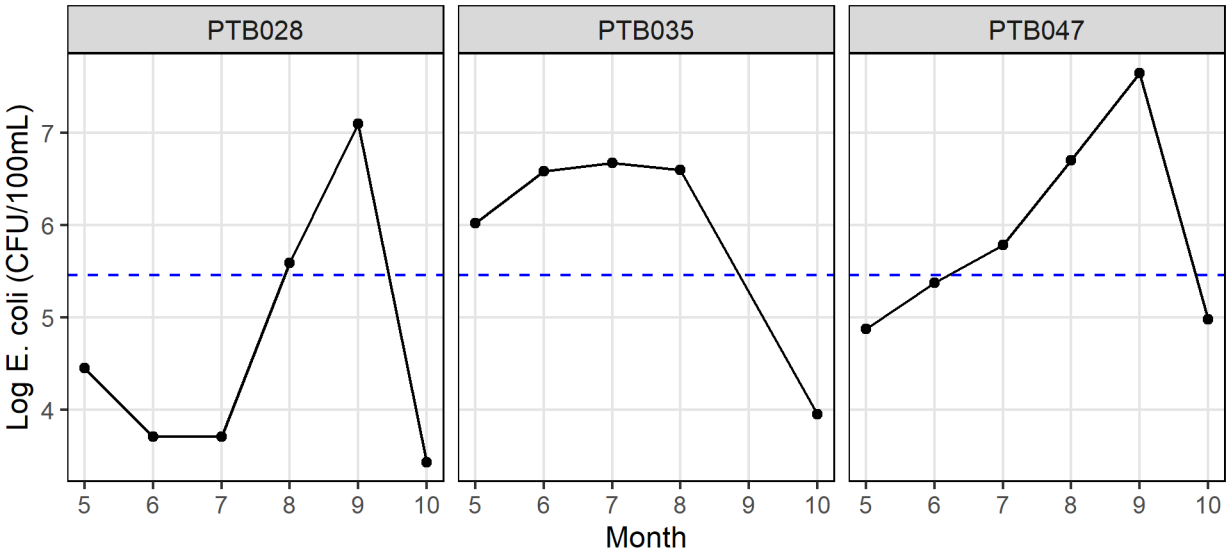

Figure 3: *E.coli* values at the Milton Pine Tree Brook sampling sites for the 2023 year by sampling month. Black lines represent log-scaled *E. coli* values, with the dashed blue line representing the single sample maximum standard (235 CFU/100mL)

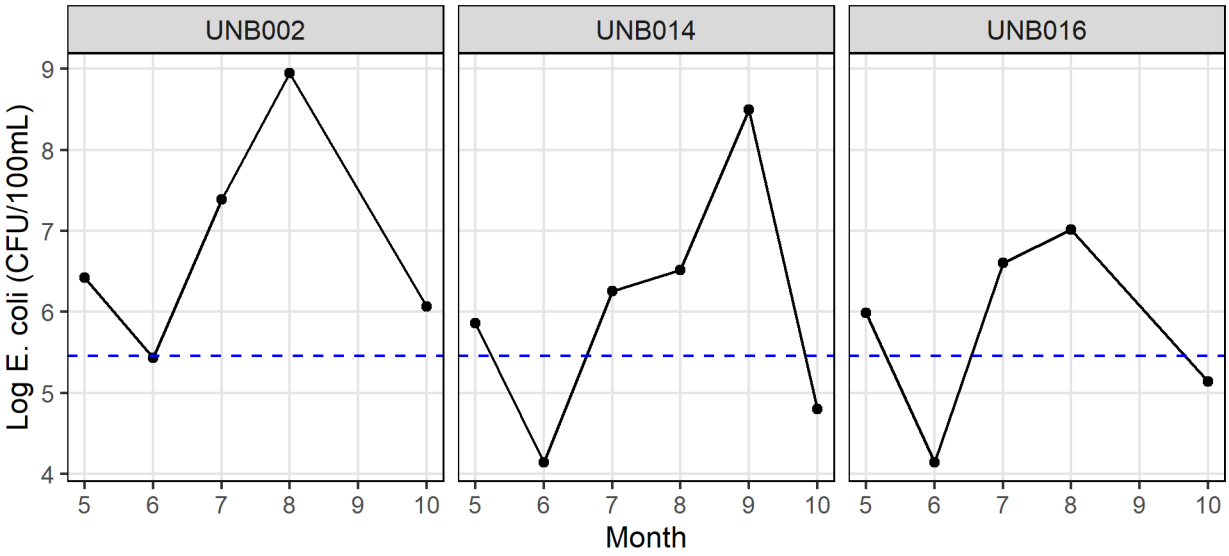

Figure 4: *E.coli* values at the Milton Unquity Brook sampling sites for the 2023 year by sampling month. Black lines represent log-scaled *E. coli* values, with the dashed blue line representing the single sample maximum standard (235 CFU/100mL)

Using data from 2013 onward, wet weather events generally lead to higher *E. coli* levels in the Neponset River (Figure 5), Pine Tree Brook (Figure 6), and Unquity brook (Figure 7). The levels during wet weather almost always exceed levels during dry events and similarly almost always exceed the single sample standard. While all wet weather samples end up exceeding the

single sample standard, only the upper reaches of the Neponset (NER150 and NER179) appear to consistently pass in dry weather. Unquity Brook appears to have the greatest problem with *E. coli* of any of the streams in Milton, with levels above the criteria consistently even in dry weather, however recent years have shown improvement for dry weather samples. Sites PTB035 and PTB047 also had high *E. coli* levels that have remained fairly consistent over the last decade, likely due to the high residential and developed area they flow through compared to the headwaters.

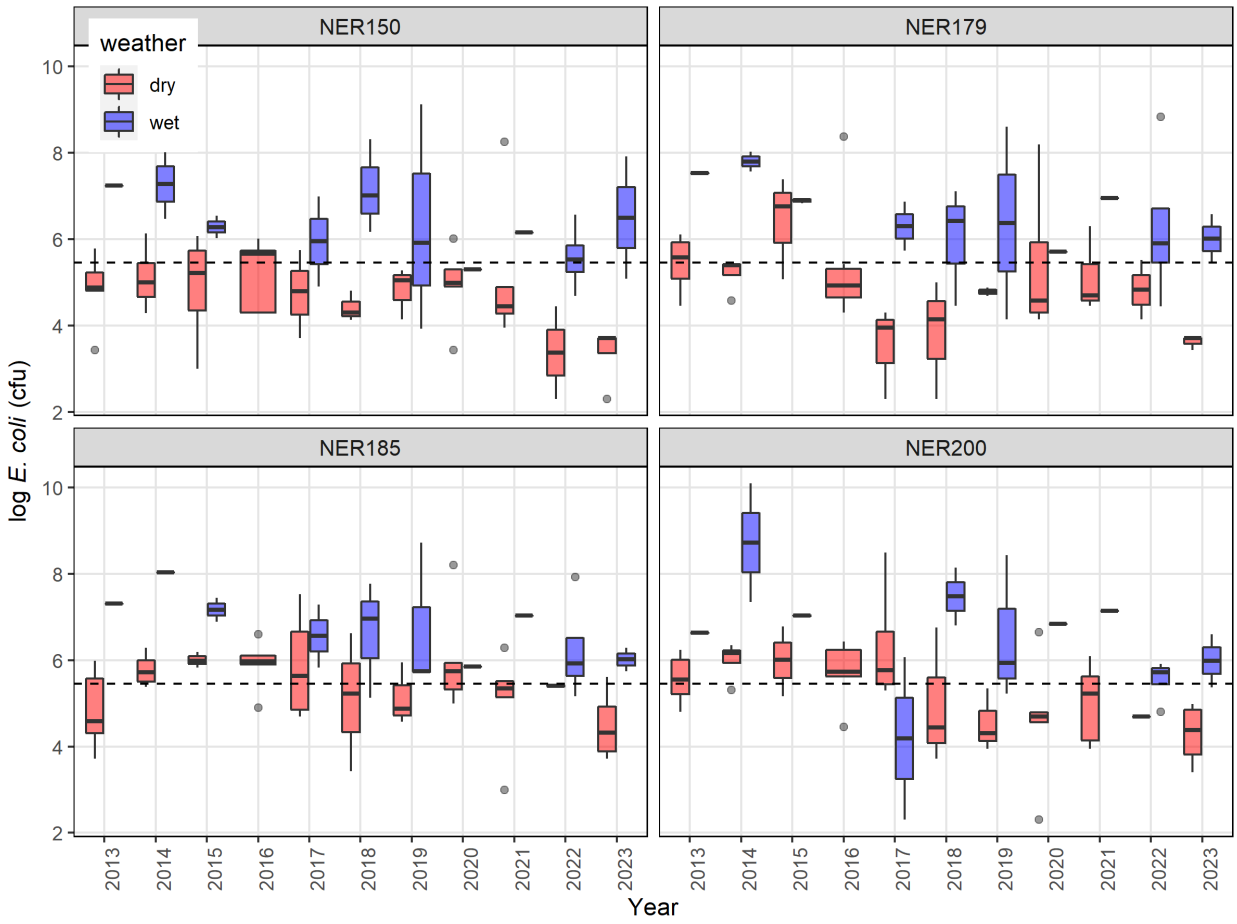

Figure 5: *E. coli* levels at the four sampling sites on the Neponset River from years 2013 to 2023. Levels are grouped by weather (blue = wet, red = dry). The black dashed line shows the single sample maximum acceptable threshold (235 CFU/100mL). The lower and upper bounds of each box correspond to 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.

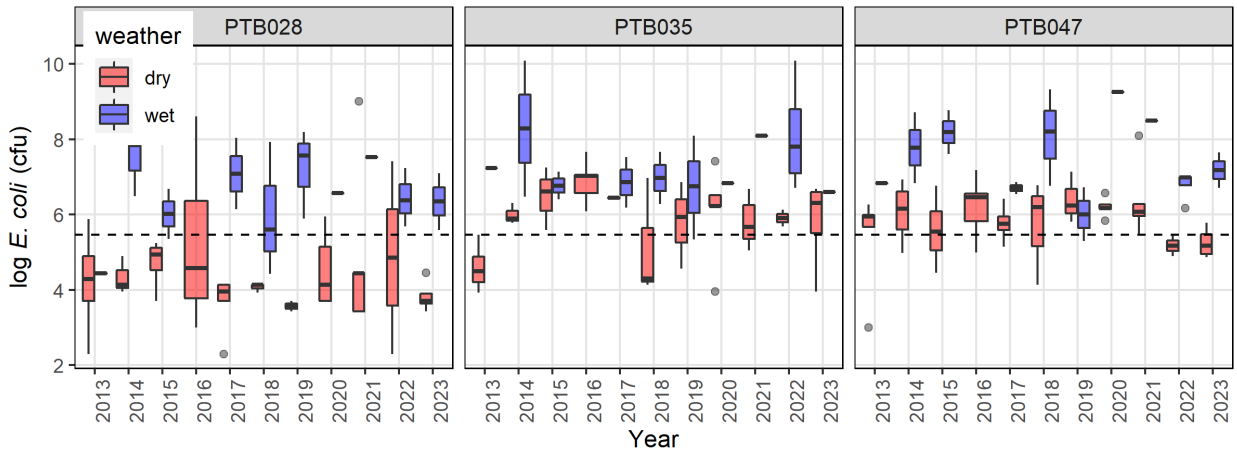

Figure 6: *E. coli* levels at the three sampling sites on Pine Tree Brook from years 2013 to 2023. Details are the same as in Figure 5.

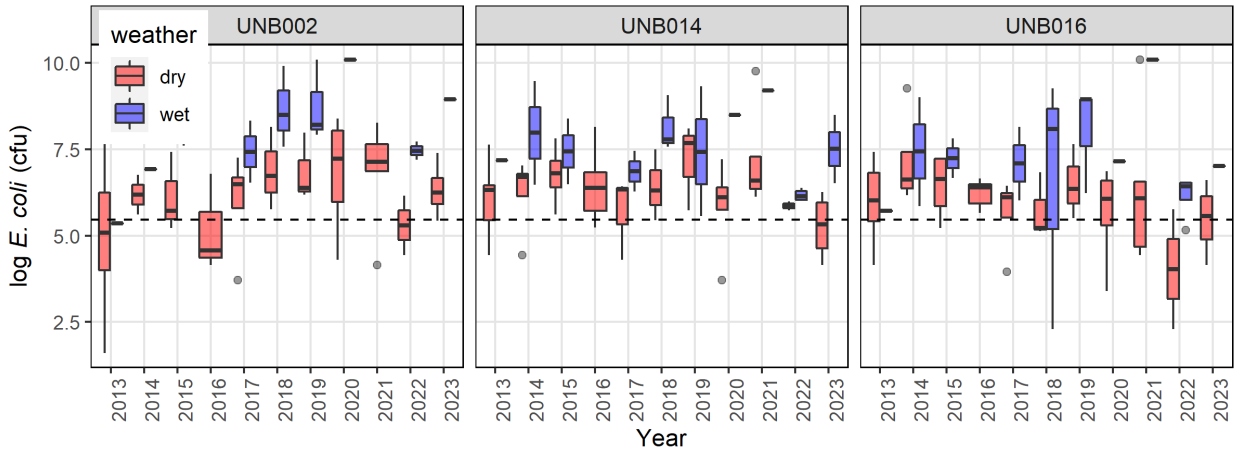

Figure 7: *E. coli* levels at the three sampling sites on Unquity Brook from years 2013 to 2023. Details are the same as in Figure 5.

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 consider all sites in Milton to be subject to the flowing

waters guidance. 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 2023, only one site in Milton had a season average that exceeded the 0.1mg/L Phosphorus: UNB002 (mean = 0.21 mg/L) (Table 3). The other nine sampling sites were below the threshold. However, the highest annual concentration samples at all Pine Tree Brook sites and the two upstream Unquity Brook sites (UNB002 and UNB014) did exceed the threshold.

Table 3: The maximum, average, and minimum values of total phosphorus recorded during 2022 at the 10 sampling sites in Milton. Bolded values represent exceedance of EPA recommended levels. Bolded site IDs have a seasonal average that exceeds the EPA gold book standard for total Phosphorus. N=6 for each site except for PTB028 (N-5) and UNB002 (N=4).

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)
NER150	0.1	0.06	0.03
NER179	0.09	0.06	0.04
NER185	0.09	0.07	0.05
NER200	0.1	0.06	0.04
PTB028	**0.11**	0.06	0.03
PTB035	**0.14**	0.07	0.03
PTB047	**0.15**	0.07	0.04
UNB002	**0.46**	**0.21**	**0.13**
UNB014	**0.12**	0.06	0.03
UNB016	0.07	0.05	0.03

The levels of total Phosphorus in 2023 appear consistent with past years in the Neponset River sites (Figure 8). Overall, phosphorus levels in the Neponset River do not appear to be a concern. The high levels at site NER150 in 2016 have not occurred in any years since. On Pine Tree Brook, levels appeared to be increasing annually at all three sites between 2015-2020, however in 2021 these values dropped to previous averages and were maintained since (Figure 9). The only exception is PTB035, where 2022 phosphorus levels once again rose higher and in general appear more variable. We would hope to see this low baseline remain in subsequent years. Levels have generally remained below the 0.1mg/l threshold in past years (except PTB035 in 2016 and 2020), but in year 2022, PTB035 averaged above the threshold again. The fact that these coincide with drought years merits further investigation, possibly due to low flow concentration or other input source. Similarly, total phosphorus levels on Unquity appear to have dropped following 2020's high values, except at UNB002, which now appears

consistently high. Likewise, the drought connection merits further investigation, as UNB002 values are highest in drought years 2020 and 2022, potentially suggesting a concentrating effect. Total phosphorus values continue to be generally below the 0.1mg/l threshold at UNB014 and UNB016, while UNB002 is more variable and above recommended values.

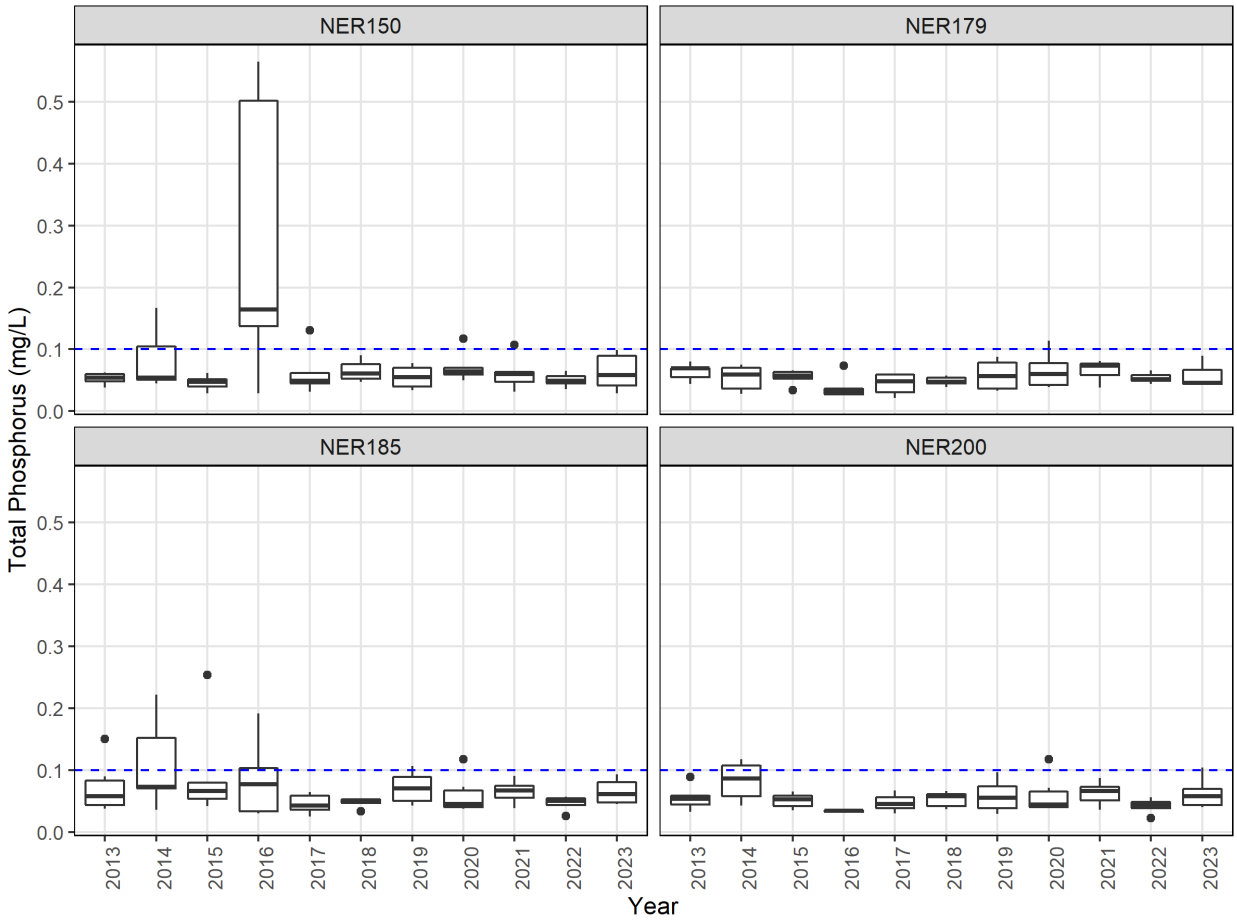

Figure 8: Total phosphorus levels at the four sites in the Neponset River from year 2013 to 2023. N >= 5 each year except NER200 in 2016 (N=4) and NER179 in 2019 (N=4). The blue dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 5.

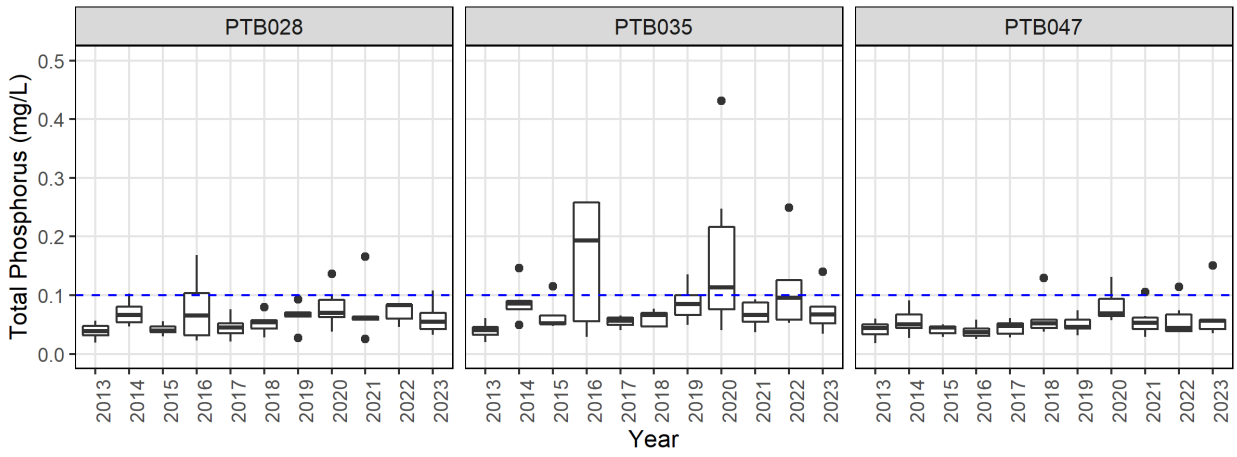

Figure 9: Total phosphorus levels at the three sites on Pine Tree Brook from year 2013 to 2023. N >= 5 each year. The red dashed line is at 0.1mg/l. Note that the y-axis range is different than Figure 5 and Figure 7. **Note that one extreme outlier was excluded on PTB035 in 2016, TP = 0.79.**

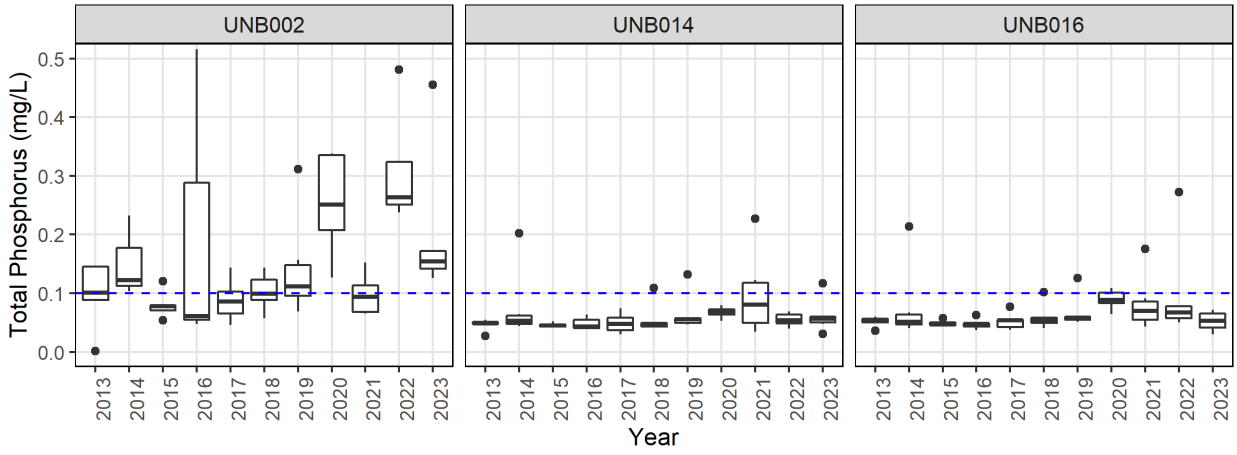

Figure 10: Total phosphorus levels at the three sites on Uniquity Brook from year 2012 to 2022. N >= 4 each year except UNB002 in 2014 and 2016, when N = 3. The blue dashed line is at 0.1mg/l. **Note that one extreme outlier was excluded on UNB002 in 2013, TP = 1.00.**

pH

The Commonwealth of Massachusetts considers a pH range between 6.5 and 8.3 to be healthy for waterbodies in the state. Almost all sampling events in Milton had unusually low pH values in 2022 but rebounded in 2023, possibly due to the impact of the drought and low flow leading to more acidic conditions. This effect was more pronounced in the tributaries, with UNB002 actually being fully outside the range during the sampling year, though only 3 events qualified due to no or low flow. The impact of drought on stream pH is a significant concern, and bolstering low level flow through groundwater improvements could aid both pH and other

biologically relevant parameters. In periods of adequate flow however, pH itself does not appear to be a high concern.

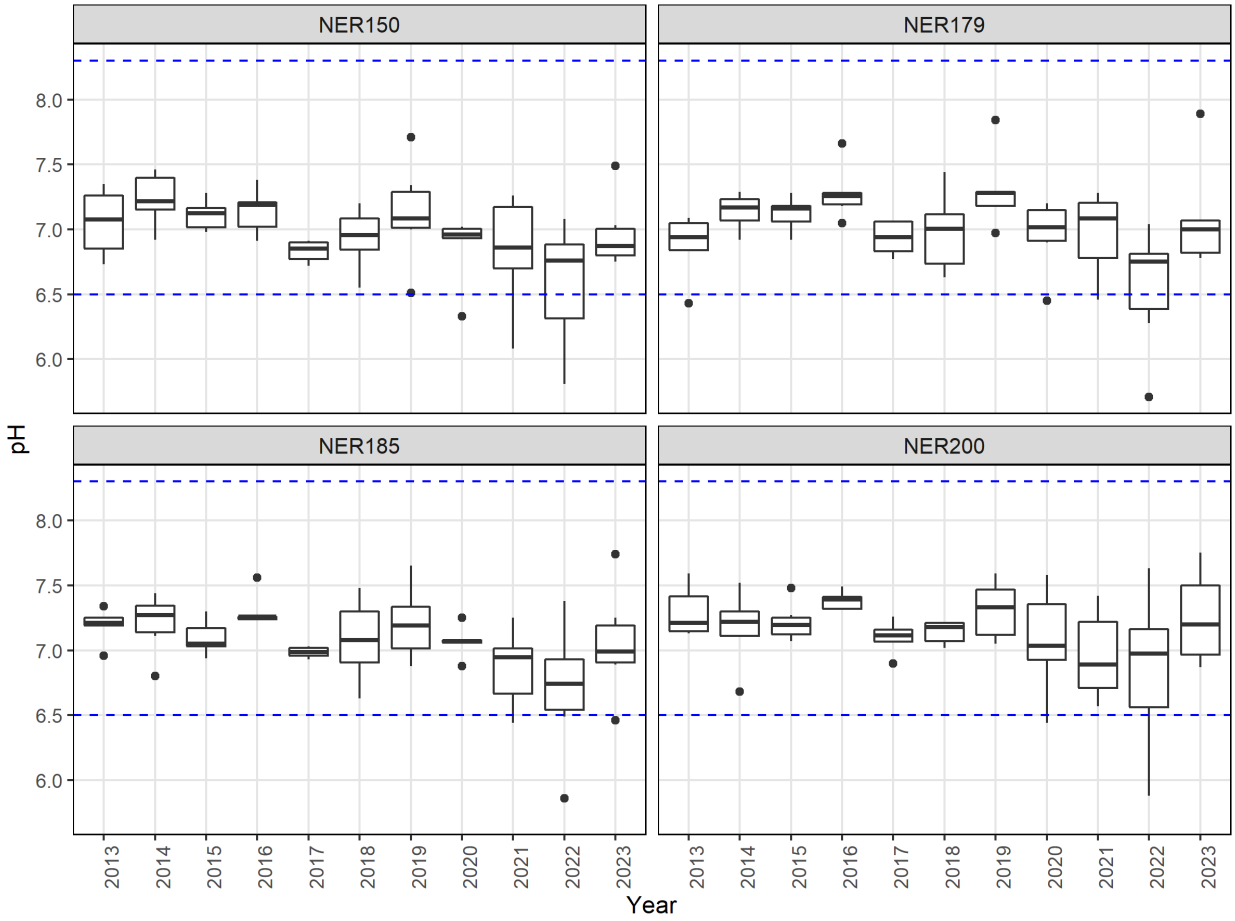

Figure 11: The pH levels at the four sites on the Neponset River. Boxplots statistics are the same as Figure 5.

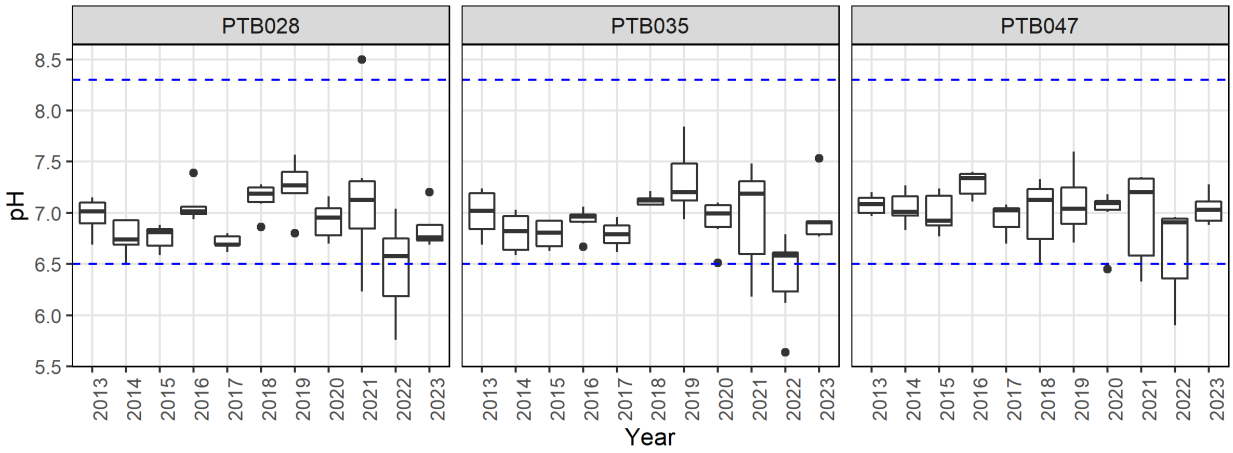

Figure 12: The pH levels at the three sites on Pine Tree Brook. Boxplots statistics are the same as Figure 5.

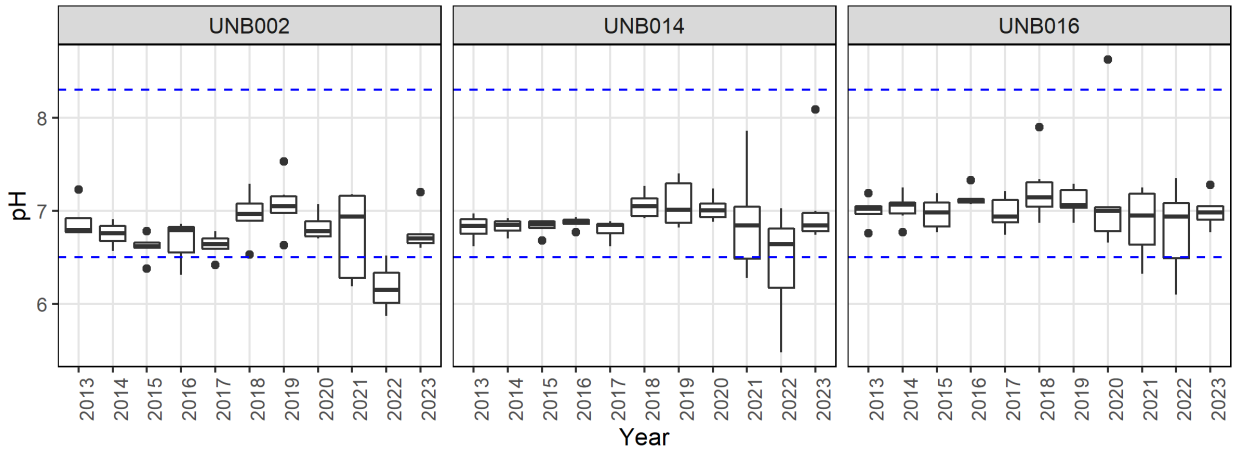

Figure 13: The pH levels at the three sites on Unquity Brook. Boxplots statistics are the same as Figure 5.

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. Pine Tree 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 those three sites and the 5mg/l threshold for the sites on Unquity Brook and the Neponset River. However, it is important to note that the Massachusetts DEP does not recognize Pine Tree Brook as a cold-water fishery stream and they are therefore not regulated as such under the Surface Water Quality Standards.

In 2023, monthly DO levels were similar to the average monthly levels for most sites (Figure 14), however NER179 showed a significant July drop, as did UNB002. Given this was a wet weather sample, there may be a relationship to stormwater inputs dropping dissolved oxygen levels. For the most part, the sites on the Neponset River remained above the 5mg/l threshold. The upper two sites on Pine Tree Brook (PTB028 and PTB035) typically experience low DO levels in the summer months whereas the lower site, PTB047, has adequate DO levels throughout the year, though 2023 had higher DO levels than the average trend. The low dissolved oxygen concentrations on Pine Tree Brook in summer months are particularly worrisome because it is a cold-water resource stream according to the Massachusetts Division of Fisheries and Wildlife and it supports a known population of Brook Trout further upstream. Unquity Brook actually experienced better than average DO values in 2023 and were above

DEP criteria in all cases except for the prior mentioned July sample at UNB002. The lower Unquity Brook sites have fairly consistent DO across the sampling season, instead of dipping in the summer as is typical at other sites.

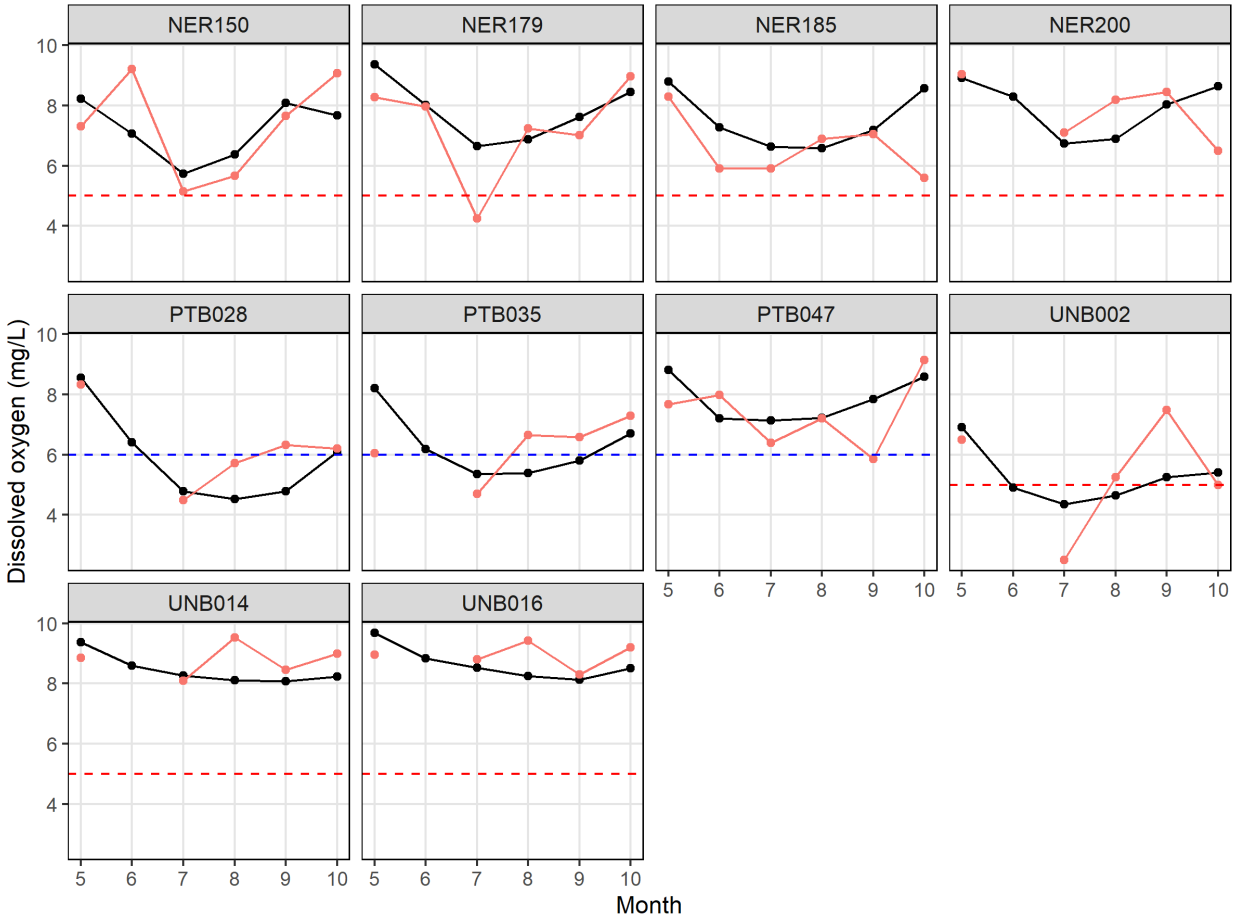

Figure 14: Monthly dissolved oxygen levels at the ten sites in Milton. The black line shows the mean monthly value from 2013 to 2022 and the red line shows the 2023 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l because Pine Tree Brook is listed as a coldwater fishery resource stream by Massachusetts Division of Fisheries and Wildlife.

Conclusion

All sites in Milton experience high *E. coli* levels - these values are high in wet weather, however other sites also experience problematic values in dry sampling weather as well. Identification of the source of high levels will help with implementing management interventions. This can be addressed through investigation of potential sewer leaks or DNA source tracking (human vs pets vs wildlife). Very high levels during a single sampling event could be caused by a one-time sewage leaks or contamination whereas consistent high levels

suggest a systemic problem that needs to be identified. Similarly, high levels during wet weather could suggest a problem with runoff whereas high levels during dry weather could suggest an issue with urban discharge. The Neponset mainstem sites are impacted by illicit discharges coming from Boston, which could direct additional hotspot sampling after reviewing Boston Water and Sewer IDDE results. While just one key site in Milton suffers from very high total phosphorus levels, primary producer data is needed to identify impacts to the ecology. We recommend investigating to identify the source of high phosphorus at sites on Pine Tree Brook that contributed to this trend in drought years, which are unfortunately becoming more common. Unquity Brook's headwaters behind Milton Academy have the most extreme phosphorous levels, perhaps suggesting more work is needed to coordinate with the school. Dissolved oxygen is generally at acceptable levels throughout the sampling sites in Milton except in July, when many sites dipped below recommendations. In particular, UNB002 had significant hypoxia during that sampling event. Finally, pH does not appear to typically be a significant problem at any sites in Milton, though the increased acidity in 2022 may reflect drought impacts on water pH. Table 4 outlines the top parameters of concern by site and recommendations of next steps.

Table 4: Major parameters of concern by site with recommendations on first steps to address the problem. DO = dissolved oxygen.

Site	Major parameters of concern	Recommendation
UNB002 **Unquity Brook @ Randolph Ave**	*E. coli*	• Follow up on results of past *E. coli* investigations and infrastructure repairs. • Review town MS4 IDDE results and follow up as needed. • Identify the source of the *E. coli* (for example, bird, dog, human) with DNA source tracking
	Phosphorus	• Identify sources of phosphorus and high drought related values (2016, 2020, 2022), though phosphorus is high even in non-drought years. Explore possible connection to Milton Academy.

		• Survey for primary producers (chlorophyll or macrophytes) and determine if sites with high levels are impacting the ecology.
	DO	• Identify cause of low values on average. • Assess primary producer growth in the summer and/or dead organic matter loads.
	pH	• Determine ways to bolster base flow and limit high acidity conditions, which are more severe than other drought related low values.
UNB014 **Unquity Brook @ Adams St**	*E. coli*	• Determine cause of consistently high bacteria values across the sampling season and if there are potential sewage influences.
UNB016 **Unquity Brook @ Squantum St**	Phosphorus	• Identify sources of high phosphorus maximum. • Evaluate if shelved Algerine Corner project could be leveraged in another location or move forward.
PTB047 **Pine Tree Brook @ Central Ave**	*E. coli*	• Follow up on results of past *E. coli* investigations, consider source tracking for human vs dog at full tributary hotspots • Review town MS4 IDDE results and follow up as needed.
	Phosphorus	• Identify sources of phosphorus and assess increases through 2020 and what has changed.
PTB035 **Pine Tree Brook @ Brook Rd**	*E. coli*	• Identify the source of high *E. coli* values over this year, including high dry flow and early/late season values, which could indicate as sewage issue. See above re: source tracking

	Phosphorus	• Identify sources of phosphorus and assess increased through 2020 and what has changed. • Assess primary producer and determine if high levels are impacting the ecology.
PTB028 **Pine Tree Brook @ Blue Hills Pkwy**	summer/fall DO	• Assess early summer flow and shading issues • Assess primary producer growth in the summer and/or dead organic matter loads
NER150 & NER179 **Neponset River @ Paul's Bridge and Brush Hill Rd**	*E. coli*	• Investigate sources of animal waste that can be managed (trails and adjacent park land) and increase signage and utilities for pet waste disposal.
NER185 & NER200 **Neponset River @ Ryan Playground and Adams St Bridge**	*E. coli*	• Determine source of high E. coli spikes during summer months, and whether they are wet weather dependent.
	DO	• Determine source of hypoxic July sample and if it is an aberration or a sign of actual hypoxic conditions.