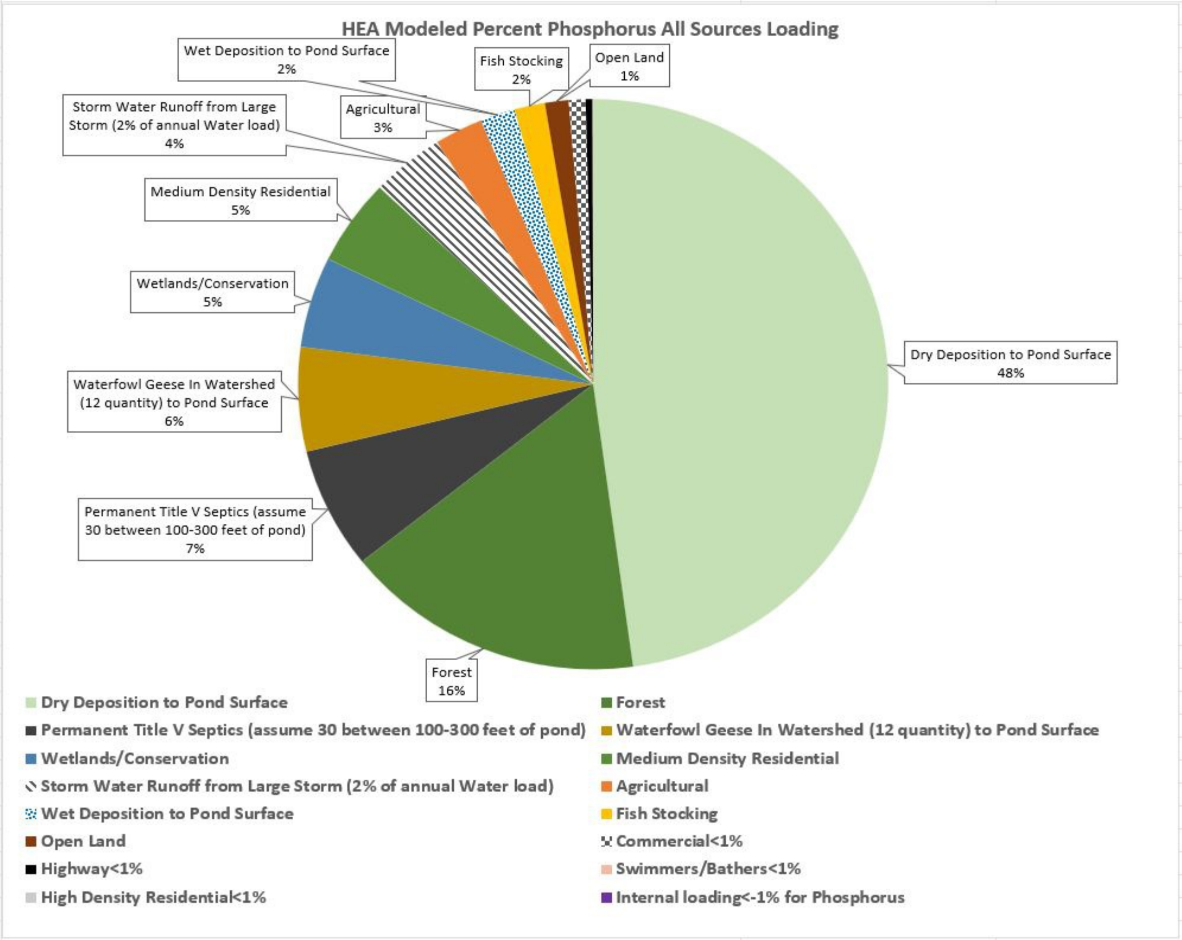
2024
STILES POND NUTRIENT SOURCE EVALUATION



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1 .0 INTRODUCTION

This report serves to summarize Higgins Environmental Associates, Inc. (HEA's) activities, data and findings for a Nutrient Source Evaluation of Stiles Pond in Boxford, Massachusetts. This work was completed by HEA under contract to the Town of Boxford, in accordance with HEA's Proposal No. 10232 dated May 20, 2024 which was approved by the Town on June 18, 2024. HEA's field work was completed from June to December 2024.

Stiles Pond is an approximately 59 acre, 25 foot deep, impounded (flow-regulated) natural pond, a cold water fishery and is utilized by the public (Boxford public beach) and four summer camps for swimming, boating and recreation, **Figure 1 - General Location of Stiles Pond**. All residential, recreational and summer camp uses within the Stiles Pond watershed rely on private/communal drinking water wells and onsite septic systems. Stiles Pond is approximately 1,000 feet wide (north to south) by 4,000 feet long (east to west) and was formerly known as Long Pond (circa 1900). Based upon numerous bedrock outcrops and steeply dipping shorelines, the configuration and depth of Stiles Pond is controlled to a large degree by bedrock topographic relief patterns. Several bedrock outcrops observed by HEA had sizable fractures and as such, the hydrologic characteristics of bedrock may play an important role at Stiles Pond. Some bedrock fractures can intercept other bedrock fractures and nutrient sources outside the more limited, surficial elevation-based topographic watershed area.

The watershed area for Stiles Pond, based on topographic relief, is approximately 370 acres. Overburden soils in the watershed are not mapped as being significant water bearing units (*i.e.*, they appear to be relatively thin deposits over bedrock) and as such, topographic relief patterns should be reasonably consistent with the currently mapped (by earlier studies, and as publicly-available from Federal and State sources) overburden soil-based watershed area. In thicker, more extensive glacial stratified drift or coastal plain deposits, topographic relief and partially-penetrating streams or rivers alone may underestimate surface elevation based watershed areas.

The outlet from Stiles Pond has been called both Fish Brook and an un-named tributary to Fish Brook which flows into the Ipswich River to the south. **Figure 1** includes Massachusetts Department of Environmental Protection (MassDEP) information on sensitive environmental receptors and regulated areas at and proximate to Stiles Pond. A public boat launch is located on the western side of the pond and use by motor-powered boats is limited to 10 horsepower. The Town of Boxford has a public beach and swimming area on the western side of the pond and there are four seasonal use (day and night) camps along the northern and eastern shores. There are approximately 30 residences within 300 feet of the northern and southern shorelines. Visually, the pond is reasonably clear with a majority of the pond surface being open water (approximately 90 percent of pond surface) with emergent-floating plants (mostly pond lily) near shorelines. Submergent plants (flat-leaf pondweed) extend around the entire pond border except at active swimming areas from a depth of approximately one to fourteen feet below the water surface.

1.1 Year 2024 Field Conditions

Year 2024 was characterized by heavy rains in late winter and early spring (up to May) followed by drought conditions (late June to early December) with very little rain. Pond surface water elevations started out high and gradually decreased throughout the year with slight but brief increases following rain events. An approximately 10 inch drop in surface water elevation occurred between the end of August and early September when debris were removed by the Town from the outlet structure. Outlet flows to Fish Brook are regulated by the Town using a stop log at the outlet structure but predominant flow control was managed by beavers which effectively removed sustained (more than a few days) of outlet flow from the pond. There are several beaver lodges on the pond that were not noted in previous studies, **Section 2.0**. Extensive beds of flat-leaf pond weed were noted around the perimeter of the 60 acre pond occurring at depths between one to approximately fourteen feet below the water surface. Water clarity dropped by approximately 50 percent (11 to 5.8 feet) at the end of tree pollen season (by July) but then improved (to 9.75 by September 11 and 14.3 feet on October 9) as the season progressed.

There were no surface blooms of cyanobacteria, scums, or foul (septic or rotten) odors as noted in prior years by HEA and others. Stiles Pond is a cold water fishery and was stocked twice in 2024. All pond users interviewed by HEA including swimmers, boaters and fisherpeople reported good water quality this year other than the early season drop in water clarity (confirmed by HEA as tree pollen).

1.2 Objectives of 2024 Nutrient Source Evaluation

In accordance with HEA's approved scope of work, objectives and tasks consisted of the following:

1) Review and evaluation of existing documented conditions for Stiles Pond;
2) Field and surface water quality assessments to support sampling and laboratory analysis;
3) Surface water sampling and laboratory analysis;
4) Sediment sampling and laboratory analysis;
5) Shallow ground water, storm water, and wet/dry deposition sampling and laboratory analysis;
6) Nutrient source ranking; and,
7) Correspondence and documentation of findings, including comparison of findings to historical study results, and recommendations for controlling ongoing nutrient sources to the pond.

1.3 Summary of Stiles Pond (from Boxford's Document Center)

The following information about Stiles Pond, it's general history and uses is taken directly from an article on

Stiles Pond in Boxford's Document Center (https://www.boxfordma.gov/DocumentCenter). Based on HEA's review of other documents on Stiles Pond, the following description is reasonably accurate and a good summary for the reader that may not be familiar with the pond and its recreational and past industrial (as water-power reservoir) use. Where information is contrary or short on information from others sources, HEA has added an additional statement in parenthesis and colored in blue. Stiles Pond is a seasonal cold water fishery with a high recreational value to Boxford residents and out-of-town users (visitors/boaters/sportspeople), and to youth summer campers from northshore communities (primarily). There is a publicly-accessible boat ramp and parking area off Stiles Pond Road for small car-top and trailered boats with a 10 horsepower outboard limit.

Town of Boxford Description of Stiles Pond:

Stiles Pond is a 60-acre natural great pond located three miles west of Boxford center. Maximum depth of the Pond is 26 feet located at its midpoint, with an average depth of 14 feet (16 feet). Public access, including a boat ramp, can be found at the southwestern end of the Pond just off of Main Street. State Fish & Wildlife stock the Pond with rainbow and occasionally brown trout each spring (and fall in 2024). While the Pond is not deep or cold enough to enable trout to hold over year-to-year, it becomes a prime target for trout fishermen starting each May through the spring and early summer (and fall). Trolling jointed Rapallas or streamers from a boat is a preferred method of catching trout here. For the fly-fisherman the most productive patterns seem to be an Adams or Griffith's Gnat #12-16 fished near the shoreline. Other warm water fish species can be found including largemouth bass, black crappie, bullhead, pickerel, bluegill, golden shiners and an overabundance of pumpkinseeds.

Stiles Pond wasn't always a 60-acre pond. Prior to 1878, this area was the upper reach of Fish Brook with a considerably smaller ponded area (referred to as Long Pond going back circa 1650s). In 1878 the Diamond Match Company built a dam at what is now the Pond outlet at Stiles Pond Road. The Company had an existing water wheel at its mill on Lawrence Road but found that in July and August of each year the water level in Fish Brook became too low to turn the wheel. The solution was to create water storage that could be released in a controlled manner. The Company paid for land damage to abutters when the water rose over their original property lines. The dam was repaired and rebuilt on three subsequent occasions, the last occurring in 1994 (additional maintenance was performed in 2015). In a significant departure from prior designs, the 1994 construction excluded a low water release function, which had been served by an outlet pipe embedded some eight feet beneath the top of the dam. That pipe was deemed unnecessary by the design engineer as a safeguard against high water conditions. The engineer, however, did not consider the ecological impact to eliminating a low water release function at the dam, which some believe has contributed to poor or no water conditions in the upper reaches of Fish Brook in July, August and September. Detractors also suggest that this design error contributed to Fish Brook being delisted as a "cold water fishery" by the state of Massachusetts and the sharp decline of cold water species, such as brook trout, in Fish Brook.

Keith Koster Park located just off of Main Street on the southwestern shore of Stiles Pond, is a popular summer recreational facility for Boxford residents and their guests. Re-named in 2006 after a long time Boxford resident and former lifeguard, this Park features sandy beaches, docks, floats and free use of watercraft as well as a summer concession stand that offers hamburgers, hot dogs, pizza and soft drinks during prime time hours. Lifeguards are on duty during the summer months and swimming lessons are offered by certified Red Cross instructors. Picnic tables are also readily available together with a children's playground. Adjacent to the beach area is a finely manicured and frequently used Little League field. As many as 400 Boxford residents pay for annual memberships to the Park.

Stiles Pond has a long history of youth recreational camps (there are four summer camps with direct frontage on and use of Stiles Pond for swimming and boating). Camp Rotary, located at 372 Ipswich Road in Boxford, has been in operation since 1921. It continues to offer a co-ed overnight camp experience for children ages 7-15 including swimming, fishing and other sports and crafts activities. Located at 4A Stiles Pond Road, the Stiles Pond Day Camp sponsored by the Danvers YMCA has been in operation for 66 years. This camp provides transportation from Danvers, Boxford, Topsfield and Middleton for day campers aged 6 to 14. Recreational activities include boating, fishing, multiple sports, nature, and arts and crafts. New buildings, two new basketball courts, new parking lots and trails were added for the 2015 season. Camp Steppingstone, also called Camp Sacagawea, occupies a 35 acre property at 1 Stiles Pond Road, which is owned by the Town of Boxford and leased to the Greater Lawrence Cooperative. Steppingstone has a six week educational day program for students aged 5-22 who have moderate to intensive developmental delays or multiple disabilities. Finally, Camp Wakenda at 99 Chandler Road is a Greater Boston YMCA sponsored co-ed day camp for children ages 5-17. A multitude of programs are available at Wakenda including relationship building, a sports camp, a Teen Adventure camp, leadership and employment skills as well as a CIT program for ages 16-17.

2.0 SUMMARY OF PRIOR STUDIES

2.1 Seven Pond Study by KV Associates, Inc.

Between 1994 and 1995, KV Associates, Inc. (KV) of Falmouth, Massachusetts completed a Water Quality Management Study of Seven Ponds (the "Seven Pond Study") for the Town of Boxford. The seven ponds included Baldpate, Hoveys, Howes, Lowe, Sperrys, Spofford and Stiles. Assessment of each pond included:

1) Collection and review of existing background data for in-pond and watershed conditions;
2) Completion of a diagnostic feasibility survey including field sampling and laboratory analysis; an assessment of septic systems in the watershed; hydrologic modeling, sediment and stormwater evaluations;
3) Assess existing conditions consistent with MassDEP guidelines, including an evaluation of improvements to address identified problems;
4) An evaluation of potential development impacts from a future build out scenario; and,
5) To develop a watershed management plan for each pond including a model watershed protection law with planning guidelines for future development around each pond.

The KV report included reference to data from MassDEP (then Massachusetts Department of Environmental Quality (DEQE) in 1978 (Ipswich River Basin report) that included field assessment and laboratory analysis for samples from Stiles Pond. HEA was not able to locate an original copy of this 1978 DEQE report and we contacted MassDEP specifically in this regard, including inquiring as to whether the report was a different date than 1978, notably 1968. MassDEP could not locate a report during this timeframe (1968-1978) by the name or study area. HEA has also not seen reference to this 1978 DEQE report in other technical report references we have reviewed as part of this scope of services to Boxford. Having said that, HEA believes like many water body studies in the area, that there likely was a 1970s report by DEQE that included Stiles Pond and provided data as referenced by KV Associates. HEA is relying on the KV report for their assessment, inclusion and reference to data prior to their study (1994-1995).

For comparative purposes, HEA has resampled prior surface water quality sampling stations and laboratory analysis completed by KV as documented in the Seven Ponds Study. HEA has to the best of our knowledge, also retested the approximate location of ground water sampling completed by KV although actual sampling locations by KV were not documented (*i.e.*, mapped) in the Seven Ponds Study. HEA also included additional sampling and laboratory analysis for media (storm water, wet and dry deposition) not sampled by KV Associates.

The Seven Ponds Study also included an assessment of nutrient loading from land uses within the watershed (a "contributing-area method) combined in part with a water balance approach that included changes in water (inflow, outflow and storage) and nutrient mass for each pond and watershed area. KV's assessment of export load from land areas to the pond were by either storm water runoff (overland flow) or by ground water discharging to the pond. The contributing area water balance method is suitable when a water body has inlet and outlet (surface water drainage) flows. An assumption by some of the contributing-area approach is that no upgradient ground water flows beneath or by-passes the water body because deep areas of the water body extend to a relatively impermeable surface (*i.e.*, clay-rich deposits such as some types of glacial till and/or bedrock surface). If not for the impounded, flow-controlled status of Stiles Pond and apparent bedrock controls, this assumption would be reasonably valid for Stiles Pond. The water balance method can provide a general estimate of water and nutrient flows to a pond or importantly, just through the watershed area without the use of more detailed assessments for various reasons (*i.e.*, timing of study, lack or suitability of local published information, financial limitations on field assessments, etc.).

As pertinent and informative, earlier data from the Seven Ponds Study are included as part of this 2024 study by HEA. Findings of KV's 1995 Seven Ponds Study for Stiles Pond and its' watershed will be discussed further in **Section 5.0 - Evaluation of Nutrient Sources and Comparison to Historical Information**.

2.2 Three Ponds Study by Horsley & Witten, Inc.

In 1996, Horsley & Witten, Inc. (H&W) of Barnstable, Massachusetts completed a Nutrient Modeling Report for three ponds (Baldpate, Hoveys and Stiles) in Boxford (the "Three Pond Study"). The stated intent of this modeling was to evaluate potential nutrient loading from land-based sources (*i.e.*, a "contributing-area" approach) in each of these pond watersheds so that impacts to water quality could be assessed on the basis of changes (future build out scenarios) in watershed land uses. This type of modeling approach is commonly referred to as a "contributing area" model whereby various land uses contribute water with nutrients to a drainage-based water body {*i.e.*, that has an active storm water or ground water discharges to a water body and outlet stream discharge flow ("Q")}. Although not stated in H&W's 1996 report, HEA assumes that these three ponds were selected for additional evaluation by the Town of Boxford following KV's 1995 Seven Pond Study. H&W's stated effort generally followed a seven step process as follows:

1) Delineate watershed boundaries about each pond;
2) Inventory land uses within each watershed;
3) Develop nitrogen and phosphorus loading models for each watershed;
4) Evaluate pond water quality under existing land use conditions;
5) Conduct watershed buildout analysis for each watershed;
6) Evaluate pond water quality under different buildout land use conditions; and,
7) Recommend management strategies for reducing nutrient loading.

For Stiles Pond, H&W utilized prior sampling and laboratory analysis as reported in KV's Seven Pond Study as the primary basis for development of a "contributing area" land-based analytical model of existing nutrient loading conditions (*i.e.*, watershed land uses and pond water quality). H&W's "existing" conditions model appears to have been calibrated so that modeled pond water quality data (for the nutrient phosphorus) were adjusted to obtain the average phosphorus surface water concentration determined by sampling and laboratory analysis in KV's 1994-1995 study of Stiles Pond (*i.e.*, H&W's calibrated model value of 0.030 milligrams per Liter (mg/L) for phosphorus compared to KV's pond water sample average of 0.03 mg/L). Calibration criteria included the use of attenuation factors (i.e., how much nutrients are retained essentially by plants and soils in the watershed without reaching the pond). H&W then completed two watershed area future build out scenarios for Boxford' two-acre minimum zoning allowed lot size and one for three-acre lot size build out. Accordingly, "contributing-area" land uses and related nutrient source contributions were then changed to reflect either 2 or 3 acre build out scenarios to evaluate the corresponding modeled potential change in nutrient export impact to pond water quality. H&W's model nutrient export from land areas to the pond were by both storm water runoff and ground water discharge (to the pond).

As pertinent and informative, HEA has included earlier information and model findings from the Three Ponds Study for Stiles Pond as part of this 2024 study by HEA. Importantly, as part of our service to the Town of Boxford, HEA has completed an updated existing conditions "contributing-area" MassDEP Watershed-based Plan for Stiles Pond and its watershed as discussed further in **Section 4.0 - MassDEP Watershed-based Plan** (WBP) . MassDEP's WBP supporting resources include detailed land use information in years 2015-2016 from various sources including from relational databases maintained by the Massachusetts Bureau of Geographical Information (MassGIS). HEA has then amended the MassDEP WBP with additional nutrient source loading information from KV, H&W and others regarding septic systems, dry and wet deposition, swimmers, waterfowl and an unquantified but apparently likely additional source, bedrock fracture flow into Stiles Pond.

A completed "draft" MassDEP WBP for Stiles Pond is attached.

Findings of H&W's 1996 Three Pond that included Stiles Pond and its' watershed will be discussed further in **Section 5.0 - Evaluation of Nutrient Sources and Comparison to Historical Information**.

2.3 Federal and State of Stiles Pond and the Ipswich River Drainage Basin

HEA has identified and reviewed publicly-available technical reports prepared by or for the MassDEP, MassGIS, the United States Geologic Survey (USGS) and others within the Ipswich River Drainage Basin which includes Stiles Pond. HEA has also reviewed pertinent supporting references provided in both the KV and H&W reports. Unfortunately, the "1978 Ipswich River Basin report" often referred to by KV Associates and noted as being prepared by MassDEP (then Department of Environmental Quality and Engineering) could not be located by HEA or by staff at MassDEP. MassDEP was helpful and HEA also inquired about whether the 1978 report may have been from a different date such as 1968. No additional information was provided by

MassDEP during the performance of HEA's study but the attached Stiles Pond WBP does include some narrative and information on past records from MassDEP on Stiles Pond, it's watershed, and more information from the larger Ipswich River Basin that includes Stiles Pond. A significant amount of Federal and State supporting information is incorporated within the MassDEP WBP for Stiles Pond as discussed further in **Section 4.0** and **5.0** and within the attached draft WBP for Stiles Pond completed by HEA for Stiles Pond.

Federal and State records focus more on larger, regional watershed areas but often include some localized information that can be referenced for Stiles Pond.

General findings from the larger Ipswich River Basin on Stiles Pond's watershed are as follows:

Stiles Pond and its watershed area is with an upper-drainage area limit of the Ipswich River Basin and is characterized by shallow depths to bedrock and relatively thin layers of glacial till deposits as opposed to thicker, more permeable stratified drift, fluvial and coastal plain deposits within central to lower sections of the Ipswich River Basin. This geologic distinction affects the hydrogeology and geochemistry of stream and ground water quality and flow contribution to and from Stiles Pond. It also changes the influence or magnitude of nutrient contribution to the pond from land uses such as septic systems. Some reports refer to the outlet stream of Stiles Pond as Fish Brook (MA92-14), an Integrated List of Waters Category 5 - impaired water body (benthic macroinvertebrates and dissolved oxygen). Other reports indicate that the outlet stream from Stiles Pond is an unnamed tributary to Fish Brook which originates from another watershed area to the west, northwest of Stiles Pond.

MassDEP's WBP allows for some variance or "comments" in their land use-derived model for this "contributing area" watershed analytical model. MassDEP's WBP process does not in and of itself, account for septic systems or point sources of nutrients such as storm water or commercial/industrial pipe discharges to the pond. The significant improvement provided by MassDEP's WBP is both its ease of use, wealth of built in supporting information, and importantly, a completed and MassDEP-approved WBP is a required component of funding eligibility for water quality improvement and best management practice grants that have Federal (Environmental Protection Agency) funding components.

For the purpose of this Nutrient Source Evaluation for Stiles Pond, HEA relied more on MassDEP's WBP land uses and nutrient loading potential combined with direct pond and watershed-specific information, field monitoring data, sample laboratory results and field observations, as discussed further in **Section 3.0 - Year 2024 Stiles Pond Assessment**.

3.0 YEAR 2024 STILES POND ASSESSMENT

In 2024, field work took place between June 4 to December 12, 2024. Field assessment and sampling locations are depicted on **Figure 2 - Sampling Locations, Stiles Pond** which includes bathymetric map (depth to bottom contours) from Massachusetts Division of Fisheries and Wildlife (MassWildlife) for Stiles Pond. HEA completed an additional field bathymetric survey that was reasonably consistent with MassWildlife's map.

The following subsections discuss updated (2024) information obtained or measured by HEA relative to the hydrologic cycle and interaction/impact of nutrients on Stiles Pond water quality. A comparison and review of year 2024 data with similar information obtained previously by KV in 1994 and H&W in 1996 is provided in **Section 5.0**.

Remaining sections of this report will focus more on in-pond nutrients and water quality field screening (using a multiparameter sonde primarily) and laboratory analysis of:

1) dry and wet precipitation (tree pollen and rain water);
2) littoral (shallow) and profundal (deep center basin) sediment;
3) surface water (replicate of sampling locations and depths completed in 1994); and,
4) phytoplankton.

3.1 General Study Area Information

HEA's assessments began on June 4, 2024 which included a vertical multiparameter sonde survey and measurement of water clarity in the center basin, sediment sampling (center deep basin gravity core sampling and three littoral sampling stations (LNC, LSC and LW Trib), **Figure 2**, a perimeter visual survey by boat around the entire pond, and measurement of the depth to surface water below a measuring point (gaging station) established by HEA at the pond outlet structure. HEA utilized an electric-powered, 10 foot Jon boat with use of oars at times, to complete the majority of field work on Stiles Pond.

HEA continued to complete a minimum of once a month vertical sonde surveys at the deep center basin, water clarity measurements, measurement of surface water elevation at the gaging station, and visual/olfactory observations of pond conditions (presence/absence of algae blooms, scums, aquatic vegetation extent and type, odors, sheens) and interviews of pond users of their experience and knowledge of pond water quality conditions. HEA also completed shallow water perimeter and center vertical transect sonde surveys at times. Sonde snapshots were also collected from discrete surface water locations such as surface water sampling locations, from the inlet and at the outlet structure and from ground water and surface water at ground water sampling stations. HEA's field assessment activities were completed by December 2024.

Based on HEA's knowledge and review of publicly-available information, the percentage and types of land use categories (forested, residential, commercial, roadways, percent impervious, agriculture, recreation, wetlands and open space) within the topographic watershed area for Stiles Pond have not appreciably changed relative to percent land coverage from 1994 to 2024. As discussed in **Section 5.0**, there are additional or improved resolution since 1996 on some types of land uses such as percent impervious area (2.8%) provided as part of MassDEP's WBP information sources. Smaller scale changes such as addition of a storage shed on a residence or importing of sand for a private or public beach area may have occurred since 1996 but given the scope of HEA's work, our focus is on identifying ongoing or new nutrient sources of sufficient scale to impact surface water quality of Stiles Pond and to provide recommendations for controlling, removal or response actions that can be taken to reduce ongoing nutrient source impacts to Stiles Pond.

Precipitation (P) and Weather Conditions

HEA made note of general weather conditions during and a few days prior to each field visit and obtained precipitation and weather information (temperature) from a long-term (1900 to 2024) precipitation/weather station in Haverhill, Massachusetts. Based on HEA's review, field observations were consistent with Haverhill's contemporaneous monitoring records for precipitation and temperature. The following chart illustrates the record of annual precipitation from 1900 to 2024 collected by the Haverhill weather station. HEA also determined the median and mean annual precipitation amounts from 1900 to 2024 excluding years that had incomplete records (*i.e.*, 1948, 1949, 2005 and 2007). 1994 is highlighted in yellow, 2024 in red. Annual precipitation median and mean from 1900 to 2024 (excluding those four years with missing data)

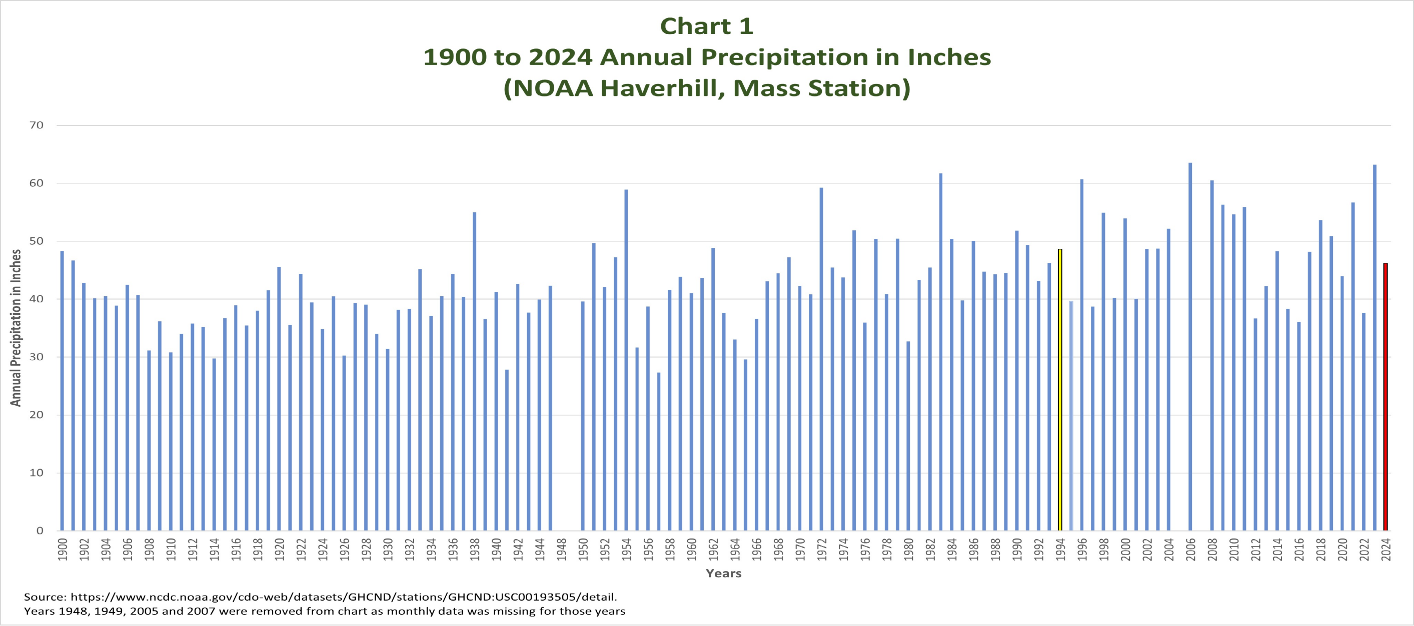


Chart 1
1900 to 2024 Annual Precipitation in Inches
(NOAA Haverhill, Mass Station)

Source: https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USC00193505/detail.
Years 1948, 1949, 2005 and 2007 were removed from chart as monthly data was missing for those years

equaled 42.26 inches/year (1.07meters/year) and 43.17 inches/year (1.09 meters/year), respectively. HEA also focused in on monthly precipitation amounts in year 1994 (KV field assessment year) and 2024 (HEA field assessment year) with comparison of monthly data to the long term monthly median from 1900 through 2024. The following table summarizes annual long term and five-year interval precipitation median and mean values. The five year intervals end on either KV's 1994 field year or HEA's in 2024. Years 2020-2024 had a higher variance (*i.e.*, greater difference between median and mean values) in annual rainfall amounts than either the long term record (1900-2024) or leading up to KV's 1994 field work (1990-1994). The data indicates that annual precipitation amounts are increasing over time (increasing mean) and becoming more variable (difference between median and mean).

Annual Precipitation	Median	Mean
Timeframe	**Inches (meters)**	**Inches (meters)**
1900-2024	42.26 (1.07)	43.17 (1.09
1990-1994	48.63 (1.23)	47.85 (1.21)
2020-2024	46.21 (1.17)	49.53 (1.26)

The total precipitation amount in year 1994 was 48.63 inches, year 2024 was 46.21 inches (approximately 2.4 inches less than in 1994). However, field work in 1994 and 2024 took place primarily between May to September. The following chart displays total month to month precipitation values for years 1994, 2024 and the long term record (monthly medians from 1900 to 2024). Both 1994 and 2024 had higher than long term median monthly amounts of precipitation from January to April-May, less than long term monthly medians in June and July, greater in August, significantly greater in September 1994 than in 2024 or the long term median for September. 2024 had significantly higher precipitation (wet and snow equivalent water) in January and March than 1994 or as compared to the monthly long term (1900 to 2024) median.

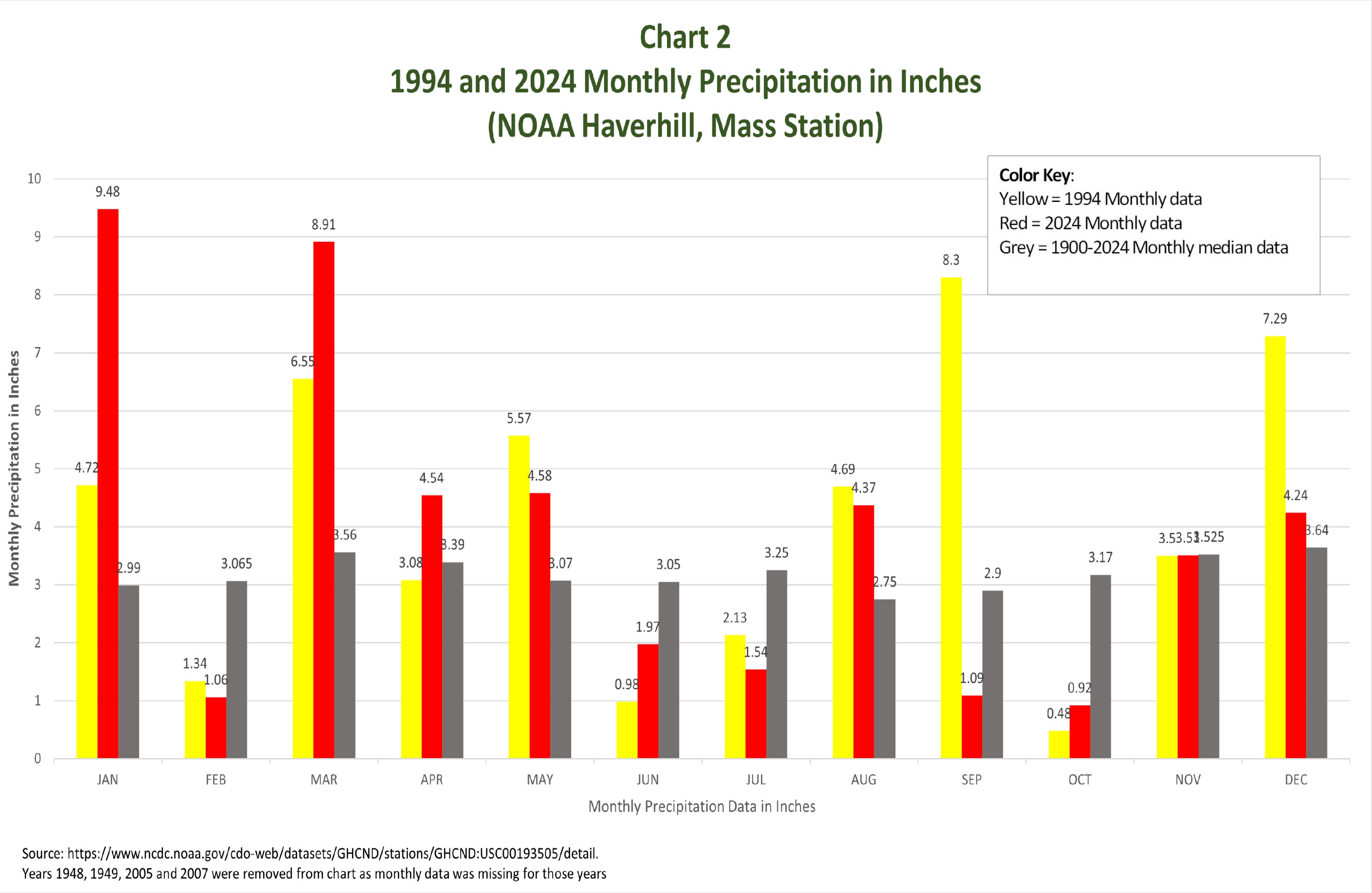


Chart 2

1994 and 2024 Monthly Precipitation in Inches

(NOAA Haverhill, Mass Station)

Source: https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:USC00193505/detail.
Years 1948, 1949, 2005 and 2007 were removed from chart as monthly data was missing for those years

On August 25, 1994, KV's measured an outflow discharge ("Q") rate at the outlet structure of 86.2 cubic feet per minute (cfm) and an inflow rate (at the "inlet") of 35 cfm. In 2024, likely due both to the presence of beavers and debris against a stop log regulating water flow at the outlet structure, there were no sustained outlet discharge flows. HEA also did not observe any inlet water flows (*i.e.*, no visually apparent water, submerged plant or floating matter movement). On one of HEA's field visits (September 11th), after the Town removed beaver dam material (mud, vegetation, sticks, rocks, and similar) from the outlet, the surface water elevation dropped by approximately 10 inches and discharging water rates were consistent with that measured by KV but water flows were not sustained as the outlet was blocked again by beaver activity debris against the stop log. The stop log and beaver damming activities would likely result in maintaining higher surface water elevations and apparently, in part, minimized ground water discharge (baseflow) into the pond in 2024 compared to 1994. KV noted the presences of a 12-inch stop log but did not observe or note the presence of debris against the stop log at the outlet structure.

HEA's monthly surface water elevations taken at the opening of the outlet structure are summarized in the following table {with elevation higher (+) or lower (-) relative to the opening of the outlet structure}. KV's 1994 estimated outflow (discharge rate) occurred when a measured two-inch depth of water (at the downstream outlet opening) was flowing around the sides of the 12-inch stop log. All measured units in the following table are in inches. Based on a review of water elevations versus antecedent (5-day precipitation) there is some correlation but variance in trend may be related to debris removal activities at the outlet structure, temperature, evapotranspiration, leakage at the outlet and surface-ground water interactions.

Date	Gage Water Height	Preceding Precip. 0-3 days	Preceding Precip. 3- 5 days
4-Jun	15	0	1.24
26-Jun	15.5	0.55	0.71
3-Jul	14	0.27	0
17-Jul	12	0.4	0.1
30-Jul	10	0.11	0
21-Aug	10.5	0.8	0.31
11-Sep	0	0.02	0
12-Sep	-1	0	0.02
19-Oct	-2	0.28	0
24-Oct	5	0	0
9-Nov	4	0	0.01
11-Dec	7.5	0.49	0.09
12-Dec	10	2.5	0.04
13-Dec	9.75	2.01	0.04

Temperature, Cloud Cover and Wind

The long term weather station in Haverhill also included records for daily maximum and minimum ambient temperatures in degrees Fahrenheit (F). For comparative purposes, between 1994 (KV field study) and 2024 (HEA field study), maximum (Tmax) and minimum (Tmin) daily temperatures were obtained, reviewed and averaged for the months of May, June, July, August and September in years 1994 and 2024 as follows.

Average Daily Maximum and Minimum Temperatures (deg.F) by Month				
Year	1994		2024	
Month	Tmax	Tmin	Tmax	Tmin
May	70	43.3	68.7	47.7
June	79.6	57.6	80.3	57.5
July	86.4	64.4	86.2	64.2
August	80.4	59.5	79.9	59.5
September	70.3	50.6	74.2	50

The range of temperatures between May to September in 1994 versus 2024 were reasonably consistent. From a hydrologic cycle and nutrient loading estimation perspective, temperature has an affect on evaporation rates from the pond surface. Biologically, temperature is also an indicator of productivity potential. There are other natural/seasonal factors that would affect the hydrologic cycle and water balance of Stiles Pond relative to it's watershed such as shading (cloud cover), wind speed and persistence, and humidity that also affect evaporation of pond water and on land, evapotranspiration rates.

Based on monthly field visits by HEA, May to September 2024 were frequently sunny with few overcast rain events from late June to September. Winds were commonly from the northwest and at times southwesterly from 5 to 10 miles per hour (consistent with records from an NRCC weather station at the Lawrence, Massachusetts airport). Boxford and Stiles Pond specific daily observations of precipitation, temperature and wind speed-direction would be helpful for future assessments of pond conditions as this relates to evaporation rates and areal contribution (*i.e.*, airshed) of dry deposition (tree pollen and forest particulates mostly) given land uses surrounding Stiles Pond.

Evaporation

Evaporation represents the amount of water lost from the surface of water bodies which for Stiles Pond is 59 acres of open water (MassDEP MassGIS 2015 WBP)). Rates of evaporation vary seasonally with changes in temperature (water and air), wind speed, and humidity, but like precipitation can be annualized as part of a hydrologic cycle budget. An average annual evaporation rate of 28 inches (0.71 m) from the surface of Stiles Pond was estimated using regional-scale rates from Farnsworth and others (1982), which were based on pan evaporation and pan coefficient measurements.

Evapotranspiration

Precipitation falling on land areas of the watershed (310.4 acres; MassDEP 2015 WBP) that is not recharged to ground water or carried away by overland (storm water) runoff are subject to evapotranspiration which includes both evaporation and transpiration from plants, soil and land cover. Like evaporation directly from water body surfaces, rates of evapotranspiration vary monthly with climate variables (temperature, wind, humidity) but also account for uptake and release from various forms of land cover (forest, grassland, impervious surfaces).

Evapotranspiration rates for this area of New England have been calculated by others at approximately 21 inches per year (Randal, 1996) and 23.35 inches per year (reference: Northeast Regional Climate Center (NRCC) at https://www.nrcc.cornell.edu/wxstation/pet/pet.html). HEA utilized NRCC's more recent data averaged between 1991 to 2020 on potential evapotranspiration (PET) of 23.35 inches per year. Evapotranspiration rates can also vary from one adjacent watershed to another based on factors such as soil types, grade, land cover (forest versus grass, etc.), percent impervious area, depth to bedrock and similar.

Given the predominance of mature forest cover (mixed hard (oak) and soft (pine) approximately 67 percent (MassDEP WBP MassGIS) of the Stiles Pond watershed area, evapotranspiration rates would be greater than estimated for grass-covered surfaces (5.3 percent of watershed). Tree cover has greater surface area for evaporation of falling precipitation and often deeper root net works for uptake of soil-ground water for evapotranspiration. A higher evapotranspiration rate associated with forest cover would also reduce the amount of water available for ground water recharge and baseflow (discharge) contribution to surface water (Stiles Pond and Fish Brook).

Overland Runoff, Stream and Storm Water Flows

KV associates did not report evidence of overland flow (runoff) or storm water flows (non-point or as point discharges) entering Stiles Pond. Similarly, HEA did not observe non-point or point discharges of overland runoff or storm water entering the pond. There were no observed, reported or permitted storm water discharge pipes or evidence of bank erosion or overland flow of storm water.

On September 23, 2024, HEA did obtain one storm water sample (first flush) for laboratory analysis from an ephemeral stream area on the northern side of Stiles Pond. This subdrainage area was primarily forest cover (Bayns Hill area) with one single-family residence driveway crossing. Even this storm water/ephemeral stream flow event in 2024 did not flow into Stiles Pond directly but may to some degree in larger storm events not observed by HEA. There are other similar ephemeral stream and wetland drainage areas leading to Stiles Pond, notably one at the Inlet (**Figure 2**) that were not observed to be flowing by KV (1994) or HEA (2024) though KV did obtain a measurement of inlet water flow (35 cfm) interpreted to represent contribution of ground water baseflow into Stiles Pond at that time.

Ground Water Recharge, Baseflow and Surface-Ground Water Interactions

Recharge to ground water in the watershed area can be measured directly or in the absence of sufficient data, estimated based on either water balance methods or on mean annual stream-runoff from comparable watersheds. Annual stream runoff (for a fully-aquifer-penetrating water body or stream), equivalent to precipitation minus evapotranspiration over the contributing watershed area, provides an estimate of maximum water available for recharge to ground water. Because Stiles Pond and it's watershed had no sustained/appreciable stream runoff in 2024 (*i.e*, no sustained discharge from the outlet), all water available (*i.e*., precipitation minus evapotranspiration from land areas) to recharge the ground water should infiltrate the permeable surficial deposits to recharge ground water. Similarly, precipitation falling directly on Stiles Pond minus evaporation, in the absence of outlet (discharge) flows, should infiltrate underlying and surrounding permeable deposits depending upon relative surface-ground water elevation differences throughout each year.

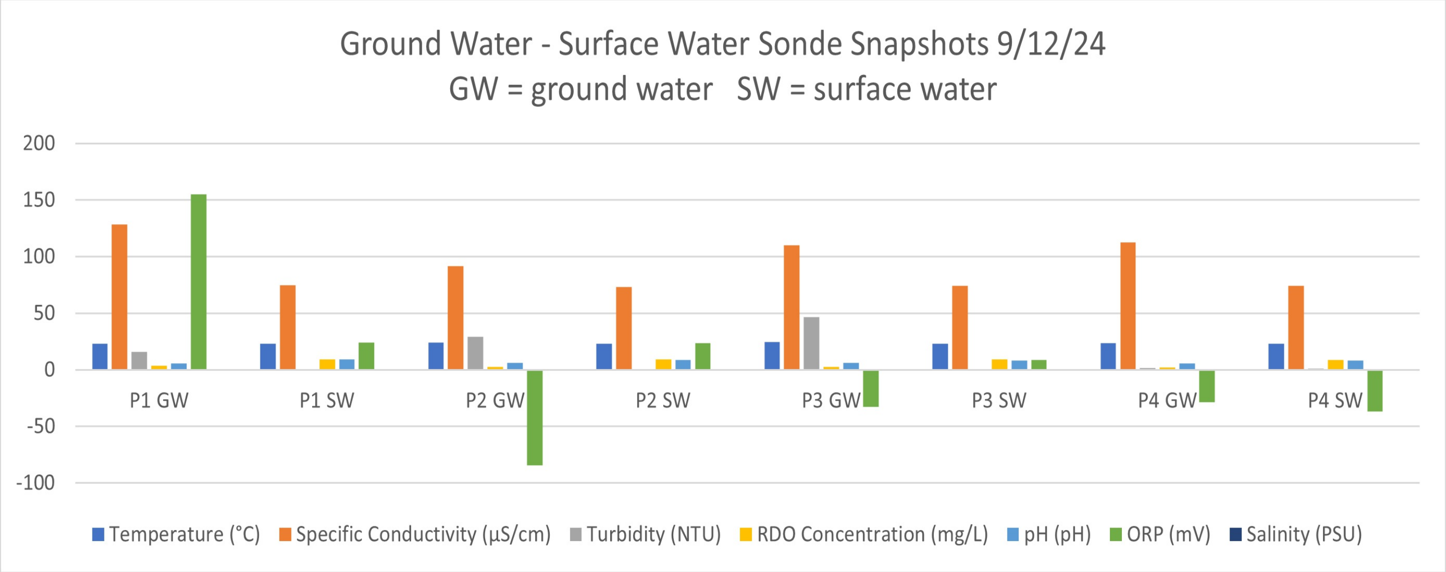
2024 Field Measurements and Observations

During ground water sampling by HEA on September 12, 2024, a measure of ground water to surface water elevation at each sampling location (P1-P4, **Figure 2**) was obtained using a manometer to measure the relative hydrostatic pressure difference between the ground water sampling point interval relative to the surface water elevation at the same sampling location. All ground water sampling points were advanced approximately 2.5 to 3 feet beneath the sediment surface in shallow surface water (about 2 feet deep) at each sampling location. A positive (hydrostatic) pressure difference, referred to as head, indicates that ground water is under pressure relative to surface water and may be contributing water flow by discharging to surface water. A negative head difference would tend to favor surface water infiltration (losing) to ground water. No pressure difference would indicate equilibrium pressure between surface water and ground water. Sample location P1 had a positive head difference of approximately 0.5 to 0.75 inches; P2 had no pressure head difference; P3 and P4 had a positive head difference of approximately 1 inch. There would be some additional lithostatic (overlying soil) pressure added to hydrostatic pressure (overlying water) so some apparent positive lithostatic-head difference between ground water and surface water can be expected; likely less than one inch for these shallow soil/ground water sampling depths. Based on outlet water elevation gage monitoring between August 21 and September 11, surface water elevations dropped by approximately 10 inches after removal of debris from the outlet structure. As such, surface water elevations (pressure head) relative to ground water prior to September 11th were more likely than not, indicative of surface water discharge to ground water (*i.e.*, no ground water discharge to surface water).

Hydrologic Evaluation of Field Observations and Measurements

Based on field measured relative pressure head differences during sampling on September 12, 2024, surface water may be: 1) slightly gaining ground water on the northern side of the pond (at P3 and P4); 2) discharging (losing) or at equilibrium on the south side of the pond (at P1); and, 3) at equilibrium (i.e., neither gaining or losing) at P2. P2 was advanced next to a large bedrock outcrop extending into the pond and the probe itself may have extended into a large, detrital-filled, bedrock fracture given HEA's observation of hard (rock) and soft (soil/detritus) during probe advancement. Under this P2 scenario, there may be little restriction of water flow between surface water and ground water so essentially no hydro- or litho-static pressure head difference would be present. However, based on outlet surface water elevation measurements by HEA, sometime after August 21 and before September 11 (a day prior to ground water sampling), surface water elevations dropped initially by 10.5 inches (Sept. 11) to an 11.5 inch drop (Sept. 12) likely due to removal of debris in the outlet structure and minimal precipitation amounts in September. Surface water elevations continued to decrease in elevation until sometime between October 19 and 24 when they began to increase. A previous table includes HEA's measured outlet surface water elevations (inches above or below the base of the outlet structure channel). As such, the apparent pressure head difference between surface water and ground water during sampling on September 12, may be an artifact of a large of surface water release at the outlet and as such, the pre-September surface water head pressure (elevation) would have been greater than ground water at P1, P3, P4 but at P2, due to an interpreted bedrock fracture at the sample interval, there may still have not been a head difference (i.e., possible unrestricted change in water with little restriction or head difference). Based on surface water elevation data and the minor head differences between ground water and surface water on September 12, weight of evidence would tend to support that prior to September 11, surface water would have been discharging to surrounding and underlying soil and into pond-connected permeable bedrock fractures. There may be pond-connected bedrock fractures that have higher (positive) head pressure differences than surface water, hence be discharging ground water to the pond, but this was not apparent, observed, or measured by HEA. In 1994, KV did report observations (hand contact) of colder water near bedrock fractures.

As an additional water-mass balance type of supporting field measurement, multiparameter sonde snapshots were taken of ground water and surface water at each ground water sampling location (P1-P4, **Figure 2**). The following chart summarizes sonde snapshot readings in relative units for comparison between ground water and surface water at and between each of the locations. Additional information can be obtained from evaluating each sonde parameter result such as dissolved oxygen content, temperature and salinity. A summary table with



sonde parameter readings at each location is provided as follows:

Sample Location and Type	Temperature (°C)	Specific Conductivity (µS/cm)	Turbidity (NTU)	RDO Concentration (mg/L)	pH (pH)	ORP (mV)	Salinity (PSU)
P1 GW	23.24	128.22	15.87	3.40	5.63	155.03	0.06
P1 SW	22.83	74.93	0.40	9.37	8.96	24.08	0.03
P2 GW	24.16	91.51	29.04	2.64	6.00	-84.67	0.04
P2 SW	22.90	73.34	0.34	9.17	8.53	23.46	0.03
P3 GW	24.33	109.96	46.77	2.44	6.38	-32.65	0.05
P3 SW	23.19	74.29	0.43	9.00	8.34	8.81	0.03
P4 GW	23.39	112.47	1.39	2.12	5.75	-28.80	0.05
P4 SW	23.07	74.26	1.08	8.85	8.10	-36.89	0.03

Sonde data for ground water stations are notably different from surface water sonde results at the same location. As such, ground water samples collected for laboratory analysis (discussed later) are more likely representative of ground water quality at these locations than of overlying surface water quality but in 2024 ground water may show more influence of surface water quality than observed or measured (lab samples) by KV in 1994, as discussed previously.

Sonde data for each of the surface water (SW) stations are fairly similar to each other with the exception of oxidation-reduction potential (ORP) at P4 SW. Lower ORP concentrations suggests that ground water contribution-discharge to surface water (gain) may be occurring to some degree which may be related to more permeable sediment at that location (end of an intermittent tributary with some deltaic, silty sand deposits) than other sample locations. This was also a location where HEA observed waterfowl (typically up to 12 ducks) frequently so some additional biological loading (feces) may have reduced ORP at this location in comparison to other SW locations. Other than for ORP, surface water sonde results at this location (P4) were similar to other surface water stations.

The temperature difference between surface water and ground water can also provide an indication of surface water - ground water interaction and ground water contribution, if any. During 2024, pond users interviewed by HEA reported areas of “springs” or cold water around the pond encountered when swimming in the past. No one reported a current (2024) area of cold water “spring” that HEA could then assess. Typically, ground water temperature (approximately 4 feet and deeper below the water table) approximates the mean annual air temperature by region (approximately 52 degrees Fahrenheit or 11 degrees Celsius for Boxford). Sonde data for ground water were approximately 0.5 to 1.3 degrees Celsius warmer than surface water temperatures at the same location and time which tends to support minimal to no ground water discharge rates into the pond at sampling locations and may also indicate that overburden (soil) ground water in the watershed is fairly shallow and influenced more by near surface radiant heating (samples were collected on September 12, 2024). Cooler nights than average summertime, shallow, ground water temperatures may explain why surface water temperatures were cooler than ground water.

HEA also completed a perimeter-continuous sonde survey (one- half foot below the water surface) around the entire pond (within 10 to 20 feet of shore) and found no notable variance in temperature. HEA also completed targeted continuous sonde surveys at areas reported, off shore, that historically had "springs"; off the Town Beach beyond the raft, and on the eastern side of the pond off the Camp Rotary swim area. KV (1994) reported discernable "by hand" cold water areas when completing near shoreline perimeter surveys (septic leachate surveys and similar). Again, HEA found no significant (*i.e.*, greater than one degree Celsius) variance in surface water temperature at a depth of one-half foot around the entire pond including offshore areas reported in the past as cold water spring areas by pond swimmers.

There were also differences between sonde readings at ground water sampling locations (P1 - P4) which may reflect changes in ground water quality around the pond and the potential influence of nutrient sources such as septic effluent (higher specific conductivity, salinity, turbidity). The higher concentration of ORP at P1, higher than even surface water samples may indicate some other type of ground water impact such as from some type of oxidant (a peroxide bleach or similar). Overall, ground water quality around the pond (P1-P4) had lower dissolved oxygen concentrations (noted as RDO on the Preceding table) and pH than overlying surface waters.

Based on relative water-mass balance measurements (manometer and sonde readings), in 2024 there was not a significant gain or loss of ground water evident at ground water sampling locations (P1-P4) or evidenced in the perimeter sonde survey. There may be a more gradual, diffusive flux that is not readily apparent based on sonde and relative surface water-ground water pressure differential readings. In addition, sediments (littoral and profundal) are likely less permeable than saturated ground water soil in the watershed area and may further limit surface water and ground water interaction where measured (P1-P4).

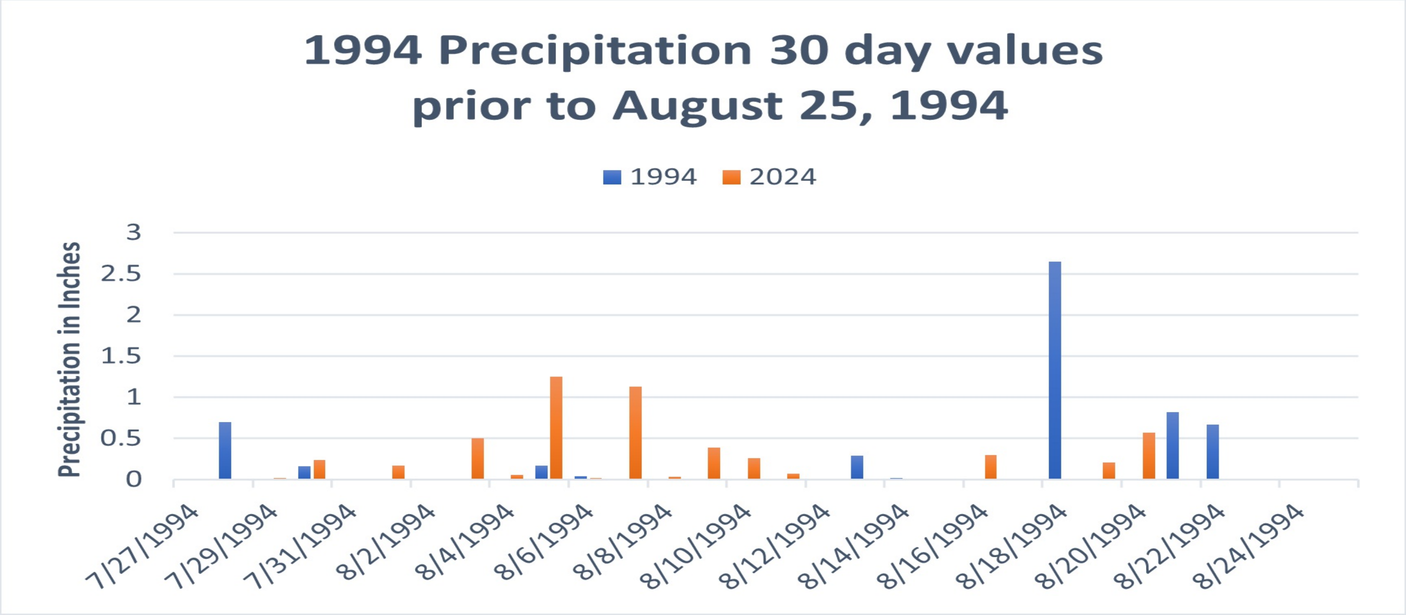
In addition, an extensive (1-14 feet deep interval around the entire pond) occurrence of flat-leaf pondweed {a native species of submerged aquatic plant (macrophyte)} was observed by HEA in 2024. Its occurrence was noted in the 1994 KV study and by KV's reference to a 1978 assessment by MassDEP (then DEQE) which included documentation of aquatic plant types and aerial coverage at Stiles Pond. The widespread coverage of this submerged plant may further limit surface water and ground water interaction and perhaps importantly, to attenuate nutrient impacts from ground water or from within the pond. The highest concentration in solid media sampled to date for the nutrient phosphorus at 2,020 milligrams per kilogram (mg/kg) was obtained by HEA from a 2024 composite sample of flat-leaf pondweed. The second highest concentration of phosphorus was from a sample of tree pollen (1,890 mg/kg) collected by HEA as a composite sample off the pond surface (*i.e.*, dry precipitation - primarily pollen from trees within the pond's airshed). Laboratory results for sampled media are discussed later in this report.

As part of HEA's evaluation and general lack of significant rainfall from May to October, on December 11, 12 and 13 HEA completed additional water balance assessments at the outlet structure, immediately downstream of Stiles Pond Road, and further downstream at Lockwood Lane. On the morning of December 11, measurements began just as a forecasted heavy rain event began. Approximately 2.5 inches of rain were recorded at the Haverhill weather station from the morning of December 11 to early on the 12th. Surface water elevations at the outlet gage rose from 7.5 to 10 inches above the outlet base measuring point by the morning of December 12 and decreased to 9.75 inches on the morning of December 13. There was no water flow out of the outlet structure (beaver dam material was against the stop log; photograph on report cover) but HEA observed increasing then decreasing water flows at the downstream station (just down stream of Stiles Pond Road). Similar increasing then decreasing surface water elevations were observed up stream (in Fish Brook) of Lockwood Lane (increase of 3 inches by Dec. 12 and decrease by an inch on Dec. 13.). The point or conclusion to our December field work was to evaluate changes in surface water elevations (positive and negative) and sonde water quality measurements during a significant rain event. Our findings indicate that precipitation rapidly enters and flows through the watershed soil, beneath the outlet structure, as part of watershed discharge rather than stream discharge. Sonde data also indicated that water entering the downstream section, below Stiles Road, was characteristic of ground water quality (higher salinity).

3.2 Hydrologic Budget and Water Balance Evaluation

In the absence of sustained (more than a few days) and measurable outlet (stream discharge) water flow ("Q") and lack of apparent water-mass balance evidence of measurable surface water - ground water interactions at ground water sampling locations (P1-P4) there are two approximation methods to estimate the hydrologic budget and water balance between the surface water of Stiles Pond and it's ground water recharge watershed area as follows (including: estimates of stream and/or ground water outflow (Q) considering that Stiles Pond is an impoundment with raised surface water elevations related to an earthen dam; and, regulation of water flow by an outlet structure at the base of the contributing watershed area):

1). Use of KV's August 25, 1994 measured surface water flow rates (inflow at inlet and outflow at outlet) as approximating a then naturally-present rate of ground water flow into and out of the pond during a dry period. A dry period is the preferred single point measurement reference for ground water related discharge measurements using stream flow discharge estimates (*i.e.* surface water based, drainage-fed water body systems). It is an estimate though as discharge rates would vary throughout the year. On August 25, 1994, KV noted a surface water height of 12 inches in the beginning of the outlet structure channel due to an in-place stop log. At that time, water was still flowing around the stop log and through the outlet structure (2 inch height at the end of the outlet channel) and then through the still existing, four immediately downstream drainage pipes (each 1 foot diameter) running under Stiles Pond Road. Using a combination of water (two inch depth) flowing through the outlet structure and as measured through the four drainage pipes, KV calculated outlet (Q) water flow from Stiles Pond of **86.2 cubic feet per minute (cfm)** (equal to 2.8 acre-feet/day or 1,260,613 cubic meters per year). KV did not note the presence of debris around the outlet structure stop log, as HEA noted in 2024. On the same day, KV calculated an inlet flow rate (at a narrow point of the "inlet" , **Figure 2**) of 35 cfm or 50,591 cubic meters per year. There is no perennial stream flow entering the pond at the "inlet" or into any other area of the pond. The "inlet" area stream shown on **Figure 2** is a small, intermittent or ephemeral stream which drains a small part of the watershed. Precipitation wise, in 1994, thirty days prior to August 25, 1994 (as recorded at the Haverhill precipitation station) had a total of 5.54 inches versus 5.23 inches for the same days (July 27-August 25) in 2024. The following chart depicts 30-day, daily antecedent precipitation totals in 1994 (blue) and 2024 (orange).



Based on HEA's 2024 surface water elevation measurements at the outlet structure, from June (15 inches) to August 21 (10.5 inches), surface water elevations at the outlet structure were slightly higher to lower than the water elevation noted by KV (12 inches; top of stop log). From September 11 to October 9, 2024 surface water elevations were at or below the outlet structure's intake and may be related to outlet maintenance (*i.e.*, debris and temporary stop log removal at the outlet structure by the town). On December 11, 12 and 13, 2024, HEA completed a three day assessment just prior to, during and after an approximately 2 day rain event of 2.5 inches that started on the morning of December 11. No water flow was noted through the outlet structure (stop log and debris were present) but rising water levels and water flow were noted to increase (up 1.5 inches) then decrease (down 1.5 inches) in a small stream (Fish Brook or tributary to same) immediately down stream of Stiles Pond Road (approximately 80 feet from the outlet structure intake). Overland water flow (storm water runoff) was not observed by HEA though small areas of storm water accumulation (ponding or large puddles) were noted on Stiles Pond Road. During this 3-day period, surface water elevations of Stiles Pond at the entrance to the outlet structure rose by 2.5 inches then dropped by 0.25 inches (final day).

Apparently, surface water is discharging to ground water proximate to the outlet structure and as such, discharge values measured by KV could remain as a viable estimate of assumed "outflow" discharge from the watershed and pond (as ground water in 2024).

There may be more permeable soils in the area of both the outlet and possibly the inlet, as well as bedrock fractures, to allow for increased ground water - surface water interaction, as these areas are along the original surface water watershed drainage pathway through Stiles Pond before the outlet structure and earthen dam were created. The lack of any observable water flow into the pond, at the inlet, in 2024 indicates that surface water elevations in the pond were likely higher, maybe by just a few inches, in 2024 versus 1994. 2024 had significant wet precipitation events early in the year and outlet flows are regulated by debris likely related to beavers (not noted by KV in 1994) in addition to the stop log.

Additional assessment of surface water and ground water elevation relative to weather conditions, precipitation events, contributing bedrock fractures and stream discharge over a full year would assist with providing more definition to and understanding of hydrologic conditions at the pond and how these relate to nutrient loading and sources, including surface water and ground water quality over time.

2) A second water balance method to estimate the mean annual watershed discharge (Q) is based on evaluating changes in overburden ground water storage available to either recharge surface water and ultimately to leave the watershed area, in accordance with the following equation:

$$\Delta S = P + GWi - E - GWo, \qquad (1)$$

According to this method, a water balance is determined by measuring or estimating the inflows and outflows to a pond and the change, if any, in pond-volume storage (ΔS). Water enters the pond from precipitation (P) that falls directly on the pond surface and from ground water upgradient of the pond (ground water inflow a.k.a. recharge, GWi). Water discharges from the pond through evaporation (E) from the pond surface and from pond-water seepage to the aquifer (ground water outflow, GWo). ΔS approximates the overall amount of ground water recharge available to leave the watershed, as ground water discharge (Q); equivalent to stream flow discharge (Q) in the first water balance method discussed earlier. This second method is appropriate for water bodies like Stiles Pond, in year 2024, without surface water inflows or outflows (*i.e.*, ground water-based, seepage-fed water bodies) as surface water outflows are impounded and flow-regulated at Stiles Pond. However, as an impounded water body, ground water inflow (GWi) at Stiles Pond would be limited by higher surface water elevation relative to ground water which appears to be the case in 2024. This second water balance method would also underestimate ground water contribution from bedrock fractures, particularly if bedrock water flows originate outside the watershed area defined by P (*i.e*, amount of precipitation falling in the watershed area).

To estimate potential GWi , HEA utilized published data on stream discharges in the glaciated northeast (New England region) by Randall (1996) who used constructed lines of equal mean annual runoff (*i.e*., stream flow) based on records from stream flow-gaging stations over a 30-year period, 1951–80. This study determined that annual runoff (*i.e*., stream flow and/or ground water discharge) averaged 0.58 meters (depth of water over a watershed) when precipitation averaged 1.12 m. Randall's study determined expected ground water recharge values, available for discharge to streams or drainage-fed ponds, for New England's glaciated watershed areas. Stiles Pond watershed can be characterized as an upper region of a glaciated watershed area with outwash deposits, bedrock outcrops and shallow depths to bedrock being common.

Watershed studies that have compared precipitation and runoff (as stream flow) have found that annual evapotranspiration rates are not greatly affected by variations in annual precipitation (Lyford and Cohen, 1988); therefore, for this Stiles Pond assessment, the amount of precipitation contributing to ground water recharge (*i.e*., without stream discharge) should equal precipitation minus evapotranspiration (including evaporation from the pond water surface) within the watershed. For Stiles Pond, the Randall (1996) annual runoff (stream or ground water) discharge value was increased by 0.14 m to 0.72 m to account for the increased average (mean) annual precipitation during the 2020-2024 period (49.53 inches or 1.26 meters). Assuming that all ground water discharges to the pond before the outlet (essentially that the pond is part of a stream's annual runoff), the ground-water contributing area of Stiles Pond (total watershed minus pond surface area) of 310.4 acres (1,256,144.23 square meters), was multiplied by the recharge value (0.72 meters) resulting in a ground-water inflow value of 904,423.85 cubic meters/year or **60.77 cfm**. KV's calculated discharge of 86.2 cfm was based on an assumed 42 inches of precipitation a year (versus the 1990-1994 five year mean annual from the Haverhill precipitation at 47.85 inches) of which 50 percent was considered lost by KV to evapotranspiration (*i.e*, 21 inches versus the NRCC estimate of 23.5 inches per year for the watershed (310.4 acres) and 28 inches a year from the 59 acre pond surface (total watershed area includes 310.4 acres of land/wetland areas and 59 acres of pond surface = 369.4 acres (MassDEP 2015 MassGIS data).

Based on weight of evidence presented previously and recognizing that the pond area is also contributing water to recharge ground water, by using the entire watershed (including the pond) area of 369.4 acres (MassDEP MassGIS 2015 WBP data) equates to 1,494,908.76 square meters when multiplied by the recharge value (0.72 meters) it would result in a watershed ground water discharge value of 1,076,334.31 cubic meters/year or **72.32 cfm**.

There would be some short term variance in ground water recharge and interpreted surface water (pond or stream) flow contribution because Stiles Pond is an impoundment where natural flows are altered (*i.e*. flow regulated) at times at the outlet structure and use of stop log(s) and debris accumulation and removal. On an annual basis though, this estimate (60.77 to 72.32 cfm) is a reasonable estimate of the range of ground water available for stream discharge given watershed area and precipitation (5 year mean) for this impounded pond.

Watershed-area water discharge via surface water flow through the outlet structure and/or ground water leaving the watershed should remain fairly consistent when accounting for changes in mean annual precipitation from one year to the next, despite flow regulation at the current outlet structure.

As such, it is plausible that the difference between measured outlet flow from Stiles Pond in 1994 by KV of 86.2 cfm versus a ground water discharge estimate in 2024 by HEA between 60.77 to 72.32 cfm may indicate a non-watershed, bedrock contribution of water flow, in 1994 of between 13.88 to 25.43 cfm. There is variance in rainfall, month to month and travel times from the watershed recharge areas to discharge (exit of watershed) from 1994 and 2024 that would affect KV's dry period estimate 0f 86.2 cfm versus annual ground water discharge rate estimates in 2024 of 60.77 to 72.32 cfm. Annually, in 1994 there was 1.68 inches less precipitation than in 2024. From January to August, in 1994 there was 29.06 inches of precipitation and in 2024, 36.45 inches. In either case though (annual or monthly relative to KV's dry period (August 25, 1994 discharge measurement),the 1994 measured discharge rate exceeded watershed discharge rates estimated by HEA in 2024, despite higher precipitation amounts (annually or monthly) in 1994. It seems likely that additional water and nutrients could be entering Stiles Pond than can be accounted for solely by watershed contributing area, land use nutrient loading models, and by in-pond nutrient loading from dry and wet deposition, swimmers and waterfowl.

3.3 Shallow and Vertical Sonde Profiles of Water Quality

From June 4 through October, 2024, HEA collected information on water quality at Stiles Pond using a multiparameter sonde in snapshot (single sample) and profile (continuous sampling) modes from shallow and deep parts of the pond and from ground water at sampling locations (P1-P4), **Figure 2**.

Material, Methods and Equipment Utilized:

Shallow and vertical profile and snapshot (*i.e.*, discrete water samples or locations) testing of water quality at Stiles Pond were completed using an In-Situ AquaTroll 500 sonde fitted with probes for measurement for pH, temperature (ambient and on sonde), dissolved oxygen, blue-green algae phycocyanin (BGA-PC; or just PC), chlorophyll-a (Chl-a), oxidation-reduction potential (ORP), turbidity, depth, barometric pressure, hydrostatic pressure, specific conductivity, salinity, resistivity, density, total dissolved solids, and recording of longitude and latitude for each sonde sampling location. The sonde was attached to a 100 foot cable and for vertical water quality profiles, was lowered by boat from the water surface to the base of the pond.

In 2024, vertical profile sonde surveys were completed on a monthly basis (June to October) at Stiles Pond's center basin, **Figure 2**. On July 3, five vertical sonde profiles were also collected along east-west and north-south transects through center of the pond . On June 26, a shallow water perimeter sonde profile was completed at a depth of one-half foot, approximately 10 to 20 feet off the entire shoreline of pond. Sonde snapshots were obtained during surface water, ground water and sediment sampling as well as just before the outlet structure and in December 2024, from four to five stations in Fish Brook from just downstream of Stiles Pond to Lockwood Lane. At each sonde surveying location (continuous or snapshot), the sonde was initially lowered into the water and allowed to equilibrate with water conditions, notably for temperature just prior to data recording. During vertical sonde surveys, the sonde unit was lowered down at a slow enough rate for sonde parameter readings to stabilize every three feet or so. Sonde measurements in survey mode are collected and recorded every few seconds by the sonde instrument.

After collection, sonde survey data records were then reviewed and processed (*i.e.*, selected results removed) to: 1) correct for instances where the sonde probe likely entered soft sediments at depth; 2) in several instances to remove some very shallow water column readings (top 1 foot) when multiple/duplicate readings at the same depth interval were obtained as the sonde was being set up for a vertical sonde survey; and, 3) when retrieving the sonde probe from the pond bottom before stopping sonde data recordings.

Sonde probes are factory-calibrated, have ongoing sonde-internal machine calibration for BGA-PC and Chl-a, and are field checked by HEA for consistency of readings between field use by using reference and calibration solution (pH, conductivity, ORP) standards including: deionized water blanks and office benchmarks (*e.g.*, covered rain water-filled bucket kept in the shade) to check for field variance of a fixed sample from one survey event to the next. In 2024, following manufacturer's calibration specifications, BGA-PC and Chl-a probes were calibrated and checked daily with reference to deionized water (essentially a zero value for both BGA-PC and Chl-a). Readings from the office bucket of rain water remained essentially unchanged other than for temperature (varied with ambient conditions) throughout 2024 sonde surveys as a reference benchmark. Monthly vertical sonde surveys at Stiles Pond were also completed on the same day by HEA at another pond (White Pond in Concord), as a field reference location to help evaluate sonde readings relative to surface water quality at Stiles Pond.

<u>Sonde PC Data</u>:

Vertical sonde monthly data records taken at the center basin and on July 3, 2024 as north-south and east-west transects through the center basin including from the inlet area are summarized on the following Charts:

Chart 1 - Dissolved Oxygen
Chart 2 - Temperature
Chart 3 - Turbidity

Chart 4 - pH
Chart 5 - Oxidation-Reduction Potential (ORP)
Chart 6 - Cyanobacteria as Phycocyanin (PC); also still referred to by some as Blue-Green Algae (BGA)
Chart 7 - Chlorophyll-a (Chl-a) a measure of overall phytoplankton which includes cyanobacteria
Chart 8 - BGA-PC East-West and North-South transects through the center basin including the inlet
Chart 9 - Chl-a North-South transect through the center basin
Chart 10 - Chl-a East-West transect through the center basin including from the inlet
Chart 11 - Temperature from East-West and North-South transects through the center basin and inlet

To make review of this document easier for the reader and to cut down on narrative for each chart. Each chart is embedded into this report and includes notes and annotations to help the reader understand each chart and presented data.

A sonde perimeter survey was completed around the entire pond on June 26, 2024. A total of 1,624 data readings were obtained. A summary table of median, mean, maximum and minimum numbers and bubble charts of data are provided after **Chart 11** in the following text.

Based on HEA's review of overall year 2024 sonde data (noted in the following charts), water quality data from sonde surveys indicates that Stiles Pond:

1. Has sufficient dissolved oxygen, suitable temperature and water volume to support seasonal cold water fisheries (stocked trout) and year round warm water fisheries;
2. Is not well-mixed laterally or vertically;
3. Had no notable evidence of ground water infiltration;
4. Had an early season and significant air-borne dry deposition of tree pollen, as additionally confirmed by sonde readings for Chl-a (which responds to tree pollen), visually and by microscopic evaluation;
5. Has a vertically-diverse and laterally-consistent patterns of cyanobacteria based on sonde PC readings;

Summary of Sonde Data Findings:

Stiles Pond is characteristic of a mesotrophic water body with internal water-column biodegradation (based on DO, ORP and turbidity data including microscopic analysis) of suspended solids that reach the sediment surface without fully degrading (in the water column). There are other criteria and definitions for lake mixing and trophic status used to describe ponds and lakes but our summary at this point is based on sonde data as noted in the following charts:

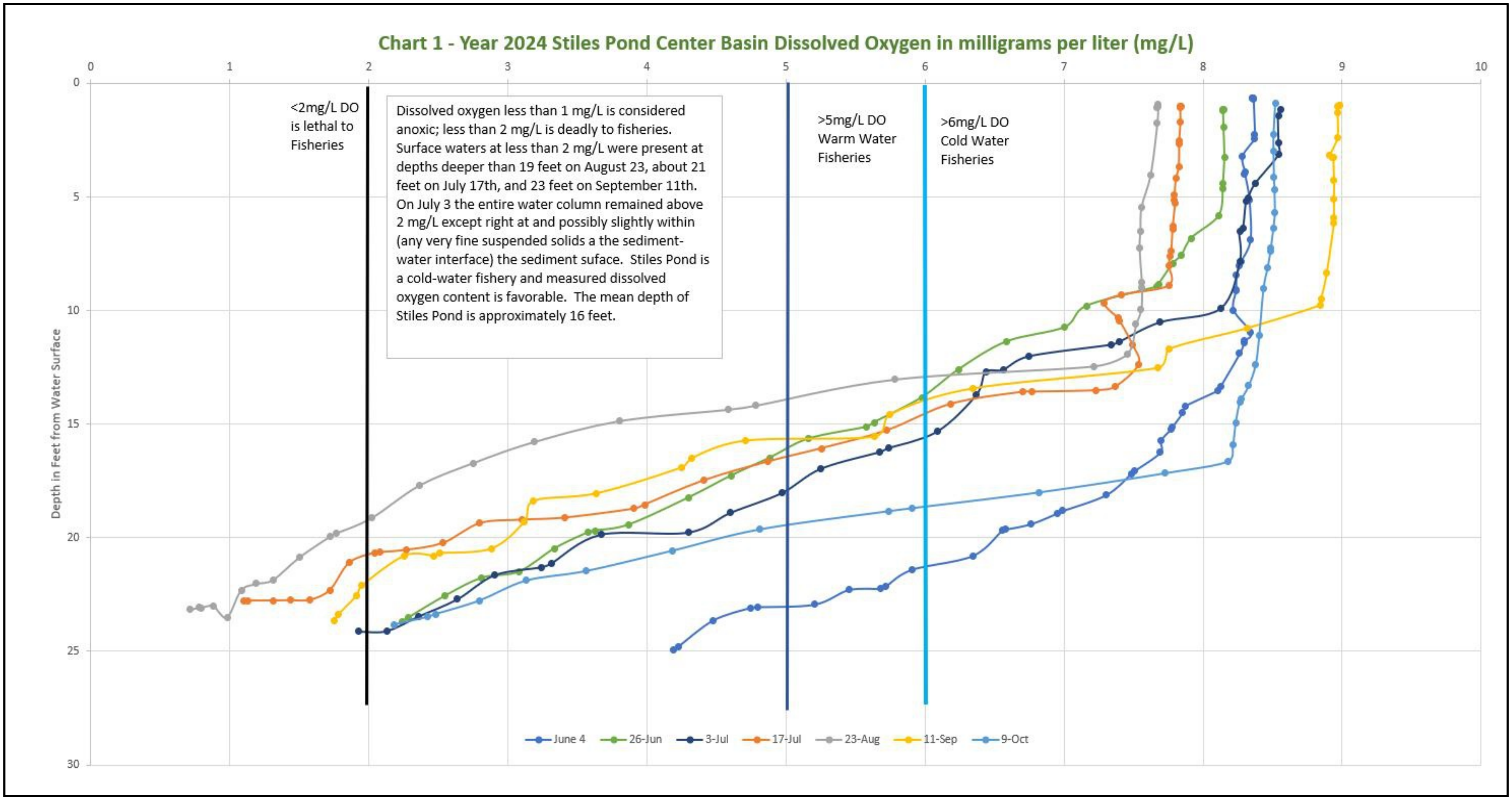


Chart 1 - Year 2024 Stiles Pond Center Basin Dissolved Oxygen in milligrams per liter (mg/L)

<2mg/L DO is lethal to Fisheries

Dissolved oxygen less than 1 mg/L is considered anoxic; less than 2 mg/L is deadly to fisheries. Surface waters at less than 2 mg/L were present at depths deeper than 19 feet on August 23, about 21 feet on July 17th, and 23 feet on September 11th. On July 3 the entire water column remained above 2 mg/L except right at and possibly slightly within (any very fine suspended solids a the sediment-water interface) the sediment suface. Stiles Pond is a cold-water fishery and measured dissolved oxygen content is favorable. The mean depth of Stiles Pond is approximately 16 feet.

>5mg/L DO Warm Water Fisheries

>6mg/L DO Cold Water Fisheries

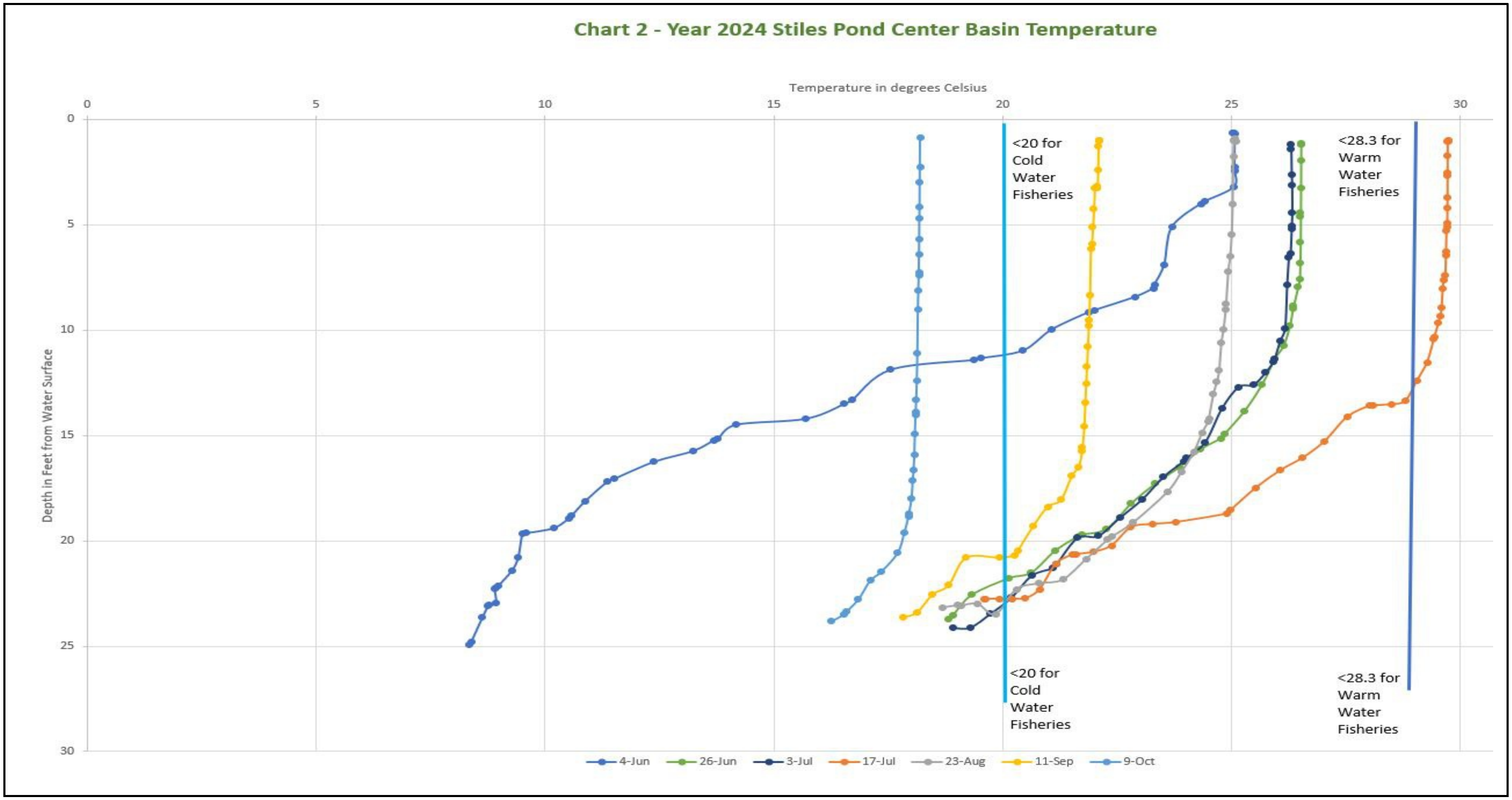


Chart 2 - Year 2024 Stiles Pond Center Basin Temperature

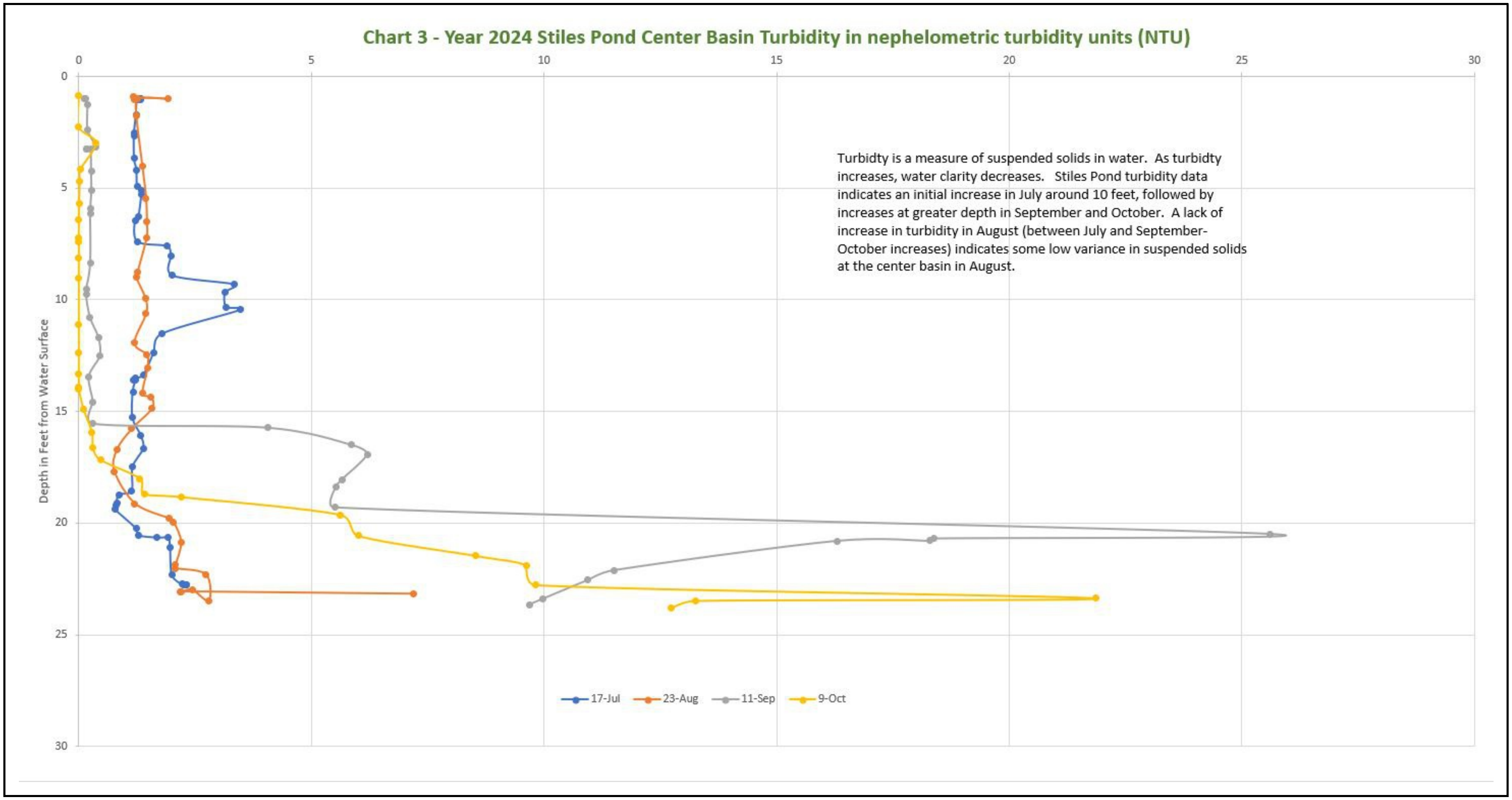
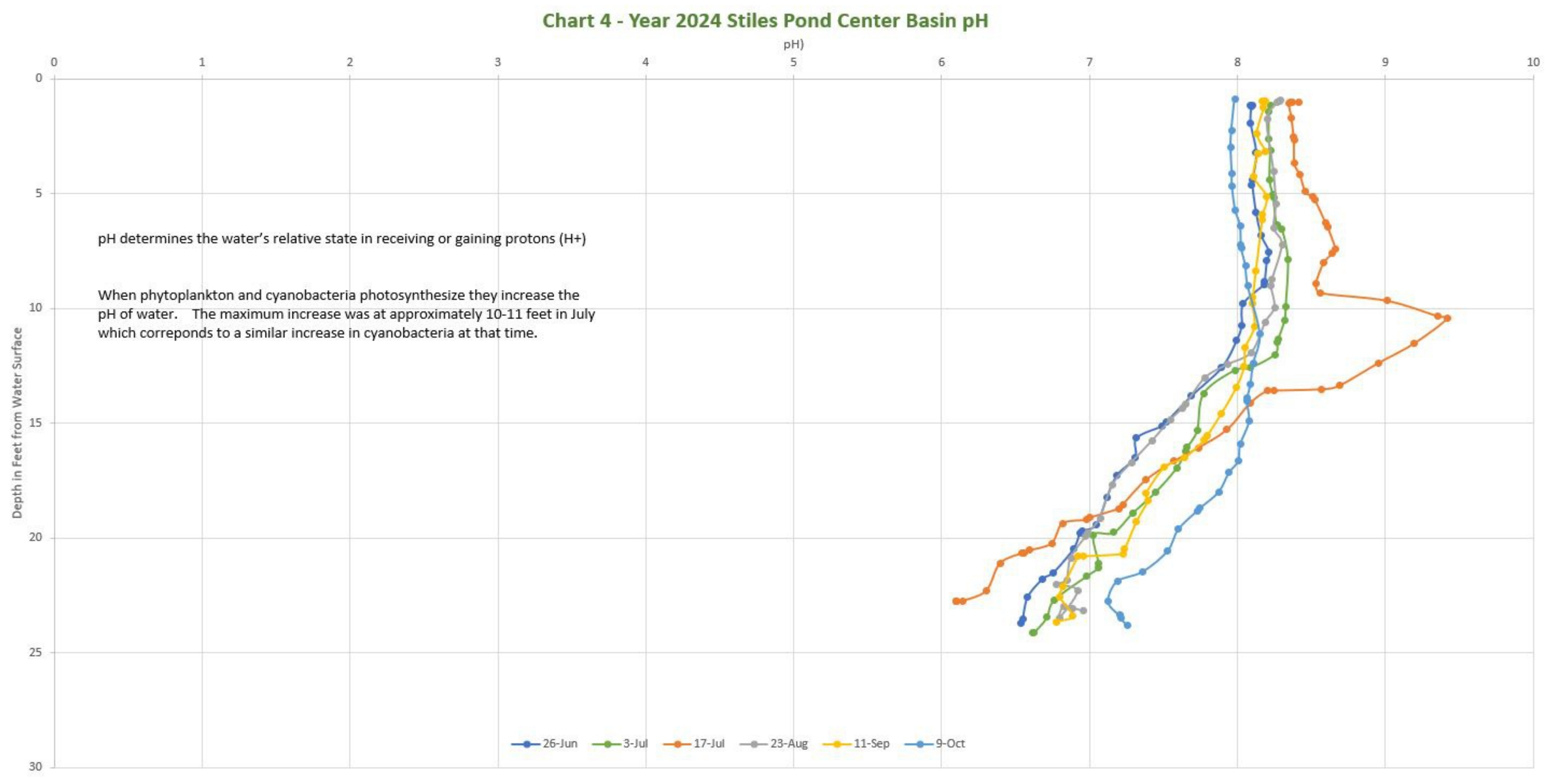


Chart 3 - Year 2024 Stiles Pond Center Basin Turbidity in nephelometric turbidity units (NTU)

Turbidty is a measure of suspended solids in water. As turbidty increases, water clarity decreases. Stiles Pond turbidity data indicates an initial increase in July around 10 feet, followed by increases at greater depth in September and October. A lack of increase in turbidity in August (between July and September-October increases) indicates some low variance in suspended solids at the center basin in August.



pH determines the water’s relative state in receiving or gaining protons (H+)

When phytoplankton and cyanobacteria photosynthesize they increase the pH of water. The maximum increase was at approximately 10-11 feet in July which correponds to a similar increase in cyanobacteria at that time.

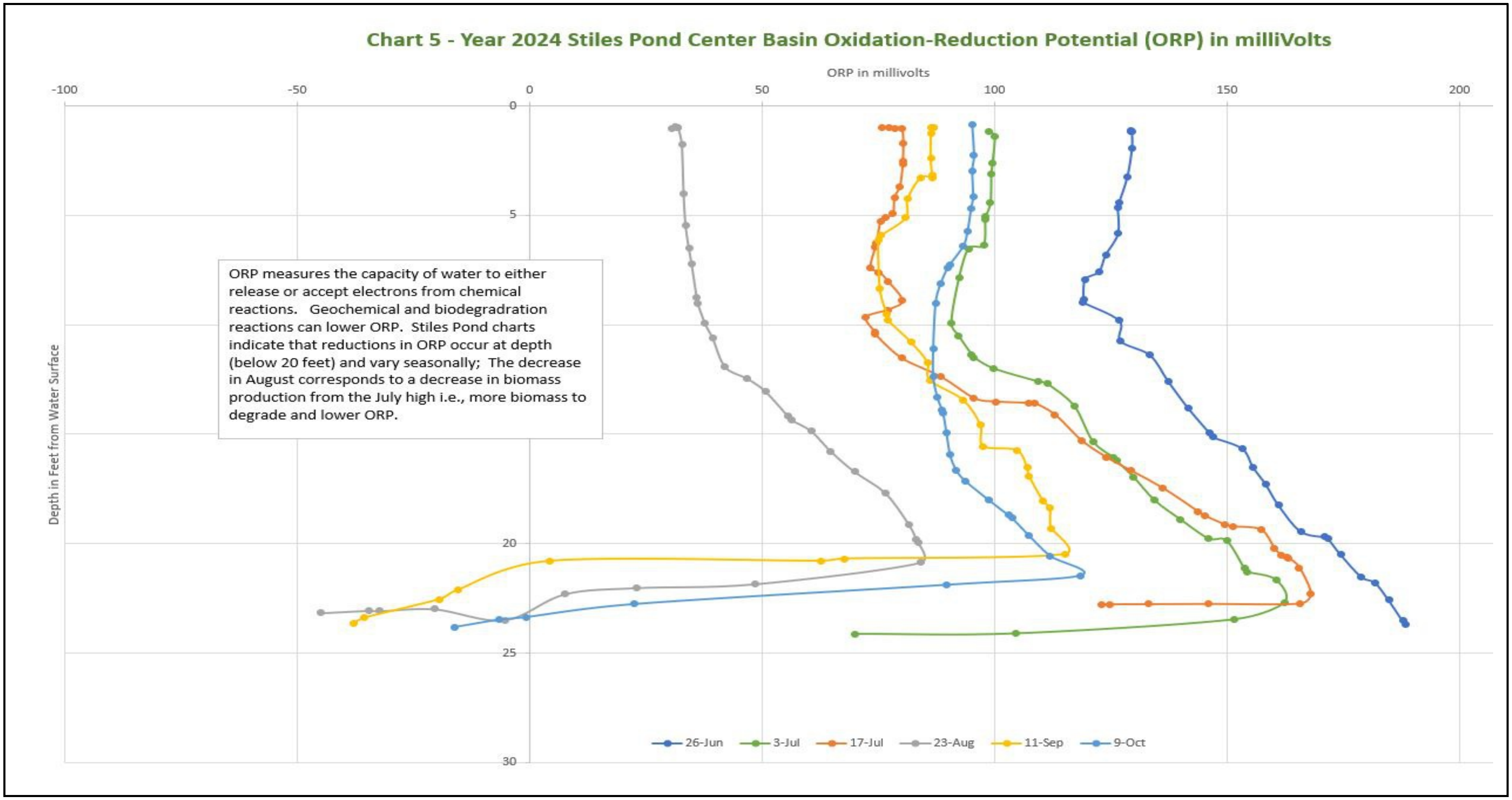
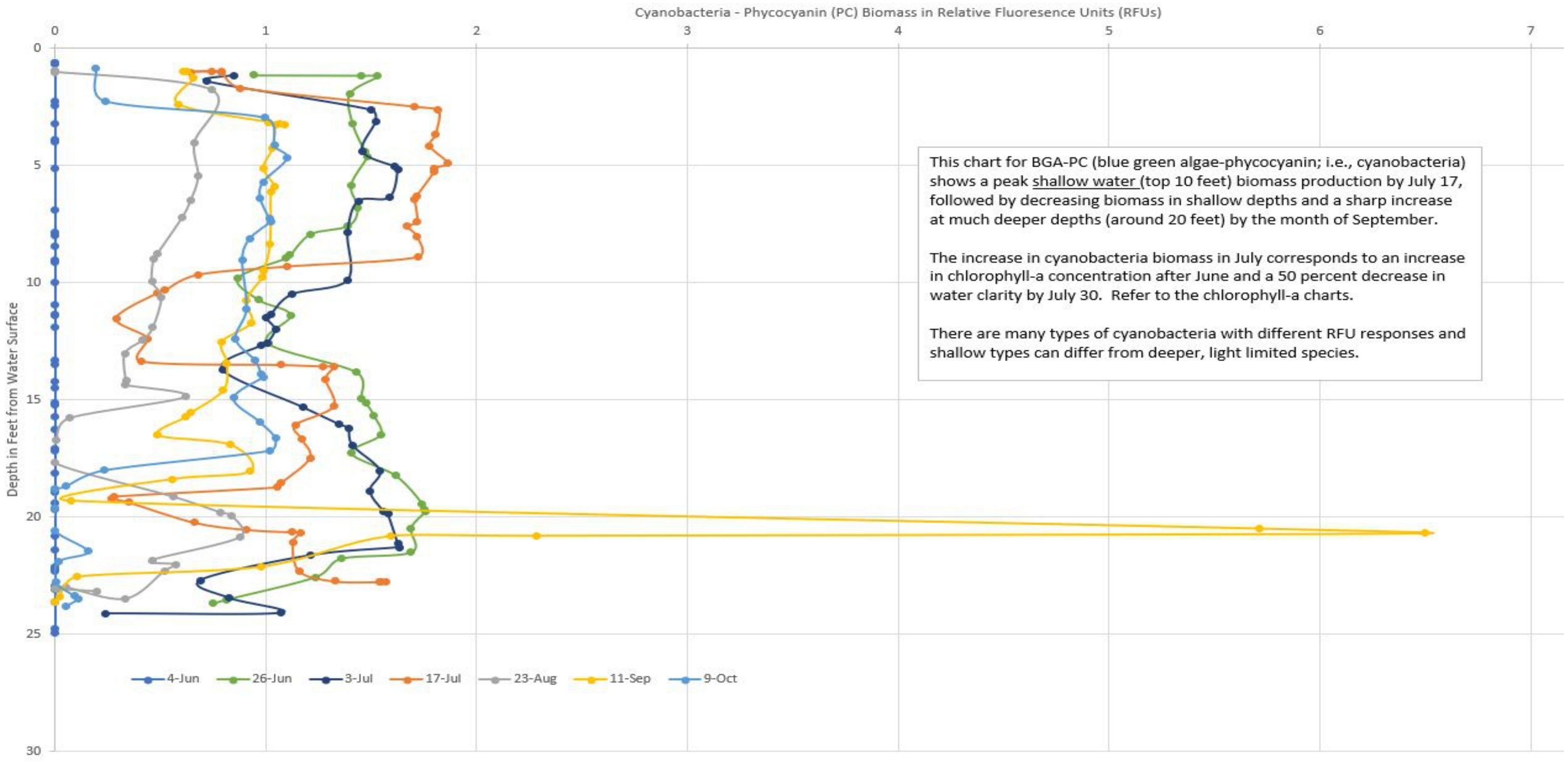


Chart 5 - Year 2024 Stiles Pond Center Basin Oxidation-Reduction Potential (ORP) in milliVolts

ORP measures the capacity of water to either release or accept electrons from chemical reactions. Geochemical and biodegradration reactions can lower ORP. Stiles Pond charts indicate that reductions in ORP occur at depth (below 20 feet) and vary seasonally; The decrease in August corresponds to a decrease in biomass production from the July high i.e., more biomass to degrade and lower ORP.

Chart 6 - Year 2024 Stiles Pond Center Basin BGA-PC (cyanobacteria) in Relative Fluoresence Units (RFUs)



This chart for BGA-PC (blue green algae-phycocyanin; i.e., cyanobacteria) shows a peak shallow water (top 10 feet) biomass production by July 17, followed by decreasing biomass in shallow depths and a sharp increase at much deeper depths (around 20 feet) by the month of September.

The increase in cyanobacteria biomass in July corresponds to an increase in chlorophyll-a concentration after June and a 50 percent decrease in water clarity by July 30. Refer to the chlorophyll-a charts.

There are many types of cyanobacteria with different RFU responses and shallow types can differ from deeper, light limited species.

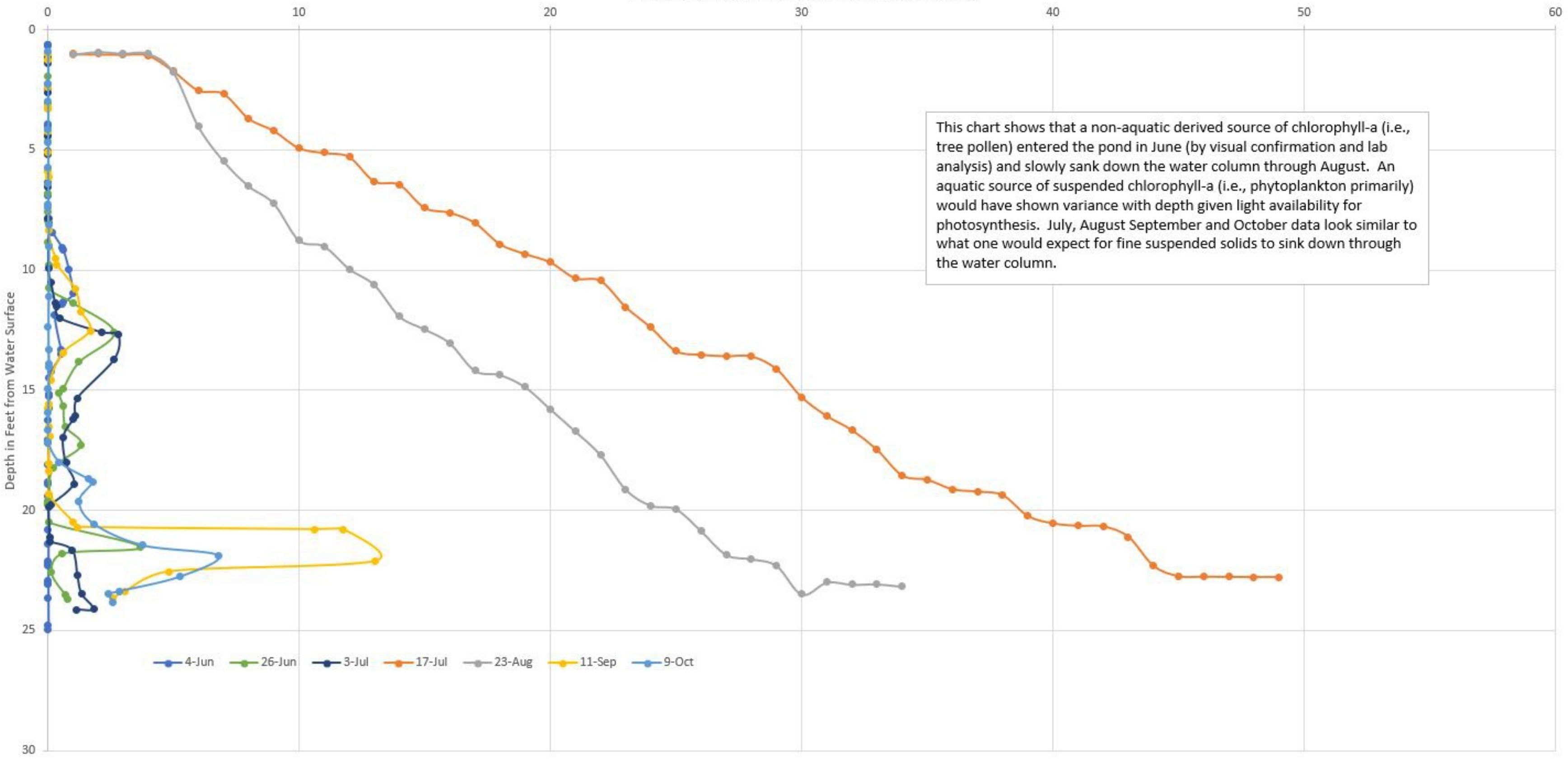


Chart 7 - Year 2024 Stiles Pond Center Basin Chlorophyll-a in Relative Fluoresence Units (RFUs)

This chart shows that a non-aquatic derived source of chlorophyll-a (i.e., tree pollen) entered the pond in June (by visual confirmation and lab analysis) and slowly sank down the water column through August. An aquatic source of suspended chlorophyll-a (i.e., phytoplankton primarily) would have shown variance with depth given light availability for photosynthesis. July, August September and October data look similar to what one would expect for fine suspended solids to sink down through the water column.

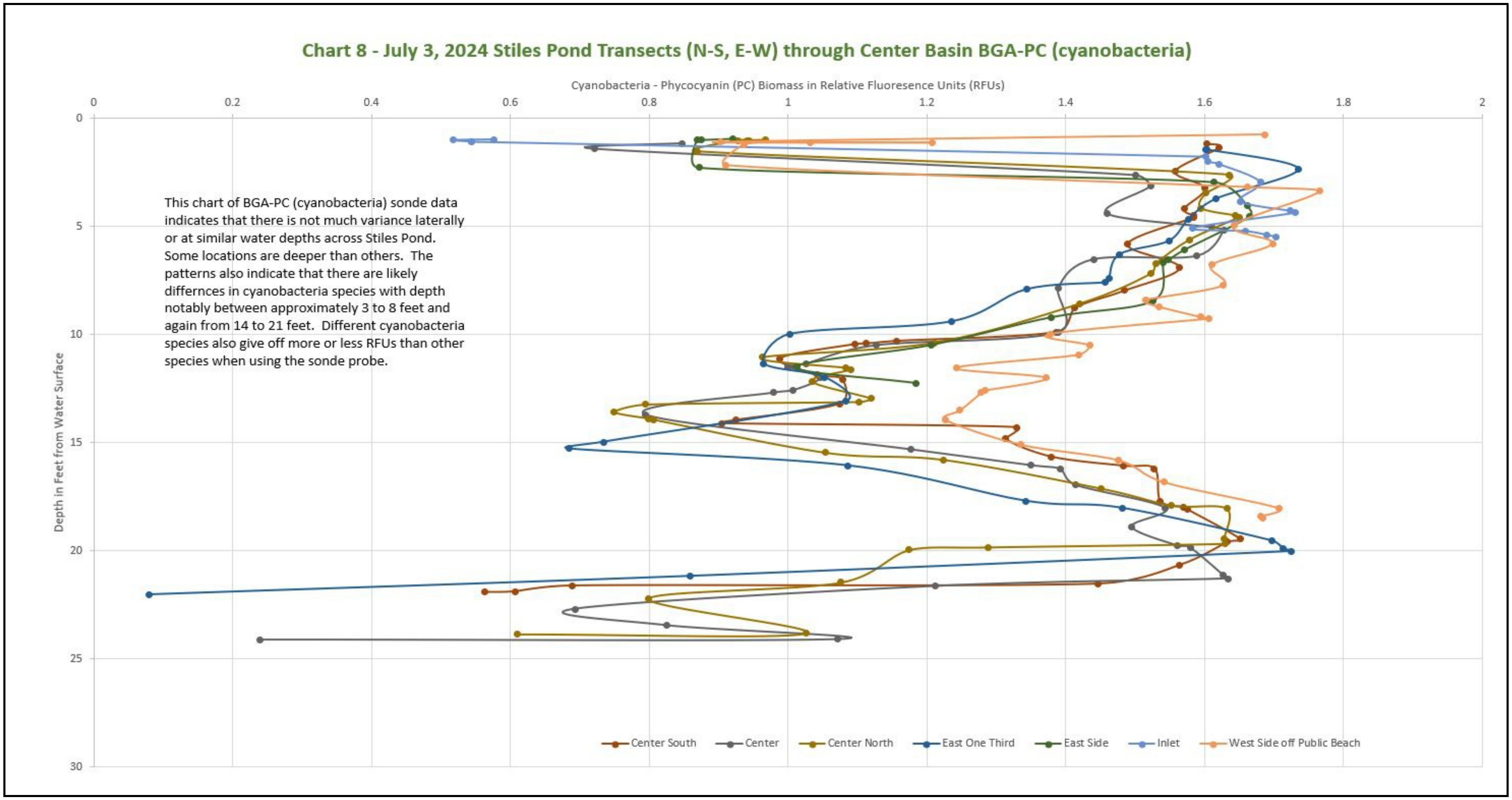
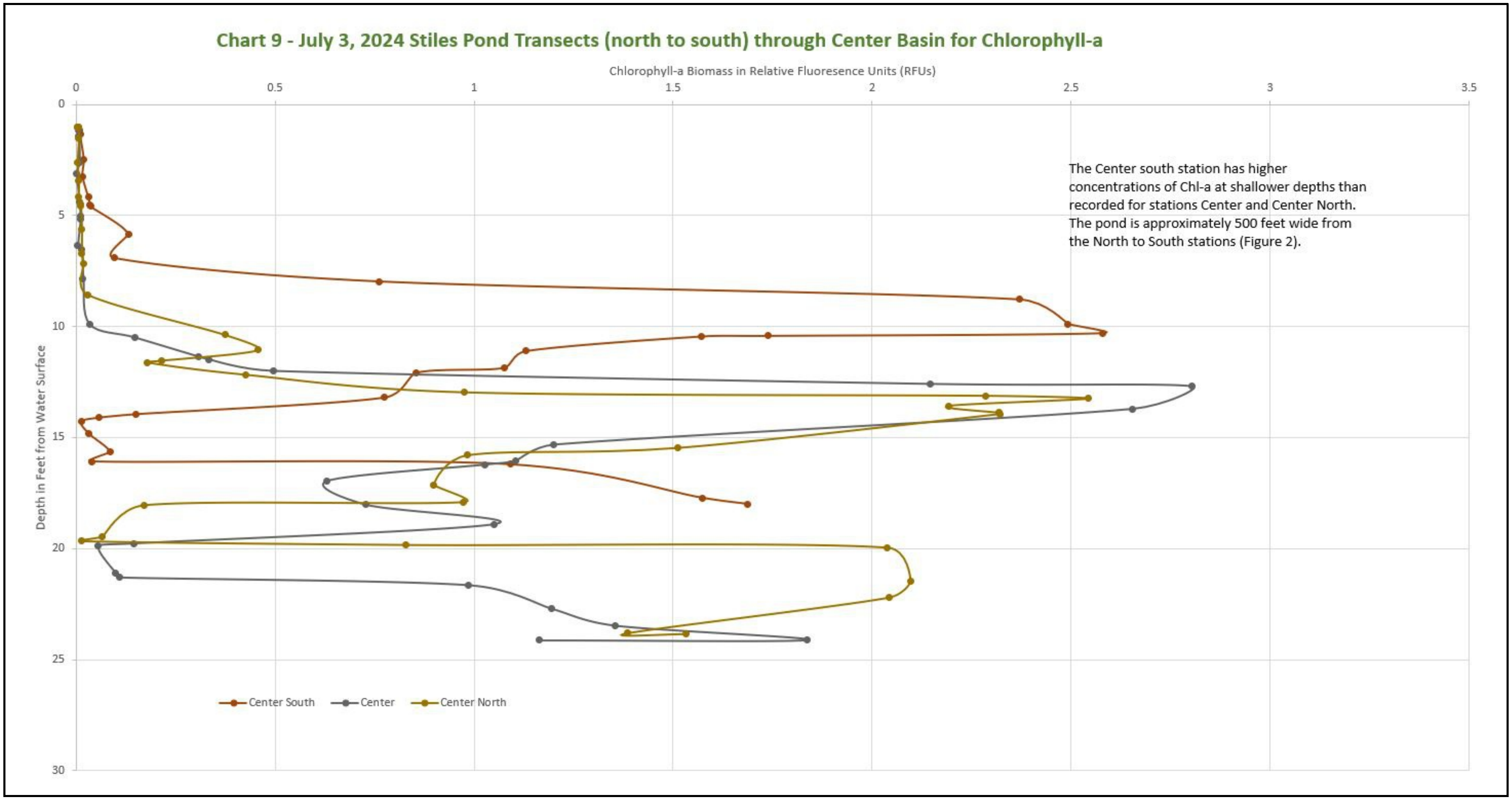


Chart 8 - July 3, 2024 Stiles Pond Transects (N-S, E-W) through Center Basin BGA-PC (cyanobacteria)

This chart of BGA-PC (cyanobacteria) sonde data indicates that there is not much variance laterally or at similar water depths across Stiles Pond. Some locations are deeper than others. The patterns also indicate that there are likely differnces in cyanobacteria species with depth notably between approximately 3 to 8 feet and again from 14 to 21 feet. Different cyanobacteria species also give off more or less RFUs than other species when using the sonde probe.



The Center south station has higher concentrations of Chl-a at shallower depths than recorded for stations Center and Center North. The pond is approximately 500 feet wide from the North to South stations (Figure 2).

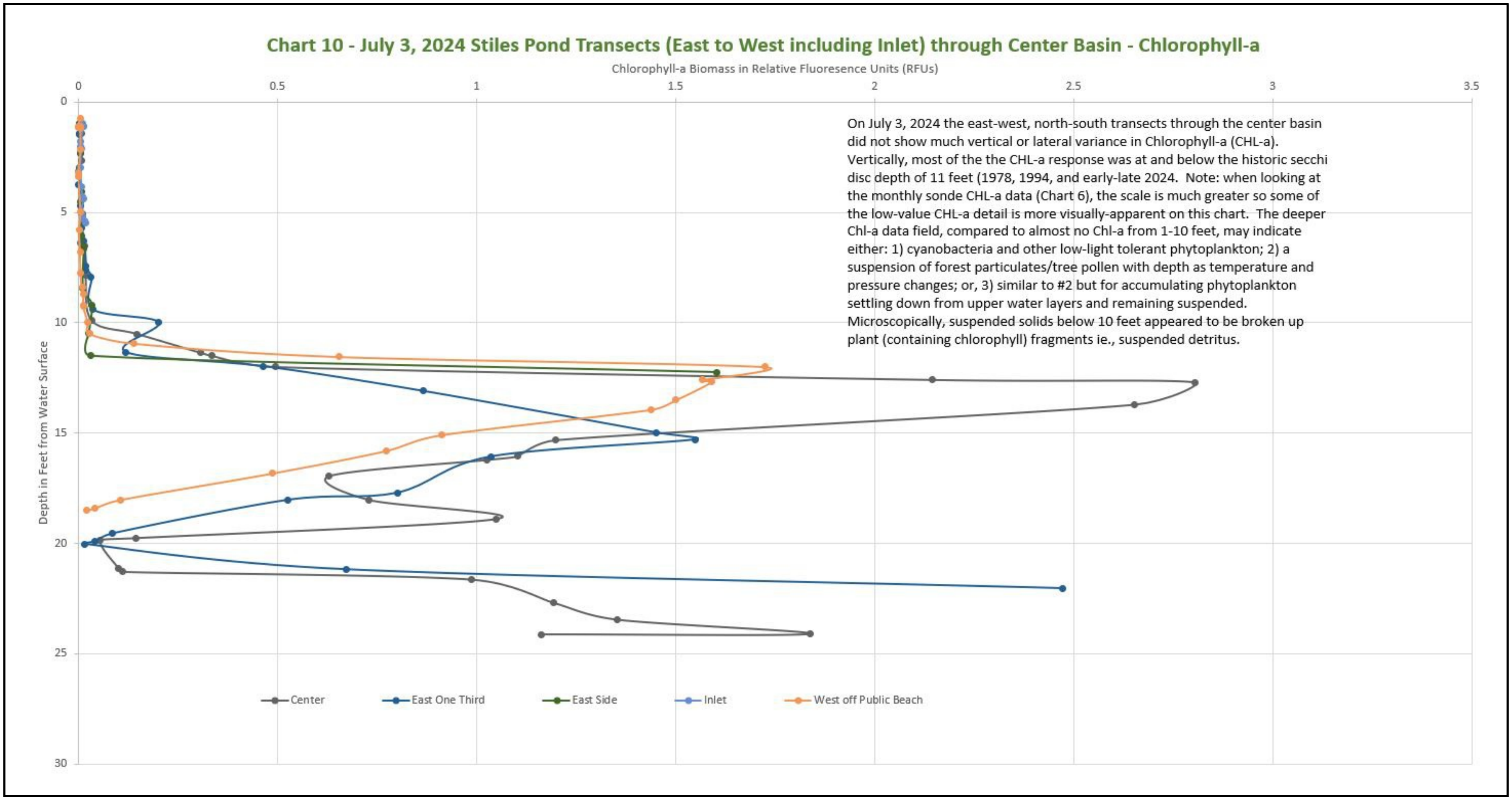


Chart 10 - July 3, 2024 Stiles Pond Transects (East to West including Inlet) through Center Basin - Chlorophyll-a

On July 3, 2024 the east-west, north-south transects through the center basin did not show much vertical or lateral variance in Chlorophyll-a (CHL-a). Vertically, most of the the CHL-a response was at and below the historic secchi disc depth of 11 feet (1978, 1994, and early-late 2024. Note: when looking at the monthly sonde CHL-a data (Chart 6), the scale is much greater so some of the low-value CHL-a detail is more visually-apparent on this chart. The deeper Chl-a data field, compared to almost no Chl-a from 1-10 feet, may indicate either: 1) cyanobacteria and other low-light tolerant phytoplankton; 2) a suspension of forest particulates/tree pollen with depth as temperature and pressure changes; or, 3) similar to #2 but for accumulating phytoplankton settling down from upper water layers and remaining suspended. Microscopically, suspended solids below 10 feet appeared to be broken up plant (containing chlorophyll) fragments ie., suspended detritus.

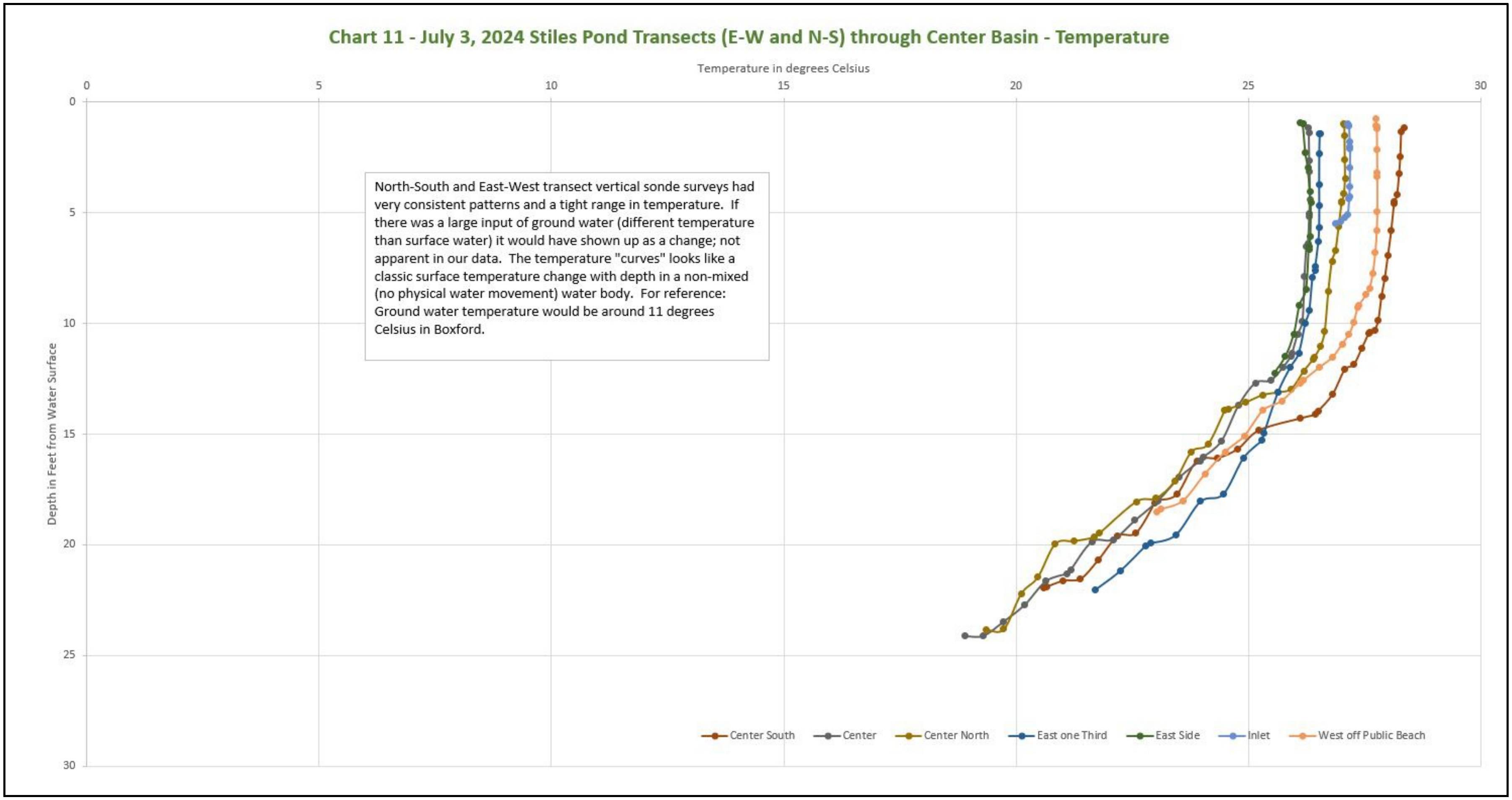


Chart 11 - July 3, 2024 Stiles Pond Transects (E-W and N-S) through Center Basin - Temperature

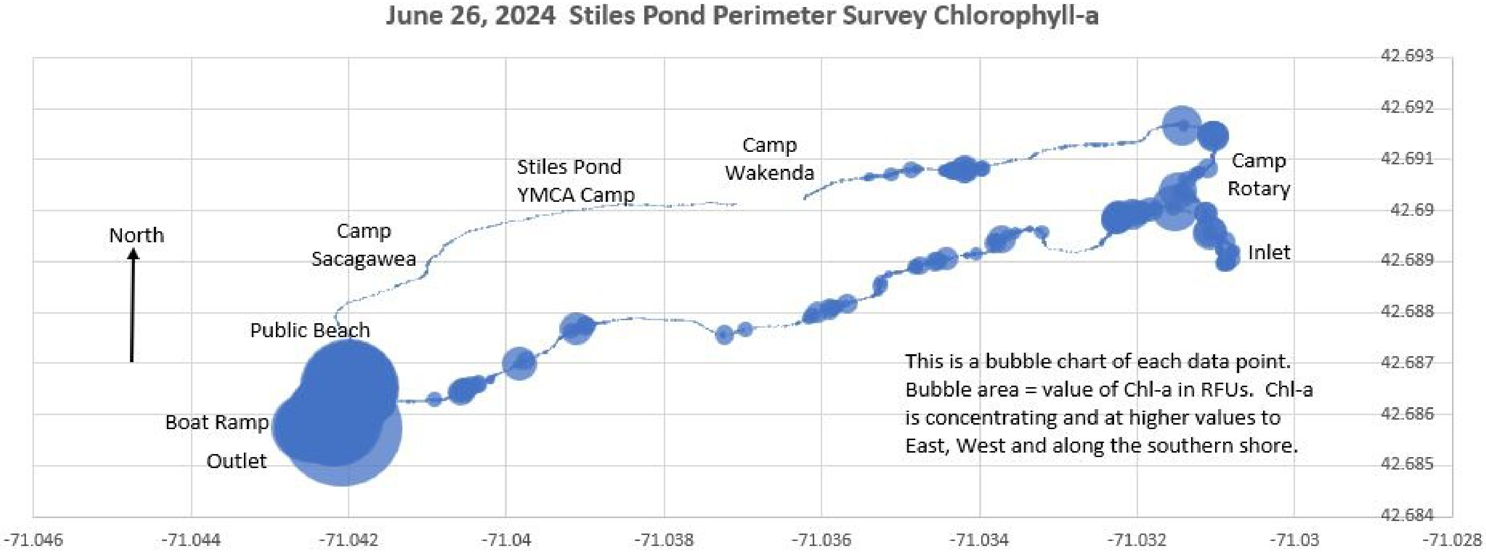
North-South and East-West transect vertical sonde surveys had very consistent patterns and a tight range in temperature. If there was a large input of ground water (different temperature than surface water) it would have shown up as a change; not apparent in our data. The temperature "curves" looks like a classic surface temperature change with depth in a non-mixed (no physical water movement) water body. For reference: Ground water temperature would be around 11 degrees Celsius in Boxford.

Sonde Perimeter Survey:

Sonde perimeter readings showed very little variance (median and mean were very similar) except for Chl-a. A summary of data with median, mean, maximum and minimum data for each type of sonde reading (dissolved oxygen, etc.) is provided in the following table and chart for Chl-a:

Summary of Data (1,624 readings) - Perimeter Sonde Survey June 26, 2024 - Stiles Pond, Boxford

	Temp (°C)	RDO (mg/L)	BGA-PC (RFU)	Chl-a (RFU)	pH (pH))	ORP (mV)
Mean	26.90	8.36	1.54	0.44	8.21	93.35
Median	26.84	8.31	1.54	0.01	8.13	94.92
max	28.12	9.75	2.65	22.91	9.49	109.35
min	26.15	7.32	0.21	0.00	7.64	51.40



This is a bubble chart of each data point. Bubble area = value of Chl-a in RFUs. Chl-a is concentrating and at higher values to East, West and along the southern shore.

All other perimeter data {RDO-dissolved oxygen; BGA-PC (cyanobacteria); pH and ORP (oxidation-reduction potential)}, plotted essentially as lines of connected and similar area "bubbles". The mean and median value difference in the above table indicates whether there are higher or lower areas of data, this was only the case for Chl-a (a measure of chlorophyll in plants (including phytoplankton, tree pollen and some forest particulates like fresh leaf pieces). Minimum and maximum data in the table could just be single data points of the 1624 readings.

3.4 Surface Water Sampling and Analysis

Material, Methods and Equipment Utilized:

To provide a basis for comparing historical results over time, surface water sampling locations and analytical testing in 2024 were essentially the same as used by KV in 1994. There may be some minor variance in lateral location of each sample, as samples were noted on a map by KV as follows:

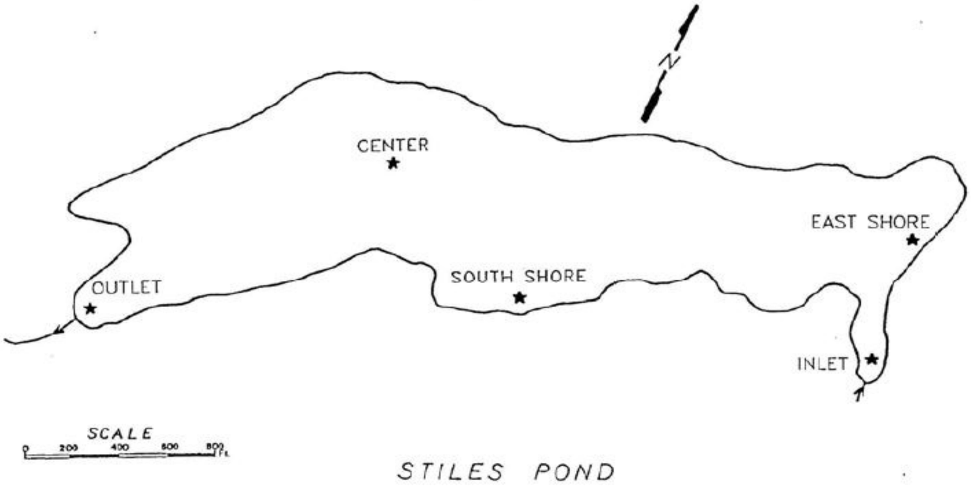


Figure 4. Location of Water Quality Sampling Stations

Surface water samples were collected by HEA on August 21, 2024 at the approximate same time of year as sampled previously by KV in 1994. KV did not indicate how their samples were collected or reference specific sampling depths other than "shallow" or "deep". KV's report did not note if water quality field testing was performed for dissolved oxygen, pH, temperature, and similar. HEA interpreted KV's shallow water sampling intervals as being at approximately 3 feet below the water surface or the mid-water column depth for locations in less than three to four feet of water and for the center "deep" sample, between 5 to 10 feet off the pond bottom (sediment surface).

HEA's surface water samples (shallow and deep) were collected using a discrete sampler (Van Dorn type) and designated as Outlet, S. Shore, Inlet, E. Shore, Center Deep1, Center Shallow, and Center Deep 2 (a duplicate sample of Center Deep 1). A vertical sonde survey was completed at the center deep station prior to sample collection to help determine an appropriate sampling depth. The Center D 1 and deep duplicate samples were collected at 15 feet below the water surface at a depth below the secchi disc reading of (5.5 feet) and just above a < 2mg/L layer of dissolved oxygen. The deep sample layer also corresponded to a layer of relative increase in cyanobacteria (PC) and chlorophyll-a (Chl-a) content based on sonde readings. Sonde probe snapshots were collected from each shallow, discrete sample location. The center deep duplicate (Center Deep 2) sample was collected at the same time and from the same discrete sampler as the Center Deep 1 sample by dispensing relatively equal one-third aliquots of sample water between each sample bottle set until filled.

All sample bottles were labeled as to sample location, date, time and requested analysis and placed in a sample cooler with ice to cool the samples to less than 4 degrees Celsius. Total coliform, fecal and E.coli samples were kept cool and all samples were picked up for laboratory analysis within four hours of sample collection. Samples were provided under chain-of-custody documentation to a Massachusetts-certified laboratory for appropriate EPA analytical methods of analysis for: total carbon, total iron, Kjeldahl-nitrogen, ammonia-nitrogen, nitrate-nitrogen, total sulfur, total phosphorus; total dissolved solids, total suspended solids, chloride, total coliform, and fecal coliform. The laboratory reported Kjeldahl-nitrogen, ammonia-nitrogen, and nitrate-nitrogen collectively as total nitrogen by error- inconsistent with the chain of custody requested analysis. Most forms of lake water nitrogen are as Kjeldahl-nitrogen which would be reflected in the total nitrogen result. KV’s 1994 samples included a breakout of nitrogen compounds, Kjeldahl-nitrogen represented approximately 90 percent and greater of the summed total nitrogen values. Laboratory datasheets and sample chain of custody forms are attached.

Surface water samples from the shallow and deep center basin sample were also submitted to a separate laboratory for algae enumeration (phytoplankton and cyanobacteria identification and determination of biovolume and biomass by species). This laboratory report is attached.

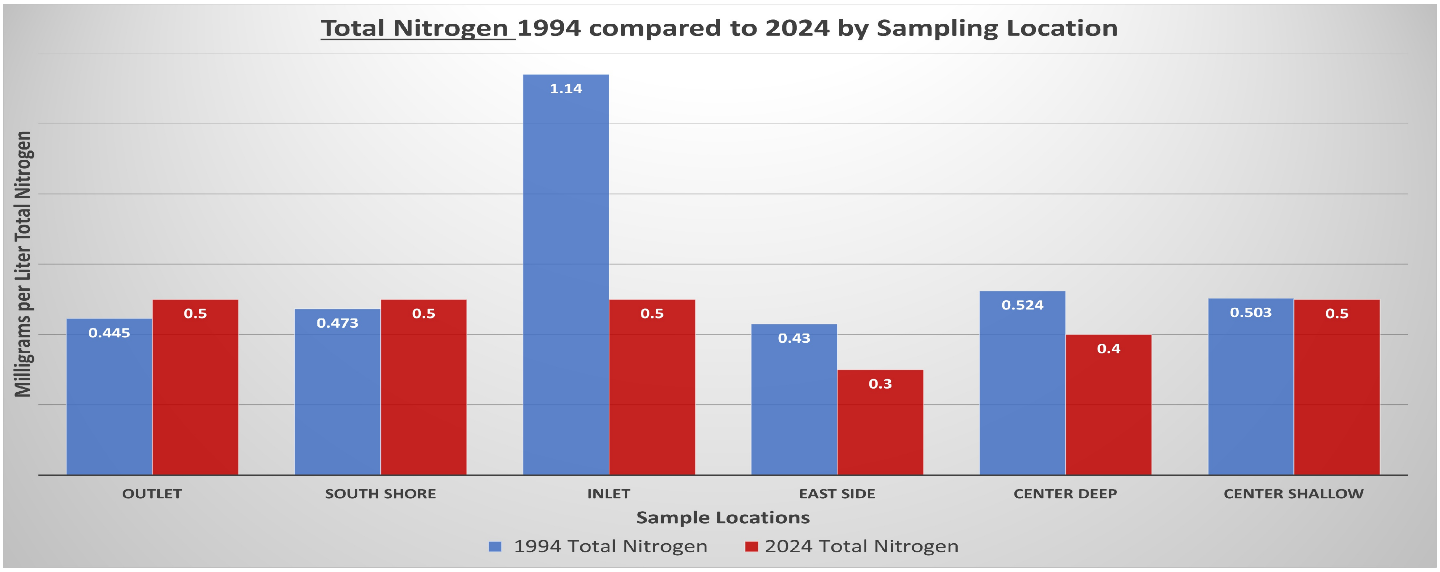
Field and Laboratory Data:

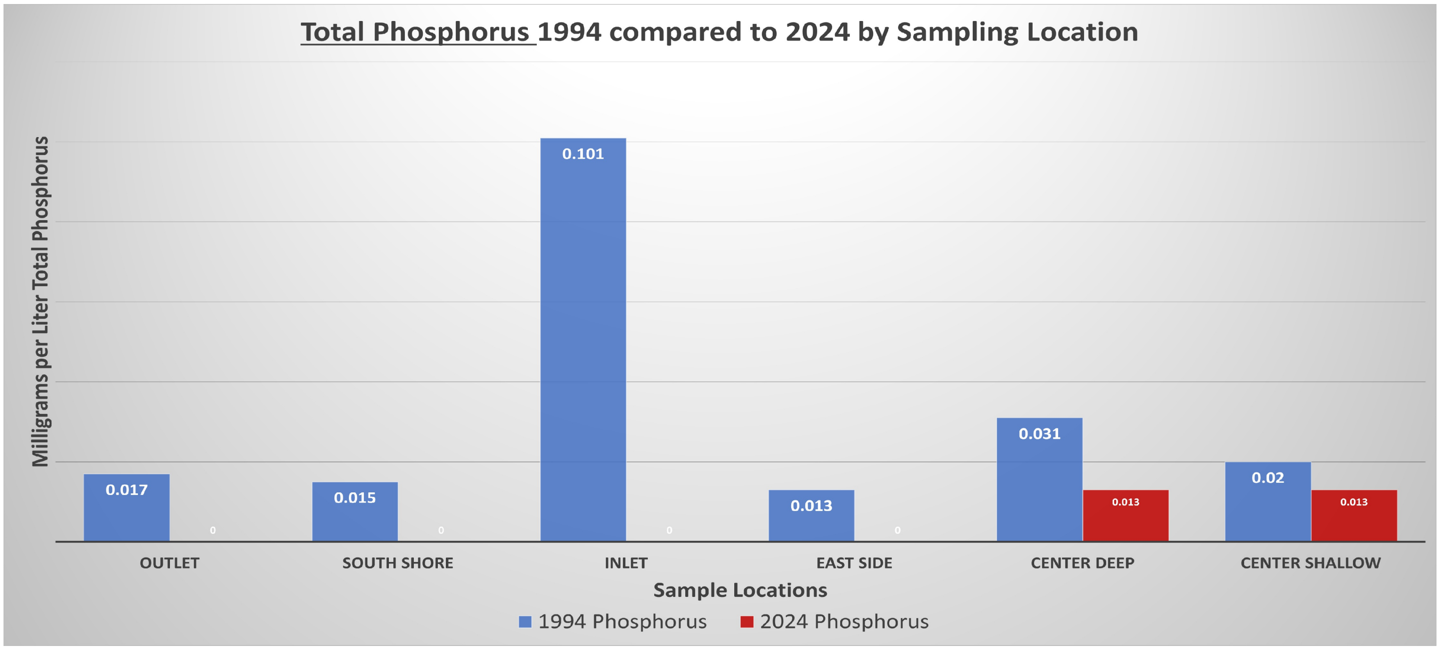
Field water quality and sonde measurements are presented in **Sections 1** and **2** of this report. Laboratory results for surface water samples are summarized in **Table 1 - Surface Water Sample Results** which includes data obtained previously by KV in August 1994. Laboratory results for algae identification are presented and discussed in **Section 3.5 - Phytoplankton Sampling and Analysis**.

Surface Water Sample Analytical Findings:

In 2024, surface water laboratory results for nutrients (carbon, iron, nitrogen, phosphorus and sulfur) for samples (with specific reference to total nitrogen and phosphorus) were significantly lower than KV’s 1994 results but 2024 data still indicates that Stiles Pond is a mesotrophic (medium nutrient range) water body. Nutrient-poor (total phosphorus less than 0.01 mg/L (EPA 2001 criteria) low productivity water bodies are classified as oligotrophic and nutrient-rich (greater than 0.25 mg/L total phosphorus) highly productive water bodies are classified as eutrophic water bodies. There are other criteria for classifying water bodies as oligotrophic to eutrophic, such as water clarity. Stiles Pond has a maximum (June-September) water clarity (2024, 1994 and by reference to MassDEP data from 1978 by KV) of approximately 11 feet at the pond’s center basin. In 2024, as discussed in **Section 3.6**, water clarity was initially reduced by approximately 50 percent by the end of tree pollen season (late June-early July) with gradual water clarity improvements by September (9.75 feet) to October (14.3 feet). A water body classified as mesotrophic would typically have water clarity readings between 6.5 to 14 feet; so given nutrient concentrations, observed and measured productivity (discussed later) and range in water clarity Stiles Pond is a mesotrophic water body consistent with classification findings in 1994.

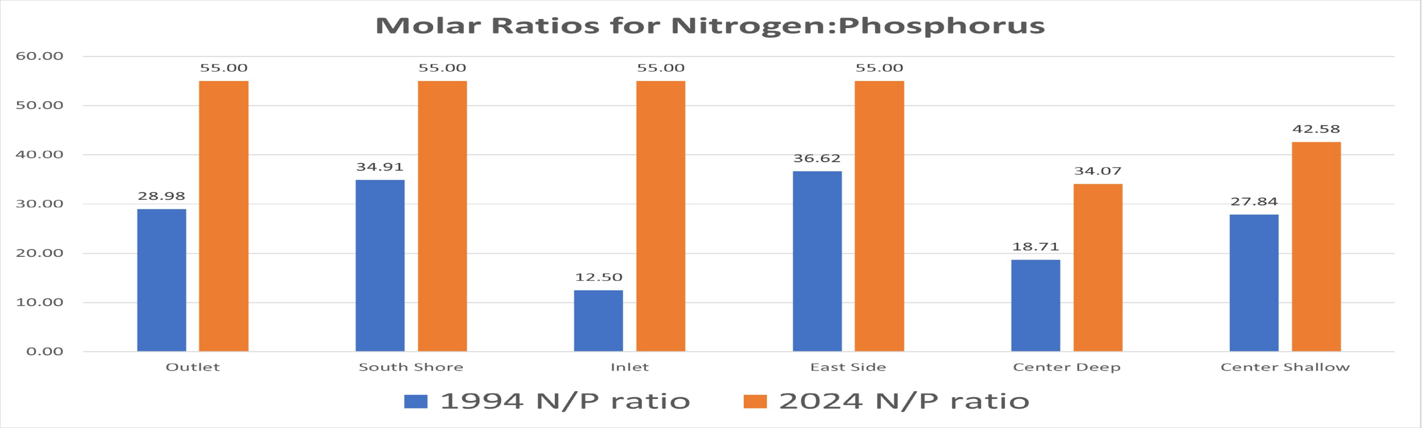
In 2024, surface water results for total phosphorus at shallow (0.013 mg/L) and deep sample (0.013 mg/L) from the center basin were slightly above EPA's oligotrophic (0.01 mg/L) threshold. All other sampling locations had non-detectable (<0.01 mg/L) for total phosphorus in 2024. Stiles Pond water quality data from 2024 for total nitrogen were similar to 1994 except at the Inlet sample (approximately 50 percent less total nitrogen in 2024 compared to 1994). KV did not include testing for the nutrients carbon, iron or sulfur as HEA did in 2024. For comparative purposes, 1994-2024 comparative charts for total nitrogen and total phosphorus follows:





Overall, total phosphorus results in 2024 were much less than detected in 1994 with the Inlet sample having the highest concentration in 1994. Other than the Center Deep and Center Shallow samples in 2024, all other sampling locations were non-detectable for phosphorus.

The nutrients nitrogen and phosphorus and the ratios between them play a role in determining water body productivity and overall, the types and biovolume of phytoplankton and cyanobacteria. Other nutrients such as iron and sulfur can geochemically-regulate (release and bind) phosphorus and as such also play a role in water body productivity and availability of nutrient to phytoplankton and cyanobacteria. Using data from 1994 and 2024 for total nitrogen and phosphorus at the same surface water sampling locations, the following chart depicts molar ratios of nitrogen(N) to phosphorus(P); N:P or N/P.

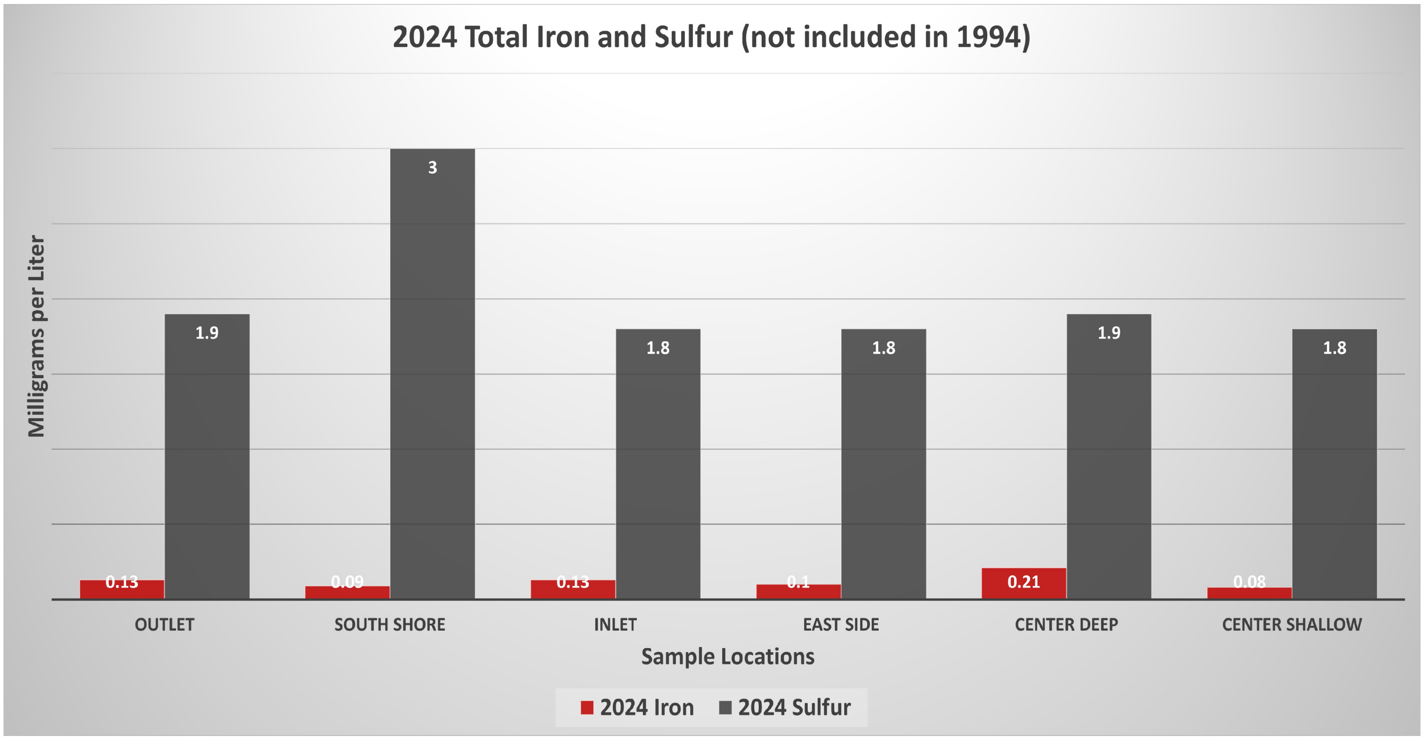


With the exception of KV's inlet sample from 1994, all N:P ratios were greater than 15:1 and as such, phosphorus can be considered a limiting nutrient for surface water productivity in Stiles Pond. The N:P ratio values of 55 for 2024 sampling locations (outlet, south shore, inlet, and east side) were based on the laboratory detection limit, as phosphorus was not detected (*i.e.*, <0.01 mg/L) at these locations. In 1994, KV's inlet sample ratio of 12.5 indicates that nitrogen and phosphorus were co-limiting nutrients. KV's 1995 report presented N:P nutrient ratios but based on HEA's review, these were not molar ratios. Molar ratios are by convention, preferred but the molecular weight of diatomic nitrogen (N_2 at 28 grams per mol) and phosphorus (31 grams per mol) are very similar, so KV's 1994 data (converted by HEA to mols) is close to the molar ratio numbers noted in the above table. Diatomic nitrogen (two atoms of nitrogen or N_2) is the predominant atmospheric form of nitrogen available for diffusion or wet precipitation into water bodies and by convention, is the molecular form of nitrogen used to derive available mols of nitrogen and to calculate N:P molar ratios. Molar ratios of nutrients such as nitrogen to phosphorus provide a basis for assessing which nutrient may be more limiting than another for growth or "productivity" by organisms such as phytoplankton. Some forms of cyanobacteria are able acquire nitrogen and phosphorus from sediment and organic sources other than just as soluble forms in water.

Molar ratios of N:P less than 7:1 would indicate that nitrogen is a limiting nutrient. An N:P ratio between 7 and 15 such as for KV's 1994 inlet sample would indicate a co-nutrient limitation. Again, Stiles Pond is phosphorus limited based on the majority of 1994 and 2024 N:P molar ratios of soluble nutrients in water being greater than 15. KV attributed the lower N:P ratio for the 1994 inlet sample to significantly higher nitrogen and phosphorus content in the inlet than other surface water sample locations. The 1994 inlet sample had a phosphorus result of 0.101 mg/L which was greater than any other sample location (all less than 0.032 mg/L) at that time. In 2024, the highest concentration for phosphorus was detected in both the center deep (15 feet) and shallow (3 foot) samples at 0.013 mg/L. The center deep duplicate sample reported phosphorus at 0.01 mg/L. All other 2024 surface water sample locations had non-detectable (<0.01 mg/L) results for phosphorus. Total nitrogen results between 1994 and 2024 were very similar (at or near approximately 0.5 mg/L) with the highest total nitrogen result noted in 1994 at the inlet (1.14 mg/L).

KV's surface water sample results for nitrogen were based on testing for kjeldahl nitrogen (organic primarily), ammonia-nitrogen and nitrate-nitrogen. In 1994, kjeldahl nitrogen was detected at all sampling locations, ammonia-nitrogen was not detected in any sample, and nitrate-nitrogen was detected at low concentrations in three samples (south shore at 0.03 mg/L; inlet at 0.02 mg/L ; and, east side or "eastern" at 0.05 mg/L). For comparative purposes, HEA totaled KV's nitrogen results to derive a total nitrogen concentration for each sample location (results noted in previous chart and on **Table 1**, attached).

Results for 2024 nutrient iron and sulfur not sampled previously are summarized in the following chart.



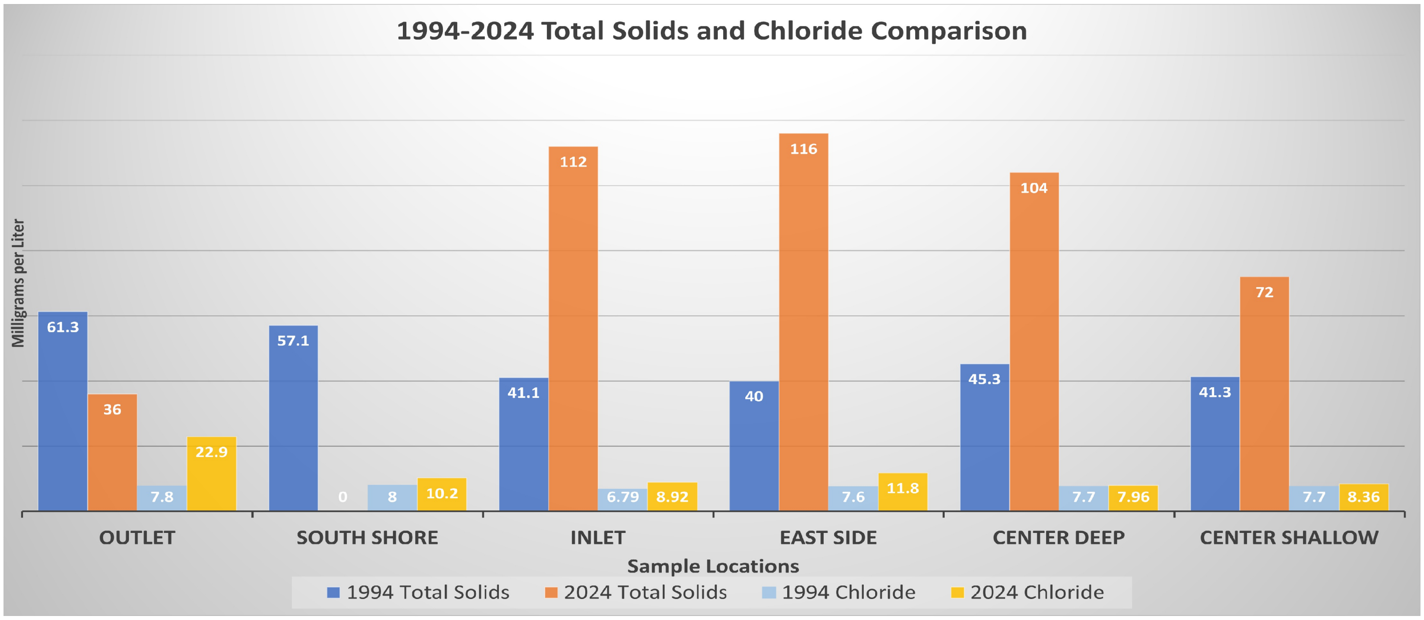
Results for sulfur in 2024 were essentially the same at all locations except the south shore (**Figure 2**) sample which had approximately twice as much sulfur as other locations. During sampling, there was no visual or olfactory indication of water quality differences between any samples. Surface water results for sulfur around 2 mg/L can be considered a reasonable background concentration for north shore ponds based on HEA's knowledge. Sulfur can be naturally-sourced from local soils, bedrock, dry (tree pollen and forest particulates) and wet (rain and snow) precipitation. Sulfur is also associated with fertilizers, septic waste, water treatment chemicals, pesticides and some commercial/industrial wastes.

Laboratory results for iron were also very similar between sample locations except the center deep sample which had approximately twice the amount of iron as other (all shallow water) samples. The higher concentration for iron likely relates to underlying, more oxygen-depleted, water that would solubilize then re-precipitate iron just at and beneath the center deep sample as part of the "ferris" cycle. This process serves to bind phosphorus that may also solubilize under anoxic or increased biodegradation conditions as water column depth increases - part of the water-column biodegradation process.

In surface water, the iron to phosphorus and importantly, iron to sulfur ratios regulate the availability, release and sedimentation of phosphorus in aquatic systems (Caraco *et. al*, 1989-1993). In August 2024, total sulfur concentrations in shallow (3 feet) and deep 9 (15 feet) intervals were 56.14 micromols/liter (umol/l) and 57.70 umol/l, respectively which would tend to limit phosphorus release from underlying sediments and anoxic waters as sulfate concentrations were 60 umol/l or less (Caraco et al, 1989). Iron to sulfur ratios in the center shallow and deep sample intervals were less than 1 which is not favorable as higher iron concentrations to sulfur would support binding and sedimentation of phosphorus. The iron to phosphorus at the same sample intervals were greater than 1 which indicates that iron is still present, above the anoxic water interval (deeper than 23 feet in August), at concentrations sufficient to bind with phosphorus under oxic conditions. If the amount of phosphorus or sulfur increased relative their ratio to iron measured in 2024, then additional phosphorus could become available to promote increased biologic productivity in surface water of Stiles Pond. Essentially, adding more sulfur to the pond would increase available phosphorus for biological productivity. As its stands in 2024, phosphorus in surface water was non detectable (less than 0.01 mg/L) except at the center shallow and deep sample locations which were still very low (0.01 to 0.013 mg/L).

If production of biomass (phytoplankton, etc.) in upper oxygenated waters equals water-column biodegradation of seston (settling organic solids - dead phytoplankton, feces, and similar) with water column depth it is an indicator of a healthy, biodiverse aquatic ecosystem (i.e. everything produced biologically in the water body gets biodegraded ("eaten") before reaching bottom sediments). Its also a function of water depth and it is part of the internal loading-water column cycling of nutrients and biomass production. Too much biomass production and not enough biodegradation can lead to eutrophic conditions, including depressed oxygen content, loss of aquatic habitat for fin- and shell-fish and impairment to water quality. Based on HEA's microscopic assessment of water quality at approximately 5 foot intervals with depth in Stiles Pond's center basin, biomass production in upper waters is in excess of water-column biodegradation with increasing depth but overall production verus biodegradation seems consistent with the eutrophic classification condition of Stiles Pond based on other factors (nutrient content, water clarity). Evaluating biomass production and degradation with water column depth is an easy metric to assess just by using a microscope and discrete water sampler; something school kids, day campers and similar could do at ponds in Boxford and elsewhere.

Total solids (dissolved plus suspended) can be another measure of biomass (aquatic and terrestrial sourced), geologic (clays, silts and minerals) or geochemical (reactions between minerals and production of precipitates and colloids). Total solids analysis were completed in 1994 and 2024 at each of the six sampling locations. Results, including for chlorides also tested in 1994 and 2024, are summarized in the following chart. All surface water sample laboratory results from 1994 and 2024 are summarized in numeric-tabular format in **Table 1**. For total solids, by comparing 1994 to 2024 results, the amount and variance in total solids was greater in 2024 (range of non detect to 116 mg/L than in 1994 (range of 40 to 61.3 mg/L). Distribution patterns for total solids content are readily apparent in the following chart. 2024 had nearly twice as much total solid content from the center basin to the eastern-half of the pond sample locations than in 1994. Chloride concentrations in 1994 were similar to 2024 except at the outlet, where 22.9 mg/L were detected in 2024 versus 7.8 mg/L in 1994. Like sulfur, chloride can be naturally-sourced from soil but less so from wet and dry deposition and more so from widespread use of deicing chemicals on roadways and paved surfaces. Chloride concentrations can also increase relative to ongoing evaporation and longer residence times for water. All chloride concentrations to date (1994 and 2024) were relatively low and not indicative of deicing chemical impairments. According to MassGIS information (MassDEP MassGIS WBP for Stiles Pond), only approximately 2.8 percent of the watershed is covered by impervious surfaces (roadways, houses, etc.) that to some degree may have use of road deicing chemicals.



3.5 Ground Water Sampling and Laboratory Analysis

Material, Methods and Equipment Utilized:

On September 12, 2024, HEA sampled ground water from four locations (P1-P4) around Stiles Pond, **Figure 2**. Samples were collected by advancing a temporary, stainless steel, small diameter pipe with an end-screen section (referred to as a micro-well or interstitial pore water sampler) approximately 3 feet into the sediment surface and approximately 5 to 10 feet off the shoreline. The well volume was then purged using a small peristaltic pump and silicon tubing until well-purge water sonde readings for pH, conductivity and temperature stabilized. Water samples were then pumped at a low flow rate through an in-line 45 micron filter into pre-preserved, laboratory-supplied bottles. The filter was used to remove purge-water suspended solids (silts and clay) disturbed during sampling. All bottles were labeled as to sample location, date, time and requested analysis and placed in a sample cooler with ice to cool the samples to less than 4 degrees Celsius.

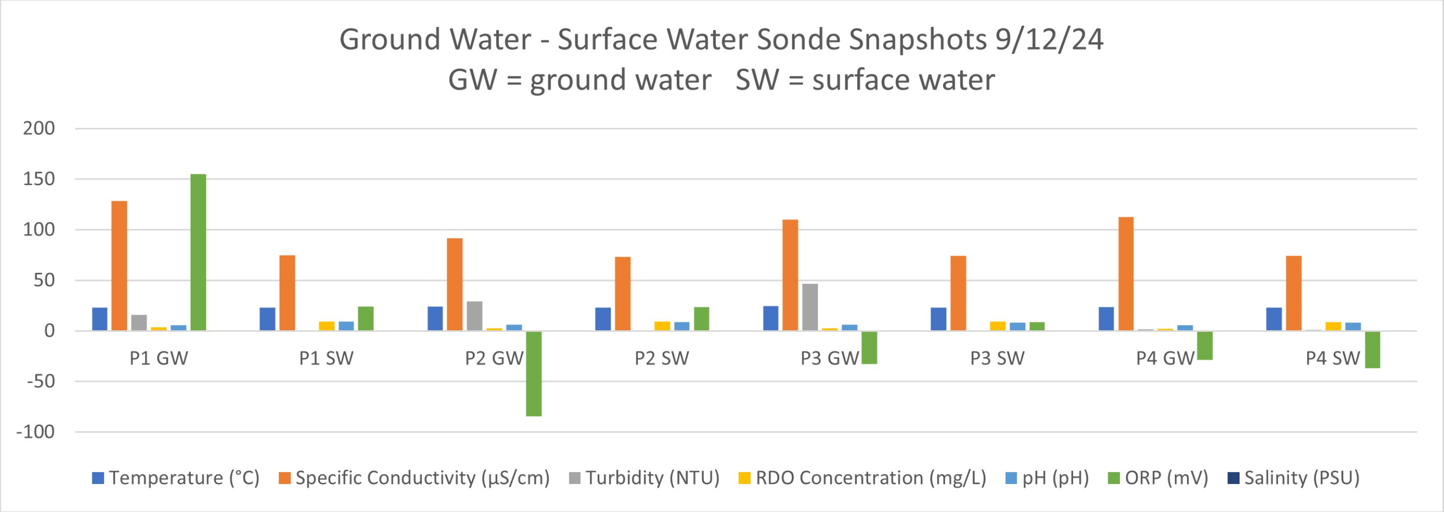
Field and Laboratory Data:

Sonde snapshot readings of ground water and surface water were obtained during ground water sampling at each sample location (P1-P4, **Figure 2**). Laboratory results for ground water samples are summarized in **Table 2 - Ground Water Sample Results** (attached) which includes ground water data obtained previously by KV in September 1994. At the end of ground water sampling at each location, the relative pressure-head difference between surface water and ground water was measured by creating a u-tube manometer using a portion of the well-discharge silicon tubing filled with ground water and lowered in part (the u-tube) below the surface water surface. If the water level within the tubing is higher than the surface water surface, it would indicate a positive hydrostatic pressure head (*i.e.*, a potential for ground water to discharge to surface water); below the water surface would be a negative pressure head (*i.e.*, a potential for surface water to discharge to ground water). Some minor positive pressure head can be expected just from the weight of soil (lithostatic pressure) above the ground water sample screen intake.

Ground Water Sample Pressure Head, Sonde and Analytical Findings

As discussed previously, the pressure head difference at each ground water sample point was: approximately +3/4 inch at P1, 0 inches at P2, and + 1 inch at P3 and P4. However, as also discussed in **Section 2**, within a week or two prior to ground water sampling, debris blocking water flow through the outlet were removed by the Town and surface water elevations (as measured by HEA) dropped by approximately 10 inches. So, the potential for surface water to discharge to ground water would have been higher prior to ground water sampling; higher since at least early June based on HEA's field measurements of surface water elevation at the outlet structure.

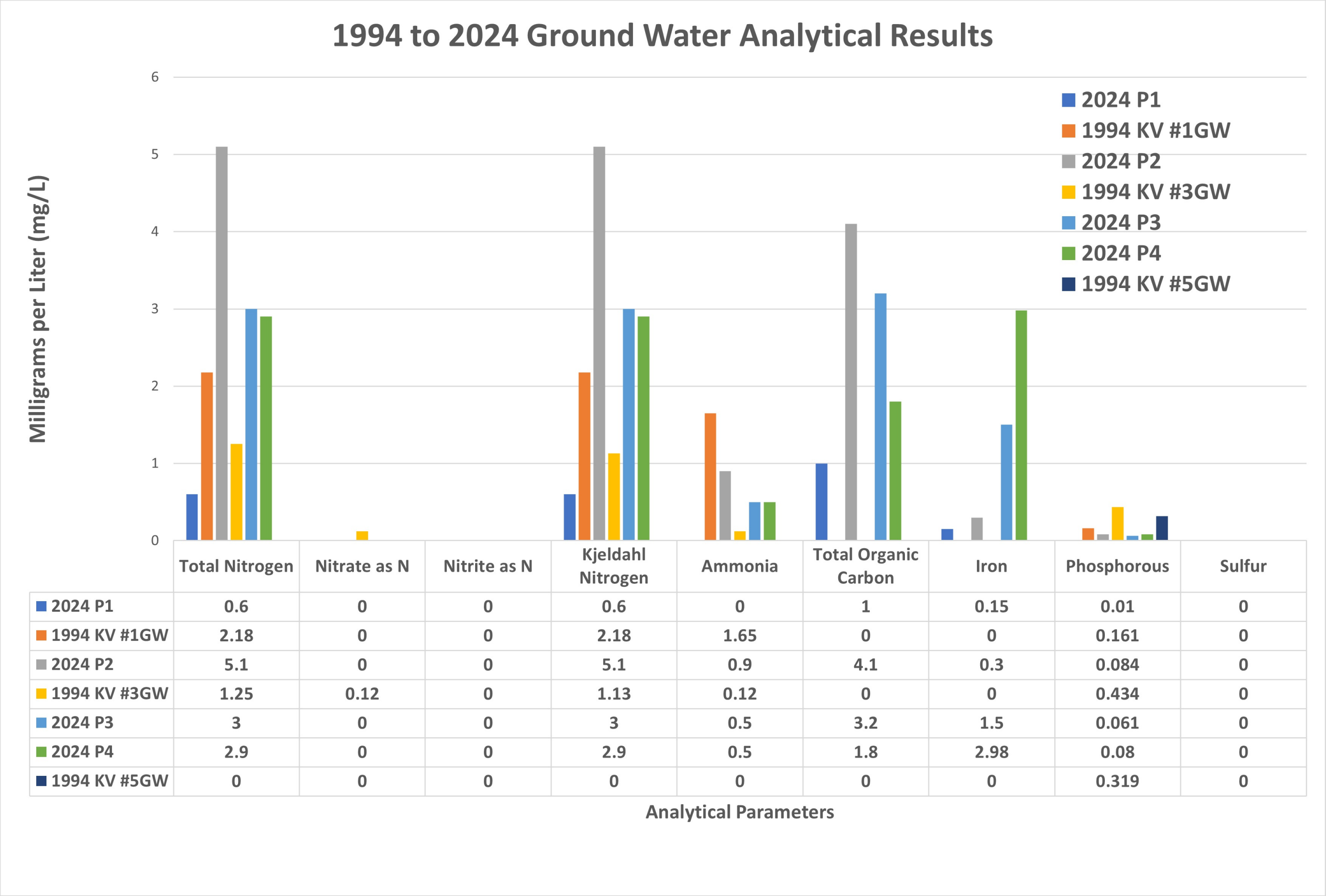
Sonde snapshot readings from ground water, as noted in the following chart and table (also presented in **Section 2**) indicate that the basic chemistry of ground water was different than surface water at the same locations. This indicates that ground water samples for laboratory analysis were more representative of ground water than surface water. There was also some variance in ground water quality based on sonde readings between sampling locations (P1-P4). Surface water sonde readings were fairly consistent between locations P1-P4. The following chart and table helps to illustrate this.



Sample Location and Type	Temperature (°C)	Specific Conductivity (µS/cm)	Turbidity (NTU)	RDO Concentration (mg/L)	pH (pH)	ORP (mV)	Salinity (PSU)
P1 GW	23.24	128.22	15.87	3.40	5.63	155.03	0.06
P1 SW	22.83	74.93	0.40	9.37	8.96	24.08	0.03
P2 GW	24.16	91.51	29.04	2.64	6.00	-84.67	0.04
P2 SW	22.90	73.34	0.34	9.17	8.53	23.46	0.03
P3 GW	24.33	109.96	46.77	2.44	6.38	-32.65	0.05
P3 SW	23.19	74.29	0.43	9.00	8.34	8.81	0.03
P4 GW	23.39	112.47	1.39	2.12	5.75	-28.80	0.05
P4 SW	23.07	74.26	1.08	8.85	8.10	-36.89	0.03

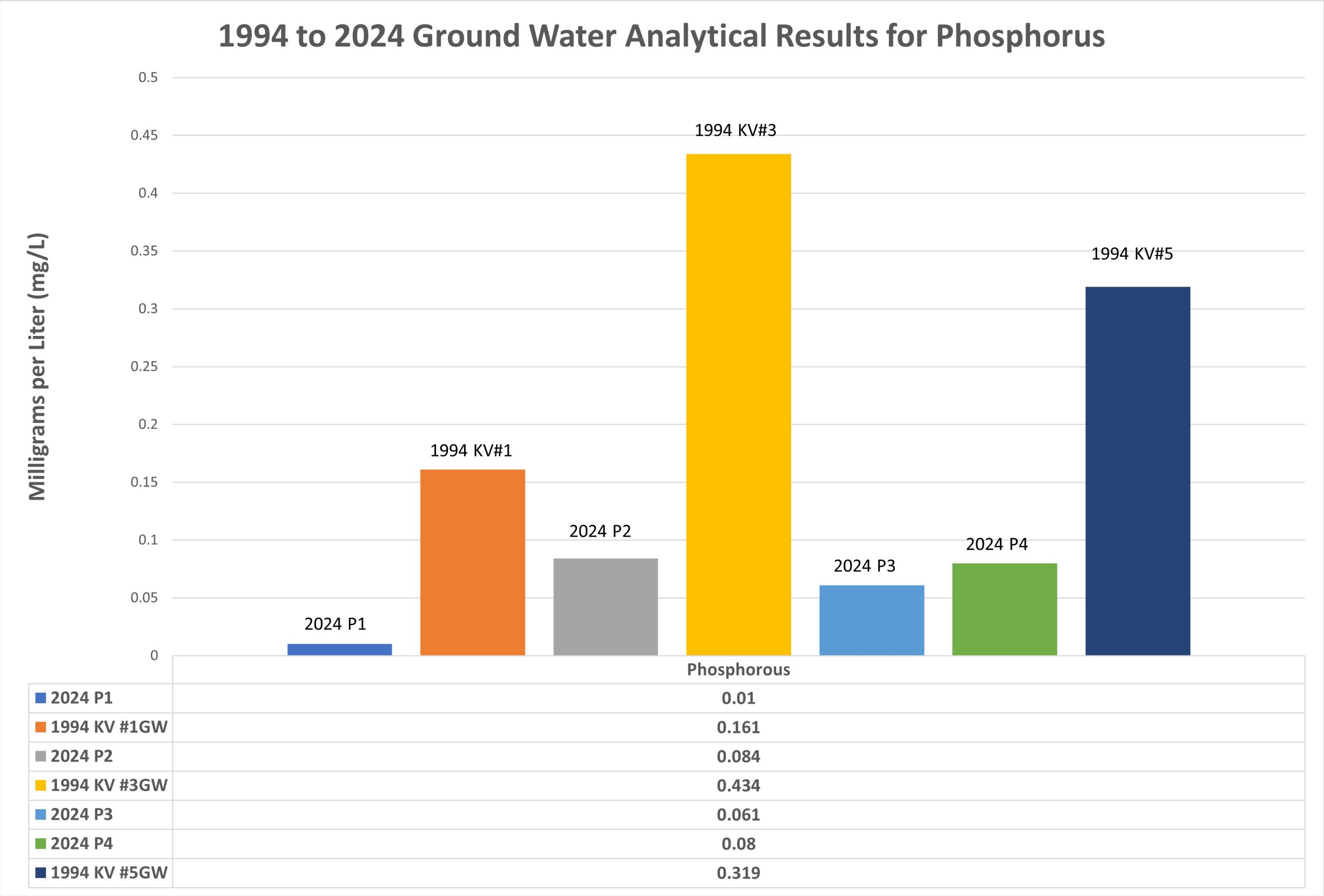
A comparison of 1994 to 2024 laboratory results for ground water, **Table 2**, indicates that total nitrogen (which did include a breakout of nitrogen components) results in 2024 were variable compared to 1994 results. In 2024, the total nitrogen result at P2 was approximately 40 percent or more higher than all other 2024 locations and higher than total nitrogen samples from 1994. Phosphorus concentrations in 1994 were more than ten times greater than that detected at all stations in 2024. KV did not indicate ground water sampling locations on a map but their report discussed ground water samples being collected from areas interpreted by them as having septic leachate breakout(s) to surface water (based on odor and field measurements). Based on a detailed review of KV's work and their narrative reference to ground water sample locations, HEA understands that 2024 P1 would be very close to KV's #1 GW; P2 (inlet) is close to KV's #3 GW; and, P3 is close to KV's #4 SW. KV's #4 GW sample was apparently off the south side of the public beach and not a location preferenced by HEA for sampling. HEA's final P4 ground water sample was collected from another KV area of apparent septic leachate outbreak (#41 and #41 on KV's Figure 6 - Observed Leachate Plumes) which also corresponded to a small ephemeral stream-like drainage feature where HEA later collected a storm water sample from, **Figure 2**.

The following chart is provided to help illustrate ground water quality nutrient content differences between 1994 and 2024. HEA has grouped P1next to KV#1, P2 next to KV#3, and P3-P4 next to KV's #5 as discussed above.



	Total Nitrogen	Nitrate as N	Nitrite as N	Kjeldahl Nitrogen	Ammonia	Total Organic Carbon	Iron	Phosphorous	Sulfur
2024 P1	0.6	0	0	0.6	0	1	0.15	0.01	0
1994 KV #1GW	2.18	0	0	2.18	1.65	0	0	0.161	0
2024 P2	5.1	0	0	5.1	0.9	4.1	0.3	0.084	0
1994 KV #3GW	1.25	0.12	0	1.13	0.12	0	0	0.434	0
2024 P3	3	0	0	3	0.5	3.2	1.5	0.061	0
2024 P4	2.9	0	0	2.9	0.5	1.8	2.98	0.08	0
1994 KV #5GW	0	0	0	0	0	0	0	0.319	0

KV reported that 1994 sample #5 GW had insufficient sample volume and only reported a value for the nutrient phosphorus. Chloride is not a nutrient and is not charted on the above graph. However, chloride results in 1994 and 2024 were not indicative of road way deicing chemical use entering the pond from the watershed. 2024 results for total phosphorus were much lower than reported in 1994 and as such are not readily apparent visually on the preceding graph. As an aid to the reader of this report, a separate graph and table for just phosphorus follows:



	Phosphorous
🟦 2024 P1	0.01
🟧 1994 KV #1GW	0.161
⬜ 2024 P2	0.084
🟨 1994 KV #3GW	0.434
🟦 2024 P3	0.061
🟩 2024 P4	0.08
🟦 1994 KV #5GW	0.319

During KV's sampling, they reported septic-like odors and presence of cold water seeps (by hand, and as reported to them by pond users). In 1994, the outlet also had measured flows of 86.2 cfm. It would appear based on KV's 1994 laboratory results, field notes, and measured outlet flows, that ground water and related nutrients were actively entering the pond from most shoreline areas.

3.6 Sediment, Benthic Macrophyte Sampling and Laboratory Analysis

Material, Methods and Equipment Utilized:

Sediment quality assessments and sampling (total of ten samples in 2024) were collected on June 4 and September 11 (from the center deep basin and three littoral (shallow water) sample location). On June 4, the center basin sediment sample was collected using a gravity corer and partitioned into three samples (top 2 inches "TC", mid-point at four inches "MC", and base at six inches "BC" of core). Littoral samples were collected from the top two inches of sediment using a macroinvertebrate sampling style "D" net with cloth covered screen area from shallow, approximately two to three feet deep water within 20 feet of shorelines. One littoral sample was collected to the south of the center basin and designated "LSC"; another to the north of the center basin "LNC" and the final sample from just outside the inlet designated "LW TRIB". On September 11, 2024, a composite sample of benthic macrophyte (flat-leaf pondweed) was collected from approximately 6 feet of water off shore from the LSC sample location. The sample was collected using a rake, gently agitating suspended sediments off the plant matter, and by cutting up and compositing plant material from above the sediment surface (*i.e.*, no roots). Laboratory results for this benthic macrophyte are discussed at the end of this section.

On September 11, sediment samples were again collected from the same June 4 locations using the same methods and sample intervals but only the top two inches of sediment core from the center basin was collected for laboratory analysis. September 11 samples were designated using the same code as the June 4 samples but with a "2" at the end as follows: TC2; LSC2; LNC2; and, LW TRIB2. Sediment sampling stations are depicted on **Figure 2**.

All samples were labeled, cooled to less than 4 degrees Celsius in a sample cooler and provided under chain-of-custody documentation to a Massachusetts-certified laboratory for analysis using EPA methods for the nutrients (as totals): nitrogen, phosphorus, organic carbon, iron and sulfur.

Field and Laboratory Data:

The June 4 core sample retrieved a total of six inches of light to medium brown-colored sediment with visible layering and no apparent odors. The September 11 center basin gravity core sample retrieved a total of 10 inches of sediment and the top two inches "TC2" were sampled for laboratory analysis. On September 11, the upper sediment layer in the center basin was grey-brown in color with visible layering and no odors. Sediment cores from June and September had no visible green- or brown- colored leaf, twig, plant or algae-like materials.

Numerous core sampling attempts were required on both June 4 and September 11 to obtain intact core samples of sediment that contained visible layering and no disturbance of the upper, almost smoke-like sediment surface. At times, gravity core attempts contained sediment-entrained pockets of some type of gas, possibly methane

(CH_4). There was no distinct or readily apparent odors given off from sediment cores. On July 3, HEA also evaluated sediment quality on an east-west transect through the center basin and observed that the upper two inches of sediment coloration ranged from brown, to light brown to reddish-brown from west to east through the center basin, including from within the inlet area.

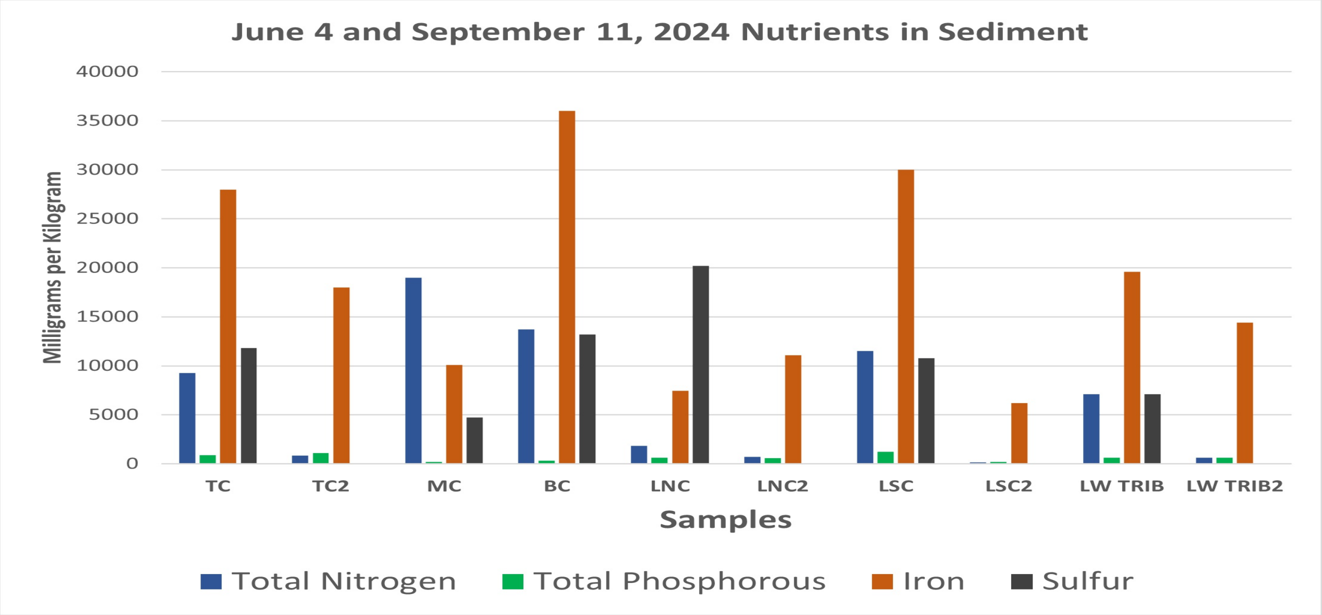
Laboratory results for sediment samples are summarized on **Table 3 - Pollen and Sediment Sample Results** (attached). This table includes solid sample results for tree pollen and from the benthic, macrophyte flat-leaf pondweed, discussed further in **Section 3.4**. Laboratory datasheets are attached.

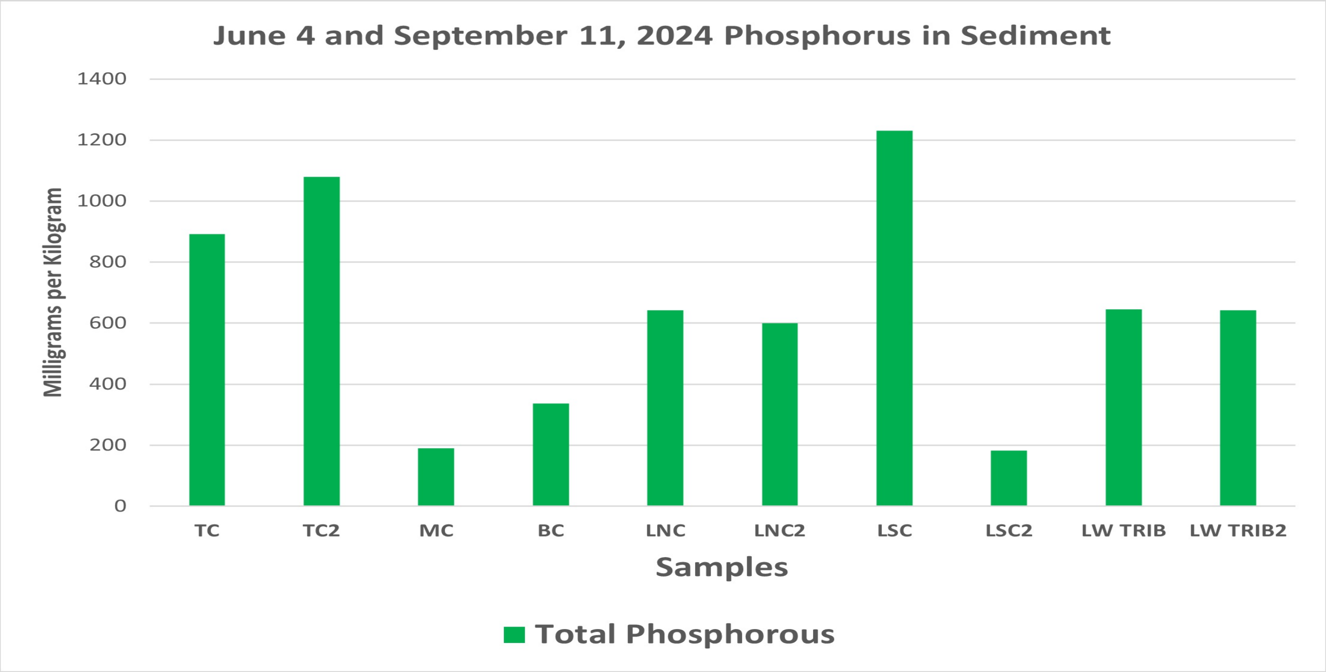
Sediment Quality Findings

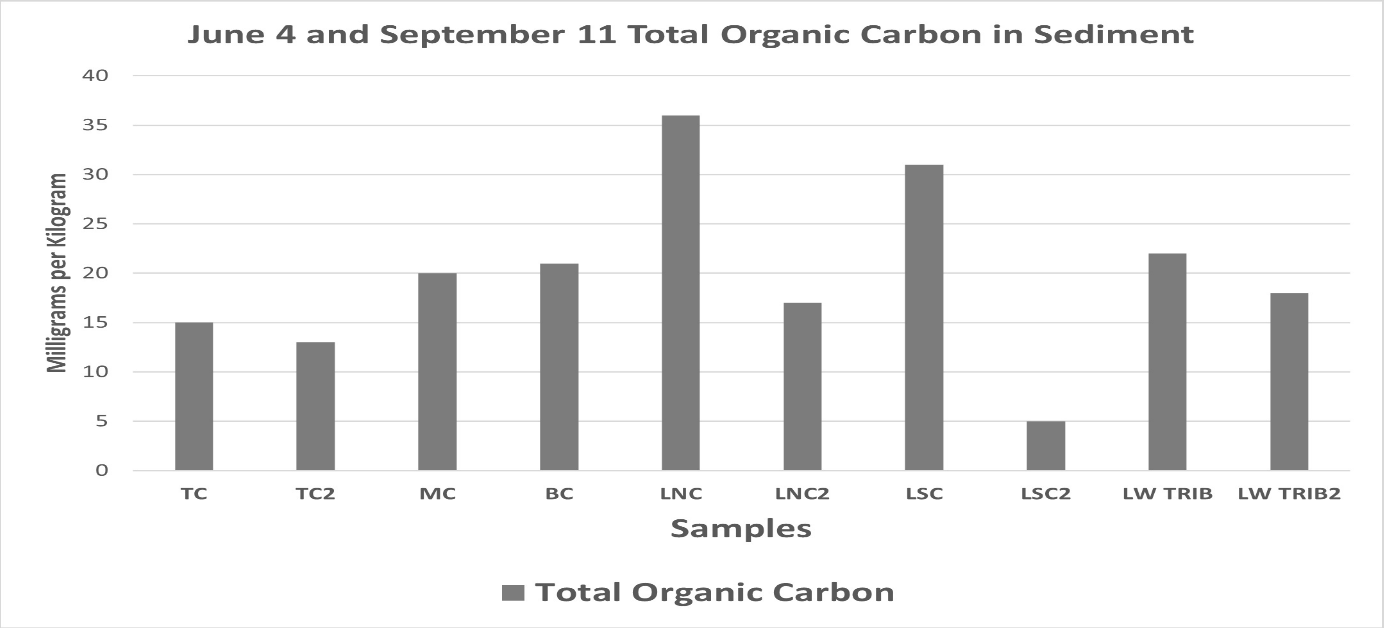
For comparative purposes, HEA is not aware of any past sediment quality assessments by others at Stiles Pond. As such, only 2024 findings are discussed. Sampling of sediment in June and September allowed for an assessment of seasonal gain and loss of nutrients from profundal (deep water) and littoral (shallow) sediment areas of Stiles Pond. The deeper core sediment samples MC and BC allow for an assessment of the historic, nutrient content of sediment accumulated over time.

The water quality of lakes and ponds are affected by external and internal sources of nutrients either imported each year from the contributing watershed area (surface-, ground- and storm water flows as applicable), from wet and dry deposition (rain, dust, pollen and forest particulates), waterfowl, stocked fish, swimmers and from the natural or induced, internal re-cycling of nutrients from pond-solid materials. Pond solids include sediment, bedrock and organic material (aquatic plants, algae, fish, shellfish and phytoplankton). When imported and pond-solids nutrients are released to surface water, they are available for uptake and production (growth) by phytoplankton, fish and shellfish, and aquatic plants. Some types of cyanobacteria can obtain nutrients directly from organic matter and sediment.

Sampling of sediment in the spring and fall allows for an assessment of the overall flux (magnitude and direction) of this internal, seasonal and re-cycling input of nutrients to surface water. The initial June sediment sampling round would capture more of the nutrients at the sediment surface before uptake and use of nutrients by phytoplankton. The September sampling results when compared to early June results, would indicate the flux (gain or loss) of nutrient mass in sediment during the summer when living organic matter (aquatic plants and phytoplankton) productivity in the water column is often at its peak due to more sunlight, higher water temperatures and overall higher biologic activity. The following charts help to illustrate the overall nutrient flux between sediment and surface water at Stiles Pond. As a reminder, samples collected in September include a “2" designation and MC (4") and BC (6") are representative of deeper-historically-deposited sediment nutrients at Stiles Pond. All laboratory data for sediment is summarized on **Table 3**, attached.


June 4 and September 11, 2024 Nutrients in Sediment
Milligrams per Kilogram
40000
35000
30000
25000
20000
15000
10000
5000
0
TC
TC2
MC
BC
LNC
LNC2
LSC
LSC2
LW TRIB
LW TRIB2
Samples
Total Nitrogen
Total Phosphorous
Iron
Sulfur


June 4 and September 11, 2024 Phosphorus in Sediment
Milligrams per Kilogram
1400
1200
1000
800
600
400
200
0
TC
TC2
MC
BC
LNC
LNC2
LSC
LSC2
LW TRIB
LW TRIB2
Samples
Total Phosphorous



The top 1 to 2 inches of sediment will contain the most actively-utilized, available and deposited suspended solids and nutrients from phytoplankton, seston, detritus and biogeochemically-active nutrient recycling.

Center Basin Core Samples

Center basin deep sediments (MC and BC) had lower concentrations for phosphorus, higher amounts of total nitrogen and more total carbon than upper (top 2 inch, TC and TC2) sediments. Iron and sulfur concentrations were variable between upper (TC), mid-core (MC) and bottom core (BC) samples from the center basin. It is a bit unusual to have higher total nitrogen concentrations with depth as nitrogen is subject to denitrification and off-gasing during biogeochemical processes over time. Sediment cores contained visible gas pockets so there may be a source of nitrogen entering the pond from below the sediments, such as from bedrock fractures. The thickness of soft sediment (6 to 10 inches) in the center basin was also lower than expected for a pond that likely has been present since glacial retreat approximately 10,000 years ago. It may be that during impounding of the pond circa mid-1800s for a nearby "match manufacturing company" that some form of dredging or bedrock removal occurred. Addition of nitrogen and possibly dissolved oxygen below the sediment, via bedrock fractures may also result in reduced sediment accumulation by increased biodegradation and breakdown of settling suspended solids (detritus and seston). The increase in total carbon at depth (MC and BC) compared to TC and TC2 would tend to indicate increased biodegradation with sediment depth over time. The difficulty in obtaining intact sediment cores, with visible sediment layering and an undisturbed sediment/water surface may also indicate that sediments in the center basin are more "active" biologically and physically (ebullition of gases, inflow of bedrock fracture water).

An evaluation of nearby bedrock water quality for the same nutrients tested for sediment would help to evaluate whether bedrock water quality is affecting (adding nutrients, altering biogeochemical cycling and influencing the hydrologic budget) of Stiles Pond. KV reported notable amounts of bedrock fracture ground water contribution (colder water than surface water) around the ponds perimeter than observed or measured by HEA in 2024. The surface water elevation in 2024 was slightly higher than 1994 when water was discharging (measured on August 25, 1994) at 86.2 cfm. HEA also did not measure changes in pond water temperature with depth on north-south and east west transects through the center basin that may indicate a strong contribution of bedrock fracture-flow of ground water into the pond. Lower flow rates of ground water entering the pond from bedrock fractures may be occurring in deeper areas of the pond than measured by HEA. The second half of 2024 was a drought year with minimal rain but compared to other ponds with no surface water discharge (similar to Stiles Pond in 2024), the surface water elevation (i.e., pond water volume) at Stiles Pond remained fairly constant based on surface elevation monitoring at the outlet, until clearing of debris and a drop in water elevation of approximately 10 inches sometime between August 21 and September 11, 2024. Surface water elevations began to rise again, though, irrespective of significant rain events, so some long term contribution of ground water from bedrock, more likely from deeper pond areas in 2024 compared to 1994, is plausible.

In terms of the sediment-water (internal loading from sediment) flux for phosphorus (the limiting nutrient for Stiles Pond), the deep basin top two inches (TC and TC2) of sediment gained more phosphorus over the season than lost even under anoxic (DO<1mg/L) conditions. The overall sediment-water flux of iron and sulfur was losing to surface waters from June to September. As iron is reduced (Fe+3 to Fe+2) it becomes soluble and the process releases nutrients such as phosphorus but as the soluble iron encounters an oxic layer, it is converted back to Fe+3 (an insoluble form of iron) and binds to and scavenges reactive (soluble) phosphorus out of the water column as part of the natural ferris cycle. The net flux for phosphorus at Stiles Pond is downward (gaining) of phosphorus at center basin deep sediment surface. However, historically, phosphorus concentrations at depth (MC and BC) are lower than more recent (TC) upper sediments indicating that either: 1) more phosphorus is being introduced and recycled than in the past; or, 2) there is some biogeochemical process that continues to remove phosphorus from deeper sediment layers over time which for Stiles Pond may be related to underlying bedrock fracture water and nutrient flow (contribution). The lower concentration of phosphorus at MC compared to BC and with the highest concentrations at TC would tend to indicate that more phosphorus is being added, externally, to Stiles Pond than in the past. This sediment nutrient profile (decreasing phosphorus with depth; TC was higher than both MC and BC), is an indicator of more recent eutrophic (i.e., nutrient-rich and higher biologic productivity than degradation) conditions at Stiles Pond than in the past (50 or more years ago).

Littoral (shallow water) Sediment Samples

The littoral, top two-inch sediment samples (LSC, LNC and LW TRIB for June and same with a “2" for September samples) had an overall release of sulfur and carbon and either a slight (LNC and LW TRIB) to large

(LSC) release of phosphorus and iron (except at LNC) from June to September. With the exception for sulfur, the LNC and LNC2 samples had the lowest concentrations for carbon, iron, nitrogen and phosphorus (except LSC2) than other littoral (LSC and LW TRIB) or the upper sediment (TC and TC2) from the center deep basin. Littoral sediment concentrations are an indicator of the amount of nutrients accumulated (settling seston, algae and phytoplankton) and released seasonally from shallow areas of the pond. Based on laboratory data, the LNC and LW TRIB locations at Stiles Pond are less of an active accumulation and release littoral area of Stiles Pond than the LSC location. The LSC location is along the primary "down wind" side of the pond and more nutrients may settle here (southern shore) than elsewhere. The LW TRIB sample is also on the southern shore but this (eastern one third) of Stiles Pond is shallower and has outcroppings of bedrock and more submergent macrophytes (lily pads) than the western two thirds of the pond where LSC is located. So, more nutrients would likely be carried into the LSC sampling area by wind and shallow water currents than at LW TRIB; even less so for LNC on the relatively up wind side of the pond. Littoral sediment samples were not collected from dense areas of flat-leaf pondweed and sediment samples were sieved to remove macro-organic matter such as plant parts, leaves and twigs.

Benthic Macrophyte Laboratory Sample Results and Findings

The highest concentration of the nutrient phosphorus at 2,020 mg/kg was detected from flat-leaf pondweed plant matter; a solid media sample. Flat-leaf pondweed occurs extensively around Stiles Pond from approximately 1 to 14 feet in water depth and has been noted by KV (1994) and by KV's reference by MassDEQE (now MassDEP) in 1978. It is a native aquatic plant species that would seasonally take up (by growth) and release (by decay) nutrients, oxygenate the water and provide habitat for aquatic species (insects, shellfish, fish).

It had lower total nitrogen than all sediment samples except at LNC (June), non-detectable concentrations for sulfur, the lowest concentration for iron, and the highest concentration for total carbon compared to sediment samples.

There are fixed and mobile pools of nutrients that vary seasonally in water bodies. The benthic macrophytes would represent more of a fixed pool of nutrients (*i.e.*, limited flux loss) as they are fixed to the sediment surface and are present through much of the growing season and to a large degree hold onto nutrients in their roots, plant matter and on sediment around their growth areas from one year to the next, if not disturbed or killed off for some reason (lack of sunlight penetration, use of some chemicals or pesticides or physical removal). Submergent plants like flat-leaf pondweed would also tend to collect and retain suspended solids including phytoplankton moving around the pond. Based on HEA's experience, the nutrient content of plants like flatleaf pondweed also increase in relation to nutrient availability from pond water and sediment.

3.7 Dry and Wet Deposition, Stormwater Sampling and Laboratory Analysis

Material, Methods and Equipment Utilized:

Based on HEA's knowledge, there has been no prior sampling or evaluation of local dry, wet or storm water quality pertinent to Stiles Pond by others. Dry deposition (dust, tree pollen and forest particulates), wet deposition (rain water), and storm water (first flush during a rain event) were collected by HEA as part of this assessment for laboratory analysis for the nutrients: total carbon, iron, nitrogen, phosphorus and sulfur. The storm water sample included laboratory analysis for total chloride and a breakout of total nitrogen (Kjeldahl-N, Nitrate-N and Ammonium-N). Laboratory results are summarized on **Table 1** (for precipitation and storm water) and on **Table 3** (for dry deposition - mostly tree pollen). All samples were submitted for laboratory analysis to a Massachusetts-certified laboratory utilizing EPA methods and quality control/assurance documented procedures.

All samples were labeled, cooled to less than 4 degrees Celsius in a sample cooler and provided under chain-of-custody documentation to the laboratory.

Field and Laboratory Data:

The dry deposition sample was collected on June 4, 2024 and designated as "Pollen 1" as it contained mostly tree pollen. The sample was collected as a composite of dry deposition floating on the water surface along and just off the southern shore of Stiles Pond, near sediment sample LSC. HEA's scope of work was not approved until June 28th and this (June 4th) sample was kept frozen until receiving authorization to complete this assessment.

The wet deposition (rain water) sample was collected on August 20, 2024 from a clean container open to falling rain water placed at the outlet structure, away from surrounding trees. The container was set up at the end of day on August 19th and retrieved the following morning (August 20th) after an approximately one-half inch rainfall. All visible forest particulates (several pine needles and similar) were removed before decanting water into laboratory-supplied, and pre-preserved bottles.

The storm water sample was collected on September 23, 2024. The sample was located within a then dry, ephemeral stream channel in a manner to collect any first flush of storm water. Approximately one inch of rain fell and HEA collected a first flush of storm water, removed any visible forest particulates and decanted water directly into laboratory-supplied and pre-preserved bottles. The ephemeral stream channel originates from a primarily forested contributing watershed section off Baynes Hill to Stiles Pond, **Figure 2**. Storm water within infiltrated surrounding soil before reaching Stiles Pond. A more robust precipitation event may have led to a direct storm water flow into Stiles Pond but would not likely be sustained in duration.

Dry, Wet and Storm Water Quality Findings

The dry deposition (Tree Pollen 1) sample had the second highest concentration of phosphorus at 1,890 mg/kg after the benthic macrophyte solid sample (2,020 mg/kg). Total carbon at 51 percent was higher than any other sample. Other nutrients (iron, nitrogen and sulfur) were moderate in concentration compared to other samples. Dry deposition can originate from both the air- and water-shed contributing area to Stiles Pond. The contributing airshed is defined primarily by predominant wind direction (towards the southeast to south at Stiles Pond) and the air-borne carry distance for air-borne particulates (dust, pollen and similar). Nearby sources of dry deposition, such as from trees or cultivated, built up land areas would contribute more dry deposition than other general and more distance land uses. Some very large emitters of air-borne dust such as incinerators or large scale, soil exposed farm areas can provide dry deposition over a larger, more distant area of the contributing air-shed. Much of New England's wet and dry deposition referred to as acid rain was sourced from the coal-burning plants in the Ohio River Valley (approximately 750 miles to the west of Boxford). Local air-sheds can be significant contributors but often neglected dry deposition, external nutrient source loading to ponds and after tree pollen season (by early July), the water clarity of Stiles Pond dropped by 50 percent (from 11 feet on June 4 to 5.6 feet on July 30) and tree pollen was coating the surface of the pond and cars at the boat launch and public beach (HEA direct observation).

The wet deposition (Wet Prec 1) sample had the lowest concentration of nutrients than any other water sample. Only total nitrogen at 3.4 mg/L and total carbon at 1.7 mg/L were reported as being detected by the laboratory. The quality and nutrient content of wet deposition can be expected to vary seasonally to some degree, especially if collected during tree pollen season or after a very dry, dusty time of year, or if there is a significant source(s) of dust generation nearby such as from construction, sand and gravel mining, and cultivated farm land. There are none of the later to any significance within the contributing air- and water-shed to Stiles Pond.

The storm water (STRM1) sample had the highest concentration for phosphorus in water at 0.598 mg/L than any other water sample (pond or precipitation) to date including KV's pond water samples from 1994. The storm water sample also had the second highest concentration for sulfur at 2.9 mg/L. As a forested contributing area primarily (there is a driveway further up-drainage), nutrients are likely related to accumulated tree pollen and forest particulates, natural surface soil and accumulated wet and dry precipitation. Storm water runoff directly into the pond was not observed by HEA or KV and would appear to be limited to ephemeral drainage areas during heavy precipitation events (not captured by HEA or KV). The outlets of ephemeral stream discharge areas to Stiles Pond were not scoured or eroded. Storm water runoff seems to be a minimal external source of nutrient loading to Stiles Pond.

3.8 Phytoplankton and Zooplankton Assessments and Laboratory Analysis

Material, Methods and Equipment Utilized:

As part of our overall assessment of nutrient sources to Stiles Pond, HEA collected in-lake samples for laboratory analysis for phytoplankton (algae identification, enumeration and biovolume/mass) and zooplankton (general microscopic - visual assessment). Water samples were collected using a discrete water sampler at depths of 3 feet and 15 feet (same as water samples for nutrient content). A vertical-composite water sample from 20 feet to the water surface was collected for zooplankton evaluation using a tow net.

Phytoplankton samples were placed into laboratory bottles, placed in a sample container, cooled and shipped overnight for laboratory analysis to GreenWater Labs in Palatka, Florida. The zooplankton tow net sample cannister was decanted into a sample container for microscopic evaluation back at HEA's office later that day.

Field and Laboratory Data:

Two water samples were collected for phytoplankton analysis on August 21, 2024 at the same time and depths (3 and 15 feet) as surface water sampling for nutrients, using the same sampling equipment (discrete water sampler). The 3 foot depth should be representative of phytoplankton communities in upper, high sunlight, oxygenated water conditions which is also where most recreational swimmers and bathers would contact pond water. The sample at 15 feet is below the secchi depth of 5.5 feet (low sunlight) and above the anoxic layer starting around 20 feet and greater. Recreational use of the pond is unlikely to encountered deeper, limited light adapted phytoplankton unless during a mixing period (not observed at Stiles Pond) where deeper waters are brought up into shallower waters by currents and at some water bodies, by thermal-driven mixing between warm and cool waters. Sonde profile readings were taken during sampling.

A vertical-composite, zooplankton sample was collected on August 21 using a 50-micron screened zooplankton tow net lowered to 20 feet below the water surface and retrieved. The tow net sample cannister was then decanted into a sample container for microscopic evaluation back at HEA's office later that day.

Water samples for phytoplankton analysis, were visually free of suspended solids, scums or discoloration. Odors from water during sampling were not apparent. Sonde readings for PC at 3 and 15 feet sampling intervals were approximately 0.67 RFUs, Chl-a at the same depths varied from 0.000012 to 0.11 RFUs. Sonde readings were collected again as a vertical profile on August 23 and had essentially the same readings for PC and Chl-a.

Microscopic analysis for the zooplankton tow indicated the abundant presence of primarily Daphnia and copepods. This was just a general assessment by HEA, a more in-depth assessment by an aquatic biologist or laboratory would provide more detail. Daphnia and copepods are indicators of a healthy water quality for zooplankton communities.

Phytoplankton Assessment Findings:

The following narrative (in italic font) is taken directly from the laboratory report (attached) from GreenWater Laboratories for the shallow water phytoplankton sample (3 foot) collected by HEA from Stiles Pond.

Total cell numbers in the Center Shallow (3 foot) *sample collected on 8/21/24 were 55,628 cells/mL. Blue-green algae (Cyanobacteria; 53,583 cells/mL) was the dominant algal group in the sample accounting for 96.3% of total cell numbers. Other algal groups observed in the sample were diatoms (Bacillariophyceae; 50 cells/mL), desmids (Charophyta; 84 cells/mL), green algae (Chlorophyta; 727 cells/mL), dinoflagellates (Dinoflagellata; 1 cell/mL), euglenoids (Euglenophyta; 3 cells/mL), eustigmatophytes (Eustigmatophyceae; 16 cells/mL) and unknown algae (Unknown; 1,164 cells/mL). The most abundant species in the sample were the filamentous cyanophytes Umezakia ovalisporum (formerly Chrysosporum ovalisporum; 27,634 cells/mL; Fig. 1) and Aphanizomenon flos-aquae/klebahnii (17,453 cells/mL; Fig. 2).* Figures included in their attached report are photographic-microscope images of species referenced.

Total biovolume in the Center Shallow sample collected on 8/21/24 was 4,092,336 um3/mL. Blue-green algae (Cyanobacteria; 3,853,309 um3/mL) was the dominant algal group in the sample in terms of biovolume, accounting for 94.2% of total biovolume. Other algal groups in the sample included diatoms (Bacillariophyceae; 12,258 um3/mL), desmids (Charophyta; 46,078 um3/mL), green algae (Chlorophyta; 58,533 um3/mL), dinoflagellates (Dinoflagellata; 21,356 um3/mL), euglenoids (Euglenophyta; 7,701 um3/mL), eustigmatophytes (Eustigmatophyceae; 1,458 um3/mL) and unknown algae (Unknown; 91,644 um3/mL). The algal species in the sample with the highest biomass were the filamentous cyanophytes Umezakia ovalisporum (1,854,252 um3/mL), Aphanizomenon flos-aquae/klebahnii (1,080,350 um3/mL) and Dolichospermum macrosporum (906,2146 um3/mL; Fig. 3).

Total numbers and biovolume of potentially toxigenic cyanobacteria (PTOX Cyano) were 48,608 cells/mL and 3,845,532 um3/mL respectively. PTOX Cyano taxa observed in the sample included Umezakia ovalisporum (27,634 cells/mL; 1,854,252 um3/mL), Aphanizomenon flos-aquae/klebahnii (17,453 cells/mL; 1,080,350 um3/mL), Dolichospermum macrosporum (3,272 cells/mL; 906,2146 um3/mL), Microcystis sp. (98 cells/mL; 2,608 um3/mL; Fig. 4), Woronichinia naegeliana (115 cells/mL; 1,187 um3/mL; Fig. 5), Dolichospermum cf. mendotae (21 cell/mL; 846 um3/mL; Fig. 6) and Limnothrix/Pseudanabaena sp. (15 cells/mL; 143 uìm3/mL; Fig. 7).

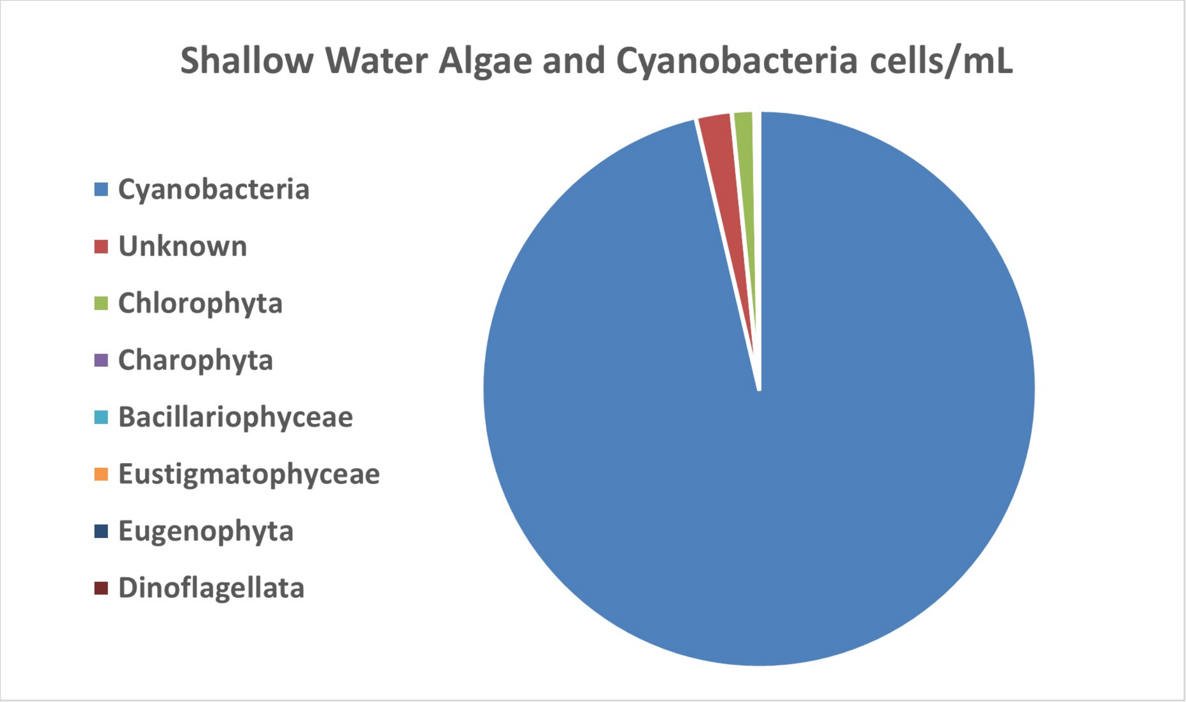
Total biovolume in the Center Shallow sample collected on 8/21/24 was 4,092,336 um3/mL.

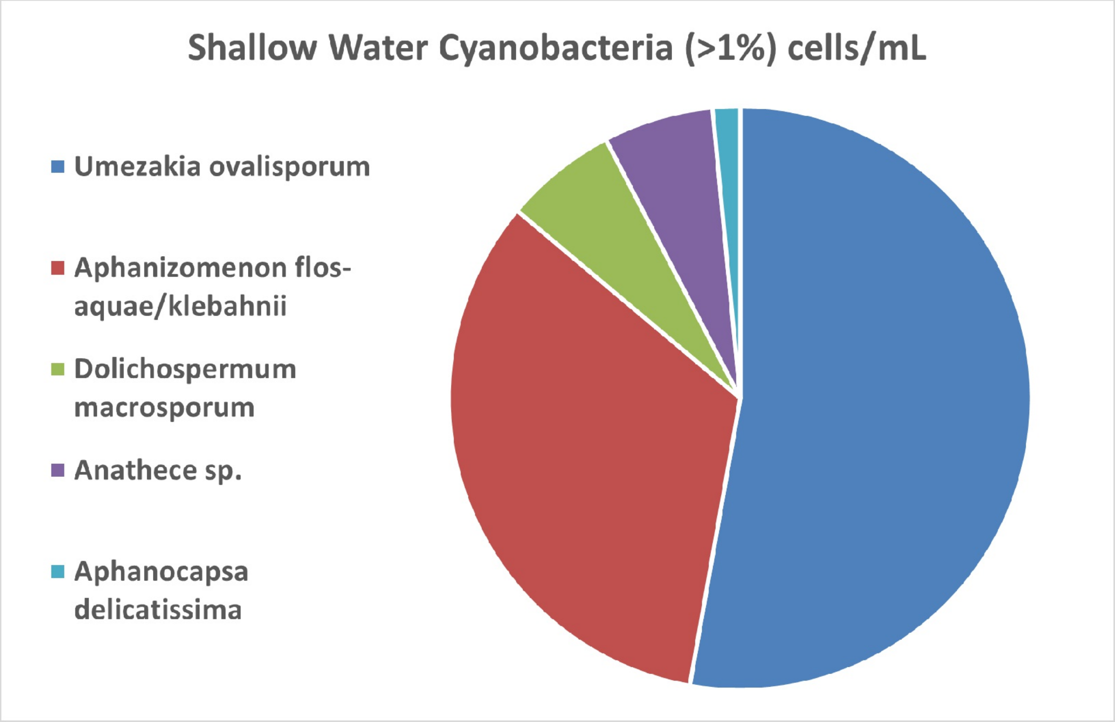
In general, to convert biovolume (BV) in um^{3}/mL to biomass (BM) in (mg/mL). The following equation can be used:

BM (mg/mL) = BV (um^{3}/mL) x 10-9 mL/um^{3} x specific gravity of algae. A specific gravity of 1 is assumed for cellular biomass. As such, the biomass for the center shallow water sample would be 0.0041 mg/mL or 10,498 wet pounds (*i.e.*, 4,762 wet kilograms) for the top 16 feet (mean depth) of the 59 acre pond. Based on laboratory analysis, phytoplankton are approximately 85 percent fluid so converting to dry weight equals 1,575 pounds or 714 kilograms of phytoplankton biomass which was mostly cyanobacteria for Stiles Pond in 2024.

Based on HEA' prior lab testing of cyanobacteria (HEA, 2022 and 2023) at a phosphorus concentration of 1,449 mg/kg dry weight this equates to 2.27 pounds of phosphorus in the shallow standing crop of phytoplankton. Similarly, at a total nitrogen concentration of 9,722 mg/kg dry weight would equate to 15.2 pounds of nitrogen in the shallow standing crop of phytoplankton. HEA's prior assessments (HEA 2022 and 2023) of cyanobacteria and tree pollen indicates that tree pollen can have approximately 20 percent more phosphorus and 30 percent less nitrogen than cyanobacteria. Cyanobacteria, phytoplankton and tree pollen nutrient concentrations can vary based on the availability of nutrients during their formation and growth. Every water body (phytoplankton) and forested area (tree pollen) is different but there are common ranges, again, related to the amount and types of available nutrients. Eutrophic water bodies can be expected to have higher nutrient concentrations in phytoplankton biomass than oligotrophic water bodies; similar for nutrient- rich forested areas (numerous septic systems, agricultural runoff, mineral forms of nutrients in soil) versus nutrient poor areas (upland sandy areas, etc.).

The following pie charts (shallow water - total phytoplankton and then a breakout for cyanobacteria with cells/mL >1 percent) help to illustrate that while cyanobacteria are the dominant species of phytoplankton, there was also a moderately diverse mix of the types of cyanobacteria themselves identified by laboratory analysis.





The following narrative (in italic font) is taken directly from the laboratory report (attached) from GreenWater Laboratories for the deep water phytoplankton sample (15 foot) collected by HEA from Stiles Pond:

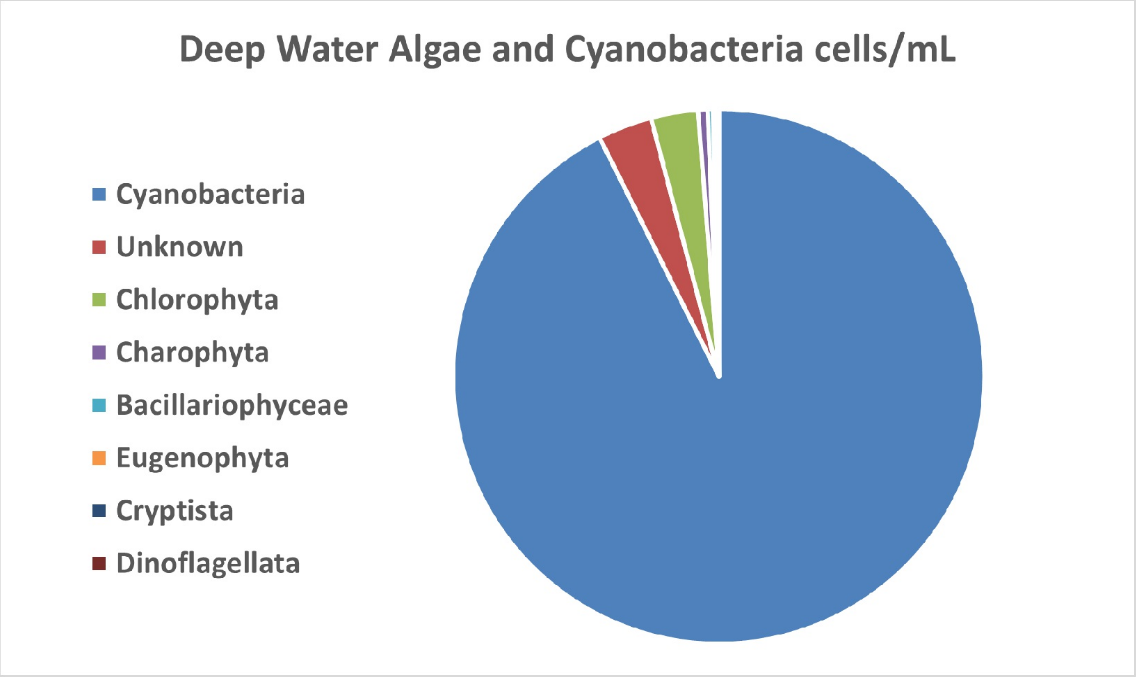
Total cell numbers in the Center Deep sample collected on 8/21/24 were 15,411 cells/mL. Blue-green algae (Cyanobacteria; 14,268 cells/mL) was the dominant algal group in the sample accounting for 92.6% of total cell numbers. Other algal groups observed in the sample were diatoms (Bacillariophyceae; 51 cells/mL), desmids (Charophyta; 89 cells/mL), green algae (Chlorophyta; 441 cells/mL), cryptophytes (Cryptista; 25 cells/mL), dinoflagellates (Dinoflagellata; 1 cell/mL), euglenoids (Euglenophyta; 28 cells/mL) and unknown algae (Unknown; 509 cells/mL). The most abundant species in the sample was the filamentous cyanophyte Planktothrix cf. rubescens (6,676 cells/mL; Fig. 8). Figures included in their attached report are photographic-microscope images of species referenced.

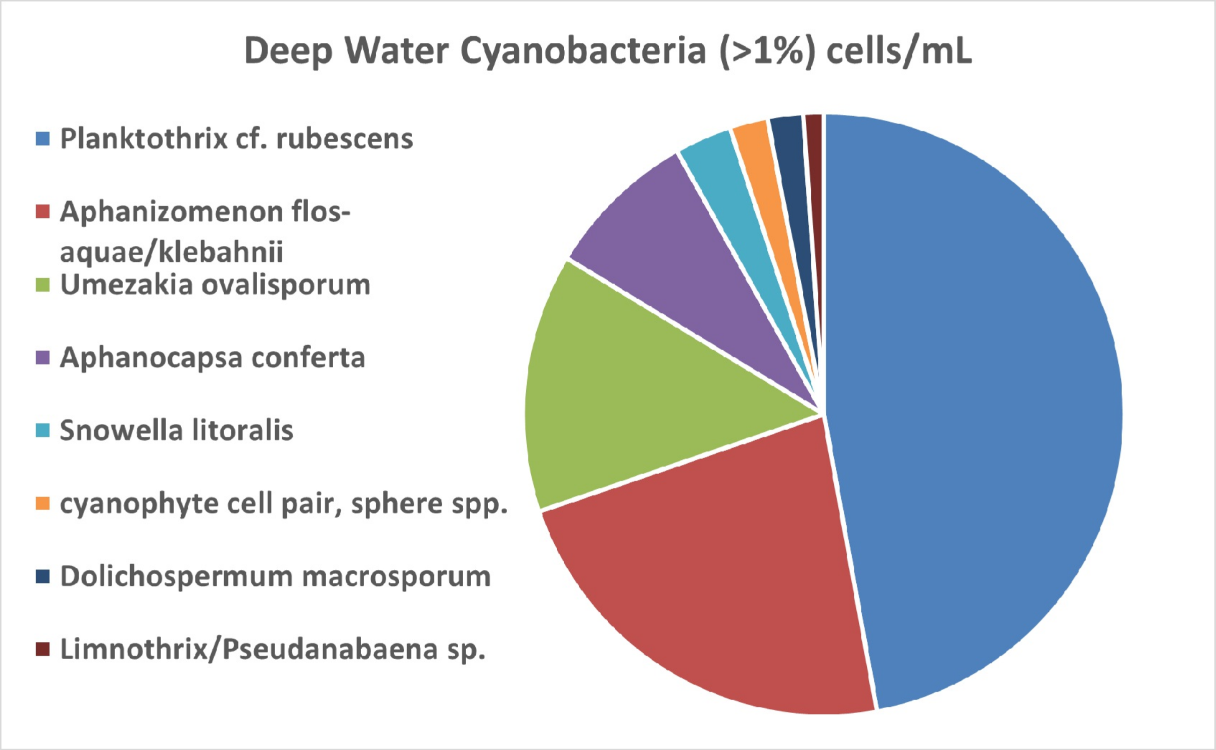
Total biovolume in the Center Deep sample collected on 8/21/24 was 1,101,665 um3/mL. Blue-green algae (Cyanobacteria; 850,671 um3/mL) was the dominant algal group in the sample in terms of biovolume, accounting for 77.2% of total biovolume. Other algal groups in the sample included diatoms (Bacillariophyceae; 10,813 um3/mL), desmids (Charophyta; 41,846 ìm3/mL), green algae (Chlorophyta; 30,906 um3/mL), cryptophytes (Cryptista; 8,044 um3/mL), dinoflagellates (Dinoflagellata; 15,547 um3/mL), euglenoids (Euglenophyta; 86,112 um3/mL) and unknown algae (Unknown; 57,726 um3/mL). The dominant algal species in the sample in terms of biomass was the filamentous cyanophyte Planktothrix cf. rubescens (439,937 um3/mL). Total numbers and biovolume of potentially toxigenic cyanobacteria (PTOX Cyano) were 12,306 cells/mL and 846,402 um3/mL respectively. PTOX Cyano taxa observed in the sample included Planktothrix cf. rubescens (6,676 cells/mL; 439,937 um3/mL), Aphanizomenon flos-aquae/klebahnii (3,200 cells/mL; 198,064 um3/mL), Umezakia ovalisporum (1,963 cells/mL; 131,750 um3/mL), Dolichospermum macrosporum (270 cells/mL; 74,757 um3/mL), Limnothrix/Pseudanabaena sp. (155 cells/mL; 1,461 um3/mL) and Woronichinia naegeliana (42 cells/mL; 433 um3/mL).

Similar to the calculation for the shallow water sample, the deep water sample biomass (BM) equates to 0.0011 mg/mL or 597 dry weight pounds (*i.e.*, 271 dry weight kilograms) of phytoplankton (mostly cyanobacteria in 2024) for the lower 16 feet (mean depth) of the 59 acre pond. Biomass estimates are approximate and can be expected to vary seasonally depending upon nutrient availability and pond-volume changes in phytoplankton biomass.

Similar to estimates for total phosphorus (using 1,449 mg/kg) and nitrogen (using 9,722 mg/kg) content for the shallow water sample, the same nutrient by dry weight values for the deep water phytoplankton sample would equate to 0.86 pounds of phosphorus and 5.73 pounds of nitrogen in the deep water standing crop of phytoplankton.

The deeper (15 foot) sample of pond water still had a population of phytoplankton dominated by cyanobacteria, as illustrated in the following pie charts:


Deep Water Algae and Cyanobacteria cells/mL
Cyanobacteria
Unknown
Chlorophyta
Charophyta
Bacillariophyceae
Eugenophyta
Cryptista
Dinoflagellata


Deep Water Cyanobacteria (>1%) cells/mL
Planktothrix cf. rubescens
Aphanizomenon flos-aquae/klebahnii
Umezakia ovalisporum
Aphanocapsa conferta
Snowella litoralis
cyanophyte cell pair, sphere spp.
Dolichospermum macrosporum
Limnothrix/Pseudanabaena sp.

The deeper water dominant cyanobacteria species also contained nitrogen fixing specie of cyanobacteria but were dominated by Planktothrix cf. rubescens, as compared to the shallow water specie, Umezakia ovalisporum (originally known as Aphanizomenon ovalisporum and then Chrysosporum ovalispoum). Planktothrix rs is capable of storing nitrogen over time, seems to be a more light-limited tolerant cyanobacteria specie, and it's growth-productivity can increase as more sunlight becomes available such as during water current and thermal-induced water mixing where deeper waters move up the water column and can receive more sunlight. There are other more light-limited species in the deep water sample from Stiles Pond such as Limnothrix that may increase in cell count with greater depth under lower light penetration. Some of the light-limited tolerant cyanobacteria specie are also considered an indicator of eutrophic conditions (high productivity and availability of nutrients) which also often has lower light penetration. Light-limited tolerant species can also be found at deeper depths in oligotrophic (low productivity, low nutrient and often higher water clarity) water bodies than other more light-tolerant species such as Microcystis and Dolichospermum.

Summary of Phytoplankton Findings:

Total cell counts for the shallow water (3-foot) sample (representative of potential contact waters for recreational use at Stiles Pond equaled 55,628 cells per milliliter which is less than the Massachusetts health guideline limit of 70,000 cells/milliliter. The deeper water (15 foot) sample had a total cell count of 15,411 cells per milliliter and it's lower biovolume and cell counts relative to the shallow water sample likely relates to light-limited growth conditions with depth. Shallow water phytoplankton cell counts are consistent with nutrient-rich and highly productive (eutrophic) water bodies which is in stark contrast to near oligotrophic (0.013 mg/L to non detectable) concentrations of phosphorus in shallow and deep waters. Seasonal sediment (top 2 inches) concentrations for nutrients indicate that sediments are net gainers of nutrients from June 4 to September 11 and not a source of nutrients supporting noted phytoplankton productivity. Ground water and storm water (over land runoff) were also not (measurable or apparent) contributors of nutrients to Stiles Pond in 2024.

The overall approximated (HEA 2022 and 2023) nutrient content for shallow and deep combined phytoplankton dry-weight biomass equates to 3.13 pounds of phosphorus and 20.93 pounds of nitrogen.

Shallow and deep phytoplankton samples were dominated by a fairly diverse group of cyanobacteria that are also nitrogen-fixers, able to make atmospheric nitrogen (N_2) bio-available as part of a symbiotic relationship with bacteria; similar to some land plants like pea plants. Nitrogen-fixers can be associated with nitrogen limited environments. Based on laboratory results of nutrients in surface water, nitrogen was not considered a limiting nutrient when compared to its molar ratio with phosphorus - indicating phosphorus to be the limiting nutrient. Some types of cyanobacteria are also able to acquire nutrients, including phosphorus directly from organic matter (tree pollen and detrital matter) and sediment in a water body. Most other non-cyanobacteria types of phytoplankton can not fix nitrogen or phosphorus as a means to increase their growth-productivity. It is one of the evolutionary advantages of cyanobacteria over other forms of phytoplankton.

The overall phytoplankton population and biovolume, dominated by diverse, nitrogen-fixing forms of cyanobacteria tends to indicate that Stiles Pond is a highly productive (eutrophic) water body limited by bio-available (soluble) forms of nitrogen and phosphorus in surface water.

Most all phytoplankton and cyanobacteria are negatively-affected by too much sun light and ultraviolet radiation - one of the reasons HEA prefers to collect water samples at 3 feet or greater below the water surface. Sonde data for PC and Chl-a support this as well, less biomass of phytoplankton in the top two feet of the water column typically, unless they are forced into the top two feet of water as part of a larger or condensed bloom movement. This “forcing” can lead to formation of scums containing of UV-damaged phytoplankton at the water surface.

No scums or blooms were noted by HEA in 2024 or by KV in 1994. Blooms have been reported at Stiles Pond in the past and as part of an unrelated assessment by HEA in 2023 (visually apparent and by sonde PC at 3 RFUs and greater; approximately twice or more sonde PC RFUs than detected at shallow depths in 2024.

KV did not complete a direct assessment or laboratory analysis for phytoplankton suspended in water. KV did reference that MassDEQE (1978) had completed this type of assessment and reported a total cell count of 415 cells/mL which KV attributed to mesotrophic conditions. KV did not indicate where this sample was collected or its sampling depth below the water surface. HEA did contact MassDEP several times to obtain a copy of this 1978 report (for Stiles Pond or for Stiles Pond as part of a larger Ipswich River Basin report) but no report was identified by them. Based on HEA’s knowledge, total cell counts for phytoplankton of less than 1,000 cells/mL would be very low even for oligotrophic water bodies. KV summarized MassDEQE’s assessment as indicating the dominant phytoplankton species as diatoms (Asterionell, sp. and euglenids) and Chrysosphaerella sp. plus unidentified flagellates. At that time (sampling apparently) the water clarity was reported at a depth of 11 feet. KV reported no significant change in August 1994 based on their overall visual assessment.

Phytoplankton (as mostly cyanobacteria) cell counts at three foot and fifteen foot depths were significantly higher in 2024 than reported by KV in 1978. Suspended solids (phytoplankton, pollen, etc.) can reduce water clarity as measured by secchi disc and sonde turbidity probe. In August 2024, water clarity at 5.5 to 6 feet was approximately 50 percent less than reported by KV in August 1994 (11 feet) and apparently by MassDEQE in August 1978 (also 11 feet). Water clarity and sonde turbidity measurements collected by HEA in 2024 are discussed in the following section (are discussed in **Section 3.9**). Sonde turbidity was also discussed in **Section 3.3** and **Chart 3**.

3.9 Field Observations, Macrophytes and Water Clarity

Material, Methods and Equipment Utilized:

During each field visit to Stiles Pond, HEA made note of any apparent odors, water discoloration, films or scums, and general types and extent of aquatic macrophytes (plants). HEA also completed several sediment assessment samples around the pond to evaluate overall sediment types and quality and presence/absence of benthic cyanobacteria or algae mats. As noted previously, field work included measuring the pond water elevation (stage) with a rigid tape measure, in inches, relative to a measuring point on the open channel base of the outlet structure. In addition to sonde measurements, water clarity was measured once a month or more, around noon on calm days using a secchi disc without the use of a view scope. Water clarity readings were obtained from the center basin of Stiles Pond and on July 3, 2024 along east-west and north-south transects through the center basin, including within the inlet.

General visual observations of water quality and conditions at Stiles Pond were also noted by HEA during sonde surveys (vertical and perimeter) and sampling of sediment, surface water, dry and wet precipitation and one storm water sample. HEA's observations were most often made from a boat.

Field Data and Findings:

No discrete or notable odors, scums or blooms of phytoplankton or cyanobacteria were observed in 2024. KV had reported numerous instances of septic-like odors around the pond and notable presence of colder water near bedrock outcrops in or immediately next to the pond, none (no odors or colder areas) were noted or measured (temperature variance) using a sonde by HEA. Sediment quality was assessed by HEA on and east-west transect through the pond including within the inlet. Upper (top 2 inches) layers of sediment by coloration ranged from a reddish-brown in eastern portions of the pond, to light brown to darker brown from east to west. There were no apparent odors given off from sediment but during sediment core sampling in June and September within the center basin, entrained gaseous pockets were present in some core samples. By September's sediment sampling event, the upper layer of sediment from the center basin had changed in coloration from light brown-brown to a greyish-brown.

Macrophyte coverage was similar in type but at slightly less of an extent around the pond in 2024 than as noted previously by KV in 1994 and by KV's reference to an earlier 1978 report by MassDEQE. Aquatic vegetation was primarily lily pads in shallow water areas. The extent of flat-leaf pond weed (measured as occurring from 1 to 14 feet around the entire pond by HEA in 2024) has apparently remained unchanged since at least KV's study in 1994.

From late May to the end of August, the four summer camps and public beach were actively used by boaters, bathers and swimmers. There are approximately 30 homes within 300 feet of the ponds' shorelines with another 30 or so within the contributing watershed area. HEA understands that all homes and camps in the watershed are serviced by private potable bedrock wells and septic systems. According to the Boxford Board of Health, some of the septic systems are "tight tanks" and one of the summer camps (Camp Rotary) has moved their earlier septic system further back from the shore than noted during KV's assessment in 1994.

Based on HEA's review of information obtained by KV which included a door to door septic survey with the

Board of Health, there are approximately 600 children that attend summer camp around the pond (essentially 600 children/day for 100 days each year). HEA often observed about 30 people using the town beach for (30/day for 100 days each year). The Town also has a baseball diamond behind the beach area but HEA did not observe use of this during our assessment but assume they would use the same septic system and restrooms as people using the public beach. HEA also observed, routinely, less than 10 people/day from late May to early September (100 day timeframe) using the entire pond for swimming. Some reportedly came from Walden Pond which was closed for part of 2024 due to bacterial levels in pond water. Fisher-people were observed mostly around the trout stocking schedule (spring and fall) and most fished from shore or off the outlet structure earthen-dam or from beach areas in September when the camps and beaches were closed. Very few boaters were observed on the pond except approximately twenty or less small sail boats and kayaks used at times by the summer camps and a few fisherpeople launching from the public boat launch off Stiles Pond Road. Pond swimmers reported good swimming conditions but one noted the pond being like bath water temperature wise (he had been a frequent Walden Pond swimmer).

One resident that swims in the pond reported concerns about “blobs” of algae, based on HEA’s direct inspection these were early-mid season occurrence of metaphyton (a form of green-algae that colonizes around submerged plant) as they are sensitive (die off) in shallower water. Metaphyton were readily observable by HEA from our boat until water clarity decreased from approximately 10 feet to 5.8 feet by July 30th. At that time, HEA observed clumps of metaphyton pushed into shallow areas on the eastern-most side of the pond. Metaphyton are just another form of algae and are not a concern at occurrence amounts observed by HEA (maybe 100 discrete metaphyton colonies from June to July were observed).

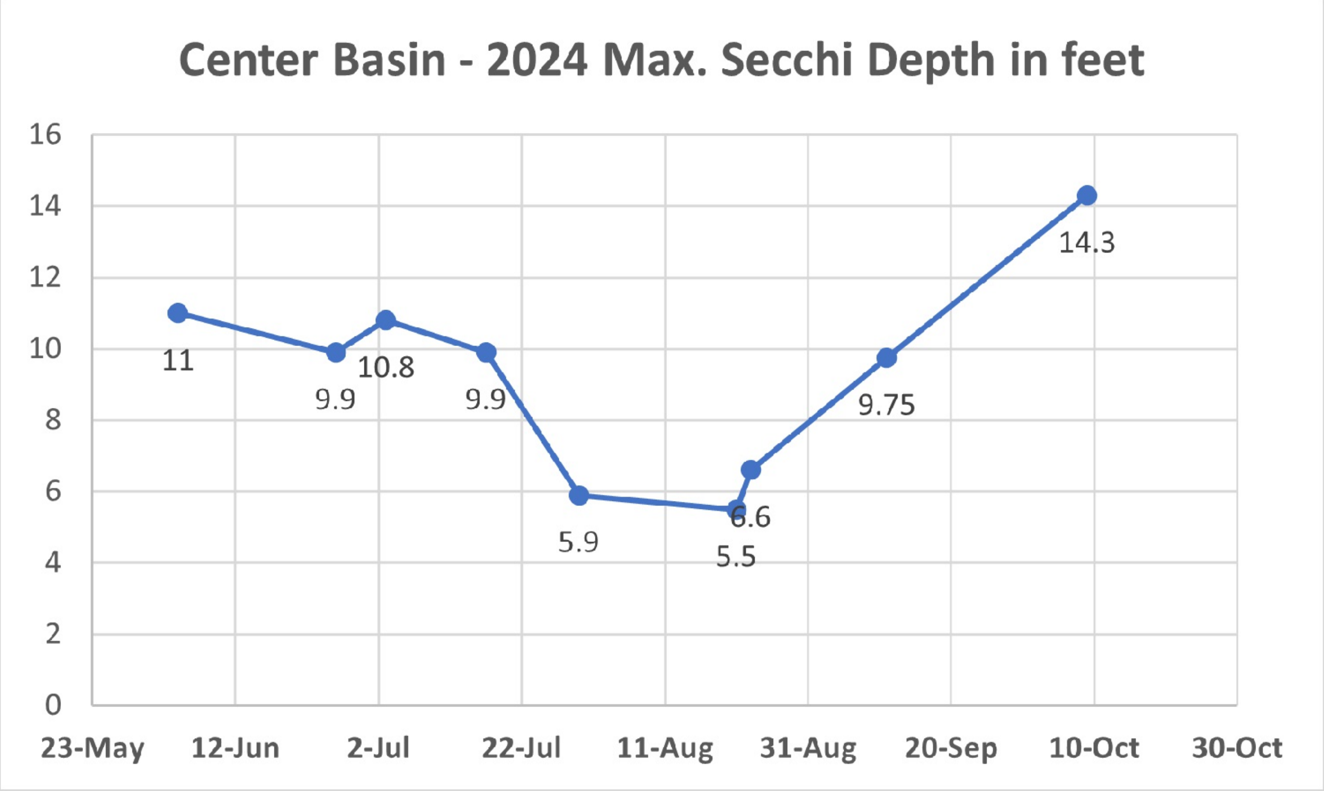
In terms of use of the pond by waterfowl, previous estimates by H&W assumed up to 35 Canada geese. In 2024, HEA observed limited amounts of waterfowl use of the pond, maybe approximately a dozen ducks at times and occasionally a small group (10 count or so) of Canada geese. Bald eagles were occasionally observed by HEA in 2024 and they may be keeping waterfowl use of the pond down by predation and flight to safety elsewhere by waterfowl.

Fresh water mussels were frequently observed during sampling and assessments down to about 8 feet below the water surface. Mussel shells were not recovered during gravity core sampling (22 plus feet) in the center basin. Open but empty mussel shells were seen collected in some shoreline areas and embankments; assumed evidence of consumption by an animal. HEA did not observe snails during assessment activities though they are likely present to some degree. Similarly, HEA did not observe evidence of crayfish or crayfish burrows. Several large snapping turtles were observed. Several unidentified type of smaller (10 inches in diameter) turtles were sometimes observed sunning themselves on logs over the water surface.

HEA also observed four beaver lodges around the pond shorelines. Two of these were either older, not completely built or just not occupied. One appeared functional but not actively occupied. One appeared actively used. Beaver debris (sticks, mud, aquatic plants, and small rocks) were pushed up against the outlet structure ‘s

12-inch high stop log and effectively kept water from discharging from the outlet structure. These debris were removed by the Town circa late August to early September and pond water elevations dropped by 10 inches. Beavers continued to build up debris at the outlet structure's stop log and water elevations began to rise by October even without appreciable (greater than 0.25 inch) storm events.

Water clarity of the pond as measured by secchi disc at the center basin ranged from 11 feet on June 4 to a low of 5.8 on July 30 and 5.5 feet on August 21 . Water clarity began to improve by August 23 (6.6 feet) to 9.75 feet by September 11 and to a year maximum depth of 14.3 feet by October 9 as biological activity and sunlight diminished. The following chart summarizes secchi disc readings obtained by HEA:



Water had a slight reddish- to golden- brown coloration assumed by HEA to be colored dissolved organic matter (CDOM).

Sonde data for turbidity is a more quantitative measure of water clarity. As an aid to the reader, HEA has reproduced the sonde chart for turbidity included earlier in this report as follows:

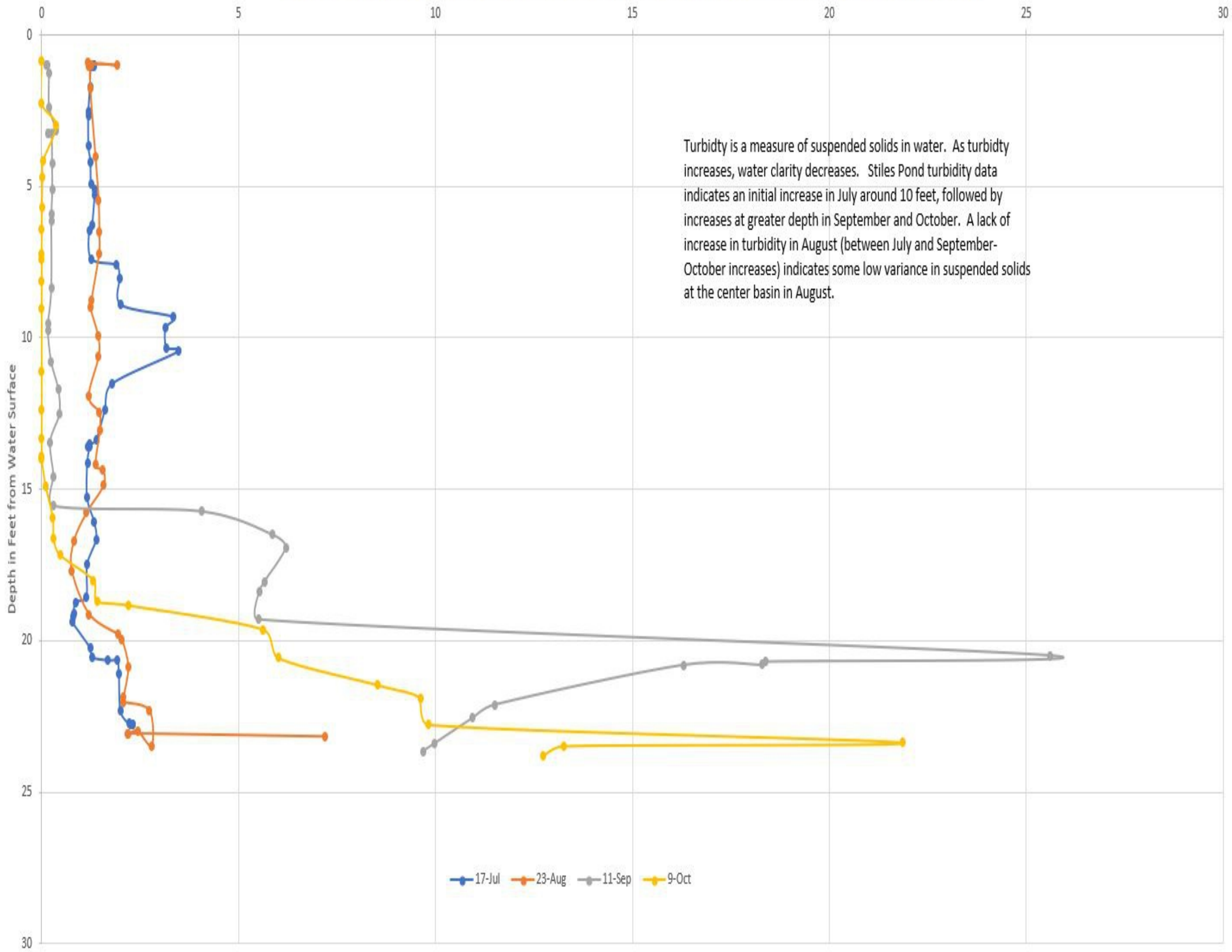


Chart 3 - Year 2024 Stiles Pond Center Basin Turbidity in nephelometric turbidity units (NTU)

Turbidty is a measure of suspended solids in water. As turbidty increases, water clarity decreases. Stiles Pond turbidity data indicates an initial increase in July around 10 feet, followed by increases at greater depth in September and October. A lack of increase in turbidity in August (between July and September-October increases) indicates some low variance in suspended solids at the center basin in August.

The turbidity measurements for shallow water (top 15 feet) indicate a higher turbidity in July and August than later in the season in September and October. A "bump out" in turbidity was present around 10 feet on July 17 and close to the sediment surface around 22-24 feet by August 23, both of which corresponded to an increase in Chl-a (tree pollen mostly at that time). As the season progressed (September and October), turbidity increased with depth as suspended solids from shallower water settled down and possibly as deep water, light-limited adapted cyanobacteria such as Limnothrix increased its productivity, as noted in following Chart 6 discussed previously in this report.

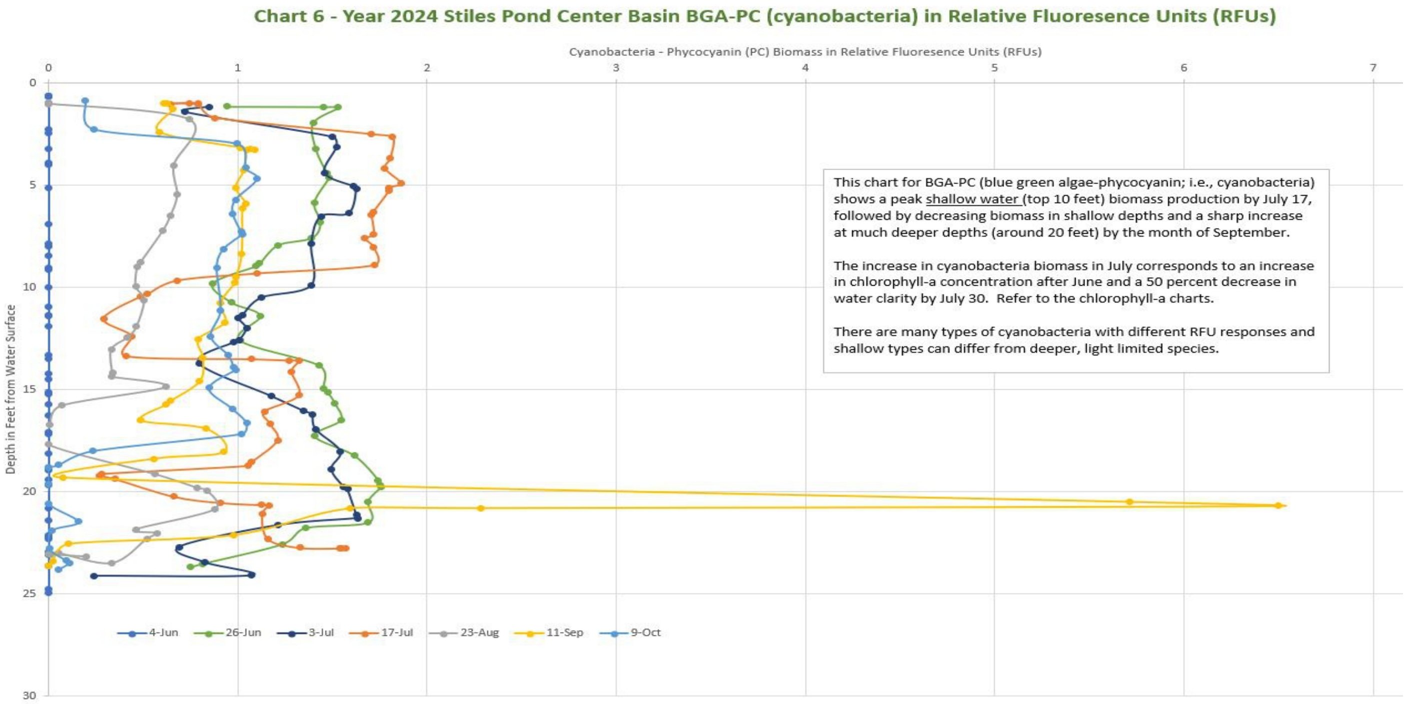


Chart 6 - Year 2024 Stiles Pond Center Basin BGA-PC (cyanobacteria) in Relative Fluoresence Units (RFUs)

This chart for BGA-PC (blue green algae-phycocyanin; i.e., cyanobacteria) shows a peak shallow water (top 10 feet) biomass production by July 17, followed by decreasing biomass in shallow depths and a sharp increase at much deeper depths (around 20 feet) by the month of September.

The increase in cyanobacteria biomass in July corresponds to an increase in chlorophyll-a concentration after June and a 50 percent decrease in water clarity by July 30. Refer to the chlorophyll-a charts.

There are many types of cyanobacteria with different RFU responses and shallow types can differ from deeper, light limited species.

There are three parts to consider about water clarity:1) the part that humans see when looking down into the water; this is the vertical-column visual observation that can be measured using a secchi disc; 2) the transmission of light needed for photoautotrophic phytoplankton and macrophytes; referred to as part of the photic zone; at Stiles Pond this extends down to about 14 feet (depth limit of the flat-leaf pondweed); and, 3) the extremely light-limited extent of the photic zone where the photoheterotrophic organisms such as *Limnothrix* and Cryptophytes at Stiles Pond thrive at 15-22 feet. Below this photic zone, there are likely other photic-capable prokaryotes known as green and purple sulfur bacteria and anoxygenic photoheterotrophs and non-photosynthetic bacteria that can utilize nitrate and sulfate/sulfides, carbohydrates and chlorophyll from seston and likely ferric iron to obtain energy under extremely light-limited to no light conditions.

Degradation of chlorophyll-rich seston with depth was documented at Stiles by microscopic analysis. This process, a form of water-column internal loading or more appropriately "recycled production" (Caraco *et. al.*, 1992; Dugdale and Goering, 1967) helps to maintain a healthy ecosystem without promoting anoxic conditions due to aerobic biodegradation of "excess" undegraded or un-recycled organic matter and nutrients at greater depth; closer to or on the profundal sediment-water interface (*i.e.*,internal loading from sediments).

The phytoplankton community (shallow and deep) are dominated by a moderately diverse group of cyanobacteria some of which are able to obtain their nutrients by fixing atmospheric nitrogen and obtaining other nutrients such as iron and phosphorus directly from organic matter and sediment. Other types of phytoplankton obtain the nutrients from surface water directly, in a dissolved or soluble form. As such, the molar nutrient ratios in surface water (discussed earlier) or from ground water inputs to surface water are more indicative of limitations on non-cyanobacteria phytoplankton productivity. Diversity of phytoplankton including cyanobacteria is an important measure of biological integrity.

4.0 MassDEP STILES POND WATERSHED BASED PLAN

MassDEP has an on-line (https://www.mass.gov/info-details/nine-element-watershed-based-plans-information) process for completing a Watershed Based Plan (WBP) that integrates MassGIS geographical and relational databases to characterize watershed contributing area land uses and nutrient loading attributes. It includes sections for addition of local information such as water quality goals or to some degree, variance in land uses provided by the WBP modeling process.

The MassDEP WBP process does not include nutrient source loading criteria for septic systems or from point source discharges such as from storm water outfall pipes.

The MassDEP WBP provides detailed land use types and coverage estimates using MassGIS data from 2015-2016. It is a convenient tool for evaluating land use planning or mitigation efforts. HEA has utilized information provided in the attached "draft" WBP completed by HEA for Stiles Pond as part of our overall Nutrient Source Assessment. The draft is attached for more information and should be utilized and modified by Boxford as appropriate.

The WBP assumes that all land-based nutrient loading such as phosphorus from agricultural fields will enter the surface water body (river, pond or lake) without attenuation of nutrients. Essentially, a drainage-fed, fully-penetrating water body that receives all nutrients (only nitrogen and phosphorus by the model) via ground water, stream flow or storm water.

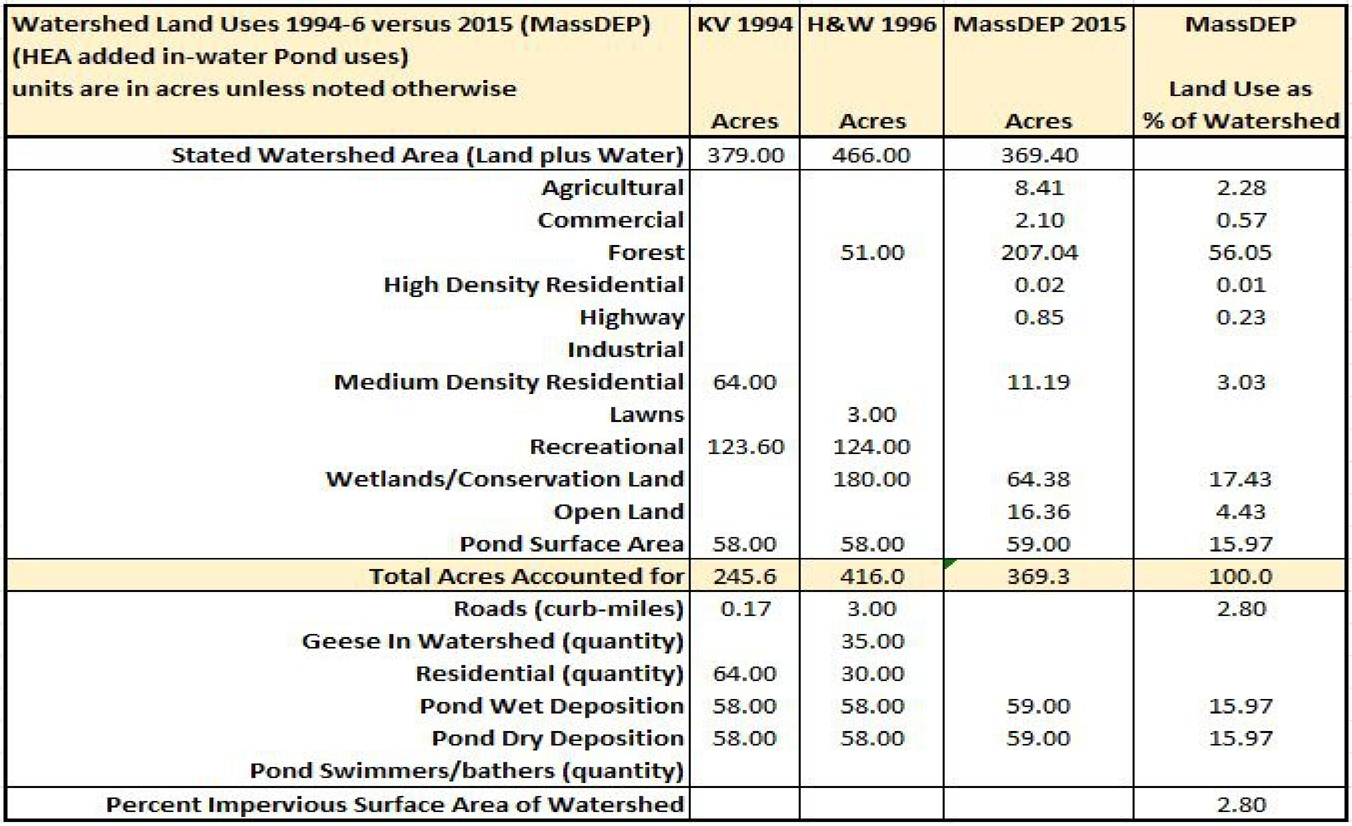
Drainage-water bodies (un-impounded, not excavated or artificially created, or controlled by bedrock contours and fractures) that lie within the base trendline of the contributing watershed drainage area do, with varying degrees of attenuation, receive a majority of nutrients from wet and dry deposition and land uses (infiltrating to ground water or as storm water runoff) within the watershed. Drainage fed ponds have streams (intermittent or perennial) flowing into and/or out of water bodies.

Stiles Pond is an impounded, historically-drainage fed, surface water body that may have been excavated to some extent circa the 1800s by the "match company" with prominent bedrock outcrops, fractures and controls on its morphology and hydrology. In 1994, KV interpreted that approximately 38 percent of water flow to the pond was from ground water from saturated soil and bedrock fractures. Stiles Pond inlet does have an ephemeral drainage feature similar to other parts of the pond, but no intermittent or perennial stream flow other than through the outlet to Fish Brook. Bedrock fractures would, more likely than not, extend beyond any overburden soil, topographically-defined, contributing watershed area (the MassDEP WBP watershed area). In 2024, HEA did not observe or measure indications (temperature, salinity, etc.) of ground water flow into Stiles Pond and there was essentially no water outflows at the outlet structure due to debris and stop log restricting water flow. In 2024, Stiles Pond was essentially a water elevation raised impoundment with no stream in- or out-flows. There may still be ground water flow into the pond at lower flow rates or volumes, through bedrock fractures at depth in the pond and there is still likely discharge of water from the pond to the overburden soils and into Fish Brook and down-drainage areas beyond Stiles Pond. These conditions limit the use of MassDEP's WBP but information from MassDEP provided as part of the WBP for Stiles Pond (attached) is very helpful when assessing overall land uses and potential nutrient sources and mitigation planning for water bodies, including for Stiles Pond. An evaluation of nutrient sources to Stiles Pond, based on information gathered by HEA and available by resources such as MassDEP WBP and prior assessments by KV(1994-1995) and H&W (1996) is presented in **Section 5.0** of this report.

5.0 EVALUATION OF NUTRIENT SOURCES AND COMPARISON TO HISTORICAL ASSESSMENT FINDINGS

This section utilizes information from others (KV and H&W) and MassDEP for nutrient loading estimates related to the number of households, septic systems and contributing area land uses and types (i.e, forested, residential, etc.) and includes additional, not previously considered information on nutrient loading from direct pond users (bathers and swimmers) and fish stocking, in addition to more current and empirical information on waterfowl, dry deposition (dust, forest particulates and tree pollen) and wet deposition (wet precipitation) directly on the 59 acre Stiles Pond surface area. HEA's has also included a high intensity storm water runoff event.

The following chart summarizes 1995-1996 nutrient loading "sources" from KV and H&W as well as information on source types and contribution gained by HEA's 2024 assessment including information from MassDEP's WBP for Stiles Pond (attached). KV's 1995 report included a section on phosphorus loading based on land uses and on their surface water quality results that included nitrogen and phosphorus; phosphorus was by ratio the limiting nutrient. H&W's 1996 report expanded on KV's nutrient source loading by adding nitrogen loading estimates based on contributing area land uses including septic systems within 300 feet of the pond shorelines. H&W also included an retention factor (60 percent) to incorporate binding (*i.e*., loss) of nutrients to soil and similar before reaching the pond by ground water from septic systems.



Watershed Land Uses 1994-6 versus 2015 (MassDEP) (HEA added in-water Pond uses) units are in acres unless noted otherwise	KV 1994 Acres	H&W 1996 Acres	MassDEP 2015 Acres	MassDEP Land Use as % of Watershed
Stated Watershed Area (Land plus Water)	379.00	466.00	369.40	
Agricultural			8.41	2.28
Commercial			2.10	0.57
Forest		51.00	207.04	56.05
High Density Residential			0.02	0.01
Highway			0.85	0.23
Industrial				
Medium Density Residential	64.00		11.19	3.03
Lawns		3.00		
Recreational	123.60	124.00		
Wetlands/Conservation Land		180.00	64.38	17.43
Open Land			16.36	4.43
Pond Surface Area	58.00	58.00	59.00	15.97
Total Acres Accounted for	245.6	416.0	369.3	100.0
Roads (curb-miles)	0.17	3.00		2.80
Geese In Watershed (quantity)		35.00		
Residential (quantity)	64.00	30.00		
Pond Wet Deposition	58.00	58.00	59.00	15.97
Pond Dry Deposition	58.00	58.00	59.00	15.97
Pond Swimmers/bathers (quantity)				
Percent Impervious Surface Area of Watershed				2.80

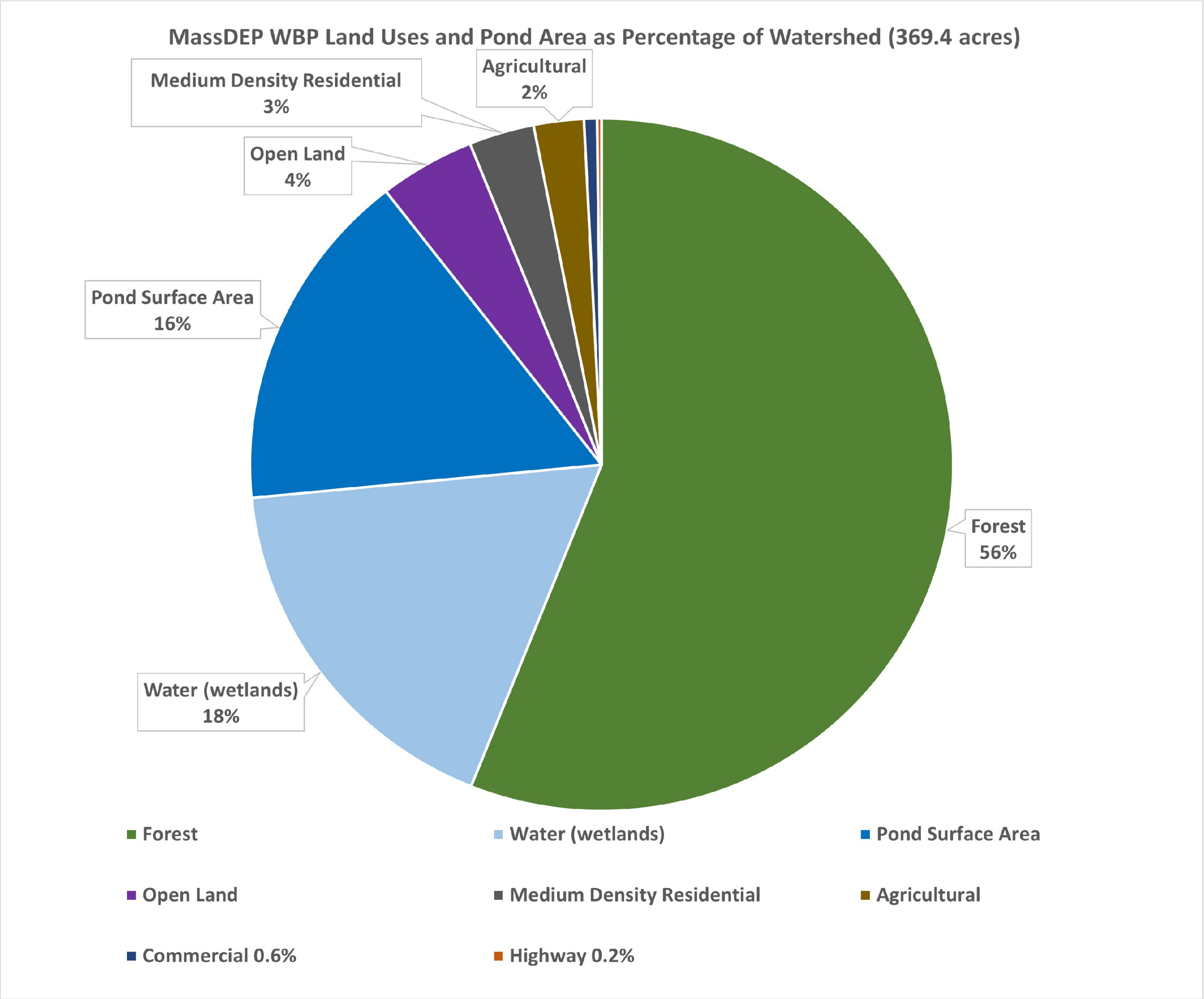
Notes for preceding Land Use Comparison Table:

1. For comparative and assessment purposes, HEA added MassDEP's WBP pond surface acreage of 59 acres to this summary table of "land uses" to obtain relative percentage of all areas (land and water) in the watershed.
2. There are differences in land use categories selected by KV, H&W and MassDEP.
3. KV's estimate for residential "quantity" is for the whole watershed, H&W's is for within 300 feet of pond shorelines.
4. There are also differences in acres accounted for which is just HEA's sum of data provided by KV, H&W and MassDEP.
5. H&W also included source loading from an interpreted stream flow at the inlet based on flow measurements (34 cfm at inlet) by KV. However, based on HEA's review and as noted in KV's report, inlet flows were likely baseflow from overburden soil and/or bedrock fractures and not stream flow-surface water. There is an ephemeral/intermittent stream mapped at the head of the inlet but it's subwatershed area is very limited and part of the inlet's eastern shore is characterized by large and steeply dipping bedrock outcrops.

MassDEP's land use acreage estimates are more current (2015-2016) and likely more accurate than earlier estimates but the general types of land uses and acreage of use has not changed much since 1994 (personal communication with Board of Health).

If the reader goes back and reviews land use categories and acreage estimates by KV and H&W they will note differences when compared to MassDEP's WBP - MassGIS (2015-2016) land use by acreage data. As an example, KV had no Forest land use and 123.6 acres of Recreational and H&W had 51 acres of Forest and 124 acres of Recreational compared to MassDEP's land use with 207.4 Forest acres and no Recreational acreage assigned. Which land use classification is more "accurate"? It helps to think of how the land area and uses within the watershed would affect both the quality of precipitation and quantity of evapotranspiration and infiltration relative to the hydrologic and nutrient impact to, in this case, Stiles Pond. With this understanding, MassDEP's WBP assigned land use cover, soils data (U.S. Dept. of Agriculture - Natural Resources Conservation Service (NRCS)) soil data, hydrologic conditions and nutrient loading estimates by land type should be considered more representative than earlier land use and loading estimates made by KV or H&W. MassDEP also has up to date nutrient loading estimates by land use categories called pollutant load export rates (PLERs) that are carried forward when completing the MassDEP WBP for Stiles Pond (attached).

The following chart depicts land use as a percentage of the total MassDEP WBP watershed acreage of 369.4 which includes the pond surface area of 59 acres.



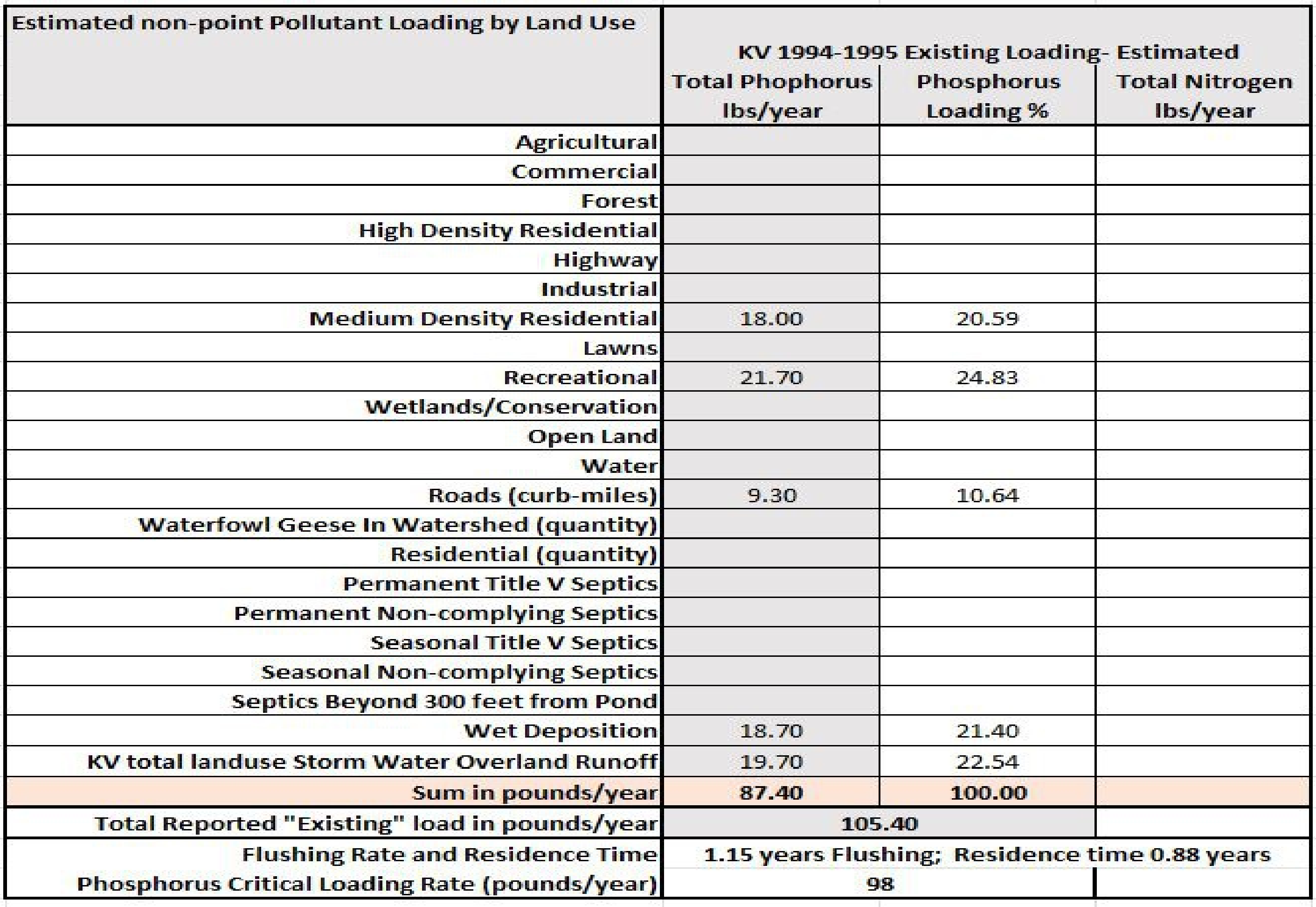
Although land use and acreage estimates differ, earlier work and classifications made by KV, H&W and other local knowledge can be used to modify or amend nutrient loading estimates using MassDEP's WBP model. As such, MassDEP's WBP only evaluates non-attenuated nutrient loading from land uses to the modeled water body (Stiles Pond in this case) as carried solely by storm water runoff (assumes all precipitation minus evapotranspiration = storm water runoff). This is a conservative approach intended to help guide decisions regarding the potential impact of watershed land uses on a water body and to evaluate and target mitigation measures to limit impacts, prioritized by land use category and those PLERs. The WBP process also does not include any evaluation of septic system influences, dry or wet deposition, swimmers, waterfowl, fish stocking or point-source discharges (outfall pipes, etc.) on surface water quality; it is just non-point sources derived from land use PLERs. This information is discussed further in the attached WBP for Stiles Pond. From a land use planning, mitigation-evaluations for land-based nutrient loading, and ease of use, MassDEP's WBP process is very helpful and cost effective first place to start for many users. The attached WBP is a draft at this point.

KV (1995 report) and H&W (1996 report) each calculated the total annual load of total phosphorus to Stiles Pond (by storm water runoff and/or ground water) and work by H&W included annual load estimates for total nitrogen. MassDEP's WBP also calculated loads for both total phosphorus and nitrogen to Stiles Pond. Essentially, the WBP assumes that all nutrients by land use type, area and PLERs will enter the water body on an annual basis without attenuation (i.e., binding and removal of nutrients in soil, etc.), irregardless of the pathway from land (storm water runoff, stream flow or ground water discharge). The WBP is primarily a planning process tool. H&W's land use loading estimates did account for 60 percent retention (attenuation coefficient) of phosphorus on land (*i.e.*, binding with soil and plants, etc.) from septic systems before discharging to the pond. H&W and KV have more information in their reports in terms of how they handled nutrient loading calculations, and importantly, inclusion of septic system influences not addressed by the MassDEP WBP process. KV and H&W also included nutrient loading estimates from waterfowl and roads (as curb-miles). KV also included nutrient loading directly to the pond by wet-precipitation. MassDEP's WBP determined total impervious area (TIA) which should include paved road ways (curb-miles) used by KV and H&W in addition to parking lots, roofs, etc.

In HEA's review of nutrient loading estimates by KV, H&W and MassDEP's WBP. HEA model used land -use categories and acreage provided by the MassDEP WBP and included nutrient loading estimates for: septic from KV; waterfowl from H&W; new load estimates for dry deposition (dust, tree pollen and forest particulates), swimmers/bathers, stocked fish, a high intensity but low frequency storm water runoff event, and an evaluation of internal loading flux from biota and sediment. HEA's estimates for dry and wet deposition, swimmers/bathers and stocked fish came from modification of published loading estimates (Colman et al, 2001, USGS -Walden Pond; and, Cole et al, 1990) and accounted for differences in the number of swimmers and increases in dry deposition (1% per year) over time (Glick et al 2021, Zang et al 2015). Walden Pond, is similar in surface area (60 acres), east-west orientation and surrounding forest cover and is located in the northeast region of Massachusetts, approximately 30 miles away from Stiles Pond. HEA used laboratory data from Stiles Pond assessments whenever possible, if suitable.

The following charts depict then "existing conditions" nutrient loading models by KV(1994), H&W (1996), MassDEP (2015-2016 land use data) and by HEA 2024.

KV Associates (1995) Nutrient Source Loading Model



Estimated non-point Pollutant Loading by Land Use	KV 1994-1995 Existing Loading- Estimated		
	Total Phophorus lbs/year	Phosphorus Loading %	Total Nitrogen lbs/year
Agricultural			
Commercial			
Forest			
High Density Residential			
Highway			
Industrial			
Medium Density Residential	18.00	20.59	
Lawns			
Recreational	21.70	24.83	
Wetlands/Conservation			
Open Land			
Water			
Roads (curb-miles)	9.30	10.64	
Waterfowl Geese In Watershed (quantity)			
Residential (quantity)			
Permanent Title V Septics			
Permanent Non-complying Septics			
Seasonal Title V Septics			
Seasonal Non-complying Septics			
Septics Beyond 300 feet from Pond			
Wet Deposition	18.70	21.40	
KV total landuse Storm Water Overland Runoff	19.70	22.54	
Sum in pounds/year	**87.40**	**100.00**	
Total Reported "Existing" load in pounds/year	105.40		
Flushing Rate and Residence Time	1.15 years Flushing; Residence time 0.88 years		
Phosphorus Critical Loading Rate (pounds/year)	98		

Horsley & Witten, Inc. (1996) Nutrient Source Loading Model

Estimated non-point Pollutant Loading by Land Use	H&W 1996 Existing Loading - Estimated							
	Storm Water Total Phophorus lbs/year	Ground Water Total Phophorus lbs/year	Total Phosphorus by Source lbs/year	Phosphorus Loading %	Storm Water Total Nitrogen lbs/year	Ground Water Total Nitrogen lbs/year	Total Nitrogen by Source lbs/year	Ntrogen Loading %
Agricultural								
Commercial								
Forest	14.00	2.00	16.00	6	171.00	68.00	239.00	7
High Density Residential								
Highway								
Industrial								
Medium Density Residential								
Lawns	5.00	1.00	6.00	3	49.00	28.00	77.00	2
Recreational	14.00	5.00	19.00	8	865.00	865.00	1730.00	50
Wetlands/Conservation	0.00	0.00			0.00	0.00		
Open Land								
Water								
Roads (curb-miles)	3.00		3.00	1	312.00		312.00	9
Waterfowl Geese In Watershed (quantity)	4.00	1.00	4.00	2	67.00	38.00	105.00	3
Residential (quantity)								
Permanent Title V Septics	0.00	10.00	10.00	4	0.00	246.00	249.00	7
Permanent Non-complying Septics	140.00	32.00	176.00	69	164.00	94.00	264.00	8
Seasonal Title V Septics	0.00	1.00			0.00	3.00		
Seasonal Non-complying Septics	3.00	1.00			4.00	2.00		
Septics Beyond 300 feet from Pond	0.00	0.00						
Wet Deposition	19.00		19.00	7	516.00		516.00	15
Sum in pounds/year	**202.00**	**53.00**	**253.00**	**100**	**2148.00**	**1344.00**	**3492.00**	**101**
Total Reported "Existing" load in pounds/year	**254.00**				**3492.00**			
Flushing Rate and Residence Time (years)	**1.26 years Flushing; 0.79 years Residence Time**							
Phosphorus Critical Loading Rate (pounds/year)	**105**							
Phosphorus Excess Loading Rate (pounds/year)	**149**							

MassDEP (2015-2016) WBP Nutrient Source Loading Model

Estimated non-point Pollutant Loading by Land Use	MassDEP WBP Estimated					
	Storm Water Total Phophorus lbs/year	Phosphorus Loading %	Storm Water Total Nitrogen lbs/year	Nitrogen Loading %	Storm Water Suspended Solids tons/year	Suspended Solids Loading %
Agricultural	10.00	5.38	72.00	5.41	1.92	5
Commercial	4.00	2.15	32.00	2.40	0.40	1
Forest	149.00	80.11	1061.00	79.65	30.33	83
High Density Residential	0.00	0.00	0.00	0.00	0.00	
Highway	2.00	1.08	11.00	0.83	0.61	2
Industrial	0.00	0.00	0.00	0.00	0.00	
Medium Density Residential	11.00	5.91	79.00	5.93	1.22	3
Lawns						
Recreational						
Wetlands/Conservation						
Open Land	10.00	5.38	77.00	5.78	1.87	5
Water						
Roads (curb-miles)						
Waterfowl Geese In Watershed (quantity)						
Residential (quantity)						
Permanent Title V Septics						
Permanent Non-complying Septics						
Seasonal Title V Septics						
Seasonal Non-complying Septics						
Septics Beyond 300 feet from Pond						
Wet Deposition						
Sum in pounds/year or Percent	**186.00**	**100.00**	**1332.00**	**100.00**	**36.35**	**100**
Total Reported "Existing" load in pounds/year	**185.00**		**1333.00**		**36.35**	
Flushing Rate and Residence Time (years)						
Phosphorus Critical Loading Rate (pounds/year)	**79**					
Phosphorus Excess Loading Rate (pounds/year)	**106**					

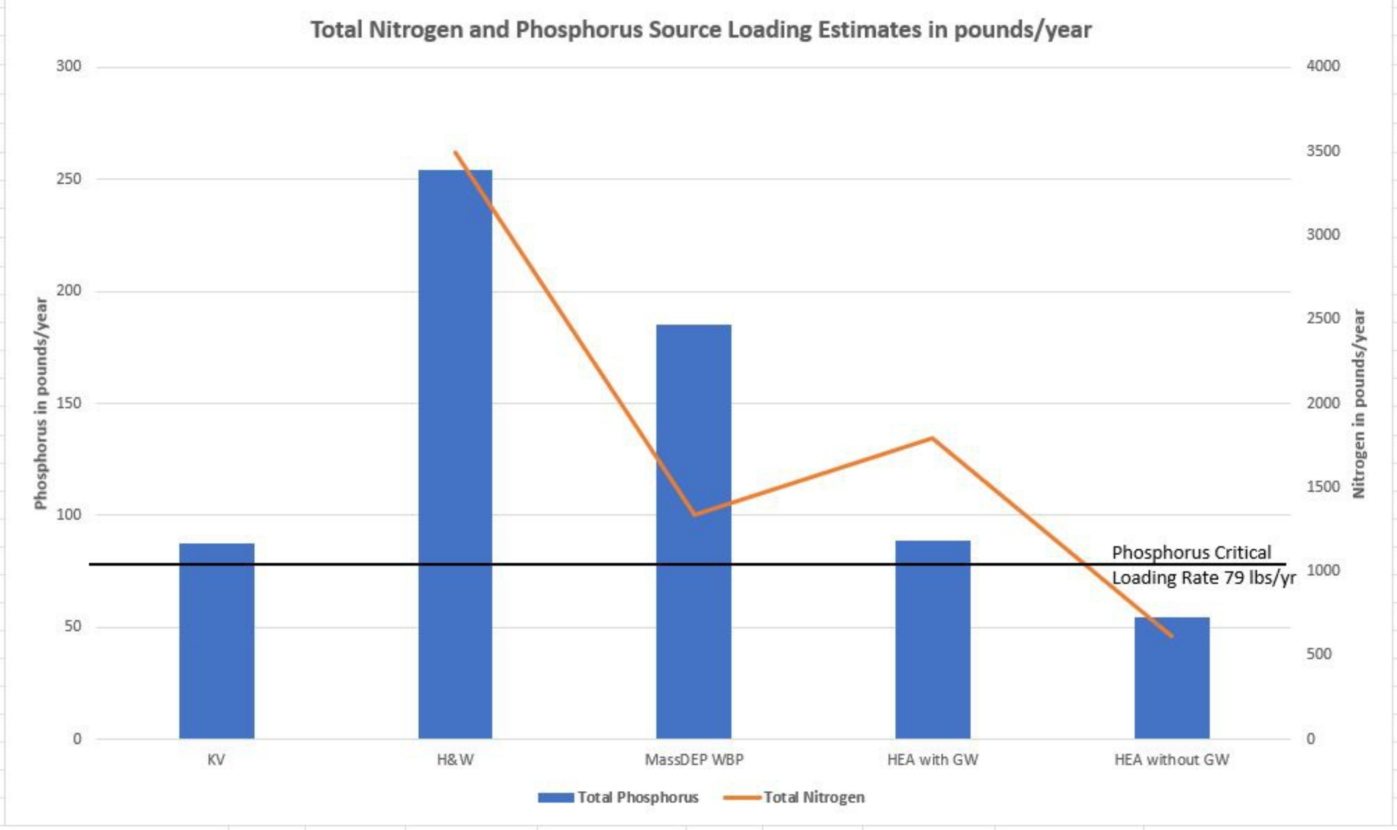
Higgins Environmental Associates, Inc. 2024 Nutrient Source Loading Model

Estimated non-point Nutrient Source Loading by Watershed Land Use	HEA 2024 Source Loading - Estimated with Watershed Source Loading Model using empirical data			
	Total Phosphorus		Total Nitrogen	
	Ground Water Loading lbs/year	Phosphorus Loading %	Ground Water Loading lbs/year	Nitrogen Loading %
Agricultural	6.00	6.92	45.47	3.46
Commercial	2.06	2.38	9.37	0.71
Forest	36.96	42.62	453.64	34.49
High Density Residential	0.02	0.02	0.13	0.01
Highway	0.84	0.97	3.79	0.29
Industrial	0.00	0.00	0.00	0.00
Medium Density Residential	10.98	12.66	7.30	0.56
Lawns				
Recreational				
Wetlands/Conservation	11.51	13.27	141.58	10.76
Open Land	2.91	3.36	35.92	2.73
Water				
Roads (curb-miles)				
Residential (quantity)				
Permanent Title V Septics (assume 30 between 100-300 feet of pond)	15.43	17.79	618.06	46.99
Permanent Non-complying Septics (assume converted to tight or Title V compliant)				
Seasonal Title V Septics (considered part of Permanent Title V)				
Seasonal Non-complying Septics (assumed no longer present)				
Septics Beyond 300 feet of Pond (assume 100 percent attenuated before reaching pond)				
Subtotal	86.71	**100.00**	1315.26	**100.00**
Sum of Land Use Nutrient Sources with 60% P and 10% N soil retention in pounds/year	**34.68**		**1183.73**	

In-pond Sources and a large storm water runoff event added by HEA in "red"	Direct "in-Pond" sources without overburden-derived ground water from watershed			
Dry Deposition to Pond Surface	42.90	79.11	214.50	35.12
Wet Deposition to Pond Surface	1.70	3.13	321.40	52.63
Waterfowl Geese In Watershed (12 quantity) to Pond Surface	5.29	9.75	25.14	4.12
Swimmers/Bathers	0.02	0.04	0.54	0.09
Storm Water Runoff from Large Storm (2% of annual Water load)	3.59	6.62	0.91	0.15
Fish Stocking	1.50	2.77	13.20	2.16
Bedrock Ground Water				
Internal Loading Loss from Biota and Sediment	-0.77	-1.42	35.00	5.73
Sum of In-Pond Nutrient Source (in "red") in pounds/year or Percent	**54.23**	**100.00**	**610.69**	**100.00**

Total sum with Ground Water in pounds/year	**88.91**	**1794.42**
Total Direct "in-Pond" (without ground water) in pounds/year	**54.23**	**610.69**
Flushing Rate and Residence Time (years)	**Flushing Rate 1.1 to 0.78 years; Residence Time for watershed ground water discharge =0.90 to 1.28 years**	
Phosphorus Critical Loading Rate (pounds/year)	**79**	
Phosphorus Excess Loading Rate with Ground Water (pounds/year)	**9.91**	
Phosphorus Excess Loading Rate without Ground Water (pounds/year)	**-24.77**	

The following chart summarizes just the total nutrient source loading estimates in pounds/year by KV, H&W, MassDEP and HEA (one that includes ground water (GW) and one that does not include GW):



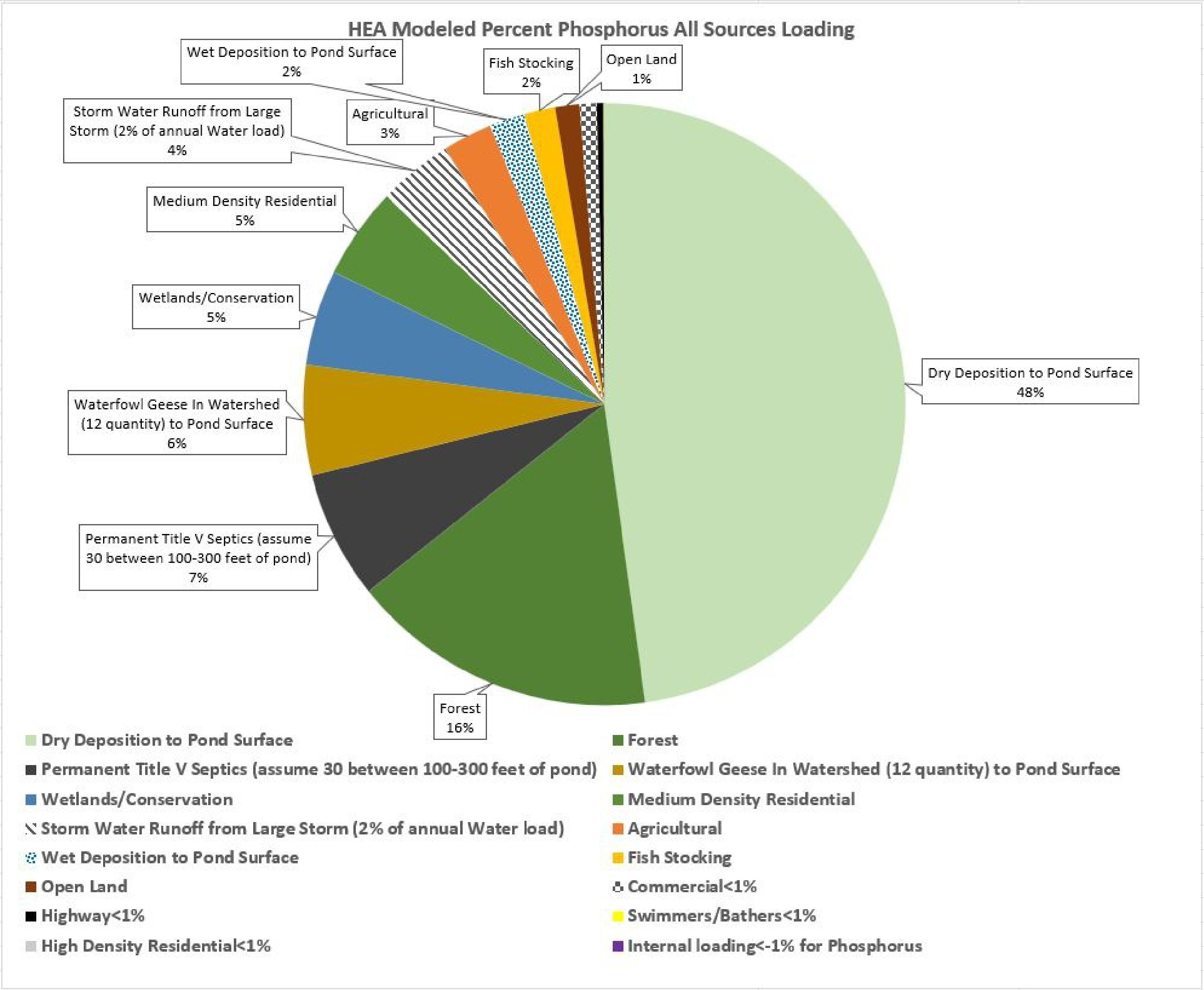
For HEA's 2024 watershed-based nutrient source model, we utilized MassDEP's watershed-mapped extent and types of land cover combined with field measurements and observations by HEA and KV, hydrologic assessments, and nutrient source loading estimates utilizing local data (laboratory results for surface water quality, dry and wet deposition, storm water quality and seasonal changes in the top 2 inches of sediment nutrient concentrations) and median coefficient values for land-use loading by published sources (Reckhow, et al, EPA 1980), (Coleman, et al, USGS 2001), (HEA 2022 and 2023). HEA did not use ground water data collected by either KV in 1994 or HEA in 2024 as KV's data did not specify how or where samples were collected and HEA's data likely occurred when Stiles Pond surface water was, to a large extent, still discharging to ground water. HEA used KV's 1994 "outlet" surface water sample result for phosphorus as representative of a time when ground water was flowing into Stiles Pond. HEA's 2024 outlet surface water results for phosphorus were non-detectable (<0.01 mg/L). As noted in the preceding chart, HEA developed two current watershed-based nutrient source models for Stiles Pond; one with ground water flow and one "In-Pond" without ground water contribution. Similar to H&W, HEA applied a ground water retention factor for phosphorus of 60 percent for all land use sources (beyond just septic sources referenced by H&W) and HEA also applied a retention factor of 10 percent for nitrogen; as phosphorus binds to soil and both nutrients undergo varying degrees of biogeochemical retardation before reaching Stiles Pond or the discharge point of the watershed (assumed at the outlet structure - similar to models by KV, H&W and MassDEP). HEA's model considered the same number (30 count) of septic systems used by KV and H&W but assumed that since 1995 these have been updated and are either Title V compliant or for a few, are tight tanks (Board of Health communication) and are located between 100 to 300 feet of the shoreline. HEA reduced the quantity of waterfowl to 12 versus 35 used by H&W as HEA frequently observed approximately 12 ducks. KV's estimate for wet precipitation for total phosphorus seemed very high and HEA opted to use detailed wet precipitation quality empirical data as published for nearby Walden Pond by Coleman et al, USGS (2001). Although storm water runoff entering the pond was not observed by KV, H&W or HEA, HEA's model does include a small quantity of storm water runoff (approximately 1 to 2 percent of the annual watershed discharge) to account for high intensity but less frequent rain events. These would likely occur at ephemeral stream locations. HEA's storm water sample (STRM1) laboratory data was used to quantify model loading for phosphorus and nitrogen.

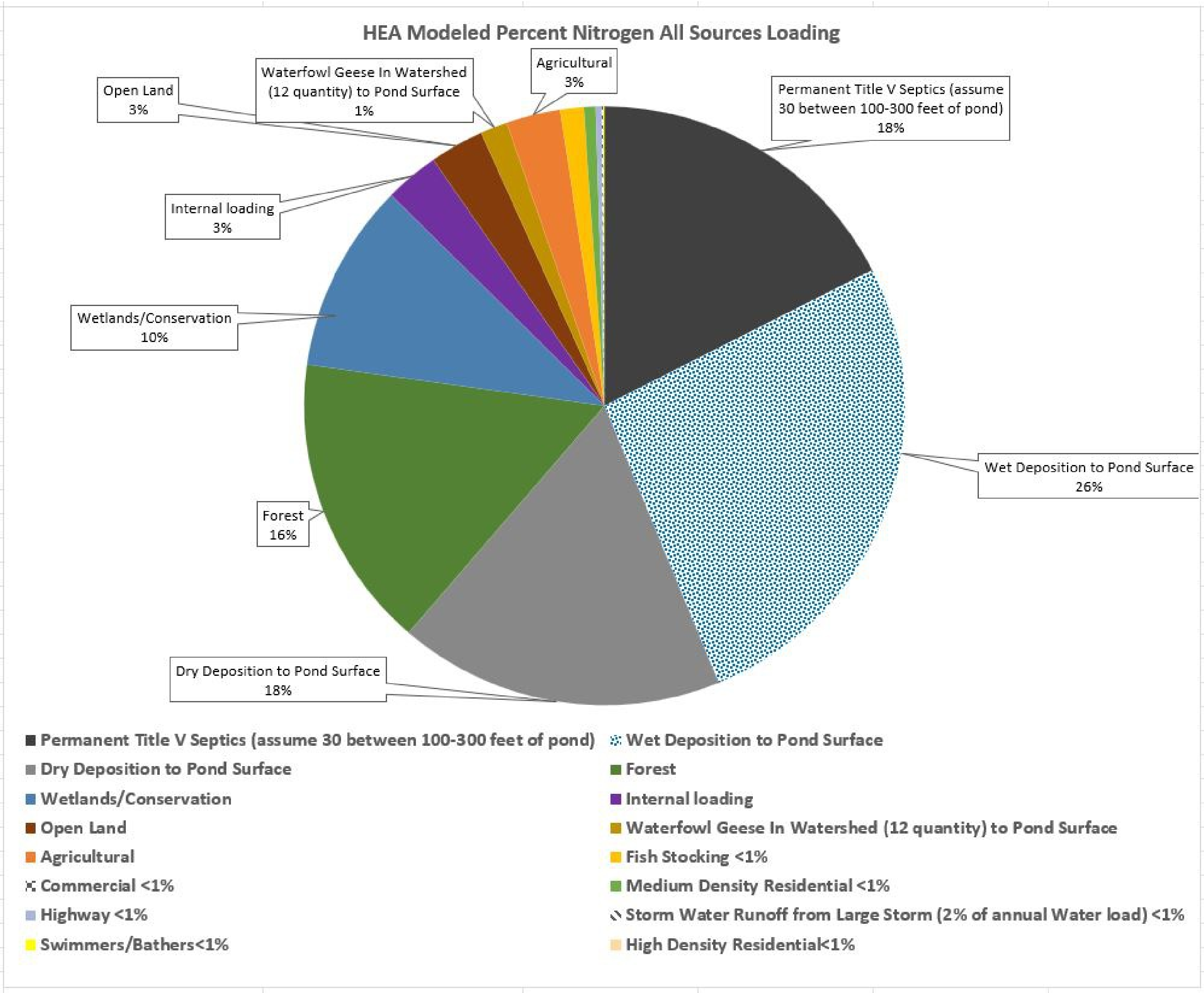
Internal loading from biota and sediment in the pond were quantified to be a net loss from surface water for phosphorus (sediment concentrations increased from June to September in the upper, most active, two inches of sediment) and a slight gain (release from sediment) for total nitrogen. Percent shown is a loss ("-") for phosphorus. This may change in other years depending upon loading from other sources and internal use of nutrients by phytoplankton biomass or if there are changes in the extent and biomass of flat-leaf pondweed and similar. Internal loading from biota including flat-leaf pondweed which is extensive around the entire pond (from 1 to 14 feet below the water surface) is considered a fixed pool of nutrients as similar extent of this type of pondweed were noted by KV in 1994 and by KV's reference to an earlier 1978 study by MassDEQE (now MassDEP). This fixed pool contained the highest concentration of phosphorus in any solid media sampled, and its presence and function (it is a native plant specie) should be preserved.

The following pie charts depict HEA modeled percent total phosphorus and total nitrogen loading to Stiles Pond as either "All Sources" which includes both ground water contribution and direct in-pond sources such as dry deposition and swimmers; and, In-Pond only which excludes ground water contribution to the pond (as noted in 2024). Although not shown or modeled, based on HEA's assessment and review of prior work by KV, there is a potential for deeper or bedrock ground water contribution with an unknown nutrient quality to enter Stiles Pond depending upon surface water elevation relative to ground water elevation or potentiometric surface differences. KV's estimate of inlet water flows of 35 cfm likely approximates deeper ground water or bedrock fracture flow contribution at that time. HEA's model includes a "blank" section for Bedrock Ground Water contribution in the "In-Pond" section as deeper ground water or bedrock fracture flow of ground water into the pond could very well be from outside the Stiles Pond watershed. This portion of the model should be updated when information on bedrock ground water nutrient-source contribution is available.

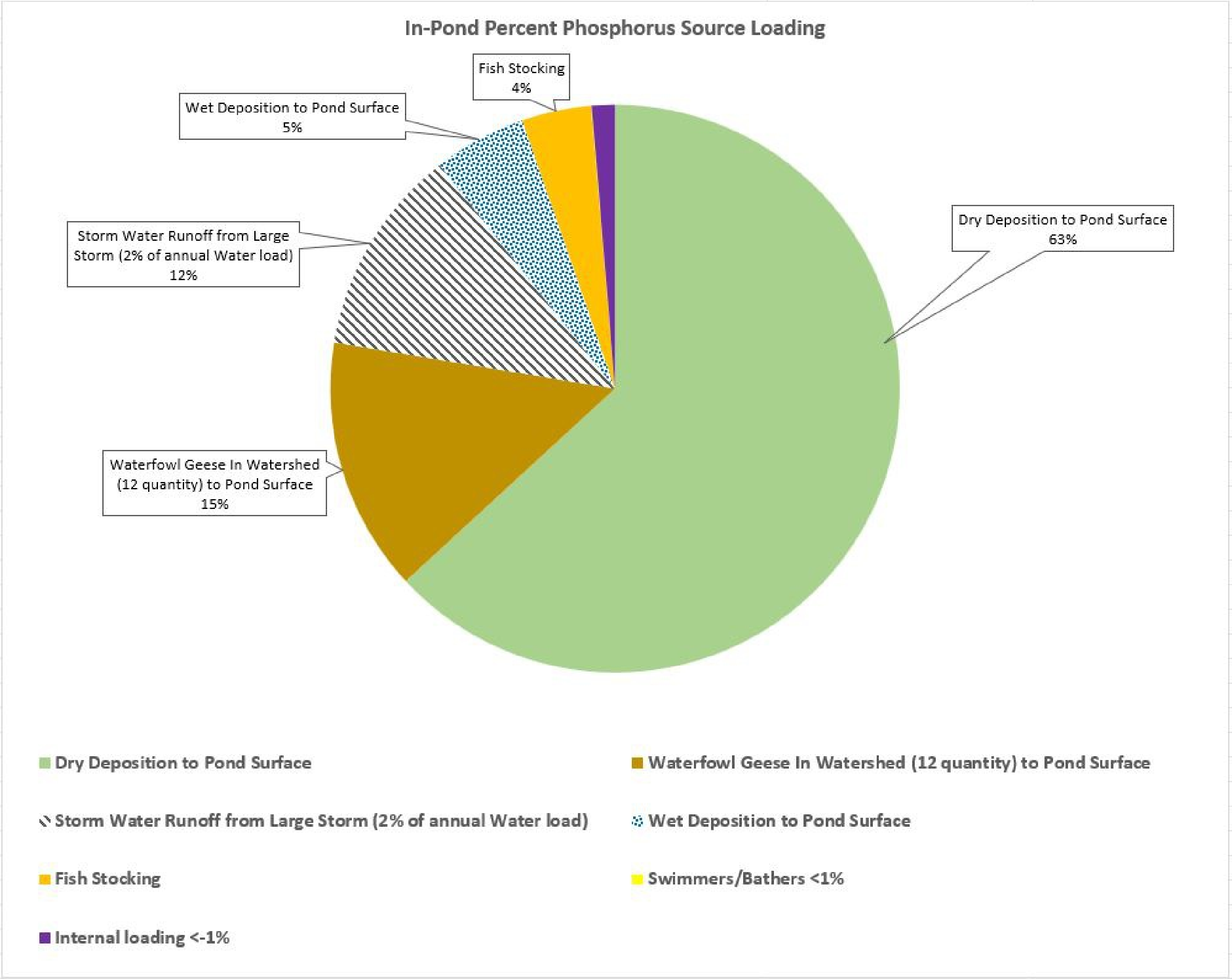
Charts of HEA's 2024 Modeled Nutrient All Sources Loading for Total Phosphorus and Total Nitrogen follows

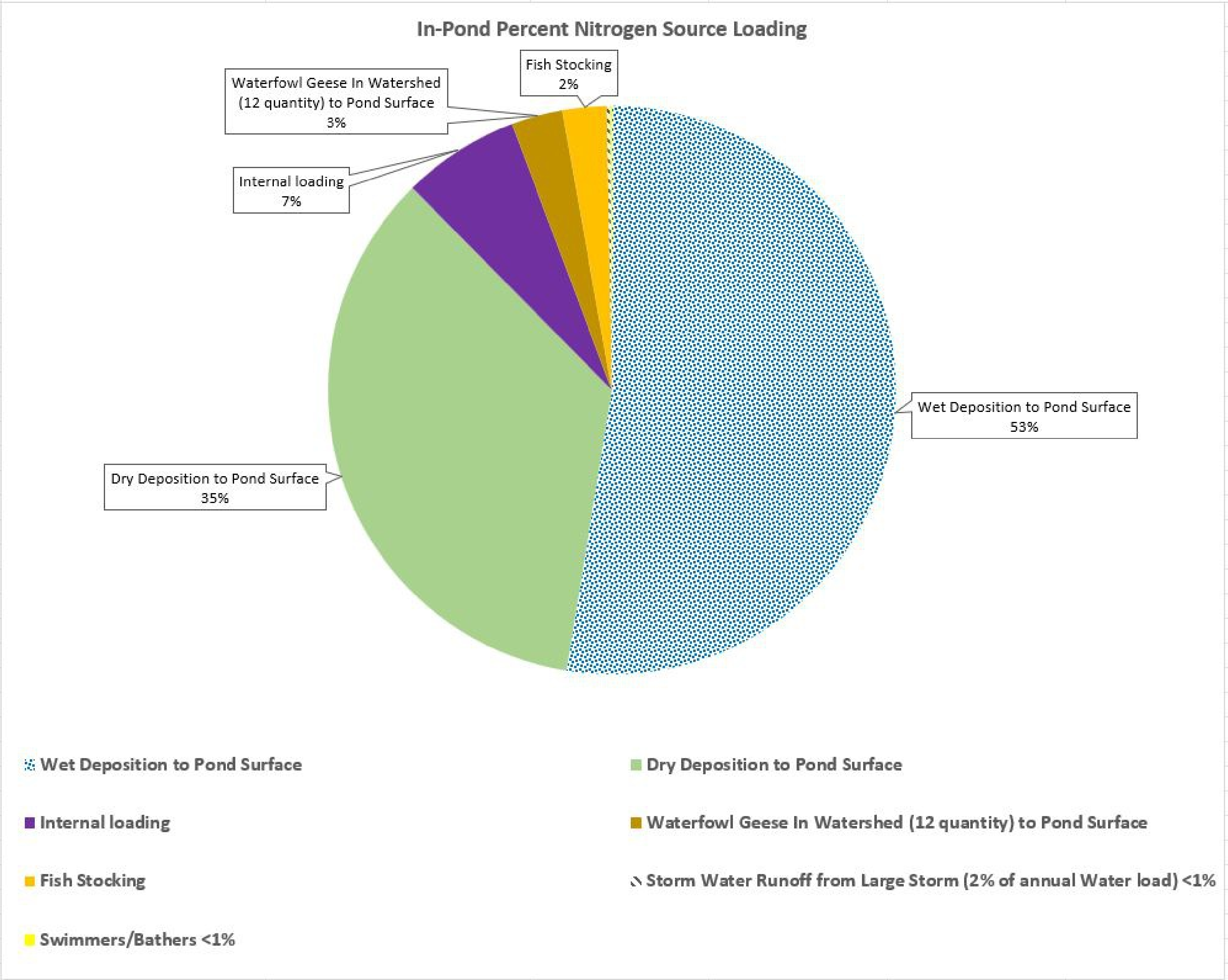
(“All Sources” includes land and in-pond or direct to pond nutrient sources):




HEA Modeled Percent Nitrogen All Sources Loading
Open Land 3%
Waterfowl Geese In Watershed (12 quantity) to Pond Surface 1%
Agricultural 3%
Permanent Title V Septics (assume 30 between 100-300 feet of pond) 18%
Internal loading 3%
Wetlands/Conservation 10%
Wet Deposition to Pond Surface 26%
Forest 16%
Dry Deposition to Pond Surface 18%
Permanent Title V Septics (assume 30 between 100-300 feet of pond)
Wet Deposition to Pond Surface
Dry Deposition to Pond Surface
Forest
Wetlands/Conservation
Internal loading
Open Land
Waterfowl Geese In Watershed (12 quantity) to Pond Surface
Agricultural
Fish Stocking <1%
Commercial <1%
Medium Density Residential <1%
Highway <1%
Storm Water Runoff from Large Storm (2% of annual Water load) <1%
Swimmers/Bathers<1%
High Density Residential<1%

As a raised impoundment, with no sustained or appreciable surface water in-flows or outflows (discharge at the outlet) or measured or apparent ground water in-flows to the pond in 2024, this condition is included HEA's 2024 Modeled In-Pond Percent Nutrient Source Loading for Total Phosphorus and Total Nitrogen as follows:





The preceding "In-Pond" nutrient source loadings does not include any land-based nutrients via ground water flow, as measurable ground water in-flow was not noted by HEA in 2024. It does include storm water contribution, as a non-ground water direct "in-pond" source of nutrients to the pond, from a high intensity storm event estimated to contribute runoff directly to the pond of approximately 1 to 2 % of the total annual watershed discharge. High intensity storm water runoff events would likely reach the pond through ephemeral stream channels; one leading into the inlet area and the other at P4 and "Stormwater Sample" depicted on **Figure 2**.

<u>Nutrient Sources and Loading Findings</u>:

Based on an evaluation of modeled watershed land-based and in-pond nutrient source loading, the <u>primary three sources</u> of nutrients to Stiles Pond are, by percent nutrient loading:

<u>Phosphorus</u>

All Sources Combined: Dry deposition (48%) and Forests (16%) followed by Title V compliant septic systems (7%).

In-Pond Sources: Dry deposition (77%), Waterfowl (9%) and Storm Water (6%)

<u>Nitrogen</u>

All Sources Combined: Septic Systems (36%), Wet Deposition (21%) and Dry Deposition (14%)

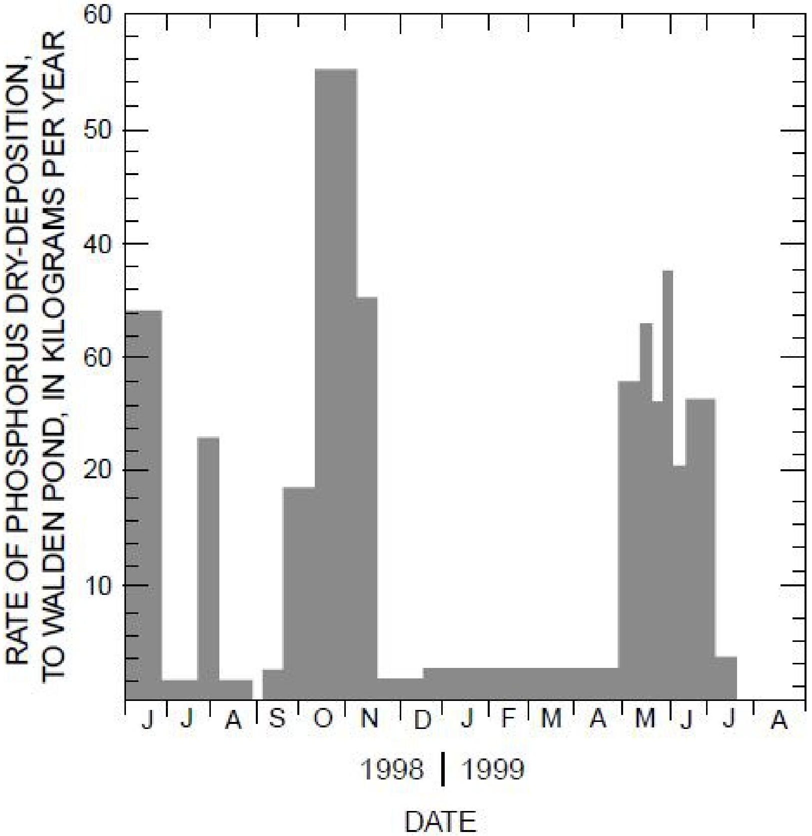
In-Pond Sources: Wet deposition (53%), Dry Deposition (35%) and Internal Loading (6%)

Remember, “All Sources” includes ground water, in-pond sources and a potential low frequency, high intensity storm water runoff event. “In-Pond” excludes ground water sources (similar to 2024).

From a management perspective, Stiles Pond has the benefit of being a raised impoundment whereby ground water contribution of nutrients to Stiles Pond can be limited by regulation of surface water elevation - naturally by beaver debris and/or regulation controls at the outlet structure by the Town. When surface water elevations are higher than ground water elevations, as was the case for much of 2024, surface water would discharge to ground water and ground water would continue to flow around the pond and out the watershed as ground water discharge rather than surface water discharge (observed and measured by KV in 1994).

However, regulation of surface water elevations is dependent on preceding precipitation and the fixed base elevation of the outlet structure discharge channel. If a preceding winter and spring are relatively “dry” on an annual basis, the pond could include more contribution of nutrients from ground water similar to that observed by KV in 1994. 1994 had similar annual amounts of wet precipitation as 2024 but less of 1994's precipitation occurred in late winter and early spring compared to 2024. KV’s 1994 phosphorus loading (87.40 pounds/year) was comparable to HEA’s 2024 All Sources Combined loading (88.91 pounds of phosphorus/year). Early season “wet” years without appreciable ground water in-flow from surrounding land uses and restriction of water flowing through the outlet structure, would be closer to HEA’s modeled “In-Pond” source estimate of 54.23 pounds of phosphorus per year.

Dry deposition of primarily tree pollen from forested areas of Stiles Pond’s air- and water-shed is the primary source of phosphorus loading; similar to USGS's 2001 findings for an in-depth study of nearby Walden Pond in Concord, Massachusetts. The timing and type of nutrient sources also plays an important role in determining the type and amount of biological production in ponds. If all the nutrient sources occurred in December each year, only internal loading from the previous year would potentially be available to support "summer" biotic productivity by phytoplankton. If a majority of the nutrient loading occurred in May-June, as is the case with most dry deposition of tree pollen, the type(s) of phytoplankton that can access those early season nutrient sources will be more productive and dominant than other forms. Cyanobacteria can fix nitrogen and phosphorus from the air, sediment and organic materials such as from tree pollen (HEA 2022, 2023 and others) better than non-cyanobacteria forms of phytoplankton. Cyanobacteria were the dominant form of phytoplankton in shallow and deep waters of Stiles Pond in 2024, so much so, that their biomass and biovolume were consistent with more eutrophic, nutrient-rich, highly productive waters. In start contrast, 2024 laboratory results of surface water for total phosphorus were consistent with near oligotrophic, nutrient-poor, low productivity waters. So, biological productivity at Stiles Pond is more likely than not sourced from a non-water soluble based form of nutrients such as dry deposition of tree pollen. Dry deposition occurs throughout the year and includes early season tree pollen, later season forest-derived leaf litter and seeds, and ongoing sources such as insects and dust. The following chart of dry deposition is taken from USGS's detailed study of Walden Pond:



For Stiles Pond, forests represent the largest land-based loading source via ground water infiltration, runoff or generation of dry deposition to the pond surface for nitrogen and phosphorus primarily because forest cover represents the largest percentage of land area in the air- and water-shed.

It may be helpful for the reader and resident of Boxford to compare nutrient source modeling done by HEA and others (KV, H&W, MassDEP WBP for Stiles Pond) to a "background" condition. To a time when there was no development (residential, commercial, roadways, septic systems) and the air- and water-shed was otherwise just the same acreage proportion of forest and wetland as mapped by MassDEP using 2015 MassGIS data. For the benefit of Boxford and HEA's assessment, background conditions have been modeled.

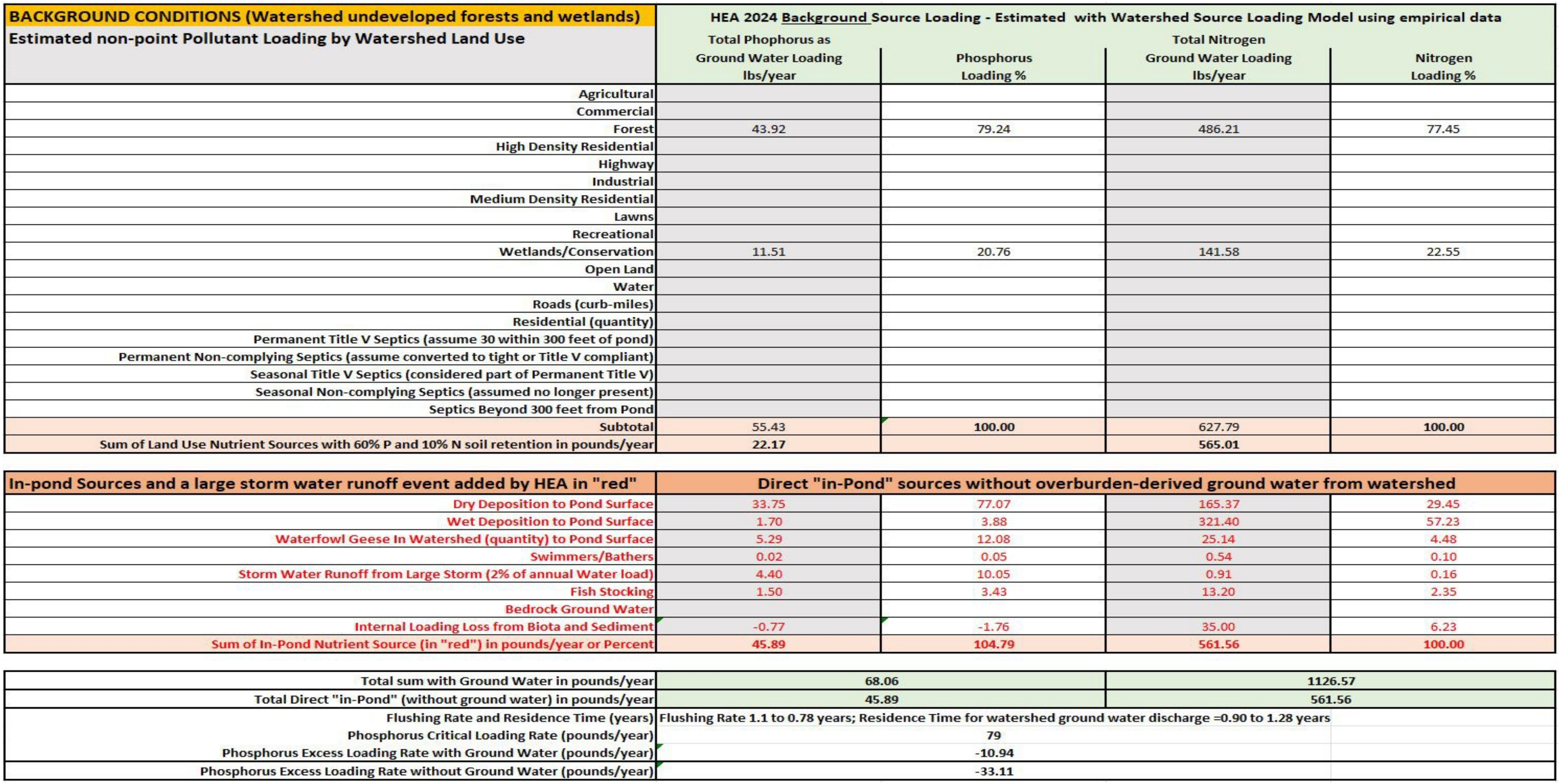
Using hydrologic and nutrient source information gained from HEA's assessment, the following Background Nutrient Sources chart was derived. HEA retained some in-pond nutrient sources such as dry and wet deposition, fish stocking, bathers/swimmers, waterfowl and that high intensity storm flow event in place. Background conditions for dry deposition nutrient source loading were reduced to circa 1990 loading (tree pollen production has been increasing approximately 1 percent/year since 1990 due primarily to climate change (increasing temperatures and carbon dioxide); published information on pollen generation and climate change are included in **Section 7.0 References and Sources**.

When reviewing background conditions on the following chart, it should be apparent that both nitrogen and phosphorus loading overall has decreased to some degree but forested landscapes and dry deposition continue to be the predominant sources of phosphorus loading in pounds per year.

After the Background Chart, HEA has also included a chart that incorporates Recommended Nutrient Source Load reduction actions for Stiles Pond that the Town and residents should consider and is discussed further in HEA's recommendation section, **Section 6.0**. The Recommended Changes are directed at the largest land-use source of nutrients and related dry-deposition source, forests, and to forestry management practices whereby forest cover is converted in part (50%) to open space (grasses and shrubs) to create a mixed watershed land-use cover of predominantly forest, grasses and shrubs (open space). Dry deposition in the Recommended situation is reduced by 50 percent to account for a corresponding reduction in forest cover. Another benefit of reducing now dominant forest cover and replacement with a mixture of forests, grasses and shrubs, if managed well, would be a decrease in evapotranspiration, an increase in precipitation infiltration and ground water flow through the watershed and into Fish Brook, and an increase in carbon sequestration in soil (*i.e.*, increase in microbial biomass in mixed cover land areas). Fish Brook's Category 5 Impaired Waters category listing due to reduced dissolved oxygen and macroinvertebrate habitat would be improved with more sustained watershed discharge (ground water baseflow) in the Recommended land use changes versus current land use condition situation.

The Background and Recommended Nutrient Source Loading charts are then followed by summary bar charts of annual total phosphorus and nitrogen loading by source (land cover and direct in-pond sources) with insert charts for the annual sum of total phosphorus and total nitrogen loading per year for each (2024, Background and Rec.).

HEA modeled Background Nutrient Sources

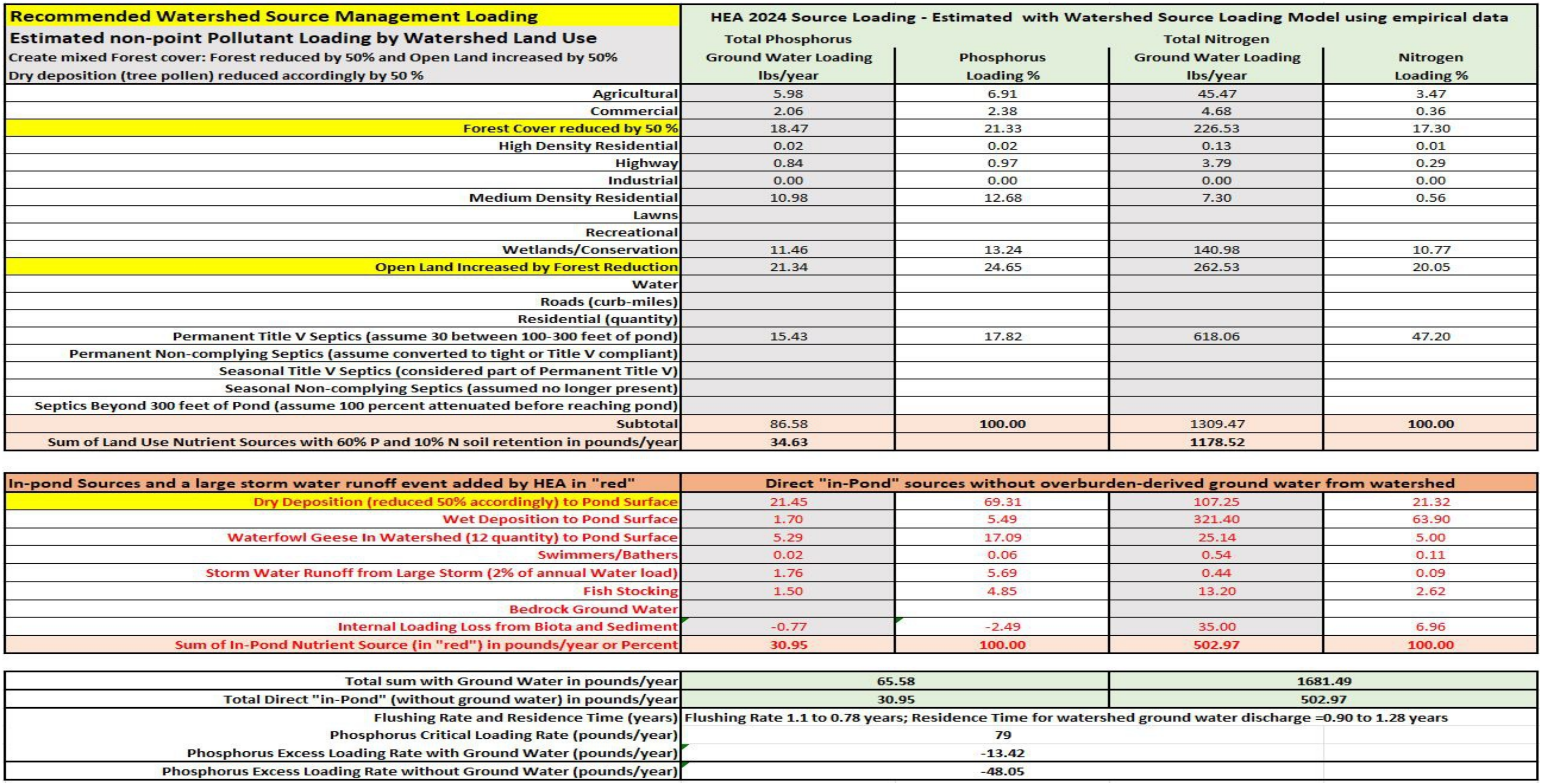


BACKGROUND CONDITIONS (Watershed undeveloped forests and wetlands) Estimated non-point Pollutant Loading by Watershed Land Use	HEA 2024 Background Source Loading - Estimated with Watershed Source Loading Model using empirical data Total Phophorus as Ground Water Loading lbs/year	Phosphorus Loading %	Total Nitrogen Ground Water Loading lbs/year	Nitrogen Loading %
Agricultural				
Commercial				
Forest	43.92	79.24	486.21	77.45
High Density Residential				
Highway				
Industrial				
Medium Density Residential				
Lawns				
Recreational				
Wetlands/Conservation	11.51	20.76	141.58	22.55
Open Land				
Water				
Roads (curb-miles)				
Residential (quantity)				
Permanent Title V Septics (assume 30 within 300 feet of pond)				
Permanent Non-complying Septics (assume converted to tight or Title V compliant)				
Seasonal Title V Septics (considered part of Permanent Title V)				
Seasonal Non-complying Septics (assumed no longer present)				
Septics Beyond 300 feet from Pond				
Subtotal	55.43	100.00	627.79	100.00
Sum of Land Use Nutrient Sources with 60% P and 10% N soil retention in pounds/year	22.17		565.01	

In-pond Sources and a large storm water runoff event added by HEA in "red"	Direct "in-Pond" sources without overburden-derived ground water from watershed			
Dry Deposition to Pond Surface	33.75	77.07	165.37	29.45
Wet Deposition to Pond Surface	1.70	3.88	321.40	57.23
Waterfowl Geese In Watershed (quantity) to Pond Surface	5.29	12.08	25.14	4.48
Swimmers/Bathers	0.02	0.05	0.54	0.10
Storm Water Runoff from Large Storm (2% of annual Water load)	4.40	10.05	0.91	0.16
Fish Stocking	1.50	3.43	13.20	2.35
Bedrock Ground Water				
Internal Loading Loss from Biota and Sediment	-0.77	-1.76	35.00	6.23
Sum of In-Pond Nutrient Source (in "red") in pounds/year or Percent	45.89	104.79	561.56	100.00

Total sum with Ground Water in pounds/year	68.06	1126.57
Total Direct "in-Pond" (without ground water) in pounds/year	45.89	561.56
Flushing Rate and Residence Time (years)	Flushing Rate 1.1 to 0.78 years; Residence Time for watershed ground water discharge =0.90 to 1.28 years	
Phosphorus Critical Loading Rate (pounds/year)	79	
Phosphorus Excess Loading Rate with Ground Water (pounds/year)	-10.94	
Phosphorus Excess Loading Rate without Ground Water (pounds/year)	-33.11	

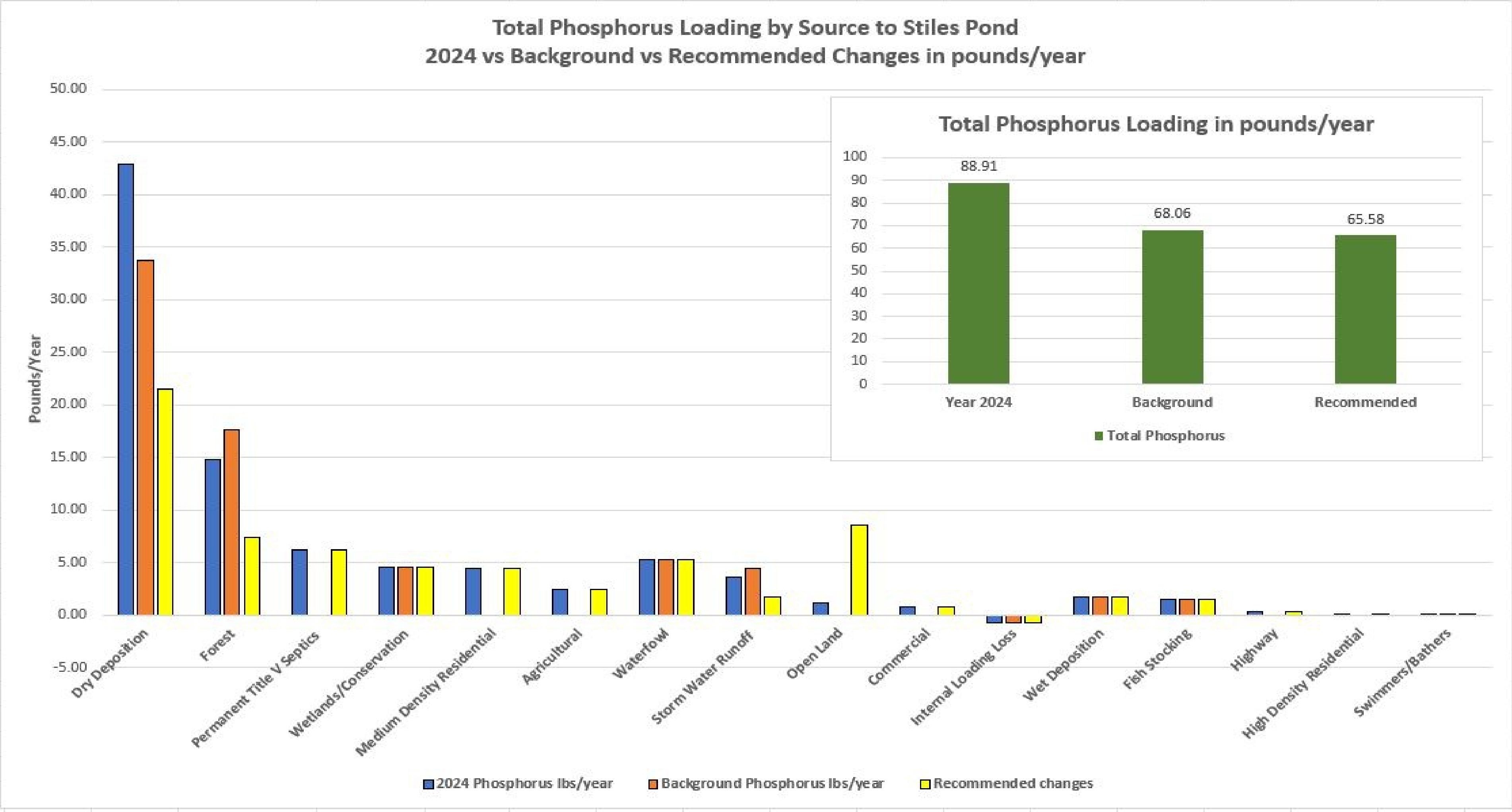
HEA modeled Recommended Changes to Nutrient Sources



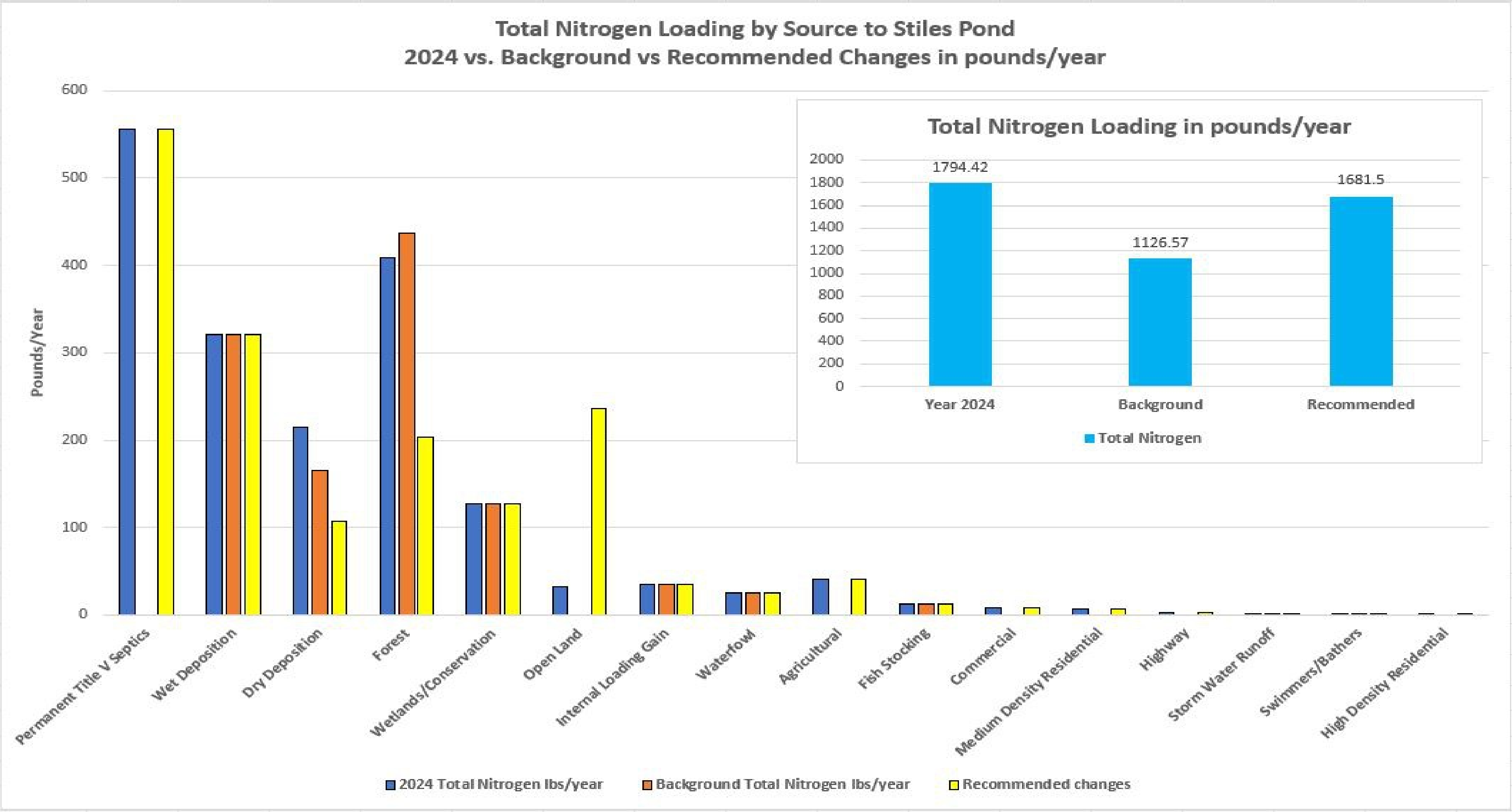
Recommended Watershed Source Management Loading	HEA 2024 Source Loading - Estimated with Watershed Source Loading Model using empirical data			
Estimated non-point Pollutant Loading by Watershed Land Use	Total Phosphorus		Total Nitrogen	
Create mixed Forest cover: Forest reduced by 50% and Open Land increased by 50%	Ground Water Loading	Phosphorus	Ground Water Loading	Nitrogen
Dry deposition (tree pollen) reduced accordingly by 50 %	lbs/year	Loading %	lbs/year	Loading %
Agricultural	5.98	6.91	45.47	3.47
Commercial	2.06	2.38	4.68	0.36
Forest Cover reduced by 50 %	18.47	21.33	226.53	17.30
High Density Residential	0.02	0.02	0.13	0.01
Highway	0.84	0.97	3.79	0.29
Industrial	0.00	0.00	0.00	0.00
Medium Density Residential	10.98	12.68	7.30	0.56
Lawns				
Recreational				
Wetlands/Conservation	11.46	13.24	140.98	10.77
Open Land Increased by Forest Reduction	21.34	24.65	262.53	20.05
Water				
Roads (curb-miles)				
Residential (quantity)				
Permanent Title V Septics (assume 30 between 100-300 feet of pond)	15.43	17.82	618.06	47.20
Permanent Non-complying Septics (assume converted to tight or Title V compliant)				
Seasonal Title V Septics (considered part of Permanent Title V)				
Seasonal Non-complying Septics (assumed no longer present)				
Septics Beyond 300 feet of Pond (assume 100 percent attenuated before reaching pond)				
Subtotal	86.58	100.00	1309.47	100.00
Sum of Land Use Nutrient Sources with 60% P and 10% N soil retention in pounds/year	34.63		1178.52	

In-pond Sources and a large storm water runoff event added by HEA in "red"	Direct "in-Pond" sources without overburden-derived ground water from watershed			
Dry Deposition (reduced 50% accordingly) to Pond Surface	21.45	69.31	107.25	21.32
Wet Deposition to Pond Surface	1.70	5.49	321.40	63.90
Waterfowl Geese In Watershed (12 quantity) to Pond Surface	5.29	17.09	25.14	5.00
Swimmers/Bathers	0.02	0.06	0.54	0.11
Storm Water Runoff from Large Storm (2% of annual Water load)	1.76	5.69	0.44	0.09
Fish Stocking	1.50	4.85	13.20	2.62
Bedrock Ground Water				
Internal Loading Loss from Biota and Sediment	-0.77	-2.49	35.00	6.96
Sum of In-Pond Nutrient Source (in "red") in pounds/year or Percent	30.95	100.00	502.97	100.00

Total sum with Ground Water in pounds/year	65.58		1681.49	
Total Direct "in-Pond" (without ground water) in pounds/year	30.95		502.97	
Flushing Rate and Residence Time (years)	Flushing Rate 1.1 to 0.78 years; Residence Time for watershed ground water discharge =0.90 to 1.28 years			
Phosphorus Critical Loading Rate (pounds/year)	79			
Phosphorus Excess Loading Rate with Ground Water (pounds/year)	-13.42			
Phosphorus Excess Loading Rate without Ground Water (pounds/year)	-48.05			



Total Phosphorus Loading by Source to Stiles Pond
2024 vs Background vs Recommended Changes in pounds/year


Total Nitrogen Loading by Source to Stiles Pond
2024 vs. Background vs Recommended Changes in pounds/year
Pounds/Year
600
500
400
300
200
100
0
Permanent Title V Septics
Wet Deposition
Dry Deposition
Forest
Wetlands/Conservation
Open Land
Internal Loading Gain
Waterfowl
Agricultural
Fish Stocking
Commercial
Medium Density Residential
Highway
Storm Water Runoff
Swimmers/Bathers
High Density Residential
2024 Total Nitrogen lbs/year
Background Total Nitrogen lbs/year
Recommended changes
Total Nitrogen Loading in pounds/year
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1794.42
1126.57
1681.5
Year 2024
Background
Recommended
Total Nitrogen

6.0 RECOMMENDATIONS

Based upon our findings to date, HEA recommends the following:

1. The quality, quantity and sources of nutrients entering the pond through bedrock fractures should be further assessed. Information from bedrock potable water supply wells in the watershed should be obtained and reviewed. Assessments should include an evaluation for nutrient water quality and basic water chemistry such as for dissolved oxygen, pH, temperature, conductivity and salinity among others. HEA recommends resampling of ground water either: A) in a year when overburden and bedrock ground water are contributing nutrients and water flow into Stiles Pond, similar to conditions noted by KV in 1994; or B) at more distance from surface water shorelines of Stiles Pond to limit surface water quality influence on overburden ground water quality.

2. Annual harvesting and removal of in-pond, dry deposition and excess phytoplankton: Stiles Pond has many direct-contact water users (bathers, swimmers, boaters) from the town beach and four summer camps. As a health prudent preventative measure, similar to other watershed-water quality best management practices like storm water controls, limitation on fertilizer use near water bodies, etc., HEA recommends that the Town consider annual harvesting and removal of dry deposition (tree pollen primarily) and excess phytoplankton from the pond to limit cyanobacteria (includes toxic species) biomass and productivity.

   In 2024, while less than Massachusetts 70,000 cells/milliliter health advisory threshold, the total shallow water phytoplankton cell count (55,628 cells/mL) contained diverse cyanobacteria species (53,583 cells/mL) of which 48,608 cells/mL were potentially toxic (PTOX) forms of cyanobacteria. This is a borderline concern for health and use of the pond that should be mitigated as a preventative and prudent measure.

   Water clarity of Stiles Pond dropped approximately fifty percent (from near 11 to 6 feet) at the end of the tree pollen (dry deposition) season. Decreasing water clarity and increased nutrient loading from dry deposition is having a noticeably greater impact on surface water quality than measured previously by KV, H&W or MassDEQE (1978).

3. The Town should consider forest and land use management practices in the air- and watershed of Stiles Pond to limit dry deposition of nutrients and to increase infiltration of precipitation for ground water discharge through the watershed and into Fish Brook. Forestry management and land use practices should focus on creating a mixed forest-grass-shrub land use cover to replace approximately fifty percent (approximately 100 acres) of now dominant forest canopy cover in the watershed. From an air-shed and proximity to pond for dry deposition perspective, forest management should focus on the predominant

upwind (northwest and western section of the watershed) and areas within 150 feet of shorelines including a focus on trees that produce and disperse pollen further than others such as pine trees.

Allowing sunlight to reach the ground surface (limited in closed forest canopies) can increase understory plant (grasses, sedges and shrubs) diversity and growth which in turn supports an increase in soil microbial biomass and diversity (leading to healthier soil). Healthy soil sequesters a significant amount of carbon and supports more favorable hydrologic conditions. Healthy soil actually can be a greater carbon sink than terrestrial plants including trees. Unlike trees, soil and its carbon are "stackable", *i.e.*, soil layers build up each year without the same limits on growth or carbon capture per biomass experienced by terrestrial plants. For more information, HEA has a side-bar paper on Healthy Soils downloadable at www.higginsenv.com that appeared (an edited version pp 28-29) in **Massachusetts' Resilient Lands Initiative-Healthy Soils Action Plan** https://www.mass.gov/info-details/resilient-lands. Promoting healthy soil is something that people and communities can do to mitigate some climate change impacts, reduce storm water runoff, improve water quality and quantity for ground water and baseflow contribution to ponds and streams.

4. HEA recommends that residents of Boxford, particularly those close to or hydrogeologically-connected by drainage area to Stiles Pond take measures to limit use of the element and nutrient sulfur in addition to phosphorus and nitrogen. Sulfur can negatively impact otherwise, natural, biogeochemical conditions and nutrient cycling in fresh water bodies like Stiles Pond. It may help to think of sulfur as the "controlling nutrient" that actually determines whether the "limiting nutrient" phosphorus remains more available than it otherwise would be to increase phytoplankton biomass and productivity. Based on surface water laboratory results for Stiles Pond in 2024, the molar concentration of sulfur at approximately 57 umol/L is close to the threshold (60 umol/L) where it can start to negatively impact (increase) internal nutrient recycling (*i.e.*, loading) and release of phosphorus from seston and sediments. Excess sulfur can also decrease dissolved oxygen content of surface water and impact benthic macrophyte health (i.e., extensive beds of flat-leaf pondweed could be diminished and release their otherwise relatively fixed pool of nutrients). Decreases in dissolved oxygen could also impact Stiles Pond cold-water fishery seasonal habitat status and recreational value to fisherpeople.

   Sulfur is a component of many common residential and commercial use products and practices including within detergents, water treatment chemicals, lawn care products and fertilizers. So, residents and camp operators near the pond can make informed decisions about which products to use or not.

5. A permanent surface water elevation gauge and weather station should be set up or at least considered for monthly monitoring and use at Stiles Pond's outlet. One or more ground water monitoring wells should be considered to evaluate surface water and ground water interaction along different shorelines of the pond (two wells on the north side, one east and one south). The Town should also consider purchase and use of basic water quality equipment (preferably a vertical profile capable sonde for pH, dissolved

oxygen, temperature), secchi disc, discrete water sampler. Set up, maintain and archive weekly-monthly monitoring records. Weekly data collection for the last two weeks of August and first two weeks in September just above the outlet structure will be particularly helpful over time.

As times change, circumstances and importantly, the degree and source(s) of external nutrient loading to the pond may change; either by intent (*i.e.*, development, infrastructure choices, over use, etc.) or by essentially uncontrollable conditions (*i.e.*, climate change, land use cover changes due to pests or disease, etc.). Consistent, annual monitoring records and observations help to document these changes and provide supporting information to respond accordingly. Response could include lowering and raising the surface water elevation of the pond. Based on HEA's observations and knowledge of phytoplankton community and nutrient source loading, maintaining surface water elevations higher than ground water from May to early September (summer camps closed and use of town beach limited) is recommended. Alternation of surface water elevations should be coordinated in advance with Boxford's Conservation Commission as changes could impact aquatic and terrestrial species that may be affected by changes in surface water elevation.

6. The Town should implement watershed-wide best management and guidance designed to limit the use of nutrients and/or chemicals that might negatively impact pond conditions and use. Land use practices that increase natural infiltration of precipitation and decrease both storm water runoff and shoreline erosion should be encouraged. As a best management practice, the Town should consider increasing the retention capacity of ephemeral/intermittent stream and drainage features that may concentrate and direct storm water flows into the pond during heavy and intense rainfall events. There are natural flow restrictions (tree fall, logs, stones) and landscaping that can be implemented with minimal labor or expense. While storm water flow was not observed by KV, H&W or HEA, based on HEA's assessment and as incorporated in our nutrient source loading (2024, background and recommended conditions), more intense rain events can lead to storm water flow into the pond and based on HEA's laboratory analysis of en-route storm water (STRM1 sample), the nutrient contribution can be significant even for short duration or volume storm events.

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ATTACHMENTS

FIGURES

MassDEP - Bureau of Waste Site Cleanup

Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii

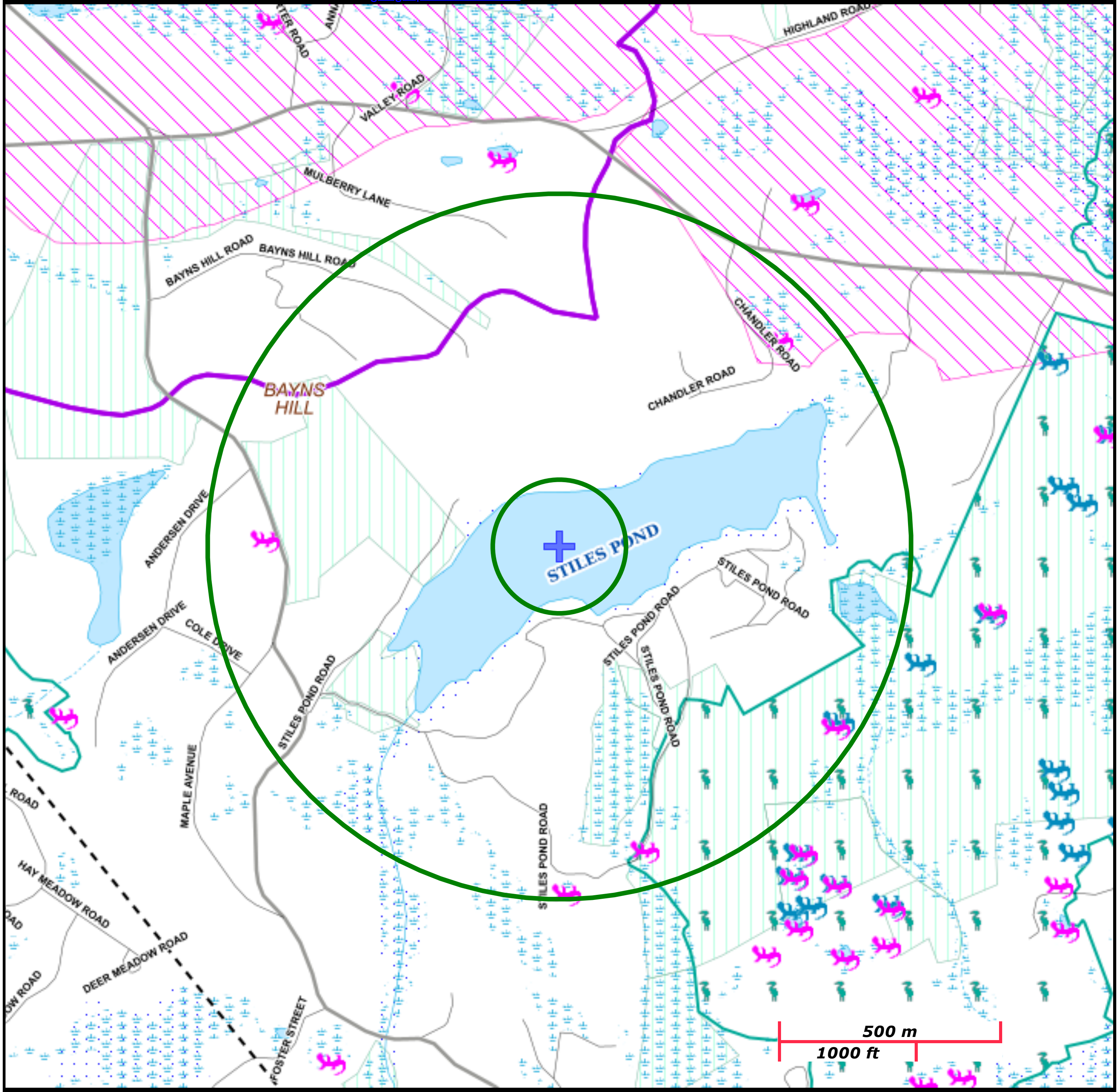
Site Information:

FIGURE 1 - GENERAL LOCATION OF STILES POND
BOXFORD, MASSACHUSETTS BOXFORD, MA

NAD83 UTM Meters:
4728287mN , 333026mE (Zone: 19)
December 6, 2024

The information shown is the best available at the date of printing. However, it may be incomplete. The responsible party and LSP are ultimately responsible for ascertaining the true conditions surrounding the site. Metadata for data layers shown on this map can be found at: https://www.mass.gov/orgs/massgis-bureau-of-geographic-information.

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection



Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail

Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct

Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore, Dam

Aquifers: Medium Yield, High Yield, EPA Sole Source

Non Potential Drinking Water Source Area: Medium, High (Yield)

PWS Protection Areas: Zone II, IWPA, Zone A

Hydrography: Open Water, PWS Reservoir, Tidal Flat

Wetlands: Freshwater, Saltwater, Cranberry Bog

FEMA 100yr Floodplain; Protected Open Space; ACEC

NHESP Pri-Hab of Rare Species; Vernal Pool: Cert., Potential

Solid Waste Landfill; PWS: Com.GW,SW, Emerg., Non-Com.

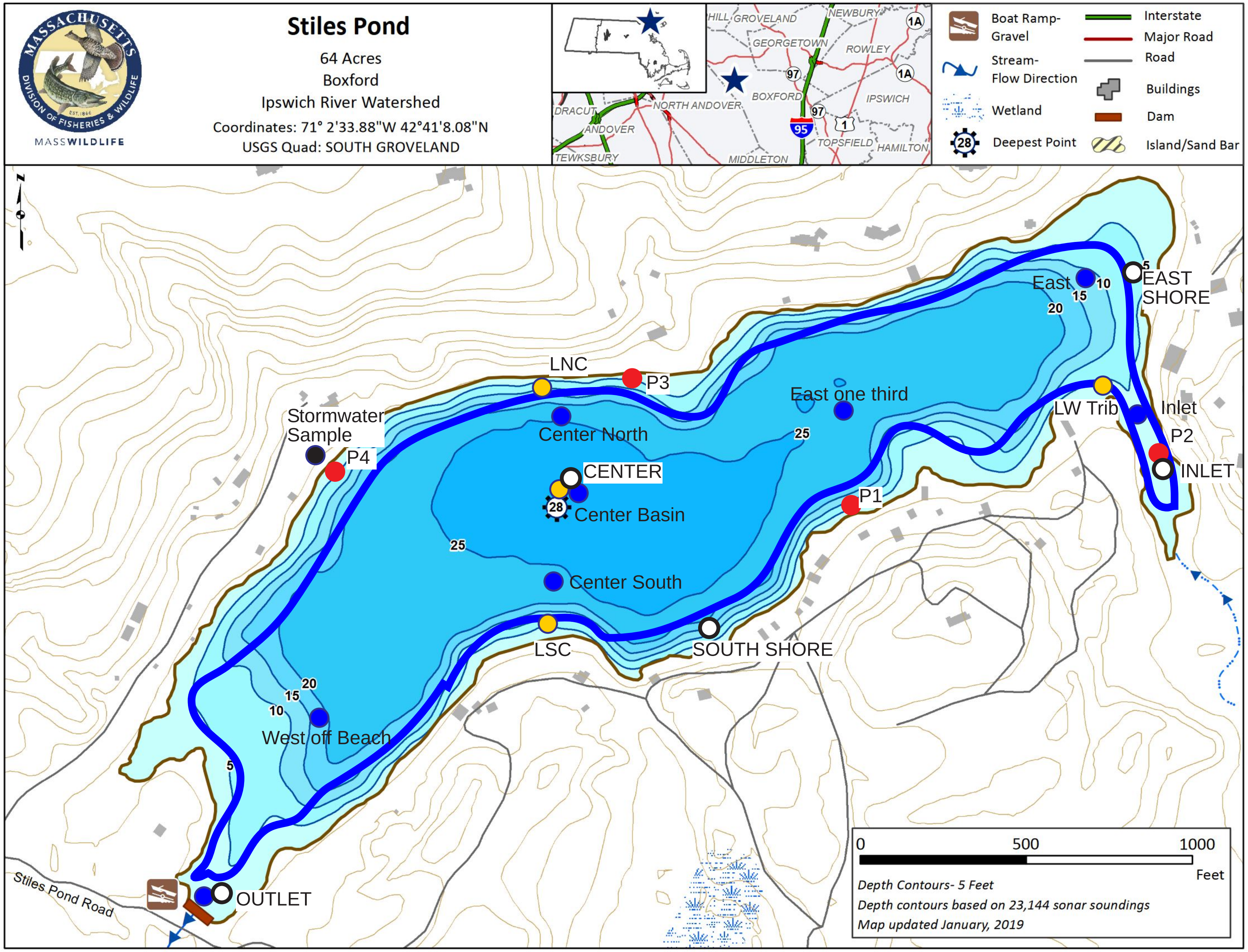


Figure 2 - Sampling Locations Stiles Pond, Boxford, Mass.

Prepared on January 31, 2025 by Higgins Environmental Associates, Inc.
Reference: MassWildlife Pond Map for Stiles Pond, updated 2019
Locations and dimensions are for illustrative purposes only.

KEY:

- ○ 2024 Surface Water Sample Location
- 🔴 2024 Ground Water Sample Location
- 🟡 Sediment Sampling Location
- 🔵 Water Quality Sonde Station (approximate) The deep center station is the primary, monthly monitoring station.
- Perimeter Pond Sonde Survey route

Higgins Environmental Associates, Inc.
Environmental Science and Hydrogeology

TABLES

Table 1 - Surface Water Sample Results

Stiles Pond, Boxford, MA

			2024 Surface Water Sample Results														Storm Water		Precipitation	
Sample Location Identification			**Outlet**		**S Shore**		**Inlet**		**E Shore**		**Center Deep 1**		**Center Shallow**		**Center Deep 2**		**STRM1**		**Wet Prec 1**	
Lab Sample Number:			**4H21036-01**		**4H21036-02**		**4H21036-03**		**4H21036-04**		**4H21036-05**		**4H21036-06**		**4H21036-07**		**4I24048-01**		**4H21035-01**	
Date Sampled:			8/21/2024		8/21/2024		8/21/2024		8/21/2024		8/21/2024		8/21/2024		8/21/2024		**9/23/2024**		**8/20/2024**	
Parameter	CAS Numb	Units	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit
General Chemistry																				
Total Nitrogen	7727-37-9	mg/L	**0.5**	0.1	**0.5**	0.1	**0.5**	0.1	**0.3**	0.1	**0.4**	0.1	**0.5**	0.1	**0.5**	0.1	**0.4**	0.1	**3.4**	0.01
Chloride	16887-00-6	mg/L	**22.9**	0.5	**10.2**	0.5	**8.92**	0.5	**11.8**	0.5	**7.96**	0.5	**8.36**	0.5	**7.97**	0.5	**10.5**	0.25	NT	
Total Dissolved Solids	TDS	mg/L	**20**	10	**96**	10	**28**	10	**12**	10	**16**	10	**28**	10	**32**	10	NT		NT	
Total solids (TS)	TS	mg/L	**36**	10	ND	10	**112**	10	**116**	10	**104**	10	**72**	10	**100**	10	NT		NT	
Total Suspended Solids	TSS	mg/L	ND	2	**5**	2	**7**	2	**12**	2	ND	2	ND	2	**7**	2	NT		NT	
Total Organic Carbon	TOC	mg/L	**4.5**	0.2	**4.8**	0.2	**4.6**	0.2	**4.8**	0.2	**4.1**	0.2	**4.6**	0.2	**4**	0.2	**1.8**	0.2	**1.7**	0.2
Total Kjeldahl Nitrogen	TKN	mg/L	NT		NT		NT		NT		NT		NT		NT		**0.4**	0.1	NT	
Ammonia Nitrogen		mg/L	NT		NT		NT		NT		NT		NT		NT		ND	0.1	NT	
Nitrate Nitrogen		mg/L	NT		NT		NT		NT		NT		NT		NT		ND	0.25	NT	
Microbiology																				
Fecal coliform bacteria	FCOLI	Col./100ml	**20**	10	**70**	10	**10**	10	**10**	10	<	10	**60**	10	<	10	NT		NT	
E. coli	ECOLI	MPN/100ml	**5**	1	**2**	1	**2**	1	**3**	1	**1**	1	**3**	1	<	1	NT		NT	
Total coliform	TCOLI	MPN/100ml	**>2419**	1	**1550**	1	**>2419**	1	**>2419**	1	**365**	1	**1050**	1	**260**	1	NT		NT	
Total Metals																				
Iron	7439-89-6	mg/L	**0.13**	0.05	**0.09**	0.05	**0.13**	0.05	**0.1**	0.05	**0.21**	0.05	**0.08**	0.05	**0.2**	0.05	**0.44**	0.05	ND	0.05
Phosphorous	7723-14-0	mg/L	ND	0.01	ND	0.01	ND	0.01	ND	0.01	**0.013**	0.01	**0.013**	0.01	**0.01**	0.01	**0.598**	0.01	ND	0.01
Sulfur		mg/L	**1.9**	0.5	**3**	0.5	**1.8**	0.5	**1.8**	0.5	**1.9**	0.5	**1.8**	0.5	**1.8**	0.5	**2.9**	0.5	ND	0.5
Phosphorous (Reprep)	7723-14-0	mg/L	ND	0.01	ND	0.01	**0.014**	0.01	ND	0.01	ND	0.01	ND	0.01	**0.011**	0.01				

			1994 Sample Results							Surface Water Maximum Concentration 1994-2024
Sample Location Identification			**Outlet**	**Southern Shore**	**Inlet Shallow**	**Eastern**	**Center Deep**	**Center hallow Du**	**Center Shallow**	
General Chemistry	CAS Numb	Units								
Total Nitrogen	7727-37-9	mg/L	**0.445**	**0.473**	**1.14**	**0.43**	**0.524**	**0.359**	**0.503**	**1.14**
Chloride	16887-00-6	mg/L	**7.8**	**8**	**6.79**	**7.6**	**7.7**	**8.2**	**7.7**	**22.9**
Total Dissolved Solids	TDS	mg/L	**57.3**	**54.7**	**38.7**	**40**	**41.3**	NT	41.3	**96**
Total solids (TS)	TS	mg/L	**61.3**	**57.1**	**41.1**	**40**	**45.3**	NT	41.3	**116**
Total Suspended Solids	TSS	mg/L	**4**	**2.4**	**2.4**	<2.00	**4**	NT	<.00	**12**
Total Organic Carbon	TOC	mg/L								
Total Kjeldahl Nitrogen	TKN	mg/L	**0.445**	**0.443**	**1.12**	**0.38**	**0.524**	**0.359**	**0.503**	**1.12**
Ammonia Nitrogen		mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**0**
Nitrate Nitrogen		mg/L	<0.02	**0.03**	**0.02**	**0.05**	<0.02	<0.02	<0.02	**0.05**
Microbiology										
Fecal coliform bacteria	FCOLI	Col./100ml	**10**	**10**	<10	<10	NT	NT	<10	**70**
E. coli	ECOLI	MPN/100ml	NT	NT	NT	NT	NT	NT	NT	**5**
Total coliform	TCOLI	MPN/100ml	**20**	**50**	**120**	<10	NT	NT	<10	**>2419**
Total Metals										
Iron	7439-89-6	mg/L	NT	NT	NT	NT	NT	NT	NT	**0.21**
Phosphorous	7723-14-0	mg/L	**0.017**	**0.015**	**0.101**	**0.013**	**0.031**	**0.019**	**0.02**	**0.101**
Sulfur		mg/L	NT	NT	NT	NT	NT	NT	NT	**3**

NOTES:

1. All detected compounds highlighted in "blue"…Maximum surface water results between 1994 and 2024 Samples highlighted in "yellow".
2. Total Nitrogen for 1994 samples were calculated from subset nitrogen results (TKN, etc.). 2024 Samples were not analyzed by the lab for nitrogen subsets but did report Total Nitrogen.
3. 2024 data has "reporting limits" (i.e., "detection limits") next to each Sample Result. 1994 data was reported as "< ##" where the number (##) is the detection limit as noted in the 1994 report.
4. 2024 Sampling key - Center Deep 1 and Center Deep 2 are duplicate samples. 1994 Sampling key - Center shallow duplicate and center shallow are also duplicate samples.
5. "Phosphorus Reprep" = At HEA's request, the laboratory resampled each of the same (2024) sample containers for phosphorus analysis. Variance between "original and reprep" attributed to total solids as samples were not filtered.

General Summary of Data 2024 vs. 1994

1. Higher concentrations of the nutrients phosphorus and nitrogen were detected in 1994 than in 2024.
2. HEA understands that improvements in septic system (by type or location moves) were made near the inlet of Stiles Pond where higher nutrient concentrations were found in 1994 than 2024.
3. Based on HEA's 2024 observations compared to documented 1994 conditions by KV Associates, surface water elevations were higher in 2024 than in 1995 but discharge in 2024 at the outlet was more limited (boards and beavers) than in 1994.
4. Increases in total coliform and detection of e.Coli could be related to increases in animal density in and around the pond and lack of appreciable water flow through the outlet. Results noted as >2419 exceeded the MPN (most probably number of colonies) noted.

Table 2 - Ground Water Sample Results
Stiles Pond, Boxford, MA

2024 Ground Water Sample Results

Sample Identification			P-1		P-2		P-3		P-4	
Lab Sample Number:			**4I13017-01**		**4I13017-02**		**4I13017-03**		**4I13017-04**	
Date Sampled:			9/12/2024 12:50		9/12/2024 13:13		9/12/2024 14:13		9/12/2024 14:50	
Date Received:			9/13/2024 12:20		9/13/2024 12:20		9/13/2024 12:20		9/13/2024 12:20	
Parameter	CAS Number	Units	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit
General Chemistry										
Total Nitrogen	7727-37-9	mg/L	**0.6**	0.1	**5.1**	0.1	**3**	0.1	**2.9**	0.1
Chloride	16887-00-6	mg/L	**14.7**	0.25	**9.6**	0.25	**9.66**	0.25	**11.5**	0.25
Nitrate as N	14797-55-8	mg/L	ND	0.25	ND	0.25	ND	0.25	ND	0.25
Nitrite as N	14797-65-0	mg/L	ND	0.02	ND	0.02	ND	0.02	ND	0.02
Kjeldahl Nitrogen	TKN	mg/L	**0.6**	0.1	**5.1**	0.1	**3**	0.1	**2.9**	0.1
Ammonia	7664-41-7	mg/L	ND	0.1	**0.9**	0.1	**0.5**	0.1	**0.5**	0.1
Total Organic Carbon	TOC	mg/L	**1**	0.2	**4.1**	0.2	**3.2**	0.2	**1.8**	0.2
Total Metals										
Iron	7439-89-6	mg/L	**0.15**	0.05	**0.3**	0.05	**1.5**	0.05	**2.98**	0.05
Phosphorous	7723-14-0	mg/L	**0.01**	0.01	**0.084**	0.01	**0.061**	0.01	**0.08**	0.01
Sulfur		mg/L	ND	0.5	ND	0.5	ND	0.5	ND	0.5

1994 Ground Water Sample Results

Sample Location Identification			1 GW	3 GW	5 GW	Maximum Conc. 1994-2024
Parameter	CAS Number	Units				
General Chemistry						
Total Nitrogen	7727-37-9	mg/L	**2.18**	**1.25**	NT	**5.1**
Chloride	16887-00-6	mg/L	NT	NT	NT	**14.7**
Nitrate as N	14797-55-8	mg/L	<0.05	**0.12**	NT	**0.12**
Nitrite as N	14797-65-0	mg/L	NT	NT	NT	
Kjeldahl Nitrogen	TKN	mg/L	**2.18**	**1.13**	NT	**5.1**
Ammonia	7664-41-7	mg/L	**1.65**	**0.12**	NT	**1.65**
Total Organic Carbon	TOC	mg/L	NT	NT	NT	**4.1**
Total Metals						
Iron	7439-89-6	mg/L	NT	NT	NT	**2.98**
Phosphorous	7723-14-0	mg/L	**0.161**	**0.434**	**0.319**	**0.434**
Sulfur		mg/L	NT	NT	NT	

NOTES:

1. All detected compounds highlighted in "blue"…Maximum result between 1994 and 2024 Samples highlighted in "yellow".
2. Total Nitrogen for 1994 samples were calculated from subset nitrogen results (TKN, etc.).
3. 2024 data has "reporting limits" (i.e., "detection limits") next to each Sample Result. 1994 data was reported as "< ##" where the number (##) is the detection limit as noted in the 1994 report.
4. 2024 Sampling key - P-1 is close to 1994 1 GW; P-2 is close to 3 GW; P-3 and P-4 were taken from the northshore of Stiles Pond; and, 5 GW was taken just south of the Town Beach in 1994.
5. Based on slight differences in field measured potentiometric ground water elevations during sampling in 2024, location P-1 (southern side of pond) was on the hydraulically downgradient (i.e., "losing") side of the pond and P-2 through P-4 on the eastern and northern sections of pond were in hydraulically upgradient ("gaining") areas of the pond. Ground water from P-2 through P-4 also had strong rotten-egg like odors; a characteristic of hydrogen sulfide. Relative elevation differences between ground water and surface water. Ground water likely flows more to the southwest (outlet area) than indicated by P-1 through P-4 test locations.
6. Relative elevation differences between ground water and surface water are likely influenced by the outlet structure. Year 2024 was a drought year with minimal rainfall after June 2024; one brief rain event on August 19th allowed for collection of one precipitation sample; another rain event on September 22nd allowed for collection of a storm water sample.
7. By July 30th, surface water was no longer discharging through the outlet and surface water levels continued to drop another 4 inches by November 9, 2024.

General Summary of Data 2024 vs. 1994

1. Higher concentrations of the nutrient phosphorus was detected in 1994 than in 2024.
2. Lower concentrations of the nutrient total nitrogen were detected in 1994 than in 2024.
3. HEA understands that improvements in septic system (by type or location moves) were made near the inlet of Stiles Pond where higher nutrient concentrations for phosphoros were found in 1994 than 2024; however, nitrogen concentrations were lower in 1994 than 2024 at this same location (inlet).
4. HEA understands that outlet structure water flows in 1994 occurred with water flowing around and over a 12-inch stop log; in 2024 beaver debris and activity effectively prevented water flow through the outlet; and, surface water elevations were now higher in 2024 than 1994. Circa late August 2024, the Town cleaned out debris in the outlet structure and surface water elevations dropped by approximately 10 inches; flows were then restricted.
5. In 2024, higher concentrations of the nutrients carbon, iron and phosphorus, while still lower than (phosphorus) detected in 1994, were greater in hydraulically upgradient (samples P-2 through P-4) than downgradient locations (P-1).

Table 3 - Pollen and Sediment Sample Results - Stiles Pond

SEDIMENT SAMPLES

Sample ID:	**TC**		**TC2**		**MC**		**BC**		**LNC**		**LNC2**		**LSC**		**LSC2**		**LW TRIB**		**LW TRIB2**		
Lab Sample Number:	**4F24018-01**		**4I13016-01**		**4F24018-02**		**4F24018-031**		**4F24018-04**		**4I13016-03**		**4F24018-05**		**4I13016-02**		**4F24018-06**		**4I13016-04**		
Date Sampled:	**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		**6/4/2024**		
Parameter	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	Sample Result	Reporting Limit	**Units**
General Chemistry	(Core top 2 inches)		(Core top 2 inches)		(Core mid-point)		(Core bottom)		(north littoral)		(north littoral)		(south littoral)		(south littoral)		(trib entrance)		(trib entrance)		
Total Nitrogen	**9280**	10	**852**		**19000**	10	**13700**	10	**1820**	10	**726**	10	**11500**	10	**165**	10	**7110**	10	**645**	10	mg/kg
Total Phosphorous	**892**	3.6	**1080**		**190**	3.5	**337**	4.04	**642**	2.26	**600**	2.26	**1230**	2.78	**183**	2.78	**646**	1.97	**642**	1.97	mg/kg
Total Organic Carbon	**15**	0	**13**		**20**	0	**21**	0	**36**	0	**17**	0	**31**	0	**5**	0	**22**	0	**18**	0	Percent (%)
Total Metals																					
Iron	**28000**	26	**18000**		**10100**	39	**36000**	64.6	**7450**	64.6	**11100**	64.6	**30000**	38.2	**6200**	38.2	**19600**	16.2	**14400**	16.2	mg/kg
Sulfur	**11800**	260	**ND**		**4720**	390	**13200**	646	**20200**	646	**ND**	646	**10800**	382	**ND**	382	**7110**	162	**ND**	162	mg/kg

POLLEN AND BENTHIC MACROPHYTE SAMPLES

Sample ID:	**Pollen 1**		**Bmacro**		
Lab Sample Number:	**4F24018-07**		**4I13016-05**		
Date Sampled:	**6/4/2024**		**6/4/2024**		
Parameter	Sample Result	Reporting Limit	Sample Result	Reporting Limit	**Units**
General Chemistry					
Total Nitrogen	**6990**	10	**3110**	10	mg/kg
Total Phosphorous	**1890**	2.34	**2020**	2.34	mg/kg
Total Organic Carbon	**51**	0	**45**	0	Percent (%)
Total Metals					
Iron	**1270**	23.7	**9.7**	23.7	mg/kg
Sulfur	**1420**	237	**ND**	237	mg/kg

Notes for Table 3:

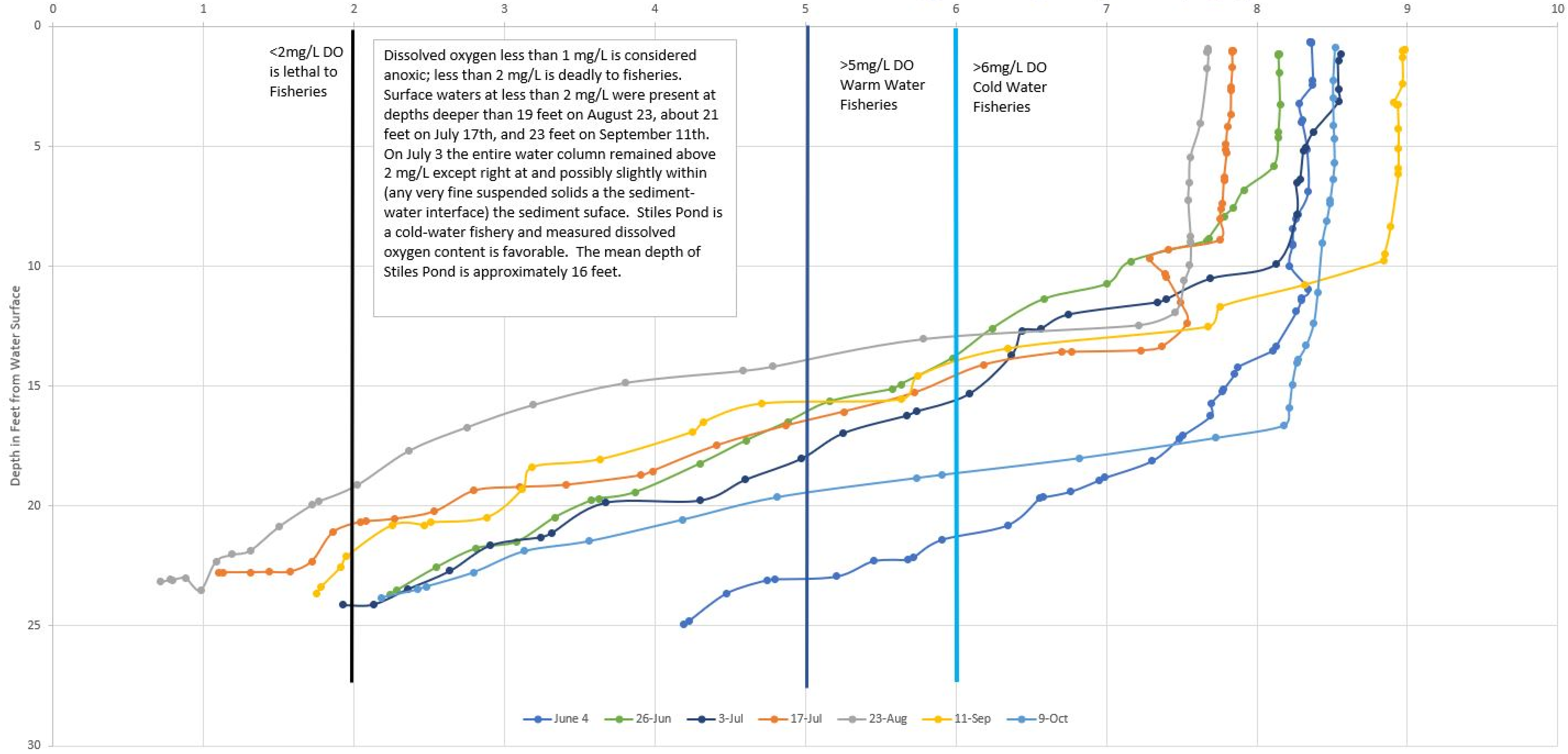
1. Sediment Sample Codes: TC = Top 2 inches of core center basin; MC = Mid-core of center basin; BC = Bottom of core center basin; LNC = Littoral north shore from center basin; LSC = Littoral south shore from center basin; LW Trib = Littoral west side of tributary entrance to pond.
2. Center basin sediment collected from a depth of approximately 24 feet below the water surface with a gravity corer. Core extruded to obtain discrete grab samples from top, mid and bottom of core. Core had 8 inches of soft sediment with color differentiation (darker grey at top lighter grey-brown at base but no strong stratification layers apparent. Sediment core contained entrained gaseous pockets...possibly methane or similar.
3. Littoral samples of sediment (codes LNC, LSC and LW Trib) were collected from a depth of approximately 2 to 3 feet below the water surface using a discrete sampler. Sediment was only approximately 3 inches thick and often located between rock fragments.
4. All results reported as total on a dry weight basis.
5. ND = not detected at or above reporting limit noted.
6. Detected results are highlighted in yellow with bold typeface.
7. Pollen 1 - discrete sample of pollen from the LSC sediment area where pollen (greenish-yellow, microscopically identified as pine pollen) was concentrating along the shoreline and around fallen trees and branches in the water.
8. Bmacro sample is a composite sample of flat-leaf pond weed collected near littoral sediment station LSC.

General Summary of Data

1. Overall, nutrient concentrations for phosphorus were low but are relatively higher at shallower (more recently deposited) depths than deeper portions (mid- and bottom) sections of sediment core sample.
2. Nitrogen concentrations in the center basin sediment core were slightly elevated and were relatively higher in deeper (mid- and bottom) sections of the core; the opposite relative trend compared to phosphorus
3. The nutrient carbon showed similar increasing trends with depth in the center basin sediment core sample as for total nitrogen.
4. The nutrients iron and sulfur in the center basin sediment core had decreasing concentations from top to mid-sections of the core and increase concentrations from top to bottom.
5. Compared to center basin deep results, littoral (near shore, shallow) sediment had relatively higher concentrations for carbon, phosphorus and sulfur, lower concentrations for nitrogen and variable concentratiosn for iron. Littoral areas are more dynamic than deep locations.
6. Pollen Sample: Compared to sediment results, the pollen sample had the highest concentration for the nutrients phosphorus and carbon.
7. Center basin sediment sample: The vertical nutrient profile with phosphorus being higher at shallow depths compared to deeper sedmient intervals suggests either: A) a more nutrient-rich than nutrient-poor water body; and/or, B) a more recent decrease in biogeochemical nutrient-removal, sedimentation processes.

CHARTS

Chart 1 - Year 2024 Stiles Pond Center Basin Dissolved Oxygen in milligrams per liter (mg/L)



Dissolved oxygen less than 1 mg/L is considered anoxic; less than 2 mg/L is deadly to fisheries. Surface waters at less than 2 mg/L were present at depths deeper than 19 feet on August 23, about 21 feet on July 17th, and 23 feet on September 11th. On July 3 the entire water column remained above 2 mg/L except right at and possibly slightly within (any very fine suspended solids a the sediment-water interface) the sediment suface. Stiles Pond is a cold-water fishery and measured dissolved oxygen content is favorable. The mean depth of Stiles Pond is approximately 16 feet.

Chart 2 - Year 2024 Stiles Pond Center Basin Temperature

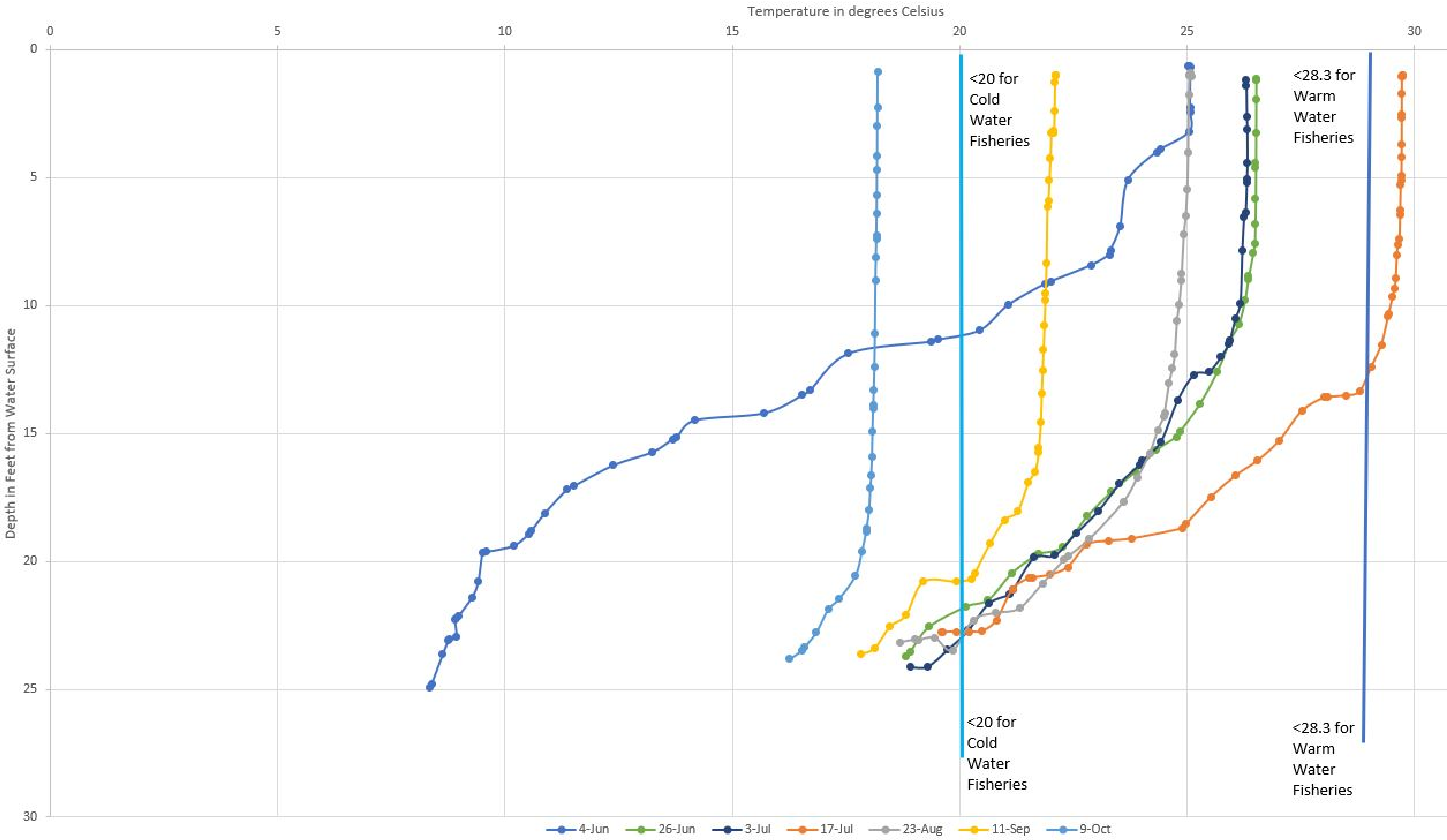
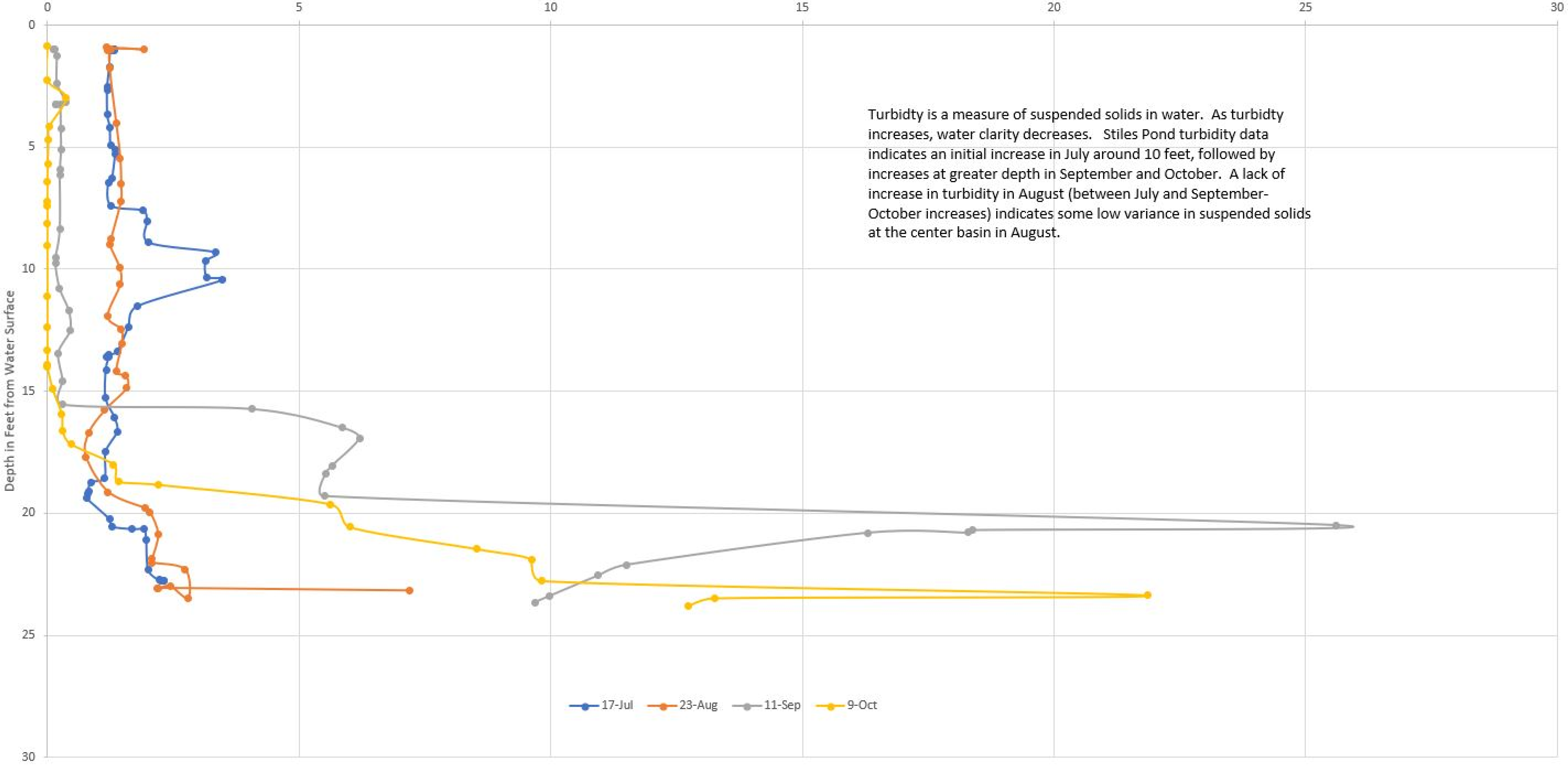
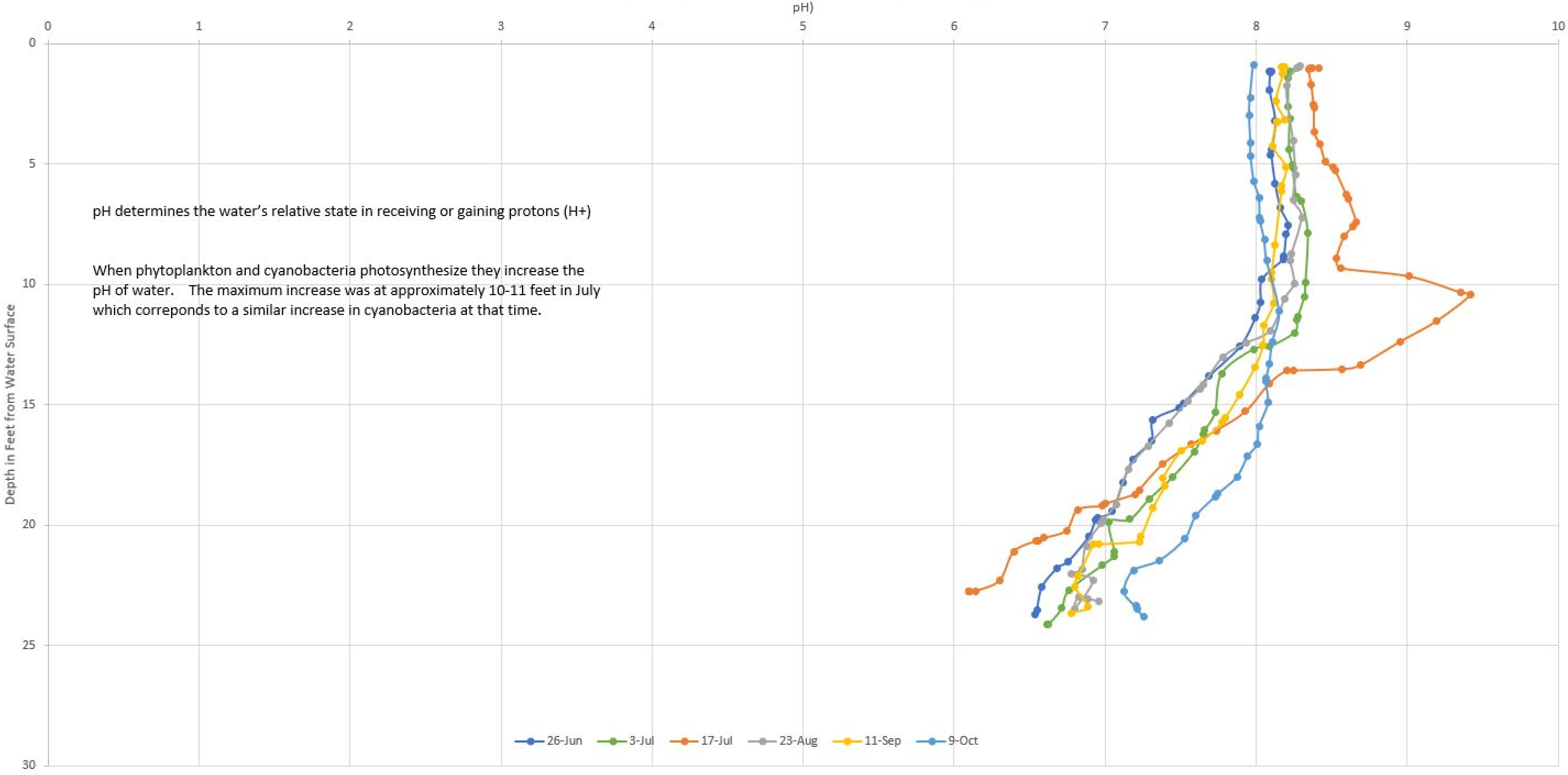


Chart 3 - Year 2024 Stiles Pond Center Basin Turbidity in nephelometric turbidity units (NTU)



Turbidty is a measure of suspended solids in water. As turbidty increases, water clarity decreases. Stiles Pond turbidity data indicates an initial increase in July around 10 feet, followed by increases at greater depth in September and October. A lack of increase in turbidity in August (between July and September-October increases) indicates some low variance in suspended solids at the center basin in August.

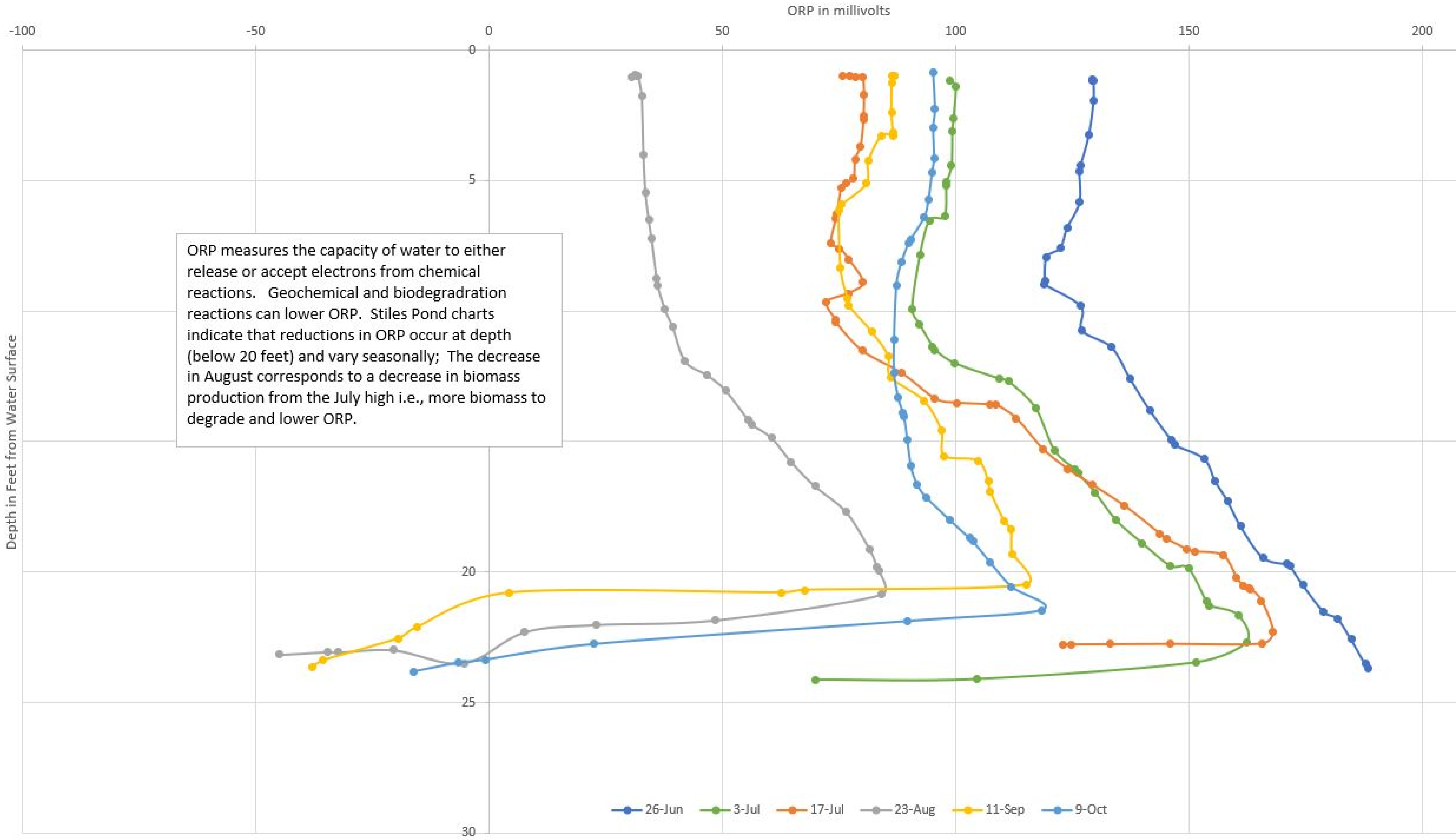
Chart 4 - Year 2024 Stiles Pond Center Basin pH



pH determines the water’s relative state in receiving or gaining protons (H+)

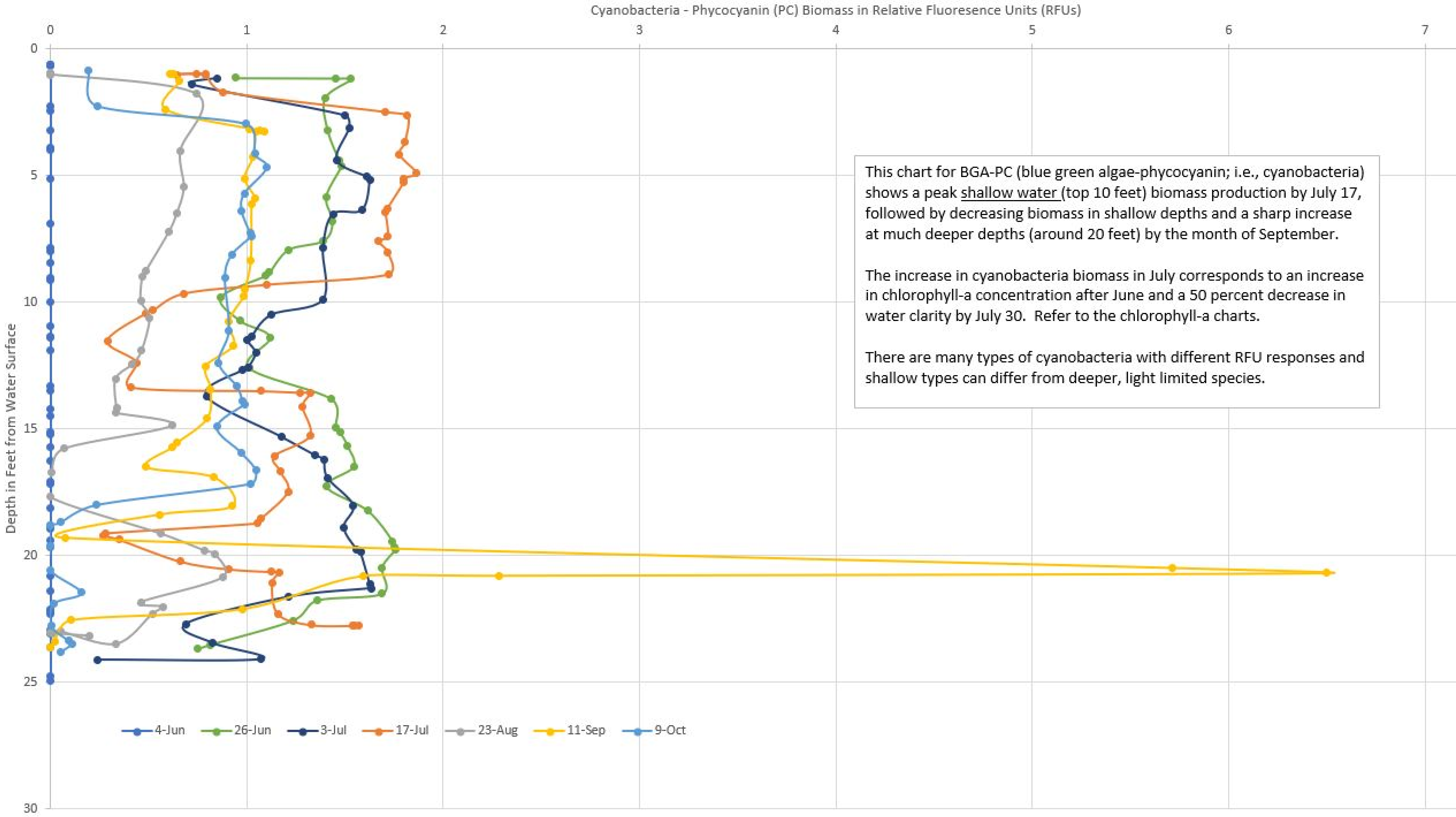
When phytoplankton and cyanobacteria photosynthesize they increase the pH of water. The maximum increase was at approximately 10-11 feet in July which correponds to a similar increase in cyanobacteria at that time.

Chart 5 - Year 2024 Stiles Pond Center Basin Oxidation-Reduction Potential (ORP) in milliVolts



ORP measures the capacity of water to either release or accept electrons from chemical reactions. Geochemical and biodegradration reactions can lower ORP. Stiles Pond charts indicate that reductions in ORP occur at depth (below 20 feet) and vary seasonally; The decrease in August corresponds to a decrease in biomass production from the July high i.e., more biomass to degrade and lower ORP.

Chart 6 - Year 2024 Stiles Pond Center Basin BGA-PC (cyanobacteria) in Relative Fluoresence Units (RFUs)

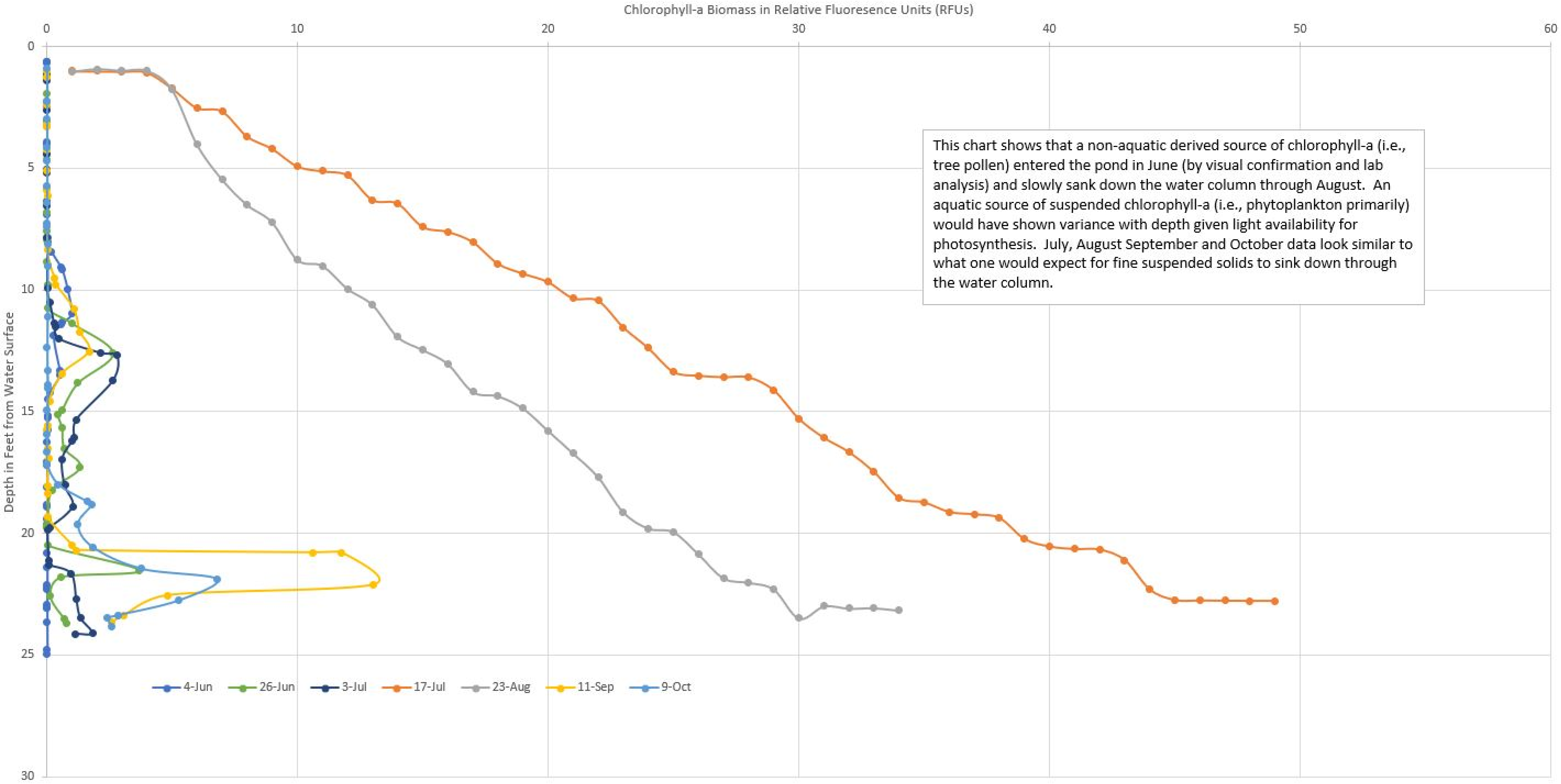


This chart for BGA-PC (blue green algae-phycocyanin; i.e., cyanobacteria) shows a peak shallow water (top 10 feet) biomass production by July 17, followed by decreasing biomass in shallow depths and a sharp increase at much deeper depths (around 20 feet) by the month of September.

The increase in cyanobacteria biomass in July corresponds to an increase in chlorophyll-a concentration after June and a 50 percent decrease in water clarity by July 30. Refer to the chlorophyll-a charts.

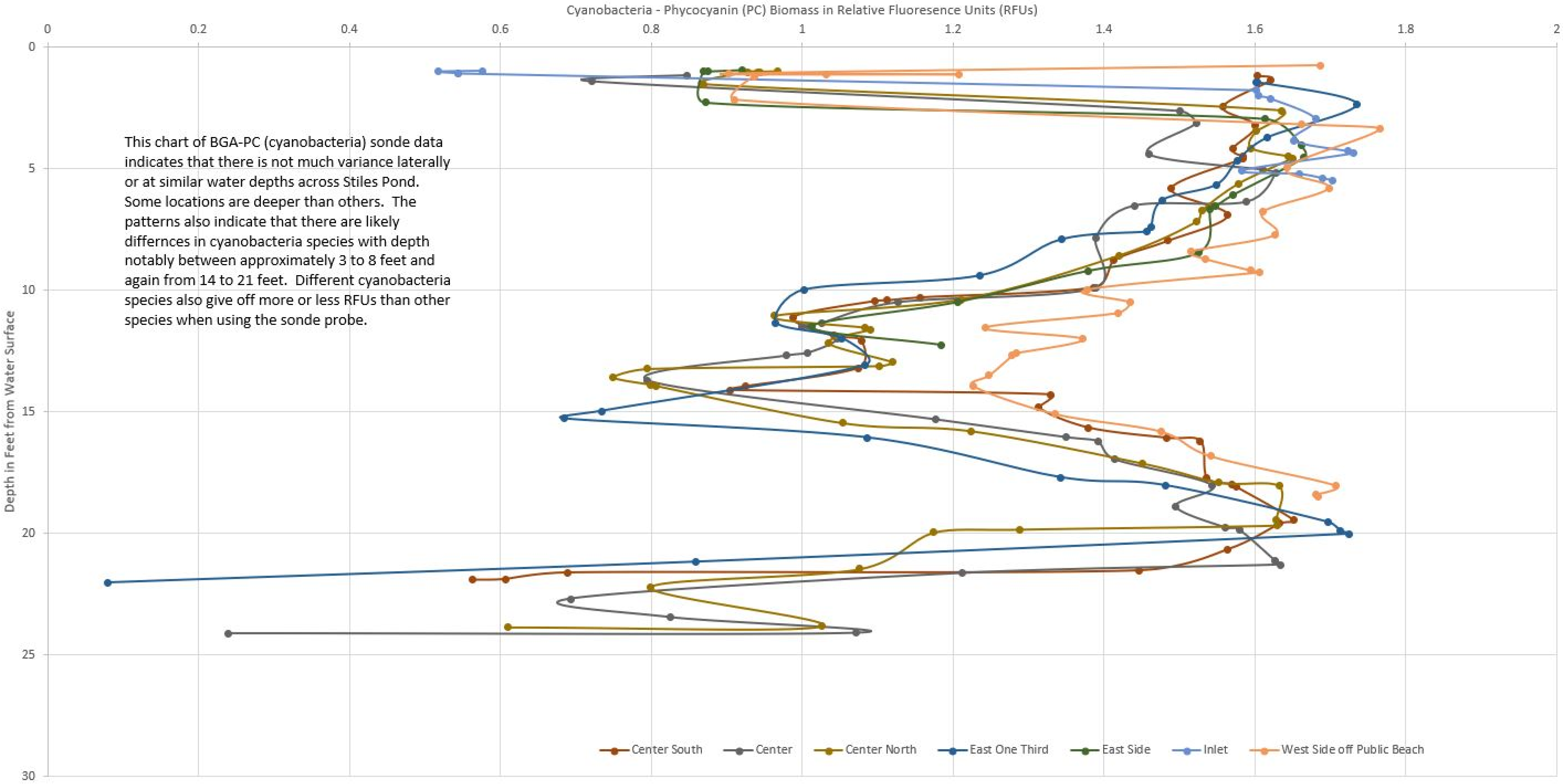
There are many types of cyanobacteria with different RFU responses and shallow types can differ from deeper, light limited species.

Chart 7 - Year 2024 Stiles Pond Center Basin Chlorophyll-a in Relative Fluoresence Units (RFUs)



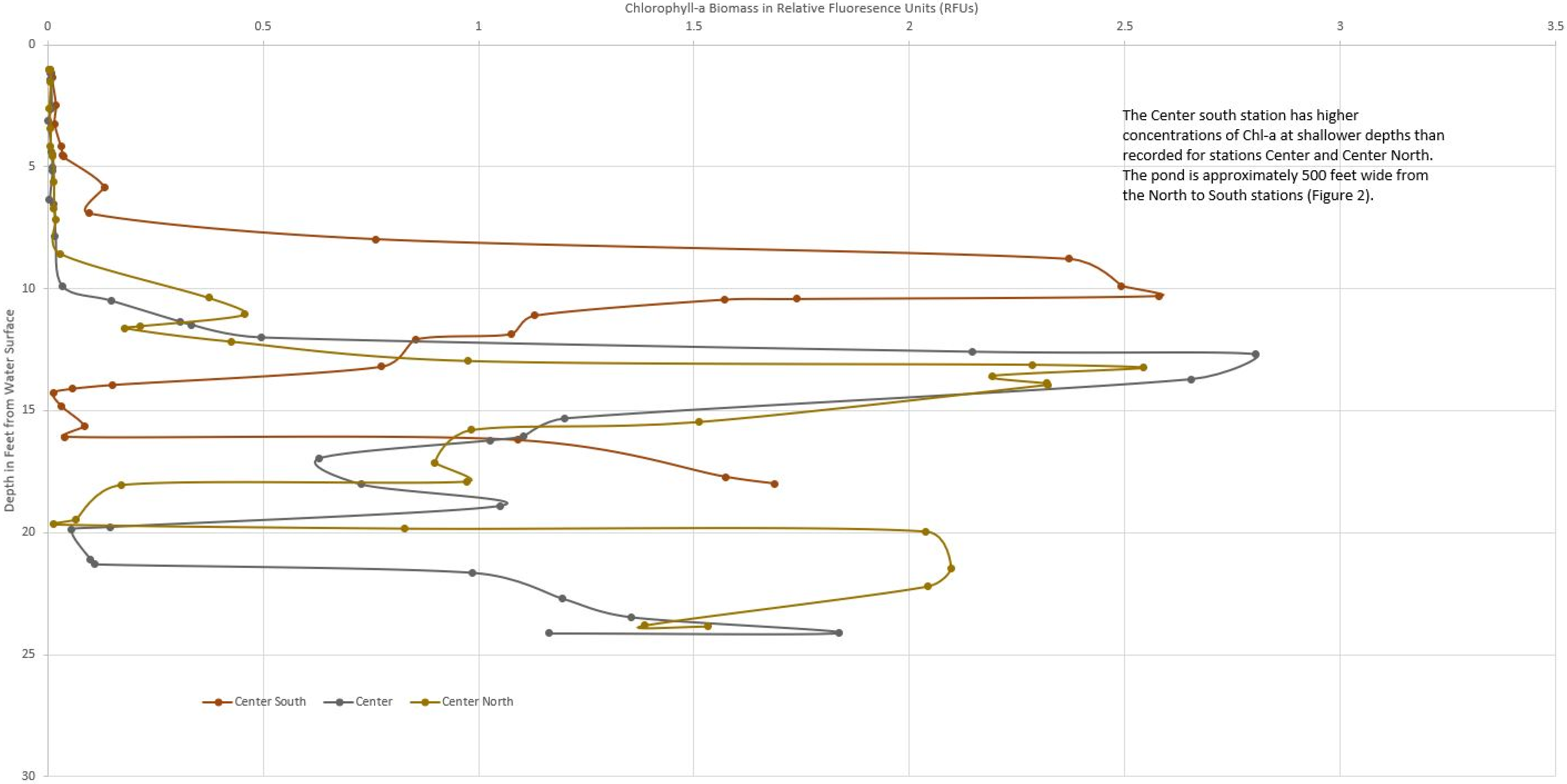
This chart shows that a non-aquatic derived source of chlorophyll-a (i.e., tree pollen) entered the pond in June (by visual confirmation and lab analysis) and slowly sank down the water column through August. An aquatic source of suspended chlorophyll-a (i.e., phytoplankton primarily) would have shown variance with depth given light availability for photosynthesis. July, August September and October data look similar to what one would expect for fine suspended solids to sink down through the water column.

Chart 8 - July 3, 2024 Stiles Pond Transects (N-S, E-W) through Center Basin BGA-PC (cyanobacteria)



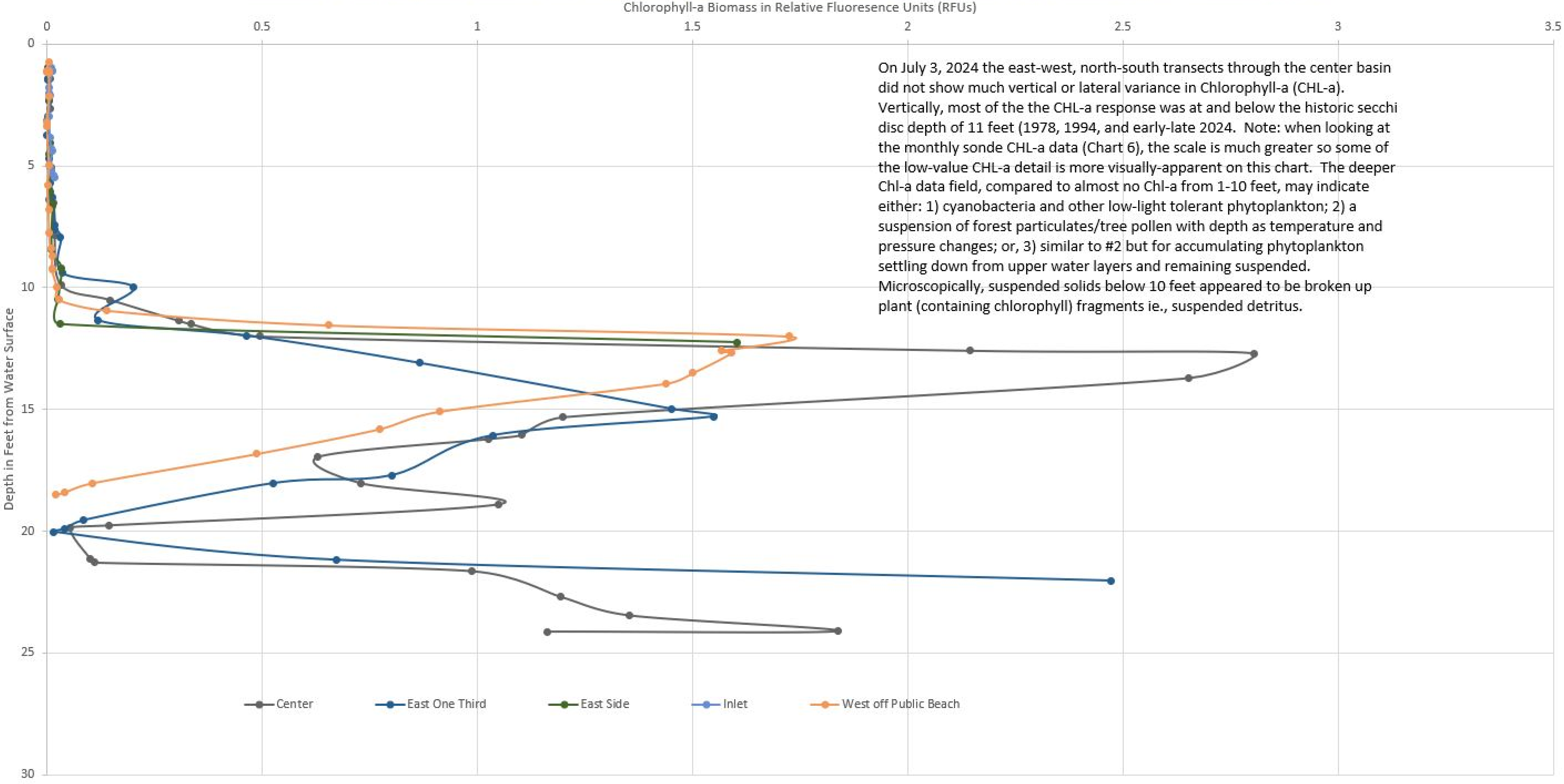
This chart of BGA-PC (cyanobacteria) sonde data indicates that there is not much variance laterally or at similar water depths across Stiles Pond. Some locations are deeper than others. The patterns also indicate that there are likely differnces in cyanobacteria species with depth notably between approximately 3 to 8 feet and again from 14 to 21 feet. Different cyanobacteria species also give off more or less RFUs than other species when using the sonde probe.

Chart 9 - July 3, 2024 Stiles Pond Transects (north to south) through Center Basin for Chlorophyll-a



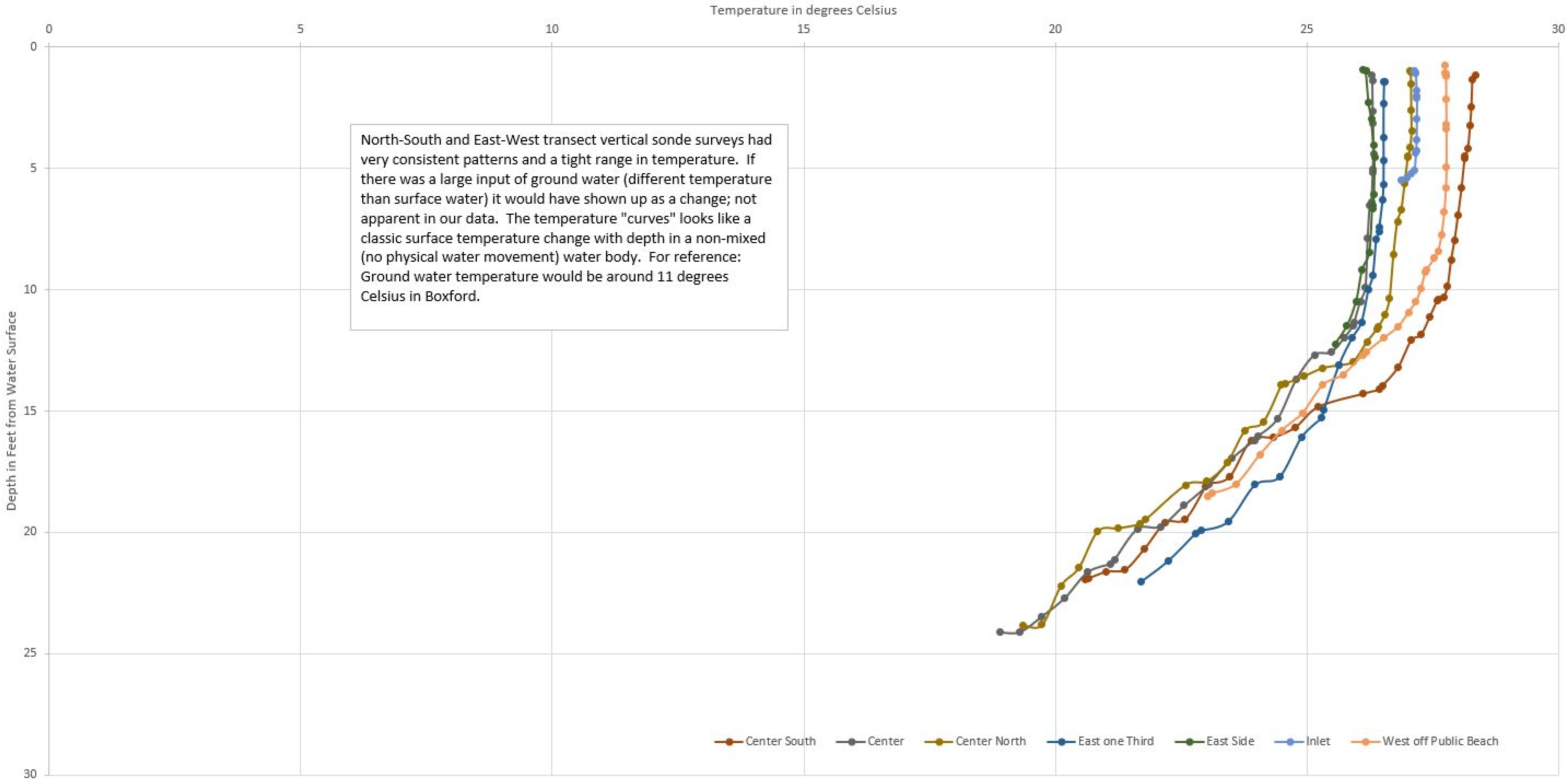
The Center south station has higher concentrations of Chl-a at shallower depths than recorded for stations Center and Center North. The pond is approximately 500 feet wide from the North to South stations (Figure 2).

Chart 10 - July 3, 2024 Stiles Pond Transects (East to West including Inlet) through Center Basin - Chlorophyll-a



On July 3, 2024 the east-west, north-south transects through the center basin did not show much vertical or lateral variance in Chlorophyll-a (CHL-a). Vertically, most of the the CHL-a response was at and below the historic secchi disc depth of 11 feet (1978, 1994, and early-late 2024. Note: when looking at the monthly sonde CHL-a data (Chart 6), the scale is much greater so some of the low-value CHL-a detail is more visually-apparent on this chart. The deeper Chl-a data field, compared to almost no Chl-a from 1-10 feet, may indicate either: 1) cyanobacteria and other low-light tolerant phytoplankton; 2) a suspension of forest particulates/tree pollen with depth as temperature and pressure changes; or, 3) similar to #2 but for accumulating phytoplankton settling down from upper water layers and remaining suspended. Microscopically, suspended solids below 10 feet appeared to be broken up plant (containing chlorophyll) fragments ie., suspended detritus.

Chart 11 - July 3, 2024 Stiles Pond Transects (E-W and N-S) through Center Basin - Temperature



North-South and East-West transect vertical sonde surveys had very consistent patterns and a tight range in temperature. If there was a large input of ground water (different temperature than surface water) it would have shown up as a change; not apparent in our data. The temperature "curves" looks like a classic surface temperature change with depth in a non-mixed (no physical water movement) water body. For reference: Ground water temperature would be around 11 degrees Celsius in Boxford.

LABORATORY DATA SHEETS

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4H21036
Client Project: 03143 - Stiles

Report Date: 09-September-2024

Prepared for:

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Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 08/21/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4H21036. Custody records are included in this report.

Lab ID	**Sample**	**Matrix**	**Date Sampled**	**Date Received**
4H21036-01	Outlet	Water	08/21/2024	08/21/2024
4H21036-02	S Shore	Water	08/21/2024	08/21/2024
4H21036-03	Inlet	Water	08/21/2024	08/21/2024
4H21036-04	E Shore	Water	08/21/2024	08/21/2024
4H21036-05	Center Deep 1	Water	08/21/2024	08/21/2024
4H21036-06	Center Shallow	Water	08/21/2024	08/21/2024
4H21036-07	Center Deep 2	Water	08/21/2024	08/21/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

Center Deep 1 (Lab Number: 4H21036-05)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Center Deep 2 (Lab Number: 4H21036-07)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Center Shallow (Lab Number: 4H21036-06)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

E Shore (Lab Number: 4H21036-04)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)

Request for Analysis (continued)

E Shore (Lab Number: 4H21036-04) (continued)

	Method
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Inlet (Lab Number: 4H21036-03)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Outlet (Lab Number: 4H21036-01)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

S Shore (Lab Number: 4H21036-02)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Method References

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA/ AWWA-WPCF, 1998

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions:

TSS: The samples were analyzed outside the method recommended holding time.

Results: Microbiology

Sample: Outlet

Lab Number: 4H21036-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**5**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	>2419		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**20**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: S Shore

Lab Number: 4H21036-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**2**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**1550**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**70**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Inlet

Lab Number: 4H21036-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**2**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	>2419		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**10**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: E Shore

Lab Number: 4H21036-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**3**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	>2419		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**10**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Center Deep 1

Lab Number: 4H21036-05 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**1**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**365**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	ND		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Center Shallow

Lab Number: 4H21036-06 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**3**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**1050**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**60**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Center Deep 2

Lab Number: 4H21036-07 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	ND		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**260**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	ND		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: General Chemistry

Sample: Outlet

Lab Number: 4H21036-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**22.9**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**20**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.5**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**36**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	ND		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: S Shore

Lab Number: 4H21036-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**10.2**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**96**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.8**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	ND		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**5**		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Inlet

Lab Number: 4H21036-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**8.92**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**28**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.6**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**112**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**7**		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: E Shore

Lab Number: 4H21036-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**11.8**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**12**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.8**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.300**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**116**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**12**		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Center Deep 1

Lab Number: 4H21036-05 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**7.96**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**16**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.1**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.400**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**104**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	ND		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Center Shallow

Lab Number: 4H21036-06 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**8.36**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**28**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.6**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**72**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	ND		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Center Deep 2

Lab Number: 4H21036-07 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**7.97**		0.50	mg/L	08/22/24	08/22/24
Total Dissolved Solids	**32**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.0**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**100**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**7**		2	mg/L	08/29/24	08/29/24

Results: Total Metals

Sample: Outlet
Lab Number: 4H21036-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.13**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.9**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: S Shore

Lab Number: 4H21036-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.09**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**3.0**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Inlet

Lab Number: 4H21036-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.13**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: E Shore

Lab Number: 4H21036-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.10**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Center Deep 1

Lab Number: 4H21036-05 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.21**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	**0.013**		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.9**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Center Shallow

Lab Number: 4H21036-06 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.08**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	**0.013**		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Center Deep 2

Lab Number: 4H21036-07 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.20**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	**0.010**		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Quality Control

Microbiology

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0849 - Microbiology										
Blank (B4H0849-BLK1)					Prepared & Analyzed: 08/21/24					
Fecal coliform bacteria	ND		1	Col./100ml						
Blank (B4H0849-BLK2)					Prepared & Analyzed: 08/21/24					
Fecal coliform bacteria	ND		1	Col./100ml						
Blank (B4H0849-BLK3)					Prepared & Analyzed: 08/21/24					
Fecal coliform bacteria	ND		1	Col./100ml						
Batch: B4H0852 - Microbiology										
Blank (B4H0852-BLK1)					Prepared & Analyzed: 08/21/24					
Total coliform	<		1	MPN/100ml						

Quality Control

(Continued)

General Chemistry

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0914 - Ion Chromatography										
Blank (B4H0914-BLK1)					Prepared & Analyzed: 08/22/24					
Chloride	ND		0.25	mg/L						
Blank (B4H0914-BLK2)					Prepared & Analyzed: 08/22/24					
Chloride	ND		0.25	mg/L						
LCS (B4H0914-BS1)					Prepared & Analyzed: 08/22/24					
Chloride	5.23		0.25	mg/L	5.00		105	90-110		
LCS (B4H0914-BS2)					Prepared & Analyzed: 08/22/24					
Chloride	5.22		0.25	mg/L	5.00		104	90-110		
Matrix Spike (B4H0914-MS1)		Source: 4H21015-01			Prepared & Analyzed: 08/22/24					
Chloride	94.4		0.25	mg/L	5.00	96.9	NR	90-110		
Matrix Spike (B4H0914-MS2)		Source: 4H21017-03			Prepared & Analyzed: 08/22/24					
Chloride	188		0.25	mg/L	5.00	212	NR	90-110		
Matrix Spike Dup (B4H0914-MSD1)		Source: 4H21015-01			Prepared & Analyzed: 08/22/24					
Chloride	94.7		0.25	mg/L	5.00	96.9	NR	90-110	0.290	10
Matrix Spike Dup (B4H0914-MSD2)		Source: 4H21017-03			Prepared & Analyzed: 08/22/24					
Chloride	189		0.25	mg/L	5.00	212	NR	90-110	0.174	10
Batch: B4H0929 - TOC										
Blank (B4H0929-BLK1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	ND		0.2	mg/L						

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0929 - TOC (Continued)										
LCS (B4H0929-BS1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	4.7		0.2	mg/L	5.00		94.6	90-110		
LCS Dup (B4H0929-BSD1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	5.1		0.2	mg/L	5.00		101	90-110	6.68	20
Batch: B4H1192 - TSS										
Blank (B4H1192-BLK1)					Prepared & Analyzed: 08/29/24					
Total Suspended Solids	ND		2	mg/L						
LCS (B4H1192-BS1)					Prepared & Analyzed: 08/29/24					
Total Suspended Solids	932		10	mg/L	1000		93.2	90-110		
Duplicate (B4H1192-DUP1)		Source: 4H22002-03			Prepared & Analyzed: 08/29/24					
Total Suspended Solids	172		10	mg/L		178			3.43	20
Batch: B4H1214 - TS										
Blank (B4H1214-BLK1)					Prepared & Analyzed: 08/29/24					
Total solids (TS)	ND		10	mg/L						
LCS (B4H1214-BS1)					Prepared & Analyzed: 08/29/24					
Total solids (TS)	1060		10	mg/L	1000		106	0-200		
Duplicate (B4H1214-DUP1)		Source: 4H14041-01			Prepared & Analyzed: 08/29/24					
Total solids (TS)	416		10	mg/L		384			8.00	200

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H1223 - TDS										
Blank (B4H1223-BLK1)					Prepared & Analyzed: 08/29/24					
Total Dissolved Solids	ND		10	mg/L						
LCS (B4H1223-BS1)					Prepared & Analyzed: 08/29/24					
Total Dissolved Solids	832		10	mg/L	1000		83.2	0-200		
Duplicate (B4H1223-DUP1)		Source: 4H21036-01			Prepared & Analyzed: 08/29/24					
Total Dissolved Solids	64		10	mg/L		20			105	200

Quality Control

(Continued)

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0909 - Metals Digestion Waters										
Blank (B4H0909-BLK1)					Prepared: 08/22/24 Analyzed: 08/29/24					
Phosphorous	ND		0.010	mg/L						
Iron	ND		0.05	mg/L						
Sulfur	ND		0.5	mg/L						
LCS (B4H0909-BS1)					Prepared: 08/22/24 Analyzed: 08/29/24					
Phosphorous	1.07		0.010	mg/L	1.00		107	85-115		
Iron	10.5		0.05	mg/L	10.0		105	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATORY, INC
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4H2 1036

CHAIN OF CUSTODY RECORD

PROJ. NO. 03143
PROJECT NAME/LOCATION Stiles
CLIENT HEA
REPORT TO: Jon Higgins
INVOICE TO: Jon Higgins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE See Remarks	TESTS** Total Carbon	Total & dissolved & suspended Solids	Fe, S, N, P	Total and Fecal Coliform	Chloride		REMARKS
8/21/24	0900		✓	outlet	✓			6	1-4	✓	✓	✓	✓	✓		-Analysis Requested:
	915			S. Shore	✓			6	"	✓	✓	✓	✓	✓		- Total Carbon (TOC)
	0935			Inlet	✓			6	"	✓	✓	✓	✓	✓		- Total Suspended & dissolved Solids
	0950			E. Shore	✓			6	"	✓	✓	✓	✓	✓		- Iron, Total
	1000			Center deep 1	✓			6	"	✓	✓	✓	✓	✓		- Sulfur, Total
	1020			Center Shallow	✓			6	"	✓	✓	✓	✓	✓		- N, Total TKN, Ammo-
	1105			Center deep 2	✓			6	"	✓	✓	✓	✓	✓		N and Nitrite-N
																- Total and fecal coliform
																- chlorides
																Preservatives:
																① HNO_3 for Fe, S
																② NON for N, P, TC/FC, wet
																③ H_2SO_4 for N and TOC
																④ all ≤ 4°C

Sampled by: (Signature)
Date/Time 8/21/24 1244
Received by: (Signature)
Date/Time 8/21/24 1244

Relinquished by: (Signature)
Date/Time 8/21/24 1244
Received by: (Signature)
Date/Time 8/21/24

Relinquished by: (Signature)
Date/Time 8/21/24 1610
Received for Laboratory by: (Signature)
Date/Time 8/21/24 1610

Laboratory Remarks:
Temp. received: 3
Cooled ☐

Special Instructions:
List Specific Detection
Limit Requirements:
Note: Total suspended & dissolved Solids is requested
* T. & Fc Coliform collected 1120 — 1200 hrs
Turnaround (Business Days)

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4H21036
Client Project: 03143 - Stiles

Report Date: 11-September-2024

Prepared for:

Jon Higgins
Higgins Environmental
19 Elizabeth Street
Amesbury, MA 01913

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 08/21/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4H21036. Custody records are included in this report.

Lab ID	Sample	Matrix	Date Sampled	Date Received
4H21036-01	Outlet	Water	08/21/2024	08/21/2024
4H21036-02	S Shore	Water	08/21/2024	08/21/2024
4H21036-03	Inlet	Water	08/21/2024	08/21/2024
4H21036-04	E Shore	Water	08/21/2024	08/21/2024
4H21036-05	Center Deep 1	Water	08/21/2024	08/21/2024
4H21036-06	Center Shallow	Water	08/21/2024	08/21/2024
4H21036-07	Center Deep 2	Water	08/21/2024	08/21/2024
4H21036-08	Outlet Phos Reprep	Water	08/21/2024	08/21/2024
4H21036-09	S Shore Phos Reprep	Water	08/21/2024	08/21/2024
4H21036-10	Inlet Phos Reprep	Water	08/21/2024	08/21/2024
4H21036-11	E Shore Phos Reprep	Water	08/21/2024	08/21/2024
4H21036-12	Center Deep 1 Phos Reprep	Water	08/21/2024	08/21/2024
4H21036-13	Center Shallow Phos Reprep	Water	08/21/2024	08/21/2024
4H21036-14	Center Deep 2 Phos Reprep	Water	08/21/2024	08/21/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

Center Deep 1 (Lab Number: 4H21036-05)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Center Deep 1 Phos Reprep (Lab Number: 4H21036-12)

	Method
Phosphorus	EPA 6010C

Center Deep 2 (Lab Number: 4H21036-07)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Center Deep 2 Phos Reprep (Lab Number: 4H21036-14)

	Method
Phosphorus	EPA 6010C

Center Shallow (Lab Number: 4H21036-06)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)

Request for Analysis (continued)

Center Shallow (Lab Number: 4H21036-06) (continued)

	Method
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Center Shallow Phos Reprep (Lab Number: 4H21036-13)

	Method
Phosphorus	EPA 6010C

E Shore (Lab Number: 4H21036-04)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

E Shore Phos Reprep (Lab Number: 4H21036-11)

	Method
Phosphorus	EPA 6010C

Inlet (Lab Number: 4H21036-03)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Inlet Phos Reprep (Lab Number: 4H21036-10)

	Method
Phosphorus	EPA 6010C

Request for Analysis (continued)

Outlet (Lab Number: 4H21036-01)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

Outlet Phos Reprep (Lab Number: 4H21036-08)

	Method
Phosphorus	EPA 6010C

S Shore (Lab Number: 4H21036-02)

	Method
Chloride	EPA 300.0
Fecal Coliform	SM9222-D MF
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total & E. coli bacteria	SM9223B(04) (Colilert 18)
Total Dissolved Solids	SM2540-C (11)
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C
Total Solids	SM2540-C (11)
Total Suspended Solids	SM2540-D (11)

S Shore Phos Reprep (Lab Number: 4H21036-09)

	Method
Phosphorus	EPA 6010C

Method References

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA/ AWWA-WPCF, 1998

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions:

TSS: The samples were analyzed outside the method recommended holding time.

Results: Microbiology

Sample: Outlet

Lab Number: 4H21036-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**5**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**>2419**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**20**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: S Shore

Lab Number: 4H21036-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**2**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**1550**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**70**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Inlet

Lab Number: 4H21036-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**2**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**>2419**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**10**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: E Shore

Lab Number: 4H21036-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**3**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**>2419**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**10**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Center Deep 1

Lab Number: 4H21036-05 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**1**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**365**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	ND		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Center Shallow

Lab Number: 4H21036-06 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	**3**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**1050**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	**60**		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: Microbiology

Sample: Center Deep 2

Lab Number: 4H21036-07 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
E. coli	ND		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Total coliform	**260**		1	MPN/100ml	08/21/24 17:45	08/21/24 17:45
Fecal coliform bacteria	ND		10	Col./100ml	08/21/24 17:40	08/21/24 17:40

Results: General Chemistry

Sample: Outlet

Lab Number: 4H21036-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**22.9**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 15:55	08/22/24 15:55
Kjeldahl Nitrogen	**0.5**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**20**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.5**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**36**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	ND		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: S Shore

Lab Number: 4H21036-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**10.2**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 16:07	08/22/24 16:07
Kjeldahl Nitrogen	**0.5**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**96**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.8**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	ND		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**5**		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Inlet

Lab Number: 4H21036-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**8.92**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 16:19	08/22/24 16:19
Kjeldahl Nitrogen	**0.5**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**28**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.6**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**112**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**7**		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: E Shore

Lab Number: 4H21036-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**11.8**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 16:31	08/22/24 16:31
Kjeldahl Nitrogen	**0.3**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**12**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.8**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.300**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**116**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**12**		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Center Deep 1

Lab Number: 4H21036-05 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**7.96**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 16:42	08/22/24 16:42
Kjeldahl Nitrogen	**0.4**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**16**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.1**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.400**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**104**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	ND		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Center Shallow

Lab Number: 4H21036-06 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**8.36**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 16:54	08/22/24 16:54
Kjeldahl Nitrogen	**0.5**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**28**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.6**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**72**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	ND		2	mg/L	08/29/24	08/29/24

Results: General Chemistry

Sample: Center Deep 2

Lab Number: 4H21036-07 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Chloride	**7.97**		0.50	mg/L	08/22/24	08/22/24
Nitrate and Nitrite as N	ND		0.50	mg/L	08/22/24 17:06	08/22/24 17:06
Kjeldahl Nitrogen	**0.5**		0.1	mg/L	08/27/24	08/27/24
Total Dissolved Solids	**32**		10	mg/L	08/29/24	08/29/24
Total Organic Carbon	**4.0**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**0.500**		0.100	mg/L	08/27/24	08/27/24
Total solids (TS)	**100**		10	mg/L	08/29/24	08/29/24
Total Suspended Solids	**7**		2	mg/L	08/29/24	08/29/24

Results: Total Metals

Sample: Outlet

Lab Number: 4H21036-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.13**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.9**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: S Shore
Lab Number: 4H21036-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.09**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**3.0**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Inlet

Lab Number: 4H21036-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.13**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: E Shore

Lab Number: 4H21036-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.10**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Center Deep 1

Lab Number: 4H21036-05 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.21**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	**0.013**		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.9**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Center Shallow

Lab Number: 4H21036-06 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.08**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	**0.013**		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Center Deep 2

Lab Number: 4H21036-07 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.20**		0.05	mg/L	08/22/24	08/29/24
Phosphorous	**0.010**		0.010	mg/L	08/22/24	08/29/24
Sulfur	**1.8**		0.5	mg/L	08/22/24	08/29/24

Results: Total Metals

Sample: Outlet Phos Reprep

Lab Number: 4H21036-08 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	ND		0.010	mg/L	09/11/24	09/11/24

Results: Total Metals

Sample: S Shore Phos Reprep
Lab Number: 4H21036-09 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	ND		0.010	mg/L	09/11/24	09/11/24

Results: Total Metals

Sample: Inlet Phos Reprep

Lab Number: 4H21036-10 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**0.014**		0.010	mg/L	09/11/24	09/11/24

Results: Total Metals

Sample: E Shore Phos Reprep

Lab Number: 4H21036-11 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	ND		0.010	mg/L	09/11/24	09/11/24

Results: Total Metals

Sample: Center Deep 1 Phos Reprep

Lab Number: 4H21036-12 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	ND		0.010	mg/L	09/11/24	09/11/24

Results: Total Metals

Sample: Center Shallow Phos Reprep

Lab Number: 4H21036-13 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	ND		0.010	mg/L	09/11/24	09/11/24

Results: Total Metals

Sample: Center Deep 2 Phos Reprep

Lab Number: 4H21036-14 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**0.011**		0.010	mg/L	09/11/24	09/11/24

Quality Control

Microbiology

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0849 - Microbiology										
Blank (B4H0849-BLK1)					Prepared & Analyzed: 08/21/24					
Fecal coliform bacteria	ND		1	Col./100ml						
Blank (B4H0849-BLK2)					Prepared & Analyzed: 08/21/24					
Fecal coliform bacteria	ND		1	Col./100ml						
Blank (B4H0849-BLK3)					Prepared & Analyzed: 08/21/24					
Fecal coliform bacteria	ND		1	Col./100ml						
Batch: B4H0852 - Microbiology										
Blank (B4H0852-BLK1)					Prepared & Analyzed: 08/21/24					
Total coliform	<		1	MPN/100ml						

Quality Control
(Continued)

General Chemistry

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0914 - Ion Chromatography										
Blank (B4H0914-BLK1)					Prepared & Analyzed: 08/22/24					
Chloride	ND		0.25	mg/L						
Nitrate and Nitrite as N	ND		0.25	mg/L						
Blank (B4H0914-BLK2)					Prepared & Analyzed: 08/22/24					
Chloride	ND		0.25	mg/L						
Nitrate and Nitrite as N	ND		0.25	mg/L						
LCS (B4H0914-BS1)					Prepared & Analyzed: 08/22/24					
Chloride	5.23		0.25	mg/L	5.00		105	90-110		
LCS (B4H0914-BS2)					Prepared & Analyzed: 08/22/24					
Chloride	5.22		0.25	mg/L	5.00		104	90-110		
Matrix Spike (B4H0914-MS1)		Source: 4H21015-01			Prepared & Analyzed: 08/22/24					
Chloride	94.4		0.25	mg/L	5.00	96.9	NR	90-110		
Matrix Spike (B4H0914-MS2)		Source: 4H21017-03			Prepared & Analyzed: 08/22/24					
Chloride	188		0.25	mg/L	5.00	212	NR	90-110		
Matrix Spike Dup (B4H0914-MSD1)		Source: 4H21015-01			Prepared & Analyzed: 08/22/24					
Chloride	94.7		0.25	mg/L	5.00	96.9	NR	90-110	0.290	10
Matrix Spike Dup (B4H0914-MSD2)		Source: 4H21017-03			Prepared & Analyzed: 08/22/24					
Chloride	189		0.25	mg/L	5.00	212	NR	90-110	0.174	10
Batch: B4H0929 - TOC										
Blank (B4H0929-BLK1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	ND		0.2	mg/L						

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0929 - TOC (Continued)										
LCS (B4H0929-BS1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	4.7		0.2	mg/L	5.00		94.6	90-110		
LCS Dup (B4H0929-BSD1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	5.1		0.2	mg/L	5.00		101	90-110	6.68	20
Batch: B4H1100 - TKN										
Blank (B4H1100-BLK1)					Prepared & Analyzed: 08/27/24					
Kjeldahl Nitrogen	ND		0.1	mg/L						
Blank (B4H1100-BLK2)					Prepared & Analyzed: 08/27/24					
Kjeldahl Nitrogen	ND		0.1	mg/L						
LCS (B4H1100-BS1)					Prepared & Analyzed: 08/27/24					
Kjeldahl Nitrogen	0.9		0.1	mg/L	1.00		90.0	80-120		
LCS (B4H1100-BS2)					Prepared & Analyzed: 08/27/24					
Kjeldahl Nitrogen	0.9		0.1	mg/L	1.00		88.4	80-120		
Duplicate (B4H1100-DUP1)		Source: 4H21036-01			Prepared & Analyzed: 08/27/24					
Kjeldahl Nitrogen	0.5		0.1	mg/L		0.5			2.19	20
Matrix Spike (B4H1100-MS1)		Source: 4H21036-01			Prepared & Analyzed: 08/27/24					
Kjeldahl Nitrogen	1.4		0.1	mg/L	1.00	0.5	89.7	80-120		
Batch: B4H1192 - TSS										
Blank (B4H1192-BLK1)					Prepared & Analyzed: 08/29/24					
Total Suspended Solids	ND		2	mg/L						

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H1192 - TSS (Continued)										
LCS (B4H1192-BS1)					Prepared & Analyzed: 08/29/24					
Total Suspended Solids	932		10	mg/L	1000		93.2	90-110		
Duplicate (B4H1192-DUP1)		Source: 4H22002-03			Prepared & Analyzed: 08/29/24					
Total Suspended Solids	172		10	mg/L					200	20
Batch: B4H1214 - TS										
Blank (B4H1214-BLK1)					Prepared & Analyzed: 08/29/24					
Total solids (TS)	ND		10	mg/L						
LCS (B4H1214-BS1)					Prepared & Analyzed: 08/29/24					
Total solids (TS)	1060		10	mg/L	1000		106	0-200		
Duplicate (B4H1214-DUP1)		Source: 4H14041-01			Prepared & Analyzed: 08/29/24					
Total solids (TS)	416		10	mg/L		384			8.00	200
Batch: B4H1223 - TDS										
Blank (B4H1223-BLK1)					Prepared & Analyzed: 08/29/24					
Total Dissolved Solids	ND		10	mg/L						
LCS (B4H1223-BS1)					Prepared & Analyzed: 08/29/24					
Total Dissolved Solids	832		10	mg/L	1000		83.2	0-200		
Duplicate (B4H1223-DUP1)		Source: 4H21036-01			Prepared & Analyzed: 08/29/24					
Total Dissolved Solids	64		10	mg/L		20			105	200

Quality Control

(Continued)

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0909 - Metals Digestion Waters										
Blank (B4H0909-BLK1)					Prepared: 08/22/24 Analyzed: 08/29/24					
Sulfur	ND		0.5	mg/L						
Iron	ND		0.05	mg/L						
Phosphorous	ND		0.010	mg/L						
LCS (B4H0909-BS1)					Prepared: 08/22/24 Analyzed: 08/29/24					
Iron	10.5		0.05	mg/L	10.0		105	85-115		
Phosphorous	1.07		0.010	mg/L	1.00		107	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATORY, INC
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4 H 2 1036

CHAIN OF CUSTODY RECORD

PROJ. NO.: 03143
PROJECT NAME/LOCATION: Stiles
CLIENT: HEA
REPORT TO: Jon Higgins
INVOICE TO: Jon Higgins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE See Remarks	TESTS** Total Carbon	Total & dissolved Solids & suspended	Fe, S,	N, P	Total and fecal coliform	Chloride		REMARKS
8/21/24	0900		✓	outlet	✓			6	1-4	✓	✓	✓	✓	✓	✓		-Analysis Requested:
	915			S. Shore	✓			6	"	✓	✓	✓	✓	✓	✓		- Total Carbon (TOC)
	0935			Inlet	✓			6	"	✓	✓	✓	✓	✓	✓		- Total suspended & dissolved Solids
	0950			E. Shore	✓			6	"	✓	✓	✓	✓	✓	✓		- Iron, Total
	1000			center deep 1	✓			6	"	✓	✓	✓	✓	✓	✓		- Sulfur, Total
	1020			Center Shallow	✓			6	"	✓	✓	✓	✓	✓	✓		- N, Total & TKN, Ammonia-N and Nitrite-N
	1105			Center-deep 2	✓			6	"	✓	✓	✓	✓	✓	✓		
																	- Total and fecal coliform
																	- chlorides
																	Preservatives:
																	① HNO3 for Fe, S
																	② NON for N, P, TC/FC, wet
																	③ H2SO4 for N and TOC
																	④ all ≤ 4°C

Sampled by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
	8/21/24 1244		8/21/24 1244

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
	8/21/24 1244	Cln m	8/21/24

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time
Cln m	8/21/24 1610		8/21/24 1610

Laboratory Remarks:
Temp. received: 3
Cooled ☐

Special Instructions:
List Specific Detection
Limit Requirements:
Note: Total suspended & dissolved solids is requested
* T. & F. coliform collected 1120 - 1200 hrs

Turnaround (Business Days)

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4H21035
Client Project: 03143 - Stiles

Report Date: 30-August-2024

Prepared for:

Jon Higgins
Higgins Environmental
19 Elizabeth Street
Amesbury, MA 01913

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 08/21/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4H21035. Custody records are included in this report.

Lab ID	Sample	Matrix	Date Sampled	Date Received
4H21035-01	Wet Prec 1	Water	08/20/2024	08/21/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

Wet Prec 1 (Lab Number: 4H21035-01)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C

Method References

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA/ AWWA-WPCF, 1998

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions: None

Results: General Chemistry

Sample: Wet Prec 1

Lab Number: 4H21035-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**1.7**		0.2	mg/L	08/23/24	08/23/24
Total Nitrogen	**3.40**		0.100	mg/L	08/23/24	08/23/24

Results: Total Metals

Sample: Wet Prec 1

Lab Number: 4H21035-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	ND		0.05	mg/L	08/22/24	08/29/24
Phosphorous	ND		0.010	mg/L	08/22/24	08/29/24
Sulfur	ND		0.5	mg/L	08/22/24	08/29/24

Quality Control

General Chemistry

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0929 - TOC										
Blank (B4H0929-BLK1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	ND		0.2	mg/L						
LCS (B4H0929-BS1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	4.7		0.2	mg/L	5.00		94.6	90-110		
LCS Dup (B4H0929-BSD1)					Prepared & Analyzed: 08/23/24					
Total Organic Carbon	5.1		0.2	mg/L	5.00		101	90-110	6.68	20

Quality Control

(Continued)

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4H0909 - Metals Digestion Waters										
Blank (B4H0909-BLK1)					Prepared: 08/22/24 Analyzed: 08/29/24					
Sulfur	ND		0.5	mg/L						
Phosphorous	ND		0.010	mg/L						
Iron	ND		0.05	mg/L						
LCS (B4H0909-BS1)					Prepared: 08/22/24 Analyzed: 08/29/24					
Phosphorous	1.07		0.010	mg/L	1.00		107	85-115		
Iron	10.5		0.05	mg/L	10.0		105	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATORY
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4 H 2 1035 z

PROJ. NO. 03143

PROJECT NAME/LOCATION stiles

CLIENT HEA

REPORT TO: Jen Higgins

INVOICE TO: Jen Higgins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE See Remarks	TESTS** TOC H2SO4	Total IRON	Total Sulfur	Total Nitrogen	Total Phosphorus	REMARKS
8/20/24	0700	✓		WetPrec. 1	✓			4	1-5	✓	✓	✓	✓	✓	

Preservatives
① HNO_3 for Fe, S
② NON for N, P 1L
③ H_2SO_4 for N
④ H_2SO_4 for TOC VOA
⑤ All <4°C

Sampled by: (Signature)	Date/Time		Received by: (Signature)	Date/Time	
	8/20/24	0940		8/20/24	0720

Relinquished by: (Signature)	Date/Time		Received by: (Signature)	Date/Time	
	8/21/24	1245	Chn M	8/21/24	1245

Relinquished by: (Signature)	Date/Time		Received for Laboratory by: (Signature)	Date/Time	
Ch M	8/21/24	1610	VR	8/21/24	1610

Laboratory Remarks:
Temp. received: 3
Cooled ☐

Special Instructions:
List Specific Detection
Limit Requirements:

Turnaround (Business Days)

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4I24048
Client Project: 03143 - Stiles

Report Date: 08-October-2024

Prepared for:

Jon Higgins
Higgins Environmental
19 Elizabeth Street
Amesbury, MA 01913

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 09/24/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4I24048. Custody records are included in this report.

Lab ID	Sample	Matrix	Date Sampled	Date Received
4I24048-01	STRM1	Water	09/23/2024	09/24/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

STRM1 (Lab Number: 4I24048-01)

	Method
Ammonia	SM4500-NH3-D (11)
Chloride	EPA 300.0
Iron	EPA 6010C
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C

Method References

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA/ AWWA-WPCF, 1998

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions: None

Results: General Chemistry

Sample: STRM1

Lab Number: 4I24048-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Ammonia	ND		0.1	mg/L	10/01/24	10/01/24
Chloride	**10.5**		0.25	mg/L	09/24/24	09/24/24
Nitrate as N	ND		0.25	mg/L	09/24/24 20:20	09/24/24 20:20
Nitrite as N	ND		0.02	mg/L	09/24/24 20:20	09/24/24 20:20
Kjeldahl Nitrogen	**0.4**		0.1	mg/L	10/04/24	10/04/24
Total Organic Carbon	**1.8**		0.2	mg/L	09/27/24	09/27/24
Total Nitrogen	**0.400**		0.100	mg/L	10/04/24	10/04/24

Results: Total Metals

Sample: STRM1

Lab Number: 4I24048-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.44**		0.05	mg/L	09/25/24	10/01/24
Phosphorous	**0.598**		0.010	mg/L	09/25/24	10/01/24
Sulfur	**2.9**		0.5	mg/L	09/25/24	10/02/24

Quality Control

General Chemistry

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I1070 - Ion Chromatography										
Blank (B4I1070-BLK1)					Prepared & Analyzed: 09/24/24					
Chloride	ND		0.25	mg/L						
Nitrate as N	ND		0.25	mg/L						
LCS (B4I1070-BS1)					Prepared & Analyzed: 09/24/24					
Chloride	4.67		0.25	mg/L	5.00		93.3	90-110		
Nitrate as N	4.62		0.25	mg/L	5.00		92.4	90-110		
Matrix Spike (B4I1070-MS1)		Source: 4I24046-02			Prepared & Analyzed: 09/24/24					
Chloride	109		0.25	mg/L	5.00	110	NR	90-110		
Nitrate as N	9.45		0.25	mg/L	5.00	4.94	90.2	90-110		
Matrix Spike Dup (B4I1070-MSD1)		Source: 4I24046-02			Prepared & Analyzed: 09/24/24					
Chloride	110		0.25	mg/L	5.00	110	0.502	90-110	0.107	10
Nitrate as N	9.45		0.25	mg/L	5.00	4.94	90.1	90-110	0.0349	10
Batch: B4I1137 - TOC										
Blank (B4I1137-BLK1)					Prepared & Analyzed: 09/27/24					
Total Organic Carbon	ND		0.2	mg/L						
LCS (B4I1137-BS1)					Prepared & Analyzed: 09/27/24					
Total Organic Carbon	5.1		0.2	mg/L	5.00		101	90-110		
LCS Dup (B4I1137-BSD1)					Prepared & Analyzed: 09/27/24					
Total Organic Carbon	4.9		0.2	mg/L	5.00		97.8	90-110	3.31	20

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4J0110 - Ammonia										
Blank (B4J0110-BLK1)					Prepared & Analyzed: 10/01/24					
Ammonia	ND		0.1	mg/L						
Blank (B4J0110-BLK2)					Prepared & Analyzed: 10/01/24					
Ammonia	ND		0.1	mg/L						
LCS (B4J0110-BS1)					Prepared & Analyzed: 10/01/24					
Ammonia	0.9		0.1	mg/L	1.00		91.2	90-110		
LCS (B4J0110-BS2)					Prepared & Analyzed: 10/01/24					
Ammonia	1.0		0.1	mg/L	1.00		99.9	90-110		
Duplicate (B4J0110-DUP1)		Source: 4I24046-02			Prepared & Analyzed: 10/01/24					
Ammonia	ND		0.1	mg/L		ND				20
Matrix Spike (B4J0110-MS1)		Source: 4I24046-02			Prepared & Analyzed: 10/01/24					
Ammonia	1.0		0.1	mg/L	1.00	ND	95.7	80-120		
Batch: B4J0324 - TKN										
Blank (B4J0324-BLK1)					Prepared & Analyzed: 10/04/24					
Kjeldahl Nitrogen	ND		0.1	mg/L						
Blank (B4J0324-BLK2)					Prepared & Analyzed: 10/04/24					
Kjeldahl Nitrogen	ND		0.1	mg/L						
LCS (B4J0324-BS1)					Prepared & Analyzed: 10/04/24					
Kjeldahl Nitrogen	0.9		0.1	mg/L	1.00		94.0	80-120		

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4J0324 - TKN (Continued)										
LCS (B4J0324-BS2)					Prepared & Analyzed: 10/04/24					
Kjeldahl Nitrogen	0.9		0.1	mg/L	1.00		88.3	80-120		
Duplicate (B4J0324-DUP1)	Source: 4I23033-06				Prepared & Analyzed: 10/04/24					
Kjeldahl Nitrogen	0.5		0.1	mg/L		0.5			7.15	20

Quality Control
(Continued)

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I1066 - Metals Digestion Waters										
Blank (B4I1066-BLK1)					Prepared: 09/25/24 Analyzed: 10/01/24					
Iron	ND		0.05	mg/L						
Sulfur	ND		0.5	mg/L						
Phosphorous	ND		0.010	mg/L						
LCS (B4I1066-BS1)					Prepared: 09/25/24 Analyzed: 10/01/24					
Phosphorous	0.983		0.010	mg/L	1.00		98.3	85-115		
Iron	9.62		0.05	mg/L	10.0		96.2	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATO
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4 I 2 4048 +

PROJ. NO. 03143

PROJECT NAME/LOCATION Stiles

CLIENT HEA

REPORT TO: Jon Higgins

INVOICE TO: Jon Higgins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE	TESTS**: Total Carbon (TOC)	Total Fe S P	Total N (TKN, Amm.-N, NO3-N)	chloride			REMARKS
									See Remarks							
~~9/23/24~~	~~0720~~			STRM1	✓			7	1-4	✓	✓	✓	✓			Totals for C, Fe, S, P Nitrogen includes TKN, Ammonia-N Nitrate -N Preservatives: ① HNO3 for Fe, S ② NON for N, P, chloride ③ H2SO4 for N & TOC ④ <4°C
9/23/24	0720															

Sampled by: (Signature) — Date/Time 9/23/24 0730 — Received by: (Signature) — Date/Time 9/23/24 0730

Relinquished by: (Signature) — Date/Time — Received by: (Signature) Chr M — Date/Time 9/24/24 1315

Relinquished by: (Signature) Chr M — Date/Time 9/24/24 1630 — Received for Laboratory by: (Signature) Ryenne T — Date/Time 9/24/24 1630

Laboratory Remarks: 4

Temp. received: ______

Cooled ☒

Special Instructions:
List Specific Detection
Limit Requirements:

Turnaround (Business Days)______

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4I13017
Client Project: 03143 - Stiles

Report Date: 01-October-2024

Prepared for:

Jon Higgins
Higgins Environmental
19 Elizabeth Street
Amesbury, MA 01913

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 09/13/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4I13017. Custody records are included in this report.

Lab ID	Sample	Matrix	Date Sampled	Date Received
4I13017-01	P-1	Water	09/12/2024	09/13/2024
4I13017-02	P-2	Water	09/12/2024	09/13/2024
4I13017-03	P-3	Water	09/12/2024	09/13/2024
4I13017-04	P-4	Water	09/12/2024	09/13/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

P-1 (Lab Number: 4I13017-01)

	Method
Ammonia	SM4500-NH3-D (11)
Chloride	EPA 300.0
Iron	EPA 6010C
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C

P-2 (Lab Number: 4I13017-02)

	Method
Ammonia	SM4500-NH3-D (11)
Chloride	EPA 300.0
Iron	EPA 6010C
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C

P-3 (Lab Number: 4I13017-03)

	Method
Ammonia	SM4500-NH3-D (11)
Chloride	EPA 300.0
Iron	EPA 6010C
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C

P-4 (Lab Number: 4I13017-04)

	Method
Ammonia	SM4500-NH3-D (11)
Chloride	EPA 300.0
Iron	EPA 6010C
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)
Total Nitrogen	Calculation
Total Organic Carbon	SM5310-C

Method References

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA/ AWWA-WPCF, 1998

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions: None

Results: General Chemistry

Sample: P-1

Lab Number: 4I13017-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Ammonia	ND		0.1	mg/L	09/24/24	09/24/24
Chloride	**14.7**		0.25	mg/L	09/13/24	09/13/24
Nitrate as N	ND		0.25	mg/L	09/13/24 20:13	09/13/24 20:13
Nitrite as N	ND		0.02	mg/L	09/13/24 20:13	09/13/24 20:13
Kjeldahl Nitrogen	**0.6**		0.1	mg/L	09/26/24	09/26/24
Total Organic Carbon	**1.0**		0.2	mg/L	09/16/24	09/17/24
Total Nitrogen	**0.600**		0.100	mg/L	09/26/24	09/26/24

Results: General Chemistry

Sample: P-2
Lab Number: 4I13017-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Ammonia	**0.9**		0.1	mg/L	09/24/24	09/24/24
Chloride	**9.60**		0.25	mg/L	09/13/24	09/13/24
Nitrate as N	ND		0.25	mg/L	09/13/24 20:25	09/13/24 20:25
Nitrite as N	ND		0.02	mg/L	09/13/24 20:25	09/13/24 20:25
Kjeldahl Nitrogen	**5.1**		0.1	mg/L	09/26/24	09/26/24
Total Organic Carbon	**4.1**		0.2	mg/L	09/16/24	09/17/24
Total Nitrogen	**5.10**		0.100	mg/L	09/26/24	09/26/24

Results: General Chemistry

Sample: P-3

Lab Number: 4I13017-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Ammonia	**0.5**		0.1	mg/L	09/24/24	09/24/24
Chloride	**9.66**		0.25	mg/L	09/13/24	09/13/24
Nitrate as N	ND		0.25	mg/L	09/13/24 20:36	09/13/24 20:36
Nitrite as N	ND		0.02	mg/L	09/13/24 20:36	09/13/24 20:36
Kjeldahl Nitrogen	**3.0**		0.1	mg/L	09/26/24	09/26/24
Total Organic Carbon	**3.2**		0.2	mg/L	09/16/24	09/17/24
Total Nitrogen	**3.00**		0.100	mg/L	09/26/24	09/26/24

Results: General Chemistry

Sample: P-4

Lab Number: 4I13017-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Ammonia	**0.5**		0.1	mg/L	09/24/24	09/24/24
Chloride	**11.5**		0.25	mg/L	09/13/24	09/13/24
Nitrate as N	ND		0.25	mg/L	09/13/24 20:48	09/13/24 20:48
Nitrite as N	ND		0.02	mg/L	09/13/24 20:48	09/13/24 20:48
Kjeldahl Nitrogen	**2.9**		0.1	mg/L	09/26/24	09/26/24
Total Organic Carbon	**1.8**		0.2	mg/L	09/16/24	09/17/24
Total Nitrogen	**2.90**		0.100	mg/L	09/26/24	09/26/24

Results: Total Metals

Sample: P-1

Lab Number: 4I13017-01 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.15**		0.05	mg/L	09/16/24	09/19/24
Phosphorous	**0.010**		0.010	mg/L	09/16/24	09/19/24
Sulfur	ND		0.5	mg/L	09/16/24	09/19/24

Results: Total Metals

Sample: P-2

Lab Number: 4I13017-02 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**0.30**		0.05	mg/L	09/16/24	09/19/24
Phosphorous	**0.084**		0.010	mg/L	09/16/24	09/19/24
Sulfur	ND		0.5	mg/L	09/16/24	09/19/24

Results: Total Metals

Sample: P-3

Lab Number: 4I13017-03 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**1.50**		0.05	mg/L	09/16/24	09/19/24
Phosphorous	**0.061**		0.010	mg/L	09/16/24	09/19/24
Sulfur	ND		0.5	mg/L	09/16/24	09/19/24

Results: Total Metals

Sample: P-4

Lab Number: 4I13017-04 (Water)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Iron	**2.98**		0.05	mg/L	09/16/24	09/19/24
Phosphorous	**0.080**		0.010	mg/L	09/16/24	09/19/24
Sulfur	ND		0.5	mg/L	09/16/24	09/19/24

Quality Control

General Chemistry

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I0563 - Ion Chromatography										
Blank (B4I0563-BLK1)					Prepared & Analyzed: 09/13/24					
Chloride	ND		0.25	mg/L						
Nitrate as N	ND		0.25	mg/L						
Nitrite as N	ND		0.02	mg/L						
Blank (B4I0563-BLK2)					Prepared & Analyzed: 09/13/24					
Chloride	ND		0.25	mg/L						
Nitrate as N	ND		0.25	mg/L						
Nitrite as N	ND		0.02	mg/L						
LCS (B4I0563-BS1)					Prepared & Analyzed: 09/13/24					
Chloride	4.69		0.25	mg/L	5.00		93.8	90-110		
Nitrate as N	4.75		0.25	mg/L	5.00		95.1	90-110		
Nitrite as N	0.51		0.02	mg/L	0.500		101	90-110		
LCS (B4I0563-BS2)					Prepared & Analyzed: 09/13/24					
Chloride	4.74		0.25	mg/L	5.00		94.7	90-110		
Nitrite as N	0.51		0.02	mg/L	0.500		101	90-110		
Nitrate as N	4.73		0.25	mg/L	5.00		94.6	90-110		
Matrix Spike (B4I0563-MS1)		Source: 4I12067-01			Prepared & Analyzed: 09/13/24					
Chloride	115		0.25	mg/L	5.00	86.6	575	90-110		
Nitrate as N	16.7		0.25	mg/L	5.00	0.82	318	90-110		
Nitrite as N	0.82		0.02	mg/L	0.500	ND	164	90-110		
Matrix Spike (B4I0563-MS2)		Source: 4I12051-02			Prepared & Analyzed: 09/13/24					
Chloride	82.5		0.25	mg/L	5.00	118	NR	90-110		
Nitrate as N	5.44		0.25	mg/L	5.00	12.9	NR	90-110		
Nitrite as N	0.44		0.02	mg/L	0.500	0.35	17.7	90-110		

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I0563 - Ion Chromatography (Continued)										
Matrix Spike Dup (B4I0563-MSD1)		Source: 4I12067-01			Prepared & Analyzed: 09/13/24					
Chloride	115		0.25	mg/L	5.00	86.6	575	90-110	0.00962	10
Nitrate as N	16.7		0.25	mg/L	5.00	0.82	318	90-110	0.0419	10
Nitrite as N	0.83		0.02	mg/L	0.500	ND	165	90-110	0.643	10
Matrix Spike Dup (B4I0563-MSD2)		Source: 4I12051-02			Prepared & Analyzed: 09/13/24					
Chloride	83.0		0.25	mg/L	5.00	118	NR	90-110	0.672	10
Nitrate as N	5.48		0.25	mg/L	5.00	12.9	NR	90-110	0.800	10
Nitrite as N	0.44		0.02	mg/L	0.500	0.35	17.6	90-110	0.0458	10
Batch: B4I0599 - TOC										
Blank (B4I0599-BLK1)					Prepared: 09/16/24 Analyzed: 09/17/24					
Total Organic Carbon	ND		0.2	mg/L						
LCS (B4I0599-BS1)					Prepared: 09/16/24 Analyzed: 09/17/24					
Total Organic Carbon	5.2		0.2	mg/L	5.00		104	90-110		
LCS Dup (B4I0599-BSD1)					Prepared: 09/16/24 Analyzed: 09/17/24					
Total Organic Carbon	5.2		0.2	mg/L	5.00		103	90-110	0.350	20
Batch: B4I1049 - Ammonia										
Blank (B4I1049-BLK1)					Prepared & Analyzed: 09/24/24					
Ammonia	ND		0.1	mg/L						
Blank (B4I1049-BLK2)					Prepared & Analyzed: 09/24/24					
Ammonia	ND		0.1	mg/L						

Quality Control

(Continued)

General Chemistry (Continued)

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I1049 - Ammonia (Continued)										
LCS (B4I1049-BS1)					Prepared & Analyzed: 09/24/24					
Ammonia	0.9		0.1	mg/L	1.00		92.5	90-110		
LCS (B4I1049-BS2)					Prepared & Analyzed: 09/24/24					
Ammonia	1.1		0.1	mg/L	1.00		106	90-110		
Duplicate (B4I1049-DUP1)		Source: 4I13017-01			Prepared & Analyzed: 09/24/24					
Ammonia	ND		0.1	mg/L		ND				20
Matrix Spike (B4I1049-MS1)		Source: 4I13017-01			Prepared & Analyzed: 09/24/24					
Ammonia	0.9		0.1	mg/L	1.00	ND	85.3	80-120		
Batch: B4I1213 - TKN										
Blank (B4I1213-BLK1)					Prepared & Analyzed: 09/26/24					
Kjeldahl Nitrogen	ND		0.1	mg/L						
Blank (B4I1213-BLK2)					Prepared & Analyzed: 09/26/24					
Kjeldahl Nitrogen	ND		0.1	mg/L						
LCS (B4I1213-BS1)					Prepared & Analyzed: 09/26/24					
Kjeldahl Nitrogen	1.1		0.1	mg/L	1.00		112	80-120		
LCS (B4I1213-BS2)					Prepared & Analyzed: 09/26/24					
Kjeldahl Nitrogen	0.8		0.1	mg/L	1.00		82.1	80-120		
Duplicate (B4I1213-DUP1)		Source: 4I13017-01			Prepared & Analyzed: 09/26/24					
Kjeldahl Nitrogen	0.7		0.1	mg/L		0.6			12.2	20

Quality Control

(Continued)

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I0620 - Metals Digestion Waters										
Blank (B4I0620-BLK1)					Prepared: 09/16/24 Analyzed: 09/19/24					
Iron	ND		0.05	mg/L						
Sulfur	ND		0.5	mg/L						
Phosphorous	ND		0.010	mg/L						
LCS (B4I0620-BS1)					Prepared: 09/16/24 Analyzed: 09/19/24					
Phosphorous	0.941		0.010	mg/L	1.00		94.1	85-115		
Sulfur	ND		0.5	mg/L				85-115		
Iron	9.24		0.05	mg/L	10.0		92.4	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATORY, IN
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4 I 1 3017 q

PROJ. NO.	03143
PROJECT NAME/LOCATION	Stiles
CLIENT	HEA
REPORT TO:	Jon Higgins
INVOICE TO:	Jon Higgins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE See remarks	TESTS** Total Carbon (TOC)	Total Fe, S, P	Total N (TKN, Amm-N, NO3-N)	Chloride			REMARKS
9/12/24	1230		✓	P1	✓			384	1-4	✓	✓	✓	✓			
11	1313		✓	P2	✓			5	1-4	✓	✓	✓	✓			Totals for C, Fe, S, P
11	1413		✓	P3	✓			5	1-4	✓	✓	✓	✓			(Total for Nitrogen
11	1450		✓	P4	✓			5	1-4	✓	✓	✓	✓			inc TKN, Ammonia-N
																Nitrate-N)

Preservative
① HNO_3 for Fe, S
② NON for N, P, chloride
③ H_2SO_4 for N & TOC
④ < 4°C

Sampled by: (Signature)	Date/Time 9/12/24 1520	Received by: (Signature)	Date/Time 9/12/24 1520
Relinquished by: (Signature)	Date/Time 9/13/24 1130	Received by: (Signature)	Date/Time 9-13-24 1300
Relinquished by: (Signature)	Date/Time 9-13-24 1520	Received for Laboratory by: (Signature)	Date/Time 9/13/24 1520

Laboratory Remarks:
Temp. received: 3
Cooled ☐

Special Instructions:
List Specific Detection
Limit Requirements:

Turnaround (Business Days)

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

6k

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4F24018
Client Project: 03143 - Stiles

Report Date: 08-July-2024

Prepared for:

Jon Higgins
Higgins Environmental
19 Elizabeth Street
Amesbury, MA 01913

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 06/24/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4F24018. Custody records are included in this report.

Lab ID	**Sample**	**Matrix**	**Date Sampled**	**Date Received**
4F24018-01	TC	Soil	06/04/2024	06/24/2024
4F24018-02	MC	Soil	06/04/2024	06/24/2024
4F24018-03	BC	Soil	06/04/2024	06/24/2024
4F24018-04	LNC	Soil	06/04/2024	06/24/2024
4F24018-05	LSC	Soil	06/04/2024	06/24/2024
4F24018-06	LW Trib	Soil	06/04/2024	06/24/2024
4F24018-07	Pollen 1	Soil	06/04/2024	06/24/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

BC (Lab Number: 4F24018-03)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

LNC (Lab Number: 4F24018-04)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

LSC (Lab Number: 4F24018-05)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

LW Trib (Lab Number: 4F24018-06)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

MC (Lab Number: 4F24018-02)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

Pollen 1 (Lab Number: 4F24018-07)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

Request for Analysis (continued)

TC (Lab Number: 4F24018-01)

	Method
Iron	EPA 6010C
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

Method References

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions: None

Results: General Chemistry

Sample: TC

Lab Number: 4F24018-01 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**15**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**9280**		10.0	mg/kg	06/25/24	06/25/24

Results: General Chemistry

Sample: MC

Lab Number: 4F24018-02 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**20**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**19000**		10.0	mg/kg	06/25/24	06/25/24

Results: General Chemistry

Sample: BC

Lab Number: 4F24018-03 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**21**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**13700**		10.0	mg/kg	06/25/24	06/25/24

Results: General Chemistry

Sample: LNC

Lab Number: 4F24018-04 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**36**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**1820**		10.0	mg/kg	06/25/24	06/25/24

Results: General Chemistry

Sample: LSC

Lab Number: 4F24018-05 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**31**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**11500**		10.0	mg/kg	06/25/24	06/25/24

Results: General Chemistry

Sample: LW Trib

Lab Number: 4F24018-06 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**22**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**7110**		10.0	mg/kg	06/25/24	06/25/24

Results: General Chemistry

Sample: Pollen 1

Lab Number: 4F24018-07 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Total Organic Carbon	**51**		0	Percent	06/27/24	06/28/24
Total Nitrogen	**6990**		10.0	mg/kg	06/25/24	06/25/24

Results: Total Metals

Sample: TC

Lab Number: 4F24018-01 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**892**		3.60	mg/kg	06/25/24	06/28/24
Sulfur	**4890**		364	mg/kg	06/25/24	07/01/24
Iron	**14500**		36.4	mg/kg	06/25/24	06/28/24

Results: Total Metals

Sample: MC

Lab Number: 4F24018-02 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**190**		3.50	mg/kg	06/25/24	06/28/24
Sulfur	**2020**		353	mg/kg	06/25/24	07/01/24
Iron	**3160**		35.3	mg/kg	06/25/24	06/28/24

Results: Total Metals

Sample: BC

Lab Number: 4F24018-03 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**337**		4.04	mg/kg	06/25/24	06/28/24
Sulfur	**3680**		408	mg/kg	06/25/24	07/01/24
Iron	**6030**		40.8	mg/kg	06/25/24	06/28/24

Results: Total Metals

Sample: LNC

Lab Number: 4F24018-04 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**642**		2.26	mg/kg	06/25/24	06/28/24
Sulfur	**6110**		228	mg/kg	06/25/24	07/01/24
Iron	**9240**		22.8	mg/kg	06/25/24	06/28/24

Results: Total Metals

Sample: LSC

Lab Number: 4F24018-05 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**1230**		2.78	mg/kg	06/25/24	06/28/24
Sulfur	**5220**		280	mg/kg	06/25/24	07/01/24
Iron	**20000**		28.0	mg/kg	06/25/24	06/28/24

Results: Total Metals

Sample: LW Trib

Lab Number: 4F24018-06 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**646**		1.97	mg/kg	06/25/24	06/28/24
Sulfur	**4820**		199	mg/kg	06/25/24	07/01/24
Iron	**9780**		19.9	mg/kg	06/25/24	06/28/24

Results: Total Metals

Sample: Pollen 1

Lab Number: 4F24018-07 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**1890**		2.34	mg/kg	06/25/24	06/28/24
Sulfur	**1420**		237	mg/kg	06/25/24	07/01/24
Iron	**1270**		23.7	mg/kg	06/25/24	06/28/24

Quality Control

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4F1028 - Metals Digestion Soils										
Blank (B4F1028-BLK1)					Prepared: 06/25/24 Analyzed: 07/01/24					
Sulfur	ND		33.3	mg/kg						
Phosphorous	ND		0.33	mg/kg						
Iron	ND		3.3	mg/kg						
LCS (B4F1028-BS1)					Prepared: 06/25/24 Analyzed: 06/28/24					
Phosphorous	114		0.33	mg/kg	100		114	85-115		
Iron	1130		3.3	mg/kg	1000		113	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATORY, INC.
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4 F 2 4018 ?

PROJ. NO. 03143

PROJECT NAME/LOCATION Stiles

CLIENT HEA

REPORT TO: Jim Hitchins

INVOICE TO: Jim Hitchins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE	TESTS** Total Carbon	Total Iron	Total Nitrogen	Total Phosphorus	Total Sulfur		REMARKS
6/14/24	1320		✓	TC		✓		1	Ice Frozen	✓	✓	✓	✓	✓		
"	1330		✓	MC		✓		1	"	✓	✓	✓	✓	✓		
	1340		✓	BC		✓		1	"	✓	✓	✓	✓	✓		
	1350		✓	LNC		✓		1	"	✓	✓	✓	✓	✓		
	1400		✓	LSC		✓		1	"	✓	✓	✓	✓	✓		
	1420		✓	LWTrib		✓		1	"	✓	✓	✓	✓	✓		
	1450	✓		Pollen1			✓	1	"	✓	✓	✓	✓	✓		

Sampled by: (Signature) Date/Time 6/14/24 1430

Received by: (Signature) Date/Time 6/14/24 1430

Relinquished by: (Signature) Date/Time 6/24/24 1200

Received by: (Signature) Date/Time 6/24/24 1200

Relinquished by: (Signature) Date/Time 6/24/24 1520

Received for Laboratory by: (Signature) Date/Time 6/24/24 1520

Laboratory Remarks:

Temp. received: 5

Cooled X

Special Instructions:

List Specific Detection

Limit Requirements:

Turnaround (Business Days)____________

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

New England Testing Laboratory, Inc.
(401) 353-3420

REPORT OF ANALYTICAL RESULTS

NETLAB Work Order Number: 4I13016
Client Project: 03143 - Stiles

Report Date: 01-October-2024

Prepared for:

Jon Higgins
Higgins Environmental
19 Elizabeth Street
Amesbury, MA 01913

Mike Mccallum, Laboratory Director
New England Testing Laboratory, Inc.
59 Greenhill Street
West Warwick, RI 02893
mike.mccallum@newenglandtesting.com

Samples Submitted :

The samples listed below were submitted to New England Testing Laboratory on 09/13/24. The group of samples appearing in this report was assigned an internal identification number (case number) for laboratory information management purposes. The client's designations for the individual samples, along with our case numbers, are used to identify the samples in this report. This report of analytical results pertains only to the sample(s) provided to us by the client which are indicated on the custody record. The case number for this sample submission is 4I13016. Custody records are included in this report.

Lab ID	Sample	Matrix	Date Sampled	Date Received
4I13016-01	TC 2	Soil	09/11/2024	09/13/2024
4I13016-02	LSC 2	Soil	09/11/2024	09/13/2024
4I13016-03	LNC 2	Soil	09/11/2024	09/13/2024
4I13016-04	LW Trib 2	Soil	09/11/2024	09/13/2024
4I13016-05	B-Macro	Soil	09/11/2024	09/13/2024

Request for Analysis

At the client's request, the analyses presented in the following table were performed on the samples submitted.

B-Macro (Lab Number: 4I13016-05)

	Method
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)-Mod
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

LNC 2 (Lab Number: 4I13016-03)

	Method
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)-Mod
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

LSC 2 (Lab Number: 4I13016-02)

	Method
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)-Mod
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

LW Trib 2 (Lab Number: 4I13016-04)

	Method
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)-Mod
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

TC 2 (Lab Number: 4I13016-01)

	Method
Iron	EPA 6010C
Nitrate and Nitrite Combined	EPA 300.0
Phosphorus	EPA 6010C
Sulfur	EPA 6010C
Total Kjeldahl Nitrogen	SM4500-N-C (11)-Mod
Total Nitrogen	Calculation
Total Organic Carbon	EPA 9060

Method References

Standard Methods for the Examination of Water and Wastewater, 20th Edition, APHA/ AWWA-WPCF, 1998

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, USEPA

Soil Survey Laboratory Methods Manual, USDA/NCRS, 2014

Case Narrative

Sample Receipt:

The samples associated with this work order were received in appropriately cooled and preserved containers. The chain of custody was adequately completed and corresponded to the samples submitted.

Exceptions: None

Analysis:

All samples were prepared and analyzed within method specified holding times and according to NETLAB's documented standard operating procedures. The results for the associated calibration, method blank and laboratory control sample (LCS) were within method specified quality control requirements and allowances. Results for all soil samples, unless otherwise indicated, are reported on a dry weight basis.

Exceptions: None

Results: General Chemistry

Sample: TC 2

Lab Number: 4I13016-01 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Nitrate and Nitrite as N	**15.7**		2.70	mg/kg	09/17/24	09/17/24
Kjeldahl Nitrogen	**836**		110	mg/kg	09/26/24	09/26/24
Total Organic Carbon	**13**		0	Percent	09/16/24	09/16/24
Total Nitrogen	**852**		0.100	mg/kg	09/26/24	09/26/24

Results: General Chemistry

Sample: LSC 2

Lab Number: 4I13016-02 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Nitrate and Nitrite as N	**3.01**		0.40	mg/kg	09/17/24	09/17/24
Kjeldahl Nitrogen	**162**		16	mg/kg	09/26/24	09/26/24
Total Organic Carbon	**5**		0	Percent	09/16/24	09/16/24
Total Nitrogen	**165**		0.100	mg/kg	09/26/24	09/26/24

Results: General Chemistry

Sample: LNC 2

Lab Number: 4I13016-03 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Nitrate and Nitrite as N	**8.53**		1.34	mg/kg	09/17/24	09/17/24
Kjeldahl Nitrogen	**717**		52	mg/kg	09/26/24	09/26/24
Total Organic Carbon	**17**		0	Percent	09/16/24	09/16/24
Total Nitrogen	**726**		0.100	mg/kg	09/26/24	09/26/24

Results: General Chemistry

Sample: LW Trib 2

Lab Number: 4I13016-04 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Nitrate and Nitrite as N	**7.37**		1.38	mg/kg	09/17/24	09/17/24
Kjeldahl Nitrogen	**638**		54	mg/kg	09/26/24	09/26/24
Total Organic Carbon	**18**		0	Percent	09/16/24	09/16/24
Total Nitrogen	**645**		0.100	mg/kg	09/26/24	09/26/24

Results: General Chemistry

Sample: B-Macro

Lab Number: 4I13016-05 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Nitrate and Nitrite as N	**57.0**		3.04	mg/kg	09/17/24	09/17/24
Kjeldahl Nitrogen	**3050**		115	mg/kg	09/26/24	09/26/24
Total Organic Carbon	**45**		0	Percent	09/16/24	09/16/24
Total Nitrogen	**3110**		0.100	mg/kg	09/26/24	09/26/24

Results: Total Metals

Sample: TC 2

Lab Number: 4I13016-01 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**1080**		0.37	mg/kg	09/17/24	09/24/24
Sulfur	ND		37.8	mg/kg	09/17/24	09/19/24
Iron	**18000**		3.8	mg/kg	09/17/24	09/24/24

Results: Total Metals

Sample: LSC 2

Lab Number: 4I13016-02 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**183**		0.05	mg/kg	09/17/24	09/24/24
Sulfur	ND		5.5	mg/kg	09/17/24	09/19/24
Iron	**6200**		0.5	mg/kg	09/17/24	09/24/24

Results: Total Metals

Sample: LNC 2

Lab Number: 4I13016-03 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**600**		0.18	mg/kg	09/17/24	09/24/24
Sulfur	ND		18.3	mg/kg	09/17/24	09/19/24
Iron	**11100**		1.8	mg/kg	09/17/24	09/24/24

Results: Total Metals

Sample: LW Trib 2

Lab Number: 4I13016-04 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**642**		0.19	mg/kg	09/17/24	09/24/24
Sulfur	ND		19.2	mg/kg	09/17/24	09/19/24
Iron	**14400**		1.9	mg/kg	09/17/24	09/24/24

Results: Total Metals

Sample: B-Macro

Lab Number: 4I13016-05 (Soil)

Analyte	Result	Qual	Reporting Limit	Units	Date Prepared	Date Analyzed
Phosphorous	**2020**		2.02	mg/kg	09/17/24	09/24/24
Sulfur	ND		204	mg/kg	09/17/24	09/19/24
Iron	**9170**		20.4	mg/kg	09/17/24	09/24/24

Quality Control

General Chemistry

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I0704 - Ion Chromatography										
Blank (B4I0704-BLK1)					Prepared & Analyzed: 09/17/24					
Nitrate and Nitrite as N	ND		0.25	mg/kg						
LCS (B4I0704-BS1)					Prepared & Analyzed: 09/17/24					
Nitrate and Nitrite as N	5.57			mg/L	5.00		111	0-200		
Matrix Spike (B4I0704-MS1)		Source: 4I11050-01			Prepared & Analyzed: 09/17/24					
Nitrate and Nitrite as N	533		1.02	mg/kg dry	509	ND	105	0-200		
Matrix Spike Dup (B4I0704-MSD1)		Source: 4I11050-01			Prepared & Analyzed: 09/17/24					
Nitrate and Nitrite as N	529		1.02	mg/kg dry	509	ND	104	0-200	0.625	200
Batch: B4I1215 - TKN										
Blank (B4I1215-BLK1)					Prepared & Analyzed: 09/26/24					
Kjeldahl Nitrogen	ND		10	mg/kg						

Quality Control

(Continued)

Total Metals

Analyte	Result	Qual	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
Batch: B4I0688 - Metals Digestion Soils										
Blank (B4I0688-BLK1)					Prepared: 09/17/24 Analyzed: 09/19/24					
Sulfur	ND		33.3	mg/kg						
Phosphorous	ND		0.33	mg/kg						
Iron	ND		3.3	mg/kg						
LCS (B4I0688-BS1)					Prepared: 09/17/24 Analyzed: 09/19/24					
Sulfur	ND		33.3	mg/kg				85-115		
Phosphorous	104		0.33	mg/kg	100		104	85-115		
Iron	1030		3.3	mg/kg	1000		103	85-115		

Notes and Definitions

Item	Definition
Wet	Sample results reported on a wet weight basis.
ND	Analyte NOT DETECTED at or above the reporting limit.

NEW ENGLAND TESTING LABORATORY, INC.
59 Greenhill Street
West Warwick, RI 02893
1-888-863-8522

4I1 3016k

CHAIN OF CUSTODY RECORD

PROJ. NO.: 03143
PROJECT NAME/LOCATION: Stiles
CLIENT: HEA
REPORT TO: Jon Higgins
INVOICE TO: Jon Higgins

DATE	TIME	COMP	GRAB	SAMPLE I.D.	AQUEOUS	SOIL	OTHER	NO. OF CONTAINERS	PRESERVATIVE	TESTS** Total Carbon	Total Iron	Total Nitrogen	Total Phosphorus	Total Sulfur		REMARKS
9/11/24	1120		✓	TC2		✓		1	<4°C "	✓	✓	✓	✓	✓		
	1150		✓	LSC2		✓		1	"	✓	✓	✓	✓	✓		
	1215		✓	LNC2		✓		1	"	✓	✓	✓	✓	✓		
	1240		✓	LWTrib2		✓		1	"	✓	✓	✓	✓	✓		
	1300		✓	B-Macro			✓	1	"	✓	✓	✓	✓	✓		

Sampled by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
	9/11/24 1300		9/11/24 1300
Relinquished by: (Signature)	**Date/Time**	**Received by: (Signature)**	**Date/Time**
	9/13/24 1130		9-13-23 11 30
Relinquished by: (Signature)	**Date/Time**	**Received for Laboratory by: (Signature)**	**Date/Time**
	9-13-24 15 20		9/13/24 1520

Laboratory Remarks:
Temp. received: 3
Cooled ☐

Special Instructions:
List Specific Detection
Limit Requirements:

Turnaround (Business Days)

**Netlab subcontracts the following tests: Radiologicals, Radon, Asbestos, UCMRs, Perchlorate, Bromate, Bromide, Sieve, Salmonella, Carbamates, CT ETPH

GR

MassDEP WATERSHED BASED PLAN
FOR STILES POND
(provided under separate cover due to file size and format)