2022 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.

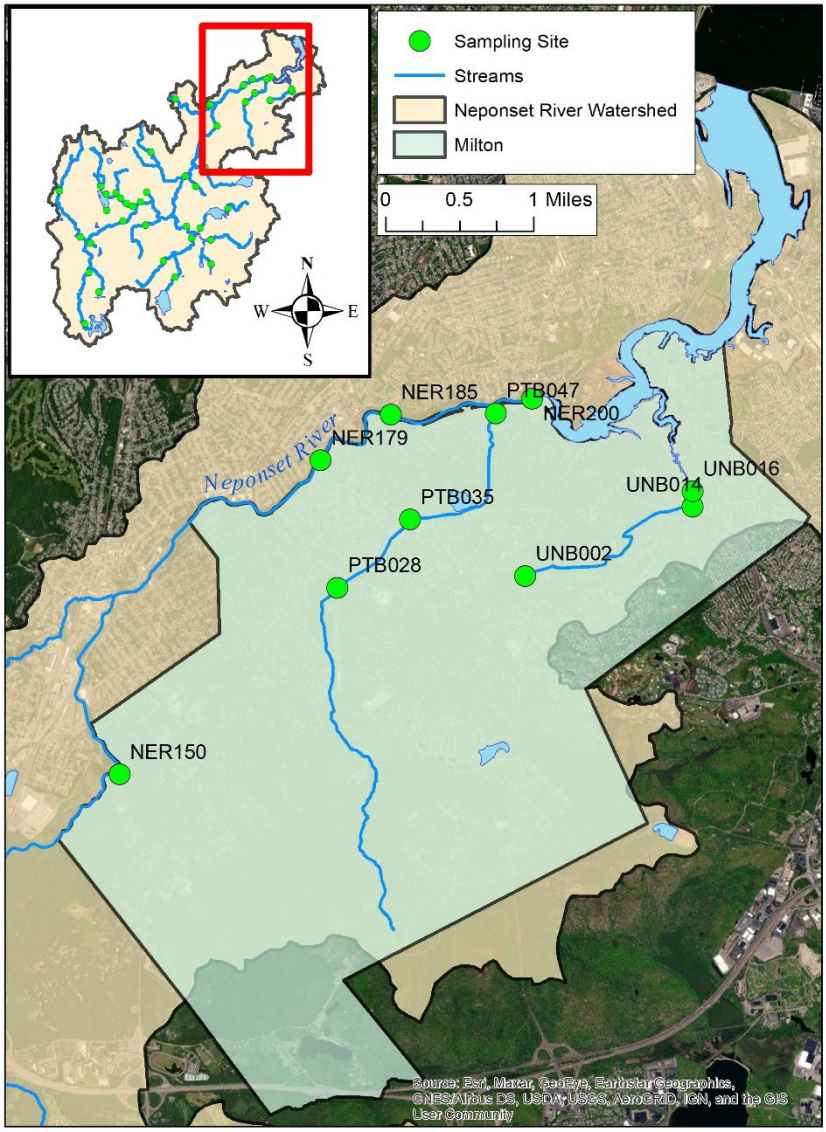

Figure 1: Map of the CWMN sites in Milton, Massachusetts.

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 2022, two sampling days occurred during dry periods and four sampling days occurred during a wet period, despite the severe drought experienced over the year. 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, both 2021 and 2020 had more sampling events occur during dry weather than any year since 2016, when all six sampling events occurred during dry weather. This means 2022 data provides needed additional data during wet weather to see if any improvements over the last several years in parameters, especially for *E. coli*, reflect real improvements to water quality or changes in the frequency of sewage spills or are an artifact of low wet weather sampling in the prior 2 years. However, the 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 2012.

Year	Dry (days)	Wet (days)
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
2021	5	1
2022	2	4

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). Changes in the 2022 sample year 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, and the purpose of these reports is to provide meaningful historic comparison, the new criteria will not be applied in this report. For Milton sites, this means that no single sample should exceed 235 CFU/100mL (the single sample standard), nor should the geometric mean of at least 5 samples taken within the same season exceed 126 CFU/100mL (the seasonal standard). For ease of interpretation, NepRWA calculates the geometric mean as the whole sampling season (usually 6 samples).

In 2022 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 (Table 2). The highest seasonal levels were observed in Pine Tree Brook and Unquity Brook (PTB035 and UNB002). Two sites on Pine Tree Brook and Unquity Brook were also above the single sample maximum for their minimum value, meaning that every sample for the season failed to meet swimming standards. Broadly speaking, the mainstem of the Neponset sites faired better than either tributary, with NER150 coming the closest to meeting swimmable quality for the season.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the ten sampling sites in Milton, MA, year 2022. Due to drought low flows, some samples were unable to be collected.

Sampling Site	Maximum	Average	Minimum	Geometric Mean	Samples
NER150	**712**	**237**	10	**127**	**6**
NER179	**6870**	**1334**	63	**328**	**6**
NER185	**2760**	**689**	175	**387**	**6**
NER200	**369**	220	109	**191**	**6**
PTB028	**1670**	**789**	10	**331**	**5**
PTB035	**24200**	**5248**	**295**	**1585**	**6**
PTB047	**1150**	**692**	134	**521**	**6**
UNB002	**2250**	**1034**	85	**588**	**4**
UNB014	**591**	**440**	**309**	**431**	**6**
UNB016	**691**	**405**	10	**229**	**6**

In 2022 there were four wet weather events that were sampled, with dry weather sampling only in May and October, generally already the lowest bacteria value months. However, while some sites were relatively variable, others like NER200 and UNB014 showed relative consistency across the sampling year, which may suggest systemic problems less related to street runoff (Figures 2-4). Interpretation of the wet weather data is made difficult by the confounding influence of seasonal changes during the dry weather and the additional influence of severe drought, which may exacerbate the runoff potential of the few rain events, as our sampling days coincided with the relatively few rainy days capable of washing accumulated waste into our waterways.

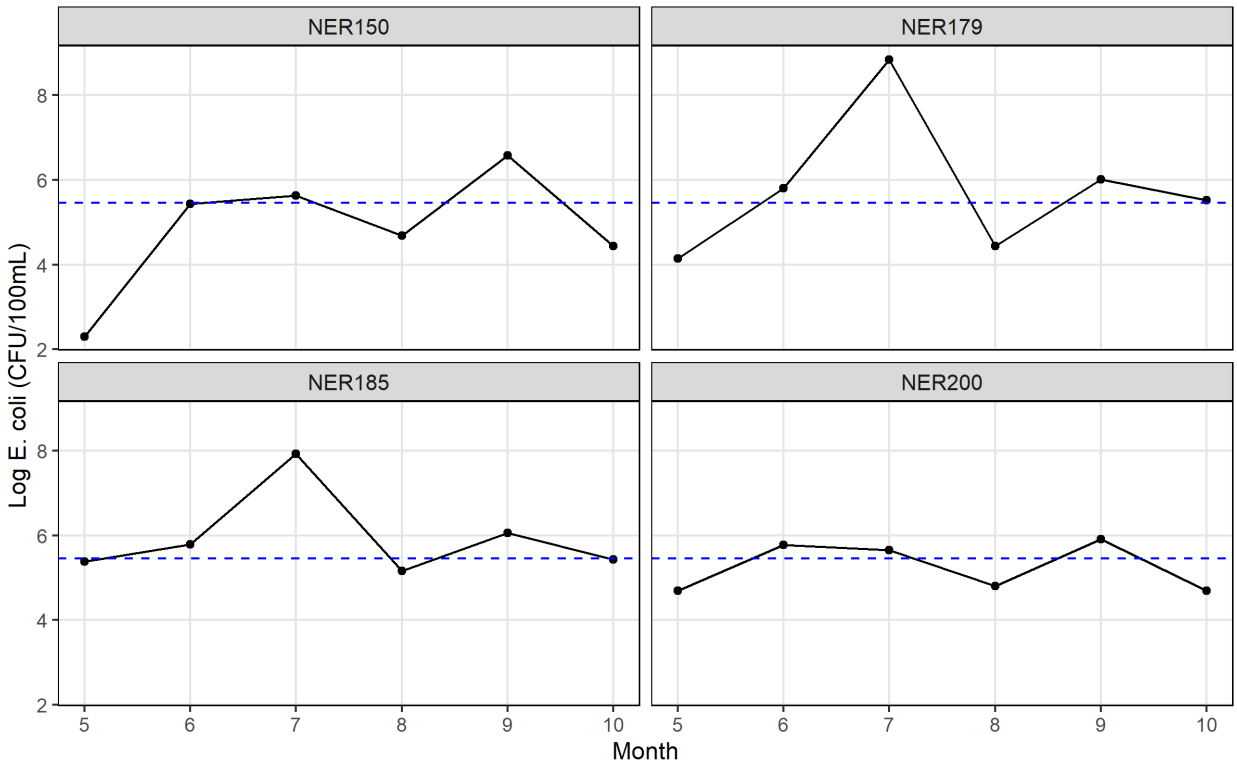

Figure 2: *E.coli* values at the Milton Neponset sampling sites for the 2022 year by sampling month. Black lines represent log-scaled *E. coli* values, with the dashed blue line representing the single sample maximum standard (235 CFU/100mL)

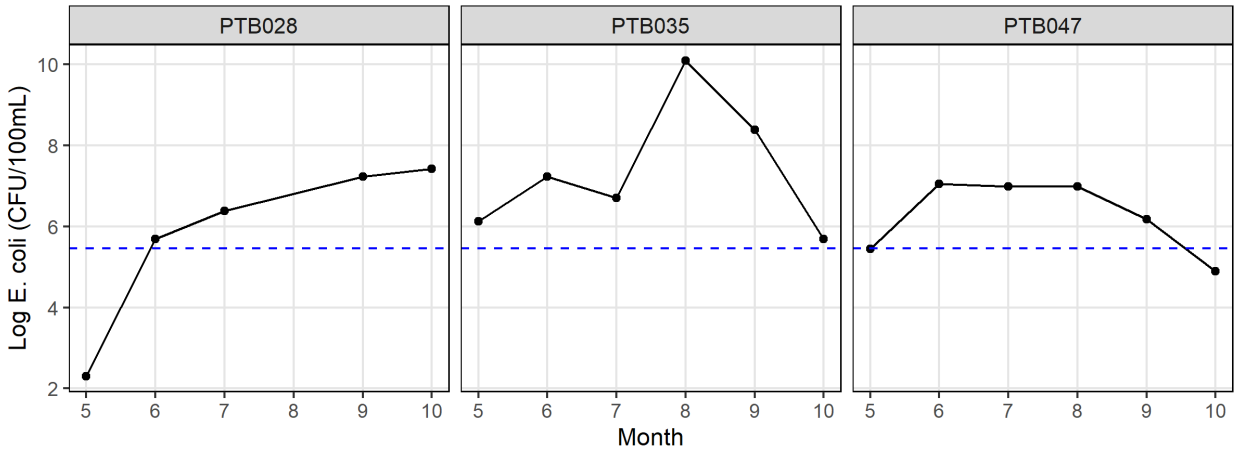

Figure 3: *E.coli* values at the Milton Pine Tree Brook sampling sites for the 2022 year by sampling month. Black lines represent log-scaled *E. coli* values, with the dashed blue line representing the single sample maximum standard (235 CFU/100mL)

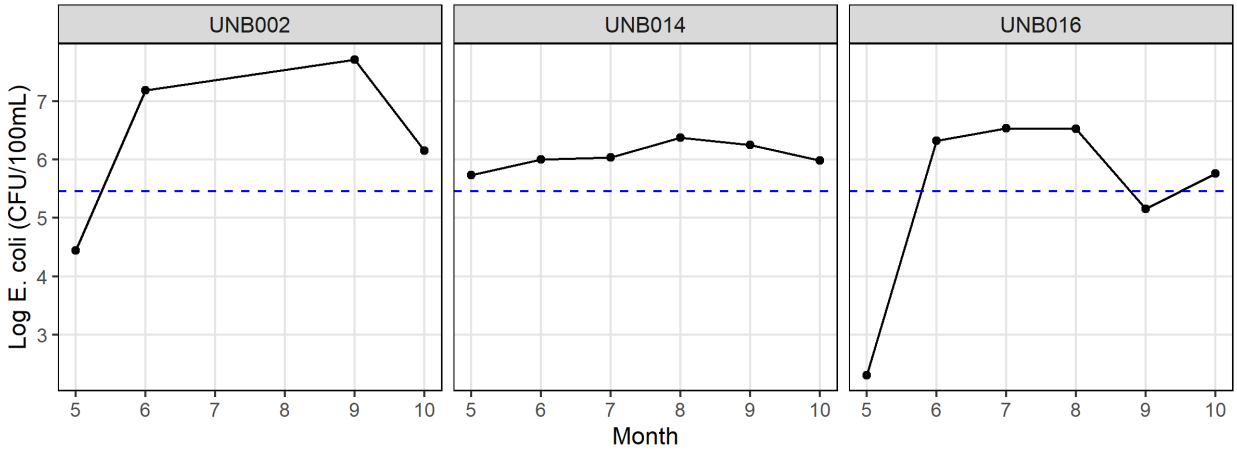

Figure 4: *E.coli* values at the Milton Unquity Brook sampling sites for the 2022 year by sampling month. Black lines represent log-scaled *E. coli* values, with the dashed blue line representing the single sample maximum standard (235 CFU/100mL)

Using data from 2012 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. 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 2022 showed decreases at UNB016 in both wet and dry weather. Sites PTB035 and PTB047 also had high *E. coli* levels that have remained fairly consistent over the last decade.

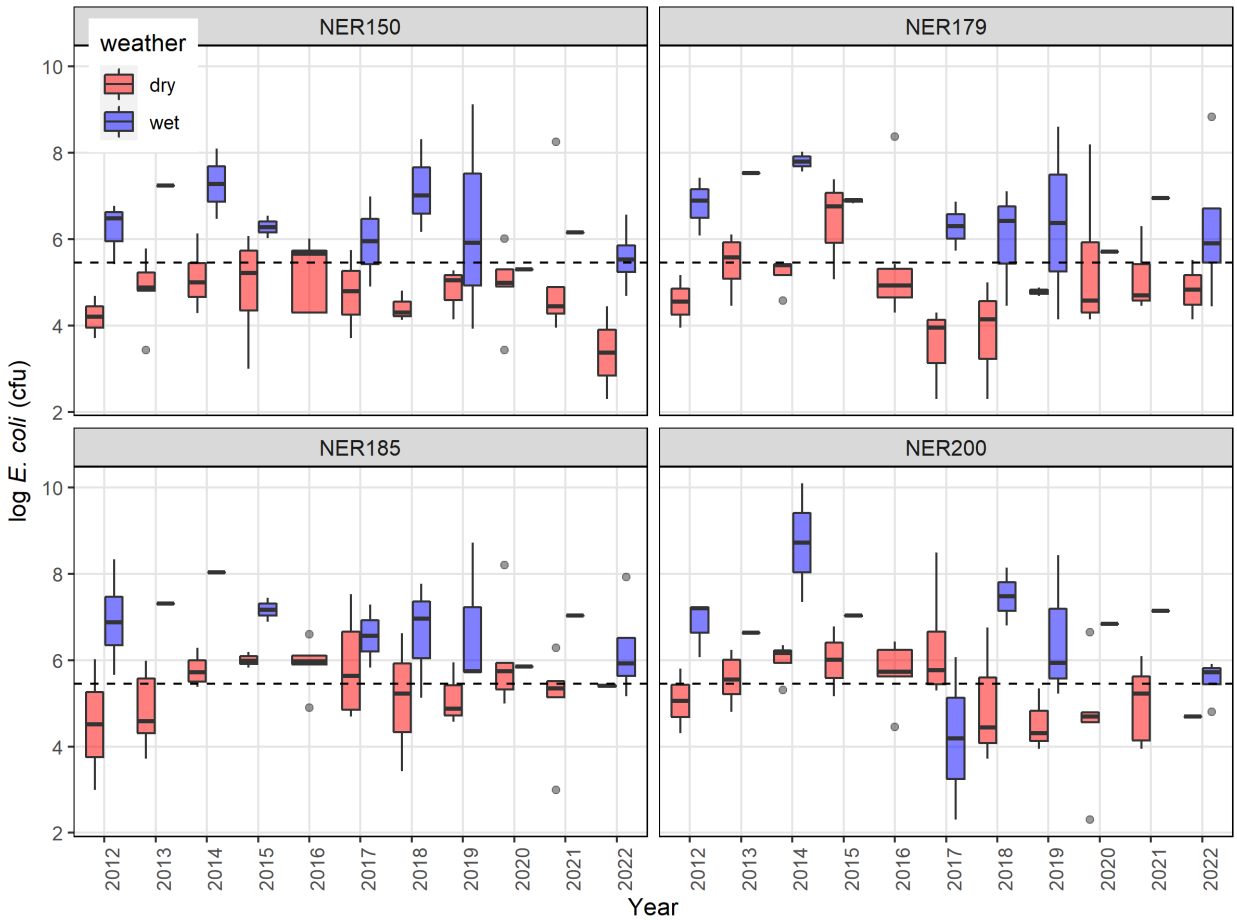

Figure 5: *E. coli* levels at the four sampling sites on the Neponset River from years 2012 to 2022. Levels are grouped by weather (blue = wet, red = dry). The black dashed line shows the single sample maximum acceptable threshold (235 CFU/100mL). The lower and upper bounds of each box correspond to 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.

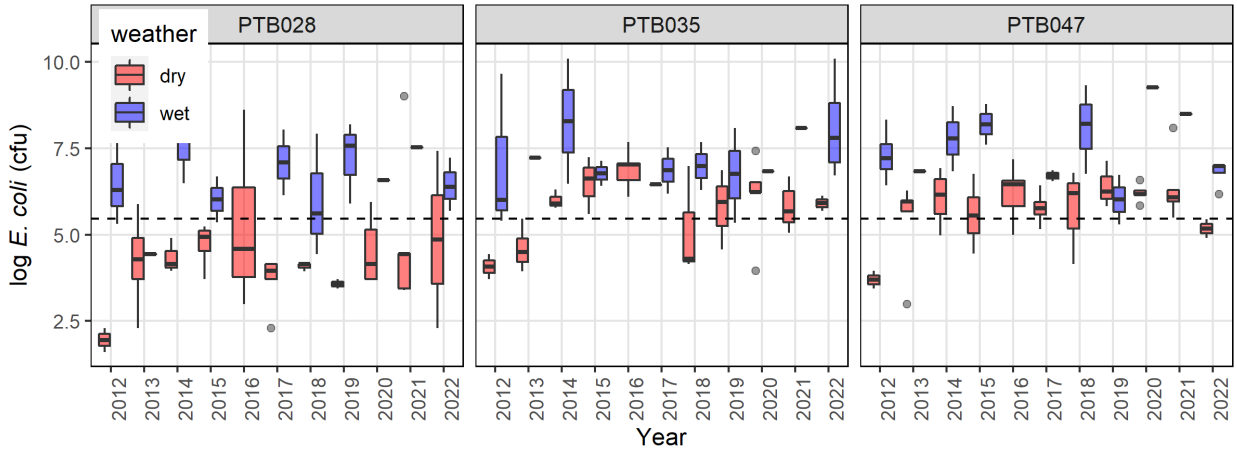

Figure 6: *E. coli* levels at the three sampling sites on Pine Tree Brook from years 2012 to 2022. Details are the same as in Figure 5.

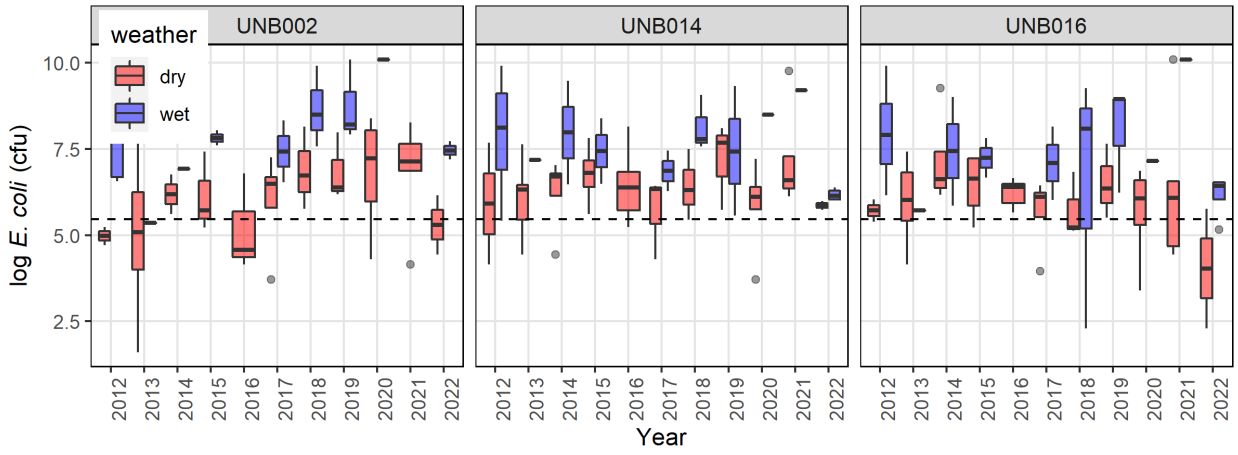

Figure 7: *E. coli* levels at the three sampling sites on Unquity Brook from years 2012 to 2022. Details are the same as in Figure 5.

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 2021, three sites in Milton had a season average that met or exceeded the 0.1mg/L Phosphorus: UNB002 (mean = 0.31 mg/L), UNB016 (mean = 0.1 mg/L), and PTB035 (mean = 0.11 mg/L) (Table 3). The other seven sampling sites were below the threshold. However, maximum levels at PTB047 did exceed the threshold during the year.

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	0.06	0.05	0.04
NER179	0.07	0.05	0.04
NER185	0.06	0.05	0.03
NER200	0.06	0.04	0.02
PTB028	0.09	0.07	0.05
PTB035	**0.25**	**0.11**	0.05
PTB047	**0.11**	0.06	0.04
UNB002	**0.48**	**0.31**	**0.24**
UNB014	0.07	0.05	0.04
UNB016	**0.27**	**0.1**	0.05

The levels of total Phosphorus in 2022 appear similar to 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 in 2022 (Figure 9). The only exception is PTB035, where 2022 phosphorus levels once again rose higher. 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. Likewise, the drought connection merits further investigation, as UNB002 ran completely dry for 2 sampling events in 2022. 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.

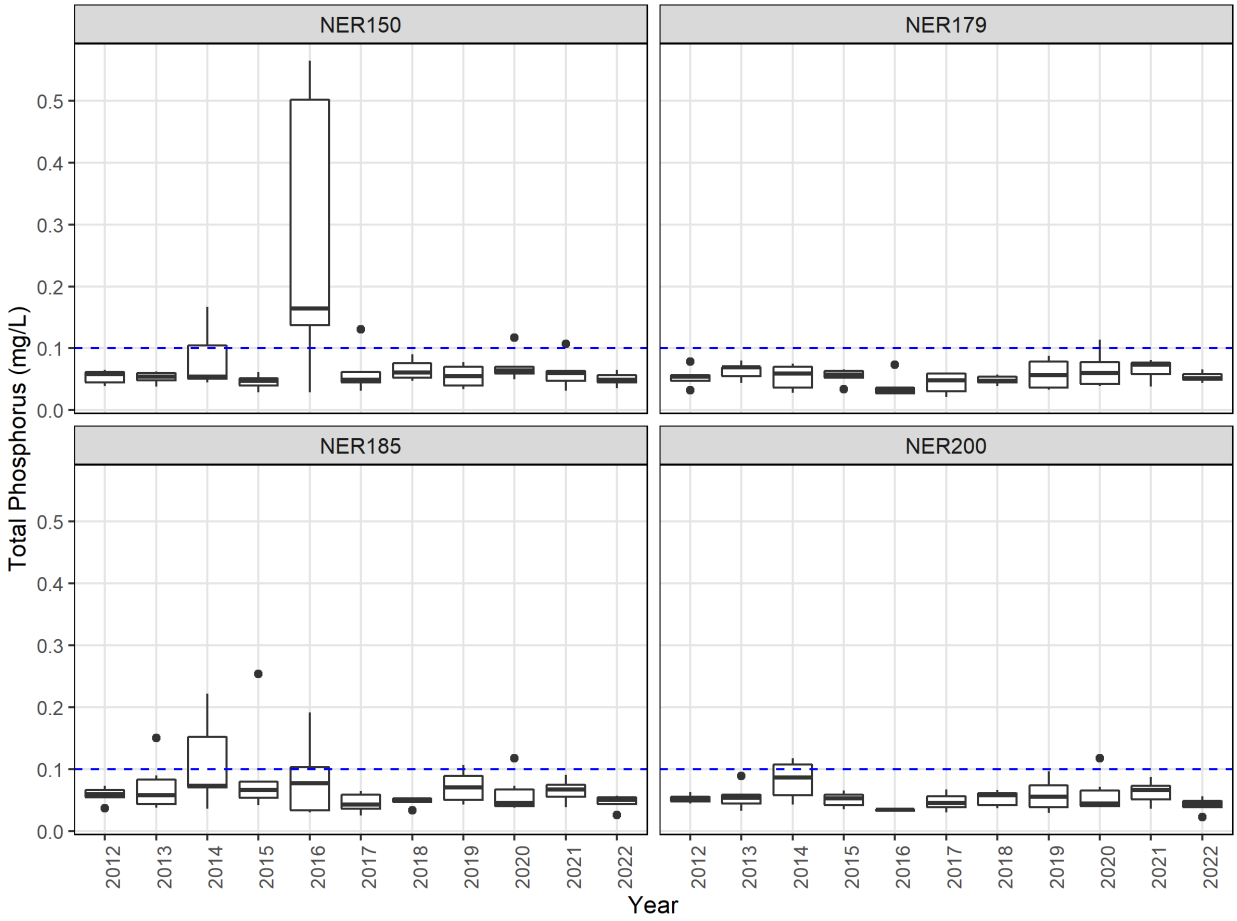

Figure 8: Total phosphorus levels at the four sites in the Neponset River from year 2012 to 2022. N > 4 each year except NER200 in 2016 (N=4) and NER179 in 2019 (N=4). The blue dashed line is at 0.1mg/l. Boxplot statistics are the same as Figure 5.

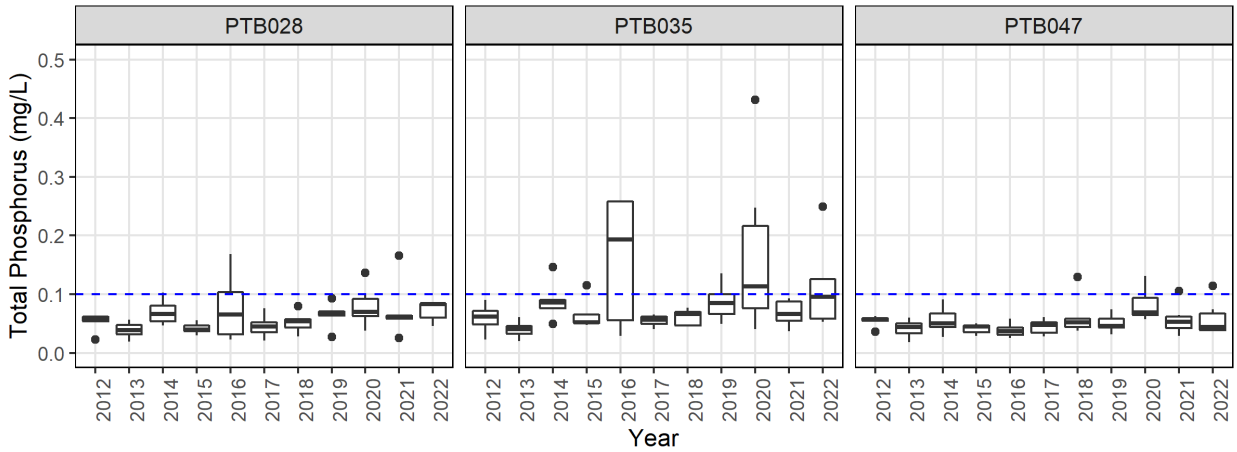

Figure 9: Total phosphorus levels at the three sites on Pine Tree Brook from year 2012 to 2022. N >= 5 each year. The red dashed line is at 0.1mg/l. Note that the y-axis range is different than Figure 5 and Figure 7. **Note that one extreme outlier was excluded on PTB035 in 2016, TP = 0.79.**

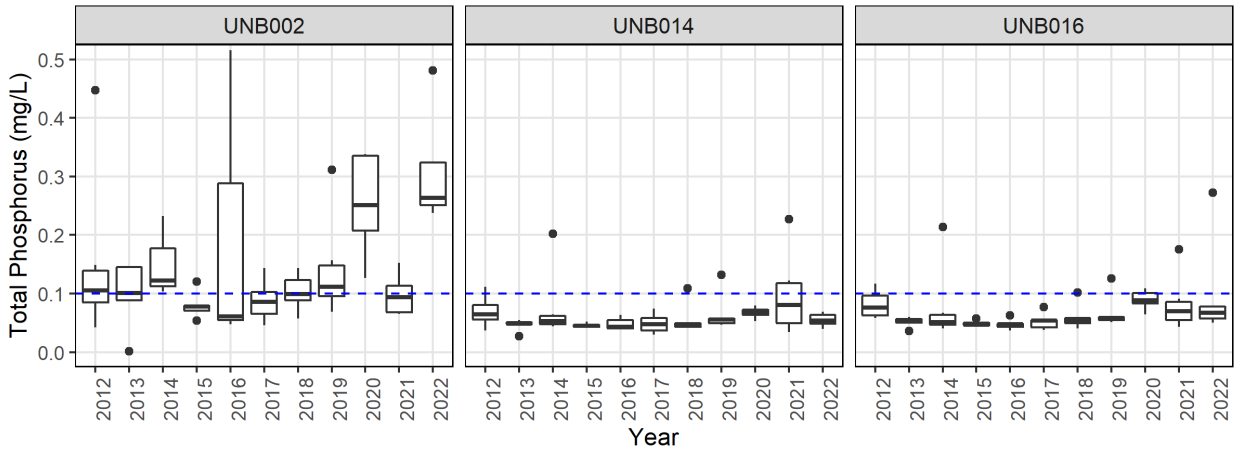

Figure 10: Total phosphorus levels at the three sites on Uniquity Brook from year 2012 to 2022. N >= 4 each year except UNB002 in 2014 and 2016, when N = 3. The blue dashed line is at 0.1mg/l. **Note that one extreme outlier was excluded on UNB002 in 2013, TP = 1.00.**

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, 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.

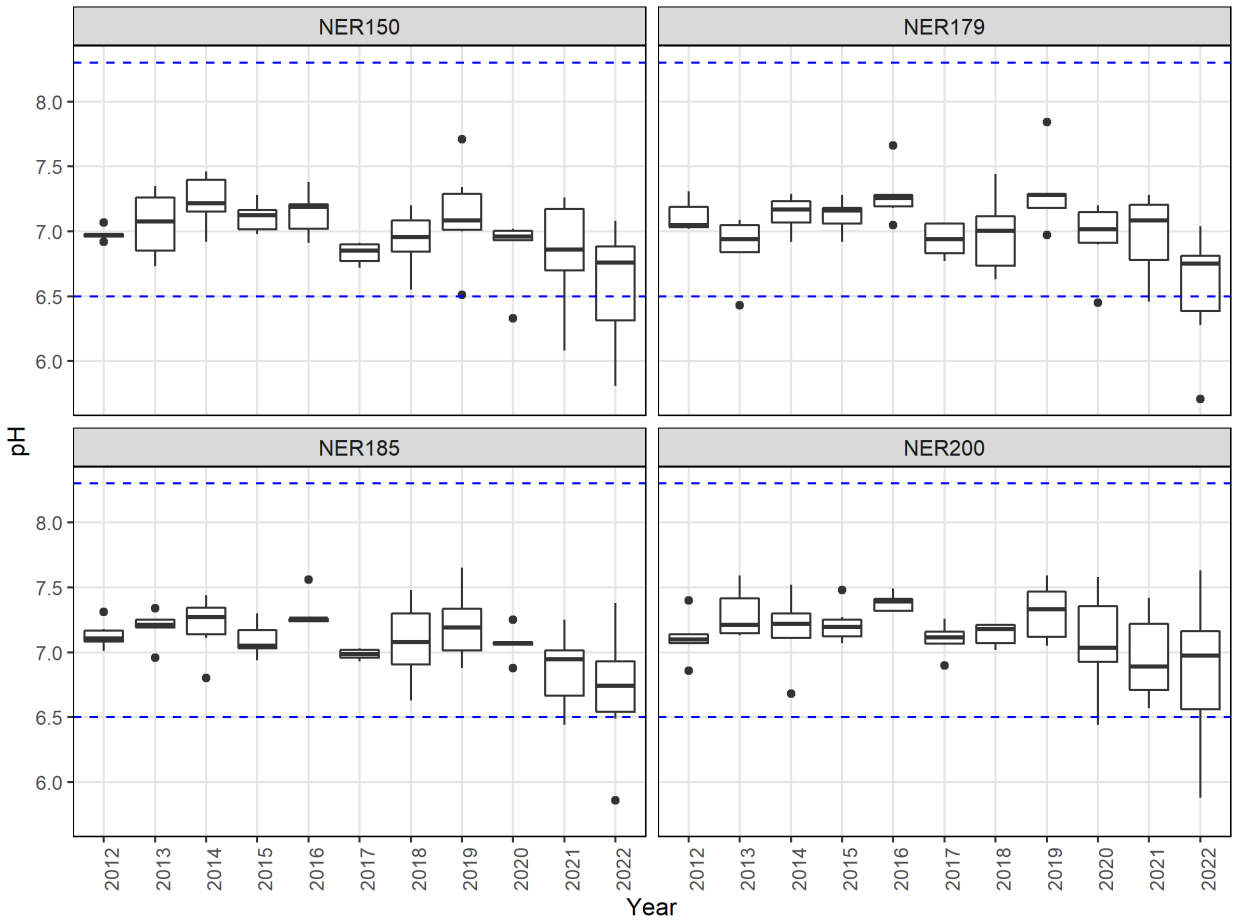

Figure 11: The pH levels at the four sites on the Neponset River. Boxplots statistics are the same as Figure 5.

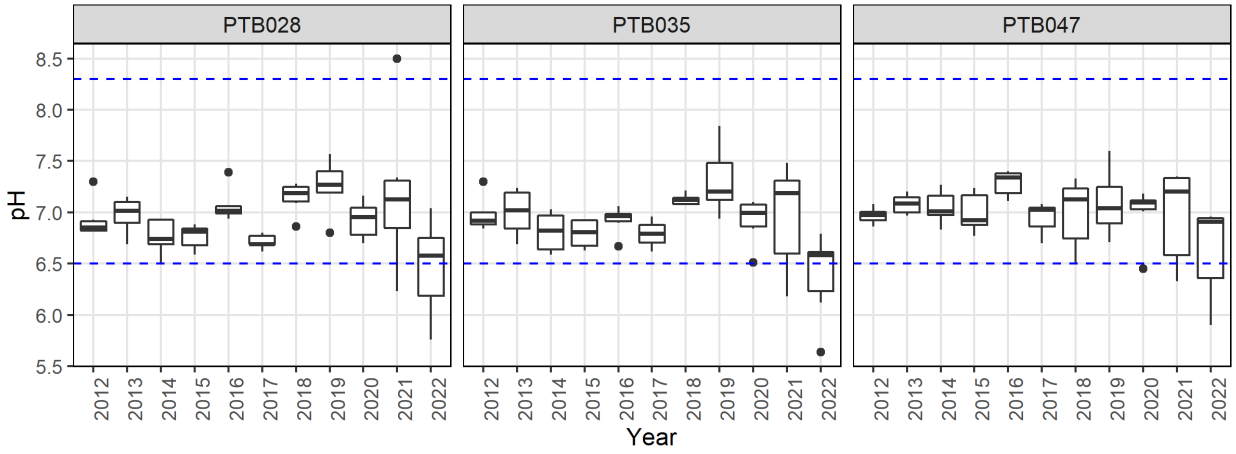

Figure 12: The pH levels at the three sites on Pine Tree Brook. Boxplots statistics are the same as Figure 5.

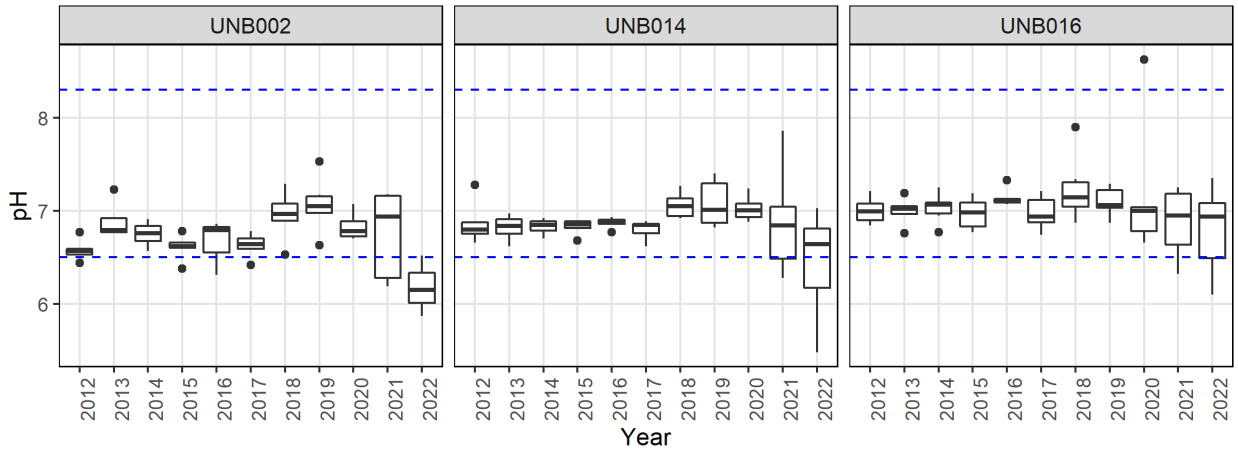

Figure 13: The pH levels at the three sites on Unquity Brook. Boxplots statistics are the same as Figure 5.

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 2022, monthly DO levels were similar to the average monthly levels for most sites (Figure 14), however NER200 showed a significant July drop, again, possibly due to transient impacts of the drought. For the most part, the sites on the Neponset River remained above the 5mg/l threshold, though almost all sites had a dip in their July event DO, putting three of the four sites below the 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, with 2022 being similar to 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 2022 and were above DEP

criteria. 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.

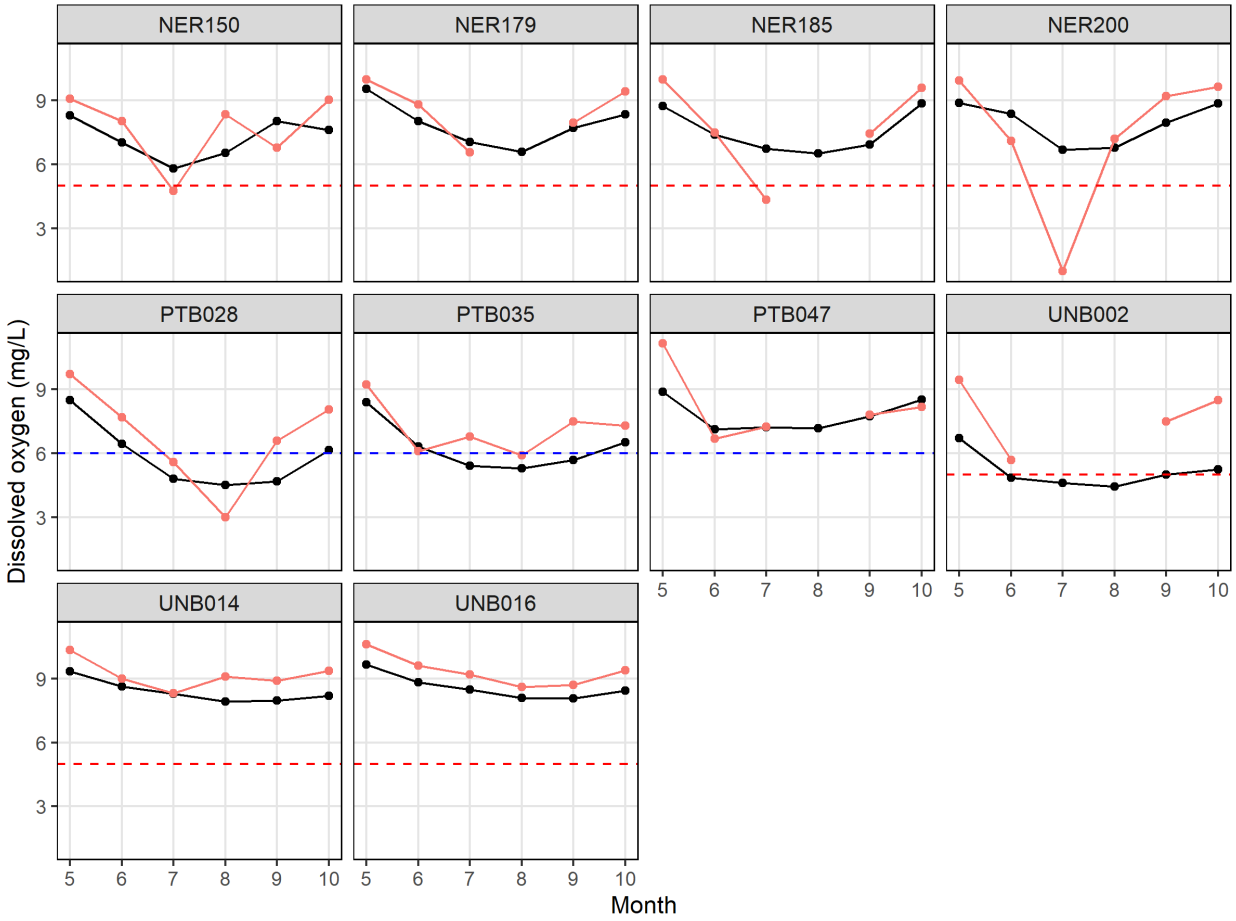

Figure 14: Monthly dissolved oxygen levels at the ten sites in Milton. The black line shows the mean monthly value from 2012 to 2022 and the red line shows the 2022 values. The red dashed line is at dissolved oxygen = 5mg/l and the blue dashed line is at dissolved oxygen = 6mg/l because Pine Tree Brook 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 the 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 a few key sites in Milton suffer from 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. Dissolved oxygen is generally at acceptable levels throughout the sampling sites in Milton except in July, when many sites dipped below recommendations. In particular, NER200 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). • 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.
PTB047 **Pine Tree Brook @ Central Ave**	*E. coli*	• Follow up on results of past *E. coli* investigations. • Review town MS4 IDDE results and follow up as needed.
	Phosphorus	• Identify sources of phosphorus and assess increased 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.
	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
NER179 & NER185 **Neponset River @ Brush Hill Rd and Ryan Playground**	*E. Coli*	• Determine source of high E. coli spikes during summer months, and whether they are wet weather dependent.
NER200 **Neponset River @ Adams St Bridge**	DO	• Determine source of hypoxic July sample and if it is an aberration or a sign of actual hypoxic conditions.