2022 Water Quality Report, Westwood, Massachusetts

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Background

The Neponset River Watershed Association (NepRWA) has been collecting water quality data both in Westwood 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 three permanent CWMN stations within and bordering the town of Westwood: on Mill Brook, Purgatory Brook, and the Neponset River (Figure 1). Waterbodies in Westwood are tested for *Escherichia coli* (*E.coli*), total phosphorus, pH, dissolved oxygen, and temperature once per month between May and October. The following report summarizes the findings for the 2022 season, with raw water quality data available upon request..

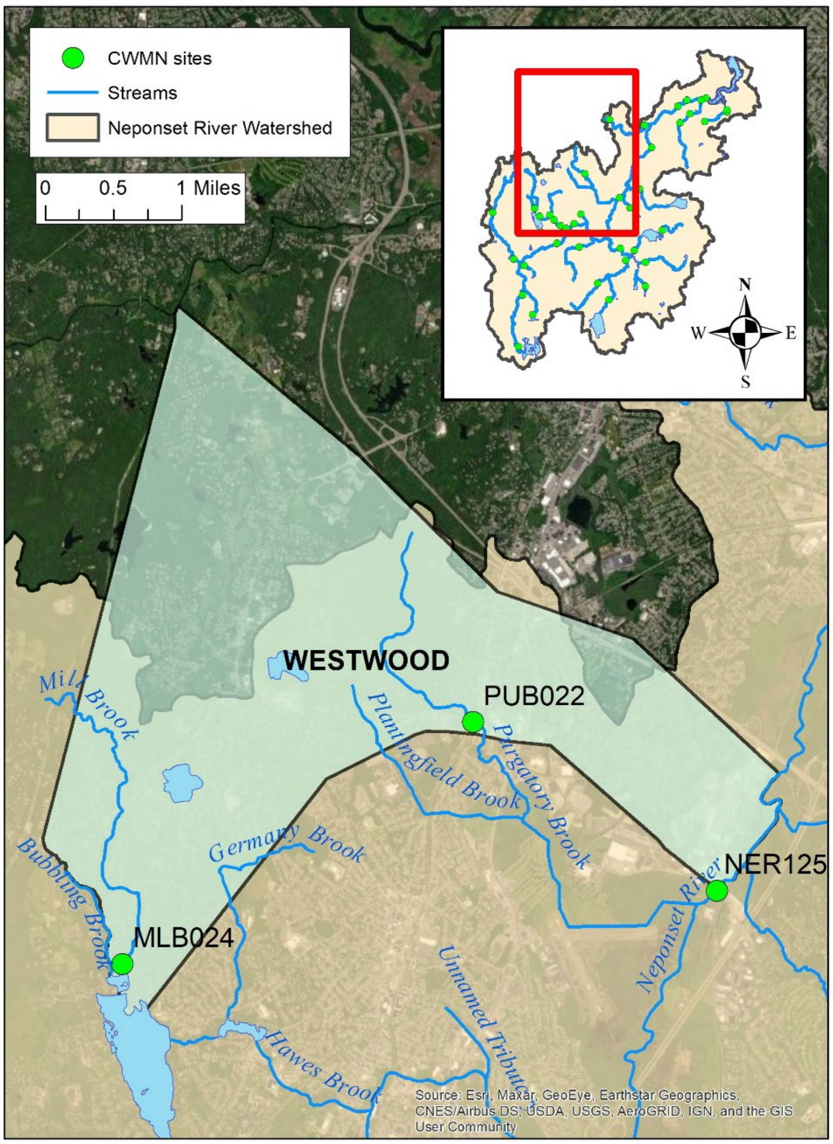

Figure 1: Map of the CWMN sites in Westwood, Massachusetts.

Sites PUB022 and NER125 are also tested for ortho-phosphate and ammonia, however, the parameters discussed in this report are limited to those that are tested at every site and have state guidelines for acceptable levels: *E. coli*, total Phosphorus, pH, and dissolved oxygen.

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 phosphorus 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 lack of additional data during wet weather suggests we should be cautious in any improvements in parameters, especially for *E. coli*, as the relative improvement may reflect wet vs. dry dynamics rather than real improvements to water quality or changes in the frequency of sewage spills. Likewise, any decline this year may simply reflect an increase in wet weather sampling over the prior two years.

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 sites in Westwood, this means no single sample should exceed 235 CFU/100 mL (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 on the whole sampling season (6 sampling events).

In 2022 maximum *E. coli* levels at the three sites in Westwood were greater than the single sample maximum (maximum values in Table 2) and the seasonal average (geometric mean values in Table 2). However, for the site on the Neponset River (NER125), the seasonal average was very close to the state criteria of 126 CFU/100mL. All three sites had their maximum *E. coli* levels during wet weather. While Purgatory Brook in 2022 had a worse than average year with respect to *E. coli*, both the Neponset River and Mill Brook showed significant improvement, with geometric means below the average for the sites (Tables 2 and 3).

In past years, particularly 2019 and 2018, large concentrations of *E. coli* occurred during wet weather for both Mill Brook and the Neponset River, suggesting that the excess runoff during precipitation was contaminated with *E. coli* (Figure 2). Purgatory Brook, between 2013 to 2019 had dry weather *E. coli* levels similar to those in wet weather, suggesting a problem with *E. coli* contamination less related to stormwater. This appears to have shifted since 2020, with falling values for dry weather samples, which may indicate the non-stormwater bacterial issues are improving. However, in 2022, Purgatory Brook was well over the seasonal and single sample maximum limit, despite some evidence in 2021 of being close to passing criteria.

Table 2: The maximum, average, minimum, and geometric mean levels of *E. coli* at the sites in Westwood, MA, in 2022. N=6. Units are in cfu/100ml. Bolded rows represent levels over the state standards for *E. coli*.

CWMN Site	Maximum	Average	Minimum	Geometric Mean
MLB024	**959**	**335**	10	**154**
NER125	**862**	**273**	20	**128**
PUB022	**24200**	**5829**	10	**959**

Table 3: The maximum, average, minimum, and geometric mean levels of *E. coli* at the sites in Westwood, MA, for 2012-2021. N=60. Units are in cfu/100ml. Average and Average Geometric Mean are both calculated by averaging across the 9 years, not all 60 samples, which reflects a more accurate value for what is typical in these sites.

CWMN Site	Maximum	Average	Minimum	Avg. Geo. Mean
MLB024	**15500**	1056	5	**245**
NER125	**14100**	829	5	**304**
PUB022	**19900**	1551	30	**531**

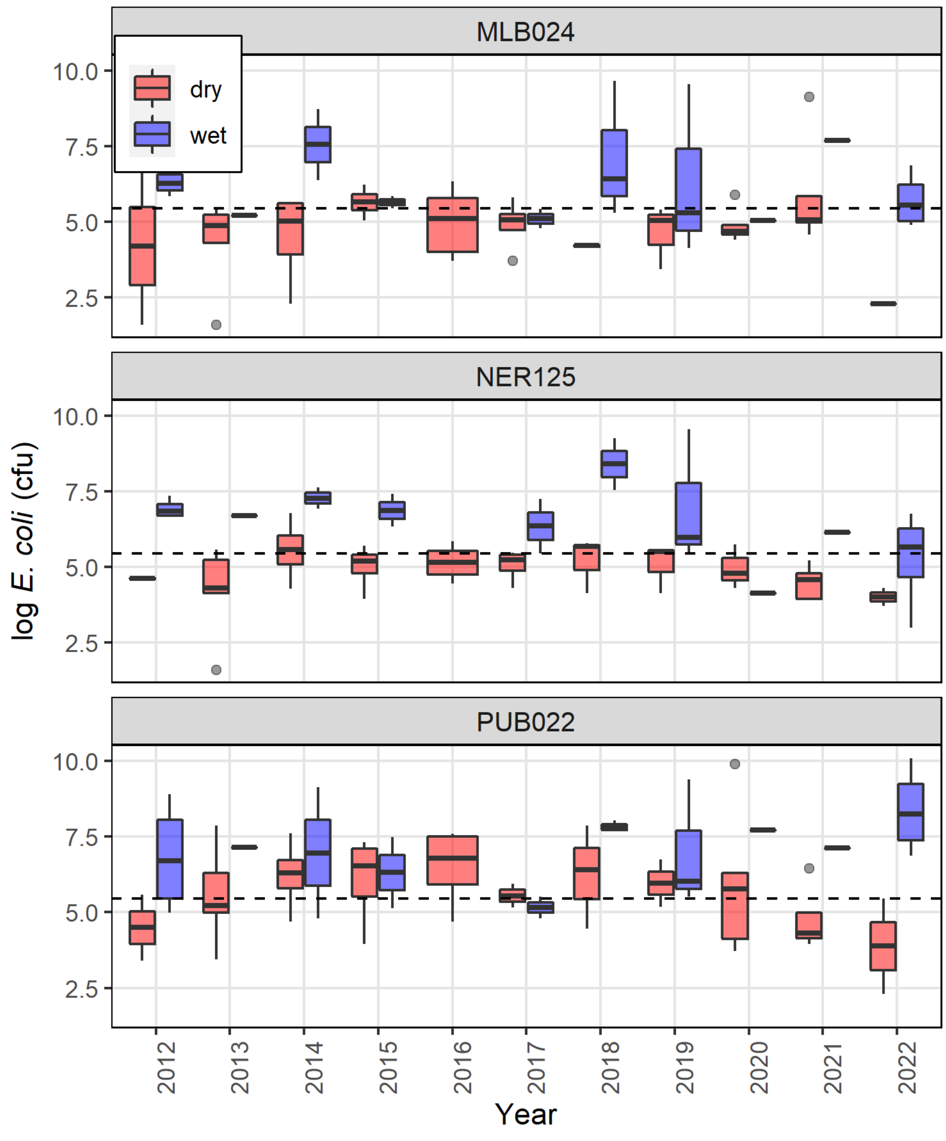

Figure 2: *E. coli* levels at the sites in Westwood, MA from years 2012 to 2022 – note the log scale, which allows exponential data to be viewed more easily. The plot shows levels grouped by weather (blue = wet, red = dry). The plot shows levels grouped by weather (blue = wet, red = dry). The black dashed 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. 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. 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.

The sampling site on Mill Brook is directly upstream of Pettee Pond, so we apply the 0.05mg/L threshold. The other two sites do not empty directly into a pond or lake, so we apply the 0.1mg/L threshold for flowing waters. The seasonal average total phosphorus concentration in 2022 was in compliance for the sites on the Neponset River and Purgatory Brook but was above the higher threshold for the site on Mill Brook, due to the stricter standard for waters entering an impoundment (Table 4). At all 3 sites, 2022 phosphorus levels were lower than the previous 2 years, continuing a trend seen from 2021 (Figure 3). However, given the switch between drought and rainy years, this may be related to lawn care changes between years. It remains to be seen if phosphorus levels are continuing to drop due to policy changes.

Mill Brook phosphorus levels in 2022 were below the threshold in almost all samples, with one outlier in June, nearly 3 times larger than any other sample. This suggests there may have been a specific reason for elevated phosphorus during that month and that average levels of phosphorus may be within the standard. In contrast, Neponset and Purgatory Brook showed relatively consistent phosphorus levels and both were below the 10-year average (Figure 3).

Table 4: The maximum, average, and minimum values of total phosphorus recorded during 2022 at the three sites in Westwood, MA. N=6. Bolded values show exceedance of the phosphorus criteria.

Site	Maximum (mg/l)	Average (mg/l)	Minimum (mg/l)	Standard (mg/l)
MLB024	**0.17**	**0.07**	0.03	0.05
NER125	0.07	0.05	0.03	0.1
PUB022	0.07	0.06	0.04	0.1

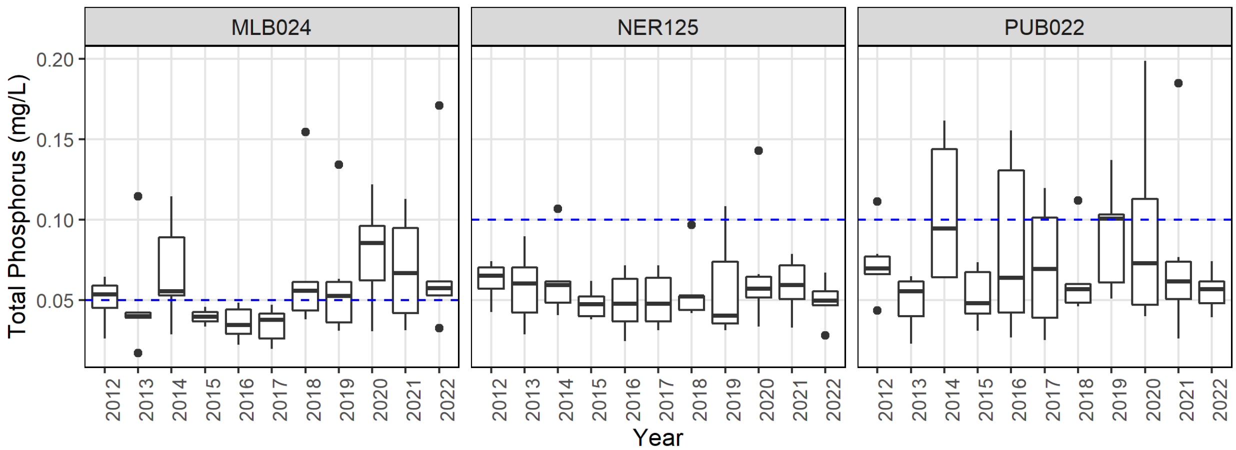

Figure 3: Total phosphorus levels at the three sites in Westwood, MA from year 2012 to 2022. The blue dashed line is at 0.05mg/l for Mill Brook (entering a pond) and at 0.1mg/l (for flowing waters) for the sites on the Neponset River and Purgatory Brook. Boxplot statistics are the same as Figure 2.

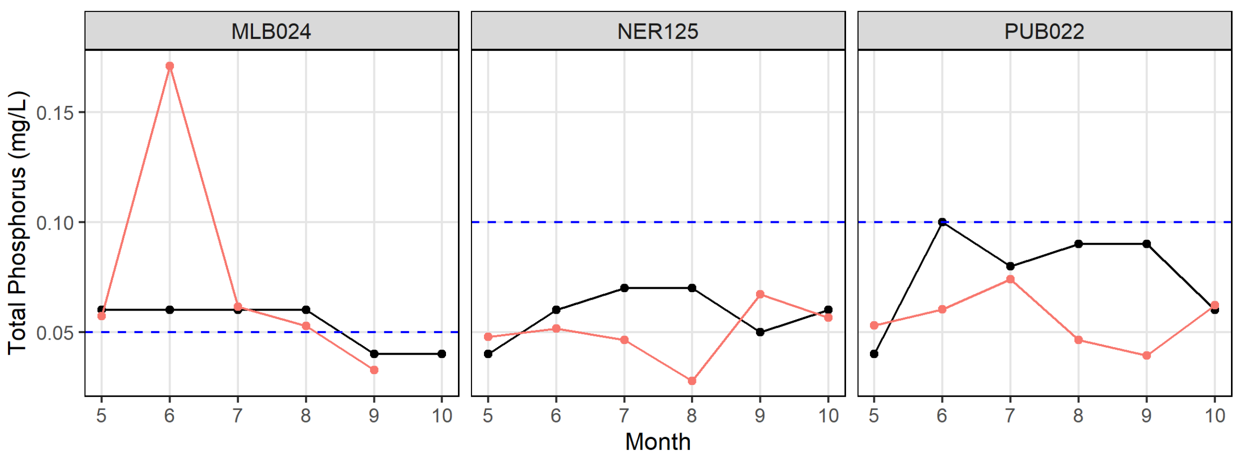

Figure 4: Monthly total Phosphorus concentrations at the three sites in Westwood, MA. The black line shows the mean monthly value from 2012 to 2021 and the red line shows the 2022 values. The blue dashed line is at 0.05mg/l for Mill Brook and at 0.1mg/l for the sites on the Neponset River and Purgatory Brook.

It is important to note that the Massachusetts DEP asks for additional information to help identify problems with total phosphorus, as high values alone are insufficient without documented issued in primary production and eutrophication. While we do not have primary producer data at these sites, there are slight negative correlations between total phosphorus levels and dissolved oxygen levels for all 3 sites (R = -0.20, R = -0.31, R = -0.29 at MLB024, NER125, and PUB022, respectively). This negative relationship could be supplemented with chlorophyll testing or summer macrophyte surveys.

pH

The Commonwealth of Massachusetts considers a pH range between 6.5 and 8.3 to be healthy for waterbodies in the state. Since 2012, pH has been within acceptable range at both Mill Brook and Purgatory Brook (Figure 5). However, the Neponset site showed more acidic values than in the last 2 years compared to the previous decade, which may suggest some new issue related to acidity in the mainstem. In 2022, Mill Brook showed a sharp decrease in pH, suggesting a considerable concern related to acidity. All 3 sites showed a trend towards more acidity this year, possibly due to low water levels in the drought leading to an increased concentration of natural acids. This appears most severe at Mill Brook, and continued monitoring is needed to see if a more systemic issue is responsible.

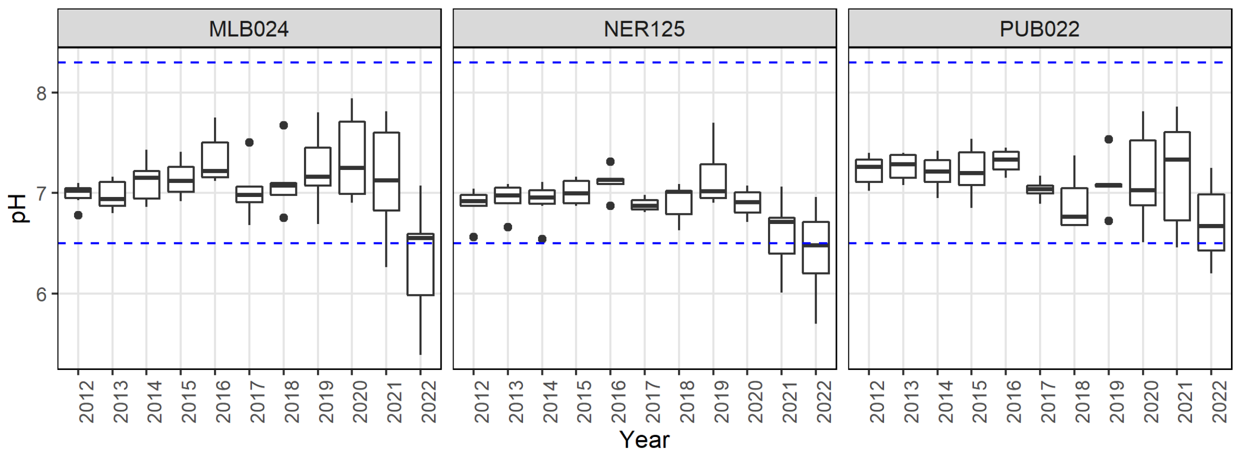

Figure 5: The pH levels at the three sites in Westwood for years 2012 through 2022. Boxplots statistics are the same as Figure 2. The blue dashed lines represent the recommended range for pH within Massachusetts.

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. Purgatory Brook and Mill Brook are listed as a Coldwater Fish Resource by the Massachusetts Division of Fisheries and Wildlife so we apply the 6 mg/l threshold for those two sites and the 5mg/l threshold for the site on the Neponset River. However, it is important to note that the Massachusetts DEP does not recognize Purgatory Brook and Mill Brook as cold-water fishery streams and are not regulated as such under the Surface Water Quality Standards.

Dissolved oxygen concentrations in 2022 were very different from the 10-year average levels at all Mill Brook, although the Neponset and Purgatory Brook were more in line with yearly averages. One exception is Purgatory Brook's August sample (Figure 6 and Figure 7). Purgatory Brook had DO levels well above the coldwater fishery standard, with the noted exception of August. Mill Brook on the other hand experienced two months below the coldwater standard, representing a drastic decline in available oxygen (Figure 6 and Figure 7). Mirrored with the low pH and high spike in June phosphorus, this could represent low flow conditions due to drought, or eutrophic overgrowth of algae. Additional years of data, or plant/algae surveys at the site could help clarify the issue. The Neponset River experiences DO concentrations in the summer just below the 5mg/l threshold based on the 10-year average.

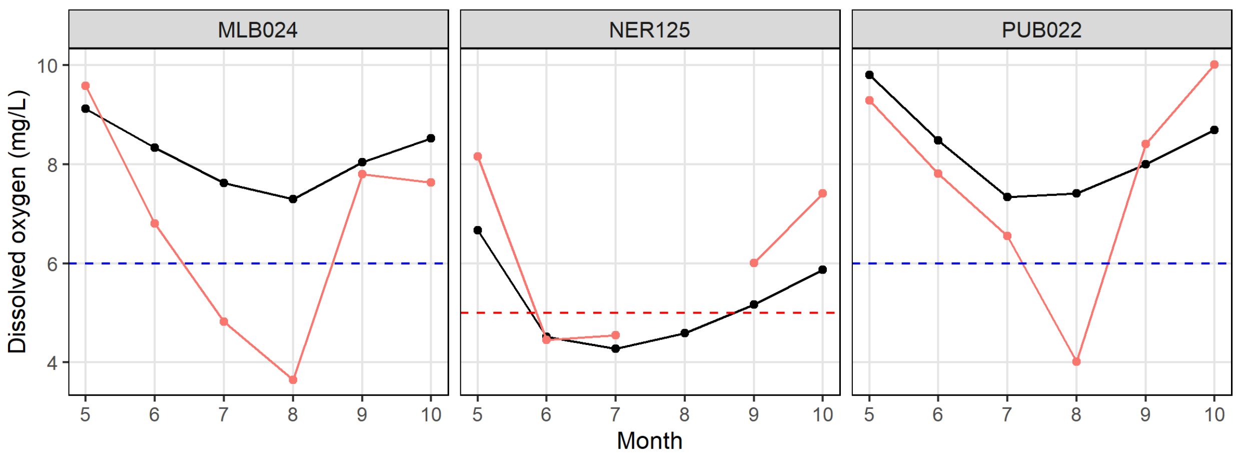

Figure 6: Monthly dissolved oxygen levels at the three sites in Westwood, MA. The black line shows the mean monthly value from 2012 to 2022 and the red line shows the 2022 values. The blue dashed lines are at DO = 6mg/l for MLB024 and PUB022, and the red dashed line is at DO = 5mg/l at NER125.

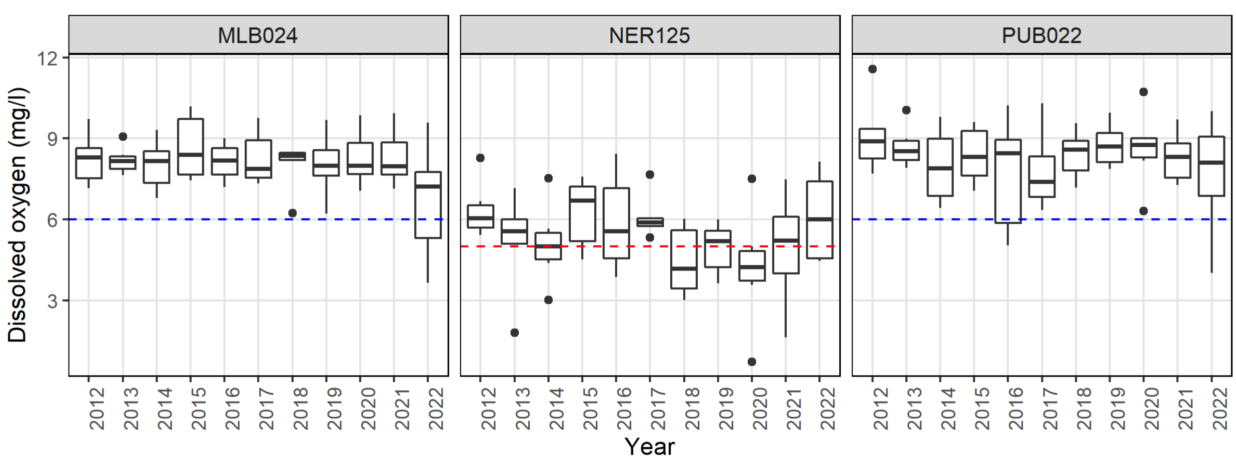

Figure 7: Dissolved oxygen levels at the three sites in Westwood, MA over the last 10 years. The blue dashed lines are at DO = 6mg/l for MLB024 and PUB022, and the red dashed line is at DO = 5mg/l at NER125.

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 5 details our recommendations and items to discuss with the Town.

Table 5: Major parameters of concern by site with recommendations on first steps to address the problem. TP = total phosphorus, DO = dissolved oxygen.

Site	Parameter	Recommendation
MLB024 **Mill Brook @ Inlet of Petee's Pond**	TP	• Identify sources of Phosphorus that could have contributed to the high concentration in the June sample. • Assess issues with runoff during dry weather. • Assess primary producer growth at this site and at Pettee Pond to identify ecological impacts.
	E. coli	• Identify sources of bacteria, although 2022 continues to be an improvement over the 10 year average.
NER125 **Neponset River @ Dedham St. Bridge**	DO	• Evaluate issues related to summer low DO, investigate primary producers as a potential oxygen sink.
	pH	• Identify cause of decline in pH values in last 2 years, including potential contributors.
	E. coli	• Continue to work to limit pet waste runoff, as wet sampling appears to be the dominant source of high *E. coli* values
PUB022 **Purgatory Brook @ Rt 1A**	TP	• Identify sources of phosphorus behind occasional high spikes in last decade – not a consistent issue year to year.
	E. coli	• Assess issues with *E. coli*, in both wet and dry weather, as causes may be different.