Final Report

2025 Putnam Lake
Water Quality Assessment

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Table of Contents

Executive Summary

Putnam Lake, a vital resource for community recreation, is facing increasing pressure from sedimentation, harmful algal blooms (HABs), nutrient loading, and other ecological concerns that have resulted in an impairment designation for the waterbody. To address these significant challenges, the Town of Patterson (TOP) released a 2024 Request for Proposals (RFP). This RFP sought a summary of the lake's current physical, chemical, and biological data, specifically focusing on whether the recommendations within a recent Dredge Feasibility Study conducted by GEI Consultants Inc. (GEI) would be curative for water quality impairments relating to nutrient loading and HABs.

In response, Little Bear Environmental Consulting, LLC. (LBE) prepared the enclosed ecological report, intended to allow the Town of Patterson and local stakeholder groups to explore the listed options for management and determine which method(s) work best to sustain Putnam Lake for use by the community while promoting ecological health. The report includes:

- An exploration of the dredge scenarios recommended within GEI's feasibility study in relation to the overall phosphorus budget for the lake,
- Long-term nutrient mitigation strategies for 2026-2030 with preferred, limited, and no-action scenarios,
- Additional harmful algal bloom control scenarios for 2026-2030 including discussion of active ingredients, permitting requirements, risks of cyanobacteria; and
- Aquatic invasive species management methods, as warranted following survey.

Several relatively recent studies and papers have laid important groundwork for establishing a baseline of Putnam Lake's ecological report card. LBE conducted an in-depth review of the following reports/studies provided by the TOP within the RFP to create a more complete picture of Putnam Lake's hydrological/ecological issues, including:

- GEI's Dredging Feasibility Study 2024,
- 2011 Bathymetric Study,
- 2000 United States Geological Survey (USGS) Groundwater Study,
- The New York State Department of Environmental Conservation (NYSDEC) 2018 HAB Action Plan; and
- historic Citizen Science Lake Assessment Program (CSLAP) data.

LBE then identified which additional physical, biological, ecological, chemical, and hydrologic/hydraulic investigations of Putnam Lake would be necessary to develop successful mitigation strategies to address the impairments. Based on the resulting data, a combination of proactive nutrient mitigation and reactive algaecide treatment tools is deemed most scientifically appropriate for restoring water quality while limiting non-target impacts to Putnam Lake, particularly when compared to the recommended dredge scenario. While New York State's regulatory framework currently significantly limits the immediate application of certain nutrient mitigation tools (despite robust evidence-based published data in support of their use), LBE includes them as a recommendation. This is because pending legislative approval may allow for their implementation within this report's proposed project timeline. Here is a summary of findings:

Putnam Lake's Persistent HABs are the Main Concern for Water Quality
HABs have been reported within Putnam Lake since at least 2012, which marked the first documented blooms to cause beach closures. These reports coincide with the formalization of NYSDEC's comprehensive HAB reporting tool. LBE sampled lake-wide HABs throughout the later part of the summer in 2025 which posed a significant risk to the public due to their extreme densities.

HABs, which are commonly called "blue-green algae," are typically comprised of cyanobacteria. Unlike true algae, which are eukaryotes (possessing a true nucleus and membrane-bound organelles) and belong to the Kingdoms Plantae and Protista, cyanobacteria are prokaryotes (lacking these complex structures) and belong to the Kingdom Bacteria. While both cyanobacteria and true algae photosynthesize and can reach nuisance densities under ideal growing conditions, the potential harm they pose is vastly different. An overgrowth of true algae within a lake system may potentially inhibit recreation like swimming or angling or impact aesthetics but are generally not harmful. In stark contrast, an overgrowth of cyanobacteria (also called a "bloom") may present a significant and urgent risk to human and environmental health. This is because many cyanobacteria species produce highly potent compounds called cyanotoxins, which can be severely detrimental or event fatal to people, pets, and wildlife. Cyanotoxins pose a risk to people, pets, and wildlife through contact with skin, ingestion of infested water, or inhalation from aerosolized toxins. Various cyanobacteria can also produce taste and odor compounds that impact potable water uses. HABs thrive under the following environmental conditions: high nutrient loading (especially phosphorus and nitrogen), warm water temperatures, prolonged periods of stable (calm) water columns, and ample sunlight.

Under NYSDEC's Priority Waterbodies List (PWL) Assessment (6 NYCRR Part 864), Putnam Lake is a Class B waterbody, meaning it is best intended for contact recreation (i.e., swimming and bathing), non-contact recreation (i.e., boating and fishing), aesthetics, and aquatic life (NYSDEC, 2018) and is listed as "impaired" due to excessive nutrients – i.e. phosphorus (CSLAP, 2016 & 2018). CSLAP has cited presence of HABs within Putnam Lake for several years. Presence of HABs, as determined by their identified taxa, cell counts and toxin concentrations, can significantly limit the intended uses of the waterbody. NYSDEC's public guidance for encountering HAB's is "Know it, Avoid it, Report It" (NYSDEC, 2017). Under this guidance, the public should avoid all visible discoloration, scums, and globules along shorelines which may limits access for swimming, hiking, dog-walking, fishing from shore, and launching recreational watercraft. There is confusion among the public regarding what designates "scum" or "discoloration", and cyanobacteria can often be mistaken for harmless floating aquatic plants, true algae, or biofilms. This report aims to introduce a professional level of routine monitoring that will eliminate the magnitude of guesswork and use data collected to ensure public safety while maintaining desired water uses to the greatest extent possible. 2025 HAB photos from various Putnam Lake sites are located Appendix C as examples to educate water users.

Excess Nutrients are Driving HABs
Nutrient problems within Putnam Lake were identified as far back as 2000, when the watershed was studied by NYSDEC as a contributor to nutrient loading as part of the Total Maximum Daily Load (TMDL) for Middle Branch Reservoir in the New York City Water Supply Watershed (NYSDEC, 2000). Routine sampling has consistently concluded that phosphorus is the limiting

nutrient that in excess will drive HABs within Putnam Lake. As a shallow lake, with a relatively low drainage-to-surface area ratio, Putnam Lake has a relatively low turnover rate thus accumulation of nutrient-rich sediment occurs (NYSDEC, 2018). According to lab reports for samples collected by LBE in 2025, phosphorus was found to spike to extremely high levels (an order of magnitude into the hypereutrophic range) during mid-summer. Following this nutrient spike, multiple species of cyanobacteria were identified in extreme densities near multiple outfalls and within the lake. This HAB, including visual presence of cyanobacterial scums was sampled throughout late summer and observed to persist into the fall season of 2025.

Review of Previous Reports

LBE's review of existing data from previously collected Putnam Lake data by various agencies/firms revealed a few key points of interest:

- NYSDEC's 2018 HAB Action Plan cites adequate nutrient (e.g. phosphorus) availability, warm temperatures, and calm winds as the main ingredients to spur Putnam Lake HABs.
    - LBE data confirmed these conditions during the growing season of 2025, which by late summer had fostered a HAB despite two algaecide treatments occurring previously within the growing season.
- A 2002 USGS Groundwater study sampled nitrate concentrations throughout the watershed as nitrate is the dominant nitrogen species in ground-water discharge.
- Phosphorus concentration was non-detect within the well samples, which is the limiting nutrient for cyanobacteria growth (as some cyanobacteria can acquire nitrogen by other means such as from the atmosphere through nitrogen fixation).
    - LBE sampled and confirmed eutrophic phosphorus levels within groundwater wells during the 2025 growing season, indicating a potential input pathway.
- GEI's 2024 Dredging Feasibility Study included ten "proposed dredge zones" predetermined by TOP for assessment.
    - Water depth significantly limits the areas accessible for dredging to roughly <8 feet, while the lake's deeper sediments are likely the main source of internal phosphorus loading (with a maximum depth of 16 feet). GEI's report cites "All [dredge] areas had water depths deeper than 10 feet at the outermost, lake-facing sides except for areas 5 and 6."
- According to the GEI report, samples were collected using an Ekman dredge from the first 5 cm of the sediment and analyzed for total phosphorus. Data from the first 5 cm of sediment can be used to produce estimates of the amount of phosphorus that would be removed from the system from a dredge project.
    - An important goal of sampling is to test the sediment that remains and would become the new sediment water interface following a dredge project. The GEI report cites that sediment would be removed up to reaching the "first layer of refusal" which was assumed to be bedrock or hard substrate at some locations. However, samples from this layer were not obtained and total phosphorus within this material was not measured.
    - Phosphorus input from outfalls was outside the scope of the GEI report and therefore was not sampled, making a determination of the relative contribution of internal versus external nutrient loading unfeasible.
    - In 2025, LBE collected outfall samples and found multiple inlets to be a significant source of highly nutrient-enriched (hypereutrophic) water.

- GEI's Dredge Feasibility Study recommended four out of the 10 mapped sites investigated be explored for dredging (sites 1, 5, 6, and 7), with only two of those areas having "high potential for phosphorus removal" (sites 1 and 7). Potential was based on use for recreation, accessibility, sediment type, water depth, and average sediment depth.
  - A total of 104,716 kgs of Phosphorus are expected to be removed within the 4 sites, or 38% of the Total Phosphorus within the ten combined sites investigated. This does not include the area outside of the proposed dredge zones, which comprises approximately 40-45% of the lake's surface area and the majority of its depth, which contributes to internal loading within the deeper portions of the lake.
  - Phosphorus sampling from outfalls was outside the scope of the GEI report. Therefore, external loading from these sources was not considered.

Limited Efficacy of Dredging
The findings of LBE's investigation indicate that while sediment dredging may significantly reduce nutrient loading in localized shallow areas of the lake, this action is unlikely to be a complete curative measure for lake-wide HABs given several major limiting factors including:

- internal loading from remaining (un-dredged) portions of nutrient rich sediment,
- un-dredged accumulated overwintering cyanobacterial vegetative cells that act as an in-lake "seed source" or "inoculum",
- potential internal loading from deep-water anoxic portions of the lake through reduction-oxidation (redox) reactions,
- the unknown composition (including nutrient makeup) of new material that would become the sediment water interface once dredging is completed,
- potential significant external loading from multiple highly hypereutrophic outfall inputs to the lake; and
- potential plant loading from infestations of invasive aquatic plants which may contribute significant bioavailable phosphorus for use by cyanobacteria during their natural seasonal senescence periods.

Nutrient Inactivation Technology is Necessary
Given the significant limitations identified and the complexity of the lake's nutrient dynamics, LBE proposes the utilization of a combination of targeted management tools. This integrated strategy is designed to more holistically address nutrient and HAB-based impairments while actively minimizing non-target impacts and sustaining all intended water uses for the lake. This strategy combines a proactive nutrient inactivation (regarding both external loading and internal deep-water fluxes) with an "Action Threshold Approach" to reactive algaecide treatments for HABs. The nutrient mitigation program proposed and budgeted within this report would require inactivation of only ~7,922 pounds of phosphorus (or 35 pounds per acre) to prevent HABs.

Implementing proactive nutrient inactivation will necessitate coordinated local municipal support to secure the required permit mechanism from NYSDEC. Although this approach may be time-intensive to pursue, it represents the management option with the most favorable environmental use profile compared to all other alternatives. Within New York State, a *de facto* moratorium exists because nutrient inactivant products currently fall into a regulatory gap within NYSDEC's purview. Nutrient inactivants are not a pesticide and do not fall under the standard permit process for applying chemicals like algaecides. The State Pollution Discharge Elimination System (SPDES) also does not include the application of nutrient inactivants through a General Permit;

in the way pesticides have coverage through this mechanism. Because of this lack of clear permitting process for nutrient inactivants (other than projects done as NYSDEC's own pilot studies such as Peach Lake, Honeoye Lake, and Mohegan Lake), municipalities and lake associations are currently unable to apply for the use of these products. New legislation has been introduced to the State legislature (such as S8419A/A9287 within the State Senate and Assembly respectively) written to establish a "nutrient inactivant application permit". The passage of this legislation is a vital component in the process to use nutrient inactivant technology within New. York State that is already being used in most other U.S. States and worldwide. Formulations of nutrient inactivants are currently commercially available to permanently bind phosphorus from lake bottom sediments as well as within the water column from flowing water inputs with excellent environmental use profiles.

An Action Threshold Approach to HABs

The action threshold approach for algaecide treatment will shift decision-making away from a purely temporal treatment schedule toward an evidence-based tool. This approach incorporates routine sampling and data analysis into treatment scheduling, maximizing the effectiveness of the TOP's annual treatment budget while safeguarding public health. Installation of anchored monitoring stations could provide real-time data regarding multiple water quality parameters like nutrients, chlorophyll-a and phycocyanin (as proxies for phytoplankton growth), temperature, pH, and dissolved oxygen that can alert managers to impending HAB conditions. Monitoring station data can be accessible by online dashboard or mobile app. These monitoring stations can be linked to future nutrient mitigation delivery devices.

Algae samples should be routinely collected between May and September during the growing season. With an effective monitoring program, an algal infestation can be mitigated early in a bloom scenario which is an ideal timeframe for several reasons: 1.) there is a much lower biomass/density of algae, 2.) less risk of high toxin levels being produced, 3) less risk of dissolved oxygen being depleted following treatment, 4) more thorough control of the bloom (less re-growth potential), 5.) less product/cost needed to control the density present (Bishop et al., 2017). Field samples could be routinely collected or collected based on triggering thresholds from the buoy data. Field samples could be verified by cell counts and/or toxin concentrations. Toxin analysis can be expensive and may only represent a small fraction of well described toxins while missing entirely new classes of cyanotoxins. Minimal production of toxins is predicted within low cyanobacterial densities (<2,000 cells/mL) and toxin testing may not be warranted within this range (Otten an Paerl, 2015 and Szlag et al., 2015). Furthermore, cell counts could be used as the sole investigative criteria, should toxin analysis be too costly for routine testing. However, the value of toxin testing should not be discounted as an important data source for protecting public health and certainly could be incorporated into NYSDOH's protocols for monitoring swimming beaches, and for investigating reports of symptoms of irritation or sickness following exposure to HABs. This report seeks to establish criteria to respond to HABs and aid decision making about recommended changes to water use: including issuing an advisory, installing signage, closing swimming beaches, fish consumption restrictions, etc. The HAB alert system utilized by the New Jersey Department of Environmental Protection (Figure 1), or similar could be implemented at Putnam Lake. Routine sampling could be conducted by municipal staff, NYSDOH staff, private contractors, or a combination as needed. According to this alert system, monitoring buoys can remotely signal to managers that field sampling is necessary, and field sampling can confirm cell counts. As cell counts approach <80,000 cells/mL a reactive algaecide treatment can be scheduled with NYSDEC by the TOP's licensed applicator.

Figure 1: NJDEP HAB Alert System

HAB Alert Level	Criteria	Recommendations
HAB Not Present	HAB reported and investigated. No HAB present.	None
WATCH *Suspected or confirmed HAB with potential for allergenic or irritative health effects*	Suspected HAB based on field survey **OR** Confirmed cell counts ≥20K - <80K cells/mL **AND** No known toxins above public health thresholds	**Public Bathing Beaches Open** Waterbody Accessible: Use caution during **primary contact (e.g. swimming) and secondary (e.g. non-contact boating)** activities Do not ingest water (people/pets/livestock) Do not consume fish
ADVISORY *Confirmed HAB with moderate risk of adverse health effects and increased potential for toxins above public health thresholds*	Lab testing for toxins Microcystins: ≥2 µg/L Cylindrospermopsin: ≥5 µg/L Anatoxin-a: ≥15 µg/L Saxitoxin: ≥0.6 µg/L **OR** Confirmed cell counts ≥80K cells/mL	**Public Bathing Beaches Closed** Waterbody Remains Accessible: Avoid primary contact recreation Use caution for secondary contact recreation Do not ingest water (people/pets/livestock) Do not consume fish
WARNING *Confirmed HAB with high risk of adverse health effects due to high toxin levels*	Toxin (microcystins) ≥20 - <2000 µg/L	**Public Bathing Beaches Closed** Cautions as above May recommend against secondary contact recreation.
DANGER *Confirmed HAB with very high risk of adverse health effects due to very high toxin levels*	Toxin (microcystins) ≥2000 µg/L	**Public Bathing Beaches Closed** Cautions as above. Possible closure of all or portions of waterbody and possible restrictions access to shoreline.

Project Cost

Based on the evidence we have, HABs are currently the greatest risk to water quality within Putnam Lake. While both dredging and nutrient mitigation tools can be used to achieve the goal of mitigating HABs, the main objectives of each tool can vary significantly, and the methods are not easily prone to comparison. For example, GEI's (moderate) cost estimate for the proposed dredge scenario (of $8.3 million to remove 230,859 pounds of Phosphorus) may not be curative for HABs as it does not address nutrient loading from anoxic deep-water sites, although it may also provide additional benefits such as relief from sedimentation in certain areas of the lake.

Based on the phosphorus data available, a more effective multi-year nutrient mitigation program utilizing monitoring, nutrient inactivants, supplemental algaecide treatments, invasive aquatic plant control, and intensive monitoring is estimated at $2.75 million, would require mitigation of 7,922 pounds of Phosphorus, and could be implemented over a 3–5-year period.

In-Lake Water Sampling (Discrete)

LBE sampled Putnam Lake and analyzed for discrete and *in-situ* data during multiple visits throughout the 2025 growing season. LBE collected three water samples from the surface and three from water sediment interface at sites within deep zone of Putnam Lake during the Spring of 2025. (6 samples total). Figure 2: Putnam Lake Sample Locations Map shows locations where samples were collected. Samples were collected using 250 mL preserved and unpreserved containers and overnight shipped on ice and analyzed by SePRO Laboratories for the following parameters utilizing the following approved EPA methodologies and procedures respectively:

- Alkalinity (mg/L as CaCO3) (EPA 310.2)
- Chlorophyll a (μg/L) (EPA 445)
- Conductivity (μS/cm) (EPA 120.1)
- Total Hardness (mg/L as CaCO3) (EPA 130.2)
- Total Nitrate (mg/L) and Nitrite (mg/L) (Campbell et al 2004)
- Total Kjeldahl Nitrogen (mg/L) (EPA 351.2)
- pH
- Total Phosphorus (μg/L) (EPA 365.3)
- Free Reactive Phosphorus (μg/L) (EPA 365.3)
- Total Dissolved Solids
- Total Suspended Solids
- Turbidity (NTU) (EPA 180.1)

Appendix A: Water Quality Parameters Described, contains a description of each water quality parameter analyzed, their definition, EPA Method, relevant units, and thresholds (if applicable). Table 1 contains the results of the spring in-lake water samples collected on May 22, 2025.

May Results Described:

- The pH values for Putnam Lake were between 7.6 and 7.7 being neutral and standard for typical freshwater.
- The water hardness (total hardness) values for Putnam Lake ranged from between 109.6 and 113.5 mg/L, being moderately hard.
- Putnam Lake's alkalinity measured between 31.2 and 32.5 mg/L as CaCO3, being low buffered.
- Putnam Lake's conductivity measured between 483.8 and 490.7 *μS/cm* which is typical of freshwaters.
- Putnam Lake's Total Phosphorus (TP) in surface water ranged between 52.1 and 87.5 μg/L or eutrophic (highly productive). The free reactive phosphorus (FRP) which is immediately bioavailable for plants and algae measured between 5.9 and 9.5 μg/L, in the eutrophic range.
- Putnam Lake's Total Nitrogen measured between 0.59 and 0.7 mg/L which is in the eutrophic range. Total Nitrate and Nitrite measured between 0.13 and 0.15 mg/L which is in the oligotrophic range. Nitrate measured between 0.13 and 0.15 mg/L. Nitrite measured <0.02 mg/L for all sites. Total Kjeldahl Nitrogen measured between 0.49 and 0.55 mg/L (typical for freshwater). Nitrogen species all were relatively low and suggest Phosphorus is the limiting nutrient in this system, particularly as many cyanobacteria species can obtain atmospheric nitrogen (fixation).

- Putnam Lake's Chlorophyll a measured <10 μg/L, reflecting a healthy low-level state which would be common for early in the growing season (despite growth potential from nutrient).
- Putnam Lake's turbidity ranged between 2.6 and 3.4 Nephelometric Turbidity Units (NTU).

Figure 2: Putnam Lake Sample Locations Map

Table 1: In-Lake Water Quality Discrete Sampling Results 05/22/25

Parameter	Method	Unit	Date	Deep 1 S	Deep 1 B	Deep 2 S	Deep 2 B	Deep 3 S	Deep 3 B
Turbidity	EPA 180.1	NTU	5/22/25	2.9	2.6	2.6	3	2.7	3.4
Conductivity	EPA 120.1	µS/cm	5/22/25	483.8	487	485.9	484.8	490.7	488.6
Free Reactive Phosphorus	EPA 365.3	µg/L	5/22/25	9.5	6.3	7.8	5.9	6.4	8.6
Chlorophyll a	EPA 445	µg/L	5/22/25	<10	<10	<10	<10	<10	<10
Total Phosphorus	EPA 365.3	µg/L	5/22/25	70	52.1	66.4	57.4	62.2	87.5
Alkalinity	EPA310.2	mg/L	5/22/25	32	31.4	31.7	31.5	31.2	32.5
Total hardness	EPA 130.2	mg/L	5/22/25	109.6	112.7	113	112.9	111.4	113.5
Total Nitrate and Nitrite	Campbell et al 2004	mg/L	5/22/25	0.13	0.14	0.13	0.15	0.14	0.15
Nitrite	Campbell et al 2004	mg/L	5/22/25	<0.02	<0.02	<0.02	0.02	<0.02	<0.02
Nitrate	Calculated	mg/L	5/22/25	0.13	0.14	0.13	0.13	0.14	0.15
Total Kjeldahl Nitrogen	EPA 351.2	mg/L	5/22/25	0.52	0.46	0.46	0.55	0.49	0.53
Total Nitrogen	calculated	mg/L	5/22/25	0.65	0.6	0.59	0.7	0.63	0.68
pH	EPA 150.1		5/22/25	7.6	7.6	7.7	7.6	7.7	7.6

In-Lake Water Sampling (*In-situ*)

LBE collected the following *In-situ* water quality data at three (3) locations within Putnam Lake including:

- surface temperature,
- dissolved oxygen,
- Secchi depth; and
- site photographs.

In-situ results from spring sampling event can be found in Table 2: *In-situ* Lake Parameters. pH values were all between 7.76 and 8.02 being normal for freshwater. Dissolved oxygen saturation was above 90% at all sites and healthy for aquatic life.

Table 2: *In-situ* Lake Parameters

Site	Temp ºC	DO	Secchi	Depth	pH
SED Deep 1	14.4	94.1	5.5	14.3	8.02
SED Deep 2	16.1	97.0	8.0	15.2	7.95
SED Deep 3	15.5	96.0	9.0	17.3	7.76
SED Med 1	17.4	93.1	7.5	13.1	7.94
SED Med 2	15.5	96.8	8.0	15.0	7.91
SED Med 3	15.5	96.6	8.0	13.9	8.00

Tributary Sampling

Desktop mapping revealed several outfalls to Putnam Lake and LBE sampled six to seven season-/weather-dependent outfalls over the course of the growing season. Outfalls were sampled during two dry weather and three wet weather sampling events as accessible/flowing. Samples were collected using 250 mL preserved and unpreserved containers, overnight shipped on ice, and analyzed by SePRO Laboratories for the following water quality parameters and utilizing the following EPA methods and procedures respectively:

- Alkalinity (mg/L as CaCO3) (EPA 310.2)
- Chlorophyll a (μg/L) (EPA 445)
- Conductivity (μS/cm) (EPA 120.1)
- Total Hardness (mg/L as CaCO3) (EPA 130.2)
- Total Nitrate (mg/L) and Nitrite (mg/L) (Campbell et al 2004)
- Total Kjeldahl Nitrogen (mg/L) (EPA 351.2)
- pH
- Total Phosphorus (μg/L) (EPA 365.3)
- Free Reactive Phosphorus (μg/L) (EPA 365.3)
- Total Dissolved Solids
- Total Suspended Solids
- Turbidity (NTU) (EPA 180.1)

Results: Spring sampling at six outfalls conducted in May 2025 and analyzed for total phosphorus (TP) and free reactive phosphorus revealed values were between 41.2 and 54.4 μg/L for total phosphorus and were well within the eutrophic range. Table 3: Outfall Sampling Results 05/22/25 contains May data.

Table 3: Outfall Sampling Results 05/22/25

Parameter	Method	Unit	Date	Outfall 1	Outfall 2	Outfall 3	Outfall 4	Outfall 5	Outfall 6
Free Reactive Phosphorus	EPA 365.3	μg/L	5/22/25	8.6	5.9	16.6	6.2	5.8	7.6
Total Phosphorus	EPA 365.3	μg/L	5/22/25	54.4	51.3	49.2	52.4	41.2	52.8

Summer sampling at six outfalls conducted in August 2025 and analyzed for all previously listed water quality metrics revealed the beginning of a seasonal spike in total phosphorus, free reactive phosphorus, and Chlorophyll-a. While Chlorophyll-a is not a nutrient, it is a well-studied eutrophication parameter because it is a direct proxy for the total biomass of phytoplankton in a waterbody. Total phosphorus <u>spiked by an order of magnitude</u> at multiple outfalls and shifted from eutrophic range to extremely hypereutrophic range. The threshold for lake health shows a limit of >100 μg/L being hypereutrophic or extremely highly productive/nutrient polluted. Total Phosphorus from Outfall 6 decreased to just within the mesotrophic range. Outfall 2 remained within the eutrophic range, and all other outfalls were well within the hypereutrophic range with Outfalls 3 and 5 being a full order of magnitude in the hypereutrophic range. An additional, in-lake sample was also collected (HAB-1) where a bloom was suspected to be forming. This site was later renamed LAKE-1 as the algae identified was primarily diatoms and not cyanobacteria. The total phosphorus at this location was also a full order of magnitude into the hypereutrophic range. The free reactive phosphorus available at all sites (except for Outfalls 2 and 6) were very concerning as their increased levels signaled conditions were becoming ideal for a HAB to occur. Table 4: Outfall Sampling Results 08/22/25 contains data from each site for that sampling event.

Table 4: Outfall Sampling Results 08/22/25

Parameter	Method	Unit	Date	Outfall 1	Outfall 2	Outfall 3	Outfall 4	Outfall 5	Outfall 6	HAB-1
Turbidity	EPA 180.1	NTU	8/22/25	57.9	4	10.8	74.8	17.6	3.7	3.4
Conductivity	EPA 120.1	µS/cm	8/22/25	531.9	509.5	566.1	544.1	562.0	480.6	669.2
Free Reactive Phosphorus	EPA 365.3	µg/L	8/22/25	634.4	<5	81.7	249.0	147.4	16.5	315.0
Chlorophyll a	EPA 445	µg/L	8/22/25	190.7	19.1	192.1	291	187.5	11.6	189.3
Total Phosphorus	EPA 365.3	µg/L	8/22/25	681.7	58.2	1733.8	861.2	1495.7	21.9	1645.7
Alkalinity	EPA310.2	mg/L	8/22/25	140.4	112.6	159.2	137.4	155.9	105.3	165.9
Total hardness	EPA 130.2	mg/L	8/22/25	139.9	114.6	163.3	109.8	154.2	110.0	165.9
Total Nitrate and Nitrite	Campbell et al 2004	mg/L	8/22/25	<0.02	0.07	<0.02	0.02	0.02	0.09	1.15
Nitrite	Campbell et al 2004	mg/L	8/22/25	<0.02	<0.02	<0.02	0.02	0.02	0.06	0.03
Nitrate	Calculated	mg/L	8/22/25	<0.02	0.07	<0.02	0.02	0.02	0.03	1.12
Total Kjeldahl Nitrogen	EPA 351.2	mg/L	8/22/25	1.11	<0.1	0.14	1.85	0.31	0.12	0.14
Total Nitrogen	calculated	mg/L	8/22/25	1.11	0.07	0.14	1.85	0.31	0.21	1.29
pH	EPA 150.1		8/22/25	7.7	7.8	7.7	7.6	7.8	7.9	7.9

The late summer sampling at seven outfalls conducted in September 2025 and analyzed for all previously listed water quality metrics revealed continued elevated nutrient levels within the hypereutrophic range. Table 5: Outfall Sampling 09/09/25 contains the data from the sampling event. An additional sample site “Outfall 7” was added as it was observed to be flowing into Putnam Lake at the time of sampling. High total phosphorus and free reactive phosphorus values continued to provide plenty of fuel for cyanobacterial growth. Outfall 5 continued to measure an order of magnitude into the hypereutrophic range. Unseasonably warm air temperatures and lack of rain further exacerbated ideal conditions for the “late-season” HAB. Total nitrogen continued to measure low values, providing further evidence that phosphorus is the limiting nutrient within the system. Table 6 contains data from 9/30/25 sampling (Outfall 1 was not observed to flow during this sampling event and was replaced by a sample from Putnam Dam where an active HAB resulted in highly concerning scums). pH increased significantly across some sites by as much as from 7.6 in May to 7.9 in August, indicating a rapid rate of biological activity. However, increases to a pH value of 10 can be common in extreme bloom scenarios. A pH increase to 10 would be unlikely within Putnam Lake because of the alkalinity measurements observed. In-lake alkalinity measurements from May are significantly less than outfall and in-lake sampling from the rest of the summer. The source of this alkalinity could be from an external source (such as groundwater or from sediment resuspension following outfall inputs) or from internal sources (such as denitrification from decomposition occurring in the anoxic deep-water area of the lake). Future hypolimnion and groundwater sampling would be required to fully understand the source of the significant increase in alkalinity. This increase in alkalinity acts as a massive buffer to resist pH changes, meaning that even intense photosynthesis cannot push the pH into the extreme range that would naturally stress HAB growth. Without treatment, a bloom that is not self-limited by pH means it will only be curbed by its ability to exhaust bio-available phosphorus.

Table 5: Outfall Sampling 9/09/25

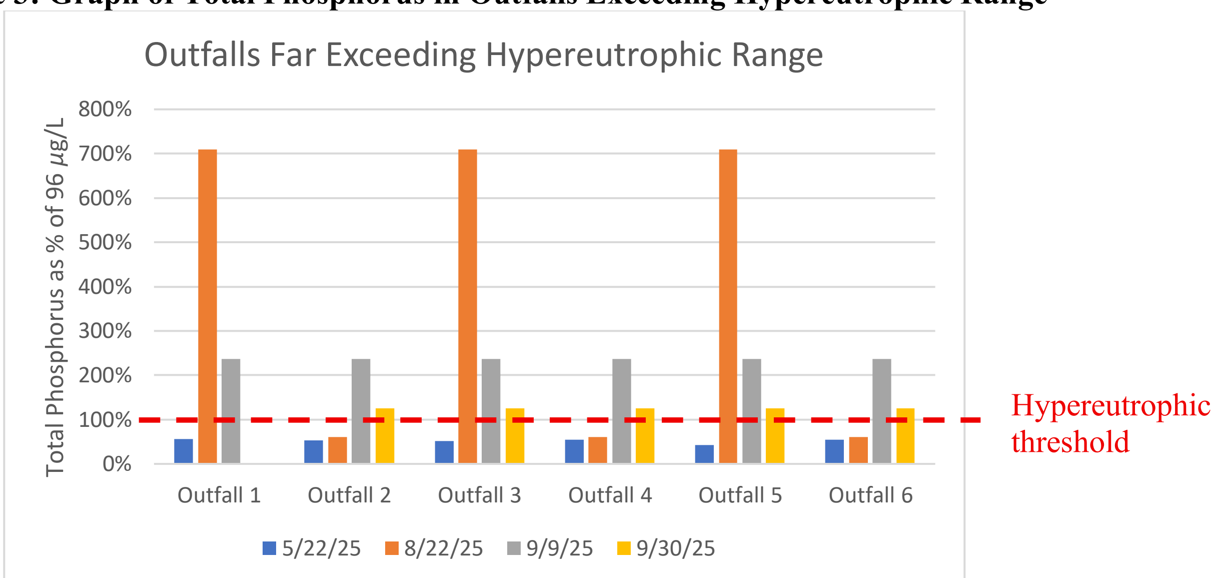
Parameter	Method	Unit	Date	Outfall 1	Outfall 2	Outfall 3	Outfall 4	Outfall 5	Outfall 6	Outfall 7
Turbidity	EPA 180.1	NTU	9/9/25	3.9	10.2	13.6	64.7	41.8	12.9	141.5
Conductivity	EPA 120.1	µS/cm	9/9/25	527.2	490.8	501.3	517.8	500.1	776.5	634.6
Free Reactive Phosphorus	EPA 365.3	µg/L	9/9/25	41.1	9.6	40.0	11.2	10.6	12.9	83.7
Chlorophyll a	EPA 445	µg/L	9/9/25	10.2	103	48.5	576.5	531.6	632.5	308.2
Total Phosphorus	EPA 365.3	µg/L	9/9/25	227.4	54	89.4	354.8	1648.8	145.7	1081
Alkalinity	EPA310.2	mg/L	9/9/25	142.2	112	107	114.7	110	146.9	158.5
Total hardness	EPA 130.2	mg/L	9/9/25	110.9	106.9	106.2	115.5	111.7	143.3	138.9
Total Nitrate and Nitrite	Campbell et al 2004	mg/L	9/9/25	0.05	<0.02	<0.02	<0.02	<0.02	0.58	<0.02
Nitrite	Campbell et al 2004	mg/L	9/9/25	<0.02	<0.02	<0.02	<0.02	0.07	0.02	<0.02
Nitrate	Calculated	mg/L	9/9/25	0.05	<0.02	<0.02	<0.02	<0.02	0.56	<0.02
Total Kjeldahl Nitrogen	EPA 351.2	mg/L	9/9/25	0.7	0.38	0.45	2.15	5	0.66	9.8
Total Nitrogen	calculated	mg/L	9/9/25	0.75	0.387.7	0.45	2.15	5	1.24	9.8
pH	EPA 150.1		9/9/25	7.5	7.7	7.3	6.7	7.2	7.5	6.9

Table 6: Outfall Sampling Results 9/30/25

Parameter	Method	Unit	Date	Outfall 2	Outfall 3	Outfall 4	Outfall 5	Outfall 6	P. Dam
Turbidity	EPA 180.1	NTU	9/30/25	25.2	85.7	194.1	151.5	92.1	110
Conductivity	EPA 120.1	µS/cm	9/30/25	455.2	480.2	477.0	528.3	467.8	509.9
Free Reactive Phosphorus	EPA 365.3	µg/L	9/30/25	7.3	21.0	7.6	17.4	26.6	26.3
Chlorophyll a	EPA 445	µg/L	9/30/25	254.5	228.4	629.5	1061.5	918.8	1135.7
Total Phosphorus	EPA 365.3	µg/L	9/30/25	119.6	2075	666.4	19.8	231.4	65.7
Alkalinity	EPA310.2	mg/L	9/30/25	105.5	119	119.9	130.4	117.1	136.4
Total hardness	EPA 130.2	mg/L	9/30/25	113.3	118.2	121.2	127.6	114.7	133.8
Total Nitrate and Nitrite	Campbell et al 2004	mg/L	9/30/25	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrite	Campbell et al 2004	mg/L	9/30/25	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate	Calculated	mg/L	9/30/25	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Kjeldahl Nitrogen	EPA 351.2	mg/L	9/30/25	1.77	10.74	1.54	1.44	2.44	2.28
Total Nitrogen	calculated	mg/L	9/30/25	1.77	10.74	1.54	1.44	2.44	2.28
pH	EPA 150.1		9/30/25	7.7	7.2	7.2	7.3	7.2	7.3

Many of the total phosphorus values from the outfalls in August-September were not just hypereutrophic, they were an order of magnitude into the hypereutrophic range, or extremely productive/nutrient polluted. The values were so high in August that they are difficult to graph visually. Figure 3 shows a graph of the samples collected from outfalls #1-6 between May and September with the Y-axis measuring the total phosphorus concentration as a percentage of the hypereutrophic range where 100% is 96 μg/L (or the cutoff between eutrophic and hypereutrophic productivity range). This data suggests the outfalls provided adequate nutrient to foster HAB conditions well into late September. Many HABs in New York State may also be limited by water temperature. However, unseasonably warm weather and lack of rainfall into October 2025 fostered ideal growing conditions for HABs in Putnam Lake.

Figure 3: Graph of Total Phosphorus in Outfalls Exceeding Hypereutrophic Range

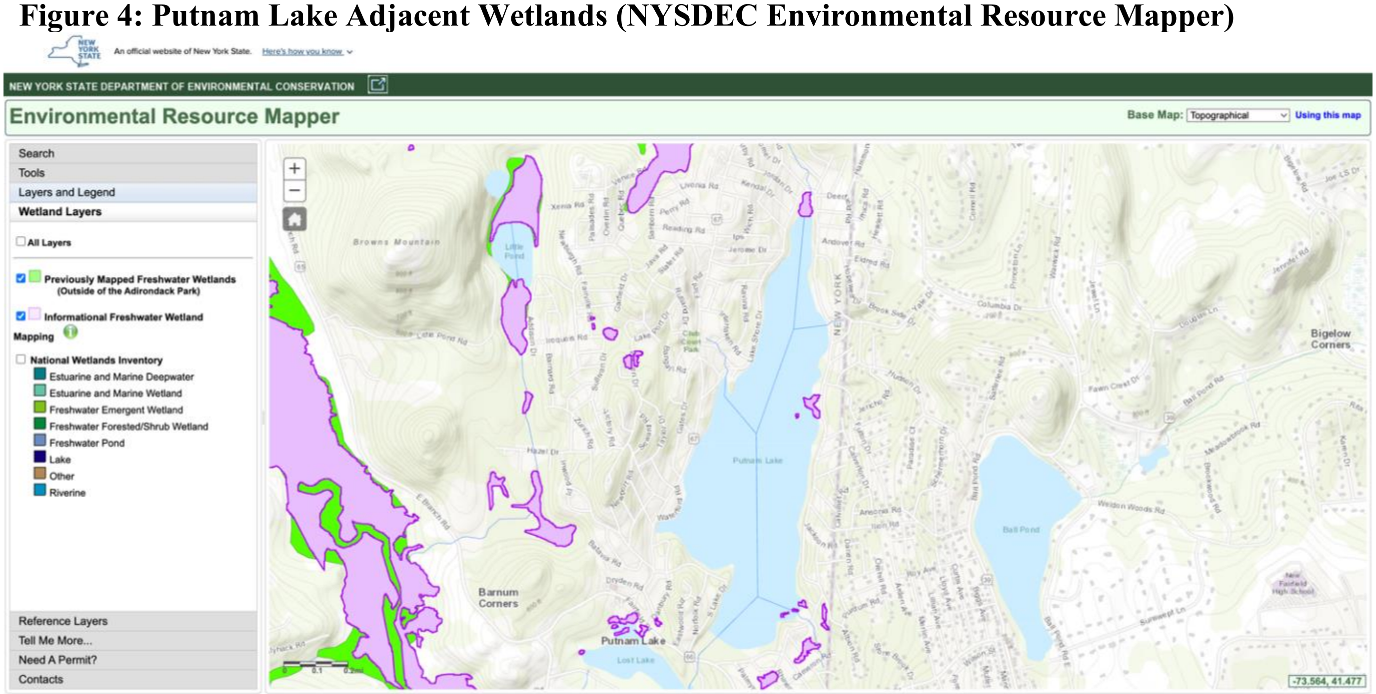


Draining Streams & Associated Wetlands

LBE proposed to identify from previous reports or additional data gathering which draining streams have functional wetlands or stormwater treatment capacity prior to entering Putnam Lake in an effort to inform external loading sources. The NYSDEC Environmental Resource Mapper's[1] Waterbody Classification for Rivers/Streams data (Figure 4) included the unnamed inlet at the northern end of Putnam Lake (Regulation: 864-3122) as a Class C waterbody where it enters Putnam Lake at Lake Shore Drive between Hanover and Homer Rds. (Figure 5). An informational wetland is mapped at this location, but no additional classification information is provided under NYSDEC's 2025 change to this online tool. The wetland boundary more or less overlaps with a National Wetlands Inventory wetland at the site totaling 1.15 acres in size and classified by type as "Freshwater Forested/Shrub Wetland" with a classification code of PFO1Eh[2]. Figure 6 contains a site photo of the site including the habitat and culvert. This wetland is fed by a much larger wetland PFO1C and PFO1/SS1C.

- P (Palustrine) indicates freshwater, FO (Forested) indicates woody vegetation that is 6 meters tall or taller with at least 30% cover, 1 (Broad-leaved Deciduous) indicates a subclass of dominant vegetation being woody angiosperms with leaves that shed during the dormant season, E (Seasonally Flooded, Saturated) indicating water is present for extended periods especially early in the growing season but is absent by the end, and h (Diked/Impounded) indicating the hydrology has been artificially altered in this case by an impoundment (culvert).

Figure 4: Putnam Lake Adjacent Wetlands (NYSDEC Environmental Resource Mapper)



[1] https://gisservices.dec.ny.gov/gis/erm/

[2] https://www.fws.gov/program/national-wetlands-inventory/classification-codes

Figure 5: Putnam Lake Wetland @ North End (NYSDEC Environmental Resource Mapper)

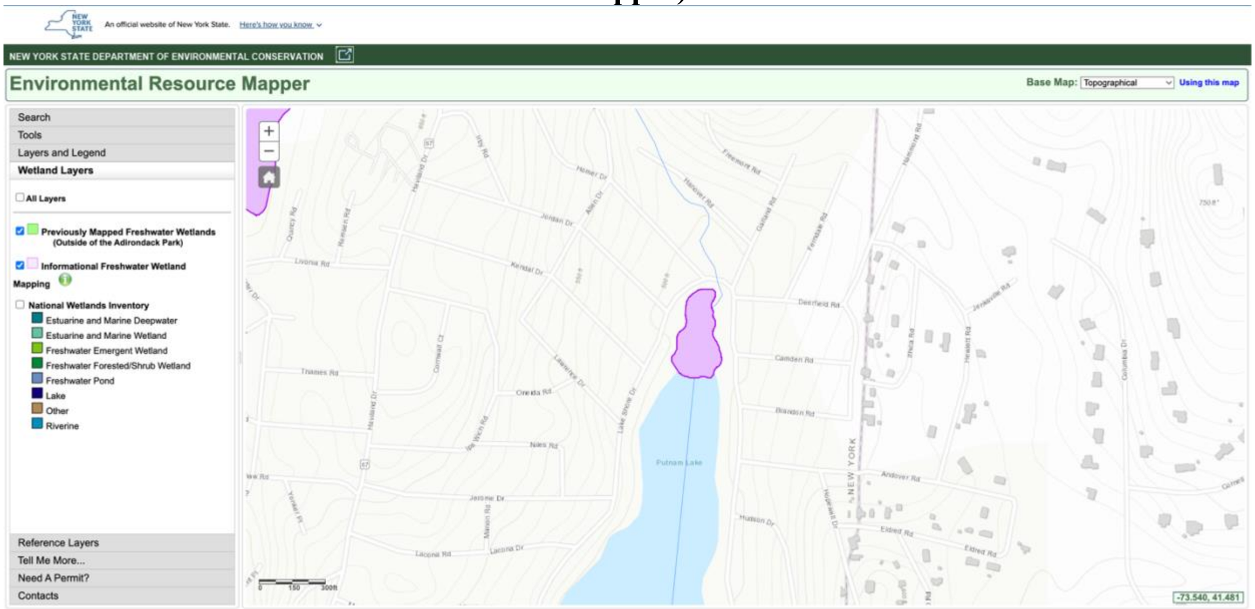


Figure 6: Putnam Lake Wetland @ North End (Site Photo)

An unnamed Class C inlet is mapped on the eastern edge of Putnam Lake near Harmon Rd. with an associated wetland located approximately 1,500 feet upstream of the confluence with Putnam Lake. (**Figure 7**: Wetland Upstream Harmon Rd Outfall). The National Wetlands Inventory classifies this wetland as a "Freshwater Forested/Shrub Wetland", 4.08 acres in size with the Classification Code: PFO1E. **Figure 8** contains a site photo of the outfall.

- P (Palustrine) indicates freshwater, FO (Forested) indicates woody vegetation that is 6 meters tall or taller with at least 30% cover, 1 (Broad-leaved Deciduous) indicates a subclass of dominant vegetation being woody angiosperms with leaves that shed during the dormant season, and E (Seasonally Flooded, Saturated) indicating water is present for extended periods especially early in the growing season but is absent by the end.

Figure 7: Wetland Upstream of Harmon Rd Outfall

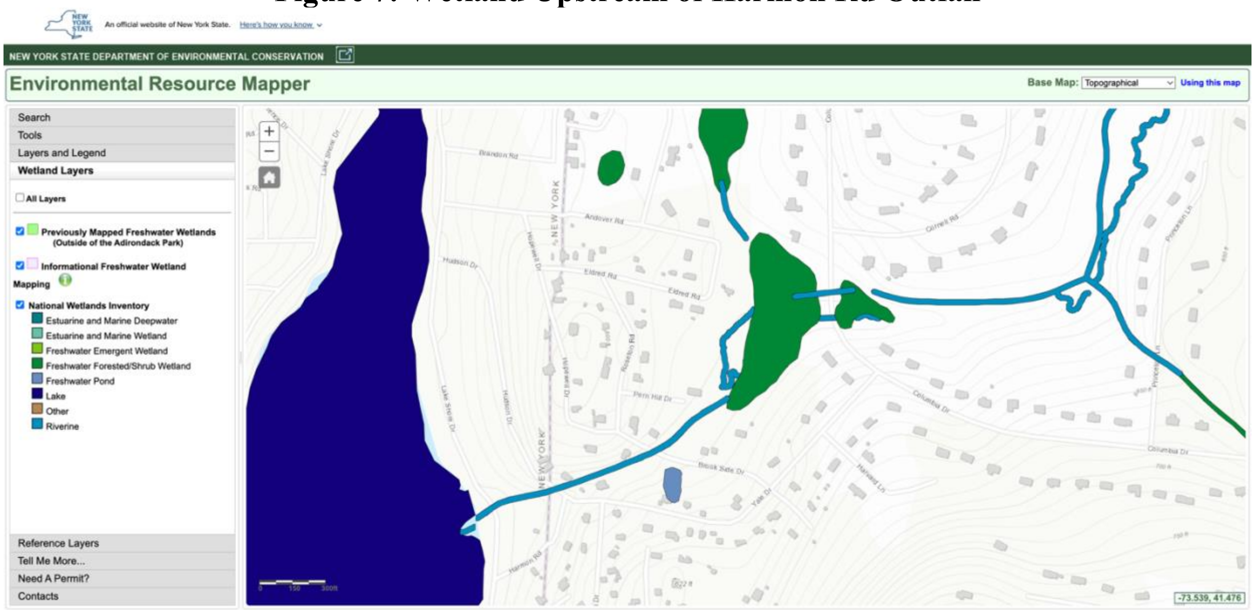
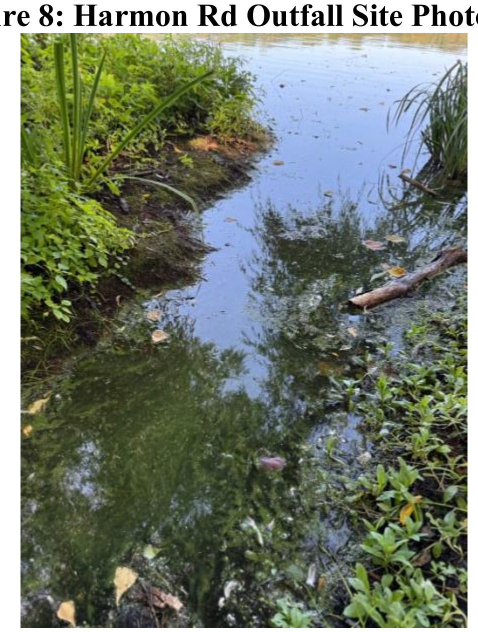
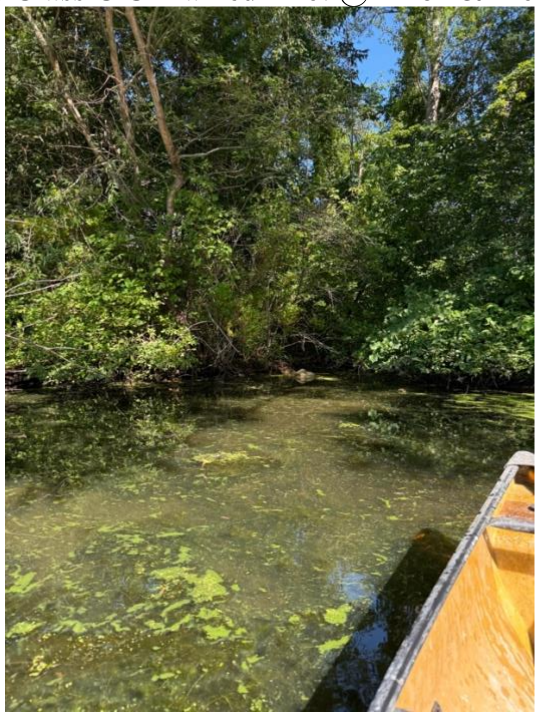


Figure 8: Harmon Rd Outfall Site Photo



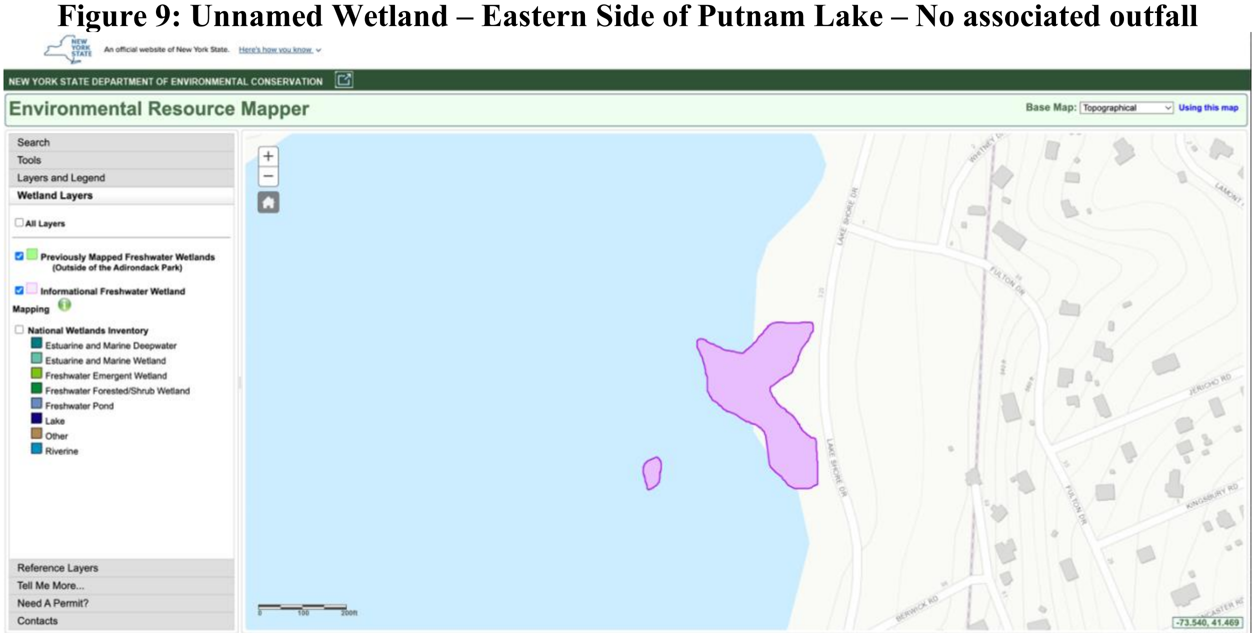
A Class C unnamed inlet entering the western side of Putnam Lake between Knox and Irene Roads did not have associated mapped wetlands within the NYSDEC Environmental Resource Mapper.

Figure 9: Class C Unnamed Inlet @ Knox & Irene Roads



An information wetland is mapped along the eastern shore of Putnam Lake between Fulton Dr and Berwick Rd. However, there is not data for this wetland within the National Wetlands Inventory and no additional is available within NYSDEC's Natural Resource Mapper (Figure 9).

Figure 9: Unnamed Wetland – Eastern Side of Putnam Lake – No associated outfall



A final Class B stream is located in the southeastern end of Putnam Lake between Valley Rd and Ingleside Rd (Figure 11). Informational Wetlands are mapped in the area where the outfall meets Putnam Lake. However, no data exists from the National Wetlands Inventory, and no additional information is provided from the NYSDEC Environmental Resource Mapper (Figure 10).

Figure 10: Southeastern Outfall & Associated Wetlands

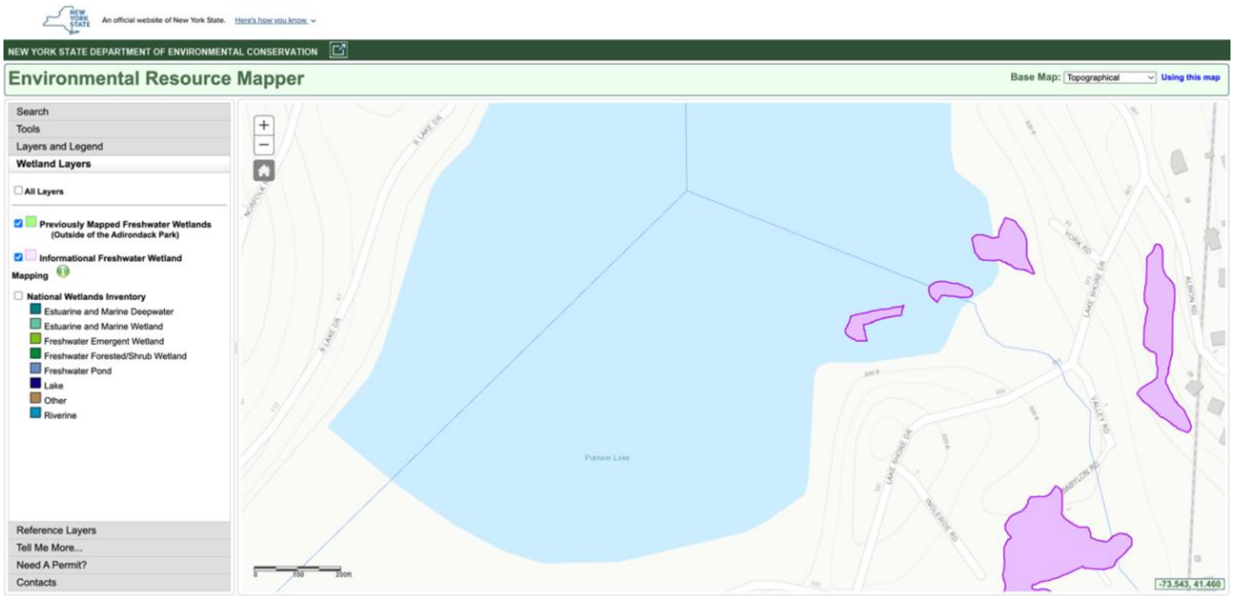
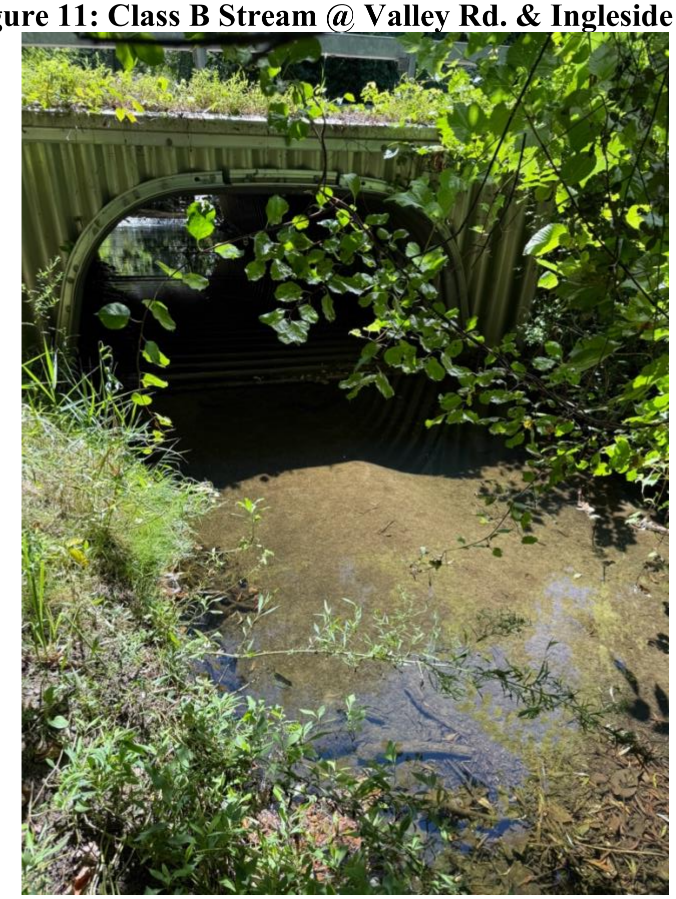


Figure 11: Class B Stream @ Valley Rd. & Ingleside Rd.



Groundwater Sampling

Septic effluent was also identified as a potential source of external loading and samples were analyzed for phosphorus species from the groundwater wells as previously conducted during the USGS 2000 study. The TOP provided access to well sites during site visits. LBE collected discrete samples in standard 250 mL preserved and unpreserved bottles from two (2) shallow groundwater wells during two (2) sampling events (one wet and one dry event). Samples were overnight shipped on ice and analyzed by SePRO Laboratories using approved EPA methodologies and procedures (Appendix A) for:

- Total Phosphorus (μg/L) (EPA 365.3)
- Free Reactive Phosphorus (μg/L) (EPA 365.3)

Well #1 is located on the eastern side of Putnam Lake near the cross street with Fulton Drive. Well #2 is located in the northwestern tip of Putnam Lake near the cross street with Kendall Drive. Both well samples collected during the dry sampling event on 8/22/25 were <12 μg/L and oligotrophic. During the wet sampling event on 9/30/24, Well #1 measured 117.2 μg/L or well within the hypereutrophic range for phosphorus. Phosphorus typically binds to soil particles and is considered less mobile in groundwater compared to nitrogen. However, following this storm event, it appears phosphorus had migrated through groundwater to enter the Well #1. Well #2 remained within the oligotrophic range. Table 7 contains well sample results from both sampling events.

Table 7: Well Sample Results

		Date	8/22/25		9/30/25	
Parameter	**Method**	**Unit**	**Well 1**	**Well 2**	**Well 1**	**Well 2**
Free Reactive Phosphorus	EPA 365.3	μg/L	12.5	<5	<5	9.6
Total Phosphorus	EPA 365.3	μg/L	117.2	<10	<10	<10

Figure X: Groundwater well sites

Lake Sediment Sampling

The GEI Report included within the RFP by the Town of Patterson, targeted pre-determined dredge scenario sites and phosphorus fractioning was conducted on four (4) samples, two of which were from shallow water. The Watershed: Lake Ratio for Putnam Lake is low (7.6:1), meaning that phosphorus load may be more likely influenced by internal loading than external loading. Because stream flows are lowest during the growing season, the relative influence of internal loading is expected to be higher when algae blooms are most prevalent. To create an accurate phosphorus budget for Putnam Lake, additional samples were collected from three medium and three deep areas of the lake (6 samples total). All samples were collected in plastic unpreserved containers and were overnight shipped on ice to SePRO Laboratory. Sediment samples were analyzed for Level 2 fractionation including:

- Labile P: Loosely adsorbed and porewater phosphorus (P),
- Reductant - Soluble P: Phosphorus mainly bound to FE-hydroxides or Mn compounds,
- Metal-Oxide P: Exchangeable with hydroxide ions,
- Organic P: Bound to microorganisms, detritus, humic compounds, etc.; and
- Apatite and Residual: Mineralized forms of phosphorus.

We refer to “mobile” phosphorus in the sediment as the sum of the releasable portion so each of the sediment fractions. This typically can include all the labile phosphorus and portions of the reductant soluble, metal oxide, and organic fractions. These ratios are site-specific based on a lake’s characteristics and sediment chemistry results. We refer to “biologically available phosphorus” (BAP) as the phosphorus that is readily available in the water column to algal/cyanobacterial cells and fuel blooms. BAP can be released from sediments through disturbance, under anoxic conditions, or can come from external sources. Phosphorus in the apatite (HCL) and residual fractions is typically considered bound and non-releasable (Table 8).

During this early season sampling, the loosely bound bio-available phosphorus was expectedly low. Sediment phosphorus fractionation results (Table 8) show an average sediment Total Phosphorus of 1,295 mg P/kg dry weight (DW) with an estimate that ~53% is potentially releasable. This yields an estimate of ~7,922 pounds (~3,593 kg) of phosphorus that would need to be mitigated in the top 5cm of the sediment (5cm being a conservative estimate of the treatment depth when the % solids are only 11%).

Table 8: Comprehensive Level 2 Fractionation Results Summary

Sample Name	Site Depth (ft)	% Solids	Wet Bulk Density (kg/L)	Loosely-Bound P (mg-P/kg)	Iron P (mg-P/kg)	Organic P (mg-P/kg)	Aluminum P (mg-P/kg)	HCl & Residual P (mg-P/kg)	Total P (mg-P/kg)
Deep 1	15.20	10%	0.99	*	672	453	472	877	2,473
Deep 2	13.10	10%	1.01	*	699	390	484	589	2,162
Deep 3	17.30	13%	1.04	5	1,346	424	1,218	543	3,536
Med 1	13.10	10%	1.01	*	800	437	653	45	1,935
Med 2	15.00	14%	1.05	5	1,013	529	597	191	2,335
Med 3	13.90	11%	1.01	*	570	336	500	922	2,329

* Concentration was less than reportable limits with 99% confidence
All concentrations are reported based on dry weight

Internal Loading Discussion

If the majority of sites with iron-bound phosphorus are located within deep sites (not proposed for dredging) internal loading during anoxic periods will continue to fuel HABs within Putnam Lake. As Putnam Lake stratifies multiple times per year, sediment resuspension may be occurring, that releases phosphorus and allows denitrification to increase alkalinity and buffer pH.

External Loading Discussion

Hypereutrophic total phosphorus measurements at outlet locations throughout August and September indicate that while external loading may not be the greatest influence on total lake load, it still represents a significant source of nutrient that HABs can utilize. Outfalls are located along shorelines open to public access and HABs in these areas pose the greatest risk to people and pets, therefore management is warranted.

Dredge Feasibility

There are a variety of short-term potential impacts to water quality from dredge projects including increased turbidity and suspended solids. While dredge projects typically target the cooler months of the year, large scale-projects may encompass multi-season or multi-year timelines. Increased turbidity can stress submersed aquatic plants which compete with algae for nutrients and can hider visual feeding of fish. Dredging can also disturb anoxic (oxygen-deprived) sediments where metals and other contaminants may be sequestered. The disturbance of nutrient rich sediment can release soluble reactive phosphorus and ammonium (Smith et al., 2006 & Cooke et al., 2005). Invasive plant material including viable fragments, seeds, and vegetative material can be disturbed and inadvertently transported to new zones within the waterbody. Putnam Lake's habit of multiple turnover events can cause sediment disturbance that re-releases nutrient, which would continue to occur in non-dredged sites. Li et al 2020 suggests that dredging effectiveness may be weakened over time as sediments are disturbed and phosphorus is released, therefore implementing *in situ* techniques that improve the oxide layer of sediments and reduce sediment suspension are recommended.

While dredging can be a viable management tool to increase water volume and depth as well as permanently reduce internal phosphorus loading in sites where sediments have accumulated over time, the process can in the short term create or exacerbate water quality impairments (Liu et al., 2024). Additionally, sediment removal could be a beneficial restoration approach, but effects of lake water quality remain only short-term unless there is an adequate control on external loading to the lake (Kiani et al., 2020). Based on the moderate costing figures provided within the GEI report at three feet of depth, dredging the four proposed sections of lake totals $8.3 million (the low-cost scenario calculated by GEI estimates $1.6 million while the high-cost scenario estates $16.6 million). While the dredge project would be expected to significantly reduce the amount of phosphorus within the lake, it is unlikely reduce the available phosphorus from remaining internal and external sources to a point that would be curative for HABs. An exploration of nutrient mitigation and algaecide treatments are the more cost-effective solution over time for long-term HAB management (Kang et al., 2023).

GEI's report cited 104,716 kgs of Phosphorus would be expected to be removed within the 4 sites, or 38% of the Total Phosphorus within the ten combined sites investigated. This does not include the area outside of the proposed dredge zones, which comprises approximately 40-45% of the lake's surface area and the majority of its depth. This anoxic zone is a primary contributor to internal loading within the deeper portions of the lake.

Nutrient Mitigation

The act of dredging relies on several factors, including which sediments are logistically feasible to access. Several formulations of nutrient inactivant product are commercially available that ensure even deep sediments or outfall inputs can be ameliorated.

Nutrient inactivants are commonly used by aquatic managers in most U.S. States and worldwide to address water quality issues by reducing phosphorus more predictably and reliably that other strategies. Commonly used nutrient inactivants are typically either aluminum-based compounds (such as aluminum sulfate or sodium aluminate "alum") or lanthanum-based (compounds of naturally occurring "rare-earth" elements). While several products are commercially available and shown to significantly reduce phosphorus, a comparison of the peer-reviewed data suggests that certain brands and formulations are most effective at permanently binding phosphorus and have better eco-toxicology profiles than others.

Alum: Alum was historically the most used nutrient inactivant on the market. Concerns with Alum arise in some situations as it's use can cause pH changes and potential buffers are needed in some water quality scenarios (including softer waters). The U.S. Environmental Protection Agency (USEPA) has established aquatic life criteria for Aluminum, and those values can increase sensitivity to aquatic life in certain water quality scenarios based on specific lake dissolved organic carbon (DOC), pH, and water hardness values. Alum application creates a layer of floc that encapsulates benthic sediments. This floc layer can become mobile, based on in-lake flows and wind and can create an anoxic layer on sediments. Within Putnam Lake, with multiple turnover events that re-stratify throughout the season, a mobile layer of floc could be problematic by either reducing product efficacy for phosphorus binding or causing ununiform accumulation in unwanted areas that could potentially result in aluminum toxicity to benthic invertebrates. Sulfates are added to the formulation which can impact some sensitive species of aquatic plants. The phosphorus binding capability has been shown to be effective, but less permanent than some newer technologies and can re-release phosphorus (Berkowitz et al. 2005, 2006). Volumes of product needed are typically 20-30x newer technologies which can become logistically impractical for large lakes and can incur shipping costs and Department of Transportation (DOT) restrictions due to corrosivity. Newer technologies have become available in more recent years that reduce or eliminate some of these concerns.

Lanthanum: Multiple lanthanum-based nutrient inactivants are available on the market. The most effective appears to be a lanthanum modified bentonite technology. This compound has the highest and most specific affinity for P binding, as it will not bind with other elements such as silica or carbonate). It does not alter pH nor add SO_4 (Holm & Armstrong, 1981). The formulation settles and integrates into the waterbody sediments (as opposed to a mobile layer of floc capping sediments with alum). Formulations exist to target phosphorus not only within sediments, but also to bind mobile phosphorus directly out of the water column. The bind is more permanent with the formation of Rhabdophane (Jonasson et al. 1988) which becomes tighter as it ages (Cetiner et al. 2005; Dithmer et al. 2015). After treatment with lanthanum, the amount of phosphorus within releasable fractions will decrease and the quantity of phosphorus in the apatite and residual fractions will increase.

For the purposes of comparison with the dredge project, a cost analysis was created using the lanthanum-modified bentonite products EutroSORB G (for sediments) and EutroSORB WC (for water column) over a 3–5-year period. EutroSORB G is a granular product containing lanthanum-modified bentonite (a naturally occurring earth element). EutroSORB G would be applied by boat to the entire surface area of Putnam Lake, where it will disperse, sink and permanently bind phosphorus within the sediment. This treatment could be supplemented with EutroSORB WC, a liquid product, that will inactivate phosphorus within the water column and can be applied by boat or through injection systems (Figure 11) along tributary inputs. Both EutroSORB G and EutroSORB WC are stable across water chemistries and would not cause shifts in pH upon application, they do not require any additives to apply to water. There is no environmental toxicity concern for wildlife associated with the treatment.

Table 8 showed an average sediment Total Phosphorus of 1,295 mg P/kg dry weight (DW) with an estimate that ~53% is potentially releasable. This yields an estimate of ~7,922 pounds (~3,593 kg) of phosphorus that would need to be mitigated in the top 5cm of the sediment. 5cm may be a conservative estimate of the treatment depth when the % solids are only 11% and an increase to 8cm may be warranted. As a multi-year treatment plan, monitoring will occur at sites prone to disturbance and an increase could be warranted in those areas. Based on the total phosphorus calculated within the sediment samples of Putnam Lake (~7,922 pounds) an application of ~400,000 pounds of EutroSORB G could be implemented in-lake at an estimated cost of $2 million. EutroSORB WC treatment could be completed by boat or through installation of satellite automated treatment technology (SATT system) units at two of the outfalls and estimated to be $1 million over the course of a 3–5-year period. Utilization of comprehensive monitoring and adaptive management are key components of this nutrient mitigation program. Use of reactive algaecide treatments would be used to supplement the use of the EutroSORB platform but need will likely be significantly reduced over time as nutrients are bound. One EutroSORB G and WC are applied the sediment and water column phosphorus are permanently bound. Results would last several years, during which the site would be monitored. Re-treatments may be required in areas where physical disturbance or turnover events expose untreated sediments (EutroSORB G) or from external sources (EutroSORB WC). Re-treatment rates are typically significantly reduced in scope from initial treatments and function as maintenance treatments.

Management Method	Approximate Cost
Dredging	$8.3 Million
OR	
EutroSORB G	$2 Million
EutroSORB WC	$1 Million
Supplemental Algaecide	$20,000 per year
Invasive Plant Control	$50,000 (total 3 years)
Sampling	$15,000 per year
Monitoring Systems	$20,000
Project Total 3-5 years	**$2.75 Million**

GEI’s estimated moderate dredging cost of $8.3 million may not be curative for HABs as it does not address loading from anoxic deep-water sites. The estimated phosphorus reduction achieved as estimated within the GEI report is also not directly comparable to the figures achieved by nutrient inactivation, as they are separate tools with different objectives.

SePRO's Automated Treatment Technology (SATT) systems have been used in various flowing systems throughout the United States to apply herbicides and algaecides as well as nutrient inactivants. SATT systems are metered injection systems, cellular-controlled and either solar powered or hard-wired (where possible). Injector housings (which can be as small as a refrigerator) are weather-proof and alarmed to house the required pumps, product tanks, and monitoring equipment needed to apply nutrient inactivant to flowing systems as it is needed. The system controls for SATTs are accessible via cellular device or computer access through the user interface where units can be stopped or started and sensors can report battery voltage, tank levels, and alerts. Figure 11 shows a SATT system trailered unit with solar panels.

Figure 11: SATT System within trailer and solar panels.

LBE recognizes there is currently no permit mechanism allowing the use of nutrient inactivants within New York State. However, Senate counsel cleared Nutrient Inactivant Bill S.5936 from the Senate Environmental Conservation Committee during the April 2, 2025, meeting. The Bill will go to Senate Finance Committee. To proactively prepare for the potential passage of Bill S.5936 and HAB Bill A.5150-a, municipalities should explore various scenarios that incorporate the appropriate nutrient inactivant formulations for their waterbody site characteristics. This foundational work will facilitate swift and effective implementation upon approval and also will uniquely position TOP to apply for grant funding outlined within the HAB Bill A-5150-a as much of the site-specific preparatory work will be completed.

Harmful Algal Blooms (HABs)

LBE reviewed NYSDEC's 2018 HAB Action Plan for Putnam Lake which detailed what dominant cyanobacteria taxa were represented in blooms between 2013-2017. Significant environmental shifts (i.e., major storm events, precipitation patterns, nutrient inputs, temperature increase) have occurred since this data was collected. Likely due to a combination of those factors, changes to dominant cyanobacteria taxa have been reported throughout the region within the last several years. LBE collected additional algae and cyanobacteria samples from seven (7) outfalls and various in-lake surface water sites to appropriately inform lake management scenarios. While the term "harmful algal blooms" or "HABs" has recently become used regionally and statewide to refer to cyanobacteria blooms (often also called blue-green algae), it is vital to understand which cyanobacteria taxa are present to accurately assess risk and provide management options. Shifts within the plankton community occur seasonally, as dominant taxa compete to consume available resources. Cyano-dominated systems can impact water users and wildlife alike, as many species of cyanobacteria are known toxin and/or taste and odor producers. Proposed management scenarios may also differ between planktonic cyano species versus benthic mat forming cyano species and those that inhabit both (like *Microcystis*) and are informed by cell counts and toxin concentration.

LBE sampled both shorelines/coves and open water during sampling events throughout the growing season (spring, summer, fall) to account for seasonal shifts in algae composition. Six to seven sample sites were routinely collected and analyzed for:

- algae identification,
- classification,
- description, and
- density or biomass enumeration.

All samples were collected in 250 mL non preserved bottles and overnight shipped on ice to SePRO laboratories and analyzed using approved EPA methodologies and procedures. Tables 9, 10, and 11 contain the algae collected at each site, describe whether species found are true algae or cyanobacteria (and if so, whether known toxin producers), include a description of their growth form, include their density/biomass, and threat level index as identified by the lab (Figure 12). and additional treatment prescriptions as needed. Additional notes on each cyanobacterial species are also provided in the discussion along with treatment prescriptions, as warranted, appropriate active ingredients, formulations, and dosage.

Figure 12: SePRO Laboratories Cyanobacteria Threat Level Index

SeScript Alert Index	Threat Level	Cyanobacteria Levels (cells/mL)
★	Low	Less than 20,000
★★	Moderate	20,000 to 100,000
★★★	High	More than 100,000
★★★★	Extreme	More than 100,000 with scum/mats

Table 9: Algae Sample Results: 08/26/25

Site	Date	Identification	Classification	Description	Density/Biomass	Threat Level
Outfall 1	8/26/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	93,600 cells/mL	★★
	8/26/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	78,200 cells/mL	★★
Outfall 2	8/26/25	*Cladophora* sp.	Chlorophyta-Green algae	Filamentous, mat forming	1.0 gww/cm3	
Outfall 3	8/26/25	Leptolyngbya sp.	Cyanophyta- Blue-green algae	Filamentous, mat forming, potential toxin and taste/odor producer	0.7 gww/cm3	★★★★
	8/26/25	*Cladophora* sp.	Chlorophyta-Green algae	Filamentous, mat forming	0.3 gww/cm3	
Outfall 4	8/26/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	59,900 cells/mL	★★
	8/26/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	32,100 cells/mL	★★
Outfall 5	8/26/25	*Pithophora* sp.	Chlorophyta-Green algae	Filamentous, mat forming	1.4 gww/cm3	★★
Outfall 6	8/26/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer		★★
Lake-1	8/26/25	*Nitzschia* sp.	Bacillariophyta-Diatoms	Single-celled, planktonic	< 40 cells/mL	

Table 10: Algae Sample Results: 09/12/25

Site	Date	Identification	Classification	Description	Density/Biomass (cells/mL)	Threat Level
Outfall 1	9/12/25	*Nitzschia* sp.	Bacillariophyta- Diatoms	Single-celled, planktonic	< 40	
	9/12/25	*Trachelomonas* sp.	Eulenophyta- Euglenoids	Single-celled, flagellated, planktonic	< 40	
Outfall 2	9/12/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	98,200	★★★
	9/12/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	12,500	★★★
Outfall 3	9/12/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	273,400	★★★
	9/12/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	57,100	★★★
	9/12/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	9,200	★★★
Outfall 4	9/12/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	391,900	★★★
	9/12/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	78,200	★★★
	9/12/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	50,100	★★★
Outfall 5	9/12/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	108,800	★★★
	9/12/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	81,600	★★★
	9/12/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	629,900	★★★
	9/12/25	*Dolichospermum* sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	33,500	★★★
Outfall 6	9/12/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	157,200	★★★
	9/12/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	65,800	★★★
Outfall 7	9/12/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	161,900	★★★
	9/12/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	74,300	★★★
	9/12/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	52,800	★★★
	9/12/25	*Dolichospermum* sp.	Cyanophyta- Blue-green algae	Filamentous, scum-former, planktonic, potential toxin and taste/odor producer	44,600	★★★

Table 11: Algae Sample Results: 09/30/25

Site	Date	Identification	Classification	Description	Density/Biomass (cells/mL)	Threat Level
Outlet Putnam Dam	9/30/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	125,300,000	★★★★
	9/30/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	6,100,000	★★★★
	9/30/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	999,900	★★★★
Outfall 2	9/30/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	41,200,000	★★★★
	9/30/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	12,500,000	★★★★
Outfall 3	9/30/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	512,500	★★★★
	9/30/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	289,900	★★★★
	9/30/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	73,600	★★★★
Outfall 4	9/30/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	264,800,000	★★★★
	9/30/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	573,000,000	★★★★
	9/30/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	3,300,000	★★★★
Outfall 5	9/30/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	355,100,000	★★★★
Outfall 6	9/30/25	*Microcystis* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	128,900,000	★★★★
	9/30/25	*Woronichinia* sp.	Cyanophyta- Blue-green algae	Colonial, planktonic, potential toxin producer	2,900,000	★★★★
	9/30/25	*Aphanizomenon* sp.	Cyanophyta- Blue-green algae	Colonial, scum-former, planktonic, potential toxin and taste/odor producer	513,700	★★★★

Cyanobacteria Summary for Species Present

True Algae

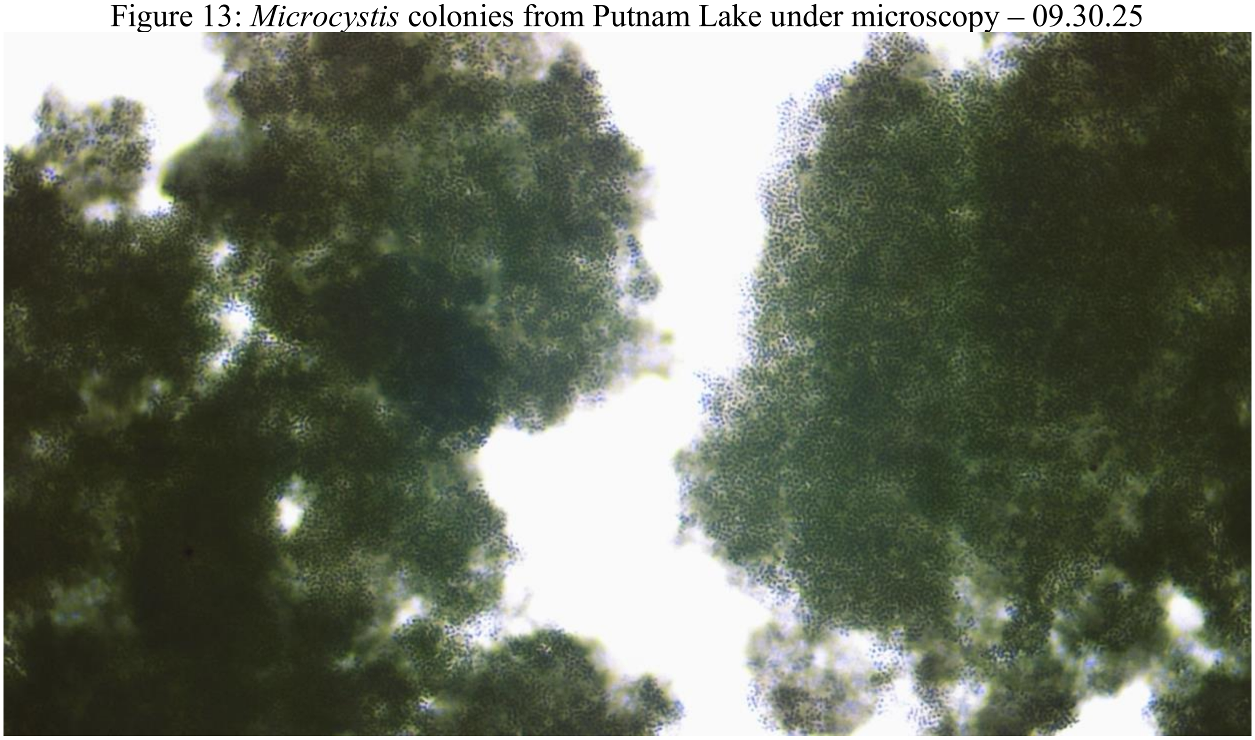
True algae (eukaryotic algae belonging to Kingdoms Plantae or Protista) are crucial components of phytoplankton communities in lakes and ponds. True algae, such a diatoms and green algae, form the base of the aquatic food web. They are primary producers that convert solar energy into chemical energy, which sustains nearly all higher life forms within the lake. True algae are edible for zooplankton which go on to feed and other organisms. While true algae may also grow to nuisance densities when conditions are ideal, impacts to water use typically include aesthetics or fishing issues with filamentous algae mats, or clogging of water intakes. These species are not typically harmful or toxin producing. The only true algae present in samples were *Cladophora* (*Chlorophyta* green algae), *Nitzschia* (*Bacillariophyta* diatoms), *Pithophora* (*Chlorophyta* green algae), and *Trachelomas* (*Euglenophyta* Euglenoid). By 9/30/25, no true algae were present within samples collected from outfalls.

Cyanobacteria

Microcystis sp.

Microcystis is of the most well-studied genera of cyanobacteria. It is a colonial, scum-former that is planktonic within the water column. It can produce toxins, called Microcystins (potent hepatotoxins) and taste and odor compounds. Specialized air-filled organelles called vacuoles allow the cells to regulate buoyancy and move vertically within the water column to access nutrients at depth and sunlight at the surface of lakes. Colonies typically resist grazing pressure by most zooplankton as they are too large to consume. Colonies can significantly raise the pH of systems as they bloom (less seen in the highly buffered system of Putnam Lake) and their decomposition can consume vast amounts of dissolved oxygen. Humans are most often exposed to Microcystis at the water's surface during summer and therefore most often observe these cells as planktonic. Brunberg, 2002 explains that while it is typically understood that cells "overwinter" at depth (Preston *et al*., 1980; Fallon and Brock, 1981), there is evidence that benthic biomass may substantially exceed the maximum planktonic biomass in eutrophic lakes (Boström *et al*., 1989), thus indicating that *Microcystis* colonies are able to survive for longer periods and accumulate at the bottom. Another sign of long-term survival is that viable Microcystis colonies have been found in substantial numbers at sediment depths corresponding to several years of age (Boström *et al*., 1989). Long-term laboratory incubations have shown that colonies are able to restart growth even after extended time periods of 'resting' (Reynolds *et al*., 1981). Benthic colonies occasionally reinvade the water column and serve as an inoculum for the planktonic populations that develop during summer (Preston *et al*., 1980; Reynolds *et al*., 1981; Trimbee and Harris, 1984). The amount of recruiting colonies depends on several factors, i.e. the number of colonies accumulated at the bottom, how long these survive in the sediments, and the development of environmental conditions favoring recruitment. These growth characteristics should significantly impact how effective a dredge project within Putnam Lake would be regarding future HAB mitigation, as deep sections of the lake may in fact retain large viable populations of these recruiting colonies. Figure 13 shows Microcystis colonies collected from Putnam Lake on 9/30/25 under microscopy.

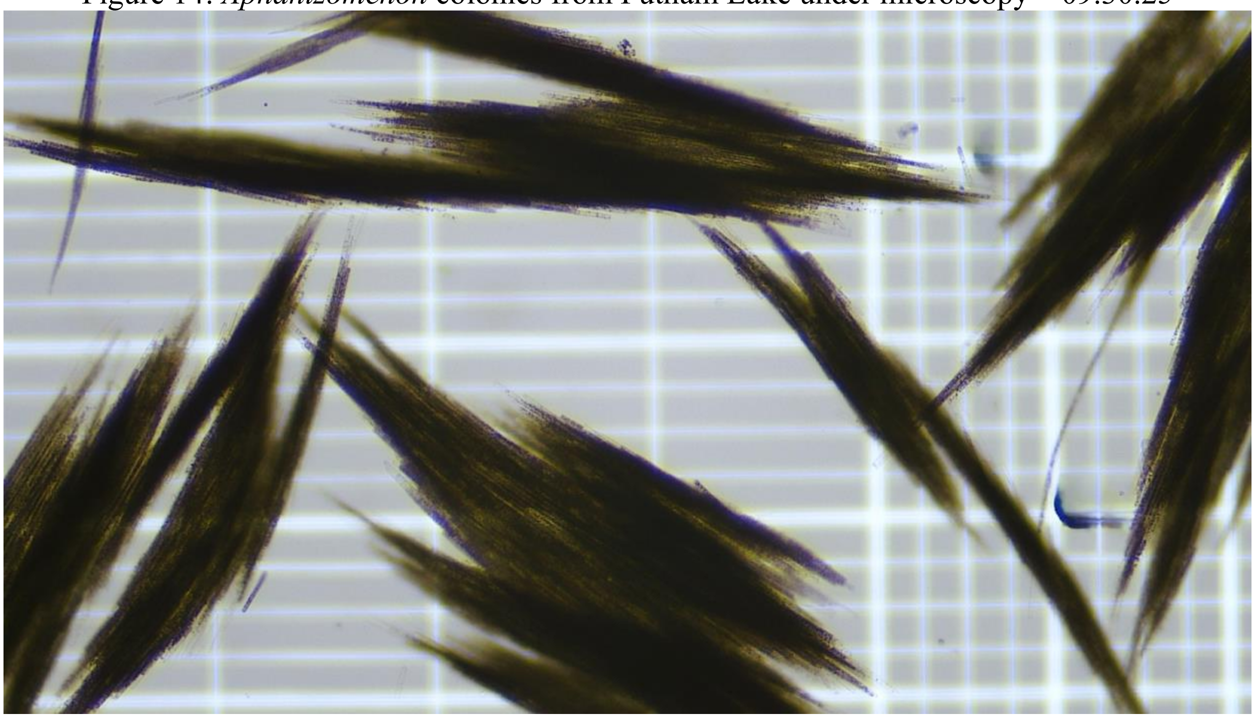
Figure 13: *Microcystis* colonies from Putnam Lake under microscopy – 09.30.25



Aphanizomenon sp.

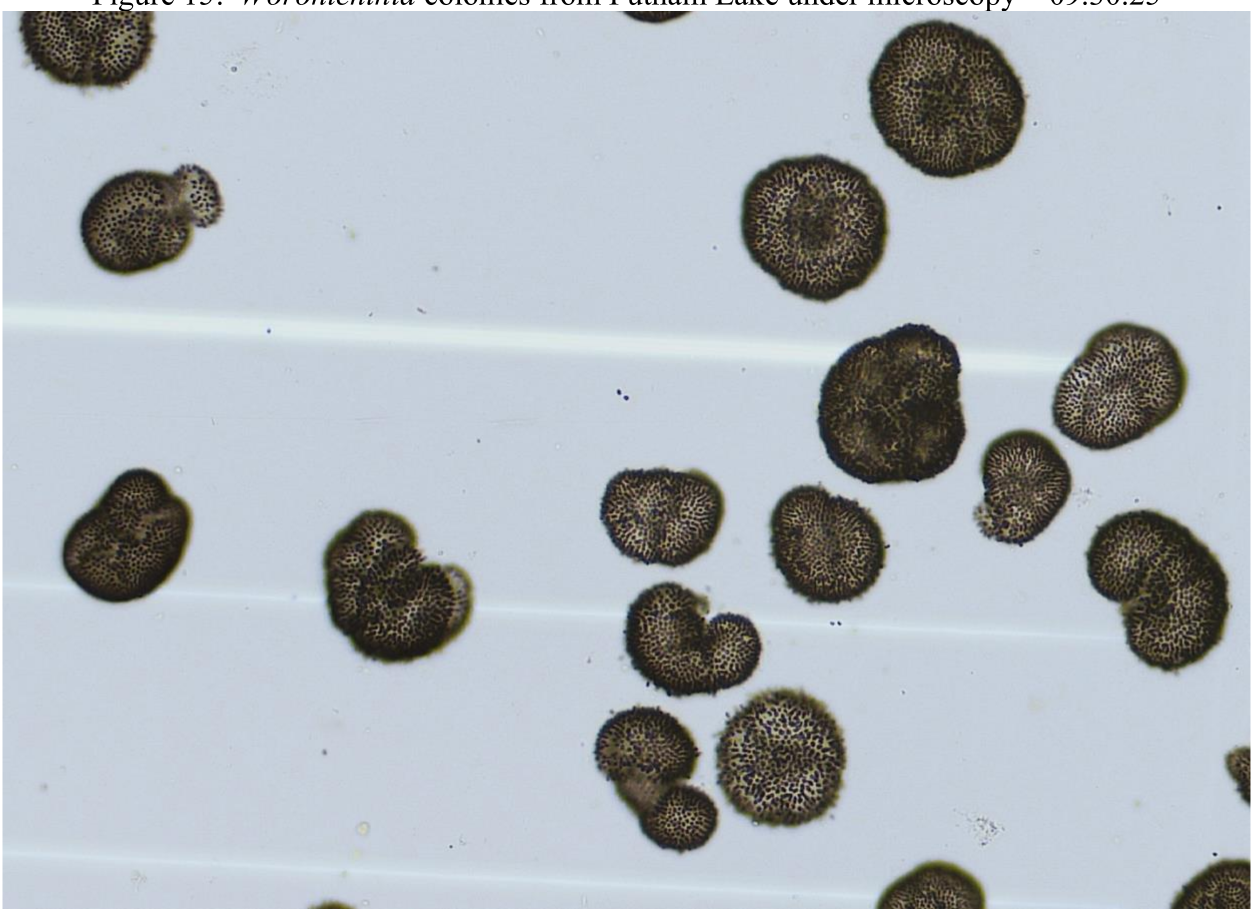
This genus was identified as a planktonic scum former within Putnam Lake. The colonies form distinctive, elongated bundles or flakes that are informally referred to as “grass clippings”. *Aphanizomenon* utilizes specialized cells called heterocysts to convert atmospheric nitrogen into usable ammonia and is therefore phosphorus limited. Gas vesicles give the cells buoyancy which enables vertical migration to access nutrients at depth and sunlight at the lake’s surface. *Aphanizomenon* can produce multiple types of potent toxin including primarily anatoxins (which are neurotoxins), cylindrospermopsin, and saxitoxins (which are paralytic). This cyanobacterium is directly responsible for serious risk to human and animal health. Blooms can be seen in cooler water temperatures than *Microcystis*. Some *Aphanizomenon* can produce taste and odor compounds like Geosmin. Decomposition can lead to severe dissolved oxygen depletion and contributes to further internal phosphorus loading from anoxic sediments. Figure 14 shows *Aphanizomenon* colonies collected from Putnam Lake on 9/30/25 under microscopy.

Figure 14: *Aphanizomenon* colonies from Putnam Lake under microscopy – 09.30.25



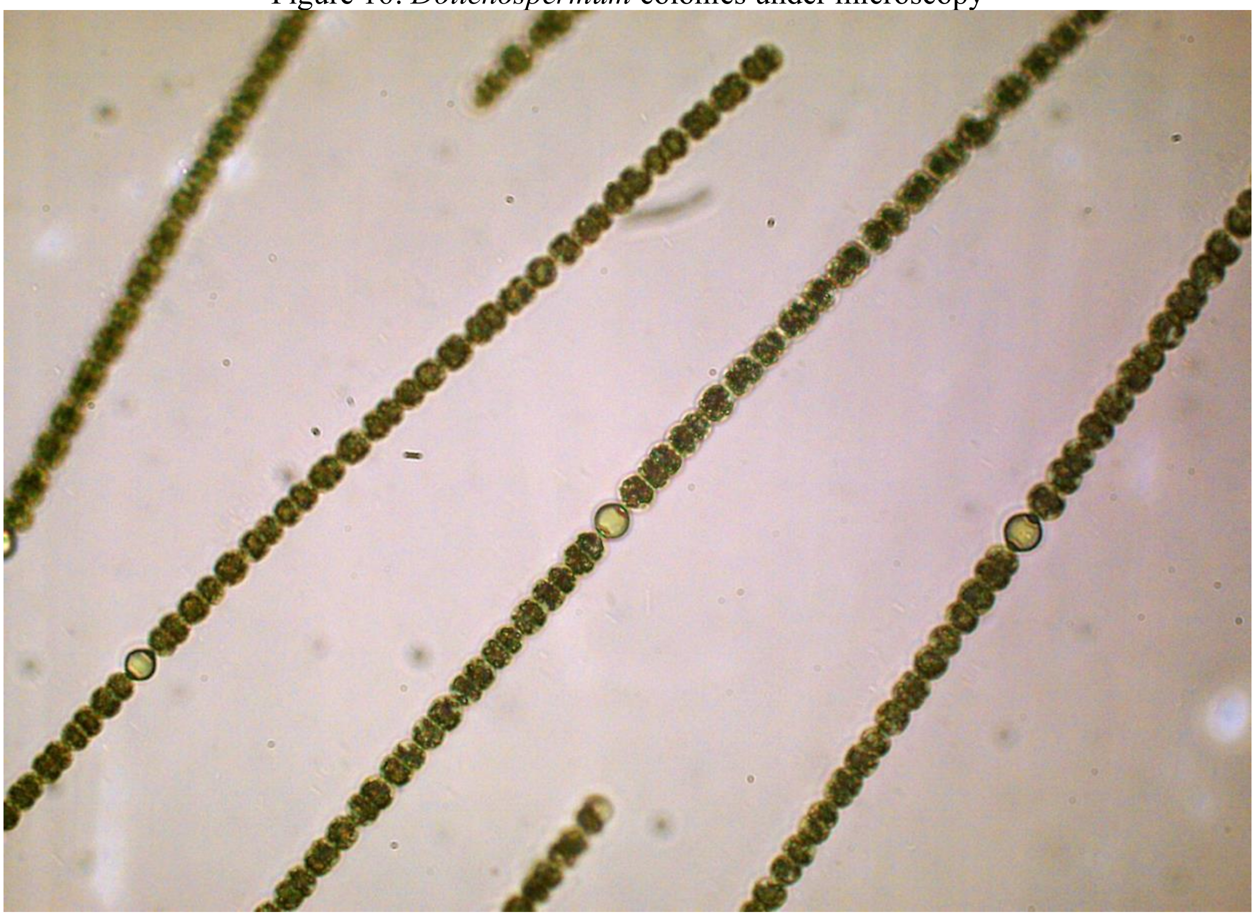
Woronichinia sp.
Woronichinia was identified as a colonial planktonic cyanobacteria within Putnam Lake. It forms distinctive spherical colonies with protective mucilage. This protects from grazing pressure and wind and water turbulence. Gas vesicles provide buoyancy and allow for vertical migration within the water column to access nutrients at depth and sunlight at the water's surface. This species overwinters in the sediment as colonies, similar to other species found within the Putnam Lake bloom. *Woronichinia* may produce several cyanotoxins, including microcystins, which can cause damage upon exposure through ingestion or skin contact. This species can outcompete true algae by forming dense scums and shading out other phytoplankton and submersed aquatic vegetation. These blooms can contribute to the "pea soup" appearance which has recently become more recognized by the public. The end of season decay of blooms can consume dissolved oxygen leading to hypoxic or anoxic conditions. Figure 15 shows *Woronichinia* colonies collected from Putnam Lake on 9/30/25 under microscopy.

Figure 15: *Woronichinia* colonies from Putnam Lake under microscopy – 09.30.25



Dolichospermum sp.
This genus was formerly classified as *Anabaena* and was identified as a planktonic, filamentous scum former within Putnam Lake. This genus can fix nitrogen from the atmosphere utilizing specialized cells called heterocysts, meaning phosphorus is the limiting nutrient. *Dolichospermum* may form long coiled (or straight) chains that appear as hair-like filaments. They possess gas vesicles that allow them to regulate buoyancy and achieve vertical migration to access nutrients at depth and sunlight at the water's surface. They are capable of producing a variety of potent toxins, including anatoxins and cylindrospermopsin. Their resting cells are called akinetes, which lie dormant on the sediment and may form rapid blooms once seasonal environmental conditions become favorable. *Dolichospermum* can produce taste and odor compounds like geosmin and methylisoborneol. Anoxic conditions can result from dissolved oxygen depletion during decomposition of blooms. Figure 16 shows *Dolichospermum* colonies collected from Putnam Lake on 9/12/25 under microscopy.

Figure 16: *Dolichospermum* colonies under microscopy



Ongoing Algae Management

Putnam Lake was treated with Algaecide Cutrine® Ultra during the 2025 sampling season by TOP's contractor The Pond & Lake Connection. Two treatments occurred (06/25/25 and 07/29/25), which likely significantly reduced algal/cyanobacteria densities within Putnam Lake. The goal of algaecide treatments has been to limit HABs and maintain a full swimming season at the town-maintained swimming beaches. While HAB prevention during the swimming season is extremely important in reducing risk to the public, later season HABs still pose a significant risk to water users, their pets, and wildlife. Concentration of cyanobacterial scums along various shoreline access areas in 2025 exceeded limits of safety. Exposure to toxins can occur upon contact with skin to people and pets at the shoreline, while fishing from shore or by boat, and can even be aerosolized for those near blooms. 2025 samples were collected from shoreline areas that are easily accessible by residents, guests, pets, and wildlife. An additional bump treatment with this chelated copper algaecide could occur in future treatment seasons, if conditions once again suggest a HAB is imminent. Water samples should be collected from May-September to assess cyanobacterial cell counts and available phosphorus levels. For cell count-based monitoring efforts: establishing a treatment threshold approaching <80,000 cells/mL for planktonic cyano species and 0.5 gww/cm^3 for mat-forming cyano species would provide a degree of safety to water users. For toxin-based monitoring EPA's recommended "do not exceed" value for protecting human health given a primary contact recreational exposure scenario is 8 μg/L for microcystin and 15 μg/L for cylindrospermopsin[3]. The EPA Lo Risk Drinking Criteria is below 0.5 μg/L for Microcystin toxin. The New York State Department of Health (NYSDOH) is responsible to monitoring Putnam Lake's public swimming beaches for bacterial contamination that could impact swimmers. NYSDOH's role in monitoring waterbodies can support NYSDEC/CSLAP/TOP in HAB surveillance, toxin analysis, and investigation of any illnesses reported from HABs for Putnam Lake.

Based on data from other waterbodies prone to late season blooms, a late season algaecide treatment would be beneficial to Putnam Lake to reduce the density of cyanobacterial resting cells for the following growing season. While some copper-based algaecide treatments (such as copper sulfate pentahydrate) permitted by NYSDEC Bureau of Pesticides require special authorization after Labor Day (6 CRR-NY 326.6) data could be presented to NYSDEC Region 3 Pesticides to request a chelated copper or peroxide-based algaecide permit to be used in the event of another late-season bloom. At the very least, it is strongly encouraged that information signage should be installed at public access points along the shoreline where members of the public could come in contact with HABs.

Public Outreach

The TOP should consider installation of informational signage along popular public access points for Putnam Lake. Signs displaying a link to the proper NYSDEC HAB reporting tool could assist with data collection by the public. The NYSDEC has issued signage templates for HABs (Figure 16), but these templates can be made site specific by the TOP of a private contractor. NYSDEC's current signage template links to the NYSDOH resources regarding HABs, which is a valuable resource.

[3] https://www.federalregister.gov/d/2019-11814/p-11

Figure 16: NYSDEC HAB Signage Example

If the TOP chooses to implement the recommended HAB alert system, like the one utilized by the New Jersey Department of Environmental Protection (Figure 1), various signage could be installed to communicate advisory status and recommended precautions for access.

Figure 17: Advisory Specific Signage Template

Aquatic Vegetation Assessment

Existing aquatic plant for Putnam Lake included the Town of Patterson's 2001 aquatic plant survey and "preliminary aquatic plant monitoring" performed by the Park District's contractor in 2013. These reports confirmed presence of the aquatic invasive plant species water chestnut (*Trapa natans*), curly leaf pondweed (*Potamogeton crispus*), and Eurasian watermilfoil (*Myriophyllum spicatum*). Prior aquatic plant survey data dates to 1987. Of the 27 HAB events confirmed within the 2018 HAB Action Plan, 48% took place during the time of year aquatic plant species are senescing for the season. An additional 29% of the HABs took place during the time of year when the aquatic invasive species Curly leaf pondweed (*Potamogeton* crispus) is senescing. Aquatic plant biomass accounts for a significant storage of bioavailable phosphorus and plant senescence can result in harmful algal blooms. In 2025, LBE conducted both an early season and late season aquatic plant survey be conducted to account for changes in species composition throughout the season due to plant phenology and to determine plant distribution and abundance.

LBE conducted two Point Intercept Method (PIM) aquatic plant surveys in 2025. An early season survey in May and late season survey in September accounted for seasonal variation in plant phenology. A motorboat and aquatic weed rake were utilized to conduct the May survey. A canoe and aquatic weed rake were used to conduct the September Survey, as plant growth and low water limited access to certain areas along the shoreline. Plants were identified to species, where possible. Semi-quantitative abundance of each species of submersed, floating, and emergent aquatic plants (trace, sparse, moderate, dense) was noted at 40 georeferenced points within Putnam Lake. A total plant abundance (all species) was also provided for each point (trace, sparse, moderate, dense). Figure 17: Putnam Lake Point Intercept Aquatic Plant Survey Points Map 2025 shows the location of each of the sample points (same for each survey). Tables 12 and 13: contains abundance values for Putnam Lake Point Intercept Aquatic Plant Survey Data for May and September, respectively. Appendix B: Plant Profiles contains species common name, scientific name, specimen photograph, native/invasive status, if invasive – Lower Hudson Partnership for Regional Invasive Species (LHPRISM) Tiered Ranking, if native – protected status, a brief description of phenologic characteristics, appropriate treatment methods, and treatment recommendations (if applicable).

Aquatic plants are found throughout Putnam Lake, although confined to the littoral zone (or area within the water column shallow enough for sunlight to penetrate). In total, eleven species of vascular aquatic macrophyte were identified. In May, seven species of aquatic plant were identified including three invasive plants and four natives. By September, eleven species of plant were identified, including the three invasive plants, and eight natives. The northern end of Putnam Lake contains the densest vegetation including the densest native and invasive plant growth. The dominant species in May were both invasive: water chestnut (*Trapa natans*) and curly leaf pondweed (*Potamogeton crispus*).

Figure 17: Putnam Lake Point Intercept Aquatic Plant Survey Points Map 2025

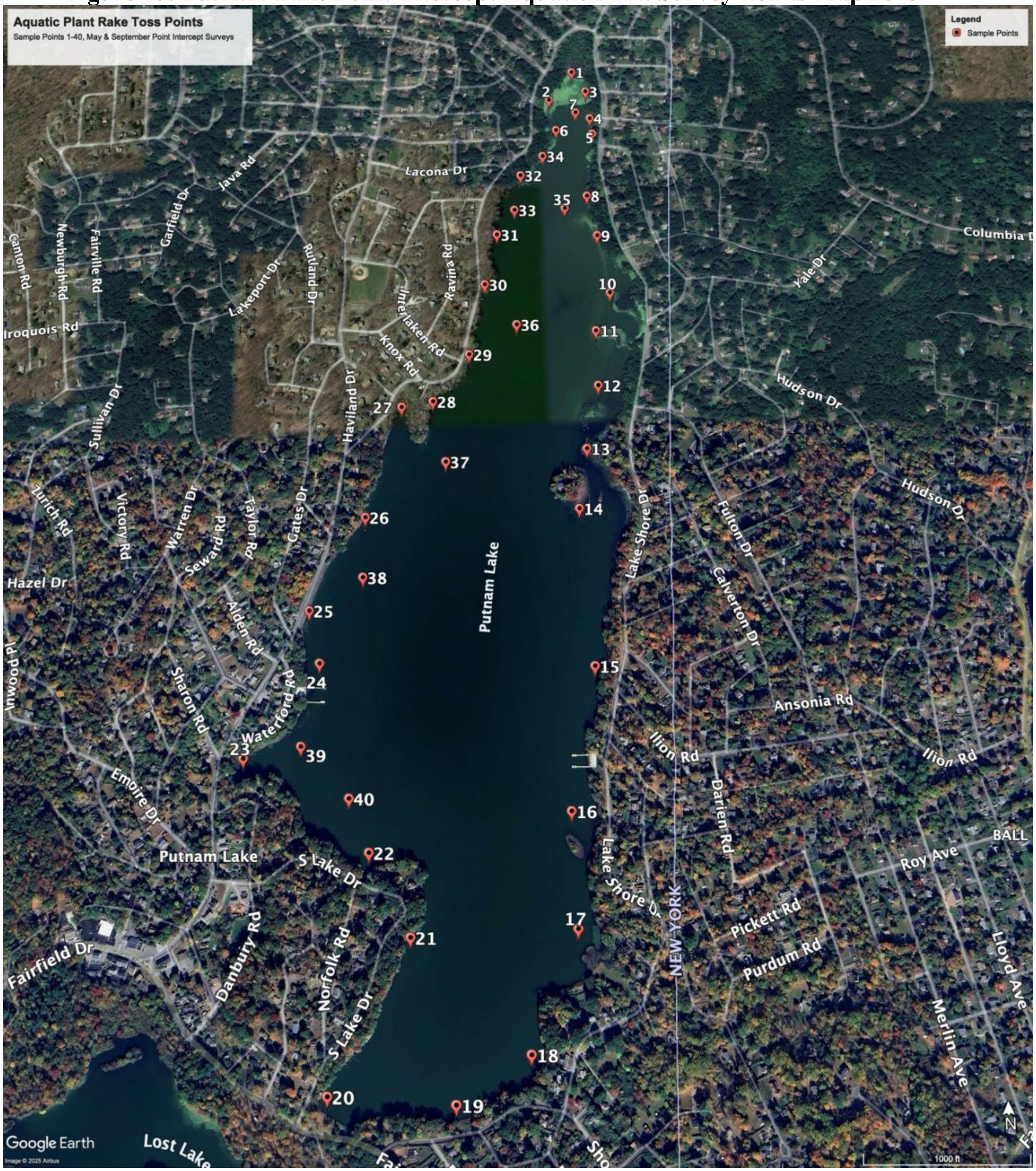


Table 12: Putnam Lake Point Intercept Aquatic Plant Survey Data May 2025

	white water lily	Eurasian watermilfoil	water chestnut	common arrowhead	curly leaf pondweed	small pondweed	water celery	TOTAL	Coordinates
Site 1		T	D					D	41°28'39.36"N, 73°32'12.93"W
Site 2		T	D	T				D	41°28'36.93"N, 73°32'15.36"W
Site 3		S	D		D			D	41°28'37.61"N, 73°32'11.63"W
Site 4		M	S		D			D	41°28'35.23"N, 73°32'11.33"W
Site 5		M			D			D	41°28'33.87"N, 73°32'11.18"W
Site 6	M	M						S	41°28'33.93"N, 73°32'13.18"W
Site 7		S			T			S	41°28'35.77"N, 73°32'12.74"W
Site 8	M	T						T	41°28'28.58"N, 73°32'12.04"W
Site 9	M	T						T	41°28'25.28"N, 73°32'11.24"W
Site 10	M	T						T	41°28'20.62"N, 73°32'10.32"W
Site 11	M	S						S	41°28'17.66"N, 73°32'11.86"W
Site 12		S						S	41°28'13.45"N, 73°32'11.92"W
Site 13						T	T	T	41°28'8.76"N, 73°32'13.28"W
Site 14					T			T	41°28'4.46"N, 73°32'14.23"W
Site 15								M	41°27'53.67"N, 73°32'13.51"W
Site 16									41°27'44.52"N, 73°32'16.09"W
Site 17								M	41°27'37.50"N, 73°32'15.95"W
Site 18								S	41°27'30.50"N, 73°32'20.09"W
Site 19								T	73°32'20.09"W, 73°32'26.14"W
Site 20								M	41°27'28.59"N, 73°32'36.32"W
Site 21							T	T	41°27'37.31"N, 73°32'29.70"W
Site 22		M					S	S	41°27'42.38"N, 73°32'33.15"W
Site 23								S	41°27'48.40"N, 73°32'43.91"W
Site 24									41°27'54.38"N, 73°32'37.55"W
Site 25	M	M						M	41°27'57.91"N, 73°32'38.55"W
Site 26		T	M						41°28'4.26"N, 73°32'33.65"W
Site 27		M		T				M	41°28'12.22"N, 73°32'30.34"W
Site 28							T	S	41°28'12.57"N, 73°32'27.42"W
Site 29		M		M			S	M	41°28'16.08"N, 73°32'23.96"W
Site 30		S		M			M	M	41°28'21.54"N, 73°32'22.32"W
Site 31				M			T	M	41°28'25.56"N, 73°32'21.02"W
Site 32	M	T					M	M	41°28'30.45"N, 73°32'18.51"W
Site 33				T	T			S	41°28'27.56"N, 73°32'19.22"W
Site 34	M	M					S	S	41°28'32.05"N, 73°32'16.24"W
Site 35									41°28'27.59"N, 73°32'14.28"W
Site 36									41°28'18.30"N, 73°32'19.38"W
Site 37									41°28'8.09"N, 73°32'26.30"W
Site 38									41°28'0.08"N, 73°32'33.83"W
Site 39									41°27'49.05"N, 73°32'39.02"W
Site 40									41°27'45.72"N, 73°32'34.86"W

KEY : Blank = No Plants, T = Trace, S = Sparse, M = Moderate, D = Dense

Table 13: Putnam Lake Point Intercept Aquatic Plant Survey Data September 2025

	spatterdock	white water lily	Eurasian watermilfoil	watermeal	duckweed	water chestnut	common arrowhead	curly leaf pondweed	small pondweed	water celery	coontail	TOTAL	Coordinates
Site 1				D	M	D						D	41°28'39.36"N, 73°32'12.93"W
Site 2				D	M	D	T					D	41°28'36.93"N, 73°32'15.36"W
Site 3			M	D	M	D						D	41°28'37.61"N, 73°32'11.63"W
Site 4		T	S			S						S	41°28'35.23"N, 73°32'11.33"W
Site 5		T	T							S		S	41°28'33.87"N, 73°32'11.18"W
Site 6		D										D	41°28'33.93"N, 73°32'13.18"W
Site 7			M					T				M	41°28'35.77"N, 73°32'12.74"W
Site 8		T	T					T		T		T	41°28'28.58"N, 73°32'12.04"W
Site 9										T		T	41°28'25.28"N, 73°32'11.24"W
Site 10		T	T			M			S	T	T	M	41°28'20.62"N, 73°32'10.32"W
Site 11			S	S	S					T		S	41°28'17.66"N, 73°32'11.86"W
Site 12			S			M		T		T		M	41°28'13.45"N, 73°32'11.92"W
Site 13				S		M			M	S	S	M	41°28'8.76"N, 73°32'13.28"W
Site 14									S	T	S	S	41°28'4.46"N, 73°32'14.23"W
Site 15			M									M	41°27'53.67"N, 73°32'13.51"W
Site 16											T	T	41°27'44.52"N, 73°32'16.09"W
Site 17	T		M								T	M	41°27'37.50"N, 73°32'15.95"W
Site 18			T								T	T	41°27'30.50"N, 73°32'20.09"W
Site 19			T									T	73°32'20.09"W, 73°32'26.14"W
Site 20			M									M	41°27'28.59"N, 73°32'36.32"W
Site 21			T									T	41°27'37.31"N, 73°32'29.70"W
Site 22			T									T	41°27'42.38"N, 73°32'33.15"W
Site 23		T	S			S			T			S	41°27'48.40"N, 73°32'43.91"W
Site 24			T						T			T	41°27'54.38"N, 73°32'37.55"W
Site 25		M	M									M	41°27'57.91"N, 73°32'38.55"W
Site 26			T						T			T	41°28'4.26"N, 73°32'33.65"W
Site 27			M	S	S	S			S			M	41°28'12.22"N, 73°32'30.34"W
Site 28			S							T		S	41°28'12.57"N, 73°32'27.42"W
Site 29			M									M	41°28'16.08"N, 73°32'23.96"W
Site 30			S		T							S	41°28'21.54"N, 73°32'22.32"W
Site 31			T									T	41°28'25.56"N, 73°32'21.02"W
Site 32		D							S			D	41°28'30.45"N, 73°32'18.51"W
Site 33									T		T	T	41°28'27.56"N, 73°32'19.22"W
Site 34		D										D	41°28'32.05"N, 73°32'16.24"W
Site 35													41°28'27.59"N, 73°32'14.28"W
Site 36													41°28'18.30"N, 73°32'19.38"W
Site 37													41°28'8.09"N, 73°32'26.30"W
Site 38													41°28'0.08"N, 73°32'33.83"W
Site 39													41°27'49.05"N, 73°32'39.02"W
Site 40													41°27'45.72"N, 73°32'34.86"W

KEY : Blank = No Plants, T = Trace, S = Sparse, M = Moderate, D = Dense

Invasive curly leaf pondweed was found present at six sample points during the May survey, and had naturally senesced by the September survey, but was still present at three of the points in significantly reduced density. As an early season grower, curly leaf pondweed can germinate in late winter from turions and commonly begins early growth under a layer of ice. This species will crowd out other plant species with a tall canopy and has been shown to produce allelopathic chemical compounds that make the immediate area surrounding infestations unsuitable for growth of other species. Dense mats can form as this species lacks predators and diseases that would otherwise keep populations in check. By mid-summer, the species naturally senesces, and the large dense mats can release significant amounts of bio-available phosphorus. This phosphorus input can be readily used by cyanobacteria as resting cells within the sediment (or washed in from upstream sources). Figure 18 shows site photos of the curly leaf pondweed in dense within Putnam Lake during the May survey. CLP is submerged perennial aquatic plant native to Eurasia, Africa, and Australia[4]. Under 6 NYCRR Part 575[5] New York prohibits its possession with the intent to sell, purchase, transport, or introduce and its sale, importation, purchase, transport, introduction, or propagation. It is also banned in the neighboring States of Connecticut[6], Massachusetts[7], Pennsylvania[8], and Vermont[9]. The Lower Hudson Partnership for Regional Invasive Species Management (LHPRISM) has categorized CLP as "Tier 4 Status - Widespread". LHPRISM defines species in Tier 4 as "highly invasive species with great abundance in the region with a management goal of local control".

Figure 18: Invasive Curly Leaf Pondweed in Dense Abundance during May 2025 Survey

[4] https://www.fws.gov/sites/default/files/documents/Ecological-Risk-Screening-Summary-Curly-Leaved-Pondweed.pdf
[5] https://www.dec.ny.gov/docs/lands_forests_pdf/islist.pdf
[6] https://cipwg.uconn.edu/invasive_plant_list/
[7] https://www.mass.gov/info-details/massachusetts-prohibited-plant-list
[8] https://www.invasive.org/species/list.cfm?id=175
[9] https://anrweb.vt.gov/PubDocs/DEC/WSMD/lakes/docs/ans/lp_Prohibited%20list.pdf

Based on this data, invasive plant management strategies are warranted for the site. After evaluating several scenarios, LBE proposes the application of the aquatic herbicide Clearcast® (imazamox) to be the most effective option based on its efficacy and specificity in controlling CLP during an early spring treatment. To control established CLP, the turions within the seed bank must be exhausted. A multi-year treatment project is required. The treatment plan is proposed for the 2026, 2027, and 2028 growing seasons and may be continued or altered in future years if warranted. An Article 15 Part 327 A single Clearcast® application during the first week of May (each year 2026, 2027, and 2028) is proposed within a designated treatment area (Figure 19). The proposed project is subject to Article 24 because the use of herbicides in regulated wetlands is a restricted activity. The proposed project is also subject to an Article 15 Aquatic Pesticide permit, and State Pollution Discharge Elimination System (SPDES), which will be resubmitted each season of the three-year project (with a possibility of extension for 2 more years). No water use restrictions for recreation will be implemented during or after the treatment; boating, swimming, fishing can all continue as normal. An irrigation restriction will occur until concentrations of imazamox are less than 1.0 ppb following treatment. Water sampling and analysis will occur following the treatment, will be analyzed via FasTEST to a 1.0ppb detection limit, and will continue until the 1.0 ppb irrigation restriction can be lifted.

Figure 19: Proposed Curly Leaf Pondweed Treatment Area

Invasive water chestnut was found at five points in May and had expanded to nine sites by September. The water chestnut is densest along the northern tip of Putnam Lake. Figure 20 contains site photos showing the significant accumulation in plant density within that area of the lake between the May and September for that species. As water chestnut naturally senesced at the end of September, plant material breaking down was observed to be coated in various cyanobacterial species, likely fueled by the bioavailable phosphorus being released from the plant tissue decay.

Figure 20: Water Chestnut at Northern Tip of Putnam Lake May vs. September

Based on this data, invasive plant management strategies are also warranted for the site to limit expansion of the invasion and internal plant loading. After evaluating several scenarios, LBE proposes the application of the aquatic herbicide Flumigard SC® (flumioxazin) to be the most effective option based on its efficacy in controlling water chestnut via foliar application. To control water chestnut, the floating rosettes must be treated prior to seed set (July). A multi-year treatment project is required to exhaust the seed bank. The treatment plan is proposed for the 2026, 2027, and 2028 growing seasons and treatment areas are likely to decrease exponentially in size as the seed bank is exhausted. An Article 15 Part 327 A single Flumigard SC® application during the mid-July (each year 2026, 2027, and 2028) is proposed within a designated treatment area (Figure 21) and will be reduced to spot treatments of remaining plants in later seasons. The proposed project is subject to Article 24 because the use of herbicides in regulated wetlands is a restricted activity. The proposed project is also subject to an Article 15 Aquatic Pesticide permit, and State Pollution Discharge Elimination System (SPDES), which will be resubmitted each season of the three-year project (with a possibility of extension for 2 more years). No water use restrictions for recreation will be implemented during or after the treatment; boating, swimming, fishing can all continue as normal. An irrigation restriction will occur for 5 days following treatment. The treatment area has been dominated by water chestnut for multiple growing seasons. Submersed species are unlikely to survive under the canopy of invasive water chestnut and therefore non target impacts are unlikely within the treatment area. Foliar application avoiding wind, boat wake, and precipitation will ensure product remains within target area.

Figure 21: Proposed Invasive Water Chestnut Treatment Area

Management Scenarios for Putnam Lake

No-action Scenario
No action would be taken to control or manage HABs or limit invasive vegetation growth within Putnam Lake. The HABs and invasive plant infestation could still be monitored by volunteers or contractors. Measures should still be taken to prevent spread on watercraft and equipment to other waterbodies after retrieval from Putnam Lake. The curly leaf pondweed will continue to spread throughout the lake and will reach nuisance densities where available light, nutrient, and sediment for rooting is available. The water chestnut will continue to expand its range within the lake and will produce a canopy that crowds out native submersed species (as it has already done in the northernmost portions of Putnam Lake). In mid-summer the thick mats of curly leaf pondweed will start to decompose, which can reduce the dissolved oxygen in the water and could result in fish kills. The phosphorus released could trigger mid-season harmful algal blooms. Known toxin producing cyanobacteria were found to be present during sampling within Putnam Lake and will utilize available resources which could result in blooms if ideal growing conditions are once again met. "No-action" is a misnomer, as action will still need to be taken if only to educate water users of the risks of HABs in accessing the lake from shorelines, or boating and fishing in-lake.

Preferred Scenario 2026
Permitting: TOP's licensed applicator or contractor should work to obtain required permits for invasive aquatic plant treatments and HAB treatments for the 2026 Season: • Article 24 Freshwater Wetland Permit *modification* to include Clearcast® for Curly Leaf Pondweed and Flumigard® SC[10] for water chestnut. • Article 15 AQV Permit for Clearcast® for curly leaf pondweed • Article 15 AQV Permit for Flumigard® SC for water chestnut • Article 15 for Cutrine® Ultra for HABs • SPDES eNOI Coverage
Monitoring: Collect and submit HAB samples every 2 weeks May-September at three sites (15 samples total per season). • Proposed sample locations include 1.) in-lake sample @ northern tip of Putnam Lake (influenced by Outfall 3), 2.) in-lake sample near Outfall 4 (upstream of western beach), 3.) in-lake sample near Outfall 5 (upstream of eastern beach). • Sample analysis should include Total Phosphorus, Free Reactive Phosphorus, and Algae Identification including classification and biomass (cell counts).
HAB Control: Institute Active Threshold Approach to algaecide treatments: approaching $<80,000$ cells/mL for planktonic cyano species and 0.5 gww/cm^3 for mat-forming cyano species to provide a degree of safety to water users. Once threshold is met, TOP's licensed applicator will provide required 7-day notice to NYSDEC for algaecide treatment.
Advocacy: <u>Join HAB Coalition:</u> work with local legislators, municipalities like Peach Lake, New York State Federation of Lake Associations (NYSFOLA), and New York State Aquatic Managers Association (NYSAMA) to support nutrient inactivant legislation.
Outreach: Install HAB signage at various shoreline locations around Putnam Lake to inform water users of risks of HABs. Create TOP webpage and post sample results throughout season along with correlated advisory and any recommended changes to water uses.
Invasive Aquatic Plant Control: (Pending issuance of NYSDEC permits) TOP's contractor will perform invasive aquatic plant treatments in early season for Curly Leaf Pondweed and prior to seed set for water chestnut.

[10] Clearcast could be substituted as a foliar treatment for water chestnut if preferred by the applicator.

Limited Scenario

Permitting: TOP's licensed applicator or contractor should work to obtain required permits for invasive aquatic plant treatments and HAB treatments for the 2026 Season:

- Article 15 for Cutrine® Ultra for HABs
- SPDES eNOI Coverage

Monitoring: Collect and submit HAB samples every 2 weeks May-September at three sites (15 samples total per season).

- Proposed sample locations include 1.) in-lake sample @ northern tip of Putnam Lake (influenced by Outfall 3), 2.) in-lake sample near Outfall 4 (upstream of western beach), 3.) in-lake sample near Outfall 5 (upstream of eastern beach).

Sample analysis should include Total Phosphorus, Free Reactive Phosphorus, and Algae Identification including classification and biomass (cell counts).

- Pre-nutrient mitigation sediment samples in fall 2026.

HAB Control: Institute Active Threshold Approach to algaecide treatments: approaching <80,000 cells/mL for planktonic cyano species and 0.5 gww/cm^3 for mat-forming cyano species to provide a degree of safety to water users. Once threshold is met, TOP's licensed applicator will provide required 7-day notice to NYSDEC for algaecide treatment.

Preferred Scenario 2027

Permitting: TOP's licensed applicator or contractor should work to obtain required permits for invasive aquatic plant treatments and HAB treatments for the 2027 Season:

- Article 15 AQV Permit for Clearcast® for curly leaf pondweed
- Article 15 AQV Permit for Flumigard® SC for water chestnut
- Article 15 for Cutrine® Ultra for HABs
- SPDES eNOI Coverage

Monitoring: Collect and submit HAB samples every 2 weeks May-September at three sites (15 samples total per season).

- Proposed sample locations include 1.) in-lake sample @ northern tip of Putnam Lake (influenced by Outfall 3), 2.) in-lake sample near Outfall 4 (upstream of western beach), 3.) in-lake sample near Outfall 5 (upstream of eastern beach).
- Sample analysis should include Algae Identification including classification and biomass (cell counts).

(Pending SATT Installation) – Install upstream and downstream GreenEYES NuLAB systems at each SATT location to monitor above and below injection point to calculate pounds and percent reduction in phosphorus for wet season, dry season, and total phosphorus reduction.

Nutrient Mitigation: Pending issuance of nutrient inactivant legislation (Bill S.5936):

- Apply 150,000 lbs. of EutroSORB G to Putnam Lake in early season (April) application to Putnam Lake medium and deep-water sites.
- Install SATT systems at two outfall locations to administer EutroSORB WC automated inline phosphorus monitoring and mitigation throughout growing season.
- EutroSORB WC: liquid, non-flocculant formulation that is applied directly to flowing water. ~1.0-1.25 gallons of EutroSORB WC will permanently bind one pound of phosphorus. Will not impact water chemistry. Safe for fish and invertebrates.
- SATT System will provide accurate remote automated application rates which will be routinely adjusted based on flow and target removal rates. Monitors in real-time and is event-triggered to apply based on flows. Solar or hard-wired power options possible.

HAB Control: Institute Active Threshold Approach to algaecide treatments: approaching <80,000 cells/mL for planktonic cyano species and 0.5 gww/cm^3 for mat-forming cyano species to provide a

degree of safety to water users. Once threshold is met, TOP's licensed applicator will provide required 7-day notice to NYSDEC for algaecide treatment.
Advocacy: Continue work with local legislators, municipalities like Peach Lake, New York State Federation of Lake Associations (NYSFOLA), and New York State Aquatic Managers Association (NYSAMA) to support nutrient inactivant legislation if not already passed. Pursue HAB funding (pending issuance of HAB Bill A-5150-a).
Outreach: Install HAB signage at various shoreline locations around Putnam Lake to inform water users of risks of HABs. Maintain TOP webpage and post sample results throughout season along with correlated advisory and any recommended changes to water uses.
Invasive Aquatic Plant Control: (Pending issuance of NYSDEC permits) TOP's contractor will perform invasive aquatic plant treatments in early season for Curly Leaf Pondweed and prior to seed set for water chestnut.

Preferred Scenario 2028
Permitting: TOP's licensed applicator or contractor should work to obtain required permits for invasive aquatic plant treatments and HAB treatments for the 2028 Season: • Article 15 AQV Permit for Clearcast® for curly leaf pondweed • Article 15 AQV Permit for Flumigard® SC for water chestnut • Article 15 for Cutrine® Ultra for HABs • SPDES eNOI Coverage
Monitoring: Collect and submit HAB samples every 2 weeks May-September at three sites (15 samples total per season). • Proposed sample locations include 1.) in-lake sample @ northern tip of Putnam Lake (influenced by Outfall 3), 2.) in-lake sample near Outfall 4 (upstream of western beach), 3.) in-lake sample near Outfall 5 (upstream of eastern beach). • Sample analysis should include Algae Identification including classification and biomass (cell counts). (Pending SATT Installation) – Install upstream and downstream GreenEYES NuLAB systems at each SATT location to monitor above and below injection point to calculate pounds and percent reduction in phosphorus for wet season, dry season, and total phosphorus reduction.
Nutrient Mitigation: Pending issuance of nutrient inactivant legislation (Bill S.5936): • Apply 150,000 lbs. of EutroSORB G to Putnam Lake in early season (April) application to Putnam Lake medium and deep-water sites. • Install SATT systems at two outfall locations to administer EutroSORB WC automated inline phosphorus monitoring and mitigation throughout growing season. • EutroSORB WC: liquid, non-flocculant formulation that is applied directly to flowing water. ~1.0-1.25 gallons of EutroSORB WC will permanently bind one pound of phosphorus. Will not impact water chemistry. Safe for fish and invertebrates. • SATT System will provide accurate remote automated application rates which will be routinely adjusted based on flow and target removal rates. Monitors in real-time and is event-triggered to apply based on flows. Solar or hard-wired power options possible.
HAB Control: Institute Active Threshold Approach to algaecide treatments: approaching <80,000 cells/mL for planktonic cyano species and 0.5 gww/cm^3 for mat-forming cyano species to provide a degree of safety to water users. Once threshold is met, TOP's licensed applicator will provide required 7-day notice to NYSDEC for algaecide treatment.
Advocacy: Continue work with local legislators, municipalities like Peach Lake, New York State Federation of Lake Associations (NYSFOLA), and New York State Aquatic Managers Association (NYSAMA) to support nutrient inactivant legislation if not already passed. Pursue HAB funding (pending issuance of HAB Bill A-5150-a).

Outreach: Install HAB signage at various shoreline locations around Putnam Lake to inform water users of risks of HABs. Maintain TOP webpage and post sample results throughout season along with correlated advisory and any recommended changes to water uses.

Invasive Aquatic Plant Control: (Pending issuance of NYSDEC permits) TOP's contractor will perform invasive aquatic plant treatments in early season for Curly Leaf Pondweed and prior to seed set for water chestnut.

Preferred Scenario 2029

Permitting: TOP's licensed applicator or contractor should work to obtain required permits for HAB treatments (as needed) for the 2029 Season:

- Article 15 for Cutrine® Ultra for HABs
- SPDES eNOI Coverage

Monitoring: Collect and submit HAB samples every 2 weeks May-September at three sites (15 samples total per season).

- Proposed sample locations include 1.) in-lake sample @ northern tip of Putnam Lake (influenced by Outfall 3), 2.) in-lake sample near Outfall 4 (upstream of western beach), 3.) in-lake sample near Outfall 5 (upstream of eastern beach).
- Sample analysis should include Algae Identification including classification and biomass (cell counts).

(Pending SATT Installation) – Maintain upstream and downstream GreenEYES NuLAB systems at each SATT location to monitor above and below injection point to calculate pounds and percent reduction in phosphorus for wet season, dry season, and total phosphorus reduction.

Nutrient Mitigation: Pending issuance of nutrient inactivant legislation (Bill S.5936):

- Apply 100,000 lbs. of EutroSORB G to Putnam Lake in early season (April) application to remaining Putnam Lake sites.
- Maintain SATT systems at two outfall locations to administer EutroSORB WC automated inline phosphorus monitoring and mitigation throughout growing season.
- EutroSORB WC: liquid, non-flocculant formulation that is applied directly to flowing water. ~1.0-1.25 gallons of EutroSORB WC will permanently bind one pound of phosphorus. Will not impact water chemistry. Safe for fish and invertebrates.
- SATT System will provide accurate remote automated application rates which will be routinely adjusted based on flow and target removal rates. Monitors in real-time and is event-triggered to apply based on flows. Solar or hard-wired power options possible.

HAB Control: Institute Active Threshold Approach to algaecide treatments: approaching <80,000 cells/mL for planktonic cyano species and 0.5 gww/cm^3 for mat-forming cyano species to provide a degree of safety to water users. Once threshold is met, TOP's licensed applicator will provide required 7-day notice to NYSDEC for algaecide treatment.

Advocacy: Pursue HAB funding (pending issuance of HAB Bill A-5150-a).

Outreach: Install HAB signage at various shoreline locations around Putnam Lake to inform water users of risks of HABs. Maintain TOP webpage and post sample results throughout season along with correlated advisory and any recommended changes to water uses.

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Appendix A: Water Quality Parameters Described

pH: is a measure of how acidic or basic a waterbody is and is expressed on a scale from 1-14. A pH of 7 is considered neutral. A range between 6 and 9 is standard for typical freshwaters. Less than 6 is notably acidic and more than 9 is notably basic. The method used was EPA 150.1.

Hardness: is a measure of the concentration of divalent cations, primarily consisting of calcium and magnesium in typical freshwaters. It is measured in mg/L. 0-60 mg/L as $CaCO_3$ soft; 61-120 mg/L as $CaCO_3$ moderately hard; 121-180 mg/L as $CaCO_3$ hard; >181 mg/L as $CaCO_3$ very hard. The method used was EPA 130.2.

Alkalinity: is a measure of the buffering capacity of water, primarily consisting of carbonate, bicarbonate, and hydroxide in typical freshwaters. Waters with lower levels are more susceptible to pH shifts. It is measured in mg/L. <50 mg/L as CaCO3 low buffered; 51-100 mg/L as $CaCO_3$ moderately buffered; 101-200 mg/L as $CaCO_3$ buffered; >200 mg/L as $CaCO_3$ high buffered.

Conductivity: is a measure of the waters ability to transfer and electrical current, increases with more dissolved ions. <50 *μS/cm* relatively low concentration may not provide sufficient dissolved ions for ecosystem health; 50-1500 *μS/cm* typical freshwaters; > 1500 *μS/cm* may be stressful to some freshwater organisms, though not uncommon in many areas. The method used was EPA 310.2.

Phosphorus: Essential nutrient often correlating to growth of algae in freshwaters. Total Phosphorus (TP) is the measure of all phosphorus in a sample as measured by persulfate strong digestion and includes inorganic oxidized organic and polyphosphates. This includes what is readily available, potential to become available and stable forms. <12 μg/L oligotrophic; 12-24 μg/L mesotrophic; 25-96 eutrophic; > 96 μg/L hypereutrophic. The method used was EPA 365.3. Free reactive phosphorus (FRP) is the measure of inorganic dissolved reactive phosphorus ($PO4^{-3}$, HPO_4^{-2}, etc.). This form is readily available in the water column for algae growth.

Nitrogen: is an essential nutrient that can enhance growth of algae.
Total Nitrogen is all nitrogen in the sample (organic N+ and Ammonia) determined by the sum of the measurements for Total Kjeldahl Nitrogen (TKN) and ionic forms. Nitrites and nitrates are the sum of the total oxidized nitrogen, often readily free for algae uptake. Measured in mg/L. <1 mg/L typical freshwater; 1-10 mg/L potentially harmful; >10 mg/L possible toxicity, above many regulated guidelines. The method used for Total Nitrate and Nitrite is Campbell et all 2004. The method used for Total Kjeldahl Nitrogen was EPA 351.2.

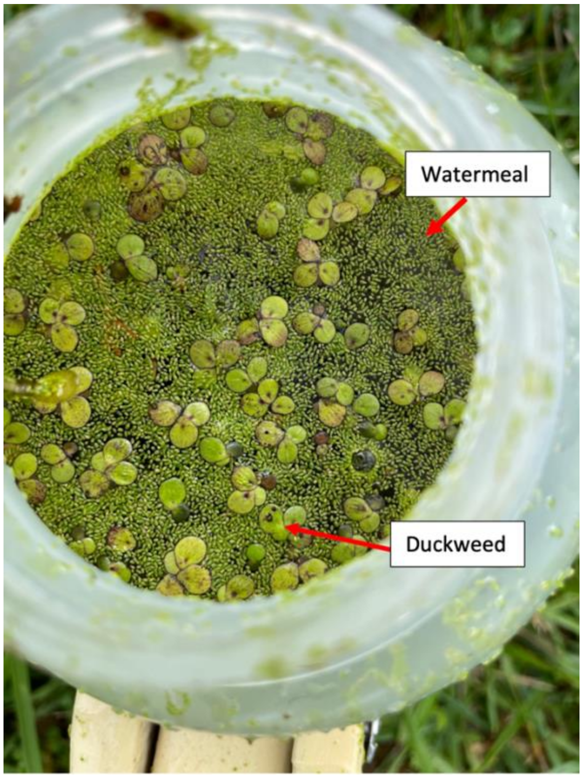
Chlorophyll a: is the primary light-harvesting pigment found in algae and a measure of the algal productivity and water quality in a system. 0.2μg/L oligotrophic; 1.7-20 μg/L Mesotrophic; 21-56 μg/L eutrophic; >56 μg/L hypereutrophic.

Turbidity: is the measurement of water clarity. Suspended particulates (algae, clay, silt, dead organic matter) are the common constituents impacting turbidity. It is measured in NTU. <10 NTU drinking water standards and typical trout waters; 10-50 NTU moderate; >50 NTU potential impact to aquatic life.

Appendix B: Plant Profiles

Eurasian watermilfoil
(*Myriophyllum spicatum)*
Submerged.
Invasive.
This species of water milfoil has long spaghetti-like stems that grow from submerged rhizomes. The stems may branch repeatedly at the water's surface creating a canopy that can crowd out other vegetation and obstruct recreation and navigation. The leaves are arranged in whorls of 4 to 5 and spread out along the stem. The leaves are divided like a feather. It typically reproduces via fragmentation.
Management notes: vegetation removal projects that cause fragmentation should take care to remove fragments to avoid additional spread. ProcellaCOR treatment early in the growing season (May) is the most effective way to control milfoil.

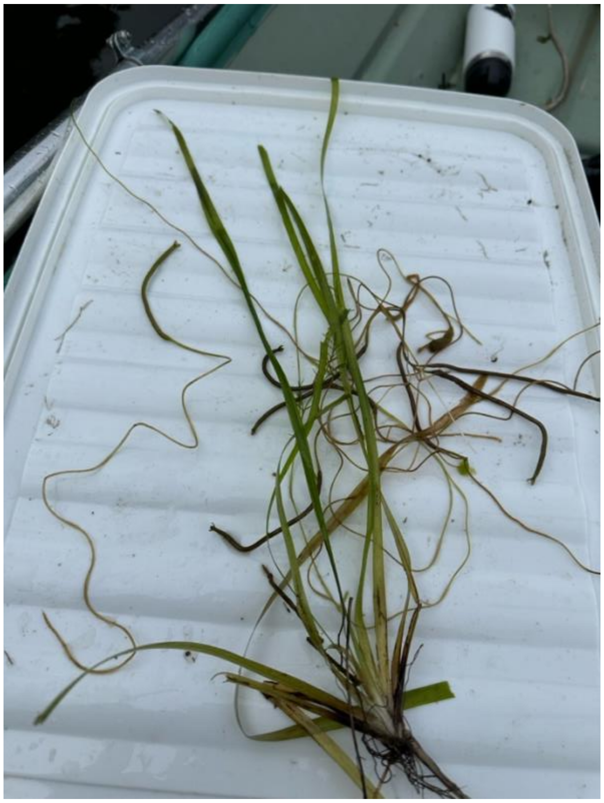
Coontail
Ceratophyllum demersum
Submersed.
Native.
Has long trailing stems that lack true roots, although it can become loosely anchored to sediment by modified leaves. The leaves are stiff and arranged in whorls of 5-12 at each node. Each leaf is forked once or twice and has teeth along the margins. The whorls of leaves are spaced closer at the end of the stem, creating a raccoon tail appearance. Reproduces via fragmentation.
Management notes: No management warranted for this species at this time, not found in nuisance densities within Putnam Lake. Provides food and habitat for native fish and invertebrates. Management could be employed should densities reach nuisance abundance within the water column. Chelated coppers such as Nautique herbicide would provide excellent control when used according to the label.



Duckweed
Lemna spp.
Native
Duckweed are tiny free-floating plants. Small roots dangle down below the leaves but are not rooted to substrate. Small round to oval shaped leaves occur in groups but measure less than 0.5cm in diameter. May form dense mats on the surface of quiescent waters but will easily drift with little wind or water currents. Reproduces via turions. Utilized by a variety of wildlife. Management notes: this species can be used as visual cue to assess where water flows are stalled throughout the Pond on top of vegetation mats and where wind currents cause plants to accumulate. Duckweed are seen as the larger floating plants in the image below with watermeal being the smaller floating plant in the jar.

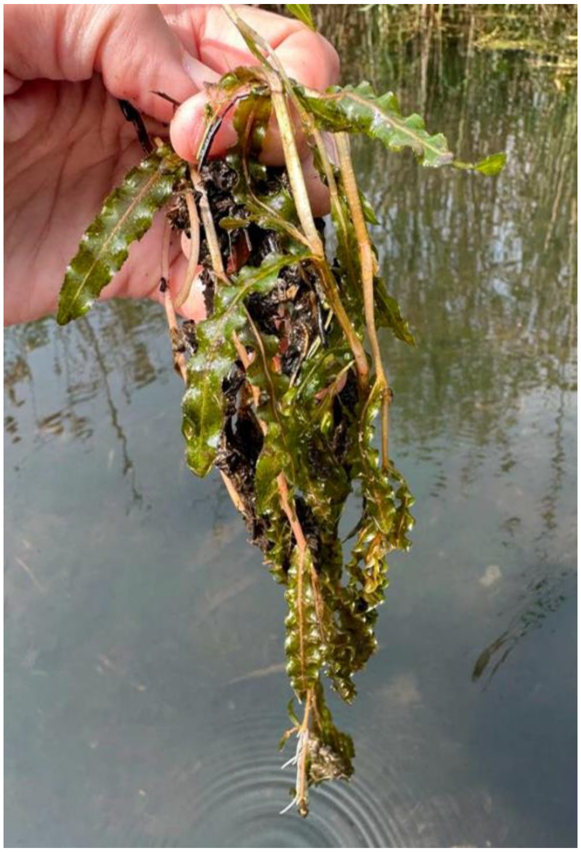
Watermeal
Wolffia spp.
Native
The world's smallest flowering plant. A free-floating plant lacking roots, stems, and true leaves. Reproduces primarily by budding. Seen as the smaller floating plant in the jar below.

Brittle Naiad
Najas minor
Invasive
Submerged. Bushy plant growing from fibrous white roots. Leaves are thin and serrated, many radiating from a single point, often with a crunchy feeling in the hand. It typically reproduces via seeds and fragmentation.
Notes: Activities that cause fragmentation could cause additional spread within Putnam Lake.



Wild Celery
Valisneria americana
Native
Submersed. This species is an important food and habitat source for a variety of wildlife. It is deep rooted with long, flat, slender leaves that are limp in the waters flow. Flowers are found on long slender stems with tubes at the top. Pollen can sometimes be seen floating from flowers at the waters surface.
Management notes: It was found to occur throughout Putnam Lake and is an important part of the lake ecosystem. The plant can become disloged by boating and floating fragments can be windswept to various areas of the lake and suggest the plant is occuring at higher densities than it actually is in rooted populations.

White-stem Pondweed
Potamogeton praelongus
Native
Submersed. This species has pale white zig zag stems and long lance to oval shaped leaves that clasp to the stem. Flowers and fruits are arranged in a cylindrical spike. Overwinters by hardy rhizomes. The fruits provide valuable grazing opportunities for ducks and geese. Considered a good food producer for trout, muskrat, and beaver and is valuable habitat for muskellunge.



Curly leaf pondweed
Potamogeton crispus
Invasive
Submerged. Most easily identified by its submersed oblong leaves with a crinkled lasagna noodle-like appearance that are crispy to the touch. An early grower, this plant can overwinter under ice cover and usually senesces by early summer. Turions are produced that can germinate in autumn, with some winter growth occurring. Spreads through fragmentation.

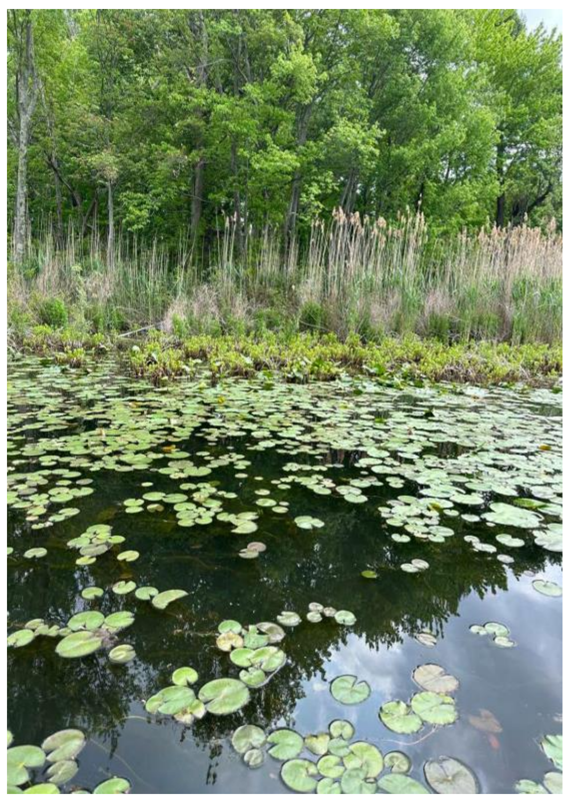
Common waterweed
Elodea canadensis
Native
Submerged. Perennial macrophyte with bright green, translucent, oblong leaves growing in whorls of 3-5 around the stem. Flowers May to October and reproduces via seed. As a submerged species it produces dissolved oxygen for the water column.
Management notes: This species did not occur in nuisance densities within the lake or mouth.

Southern naiad
Najas guadalupensis
Native
Submerged. This species has fine branch stems up to a meter in length with paired leaves. Named after water nymphs from greek mythology who were believed to protect lakes, rivers, and springs. Produces flowers and seeds. Size and spacing of leaves is extremely variable depending on growing conditions. Found to grow in association with water celery. A true annual that dies back comletely in the fall and relies on seeds to return in the spring. One of the most important regional plants for waterfowl. Good producer of food and shelter for fish.

Horned pondweed
Zannichellia palustris
Native
Submerged. This species has slenders stems emerging from slender rhizomes. Leaves are opposite, setting it apart from pondweeds. An annual that relies on seed production to return. Fruit and foliage are grazed by waterfowl. Also considered a fair food producer for trout.

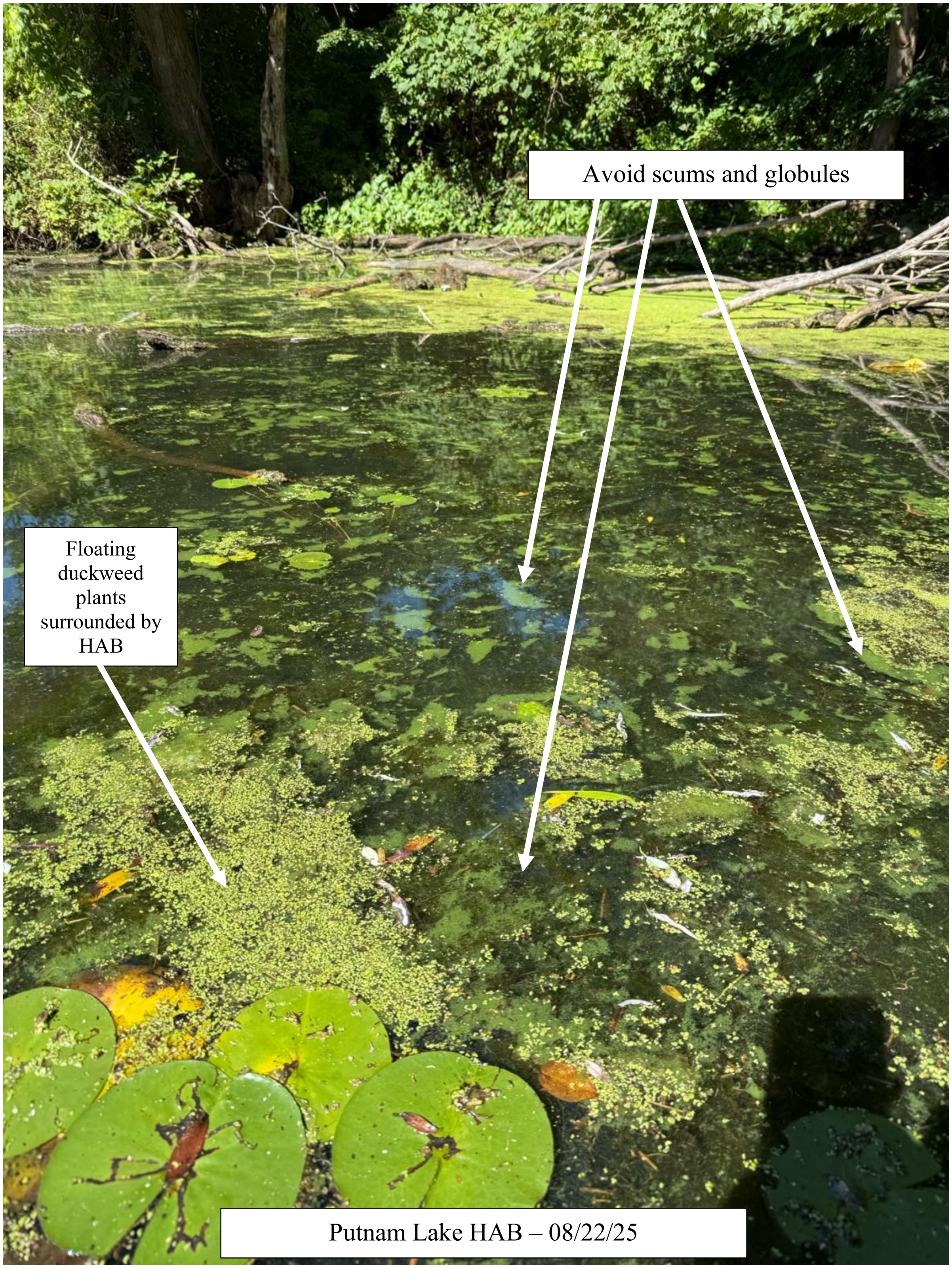
Common Arrowhead
Saggitaria latifolia
Native
Emergent. An herbaceous aquatic perennial. Plants grow up to two feet tall. Leaves are shaped like an arrowhead. Flower stem has whorls of short-stalked male flowers on the upper end and longer-stalked female flowers below.
Management notes: A few patches of this plant were found throughout shoreline areas where shallow rooting areas occur.

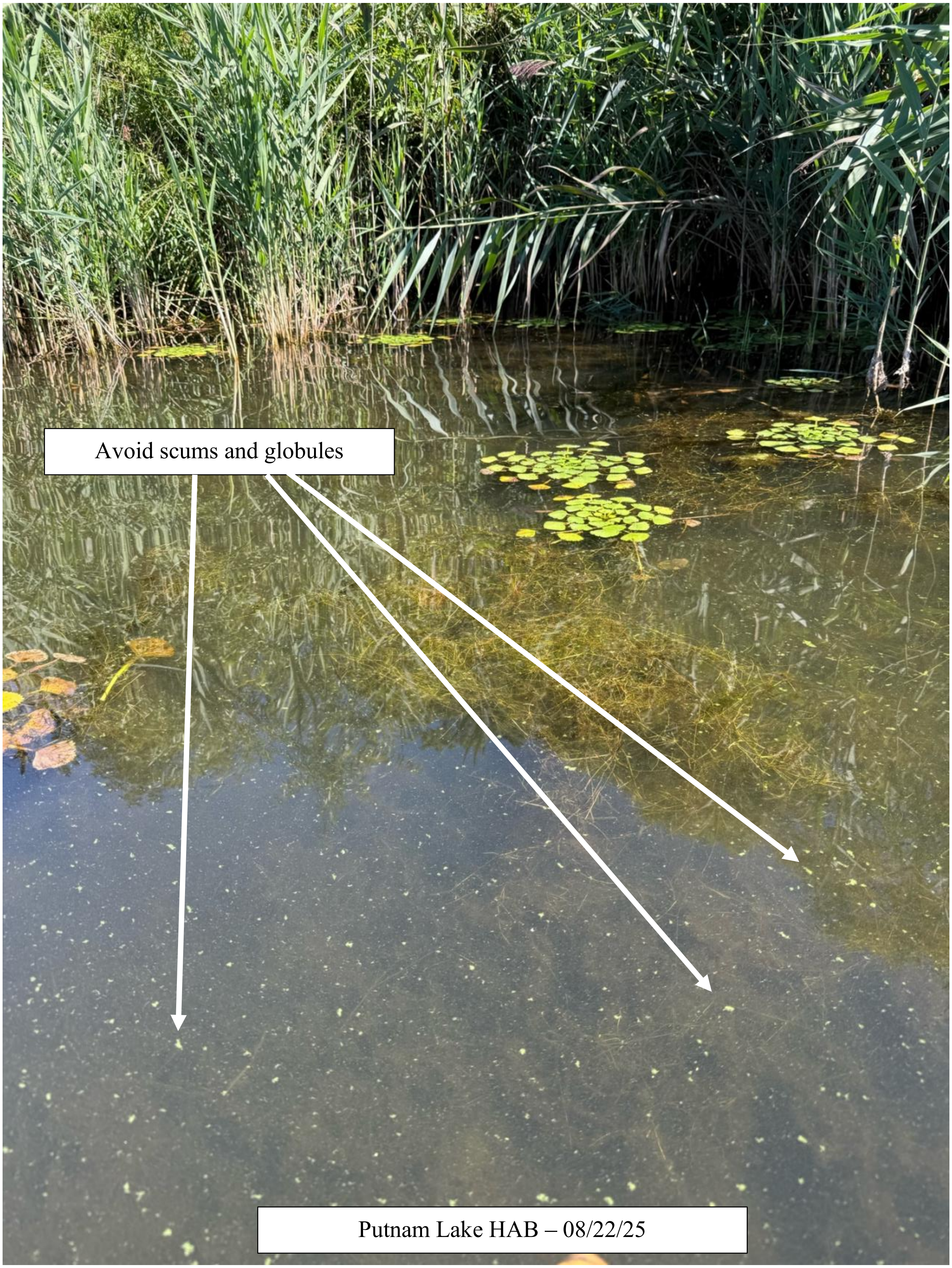
Fragrant water lily
Nymphaea odorata
Native
Floating. Round leaves measuring up to 10 inches across that float on surface of water. Leaves are narrowly and deeply cut, almost to the center where a long thin stem attaches to the roots at substrate. There is one large white flower per leaf with yellow orange stamens. Large rhizomes are buried in the sediment. Large leaves and rhizomes contribute to organic material deposition in slow moving sections of waterbodies, including the mouth of the lake.



Spatterdock
Nuphar variegata
Native
Emergent. Large green leaves may be seen floating, emerging from the water on stalks, or submerged under water. Leaves are oblong with a deep V-shaped notch where each stem connects. Flowers are bright yellow petals that emerge from the water like a bulb. Rhizomes are large and fleshy, which serve as food for some wildlife but can contribute to deposition of organic material in slow moving areas.

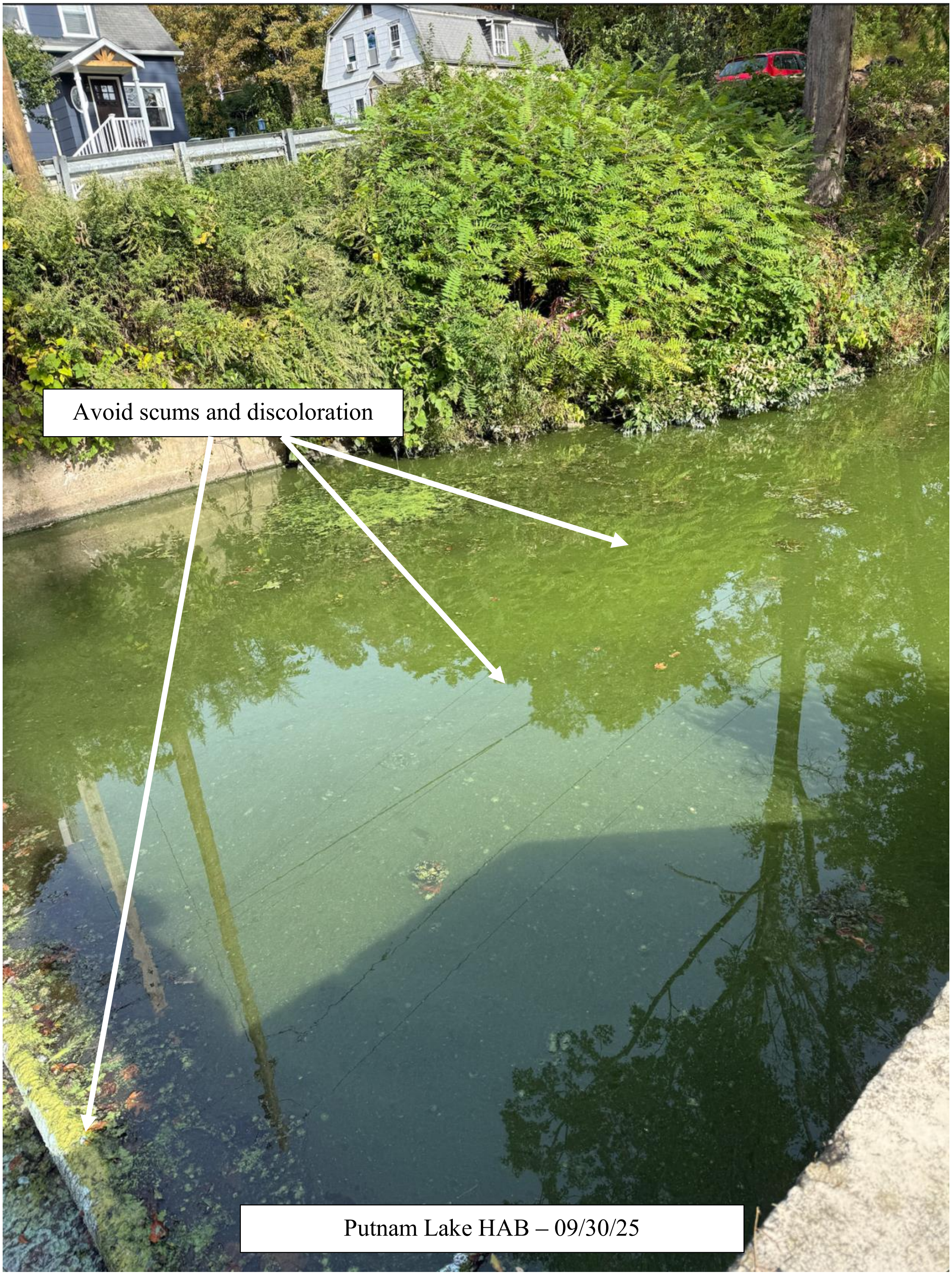
Appendix C: Putnam Lake HAB Photos 2025




Avoid scums and globules
Putnam Lake HAB – 08/22/25


Avoid scums and globules
Putnam Lake HAB – 09/30/25


Avoid discoloration
Putnam Lake HAB – 09/30/25


Avoid scums and discoloration
Putnam Lake HAB – 09/30/25


Avoid scums and discoloration
Avoid phycocyanin pigments as toxins could be present
Putnam Lake HAB – 09/30/25

Appendix D: Lake-wide Best Management Practices (BMPs)

Lake-Wide Best Management Practices
Putnam Lake should reduce future sources of nutrient loading that may contribute to nuisance weed and algae growth. Strategies for reduction of external loading include: • Utilization of nutrient inactivants (once available in NYS) • Prevent clippings from mowing/weed whacking and debris from entering the lake. • Prevent resident geese populations. • Installation of a 1-3' vegetated riparian buffer along the grass shoreline to prevent debris from entering the lake and to absorb nutrient runoff. • Avoid use of fertilizer within the watershed. • Prevent fall foliage from accumulating in the Lake, blow any leaves into forested area, not into the Lake. • Clean, drain, and dry watercraft, trailers, and equipment prior to launch into/retrieval from Putnam Lake to prevent the spread of aquatic invasive species.