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April 3, 2025
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Duncan Kruse
West Hill Pond Association
PO Box 1057
New Hartford, CT

Re: Summary Report for 2024 Annual Limnological Study of West Hill Pond
West Hill Pond – New Hartford and Barkhamsted, CT

Dear Mr. Kruse,

GZA GeoEnvironmental, Inc. (GZA) is pleased to provide this Summary Report for the West Hill Pond Association (WHPA) that details the diagnostic interpretation of the lake monitoring results from the West Hill Pond 2024 season. As in recent years, field data and water samples were jointly collected by GZA personnel and WHPA volunteers. Water samples collected for chemical analysis were sent to UCONN's CESE Lab in Storrs, CT. Additionally, GZA performed fluorometric analysis of organic parameters and phytoplankton pigments and sent subsamples to a professional taxonomist for phytoplankton identification and enumeration. GZA's recommended ongoing monitoring and management actions are also presented after the diagnostic interpretations. We look forward to the discussion this will generate with WHPA members. This report and our recommendations above are subject to the Limitations attached in **Appendix A**.

BACKGROUND – WEST HILL POND

West Hill Pond (WHP) is a 261-acre waterbody located in New Hartford and Barkhamsted, CT with a maximum depth of 63 feet (ft; 20 meters, m). The bathymetric map (**Figure 1)** shows WHP's deepest location, where sample collection is conducted, is near the southern end of the waterbody. Over the past half century, many waterbodies in Connecticut have undergone eutrophication (excessive richness of nutrients in a lake or waterbody) resulting from increased shoreline development, urbanization, and agricultural activity within their watersheds. Further, climate change trends have exacerbated New England lake eutrophication by increasing intensity and duration of thermal stratification, resulting in greater internal loading of nutrients from sediments. Despite these regional trends, GZA's work that has involved monitoring, as well as analyses of the watershed and historical data, has demonstrated that WHP has not experienced significant degradation, and it is in fact classified as one of the cleanest, least biologically productive lakes in Connecticut.

As stated in prior years' reports, as GZA has been working with the WHPA, we have witnessed the passionate and management-oriented attitudes of its members that demonstrate their seriousness to their roles as environmental stewards. This is not as common as one might expect among lake associations, and so we would like to take this opportunity to identify it, congratulate the WHPA, and communicate that it is a great opportunity to work in collaboration with its members.

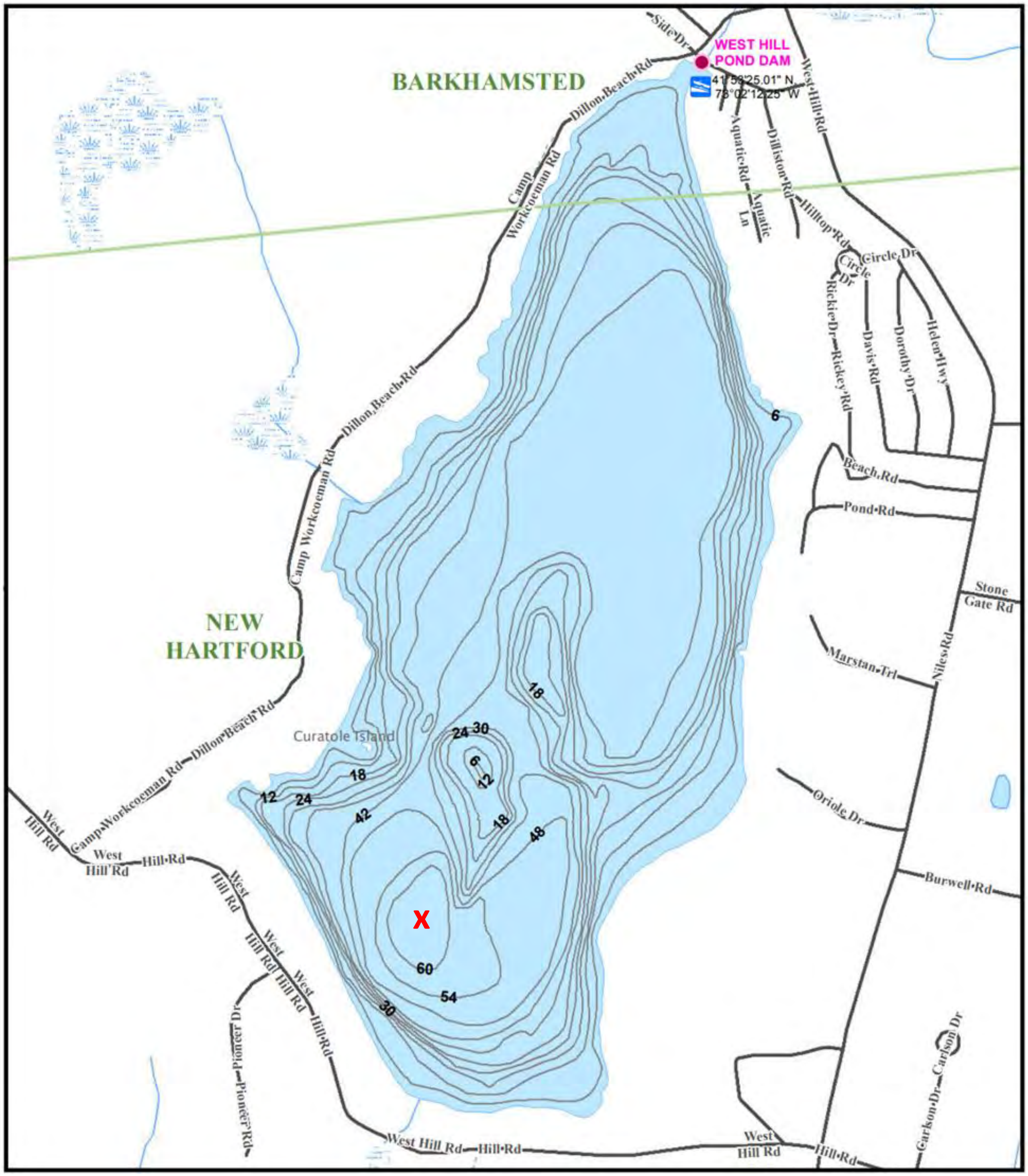

Figure 1: Bathymetric map of West Hill Pond (DEEP, 2011).
Red "X" demarcates maximum depth (Z_{max}) at 21 m.

Figure 2. Example of a datalogging buoy, though instrumentation and depths vary. In WHP, the top of the buoy remained submerged, was anchored at 20 m depth, and had five miniDOTs at 2, 7, 10, 14, and 18 m deep.

LAKE MONITORING

WHP's 2024 monitoring involved a cooperative field effort between GZA staff and WHPA volunteers. West Hill Pond was sampled six (6) times in 2024, with monitoring occurring from mid-April to early December. Field staff performed vertical water column tests in meter increments to assess the lake's physical and chemical composition. For more detailed chemical analyses, water samples were collected at 2m, 7m, 10m, 14m, and 18m below the surface of the lake using a van-Dorn water sampler. A 5-meter sampling straw was used to collect depth-integrated phytoplankton samples, which were preserved with Lugol's solution and shipped to a taxonomist for enumeration. A set of five (5) miniDOTs were deployed during the first sampling event at the deepest point of the lake in a similar fashion as shown on **Figure 2**, and though they were removed early by lake users at the very end of August, GZA was able to retrieve the devices that were eventually returned to CT DEEP. These miniDOTs recorded hourly snapshots of temperature and dissolved oxygen (DO) concentrations, and the data were used to calculate stratification intensity through the water column.

RESULTS

Climatic variability in rainfall and air temperature influence lake ecosystems in a variety of ways. For instance, increased rainfall results in increased watershed connectivity, which could mean external inputs of nutrients or organic material. Throughout the 2024 season until late August, WHP experienced considerable rain (**Figure 3**), which was very reminiscent of the 2021 and 2023 seasons. A significant rain event occurred in late August, but dry conditions followed into the fall and early winter. **Air temperature** impacts water temperature and the duration and intensity of lake thermal stratification (where warm water is located at the surface, and colder, denser water is located deep on the bottom). Air temperature can be assessed by cumulative density degree days (DDD; **FIGURE 4**) calculated by subtracting the temperature at which water is densest (4 °C or roughly 40 °F) from mean daily air temperature. The residual, which is cumulative through time, is the DDD. This is similar in concept to growing degree days (GDD), often used for agricultural purposes. WHP's 2024 season had the highest spring and summer DDD when compared to previous seasons (2023 was among the lowest), indicating it was a relatively hot summer.

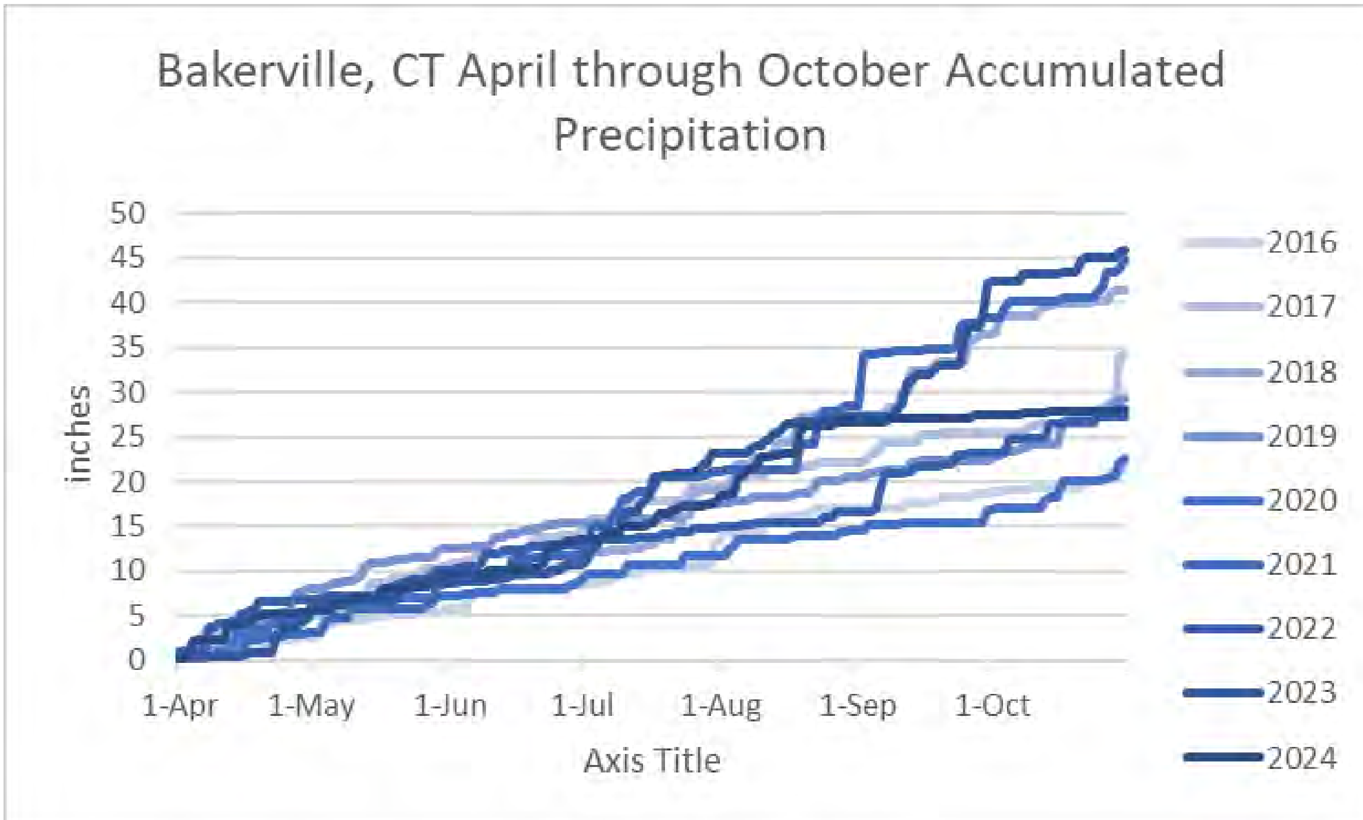

Figure 3. West Hill Pond regional accumulated precipitation.

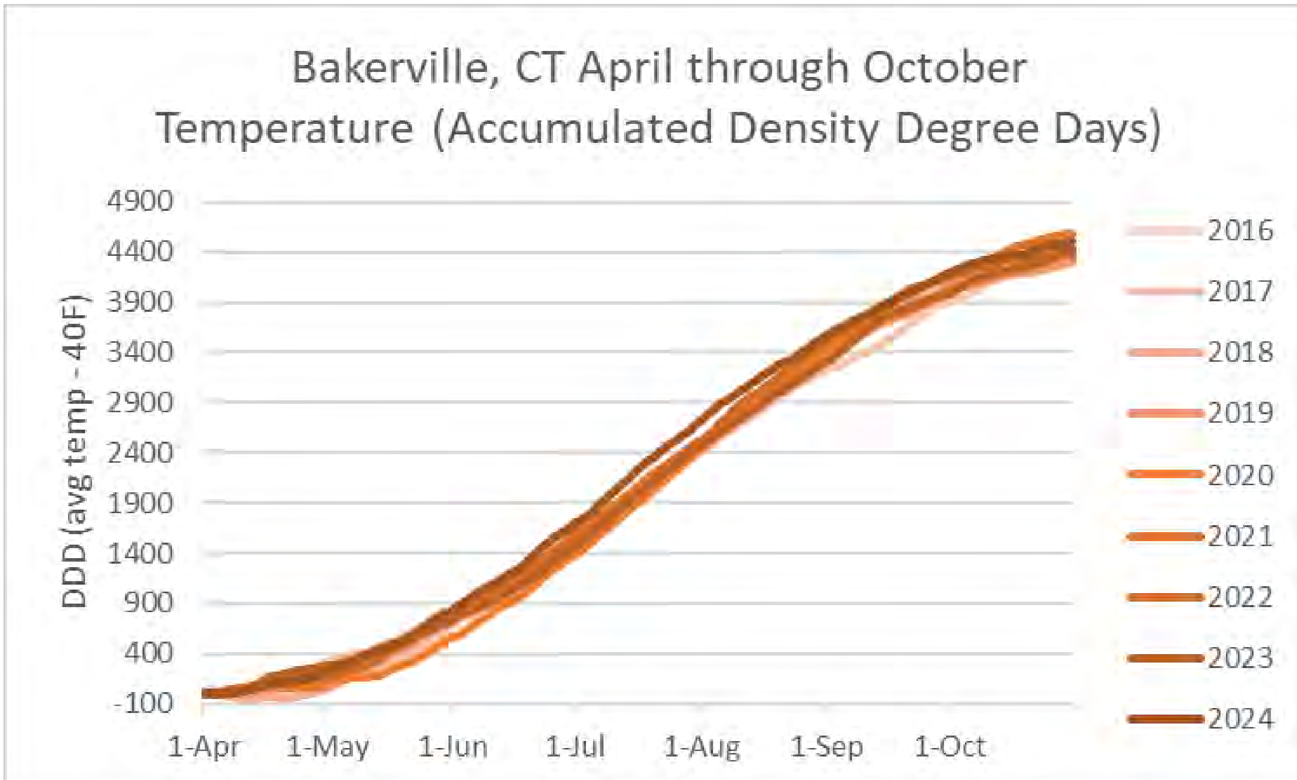

Figure 4. West Hill Pond regional accumulated temperature.

Thermal stratification is where warm water is located at the surface, and colder, denser water is located deep. Thermal stratification had not yet established at WHP during the first field monitoring trip on April 18, 2024, with water temperatures ranging from 9.0 ˚C to 5.6 ˚C from the top to the bottom of the water column, respectively (**Figure 5**). Stratification is measured by relative thermal resistance to mixing (RTRM). RTRM is a ratio, so it does not have units, but RTRM below 30-50 at any given depth, or below 100 when summed across the water column, is considered weak. Stratification was established and intense (305 RTRM total, summed across the water column) by the second sampling event on July 2, 2024, when water temperatures ranged from 23.3 ˚C to 6.1 ˚C from the top to the bottom of the water column, respectively. Peak summer temperature was recorded on July 30, 2024, with highest surface temperatures at 25.1 ˚C (over bottom temperature was 6.4 ˚C) and thermal stratification at 355 RTRM total. The thermocline, where stratification is most intense, was 6 m deep on July 2 (112 RTRM). Beginning on July 30, 2024, the thermocline gradually deepened its location in the water column until it was 9 m deep on October 9, 2024 (which was the second to last sampling date). In October, WHP's thermal stratification was still significant (85 RTRM at 9 m, 179 RTRM total), even though surface temperatures had cooled to 18.3 ˚C. In summary, WHP's thermal stratification structure this season was typical of a deep temperate lake. The thermocline was surprisingly deep, considering the warmer temperatures Connecticut experienced through the 2024 summer. Of note, a shallower thermocline depth was observed in 2023 (which was a much cooler season). RTRM remained above 300 through July in 2024. Because strong stratification isolates the top of the water column from the bottom of the water column (below the thermocline), stratification can exacerbate the depletion of oxygen at deep depths by preventing oxygen diffusion and replenishment from the surface.

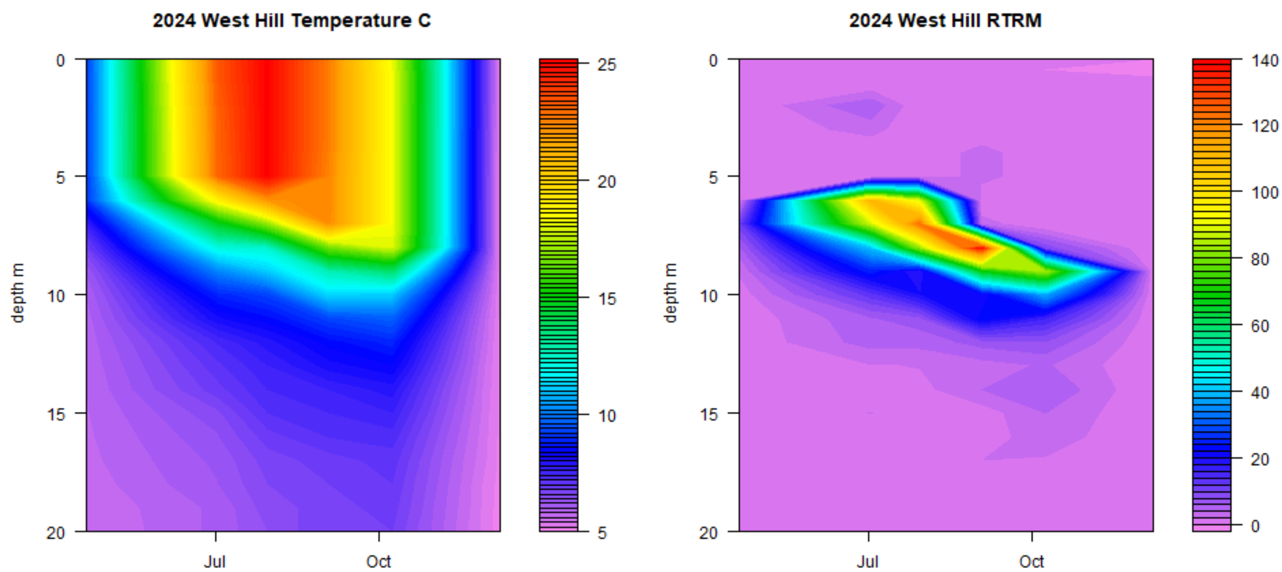

Figure 5. Temperature (left) and stratification (measured as relative thermal resistance to mixing, RTRM, right) profiles collected from the deepest point in WHP.

Dissolved oxygen is critical for lakes as it allows organisms to conduct aerobic respiration. DO is diffused across the lake surface from the atmosphere or produced by plants or phytoplankton within the lake. After lakes experience stratification, DO in the deepest hypolimnetic layer can become exhausted by biological processes (mainly, microbial respiration). This leads to anoxia (defined as DO < 1.0 mg/L) and chemically reduced conditions (low oxidation-reduction potential, (ORP)). Such conditions can promote the release and transport of problematic nutrients such as total phosphorus (TP), iron (Fe), and manganese (Mn) from the lake sediments into the water column. TP and Fe are key nutrients for cyanobacteria growth, while Mn is more of a concern to drinking water due to the treatment process required to remove it. Hence, the water at the bottom of the lake during the summer may not only be cold and dense, but if anoxic and reduced, it may also be very nutrient and metal rich.

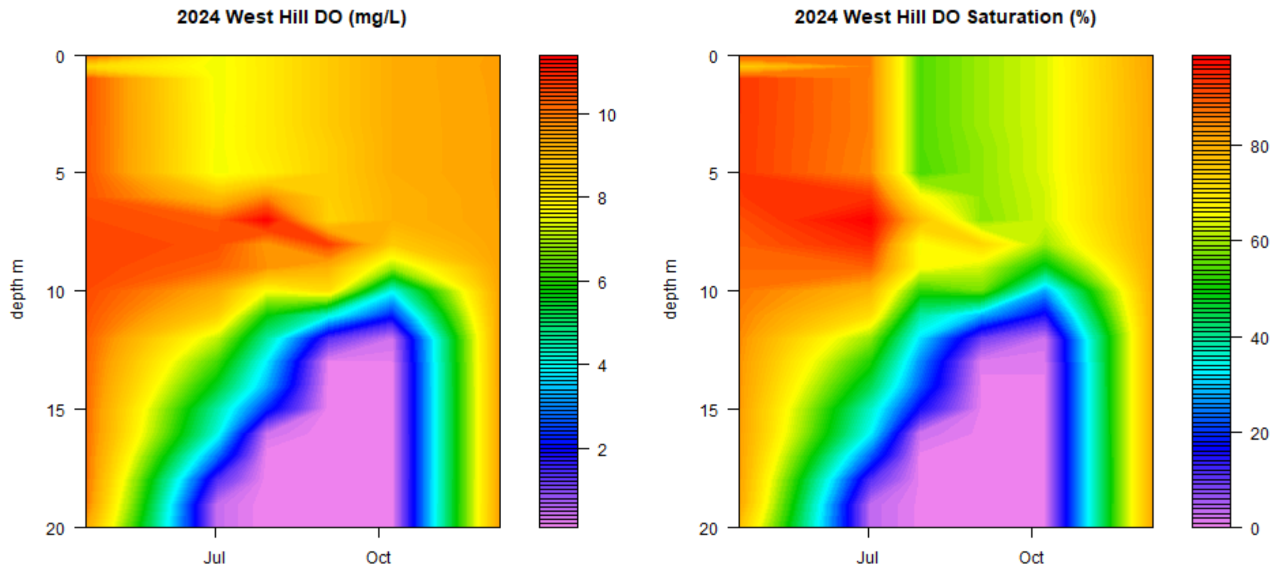

Figure 6. Dissolved oxygen profiles in terms of concentration (mg/L; left) and % saturation (right), which is water temperature dependent.

Throughout 2024, WHP's Epilimnion (upper layer) down through the metalimnion (middle layer that contains the thermocline) remained well oxygenated, with DO concentrations remaining above 7 mg/L though not exceeding 100% saturation (which has commonly happened in previous years, likely due to phytoplankton productivity; **Figure 6**). The hypolimnion (lower layer) remained aerobic (> 1 mg/L DO) until July, with anoxia initiating directly in the over bottom water parcel (19 m) and eventually ascending to 12 m deep by late October. Anoxia was contained below the metalimnion (which just reached 11 m deep in September 2024), within the hypolimnion. Anoxic ascent was higher than last year (14 m deep in 2023), and anoxic water—which is potentially nutrient-rich—did come close to the productive areas of the lake (with warmer temperatures and greater light availability). We recommend monitoring and consideration of this dynamic closely in future years, particularly in exceptionally hot summer seasons like 2024. If anoxic ascent becomes higher in future years, the WHPA may wish to begin considering management strategies to maintain separation of anoxia from the metalimnion and epilimnion to maintain low biological productivity that is currently a feature of WHP.

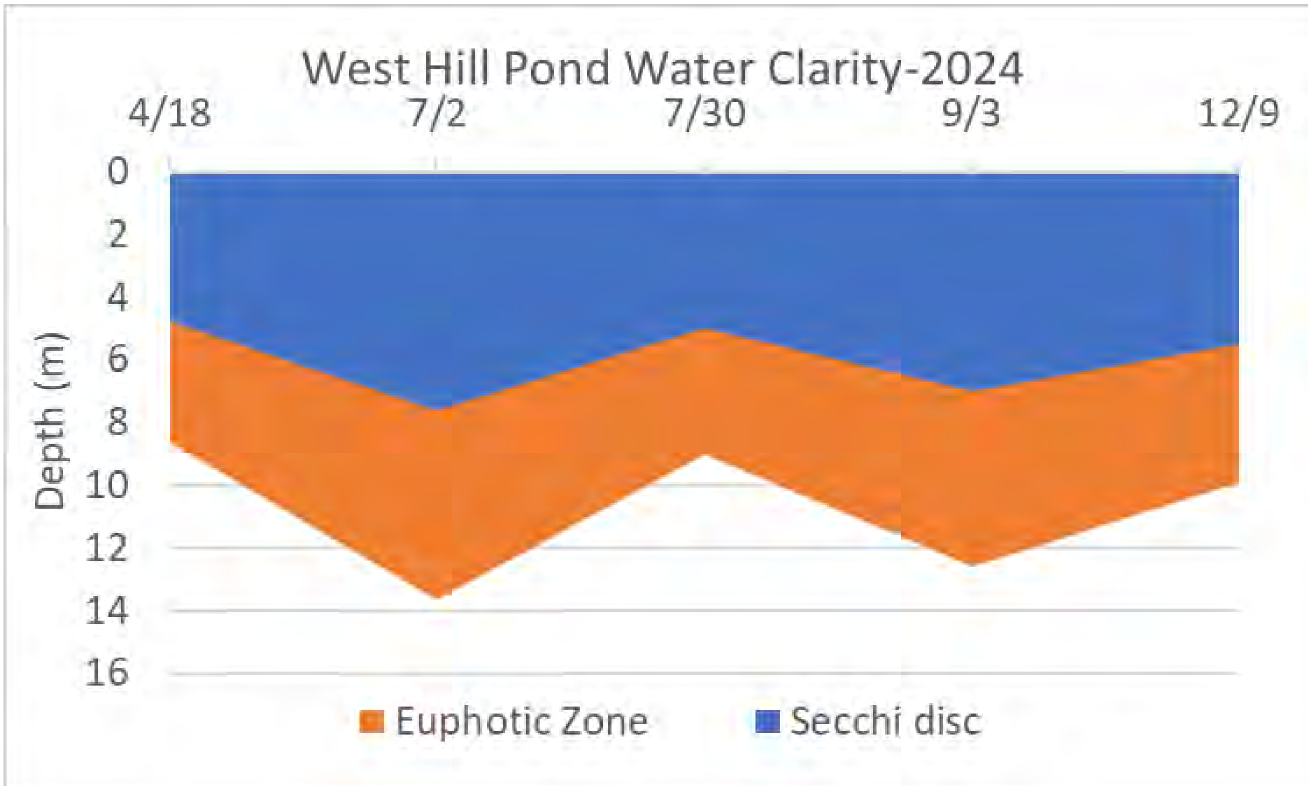

Figure 7. Water clarity in WHP, assessed by Secchi disk depth and euphotic zone depth, which corresponds to the section of the water column that supports photosynthesis.

A lake feature that helps to maintain aerobic conditions through the epilimnion and metalimnion is WHP's **water clarity**, measured by Secchi disk depth (**Figure 7**). Water clarity determines where in the water column photosynthesis may occur and WHP's euphotic zone (the depth to where photosynthesis can occur; estimated from the Secchi disk depth) spanned across much of the water column throughout the summer (9 m to 14 m). This means that photosynthesis and oxygen production could occur throughout WHP's water column down to those depths and likely contributed, at least in part, to the well-oxygenated conditions observed from the 6 m – 9 m depth range.

GZA's submersible probe measures a variety of parameters that are not collected by the WHPA probe. Because GZA sampled three times in 2024 (April 18, July 2, and December 9) as part of the client cooperative sampling program established with the WHPA, it is difficult to interpret seasonal dynamics in these parameters. Instead, we provide descriptive statistics of these parameters in **Table 1**. WHP is a rather dilute and low-productivity lake, which is indicated by the parameters that measure dissolved solutes, organic material, and phytoplankton pigments:

Descriptive Statistics					
Variable	**Units**	**Mean**	**Max**	**Min**	**Std. Dev.**
Conductivity	uS/cm	66	86	62	3.3
TDS	mg/L	0.043	0.055	0.040	0.002
Turbidity	NTU	4	148	0	23.4
fDOM	RFU	0.27	0.33	0.10	0.04
Chl - a	RFU	0.87	2.71	0.00	1.21
PC	RFU	2.03	4.10	0.01	1.44
PE	RFU	0.00	0.01	0.00	0.00

Table 1. Descriptive statistics for conductivity, total dissolved solids (TDS), turbidity, fluorescent dissolved organic matter (fDOM), chlorophyll-a (chl-a), phycocyanin (PC), and phycoerythrin (PE).

MiniDOT instruments provided measurements of hourly temperature and DO at five depths (2 m to 18 m) throughout the 2024 season (**Figures 8 and 9**). The results of these hourly records are interesting: WHP's temperature peaked in the high 20's (°C) through July at the surface, while the rest of the water column warmed more gradually with depth. The bottom of the lake remained cold, only increasing from 5.6 °C to 6.5 °C. Peak surface temperature corresponded with shallow stratification through July 2024 at 7 m – 8 m. RTRM significantly weakened toward the middle and end of August, corresponding to shorter days, cooler air temperatures, but also a rain event that dropped 3 inches of rain from August 18 to 20, 2024. A distinct 'zone', or parcel, of increased oxygen demand (roughly below 6 mg/L DO), developed over bottom starting in May 2024. Eventually this parcel also developed anoxia starting at the end of June and ascended into the water column to approximately 14 m through August, when the instruments were preemptively removed from WHP by a fisherman. Thus, anoxia was persistent up to the point of the last sampling date when the miniDOTs were extracted, and the lake was still stratified. Obviously, the early removal was unplanned, but we suggest a longer deployment in future years to evaluate anoxic duration and timing of lake turnover. During our December 2024 trip, we were able to deploy MiniDOTs through the winter, to be collected in April 2025. Supersaturation, greater than 100% DO, did not exceed 110% this year and was observed at the surface through the spring and around 8 m in peak summer, which often had higher DO concentration and saturation values than the surface. As described above, this is likely due to photosynthetic productivity by phytoplankton.

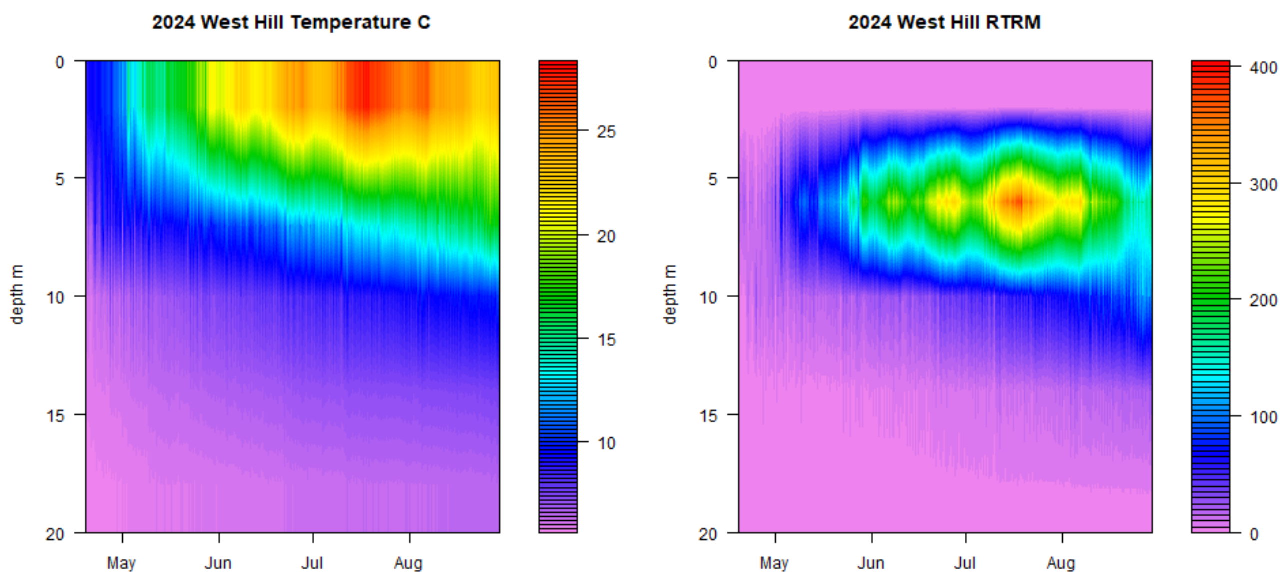

Figure 8. West Hill Pond hourly temperature (left) and stratification (measured as relative thermal resistance to mixing, RTRM, right) from miniDOTs deployed at 2, 7, 10, 14, and 18 m.

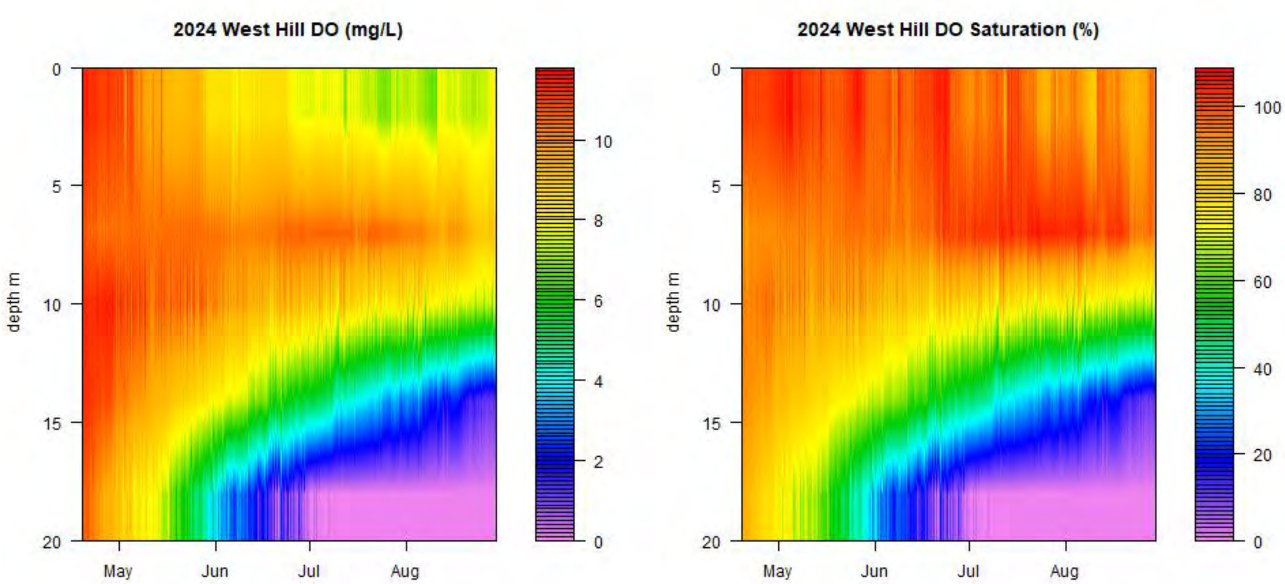

Figure 9. West Hill Pond hourly DO concentration from miniDOTs deployed at 2, 7, 10, 14, and 18 m.

TP is a key nutrient for biological productivity in New England Lakes. A threshold of 0.020 mg/L (20 ug/L) TP indicates favorable nutrient conditions for cyanobacteria, at which blooms can initiate and be sustained in fresh waterbodies. In 2024, TP concentrations in the epilimnion layer ranged from 1 ug/L to 21 ug/L, with a mean of 8 ug/L (**Figure 10**). Mid-depth (7 m to 14 m) TP was slightly higher, ranging from 2 ug/L to 20 ug/L with a mean of 11 ug/L. These were favorable conditions, suggesting that WHP was not susceptible to cyanobacteria blooms or productivity in the area of the lake that receives the most sunlight. Further, 14 m TP concentrations were low considering the vertical extent of anoxia this year (to 12 m). Over bottom TP concentrations were highest, continually increasing throughout the season (probably due to internal loading during anoxia) and peaking in September and October at 149 ug/L, returning to 10 ug/L in December.

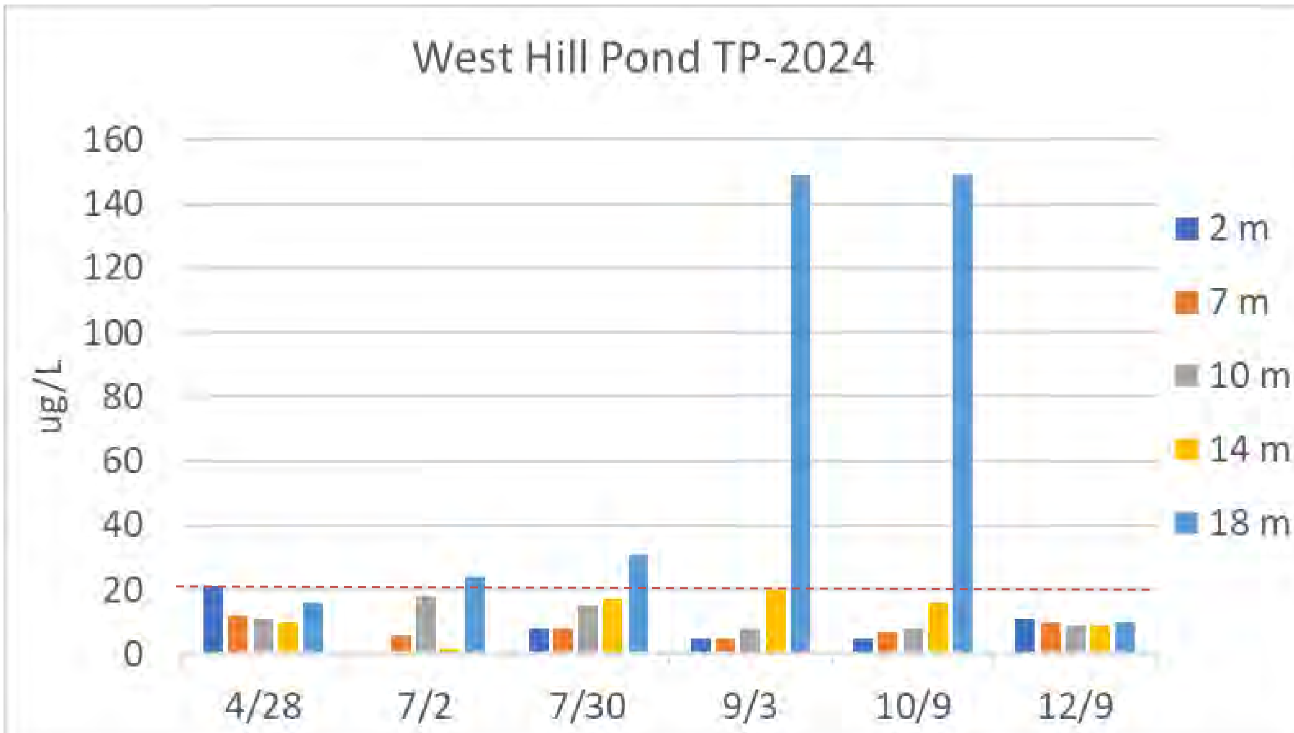

Figure 10. WHP Total Phosphorus (TP).

Ammonia-N is an important source of inorganic nitrogen to cyanobacteria and can accumulate near the bottom of lakes and reservoirs resulting from organic decomposition and anoxia. Ammonia-N concentrations throughout the upper, oxygenated water column were minimal throughout the season (**Figure 11**) but did accumulate over bottom to 719 ug/L. It became evenly distributed through the water column by December 9, 2024 (the average was 29 ug/L). Again, the relatively low concentrations of ammonia at 14 m were somewhat surprising given the anoxic conditions that ascended to 12 m, but cold hypolimnetic temperature could have slowed the metabolic processes that would cause it accumulation.

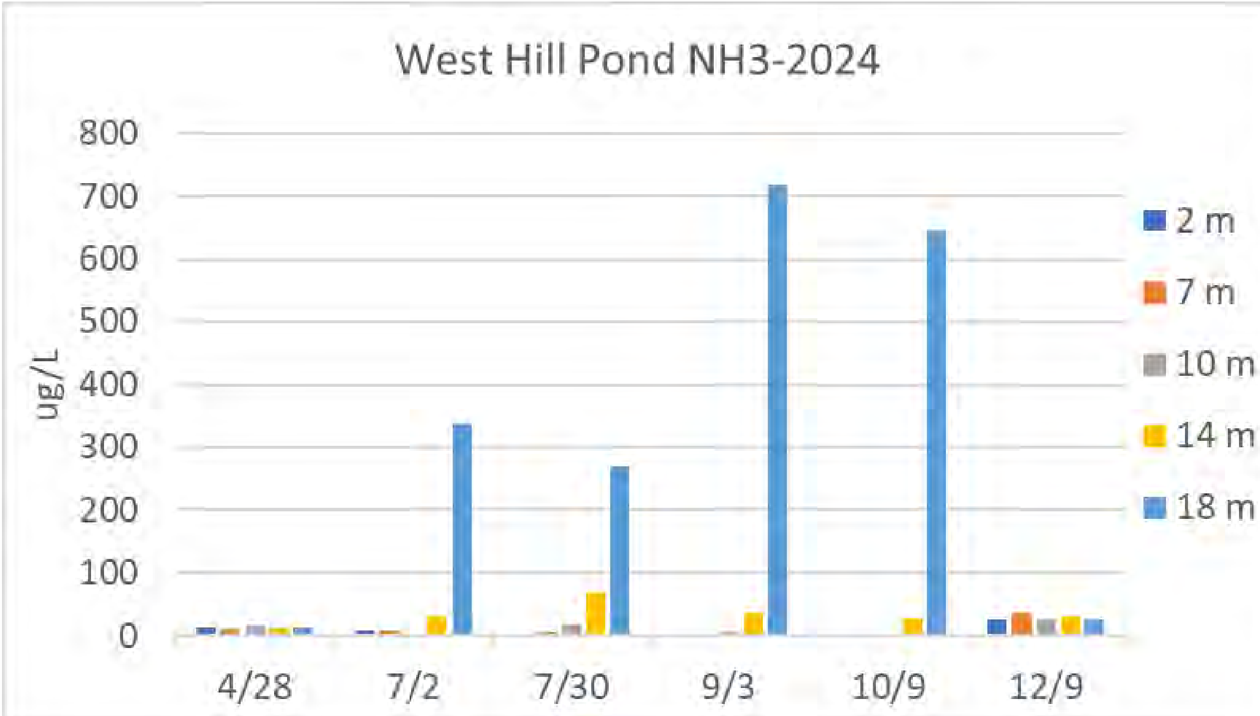

Figure 11. WHP Ammonia (NH3).

Nitrate is an important nutrient for eukaryotic phytoplankton such as diatoms, chlorophytes ("greens"), and chrysophytes, which can readily compete with cyanobacteria when conditions are favorable. Typically, temperate waterbodies are enriched with nitrate in early spring following ice off, snow melt, and spring rains. Spring diatom blooms often track nitrate availability, and "bust" when nitrate is exhausted. Following nitrate exhaustion, lakes may experience a 'clear-water phase,' where diatoms senesce and settle to the bottom of the lake. When nitrate becomes depleted in surface waters, N-fixing cyanobacteria can gain a competitive advantage over eukaryotic algae. In 2024, WHP's nitrate concentrations were low throughout the season, ranging from below detection limits (< 4 ug/L) to 14 ug/L from April through October (**Figure 12**). Thus, if there was spring nitrate enrichment in WHP, it was missed by our sampling efforts. Low nitrate through the 2024 season typically results in low eukaryotic algae density (but low TP also keeps cyanobacteria density low as well, as discussed below). Nitrate levels in 2024 were similar to 2023 (when low nitrate concentrations were also measured), but different than some historical data. Nitrate trends can be variable in WHP from year to year, and it has been measured at enriched concentrations through the spring and beginning of summer throughout the past decade. It should be a matter of interest to closely monitor nitrate in future years to understand these findings and assess if they are representative of a long-term change. Notably, we captured an episode of relative nitrate enrichment in December when concentrations peaked at 29 ug/L (averaging 15 ug/L). This resulted from biologically driven nitrification, when microbes convert ammonia to nitrate for energy production in oxygenated conditions (compare **Figures 11 & 12**).

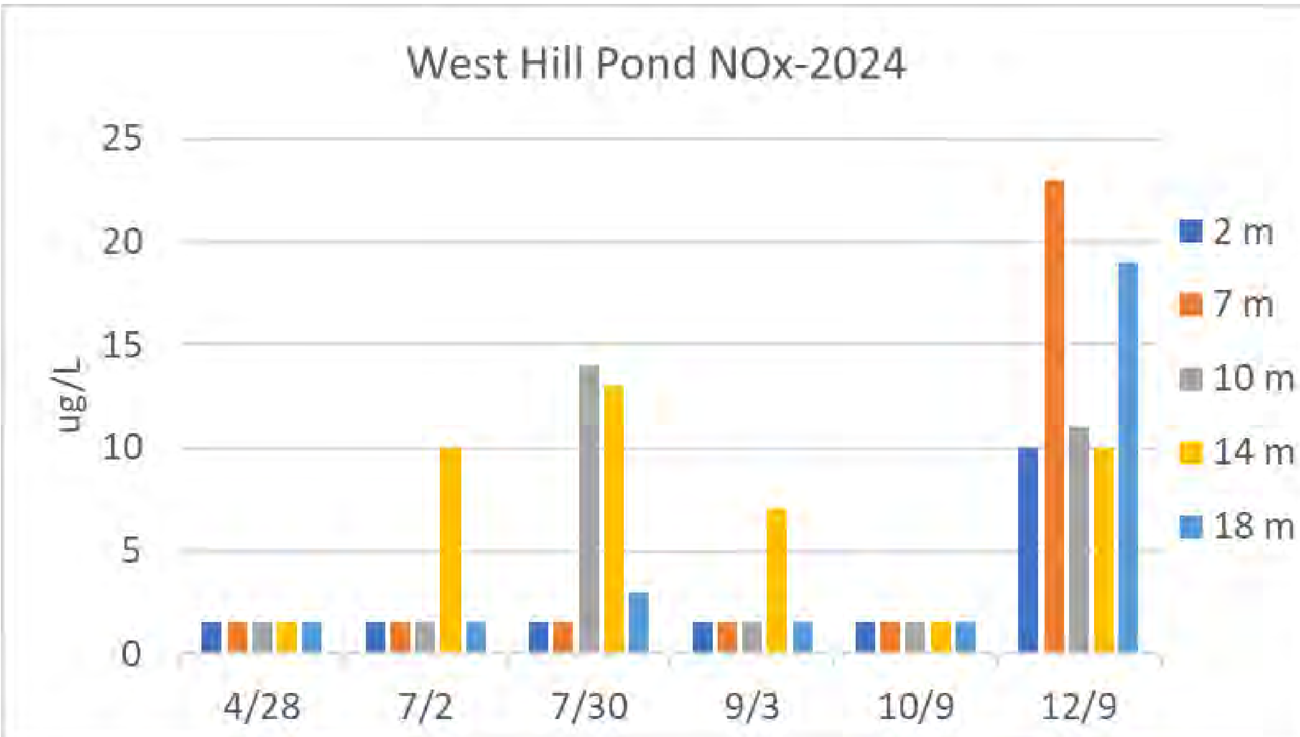

Figure 12. WHP Nitrate (NO3).

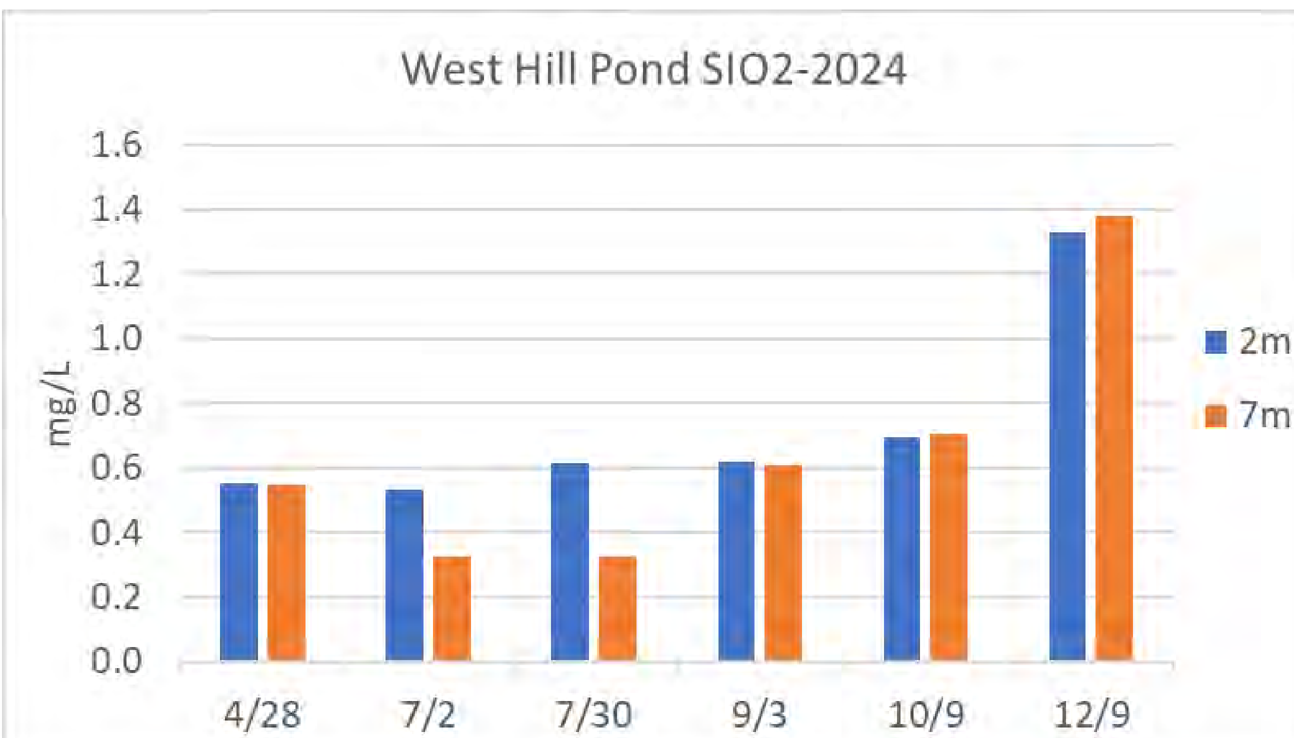

Figure 13. WHP Silica oxide (SiO_2).

Silica is an important nutrient for certain eukaryotic phytoplankton taxa, such as diatoms and chrysophytes. Diatom frustules, which are their unique cellular wall structures, are composed of silica and can be quite intricate (with geometric, and even snowflake-like shapes). Like nitrate, silica can follow seasonal dynamics of spring enrichment and depletion as senesced diatoms settle out of the water column by early summer. Also, like nitrate, silica is a nutrient that can impact how well diatoms and chrysophytes compete with cyanobacteria, so it is important to measure and understand the phytoplankton community and is part of GZA's standard nutrient chemistry suite. Silica in WHP is low, as indicated by 2024 shallow water samples (2 m and 7 m; **Figure 13**). This helps explain, at least in part, the low abundance of diatoms in WHP's phytoplankton assemblage this year.

In the absence of oxygen, **Fe and Mn** can become chemically reduced and mobilized from sediments into the water column by anaerobic microbial respiration. When anoxia occurs for a duration of time, Fe and Mn can accumulate to high concentrations in over-bottom water. Likely due to internal loading, WHP's total over bottom Fe was high, reaching a maximum concentration of 8.1 mg/L in September (**Figure 14**). WHP's total Mn was lower than total Fe, which is typical for most New England Lakes, but still accumulated to high concentrations over bottom (2.0 mg/L Mn in late October, **Figure 15**). By December, Fe and Mn became re-oxidized following lake turnover and concentrations were low (0.1 mg/L and 0.01 mg/L for Fe and Mn, respectively).

Figure 14. WHP Iron (Fe).

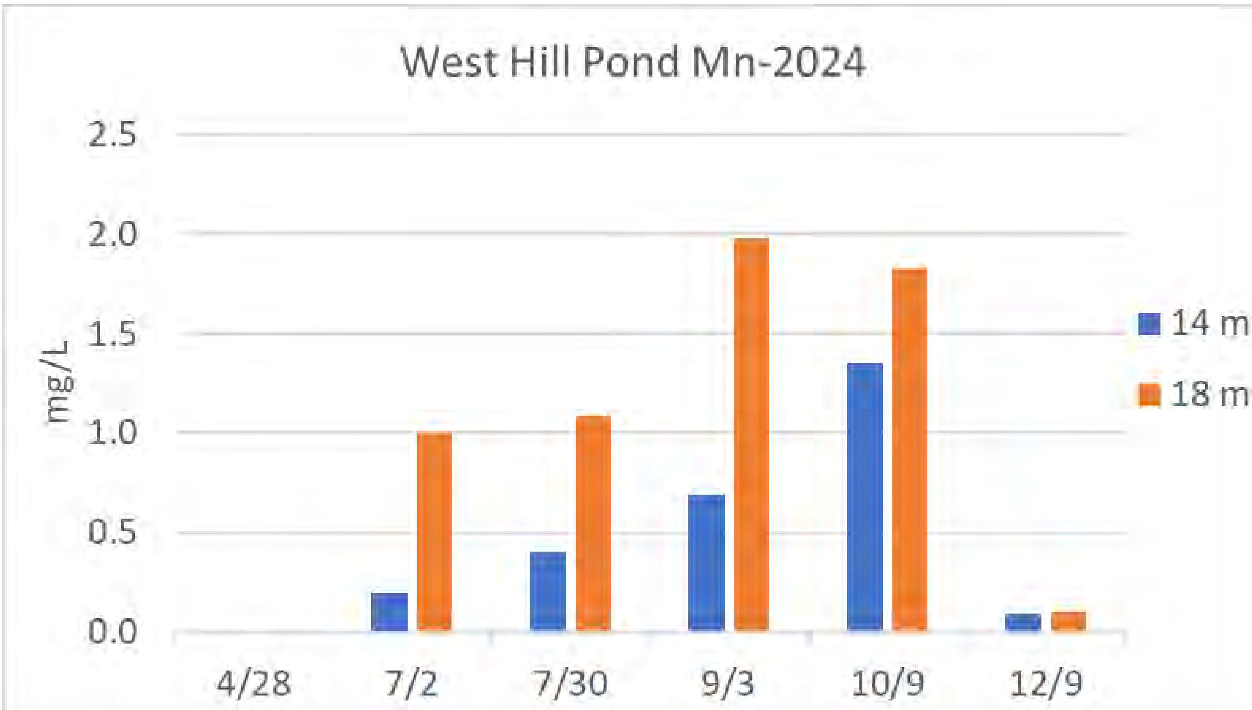

Figure 15. WHP Manganese (Mn).

Fluorometric analysis of pigments and organic matter (chromophoric dissolved organic matter (cDOM), and UV254 absorbance) was performed on monthly water samples. cDOM is the fraction of organic material that can give water a 'tea-stained' coloration. It consists of reactive organic molecules such as tannins and humic acids and is typically considered to represent allochthonous sources—that is, derived from outside the reservoir, i.e., terrestrial watershed habitat. As WHP has a relatively small and high-quality watershed, cDOM was low throughout the season compared to other Connecticut waterbodies (**Figure 16**). cDOM was also highest over bottom from September to October, which is typical as it settles out and decomposes more slowly in an anoxic environment. UVA254 quantifies the aromatic (6-carbon ring) fraction of dissolved organic material which can be more refractory than cDOM. WHP's UVA254 was low down to 14 m, with an average of 0.043 abs cm^{-1} (**Figure 17**). Like cDOM, the highest UVA254 was recorded over bottom (0.500 abs cm^{-1}). WHP generally appears to have low amounts of organic matter compared to many soft-water New England waterbodies. This is a positive characteristic, as it promotes better water clarity and decreases oxygen demand (since organic material increases microbial respiration rates). It is quite possible that in contrast to many other Connecticut waterbodies, WHP is net autotrophic, meaning that overall lake metabolism is dominated by carbon fixation processes (like photosynthesis) vs carbon oxidation processes (heterotrophy). In other words, WHP could be a carbon *sink* rather than a carbon *source* (though we did not measure this).

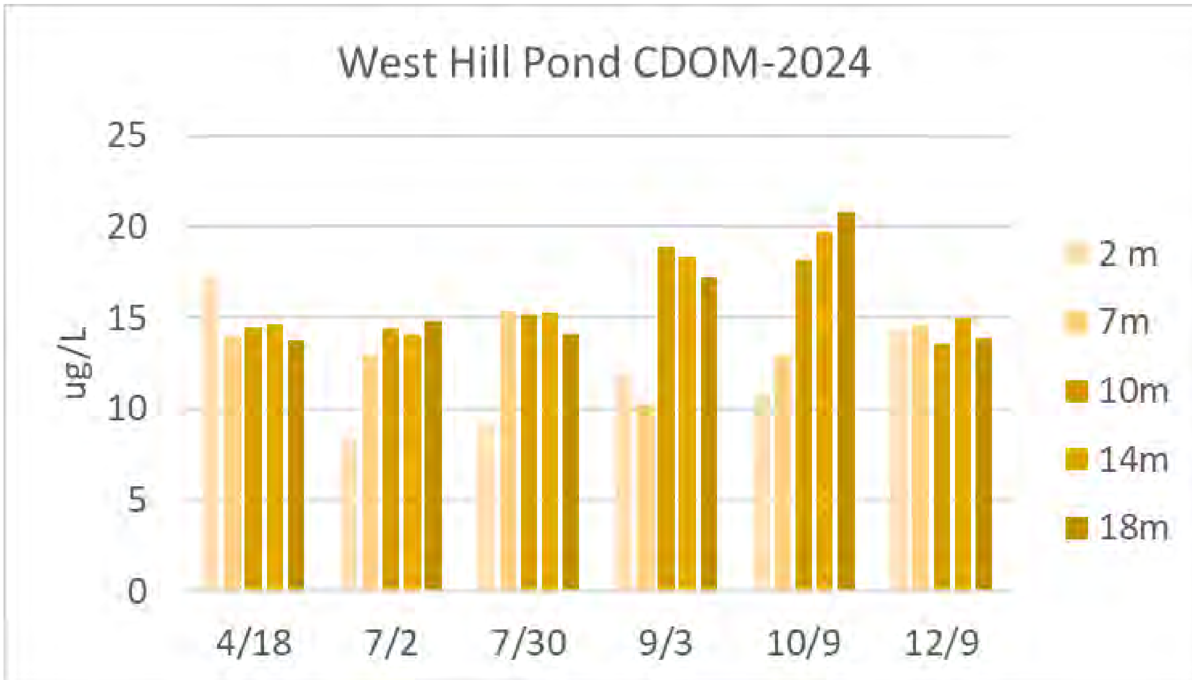

Figure 16. WHP colored dissolved organic matter (cDOM).

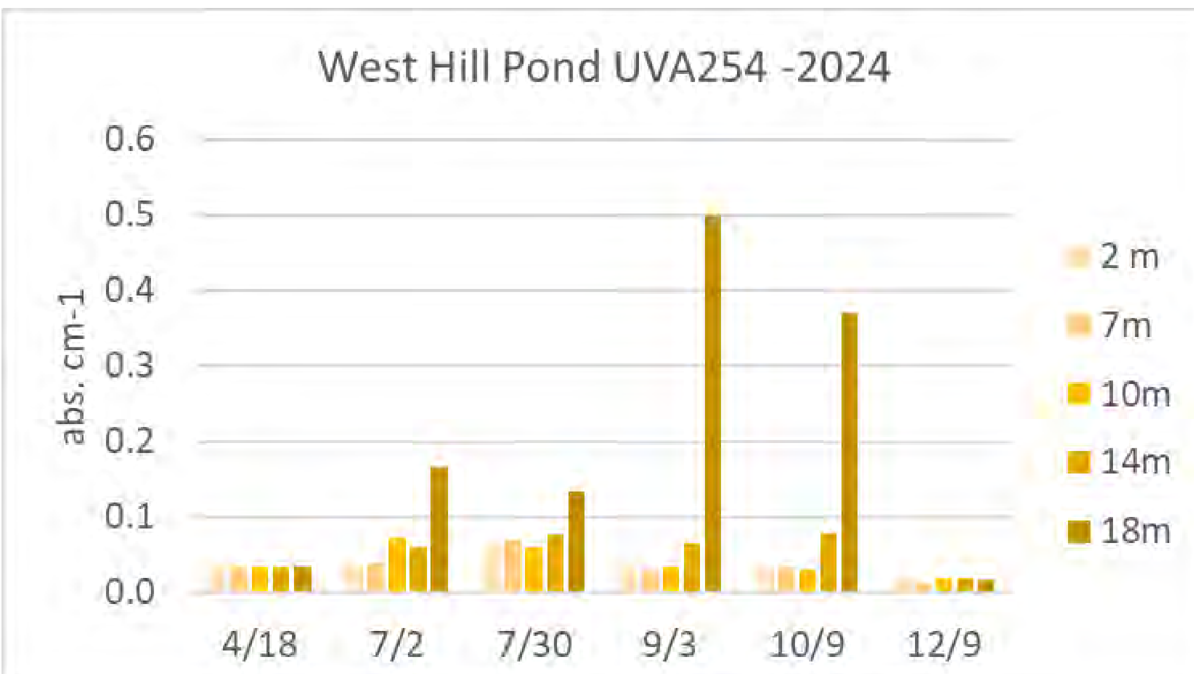

Figure 17. WHP UV light absorbance at 254 nm wavelength (UVA254).

Chlorophyll-a is a photosynthetic pigment that indicates the standing biomass of phytoplankton in the water column. As such, it is a useful proxy for tracking phytoplankton dynamics. WHP's 2024 chlorophyll-a concentrations were very similar to those recorded in 2023. They were low and mostly remained below 10 ug/L on most dates, indicating low phytoplankton densities, though there was a small peak in April from 10 m to 14 m, reaching 12 ug/L, and over bottom on September 3, 2024, reaching 17 ug/L (**Figure 18**). This September measurement corresponds to the UVA254 peak value and could be due to senescing or dead organisms settling out of the water column. In April and July, the highest chlorophyll-a was recorded at 10 m, suggesting the presence of a deep-water phytoplankton layer. **Phycocyanin** is a cyanobacteria-specific pigment that imparts the 'blue-green' color, and measuring it can indicate standing cyanobacteria biomass in a sample of water. Phycocyanin concentrations were minimal throughout all samples, but the highest readings from 2024 were recorded at the bottom of the reservoir, similar to what was recorded in 2023 (107 ug/L on September 3, 2024; **Figure 19**). Like over-bottom chlorophyll-a, this deep cyanobacteria-specific pigment could indicate increased cell densities due to settling out of the water column. **Phycoerythrin** is a reddish pigment specific to certain groups of cyanobacteria, such as *Planktothrix spp*. and *Planktolyngbya spp*., that specialize in photosynthesizing in cold, low-light environments. Phycoerythrin concentrations also peaked on September 3, 2024 over bottom (**Figure 20**), like the other pigment, but concentrations were low, indicating the relative absence of phycoerythrin-producing cyanobacteria.

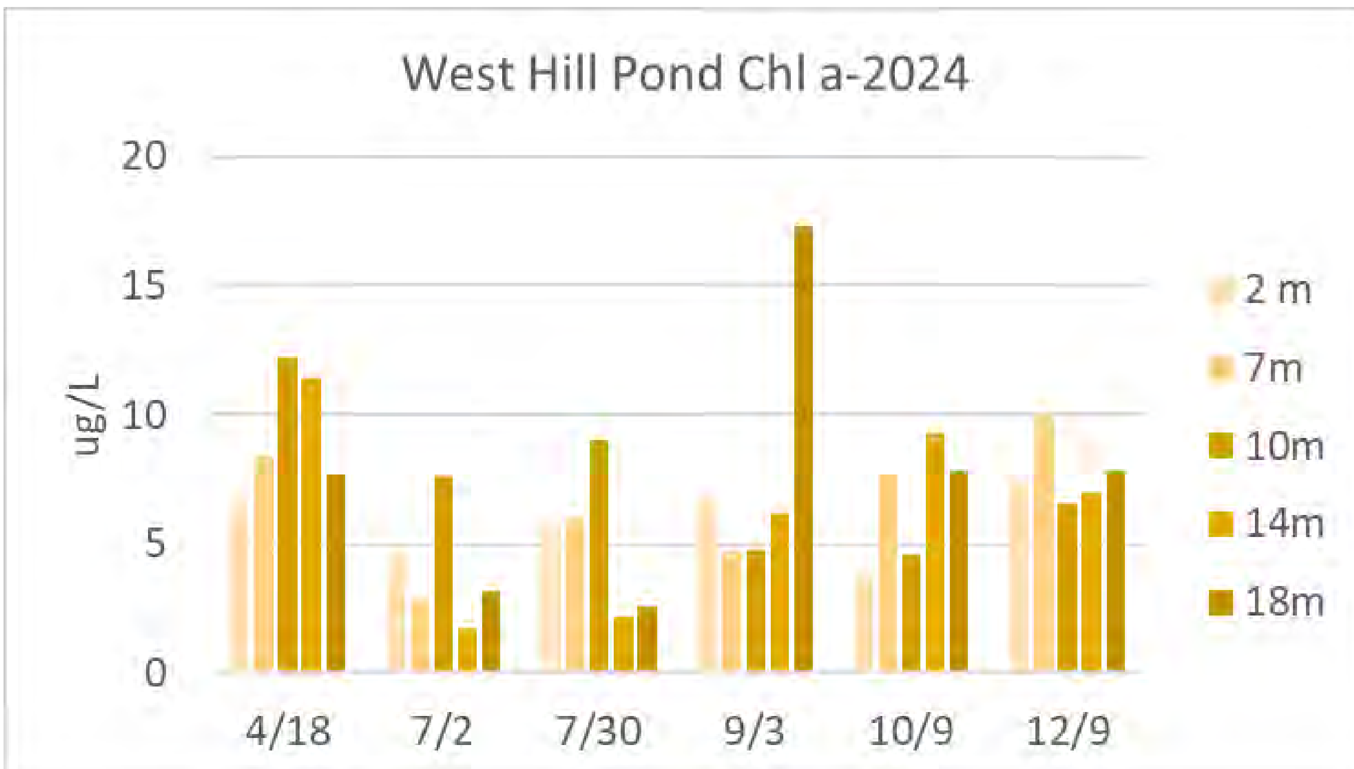

Figure 18. WHP chlorophyll-*a* (Chl *a*).

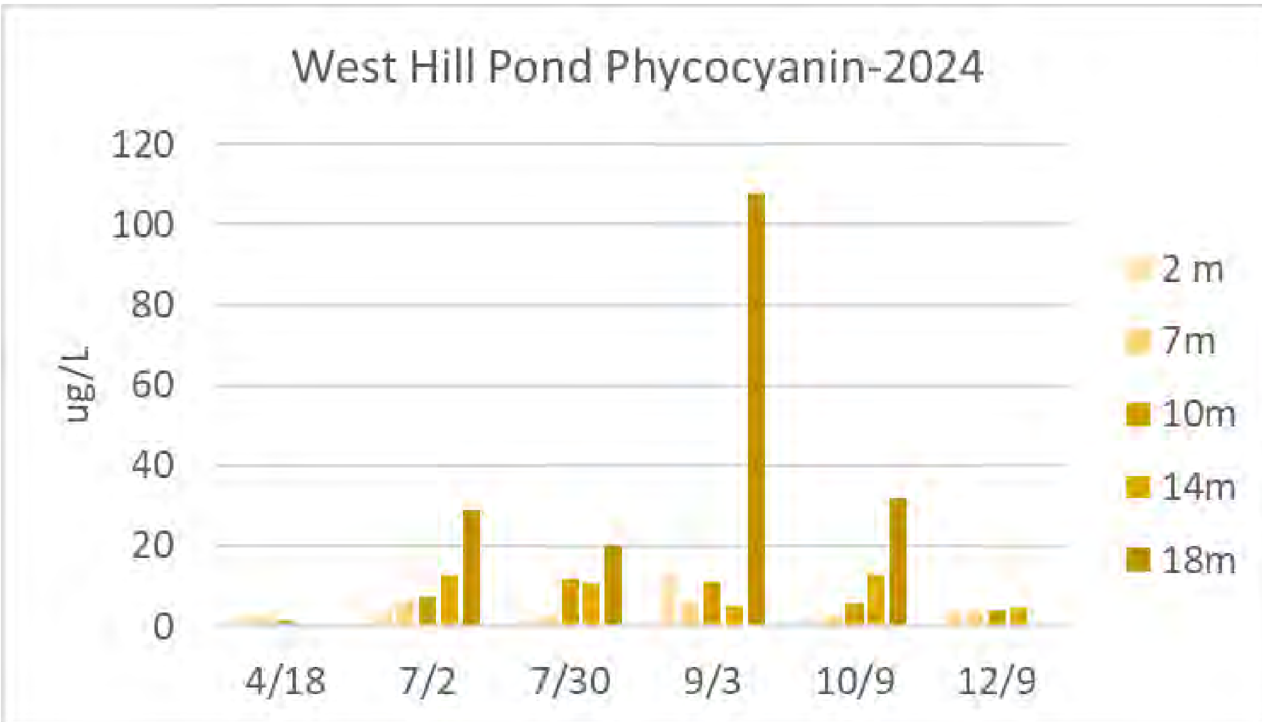

Figure 19. WHP phycocyanin (PC).

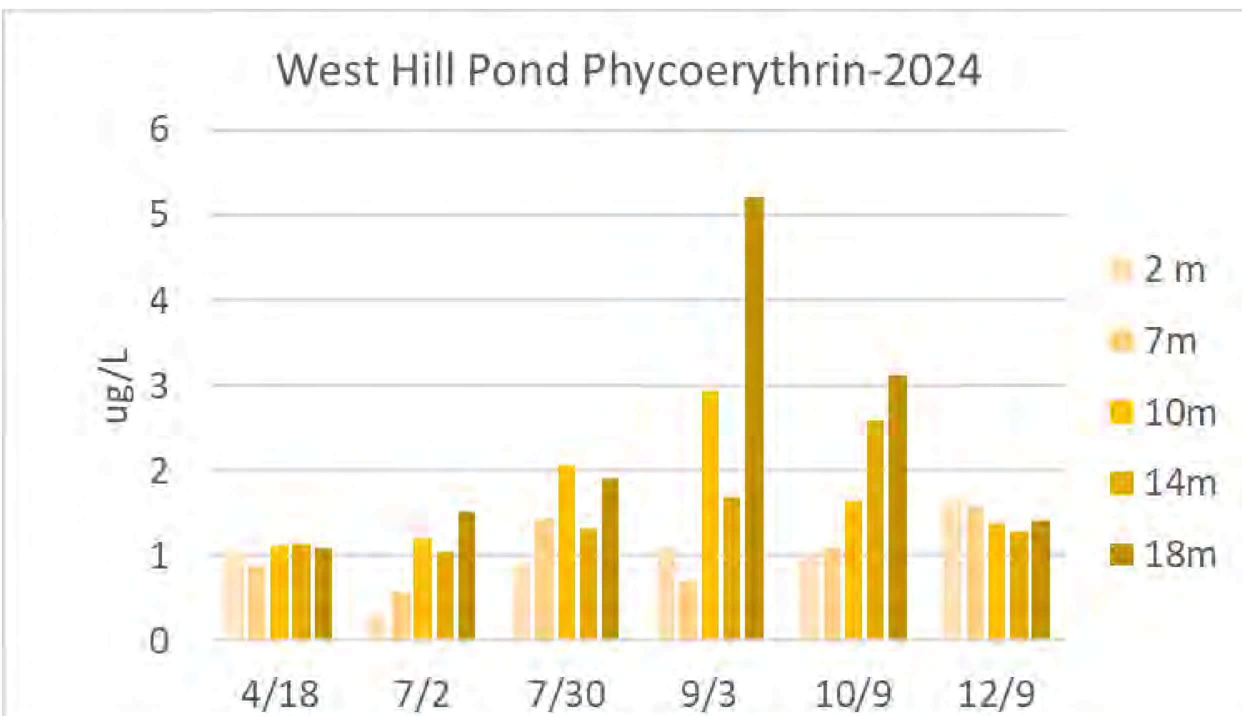

Figure 20. WHP phycoerythrin (PE).

Monthly **phytoplankton samples** collected from the top of the water column, 0-5 m, were enumerated to cells/mL by a taxonomist (**Figure 21**). WHP exhibited low densities of diatoms throughout the season, perhaps attributable to the lack of available nitrate (GZA did not observe a spring diatom bloom). The assemblage was very diverse, however, with other types of eukaryotic phytoplankton including chrysophytes, cryptophytes, and chlorophytes (or 'green algae'). Cyanobacteria were dominant in the July 2, 2024 sample but were otherwise low-abundance. Peak cyanobacteria abundance was nearly 5,000 cells/mL in July 2024, but that is still a relatively low density. Low-end bloom thresholds that would warrant alert are 20,000 cells/mL. Further, almost the entire cyanobacteria community on July 2, 2024 consisted of *Aphanocapsa spp* (**Figure 22**), which is not a known toxin producer, and has a very small cell size compared to other cyanobacteria. Thus, situations occur where Aphanocapsa may be numerically abundant but its biomass, biovolume, and risk of cyanotoxins are negligible. Phytoplankton community count data from 2024 are similar to those that were collected last year: overall, there is a very diverse, low-abundance, and healthy phytoplankton community in WHP. Though cyanobacteria were present, their cell densities did not warrant concern.

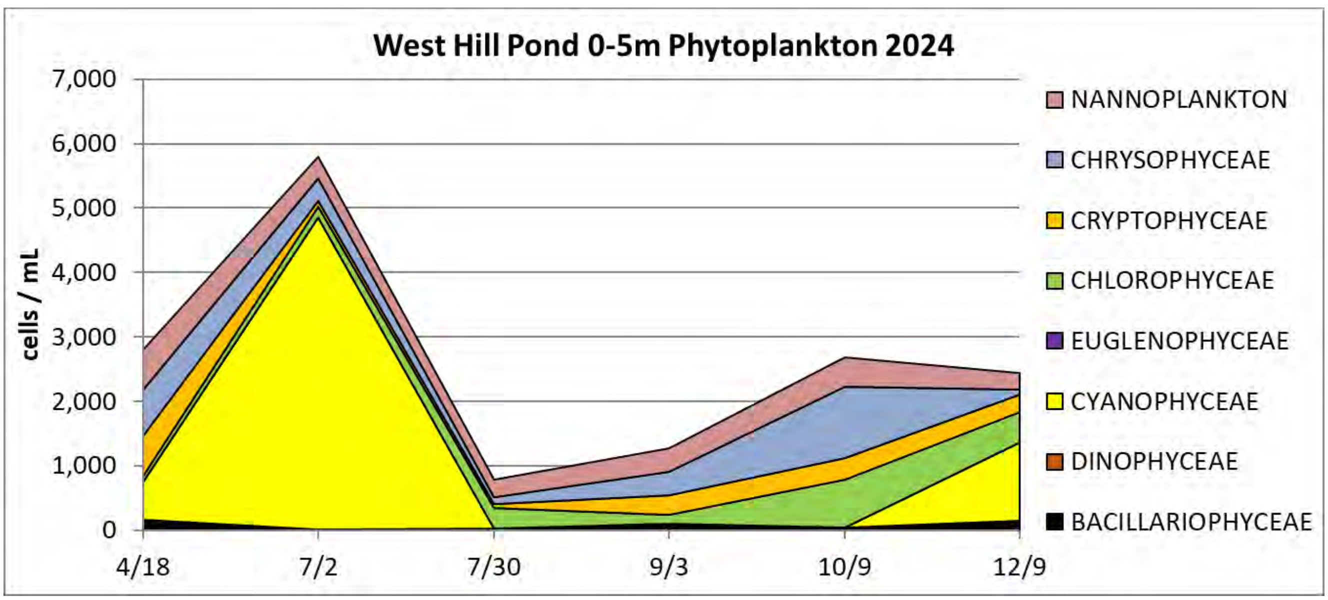

Figure 21. WHP phytoplankton community enumeration.

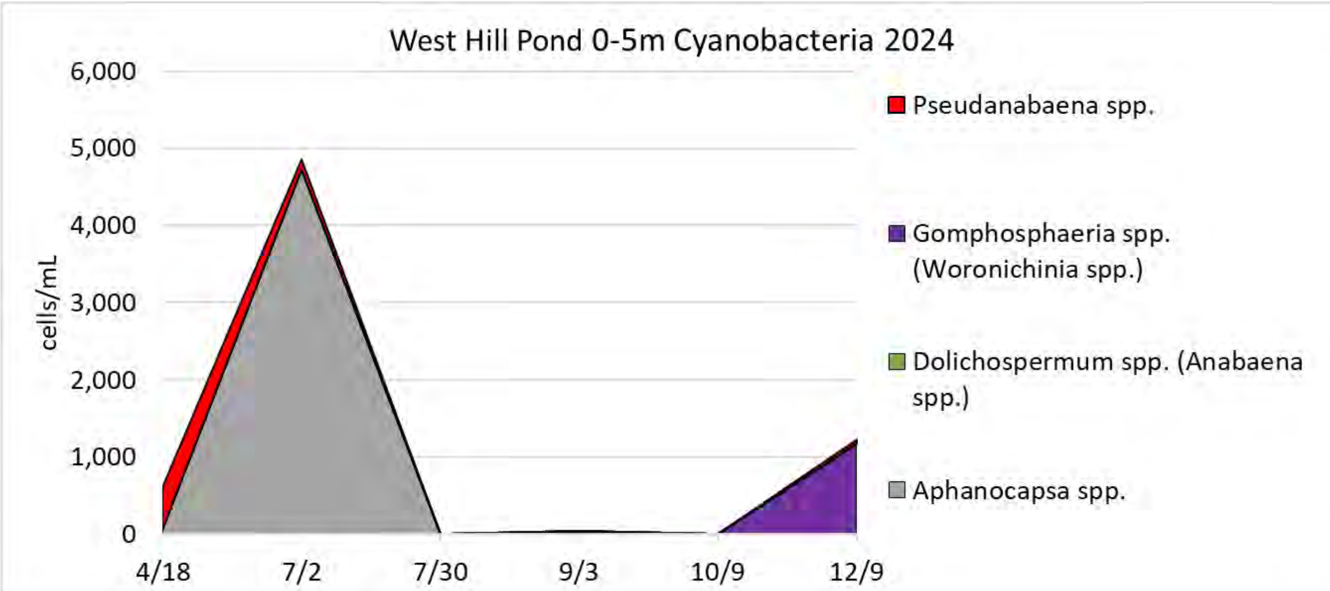

Figure 22. WHP cyanobacteria community enumeration.

DISCUSSION AND RECOMMENDATIONS

GZA has been providing WHP with services since 2023. Since the initiation of our services, we have characterized WHP extensively. Annual monitoring notwithstanding (the results of which are summarized within this and 2023's reports), GZA also conducted a historical analysis and brief watershed analysis. Both of these reports were produced as separate reports that were provided to the WHPA in 2023. The historical data review determined that recent trends indicate trophic state and metabolic processes are remaining at historical levels (some are even improving, i.e., indicating the lake is becoming slightly more oligotrophic since the 1970s). GZA suggested WHP does not yet need any in-lake management intervention beyond regular annual lake and watershed monitoring. 2024 was a good year to put that assertion to the test, as it was an exceptionally hot summer and put stress on the system (in the form of thermal stratification and oxygen loss). Even with this environmental pressure and anoxia that ascended 2 m higher than in 2023, WHP did not exhibit adverse conditions that may be typical due to higher-than-normal internal nutrient loading, such as increased phytoplankton productivity and cyanobacteria blooms. Part of the lake monitoring program's purpose at WHP is to indicate deviations from historical baseline conditions (which GZA has assessed and reported). The data collected in 2024 do not indicate such deviations.

Monitoring data from 2024 captured the characteristic deep water DO production and high DO concentration (sometimes resulting in supersaturation) at 6 m to 9 m. This is a trend that has been observed historically, not just this year, and in fact this year it was somewhat muted (max supersaturation recorded at 7 m was 110%, as opposed to 126% in 2023). We have confirmed via previous monitoring efforts that this parcel of high DO concentration and saturation contains higher densities of phytoplankton and cyanobacteria, which are likely the source of this DO, though densities were not high enough to be a management concern (measured in 2023). The decreased DO content at 6 m to 9 m in 2024 vs. 2023 may be attributable to increased oxygen demand in 2024 due to increased thermal stratification intensity (again, anoxia resulting from oxygen demand was more prevalent this year than last).

MiniDOT data records provide insight into lake mixing and stratification, diurnal or daily fluctuations in temperature, dissolved oxygen concentrations, winter oxygen depletion rates, and deep-water anoxia. Data collected in this manner are useful for evaluating lake dynamics and water quality beyond monthly summer sampling. The miniDOT data this year are highly valuable, even though the recording was truncated due to unforeseen circumstances. They provide a detailed record of lake conditions and allow for evaluation of normal seasonal lake trends such as warming and cooling, stratification, and the development of anoxia. We made the following observation in 2023, and it held true for 2024: perhaps the most interesting aspect of the MiniDOT data record was the consistency of the overall seasonal progression of the recorded temperature, stratification, and DO trends in WHP. Many lakes exhibit variability in their warming, stratification, and DO profiles that are controlled by daily light/dark and warming cycles and weather events. Even though the early 2024 season experienced many individual extreme weather events that delivered high amounts of precipitation, the miniDOT data record did not register any real disturbance to its seasonal cycle. The exception was in August; WHP received 3 inches of rain over the course of August 19 and 20, 2024, and the thermocline dramatically weakened, presumably in response to this input cooling off surface water temperatures. It's unclear how this impacts WHP going into the fall season since the MiniDOTs were removed soon after this event. Future miniDOT data will allow comparison and will be helpful in diagnosing what environmental factors WHP responds to. New this year is the additional deployment of MiniDOT data loggers in WHP during the winter season of 2024-2025. Year-round (including under ice) deployment would be useful to understand WHP dynamics through the late autumn, winter, and early spring seasons. As WHP received ice cover this winter, we are eager to collect these data in April 2025 and analyze them. These data will be included in the 2025 Annual Report.

In summary, GZA recommends continued monitoring in 2025 and going forward. The cooperative sampling model between GZA and the WHPA was successful in 2024 and will be leveraged more in the coming years. We do recommend initiating the sampling season again in April 2025 and sampling late enough in the 2025 season to capture complete lake turnover (likely November).

As we've discussed in correspondences and reports submitted previously, the WHP ecosystem is not limited to the water column, which receives much attention through annual monitoring. The ecosystem is continuous and encompasses the watershed, littoral area of the pond, and water column. All components should be part of a larger preservation effort and coordinated management plan. This year (2025), we recommend initiating the development of an EPA-approved 9-element Watershed Based Plan (WBP). The involvement and import of this project have been outlined by us in the historical and watershed studies, as it is the central and most crucial piece of an overall maintenance/preventative management scheme. WHP's watershed is small (watershed area: lake area is about 3:1) and high quality. Much of the shoreline remains undeveloped, and there have been recent projects to improve watershed and drainage function. We will restate a message that GZA has stated in other reports: WHP is a healthy ecological system, and management should be maintenance-focused to keep WHP among the least eutrophic waterbodies in Connecticut. The goal for the WHPA, New Hartford, and Barkhamsted is to maintain WHP in its current condition into the future. Proactive preservation is much easier, more effective, and more affordable compared to reactive rehabilitation/restoration efforts to a compromised system. The adage attributed to Benjamin Franklin, "an ounce of prevention is worth a pound of cure," certainly holds true in ecological and environmental sciences. This goal is given even more urgency, perhaps, considering future climate change with projected impacts on New England lakes and current trends in invasive macrophyte colonization in Connecticut (there have been several reported cases of *Hydrilla verticillata* across the State last year, which was previously only recorded in a handful of places). We describe WBPs as management 'road maps,' as it should be a comprehensive document to address ecological or recreational concerns identified by stakeholders within the watershed or waterbody, stakeholder priorities, and it will meet state and federal regulatory requirements to protect the highly valued and high-quality natural resource for current and future generations. The WBP should serve as a guiding document to describe the state of the lake, summarize previous and current studies, assist stakeholders to identify and agree upon lake management goals, decide on next steps to reach identified goals, secure funding, develop communication and education tools for the benefit of the broader community and regulators, and to track progress toward management goals. The WBP should also be a 'living document', allowing modifications to be made as conditions and priorities change over time among the stakeholder groups.

It has been a pleasure working on WHP, and alongside the passionate individuals that constitute the WHPA and volunteer sampling team. The GZA team appreciates the opportunity to provide these services to the WHPA and we look forward to continuing to serve you in the future. If you have any questions regarding the information presented, please feel free to contact Benjamin Burpee directly at 207-887-0358.

Very truly yours,
GZA, GeoEnvironmental, Inc.

Benjamin Burpee

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Attachments: APPENDIX A—LIMNOLOGY REPORT LIMITATIONS

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during its study. Additionally, GZA makes no warranty that any response action or recommended action will achieve all of its objectives or that the findings of this study will be upheld by a local, state or federal agency.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized profile(s) provided in our Report are based on widely spaced locations and are intended only to convey trends in subsurface conditions. The boundaries between depths are approximate and idealized and were based on our assessment of subsurface conditions. The composition of depths, and the transitions between depths, may be more variable and more complex than indicated. For more specific information on conditions at a specific location refer to the data summaries. The nature and extent of variations between these locations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. Water readings have been made, as described in this Report, at monitoring locations at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this report. Fluctuations in the readings however occur due to temporal or spatial variations of many types.

COMPLIANCE WITH CODES AND REGULATIONS

7. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations and compliance with codes and regulations by other parties is beyond our control.

SCREENING AND ANALYTICAL TESTING

8. GZA may have collected samples at the locations identified in the Report. These samples were analyzed for the specific parameters identified in the report. Additional constituents, for which analyses were not conducted, may be present in soil,

groundwater, surface water, sediment and/or air. Future Site activities and uses may result in a requirement for additional testing.

9. Our interpretation of field screening and laboratory data is presented in the Report. Unless otherwise noted, we relied upon the laboratory's QA/QC program to validate these data.

10. Variations in the types and concentrations of constituents observed at a given location or time may occur due to release mechanisms, disposal practices, changes in flow paths, and/or the influence of various physical, chemical, biological or radiological processes. Subsequently observed concentrations may be other than indicated in the Report.

INTERPRETATION OF DATA

11. Our opinions are based on available information as described in the Report, and on our professional judgment. Additional observations made over time, and/or space, may not support the opinions provided in the Report.

ADDITIONAL SERVICES

12. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

NUMERICAL MODELS

13. Actual conditions are likely more complex than indicated in this Report. If a mathematical model is refenced in this report, it is by its very nature, a simplification of actual conditions. Except as noted in the report, we did not validate the code used in the model. In constructing the model, point specific data was generalized and extrapolated across the study area. In addition, in areas where field data was not available, we used professional judgment, based on experience and regional information, to construct the model. Model assumptions are provided in this report. Actual flow patterns, etc. may be other than simulated. As additional field data becomes available our numerical model can be modified to better reflect conditions of possible interest.

COST ESTIMATES

14. Unless otherwise stated, our cost estimates are only for comparative and general planning purposes. These estimates may involve approximate quantity evaluations. Note that these quantity estimates are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we may have no control over either when the work will take place or the labor and material costs required to plan and execute the anticipated work, our cost estimates were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

15. A firm cost estimate, if requested, has been described and qualified herein, or submitted under separate cover.