LAKE HOPATCONG – 2022 WATER QUALITY REPORT

MORRIS AND SUSSEX COUNTIES, NEW JERSEY

DECEMBER 2022

PREPARED FOR:

THE LAKE HOPATCONG COMMISSION
PO BOX 8815
LANDING, NJ 07850

PREPARED BY:

PRINCETON HYDRO, LLC
35 CLARK STREET, SUITE 200
TRENTON, NJ 08611
908-237-5660

TABLE OF CONTENTS

1.0 INTRODUCTION

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2022 growing season (May through October). This monitoring program represents a continuation of the long-term monitoring program of Lake Hopatcong. While the 2010 through 2012 water quality monitoring programs were conducted with funds awarded to the Lake Hopatcong Commission by NJDEP through the Non-Point Source (319(h) of the Clean Water Act) grant program (Project Grant RP10-087), the water quality monitoring program of 2013 was funded through the Lake Hopatcong Foundation as a monetary match toward the grant. Remaining funds in the 319(h) grant were made available for the 2014, 2015, and 2016 water quality monitoring programs. The annual water quality monitoring program was funded by the Lake Hopatcong Commission from 2018 through 2022.

The current water quality monitoring program is a modified version of the program that was originally initiated in the Phase I Diagnostic / Feasibility Study of Lake Hopatcong (PAS, 1983) and continued through the Phase II Implementation Projects. Both the Phase I and Phase II projects were funded by the US EPA Clean Lakes (314) Program. The modified monitoring program also continued through the development, revision, and approval of the TMDL-based Restoration Plan, as well as through the installation of a series of watershed projects funded through three NJDEP 319 grants and a US EPA Targeted Watershed grant. Some additional monitoring was conducted during each sampling event in 2020, 2021, and 2022 as part of the HAB grant awarded in 2020 as well as a 319 grant (*WQR-2019-LHC00130)* awarded in 2021. The recent 319 grant involved modeling efforts to better quantify the internal phosphorus load on a seasonal and monthly basis under varying hydraulic conditions and will also involve the implementation of various in-lake and watershed-based projects to reduce nutrient loading to the waterbody. Finally, additional *in-situ* monitoring was conducted in July and August of the 2022 season as part of a Highlands Council funded project to better characterize carryover brown trout (*Salmo trutta*) habitat during the peak summer months. This grant allowed for weekly *in-situ* sampling during the summer months, providing invaluable high-frequency data.

The current water quality monitoring program is valuable in terms of continuing to assess the overall “health” of the lake on a year-to-year basis, identifying long-term trends or changes in water quality, and quantifying and objectively assessing the success and potential impacts of restoration efforts. In addition, the in-lake water quality monitoring program continues to be an important component in the evaluation of the long-term success of the implementation of the phosphorus TMDL-based Restoration Plan, which was approved by NJDEP in April of 2006. The monitoring program also provides the data necessary to support the Foundation’s and Commission’s requests for grant funding to implement both watershed-based and in-lake projects to improve the water quality of Lake Hopatcong. Also, much of the data collected in 2022 will be used to assess the relative effectiveness of in-lake and watershed-based projects, designed to prevent or minimize the impacts of HABs in Lake Hopatcong. Finally, it should be noted that the 2006 Restoration Plan was recently updated with funds provided by the NJ Highlands Council in 2021 into a Watershed Implementation Plan (WIP) and is being used to select, design and implement additional watershed-based projects.

2.0 MATERIALS AND METHODS

In-lake water quality monitoring was conducted at the following eleven (11) locations in Lake Hopatcong (represented as red circles in Figure 1, Appendix A) during the 2022 study period:

Station Number	Location
1	Woodport Bay
2	Mid-Lake
3	Crescent Cove/River Styx
4	Point Pleasant/King Cove
5	Outlet
6	Henderson Cove
7	Inlet from Lake Shawnee
8*	Great Cove
9*	Byram Cove
10	Northern Woodport Bay
11	Jefferson Canals

* *In-situ* monitoring only

During the 2022 season, standard water quality sampling was conducted on 25 May, 22 June, 25 July, 24 August and 6 October. Additional *in-situ* monitoring events that were included as part of the trout study were conducted on 5 July, 11 July, 18 July, 2 August, 10 August, and 16 August. An Aqua TROLL 500 multi-probe unit was used to monitor the *in-situ* parameters dissolved oxygen (DO), temperature, pH, specific conductance, phycocyanin, and chlorophyll *a* during each sampling event. Data were recorded at 1.0 m increments starting at 0.1-0.2 m below the water's surface and continued to within 0.5 m of the lake sediments at each station. In addition, water clarity was measured at each sampling station with a Secchi disk.

Discrete water quality samples were collected with a Van Dorn sampling device 0.5 m below the lake surface at each station, with the exception of Stations 8 and 9, as well as mid-depth and 0.5 m above the sediment at the mid-lake sampling site (Station 2). Discrete water samples were appropriately preserved, stored on ice, and transported to a State-certified laboratory for the analysis of the following parameters:

- total suspended solids
- total phosphorus-P
- soluble reactive phosphorus-P
- nitrate-N
- ammonia-N
- chlorophyll *a*

During each sampling event, phytoplankton and zooplankton samples were collected at the surface and mid-depth of the deep sampling station (Station 2). Phytoplankton samples were collected at the surface and mid-depths utilizing a Van Dorn sampling device and quantitatively assessed, while zooplankton samples were collected utilizing a Schindler sampling device and qualitatively assessed. Phytoplankton grab samples were also collected at the surface of Station 3 for the quantitative assessment of cyanobacteria.

3.0 RESULTS AND DISCUSSION

3.1 IN-SITU PARAMETERS

THERMAL STRATIFICATION

Summer thermal stratification results when increasing solar radiation and air temperatures, aided by a few days of little wind activity, combine to thermally stratify the water column. Thermal stratification consists of a relatively warm upper water layer (epilimnion), a transition zone (metalimnion or thermocline), and a cold, deep water layer (hypolimnion). The density differences imparted through thermal stratification serve to inhibit wind driven mixing of the water column thereby effectively sealing off the hypolimnetic layer from contact with the atmosphere. This phenomenon has important implications in that bottom waters of thermally stratified systems may become devoid of oxygen due to excessive bacterial decomposition of organic matter and a lack of atmospheric replenishment of dissolved oxygen through diffusion. Resultant conditions of hypolimnetic anoxia include internal sediment release of metals and phosphorus, and reduced fish habitat.

In the late summer and early fall, declining air temperatures result in a negative heat income to the lake, and a loss of heat exceeds inputs from solar radiation. Surface waters are thus cooled and induce convection currents which serve to erode the metalimnion of the lake until the water column exhibits a uniform temperature and therefore uniform density. At this point the lake experiences fall turnover. The transition from the final stages of weak summer thermal stratification to fall turnover are often times abrupt, and can occur over a period of a few hours, especially if associated with the high wind velocities of a storm.

Surface water temperatures measured at Station 2 were coolest in May and early October, with respective temperatures of 19.69 °C and 15.40 °C. Surface temperatures increased to a seasonal maximum of 27.56 °C on 10 August; this data was collected during one of the trout habitat monitoring events. The lake was still in the early stages of the annual growing season thermal stratification pattern in late May, with a shallow epilimnion in the upper 3.0 m of the water column and a thermocline present from approximately 3.0 m to 8.0 m. By late June, surface temperatures had only increased slightly relative to the 25 May event. However, water temperatures deeper in the epilimnion (4.0-6.0 m) had increased to a greater degree as this upper layer continued to mix, resulting in a more defined thermal stratification pattern and a larger epilimnion, now present in the upper 6.0 m. Water temperatures throughout the epilimnion increased significantly by 25 July in response to the hot, dry weather, resulting in a slight shrinking of the epilimnion, now present in the upper 4.0 m. Temperatures throughout the epilimnion had decreased by late August, with a surface temperature of 25.28 °C. The lake was almost completely mixed by 6 October, although a slight thermal gradient was present in the lower 3.0 m.

Water temperatures were often higher at the other stations throughout the lake as a result of the shallower depths. It takes less energy from the sun to heat the other stations since the zone of mixing is much shallower. Surface water temperatures exceeded 28.00 °C at six stations on 25 July. The only other two stations that developed true thermal stratification patterns throughout the season were Stations 8 and 9, which are both approximately 7.5 – 8.5 m deep.

In addition to collecting temperature data over the 2022 growing season, the long-term, surface water temperatures from Station 2 during the month of July have been graphed and are shown below in Figure 1. This analysis was conducted to assess the potential impacts of climate change on Lake Hopatcong. The Station 2, mid-lake data were used because there was no chance of shading from near-shore trees or structures at this location. The July data were used since it is typically the warmest month of the year in the Mid-Atlantic States.

As shown in Figure 1, there has been a statistically significant increase in surface water temperatures at Lake Hopatcong over the past 33 years. Additionally, the July 2022 surface water temperature at Station 2 was the fourth highest recorded at 27.50 °C. It should be noted that each year from 2019 to 2022 were in the top six of the highest recorded July surface water temperatures dating back to 1988. The highest surface water July temperature at Station 2 was recorded in 2005 and was 28.52 °C. These data provide evidence that climatic change is impacting Lake Hopatcong. In turn, increasing water temperatures makes the lake more favorable for larger and more frequent Harmful Algal Blooms (HABs).

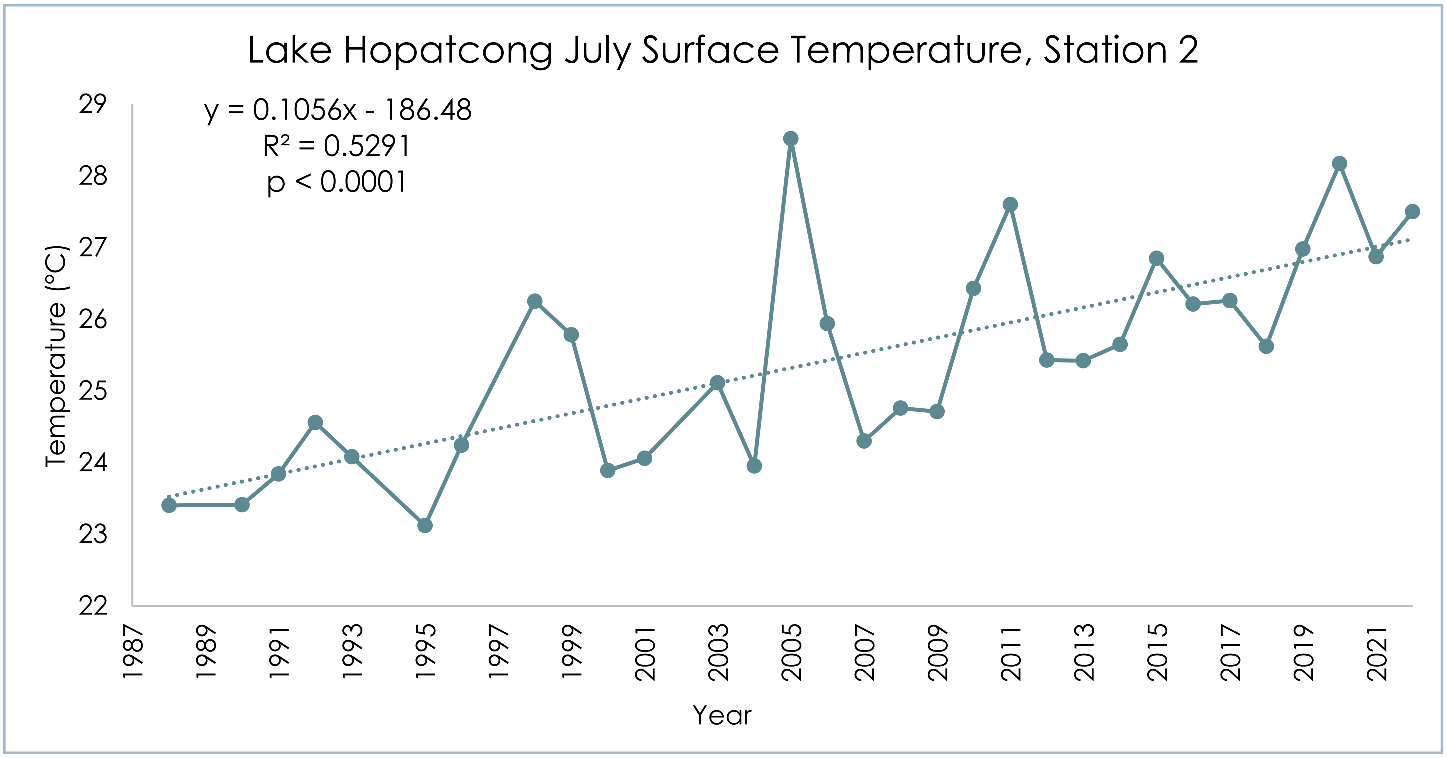


Figure 1: Long-term, July surface water temperatures at the mid-lake sampling station at Lake Hopatcong

DISSOLVED OXYGEN

Dissolved oxygen (DO) is crucial to almost all biochemical reactions occurring in freshwater ecosystems. Primary sources of dissolved oxygen are diffusion from the atmosphere and photosynthesis, while the primary sinks are biological respiration and bacterial decomposition of organic matter. The abundance and distribution of DO in a lake system is based on relative rates of producers (photosynthetic organisms) versus consumers (metabolic respiration). The DO concentration and distribution throughout a waterbody is also influenced by the thermal properties of the water column through thermal stratification, but also in terms of the extent of dissolved oxygen saturation because warmer water has less dissolved oxygen retention capacity than does cooler water. As plants and algae photosynthesize, they produce oxygen as a byproduct. This serves to increase the net concentration of dissolved oxygen in lakes during the day in the upper water layers where there is ample sunlight to support photosynthesis; this active area of the lake is known as the photic zone. As such, DO concentrations are generally higher in photic zone and lower in the deeper water, where a lack of photosynthetic activity in conjunction with aquatic animal/bacterial respiration results in a decrease.

As emphasized above, relative concentrations of DO are also due to temperature and density differences throughout the water column. When lakes thermally stratify there is generally a correlated stratification of DO levels. Deeper water layers usually contain less DO as they cannot mix with upper water layers whereby DO concentrations would be replenished with atmospheric sources. In highly productive lakes, the hypolimnion may become devoid of oxygen due to bacterial decomposition of excessive inputs of organic material. The source of this material may either be from excessive phytoplankton production in the upper water layers that then sink to the bottom when they die (autochthonous), from excessive watershed derived sediment loading (allochthonous), or more likely a mixture of the two as they are inherently intertwined. Also, as DO concentrations are generally measured during the daytime, when concentrations are highest, there will be far lower concentrations at night when photosynthesis ceases and diffusion is the sole input of oxygen to the lake.

An important consequence of anoxic conditions in the hypolimnion includes both reduced fish habitat and release of metals and phosphorus, a process termed *internal loading*. Internal loading occurs when tightly bound iron and phosphate sediment complexes are reduced, thereby dissociating phosphorus from iron, and making it available for diffusion into the water column. This process has been documented to contribute to the overall eutrophication of many lakes as this internal source of phosphorus is pulsed into the photic zone during strong storm events whereby it may serve as fuel for excessive algal growth. A general guideline for dissolved oxygen concentrations in warm-water lakes is that a concentration of greater than 1.0 mg/L is needed to preclude internal nutrient and metal release while concentrations of 4.0 mg/L and greater should be kept in order to sustain proper warm-water fisheries habitat.

DO concentrations remained above 5.0 mg/L in the epilimnion at Station 2 throughout the 2022 growing season. DO concentrations remained oxic (DO > 2.0 mg/L) throughout the water column at Station 2 on 25 May and did not drop below 5.0 mg/L until a depth of 11.0 m. As the surface water warmed in June and the lake developed a more defined thermal stratification pattern, DO concentrations began to decline rapidly below the thermocline; this trend continued until the last monitoring event on 6 October. On 22 June, 25 July, and 24 August, DO concentrations fell below the 5.0 mg/L threshold at depths of approximately 6.1 m, 4.5 m, and 6.1 m, respectively. Due to the high biological oxygen demand (BOD) in the hypolimnion that is caused by bacterial decomposition of organic matter that falls down into the hypolimnion during periods of thermal stratification, DO concentrations fell to anoxic concentrations (DO < 1.0 mg/L) shortly below the above-mentioned depths. Essentially, the entire hypolimnion was anoxic in June, July, and August. By 6 October, DO concentrations increased at depth as the lake began to mix, although the bottom 2.0 m were still anoxic.

During the 25 May event, DO concentrations at all remaining stations were above 5.0 mg/L throughout the water column with the exception of the bottom 1.0 m at the deeper (8.5 m) Station 9. On 22 June, all other sampling stations had DO concentrations that were above 5.0 mg/L, with the exception of the bottom 2.0 m at the deeper (7.2 m) Station 8. DO concentrations began to decrease slightly at the shallower stations as the water temperatures increased in July, though the only station that had a surface concentration below 5.0 mg/L was Station 11, with a surface concentration of 4.68 mg/L. The bottom 2.0 m of Stations 8 and 9 were anoxic on 25 July. By 24 August, surface concentrations remained above 5.0 mg/L at all stations while the bottom meter of Station 8 and the bottom 2 m of Station 9 were anoxic. On 6 October, all other sampling stations had DO concentrations that were above 5.0 mg/L, with the exception of the bottom meter at the deeper (7.5 m) Station 9.

To better express the relationship between thermal stratification and DO concentrations across the growing season, isopleth figures are presented below (Figures 2 and 3).

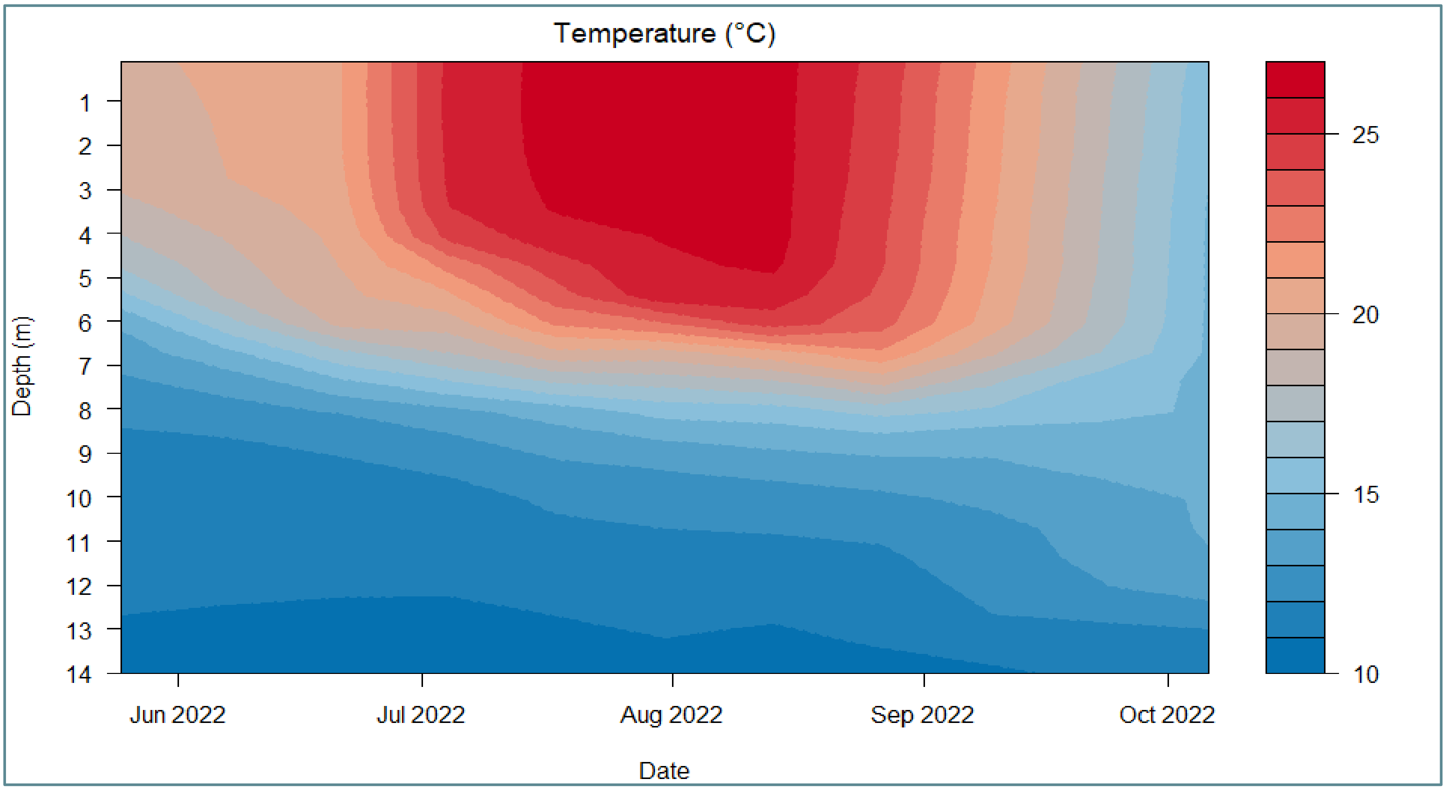


Figure 2: Temperature isopleths at Station 2 throughout the 2022 season

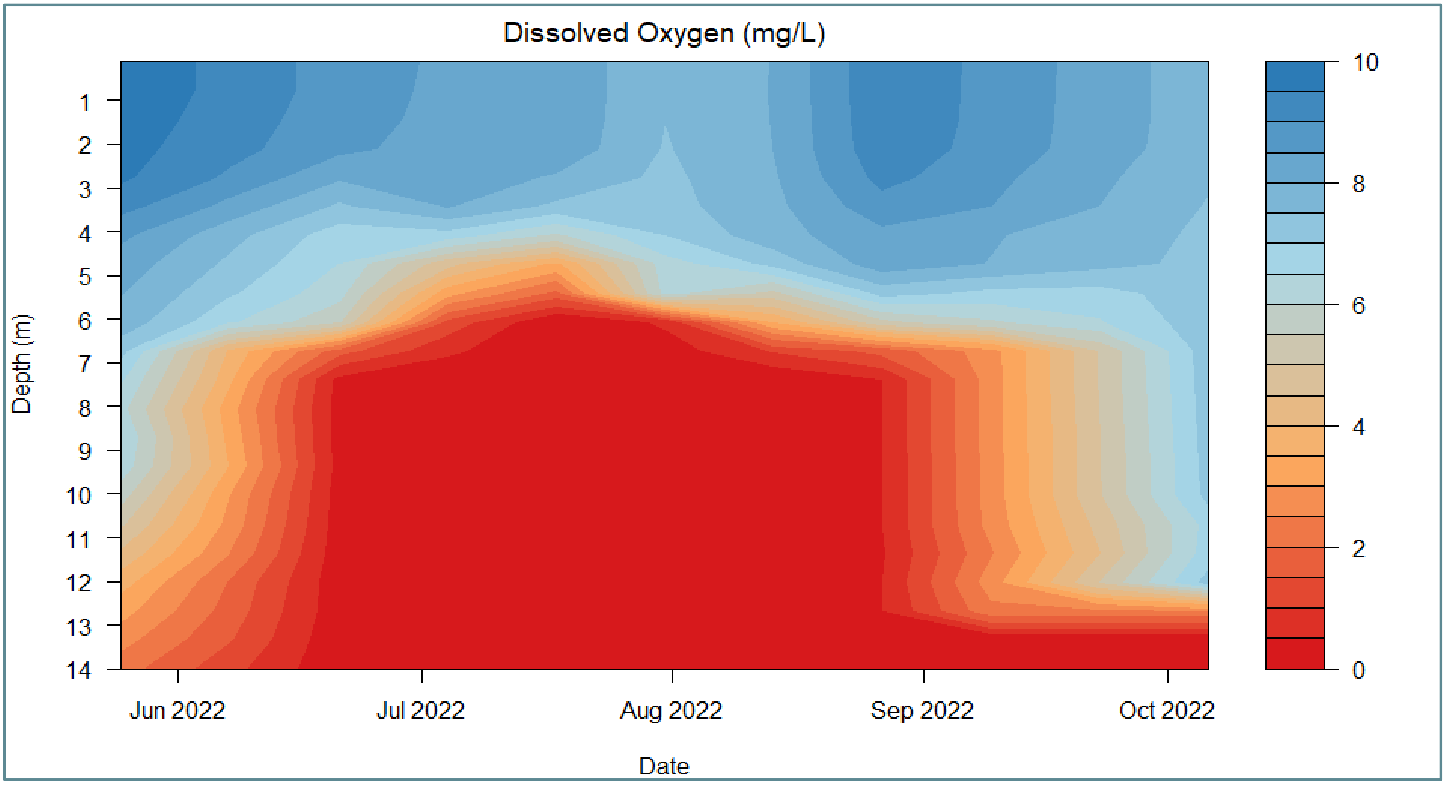


Figure 3: Dissolved oxygen isopleths at Station 2 throughout the 2022 season

PH

The pH is defined as the negative logarithm of the hydrogen ion concentration in water. When pH values are greater than 7, they are termed alkaline while those less than 7 are acidic; a pH value of 7 is neutral. The optimal range of pH for most freshwater organisms is between 6.0 and 9.0. However, the NJDEP State water quality standard for pH is for an optimal range between 6.5 and 8.5.

Surface pH values ranged between 7.1 – 9.0 on 25 May, with only Station 5 exceeding the NJDEP optimal range with a value of 9.0. On 22 June, surface pH values ranged between 7.5 – 8.2 throughout the lake. pH values often decrease with depth as a result of decreasing rates of photosynthesis, although pH values at all depths remained above 6.5 in June. Surface values again remained within the optimal range in July. In August, surface pH values exceeded 8.5 at Stations 1, 9 and 10. Cyanobacteria densities were up throughout portions of the lake in August which likely resulted in these increases, as increased rates of photosynthesis increase the pH of the water. Surface pH values had decreased by the final monitoring event on 6 October and remained within the optimal range throughout the lake.

WATER CLARITY

Transparency in lakes is generally determined through the use of a Secchi disk. The Secchi disk is a contrasting white and black disk that is lowered into the lake until no longer visible then retrieved until visible again. The average of those two lengths is termed the Secchi depth. This depth may be influenced by algal density, suspended inorganic particles, organic acid staining of the water or more commonly a combination of all three. This parameter is often times used to calculate the trophic status (productivity) of a lake and as such is a critical tool in lake evaluation. Secchi depths less than 1.0 m are generally associated with reduced water quality due to high concentrations of algae or suspended inorganic sediments and as such is generally associated with impaired quality.

Water clarity was measured at each in-lake monitoring station throughout the 2022 season. Based on Princeton Hydro's in-house, long-term database of lakes in northern New Jersey, water clarity is considered acceptable for recreational activities when the Secchi depth is equal to or greater than 1.0 m (3.3 ft).

Water clarity was variable throughout the lake during each sampling event. In May, all stations had Secchi depths above the 1.0 m threshold, ranging from 1.1 m at Station 10 up to 2.1 m at Station 5. Clarity decreased slightly at most stations on 22 June, ranging from a minimum of 0.9 m at Station 1 up to 1.5 m at Station 2. Water clarity was extremely variable throughout the lake on 25 July, with a minimum of 0.5 m at Station 3 and a maximum of 1.7 m at Station 2; there was an intense cyanobacteria bloom in the Crescent Cove / River Styx portion of the lake at this time. On 24 August, clarity ranged from 0.7 m at Stations 1 and 10 up to 1.3 m at Stations 2, 8, and 9. Clarity increased throughout most of the lake by 6 October but Station 10 was still below the 1.0 m threshold, with a Secchi depth of 0.7 m. Water clarity never fell below 1.3 m at the mid-lake Station 2.

3.2 DISCRETE PARAMETERS

AMMONIA-NITROGEN (NH_3-N)

In lakes, ammonia is naturally produced and broken down by bacterial processes while also serving as an important nutrient in plant growth. In a process termed ammonification, bacteria break down organically bound nitrogen to form NH_4^+. In aerobic systems bacteria then break down excess ammonia in a process termed nitrification to nitrate (NO_3^-). These processes provide fuel for bacteria and are generally kept in balance as to prevent accumulation of any one nitrogen compound.

Ammonia is generally present in low concentrations in oxygenated epilimnetic layers of lakes due to the rapid conversion of the ammonium ion to nitrate. In addition, most plants and algae prefer the reduced ammonium ion to the oxidized nitrate ion for growth and therefore further contribute to reduced concentrations of ammonia in the upper water layer. In the anoxic hypolimnion of lakes ammonia tends to accumulate due to increased bacterial decomposition of organic material and lack of oxygen which would otherwise serve to oxidize this molecule to nitrate.

Increased surface water concentrations of ammonia may be indicative of excessive non-point source pollution from the associated watershed. The ammonium ion, unlike that of nitrate, may easily bind to soil particles whereby it may be transported to the lake during storm events. However, when compared to nitrate-N, ammonia-N tends to be more consider more of an "internal" form of nitrogen.

Increases in ammonia concentrations in the hypolimnion of lakes are generally associated with thermal stratification and subsequent dissolved oxygen depletion. Once stratification breaks down a pulse of ammonia rich water may be mixed throughout the entire water column whereby it will cause undue stress to aquatic organisms.

Toxicity of ammonia to aquatic species generally increases with increasing pH (>8.5) and decreasing temperature (<5°C). The general guideline issued by the EPA is that ammonia should not exceed a range of 0.02 mg/L to 2.0 mg/L, dependent upon water temperature and pH, to preclude toxicity to aquatic organisms.

Surface NH_3-N concentrations were generally low throughout the lake in May, never exceeding 0.04 mg/L; Station 3 had a concentration of 0.04 mg/L. All surface concentrations were below the detection limit of 0.01 mg/L on 22 June. Surface concentrations were elevated at Stations 1, 3, and 10 in July, with respective concentrations of 0.13, 0.35, and 0.13 mg/L. The elevated concentration of 0.35 mg/L at Station 3 is likely related to the intense cyanobacteria bloom that was present in the Crescent Cove / River Styx portion of the lake at this time. Stations 1 and 10 are the two most northern stations in the lake, both located north of Brady Bridge. The water in this section of the lake was often turbid, and TSS concentrations at both of those stations were elevated in July. Thus, the elevated ammonia-N concentrations are likely the result of ammonia that was bound to soil particles. Surface ammonia-N concentrations decreased again throughout the lake on 24 August, never exceeding 0.01 mg/L. Surface concentrations began to increase again in early October, likely a result of the decomposition of organic matter at the end of the growing season and the resuspension of ammonia-N that had been accumulating in the anoxic hypolimnion throughout the season.

Mid-depth samples collected at Station 2 were generally low throughout the season, only exceeding 0.05 mg/L on 6 October after the lake had already started to partially mix, which can result in an influx of ammonia-N that had been confined to the hypolimnion during the period of thermal stratification. Deep samples at Station 2 were elevated throughout the season, peaking at a concentration of 1.40 mg/L on 25 July. As mentioned above, ammonia-N often accumulates in the anoxic hypolimnion due to the lack of oxygen which would otherwise oxidize the molecule and convert it to nitrate.

In summary, surface ammonia-N concentrations were low throughout the season with the exception of Stations 1, 3, and 10 in July.

NITRATE-NITROGEN (NO_3-N)

Nitrate tends to be the most abundant form of inorganic nitrogen in freshwater ecosystems. Common sources of nitrate in freshwater ecosystems are derived from bacterial facilitated oxidation of ammonia and through groundwater inputs. The molecular structure of nitrate lends it poor ability to bind to soil particles but excellent mobility in groundwater.

Nitrate is often utilized by algae, although to a lesser extent than ammonia, for growth. Nitrate distribution is highly dependent on algal abundance and the spatial distribution of dissolved oxygen concentrations. In many eutrophic lake systems nitrate concentrations show temporal and spatial variability due to algal productivity and relative concentrations of dissolved oxygen.

Excessively high concentrations of nitrate are primarily attributable to either wastewater inputs or excessive organic matter decomposition in oxygenated hypolimnion. Typically, lakes with concentrations above 0.30 mg/L indicates nitrogen-loading, however, concentrations below 0.50 mg/L are still considered acceptable water quality. Nitrate-N concentrations greater than 0.10 mg/L are considered excessive relative to algal and aquatic plant growth.

Surface NO_3-N concentrations were relatively low in May and June, only exceeding 0.10 mg/L at Station 3 in May at a concentration of 0.12 mg/L. It is worth noting that Station 3, where the cyanobacteria bloom occurred later in the season, had the highest surface nitrate-N concentration in May and the second highest in June. Surface concentrations were variable but still generally low throughout the lake on 25 July with the exception of Stations 5 and 7, with respective concentrations of 0.65 and 0.25 mg/L. Station 7 is located adjacent to the shoreline in a shallow area close to near-shore septic systems, which may explain the elevated concentration. Although July was a dry month, approximately 0.93" of precipitation fell in the week prior to sampling, which could have influenced the results (CLIMOD, Jefferson Twp. 4.4 SW, NJ). Surface concentrations decreased throughout the lake in August and early October, only exceeding 0.10 mg/L at Stations 7 and 11 on 6 October. Again, Stations 7 and 11 are both located adjacent to the shoreline in areas close to near-shore septic systems.

Mid-depth samples collected at Station 2 were extremely low through the end of August, only increasing slightly on 6 October to a concentration of 0.07 mg/L. Deep samples increased as the season progressed and peaked at a concentration of 0.17 mg/L on 24 August.

In summary, surface nitrate-N concentrations were generally low throughout the season with a few moderately elevated concentrations at near-shore stations including 3, 7, and 11. Additionally, on 25 July, Stations 5 and 7 had elevated concentrations of 0.65 and 0.25 mg/L.

TOTAL PHOSPHORUS (TP)

Phosphorus is often the limiting nutrient in lake ecosystems, or the nutrient in which abundance is lowest relative to demand by plants and algae. As a result, phosphorus is often the primary nutrient driving excessive plant and algal growth. Given this nutrient limitation, only relatively small increases in phosphorus concentration can fuel algal blooms and excessive macrophyte production. By monitoring total phosphorus concentrations, the current trophic status of the lake can be determined and future trends in productivity may be predicted. It is important to note that total phosphorus concentrations account for all species of phosphorus, including organic, inorganic, soluble, and insoluble. Therefore, this measure accounts not only for those dissolved, inorganic species of phosphorus that are readily available for algal assimilation, but also for those species of phosphorus either tightly bound to soil particles or contained as cellular constituents of aquatic organisms which are generally unavailable for algal assimilation.

The State's Surface Water Quality Standard (SWQS, N.J.A.C. 7:9B – 1.14(c) 5) for TP in the surface waters of a freshwater lake or impoundment is 0.05 mg/L. This established TP concentration is for any freshwater lake or impoundment in New Jersey that does not have an established TMDL. Lake Hopatcong has established a phosphorus TMDL, which was revised and approved by NJDEP in June 2006. Based on its refined phosphorus TMDL, the long-term management goal is to maintain an average growing season TP concentration of 0.03 mg/L or less within the surface waters of Lake Hopatcong. Based on Princeton Hydro's in-house database on northern

New Jersey lakes, TP concentrations equal to or greater than 0.03 mg/L have an increasing change of developing of algal blooms / mats.

Surface TP concentrations were low in May, with concentrations of 0.03 mg/L at Stations 1 and 10; all other stations had lower concentrations. Surface TP concentrations did increase around the lake on 22 June and exceeded the 0.03 mg/L recommended threshold at four stations. Stations 1 and 3 had concentrations of 0.04 mg/L while stations 10 and 11 yielded concentrations of 0.05 mg/L. Station 3 had an elevated TP concentration of 0.07 mg/L on 25 July which coincides with the intense cyanobacteria bloom in Crescent Cove during this time. Stations 1 and 10 also had concentrations that exceeded the recommended threshold in July, with respective concentrations of 0.04 mg/L and 0.06 mg/L. Stations 1 and 10 are both located north of Brady Bridge and had elevated concentrations of chlorophyll *a*, ammonia-N, and TSS relative to most other stations. As previously mentioned, the water in this northern section of the lake was often turbid which likely influenced these elevated concentrations. The water is much shallower in this section of the lake and it's possible that sediment is being resuspended into the water column. Surface TP concentrations began to decrease around the lake by 24 August and Stations 3 and 10 were the only two that exceeded the recommended threshold with concentrations of 0.04 mg/L. Surface TP concentrations were extremely low in early October, never exceeding 0.01 mg/L.

Mid-depth TP concentrations at Station 2, which were collected from the middle of the thermocline, were low all season and never exceeded 0.02 mg/L. This indicates that little to no TP that was building up in the anoxic hypolimnion throughout the season was mixed with the surface water and likely explains why TP concentrations were generally low at Station 2 throughout the season. Deep TP concentrations collected from approximately 0.5 m above the sediment increased as the season progressed and anoxic conditions persisted, reaching a maximum of 0.20 mg/L on 25 July. Deep TP concentrations remained elevated for the remainder of the season, with a concentration of 0.17 mg/L on 6 October.

The mean TP concentration was calculated for each surface water sampling station to determine if they complied with the concentration of 0.030 mg/L established under the lake's TMDL. Of the nine, long-term water quality monitoring stations, seven stations were compliant with this TMDL. Stations 1, 2, 4, 5, 6, 7, and 11 yielded average concentrations ranging from 0.014 mg/L (Station 2) to 0.028 mg/L (Station 1). Station 3 had a seasonal mean TP concentration of 0.036 mg/L while Station 10 had a seasonal mean concentration of 0.038 mg/L.

SOLUBLE REACTIVE PHOSPHORUS (SRP)

Soluble reactive phosphorus (SRP) represents the dissolved inorganic portion of total phosphorus metrics. This species of phosphorus is readily available for assimilation by all algal forms for growth and is therefore normally present in limited concentrations except in very eutrophic lakes. Princeton Hydro recommends concentrations to not exceed 0.005 mg/L to prevent nuisance algal blooms.

Surface SRP concentrations were low throughout the lake during the 2022 growing season. SRP concentrations were below the lab detection limit for much of the season and peaked at a concentration of 0.003 mg/L at Stations 4 and 5 in May. SRP concentrations remained below the lab detection limit at Station 3 during the intense cyanobacteria bloom which indicates that any SRP that was available was rapidly assimilated by the cyanobacteria. TP concentrations remained elevated at that station because the phosphorus was bound up in the cyanobacteria.

Mid-depth SRP concentrations at Station 2 were below the lab detection limit throughout the entire season. Deep SRP concentrations at Station 2 were also low throughout the season, peaking at a concentration of 0.005 mg/L in May.

CHLOROPHYLL *A*

Chlorophyll *a* is a pigment possessed by all algal groups, used in the process of photosynthesis. Its measurement is an excellent means of quantifying algal biomass. In general, an algal bloom is typically perceived as a problem by the layperson when chlorophyll-*a* concentrations are equal to or greater than 25.0 to 30.0 µg/L. In contrast, the <u>targeted</u> average and maximum chlorophyll-*a* concentrations, once Lake Hopatcong is in complete compliance with the TMDL, are predicted to be 8.0 and 14.0 µg/L, respectively.

Chlorophyll *a* concentrations remained relatively low in May and June, only exceeding the 14.0 µg/L threshold once; Station 10 had a concentration of 17.0 µg/L on 22 June. However, as the lake started to experience elevated cyanobacteria concentrations in July, chlorophyll *a* concentrations began to increase around the lake. On 25 July, five stations (1,2, 3, 5, and 10) had chlorophyll *a* concentrations that exceeded the recommended threshold, with respective concentrations of 23.0, 15.0, 63.0, 26.0, and 35.0 µg/L. The extremely elevated concentration at Station 3 occurred during the cyanobacteria bloom. Concentrations remained elevated in late August, with six of the seven stations exceeding the recommended threshold. Stations 1, 3, and 10 all had elevated concentrations of 36.0, 55.0, and 43.0 µg/L, respectively. Productivity decreased around the lake by early October and Station 1 was the only station that exceeded the threshold on 6 October, with a concentration of 24.0 µg/L. Stations 1 and 10 at the northern end of the lake continue to exhibit elevated productivity metrics throughout the 2022 season.

Lakewide average surface chlorophyll *a* concentrations were calculated for each month and compared with the targeted goal of 8.0 µg/L. May was the only month that had an average chlorophyll *a* concentration below this threshold, with an average concentration of 6.3 µg/L. June and September were slightly above the targeted average threshold, with respective average concentrations of 10.6 and 9.0 µg/L. July and August each had average concentrations that were elevated, with respective averages of 23.8 and 27.1 µg/L. Station 11 was the only site that had a growing season average below the targeted threshold of 8.0 g/L. All other stations exceeded this threshold, ranging from a seasonal average of 10.4 g/L at Station 7 up to a maximum of 29.1 g/L at Station 3. Stations 1 and 10, both located north of Brady Bridge, also had elevated seasonal averages; Station 1 had a seasonal average of 20.7 g/L and Station 10 had a seasonal average of 22.8 g/L.

TOTAL SUSPENDED SOLIDS (TSS)

The concentration of suspended particles in a waterbody that will cause turbid or “muddy” conditions, total suspended solids is often a useful indicator of sediment erosion and stormwater inputs into a waterbody. Because suspended solids within the water column reduce light penetration through reflectance and absorbance of light waves and particles, suspended solids tend to reduce the active photic zone of a lake while contributing a “muddy” appearance at values over 25 mg/L. Total suspended solids measures include suspended inorganic sediment, algal particles, and zooplankton particles.

TSS concentrations were low across the lake in May, with a maximum concentration of 2 mg/L at Station 3. TSS concentrations increased slightly in June but still remained relatively low, ranging from non-detectable at Stations 5 and 7 up to 10 mg/L at Station 1. TSS concentrations remained relatively low throughout the lake on 25 July with the exception of Stations 1 and 10, with respective concentrations of 18 and 36 mg/L. These two stations continued to yield TSS concentrations that were much higher than the other stations in August, with concentrations of 11 and 28 mg/L at Stations 1 and 10, respectively. TSS concentrations were extremely low again by 6 October, with only the deep sample from Station 2 yielding a concentration above the detection limit, but still very low at 2 mg/L. It’s apparent that the section of the lake north of Brady Bridge was much more turbid than the rest of the lake throughout the summer months. This section of the lake is relatively shallow compared to the main section, and it’s likely that sediment is easily resuspended into the water column.

3.3 BIOLOGICAL PARAMETERS

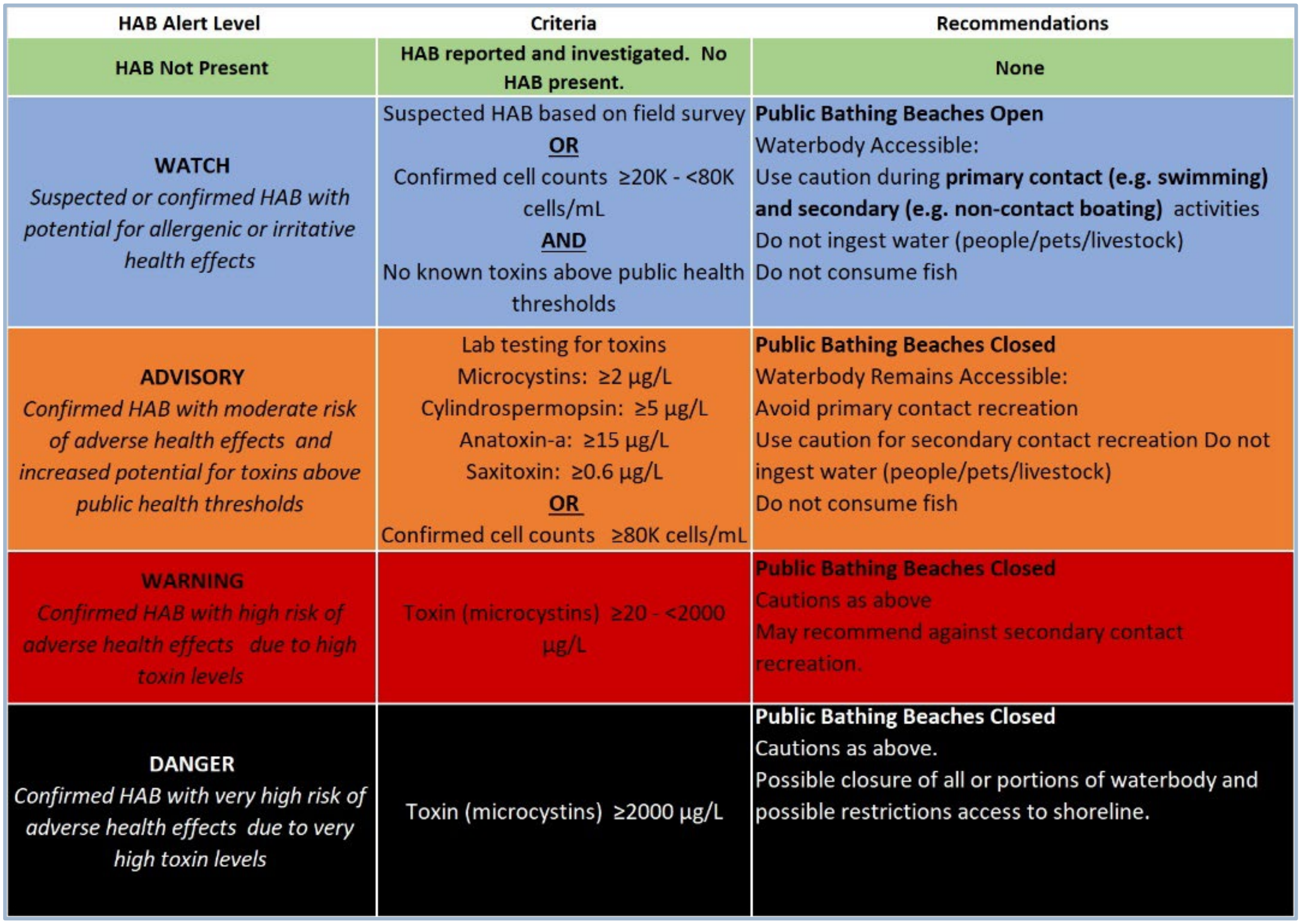
PHYTOPLANKTON

Phytoplankton are algae that are freely floating in the open waters of a lake or pond. These algae are vital to supporting a healthy ecosystem since they are the base of the aquatic food web. However, high densities of phytoplankton can produce nuisance conditions. The majority of nuisance algal blooms in freshwater ecosystems are the result of cyanobacteria, also known as blue-green algae. Some of the more common water quality problems created by blue-green algae include bright green surface scums, taste and odor problems and the generation of cyanotoxins. Phytoplankton samples were collected from the surface and mid-depths of Station 2 during the 2022 season and were quantitatively analyzed to be compared to NJDEP standards. Surface samples were also collected at Station 3 for quantitative analysis during each event. New Jersey implemented advanced harmful algal bloom (HAB) screening and response protocols in 2020 and as such may be utilized as a surrogate in this instance. NJ HAB standards are provided below in Figure 2.

Surface and mid-depth grab samples collected at Station 2 during the 22 May sampling event yielded a diverse plankton community, with 18 different genera identified at both depths. The green algae and diatom communities were the most diverse in May, with a total of 12 different genera identified at the surface and 15 genera identified at mid-depth. However, the plankton community at each depth was already dominated by cyanobacteria at this time, with a total cyanobacteria cell count of 35,145 cells /mL at the surface and 18,784 cells/mL at mid-depth; *Aphanizomenon* was the dominant genera. The plankton community at Station 2 increased in both richness and abundance in June, with 24 genera identified at the surface and 19 genera identified at mid-depth. The green algae community was again the most diverse, yielding 11 genera at the surface and 9 genera at mid-depth. However, the cyanobacteria community also increased in richness and abundance, with four genera identified at the surface and three genera identified at mid-depth. Total cyanobacteria densities at the surface and mid-depth were 123,278 cells/mL and 64,859 cells/mL, respectively; *Pseudanabaena* and *Aphanizomenon* were the dominant genera.

As the season progressed into late July, the phytoplankton community remained relatively rich with 20 genera identified at the surface of Station 2 and 17 genera identified at mid-depth. The cyanobacteria abundance also remained relatively high, with respective cyanobacteria counts of 67,984 cells/mL and 68,289 cells/mL at the surface and mid-depth. *Aphanizomenon* was again the dominant genus in July. Cyanobacteria densities increased significantly in late August, with surface and mid-depth cyanobacteria counts of 229,597 cells/mL and 111,771 cells/mL, respectively. A shift in the dominant organism also occurred, as the cyanobacteria genera *Cylindrospermopsis* was now the dominant genus that caused the elevated cell counts. This occurred while the Crescent Cove / River Styx section of the lake was experiencing an intense *Cylindrospermopsis* bloom. Phosphorus concentrations remained low at the surface and mid-depth of Station 2 during this time, so it's likely that these elevated counts at Station 2 were influenced by the bloom that started in Crescent Cove, which is in close proximity. The phytoplankton community at Station 2 was less rich and abundant by early October, with 16 genera identified at the surface of Station 2 and 15 genera identified at mid-depth. The cyanobacteria community was much less abundant, with total cyanobacteria counts of 26,299 cells/mL and 22,553 cells/mL at the surface and mid-depth, respectively. *Aphanizomenon* was again the dominant genus in October and no *Cylindrospermopsis* was identified.

Surface grabs were also collected at Station 3 during each sampling event. The sample collected at Station 3 during the 22 May sampling event yielded a diverse plankton community, with 19 different genera identified. The green algae community was the richest in May, with 11 genera identified. The cyanobacteria community only comprised a minor portion of the May plankton community at Station 3, with a total cyanobacteria cell count of 2,968 cells/mL. The plankton community at Station 3 increased considerably in richness and abundance on 22 June, with a total of 32 genera identified, with a very diverse green algae and diatom community. The cyanobacteria community also increased in richness and abundance in June, with a total of 6 genera identified and a cyanobacteria cell count of 35,866 cells/mL; *Aphanizomenon* was the dominant genus. 17 total genera were identified in the sample collected at Station 3 on 25 July, however the sample was extremely dense with cyanobacteria, as this sampling occurred while there was an intense cyanobacteria bloom in Crescent Cove. The total cyanobacteria count was 749,643 cells/mL and was dominated by *Cylindrospermopsis*. The bloom was still present in late August, although was much less intense than in late July. 23 genera were identified on 24 August, including nine genera of green algae and four genera of diatoms. The total cyanobacteria cell count was 467,145 cells/mL and was again dominated by *Cylindrospermopsis.* The bloom had dissipated by early October and the total cyanobacteria cell count at Station 3 was 23,560 cells/mL and no *Cylindrospermopsis* were identified in the sample.



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

Figure 4: NJDEP HAB Response Guidelines

The New Jersey Department of Environmental Protection (NJDEP) modified their HAB alert level classifications for 2020 and beyond. Cell counts between 20,000 – 80,000 cells/mL fall under the classification of "Watch." Under this classifications, public health beaches can remain open, depending on local health authority evaluation and assessment, but monitoring under these classifications should increase. As cell counts exceed 80,000 cells/mL, the alert levels progress into "Advisory," "Warning," and "Danger" depending on cyanotoxin concentrations; however, public bathing beaches would be closed under any of these classifications. Cyanobacteria cell counts during the 2022 season that fell under the "Watch" category include Station 2 surface on 25 May, Station 2 mid-depth and Station 3 on 22 June, and the surface and mid-depth samples at Station 2 and Station 3 on 6 October.

Cyanobacteria cell counts that fell under the "Advisory" category, based on cell counts, include Station 2 surface on 22 June, and the surface and mid-depth samples at Station 2 and Stion 3 on 25 July and 24 August.

In addition to the cyanobacteria cell counts at Station 2, Turner handheld fluorometers were utilized to measure phycocyanin at the surface during these main water quality sampling events. Phycocyanin is a pigment that is produced solely by cyanobacteria and is currently being assessed by NJDEP in terms of monitoring for HABs. While standards have yet to be set for phycocyanin, this parameter will be sampled and entered into the historic database for the waterbody. Phycocyanin measurements were taken at Stations 2 and 3 during each sampling event, as well as any other stations that appeared to have elevated cyanobacteria densities. Phycocyanin concentrations remained low in May, with a concentration of 5 µg/L at Station 2 and 4 µg/L at Station 3. Concentrations began to increase on 22 June, with respective concentrations of 9 µg/L and 28 µg/L at Stations 2 and 3. Phycocyanin concentrations increased significantly in July, ranging from a minimum of 14 µg/L at Station 2 up to 115 µg/L at Station 3. Moderate concentrations of 30, 22, and 22 µg/L were measured at Stations 5, 9, and 10, respectively. Phycocyanin concentrations remained elevated in August, with a concentration of 30 µg/L at Station 2 and 73 µg/L at Station 3. Station 10 also had an elevated concentration of 50 µg/L on 24 August. Phycocyanin concentrations decreased lakewide in early October, with concentrations of 6 µg/L and 9 µg/L at Stations 2 and 3, respectively.

Zooplankton are the micro-animals that live in the open waters of a lake or pond. Some large-bodied zooplankton are a source of food for forage and/or young gamefish. In addition, many of these large-bodied zooplankton are also herbivorous (i.e. algae eating) and can function as a natural means of controlling excessive algal biomass. Given the important role zooplankton serve in the aquatic food web of lakes and ponds, samples for these organisms were collected at the surface and mid-depths of Station 2 during each monitoring event.

The May zooplankton community at Station 2 was dominated by the Cladoceran genera *Bosmina* and the rotifer genus *Keratella*. In total, there were a total of 7 zooplankton genera identified at the surface and 10 genera identified at mid-depth, with representation from the three major groups: Cladocerans, copepods, and rotifers. Zooplankton richness increased in June, with a total of 12 genera identified at the surface and 11 genera identified at mid-depth. However, the zooplankton community was dominated by the smaller rotifers at this time, although the larger herbivorous Cladocerans were still present, with three genera identified at the surface and two genera identified at mid-depth; the Cladoceran genus *Bosmina* was common in the mid-depth sample. The zooplankton community remained relatively diverse in late July, with a total of 12 genera identified at the surface and 11 genera identified at mid-depth. The zooplankton community was again dominated by the smaller rotifers, with the genus *Conochilus* the most abundant at both depths. Three Cladoceran genera were identified in each sample as well and *Bosmina* was common at the surface. The copepod genus *Microcyclops* was also common in the surface sample.

The zooplankton community decreased in both abundance and richness in late August, with very little representation from the herbivorous Cladocerans; *Chydorus* was the only Cladoceran present and only in the mid-depth sample. The zooplankton community was dominated by the rotifers again, although no genera were identified to be common. The Cladoceran community never really rebounded towards the end of the season, as the rotifers dominated the sample in early October with little representation from the Cladocerans or copepods. In summary, the zooplankton community remained abundant and diverse through late July but as the summer progressed and cyanobacteria began to dominate the phytoplankton community, the herbivorous Cladocerans and copepods began to decrease in abundance and were replaced by the smaller rotifers.

3.4 RECREATIONAL FISHERY AND POTENTIAL BROWN TROUT HABITAT

Of the recreational gamefish that reside or are stocked in Lake Hopatcong, trout are the most sensitive in terms of water quality. For their sustained management, all species of trout require DO concentrations of at least 4.0

mg/L or greater. However, the State's designated water quality criteria to sustain a healthy, aquatic ecosystem is a DO concentration of at least 5.0 mg/L.

While all trout are designated as cold-water fish, trout species display varying levels of thermal tolerance. Brown trout (*Salmo trutta*) have an optimal summer water temperature range of 18.00 to 24.00 °C (65 to 75 °F) (USEPA, 1994). However, these fish can survive in waters as warm as 26.00 °C (79.00 °F) (Scott and Crossman, 1973), defined here as acceptable habitat. The 2022 temperature and DO data for Lake Hopatcong were examined to identify the presence of optimal and acceptable brown trout habitat. As with previous monitoring reports, this analysis focused primarily on *in-situ* data collected at the mid-lake sampling station (Station 2).

For the sake of this analysis, sections of the lake that had DO concentrations equal to or greater than 5.0 mg/L and water temperatures less than 24.00 °C were considered optimal habitat for brown trout. In contrast, sections of the lake that had DO concentrations equal to or greater than 5.0 mg/L and water temperatures between 24.00 and 26.00 °C were considered acceptable or carry over habitat for brown trout.

A separate brown trout (*Salmo trutta*) study was also conducted over the course of the 2022 season. This study involved the stocking of 1,000 tagged trout, larger than the trout stocked by the state, to determine if the increase in mass and fat reserves gives them an advantage in holding over through the hot summer months. The stocking of the tagged trout was funded by the Lake Hopatcong Commission, Foundation, and the Knee Deep Club. Additionally, the Highlands Council funded a study to collect additional, high-frequency water quality data to better define carryover habitat in the lake. The Highlands Council grant also includes the analysis of trout data garnered from tag data and creel surveys and a report that synthesizes those elements to manage the trout fishery and trout carryover habitat of Lake Hopatcong. A separate report will be submitted in 2023 that includes all of these elements.

Optimal brown trout habitat was present in the upper 10.70 m of the lake on 25 May. By late June, optimal brown trout habitat was reduced to the upper 6.10 m of the water column at Station 2 due to anoxic conditions present in the hypolimnion. Carryover habitat was available at these same depth intervals in May and June since the limiting factor was low DO in the hypolimnion rather than elevated temperatures near the surface.

In-situ sampling conducted on 5 July as part of the trout study revealed extremely limited optimal brown trout habitat throughout the lake as a result of increasing temperatures in the epilimnion as well as anoxic conditions creeping upwards in the water column. *In-situ* sampling was conducted at approximately 1 ft intervals through the thermocline during the summer to accurately define trout habitat. As such, there was approximately only 0.10 m of optimal trout habitat at Station 2 on 5 July and approximately 0.40 m of optimal habitat just south of Halsey Island. However, there was carryover trout habitat present in the upper 4.25 m of the lake at Station 2 on the same date; *in-situ* sampling at other stations around the lake revealed at carryover habitat present in at least the upper 5.50 m.

Weekly sampling through the end of August revealed that there was no optimal trout habitat present on any of the days that Princeton Hydro monitored the lake. However, carryover habitat was available later into the season and eventually proved to be extremely dynamic on a weekly basis from late July through mid-August. On 11 July, there was carryover habitat present in the upper 4.80 m of Station 2. Carryover habitat began to become extremely compressed on 18 July, with approximately 0.45 m of available habitat, between depths of 3.75 m and 4.20 m. Carryover habitat was non-existent at all 11 stations on 25 July. However, there was carryover habitat present in the upper 5.70 m of Station 2 only one week later on 2 August. There was a slight cooling at all stations on 2 August near the surface, and two of the stations, including Station 2 and King's Cove, fell back under the 26.0 °C threshold thereby extending the habitat to the surface at those locations. Temperatures increased over the following week which resulted in no available carryover habitat at any of the sampling stations. Temperatures in the epilimnion began to cool in mid-August which opened up carryover habitat in the upper 5.59 m of Station

2 on 16 August and 6.10 m on 24 August. As temperatures cooled significantly and the lake began to partially mix, optimal trout habitat was present in the upper 12.0 m of the lake on 6 October.

3.5 MECHANICAL WEED HARVESTING PROGRAM

Many of the shallower sections of Lake Hopatcong are susceptible to the proliferation of nuisance densities of rooted aquatic plants. Given the size of Lake Hopatcong, the composition of its aquatic plant community, and its heavy and diverse recreational use, mechanical weed harvesting is the most cost effective and ecologically sound method of controlling nuisance weed densities. Thus, the weed harvesting program has been in operation at Lake Hopatcong since the mid-1980's with varying levels of success. However, one consistent advantage mechanical weed harvesting has over other management techniques, such as the application of aquatic herbicides, is that phosphorus is removed from the lake along with the weed biomass. In fact, based on a plant biomass study conducted at Lake Hopatcong in 2006 and the plant harvesting records from 2006 to 2008, approximately 6-8% of the total phosphorus load targeted for reduction under the established TMDL was removed through the mechanical weed harvesting program.

In sharp contrast to the 2006 – 2008 harvesting years, only 1.2% of the phosphorus load targeted for reduction under the TMDL was removed through mechanical weed harvesting during the 2009 growing season. This substantial reduction in the amount of plant biomass and phosphorus removed in 2009 was due to severe budgetary cuts that resulted in laying off the Commission’s full time Operation Staff, as well as initiating the harvesting program later in the growing season. However, the 2010 harvesting season resulted in the estimated removal of approximately 6% of the phosphorus load targeted for reduction under the TMDL, similar to the percentages removed in 2006 – 2008.

In contrast to the 2012 growing season, the mechanical weed harvesting program ran longer in 2013 through 2016. This was primarily due to the fact that the program was initiated earlier in these years relative to 2012. NJDEP has directly overseen the operation of the weed harvesting program for the last seven years and each year displays a higher rate of removal, which was attributed to hired staff becoming more familiar with the operations and lake-specific conditions. In addition, the operations staff has been excellent at maximizing high rates of efficiency during harvesting operations.

Due to an extremely unfortunate accident at the initiation of the 2020 harvesting season, the harvesting of aquatic vegetation at Lake Hopatcong was largely postponed over the 2020 growing season. The removal of only 35 cubic yards (16 tons) of plant biomass from Lake Hopatcong in 2020 resulted in the removal of only 3 kgs (6 lbs) of TP from the lake. This was less than 0.1% of the TP load targeted for removal under the TMDL.

Mechanical weed harvested was not conducted over the 2021 growing season. However, the harvesting program was resumed in 2022, resulting in the removal of 1,178 cubic yards (531 tons) of plant biomass. This resulted in the removal of approximately 86 kgs (189 lbs) of TP, which has the potential to produce approximately 208,200 lbs of wet algae biomass. The 189 lbs of TP accounts for 2.6% of the TP targeted for removal under the lake’s TMDL.

3.6 INTERANNUAL ANALYSIS OF WATER QUALITY DATA

Annual mean values of Secchi depth, chlorophyll *a*, and total phosphorus concentrations were calculated for the years 1991 through 2021. The annual mean values for Station 2 were graphed, along with the long-term, “running mean” for the lake and can be found in Figures 2 – 4 in Appendix A.

The 2022 mean Secchi depth at Station 2 was 1.50 m which was a decrease of approximately 0.50 m relative to 2021. However, 2019 and 2020 also had a seasonal average Secchi depth of 1.50 m. While this seasonal average is below the long-term mean of 2.05, it is still above the targeted threshold of 1.00 m.

The mean chlorophyll *a* concentration at Station 2 was 11.9 µg/L. While this is slightly higher than the targeted mean value of 8.0 µg/L and the 2020 mean value of 10.3 µg/L, it is lower than 2019 and 2020, which had respective concentrations of 14.1 µg/L and 20.2 µg/L. Station 2 had slightly elevated chlorophyll *a* concentrations of 15.0 and 16.0 µg/L in July and August which raised the seasonal average. These increases in chlorophyll *a* concentrations occurred as cyanobacteria concentrations increased in this section of the lake during the cyanobacteria bloom in Crescent Cove. The long-term seasonal chlorophyll *a* average at Station 2 is 10.7 µg/L.

The 2022 mean TP concentration at Station 2 was very low, with a concentration of 0.014 mg/L. This was the lowest seasonal mean TP concentration over the past 9 years and was well below the long-term average of 0.021 mg/L. This was also well below the targeted threshold of 0.030 mg/L as per the TMDL.

3.7 WATER QUALITY IMPAIRMENTS, ESTABLISHED TMDL CRITERIA AND EVALUATION

As identified in N.J.A.C. 7:9B-1.5(g)2 "Except as due to natural condition, nutrients shall not be allowed in concentrations that cause objectionable algal densities, nuisance aquatic vegetation or otherwise render the waters unsuitable for the designated uses." For Lake Hopatcong, these objectionable conditions specifically include both algal blooms and nuisance densities of aquatic vegetation.

As described in detail in the Lake Hopatcong TMDL Restoration Plan, a targeted mean TP concentration, as well as mean and maximum chlorophyll-*a* ecological endpoint, was established to identify compliance with the TMDL. For the sake of this 2021 analysis, the mid-lake (Station 2), Crescent Cove / River Styx (Station 3) and Northern Woodport Bay (Station 10) monitoring stations were reviewed. To provide guidance for this review, the criteria developed under Lake Hopatcong's TMDL are provided below:

TMDL Criteria for Lake Hopatcong

Targeted mean TP concentration	0.03 mg/L
Targeted mean chlorophyll *a* concentration endpoint	8 µg/L
Targeted maximum chlorophyll *a* concentration endpoint	14 µg/L

Surface TP concentrations remained low throughout the 2022 season at Station 2, with the seasonal mean (0.014 mg/L) and each individual event remaining below the targeted mean concentration of 0.030 mg/L recognized under the TMDL. Overall, TP concentrations ranged from 0.010 mg/L in July, August, and September to 0.020 mg/L in May and June. The 2022 seasonal mean chlorophyll *a* concentration at Station 2 was 11.9 µg/L. As such, the 2022 average exceeded the targeted mean chlorophyll *a* concentration of 8.0 µg/L. This was largely due to increased chlorophyll *a* concentrations during the hot summer months of July and August. Chlorophyll concentrations ultimately ranged from 8.0 µg/L on 6 October to 16.0 µg/L on 24 August. The July and August sampling events exceeded the targeted maximum chlorophyll *a* concentration endpoint of 14.0 µg/L during the 2022 season, with respective concentrations of 15.0 and 16.0 µg/L.

Elevated chlorophyll *a* and TP concentrations were noted at Station 3 at various times throughout the 2022 season. Additionally, an intense cyanobacteria bloom predominantly comprised of *Cylindrospermopsis* was present in Crescent Cove in July and August. The 2022 mean TP concentration was 0.036 mg/L, exceeding the targeted mean of 0.030 mg/L. 2022 concentrations ranged between 0.010 mg/L and 0.070 mg/L, exceeding 0.03 mg/L in June, July, and August. Seasonal mean chlorophyl *a* concentrations at Station 3 were the highest compared to the other sampling stations, with an average of 29.1 µg/L. This average was more than three times the targeted TMDL average of 8.0 µg/L. Overall, chlorophyll concentrations ranged from 3.5 µg/L to 63.0 µg/L.

However, the May, June, and October sampling events were all below the targeted maximum chlorophyll *a* concentration of 14.0 µg/L. Thus, the intense cyanobacteria bloom in July and August resulted in extremely elevated chlorophyll *a* concentrations.

At Station 10, the seasonal TP average was 0.038 mg/L, exceeding the targeted mean. While somewhat elevated, a large decline was noted from 2020 values (0.060 mg/L). TP concentrations at Station 10 ranged from 0.01 mg/L in October up to 0.060 mg/L in July. Chlorophyll *a* concentrations were variable throughout the 2022 season, ranging between 9.3 µg/L in May and 43.0 µg/L in August. Concentrations exceeded the maximum target in June (17.0 µg/L), July (35.0 µg/L) and August (43.0 µg/L). The 2022 seasonal average exceeded the 8.0 µg/L targeted mean, yielding concentrations of 22.8 µg/L.

4.0 SUMMARY

This section provides a summary of the 2022 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. The water column was thermally stratified to varying degrees throughout the growing season at Station 2. Dissolved oxygen declined with depth, ultimately declining below the 5.0 mg/L threshold during each event in the deeper waters. In June, July, and August, DO concentrations dropped below 5.0 mg/L at the top of the thermocline as a result of the high BOD during the summer months. By June, anoxic conditions were present above the sediment and remained this way through the last sampling event in October. Anoxic conditions persisted through the September sampling event. In June, July, and August, anoxic conditions were present in at least the bottom 7.0 m of the water column.

2. While the previous long-term water quality database had value, the HABs experienced in 2019 identified the need to slightly expand the monitoring program. Specifically, soluble reactive phosphorus (SRP) was added to the monitoring parameters at each sampling station. The plankton monitoring was adjusted, including phytoplankton counts (in particular with the cyanobacteria) at surface and mid-depths. Finally, additional vertical sampling of discrete parameters at Station 2 to cover surface, mid-depth, and deep-water samples were added to the program in 2020. This increased sampling scope was continued during 2021 and 2022 which allowed for a more detailed analysis of nutrient concentrations throughout the lake and how they may be affecting cyanobacteria densities. This increased scope should be continued for future sampling years to continue to bolster the historic database for Lake Hopatcong.

3. It has been well documented that phosphorus is the primary limiting nutrient in Lake Hopatcong. That is, a slight increase in phosphorus will result in a substantial increase in the amount of algal and/or aquatic plant biomass. TP concentrations in the surface water were variable throughout the lake ranging between < 0.01 mg/L and 0.07 mg/L. Elevated TP concentrations at surface stations were often noted in areas with near-shore septic systems. Surface and mid-depth TP concentrations were low throughout the season at Station 2, with maximum concentrations of 0.02 mg/L. Deep water concentrations were elevated during the majority of the season with extreme elevations noted from July through October, with a maximum concentration of 0.20 mg/L in July. Elevated TP in the deep waters is attributed to extended periods of anoxia which results in the internal loading of phosphorus from the sediment.

4. 2022 was characterized as a dry year depositing a total of 15.45" of rain from May - September. This is approximately 6.94" less than normal values. Please note that 'normal' refers to the monthly averages from 1991 – 2020. As a result, flushing rates were very low during the 2022 growing season which resulted in hot, stagnant water which are ideal conditions for cyanobacteria growth.

5. Partly due to the hot and dry summer, an intense cyanobacteria bloom that began in the River Styx / Crescent Cove section of the lake in July and persisted through August, eventually spreading out towards the main body of the lake which resulted in elevated cyanobacteria counts at Station 2 in July and August. Crescent Cove is a hydraulically secluded area of the lake that is rather stagnant and doesn't mix as much with the main body of the lake as do most of the other coves on the lake. These conditions, in addition to elevated nitrogen and phosphorus concentrations in this section of the lake resulted in the intense bloom.

6. Based on the *in-situ* conditions, optimal brown trout habitat was present in the upper 10.70 m of Station 2 in May, the upper 6.10 m of the lake in June, and the upper 12.0 m in early October. Besides approximately 0.10 – 0.40 m of optimal brown trout habitat in early July, the rest of July and August was too hot and there was no optimal brown trout habitat available in the lake. However, carryover brown trout habitat was present in varying degrees until the last week of July. From late July through mid-August, carryover brown trout habitat was dynamic on a weekly basis and there were two sampling events (25 July, 10 August)

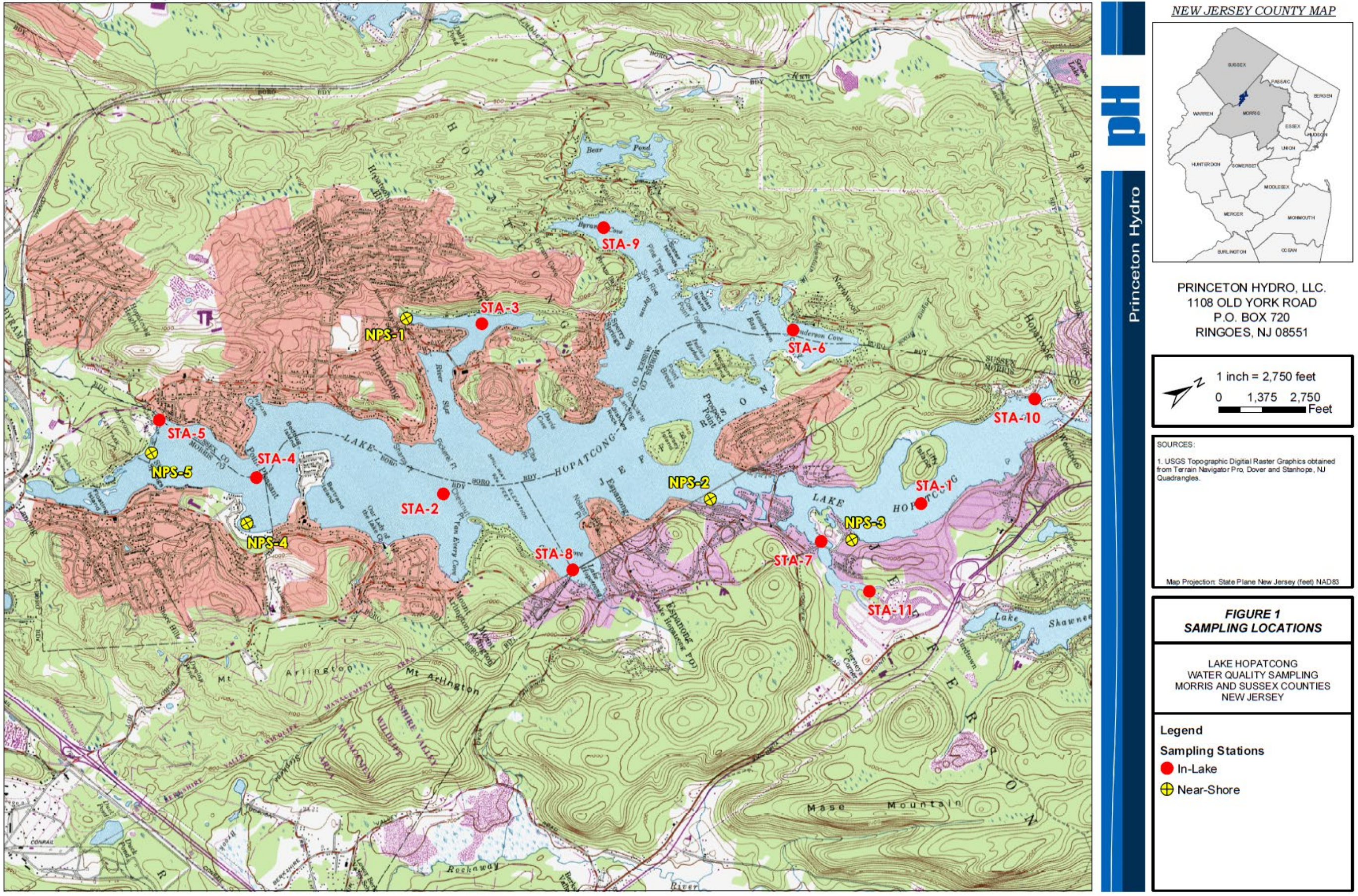
where there was no carryover habitat present at any of the stations that were monitored. Brown trout habitat became limited during the peak summer months as a result of low DO concentrations creeping upwards and warm temperatures creeping down.

7. A mechanical weed harvesting program has been in operation at Lake Hopatcong since the early 1980s. Over the 2022 growing season approximately 1,178 cubic yards (531 tons) of plant biomass was removed. This resulted in the removal of approximately 189 lbs of TP, which has the potential to produce approximately 208,200 lbs of wet algae biomass. The 189 lbs of TP accounts for 2.6% of the TP targeted for removal under the lake's TMDL.

APPENDIX A

Figures

File: P:\0003\Projects\0003047\GIS\MXD\SamplingLocations.mxd, May 25, 2010, Drawn by CLP, Copyright Princeton Hydro, LLC



PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551

SOURCES:

1. USGS Topographic Digitial Raster Graphics obtained from Terrain Navigator Pro, Dover and Stanhope, NJ Quadrangles.

Map Projection: State Plane New Jersey (feet) NAD83

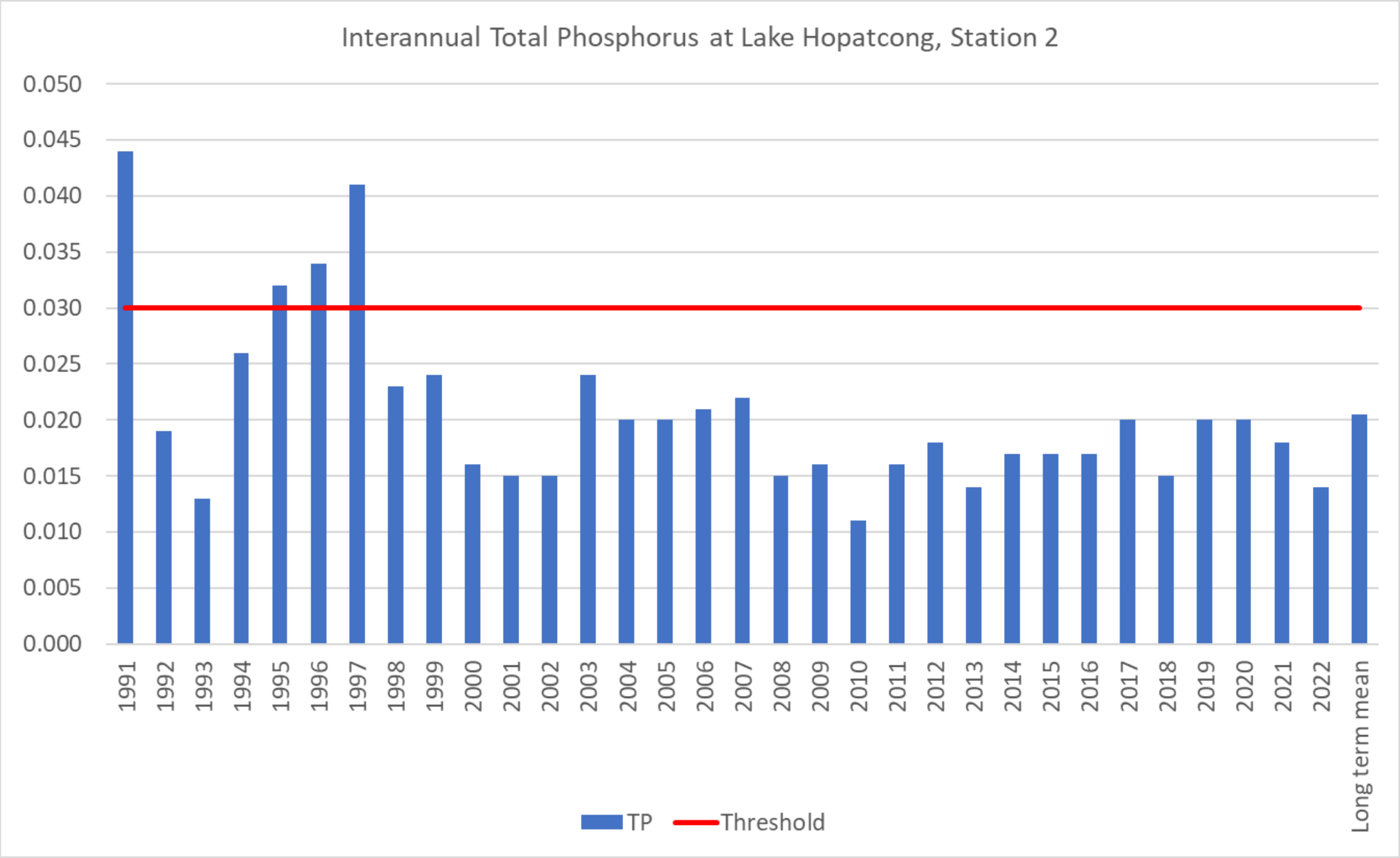
FIGURE 1
SAMPLING LOCATIONS

LAKE HOPATCONG
WATER QUALITY SAMPLING
MORRIS AND SUSSEX COUNTIES
NEW JERSEY

Legend

Sampling Stations

- ● In-Lake
- ⊕ Near-Shore


Interannual Total Phosphorus at Lake Hopatcong, Station 2
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Long term mean
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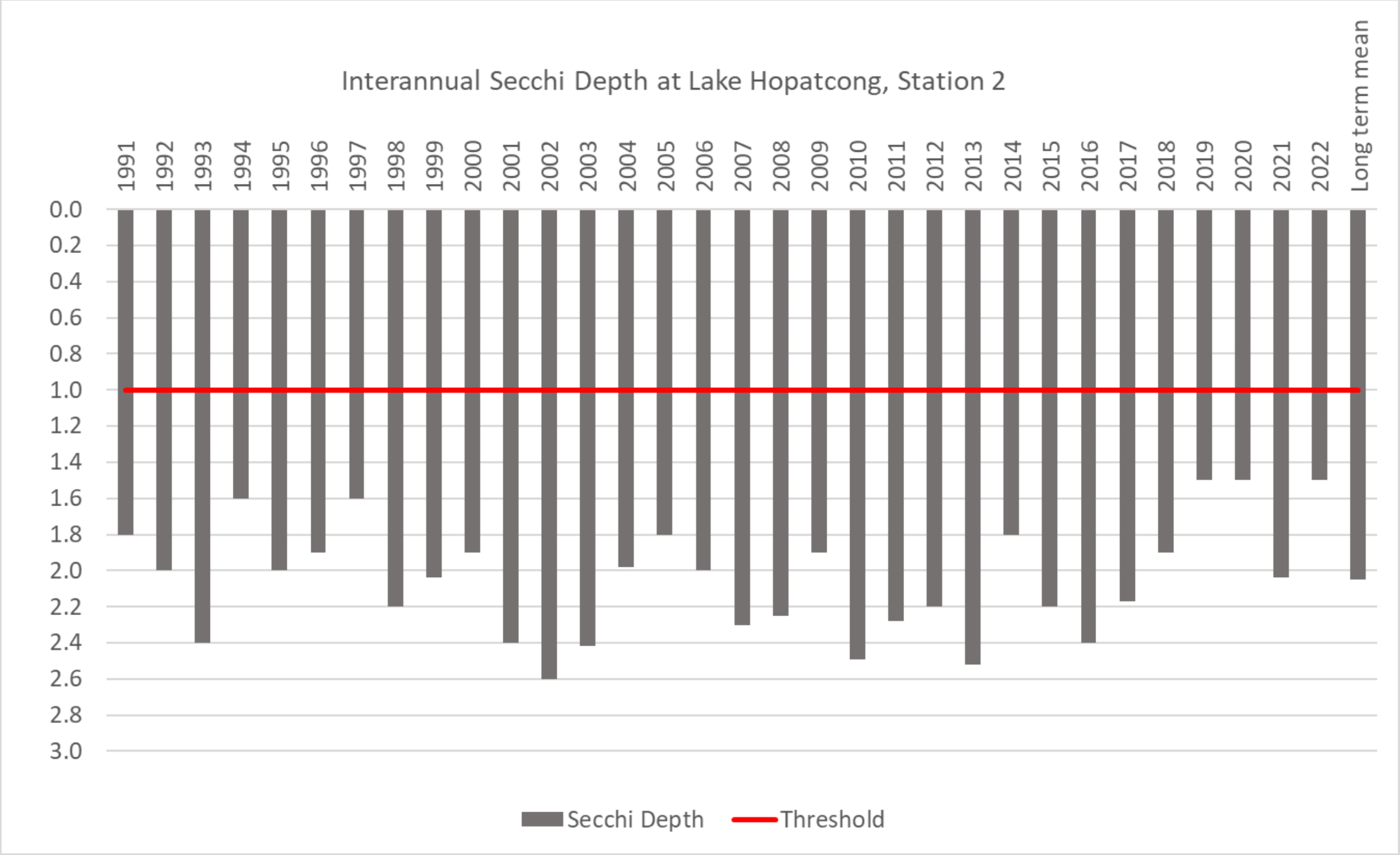
Threshold


Interannual Secchi Depth at Lake Hopatcong, Station 2
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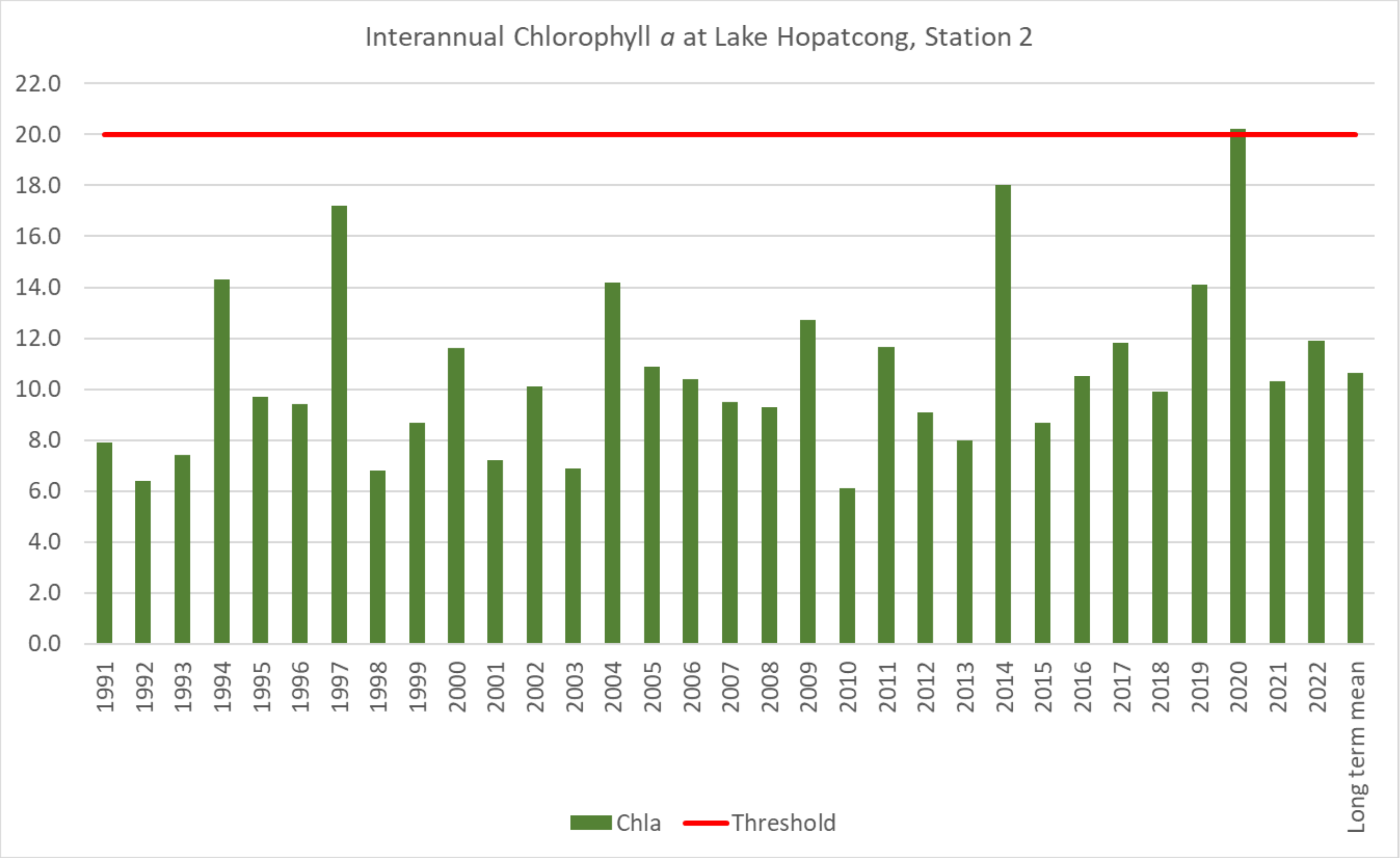
2021
2022
Long term mean
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
Secchi Depth
Threshold


Interannual Chlorophyll *a* at Lake Hopatcong, Station 2
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1991
1992
1993
1994
1995
1996
1997
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2018
2019
2020
2021
2022
Long term mean
Chla
Threshold

APPENDIX B

In-Situ Data

In-Situ Monitoring for Lake Hopatcong 5/25/2022

Station	Depth (meters)			Temperature	Specific Conductance	Dissolved Oxygen		pH	Phycocyanin	Chlorophyll *a*
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.	RFU	RFU
STA-1	2.20	1.30	0.1	22.09	0.366	8.55	99.7	7.6	0.601	0.035
			1.0	21.24	0.363	8.54	98.1	7.6	0.616	0.744
			2.0	20.78	0.366	8.28	94.2	7.5	0.829	1.240
STA-2	14.30	1.50	0.1	19.69	0.428	9.86	109.6	8.1	0.253	0.020
			1.0	19.52	0.428	9.87	109.3	8.1	0.266	0.132
			2.0	19.34	0.428	9.69	107.0	8.1	0.204	0.079
			3.0	19.24	0.428	9.55	105.2	8.0	0.258	0.824
			4.0	18.04	0.424	8.65	92.9	7.6	0.113	1.409
			5.0	16.80	0.424	8.13	85.2	7.5	0.050	1.779
			6.0	14.19	0.424	7.87	72.9	7.3	0.481	1.975
			7.0	13.20	0.423	6.88	66.5	7.0	0.756	1.863
			8.0	12.20	0.422	6.12	57.8	7.0	0.912	1.930
			9.0	11.71	0.422	6.63	62.2	6.9	0.869	1.745
			10.0	11.45	0.422	5.74	52.6	6.9	0.851	1.155
			11.0	11.27	0.423	4.76	44.2	6.8	0.990	0.775
			12.0	11.10	0.424	3.72	34.4	6.8	1.102	0.164
			13.0	10.95	0.426	2.94	26.9	6.7	1.124	0.039
			14.0	10.85	0.427	2.20	19.6	6.7	1.191	0.021
STA-3	2.00	1.80	0.1	20.56	0.640	8.96	101.6	8.2	0.403	0.030
			1.0	20.24	0.662	9.18	103.5	8.3	0.888	0.034
			1.8	19.88	0.578	9.06	101.1	8.3	0.955	0.072
STA-4	2.80	1.50	0.1	19.74	0.434	9.43	105.0	8.0	0.185	0.015
			1.0	19.60	0.433	9.30	103.4	8.0	0.320	0.124
			2.0	19.43	0.431	9.08	100.5	7.9	0.402	0.327
			3.0	19.26	0.432	8.11	89.1	7.7	0.257	0.456
STA-5	3.00	2.10	0.1	20.04	0.437	10.62	118.3	9.0	0.088	0.012
			1.0	19.79	0.437	10.41	116.2	9.0	0.839	0.014
			2.0	19.14	0.441	8.19	90.5	8.3	1.008	0.014
			2.5	18.69	0.443	5.61	61.2	7.7	0.960	0.028
STA-6	3.10	1.30	0.1	20.75	0.409	10.44	118.2	8.3	0.453	0.016
			1.0	20.93	0.422	10.43	118.1	8.1	0.856	0.029
			2.0	20.26	0.422	10.51	118.2	8.0	0.774	0.445
			2.8	18.60	0.421	9.93	108.7	7.8	0.704	0.597
STA-7	1.50	1.50+	0.1	21.42	0.221	5.97	68.8	7.1	0.576	0.023
			1.0	20.93	0.219	5.86	66.8	7.2	1.178	0.032
STA-8	7.20	1.50	0.1	20.14	0.427	9.84	110.8	7.7	0.009	0.016
			1.0	19.51	0.427	10.05	111.4	7.9	0.187	0.120
			2.0	19.11	0.426	9.82	107.1	7.9	0.323	0.841
			3.0	18.95	0.427	9.77	107.0	7.9	0.392	0.764
			4.0	18.05	0.424	8.36	89.6	7.6	0.001	1.124
			5.0	15.15	0.422	7.46	75.4	7.5	0.132	1.410
			6.0	13.64	0.420	6.76	66.1	7.3	0.479	1.613
			7.0	13.20	0.421	6.61	63.9	7.2	0.702	1.845
STA-9	8.50	1.50	0.1	20.50	0.430	10.54	119.5	7.9	0.304	0.030
			1.0	20.21	0.430	10.62	119.7	8.0	0.535	0.161
			2.0	20.15	0.430	10.52	118.1	8.0	0.366	1.143
			3.0	19.40	0.431	10.51	116.4	8.0	0.438	1.298
			4.0	19.15	0.431	10.32	113.2	7.9	0.465	1.091
			5.0	18.97	0.435	9.60	105.4	7.6	0.562	1.062
			6.0	14.87	0.425	7.38	74.4	7.3	0.244	1.690
			7.0	12.67	0.424	5.16	49.4	7.0	0.654	1.345
			8.0	12.20	0.423	4.68	44.5	7.0	0.625	2.282
STA-10	1.40	1.10	0.1	22.56	0.390	9.05	106.5	7.7	0.178	0.027
			1.0	21.45	0.404	9.28	105.6	7.8	0.636	0.379
STA-11	1.20	1.20+	0.1	21.21	0.181	6.47	74.1	7.0	0.517	0.017
			1.0	20.66	0.182	6.48	73.7	7.6	1.095	0.019

***In-Situ* Monitoring for Lake Hopatcong 6/22/2022**

Station	Depth (meters)			Temperature	Specific Conductance	Dissolved Oxygen		pH	Phycocyanin	Chlorophyll *a*
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.	RFU	RFU
STA-1	2.20	0.90	0.1	21.00	0.373	8.68	100.3	7.9	0.033	3.538
			1.0	21.05	0.373	8.67	106.2	8.0	0.000	3.048
			2.0	21.04	0.373	8.58	98.9	8.0	0.000	4.512
STA-2	14.30	1.50	0.1	20.93	0.431	8.74	100.9	8.0	0.351	0.165
			1.0	20.93	0.432	8.73	100.6	8.0	0.000	0.180
			2.0	20.91	0.432	8.61	99.5	8.0	0.176	0.235
			3.0	20.80	0.431	7.79	89.1	7.8	0.204	0.115
			4.0	20.30	0.430	6.67	76.3	7.6	0.206	0.037
			5.0	20.05	0.429	6.31	71.6	7.5	0.005	0.319
			6.0	19.67	0.428	5.82	65.6	7.4	0.063	0.040
			7.0	15.92	0.424	0.00	0.0	6.8	0.144	0.019
			8.0	13.17	0.424	0.00	0.0	6.7	0.690	0.021
			9.0	11.92	0.422	0.00	0.0	6.6	0.861	0.015
			10.0	11.63	0.423	0.00	0.0	6.6	0.887	0.014
			11.0	11.32	0.427	0.00	0.0	6.6	0.829	0.021
			12.0	11.05	0.434	0.00	0.0	6.6	0.858	0.024
			13.0	10.87	0.440	0.00	0.0	6.6	1.009	0.012
			14.0	10.71	0.441	0.00	0.0	6.6	1.072	0.008
STA-3	2.00		0.1	21.29	0.643	8.25	95.9	7.8	0.759	1.892
			1.0	21.37	0.650	8.25	96.0	7.8	0.202	2.109
			1.8	21.37	0.649	8.24	95.9	7.8	0.044	2.258
STA-4	2.80	1.30	0.1	21.19	0.438	8.97	104.1	8.0	0.278	0.595
			1.0	21.20	0.438	8.89	103.1	8.0	0.002	0.609
			2.0	21.19	0.438	8.89	103.3	8.0	0.000	0.587
			3.0	21.16	0.439	8.59	99.7	7.9	0.000	0.779
STA-5	2.30	1.40	0.1	21.33	0.441	9.02	111.9	8.3	0.000	0.658
			1.0	21.33	0.441	9.61	111.8	8.3	0.000	0.762
			2.0	21.32	0.441	9.63	112.0	8.3	0.100	0.694
STA-6	3.10	1.20	0.1	21.16	0.428	8.82	102.1	7.8	0.000	0.459
			1.0	21.21	0.426	8.82	102.3	7.8	0.000	0.531
			2.0	21.24	0.426	8.76	101.7	7.9	0.007	0.715
			2.8	21.20	0.426	8.19	94.7	7.8	0.006	0.500
STA-7	1.50	1.10	0.1	20.78	0.282	8.16	93.2	7.5	0.000	1.137
			1.0	21.05	0.279	8.07	93.3	7.4	0.385	1.031
STA-8	7.20	1.40	0.1	20.66	0.383	8.19	93.9	7.7	0.048	0.273
			1.0	20.74	0.384	8.17	94.1	7.8	0.304	0.202
			2.0	20.73	0.386	8.13	93.4	7.8	0.175	0.198
			3.0	20.70	0.388	7.88	89.6	7.7	0.173	0.416
			4.0	20.22	0.390	6.72	76.3	7.6	0.026	0.223
			5.0	19.37	0.392	5.35	59.9	7.4	0.000	0.514
			6.0	18.72	0.394	3.97	43.8	7.2	0.000	0.028
			7.0	17.57	0.396	2.14	23.0	7.2	0.000	0.021
STA-9	7.50	1.30	0.1	21.88	0.430	8.91	103.1	8.0	0.000	0.175
			1.0	21.15	0.429	8.88	103.1	8.0	0.000	0.035
			2.0	21.16	0.429	8.92	103.3	8.0	0.000	0.054
			3.0	21.10	0.429	8.98	104.1	8.0	0.000	0.253
			4.0	21.02	0.429	8.97	103.7	8.1	0.000	0.143
			5.0	20.98	0.429	8.90	102.6	8.0	0.000	0.210
			6.0	20.91	0.429	8.79	101.3	8.0	0.000	0.219
			7.0	20.91	0.429	8.74	100.8	8.0	0.000	0.081
STA-10	1.40	0.70	0.1	21.20	0.394	9.03	104.7	8.2	0.001	2.997
			1.0	21.27	0.400	9.00	104.3	8.2	0.000	3.753
STA-11	1.20	1.20+	0.1	20.27	0.225	7.04	80.6	7.1	0.075	0.906
			1.0	20.34	0.231	6.94	79.1	7.1	0.652	1.302

In-Situ Monitoring for Lake Hopatcong 7/25/2022

Station	Depth(meters)			Temperature	Specific Conductance	Dissolved Oxygen		pH	Phycocyanin	Chlorophyll *a*
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.	RFU	RFU
STA-1	1.80	0.80	0.1	28.62	0.401	6.70	89.5	7.3	0.000	4.061
			1.0	28.69	0.401	6.58	86.8	7.3	0.149	4.755
			1.6	28.73	0.401	6.39	85.2	7.3	0.052	4.620
STA-2	14.30	1.70	0.1	27.50	0.453	7.50	93.4	7.7	0.000	0.970
			1.0	27.48	0.453	7.51	98.4	7.7	0.142	0.803
			2.0	27.47	0.453	7.46	97.7	7.7	0.043	0.951
			3.0	27.45	0.453	7.42	97.1	7.6	0.300	0.936
			4.0	27.41	0.453	7.33	95.9	7.4	0.460	1.030
			5.0	26.20	0.449	3.64	76.6	6.8	0.232	0.986
			6.0	21.44	0.440	0.00	0.0	6.5	0.916	0.035
			7.0	17.15	0.434	0.00	0.0	6.5	1.257	1.219
			8.0	15.38	0.431	0.00	0.0	6.4	1.121	1.430
			9.0	13.27	0.432	0.00	0.0	6.4	1.175	0.044
			10.0	12.20	0.431	0.00	0.0	6.5	1.191	0.010
			11.0	11.56	0.434	0.00	0.0	6.5	0.057	0.068
			12.0	11.61	0.440	0.00	0.0	6.7	1.205	0.012
			13.0	10.88	0.447	0.00	0.0	6.7	1.101	0.011
			14.0	10.61	0.467	0.00	0.0	6.9	0.772	0.010
STA-3	2.20	0.50	0.1	28.32	0.541	6.69	89.2	7.7	11.504	3.553
			1.0	28.44	0.597	6.71	89.3	7.8	10.051	3.368
			2.0	28.34	0.581	6.43	85.4	7.7	7.516	3.927
STA-4	3.00	1.20	0.1	27.13	0.453	6.05	86.7	7.4	0.985	1.577
			1.0	27.16	0.452	6.00	86.0	7.4	0.008	1.493
			2.0	27.15	0.452	6.49	84.4	7.3	0.001	2.029
			2.7	26.98	0.452	5.34	69.4	7.2	0.002	2.645
STA-5	2.30	0.80	0.1	27.91	0.455	6.47	85.4	7.3	1.599	3.379
			1.0	27.76	0.454	5.59	73.1	7.3	0.540	2.989
			2.0	27.37	0.453	4.08	53.1	7.1	0.000	3.706
STA-6	3.10	1.00	0.1	28.32	0.451	7.17	95.6	7.5	0.302	1.000
			1.0	28.43	0.452	7.11	94.8	7.5	0.000	2.007
			2.0	28.43	0.452	6.94	92.3	7.5	0.000	2.285
			3.0	28.39	0.452	6.76	89.4	7.4	0.011	2.412
STA-7	1.50	0.90	0.1	28.43	0.335	6.38	84.9	7.4	0.168	1.976
			1.0	28.52	0.433	6.36	84.6	7.4	0.000	2.146
STA-8	7.20	1.50	0.1	27.90	0.454	7.68	101.1	7.9	0.000	0.526
			1.0	27.92	0.454	7.67	101.2	7.9	0.333	1.081
			2.0	27.90	0.454	7.59	99.9	7.8	0.869	0.824
			3.0	27.88	0.454	7.54	99.4	7.7	0.720	1.158
			4.0	27.86	0.454	7.50	98.9	7.7	0.761	1.040
			5.0	27.52	0.452	6.71	87.8	7.4	0.760	1.306
			6.0	23.04	0.437	0.00	0.0	6.6	0.784	0.037
			7.0	17.81	0.432	0.00	0.0	7.0	1.180	0.726
STA-9	7.50	1.30	0.1	28.09	0.454	7.99	105.7	7.9	0.003	1.239
			1.0	28.13	0.453	8.05	106.6	7.9	0.010	1.639
			2.0	28.13	0.453	7.96	105.5	7.8	0.325	1.686
			3.0	28.14	0.453	7.94	105.2	7.8	0.014	1.564
			4.0	27.87	0.454	6.43	84.5	7.3	0.111	1.590
			5.0	26.55	0.449	4.31	55.5	6.9	0.258	1.467
			6.0	23.48	0.438	0.00	0.0	6.6	0.685	0.368
			7.0	19.62	0.440	0.00	0.0	6.5	1.259	0.327
STA-10	1.40	0.70	0.1	28.34	0.430	7.69	102.3	7.8	0.858	4.940
			1.0	28.52	0.429	7.59	100.9	7.1	0.660	4.343
STA-11	1.20	1.00	0.1	27.98	0.432	4.68	62.8	7.1	1.161	0.749
			1.0	27.93	0.432	4.58	60.3	7.1	1.198	1.691

In-Situ Monitoring for Lake Hopatcong 8/24/2022

Station	Depth (meters)			Temperature	Specific Conductance	Dissolved Oxygen		pH	Phycocyanin	Chlorophyll *a*
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.	RFU	RFU
STA-1	2.20	0.80	0.1	26.19	0.434	9.90	126.0	8.6	5.899	4.327
			1.0	25.88	0.434	9.77	123.0	8.4	4.391	4.484
			2.0	25.20	0.433	8.38	104.0	8.0	3.475	5.195
STA-2	14.30	1.30	0.1	25.28	0.398	9.54	119.5	8.5	1.211	0.035
			1.0	25.16	0.454	9.52	119.5	8.5	0.970	0.226
			2.0	25.11	0.455	9.49	118.5	8.5	1.538	0.995
			3.0	24.96	0.455	9.19	114.3	8.4	1.305	1.190
			4.0	24.74	0.456	8.44	104.7	8.0	1.152	1.335
			5.0	24.67	0.456	8.33	103.2	8.0	1.510	1.182
			6.0	24.09	0.456	5.57	68.7	7.4	0.022	0.563
			7.0	21.75	0.443	0.00	0.0	6.9	0.850	0.037
			8.0	16.56	0.445	0.00	0.0	7.0	1.489	0.029
			9.0	13.88	0.439	0.00	0.0	6.7	1.827	0.021
			10.0	12.75	0.437	0.00	0.0	6.5	1.720	0.014
			11.0	11.85	0.438	0.00	0.0	6.6	1.715	0.012
			12.0	11.43	0.443	0.00	0.0	6.6	1.079	0.010
			13.0	11.15	0.447	0.00	0.0	6.6	1.496	0.012
			14.0	10.70	0.460	0.00	0.0	6.5	0.797	0.015
STA-3	2.00	0.70	0.1	25.80	0.531	8.57	104.0	8.3	8.793	2.301
			1.0	25.14	0.519	7.26	90.2	7.9	7.784	2.710
			1.5	24.56	0.507	6.62	82.4	7.7	6.900	2.851
STA-4	3.10	1.10	0.1	24.89	0.461	8.21	102.1	7.8	2.185	1.484
			1.0	24.84	0.461	8.16	101.5	7.8	1.499	1.860
			1.0	24.70	0.460	7.75	96.1	7.7	1.554	2.138
			3.0	24.61	0.460	7.23	89.5	7.6	1.760	2.507
STA-5	2.30	1.00	0.1	25.18	0.462	8.01	100.2	7.5	2.906	1.685
			1.0	24.94	0.463	7.49	99.6	7.5	3.022	3.137
			2.0	24.74	0.402	7.22	89.2	7.5	2.338	3.317
STA-6	2.70	1.20	0.1	26.43	0.470	9.41	120.7	8.4	1.273	0.157
			1.0	26.05	0.469	9.65	122.2	8.4	0.818	0.923
			2.0	25.31	0.468	9.56	120.5	8.3	0.592	1.253
			2.5	25.14	0.468	8.11	101.4	7.8	0.575	1.177
STA-7	1.50	0.90	0.1	26.70	0.513	8.79	113.0	7.9	1.767	2.103
			1.0	25.83	0.524	8.44	107.1	7.8	0.252	2.837
STA-8	7.20	1.30	0.1	25.63	0.459	9.17	115.6	8.3	1.844	0.340
			1.0	25.44	0.460	9.25	116.5	8.4	1.197	0.749
			2.0	25.42	0.462	9.25	116.3	8.3	1.317	1.168
			3.0	25.27	0.461	9.21	115.5	8.3	1.319	1.026
			4.0	25.17	0.463	9.04	113.1	8.2	0.927	1.238
			5.0	24.97	0.464	8.42	104.6	8.0	1.033	1.210
			6.0	23.44	0.458	2.10	28.4	7.2	0.523	0.089
			7.0	22.20	0.454	0.00	0.0	6.8	1.140	0.053
STA-9	7.50	1.30	0.1	26.07	0.472	9.52	121.3	8.7	1.687	0.035
			1.0	25.86	0.470	9.61	121.2	8.1	0.776	0.380
			2.0	24.91	0.469	9.29	115.8	8.1	1.364	1.377
			3.0	24.61	0.469	7.90	97.9	7.6	0.762	1.237
			4.0	24.33	0.468	6.14	76.6	7.3	0.019	0.242
			5.0	24.00	0.466	3.72	45.9	6.9	0.500	0.042
			6.0	22.02	0.453	0.00	0.0	6.7	1.070	0.033
			7.0	20.67	0.468	0.00	0.0	6.6	0.389	0.154
STA-10	0.80	0.70	0.1	26.82	0.499	10.64	137.1	8.7	4.014	3.478
			0.7	25.89	0.442	9.88	125.5	8.5	3.684	5.204
STA-11	1.00	1.0+	0.1	25.38	0.596	6.67	83.8	7.5	0.350	0.846
			1.0	25.04	0.598	6.67	83.0	7.4	0.924	1.590

***In-Situ* Monitoring for Lake Hopatcong 10/6/2022**

Station	Depth (meters)			Temperature	Specific Conductance	Dissolved Oxygen		pH	Phycocyanin	Chlorophyll *a*
	Total	Secchi	Sample	°C	mS/cm	mg/L	% Sat.	S.U.	RFU	RFU
STA-1	2.20	1.80	0.1	13.76	0.430	10.34	102.8	7.8	0.210	0.779
			1.0	13.17	0.430	10.39	102.1	7.8	0.001	1.404
			2.0	12.56	0.428	10.27	99.6	7.7	0.061	3.030
STA-2	14.30	1.30	0.1	15.40	0.445	7.69	79.2	7.5	0.073	0.017
			1.0	15.20	0.446	7.69	79.0	7.5	0.378	0.036
			2.0	15.13	0.446	7.69	78.9	7.5	0.570	0.360
			3.0	14.95	0.446	7.50	76.6	7.5	0.570	0.452
			4.0	14.89	0.446	7.42	75.6	7.4	0.547	0.440
			5.0	14.88	0.446	7.34	74.8	7.4	0.634	0.458
			6.0	14.86	0.446	7.32	74.6	7.3	0.720	0.671
			7.0	14.86	0.446	7.30	74.3	7.3	0.726	0.634
			8.0	14.86	0.446	7.25	73.8	7.3	0.691	0.508
			9.0	14.85	0.446	7.19	73.2	7.3	0.648	0.526
			10.0	14.10	0.446	7.18	73.2	7.3	0.726	0.348
			11.0	14.10	0.444	6.45	64.5	7.2	0.775	0.141
			12.0	13.64	0.443	7.27	72.1	7.2	0.619	0.319
			13.0	11.77	0.466	0.00	0.0	6.9	0.851	0.023
			14.0	11.27	0.472	0.00	0.0	6.8	0.201	0.033
STA-3	2.00	1.30	0.1	13.89	0.444	9.05	90.8	7.4	0.000	1.197
			1.0	13.14	0.448	9.40	92.4	7.4	0.002	1.700
			1.5	12.74	0.449	9.60	93.5	7.4	0.000	2.331
STA-4	2.80	1.40	0.1	14.59	0.444	8.62	87.5	7.5	0.000	0.021
			1.0	14.49	0.445	8.66	87.1	7.5	0.234	0.746
			1.0	13.60	0.442	9.12	90.4	7.6	0.587	0.470
			2.5	13.23	0.440	9.11	89.6	7.5	0.499	0.088
STA-5	2.30	1.20	0.1	17.56	0.443	9.15	98.4	7.7	0.000	0.022
			1.0	16.83	0.444	9.50	100.8	7.8	0.411	0.032
			2.0	15.63	0.448	8.92	93.2	7.8	0.587	0.030
STA-6	2.70	1.50	0.1	17.18	0.445	7.03	75.3	7.7	0.000	0.021
			1.0	16.27	0.443	6.79	71.3	7.6	0.560	0.571
			2.0	15.61	0.442	7.46	77.2	7.6	0.781	0.677
			2.5	15.16	0.446	7.60	78.1	7.5	0.684	0.914
STA-7	1.70	1.60	0.1	13.42	0.436	8.87	87.6	7.3	0.166	0.016
			1.0	12.36	0.317	9.43	91.4	7.2	0.630	0.016
STA-8	7.20	1.20	0.1	15.71	0.445	7.35	76.3	7.6	0.621	0.017
			1.0	15.54	0.444	7.27	74.7	7.5	0.692	0.037
			2.0	14.95	0.445	7.05	71.8	7.4	0.753	0.483
			3.0	14.89	0.445	6.96	70.9	7.4	0.814	0.384
			4.0	14.86	0.445	6.93	70.6	7.3	0.782	0.524
			5.0	14.83	0.445	6.92	70.5	7.2	0.766	0.187
			6.0	14.81	0.445	6.85	69.7	7.2	0.810	0.159
			7.0	14.73	0.447	6.74	68.5	7.2	0.995	0.189
STA-9	7.50	1.50	0.1	16.52	0.444	7.55	79.7	7.5	0.000	0.032
			1.0	15.95	0.444	7.39	77.5	7.4	0.289	0.847
			2.0	15.44	0.443	6.17	63.5	7.3	0.683	0.517
			3.0	15.27	0.443	6.10	62.5	7.2	0.876	0.078
			4.0	15.16	0.444	5.96	61.6	7.2	0.975	1.076
			5.0	15.09	0.445	5.86	60.0	7.1	1.143	0.446
			6.0	14.99	0.445	5.69	58.0	7.0	1.099	1.295
			7.0	14.82	0.447	4.80	48.7	7.0	1.168	0.056
STA-10	0.80	0.70	0.1	15.46	0.440	10.36	100.7	8.0	0.000	0.748
			0.7	14.70	0.442	10.55	106.9	8.0	0.071	1.509
STA-11	1.00	1.00+	0.1	13.36	0.298	9.36	92.1	7.6	0.419	0.013
			1.0	13.18	0.304	9.42	92.3	7.4	0.871	0.041

APPENDIX C

Discrete Data

Discrete Data 5/25/2022						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	8.6	0.01	0.10	0.002	0.03	ND < 2
ST-2 SURFACE	8.3	0.03	0.03	ND<0.002	0.02	ND < 2
ST-2 MID	8.7	0.05	0.02	ND<0.002	0.02	ND < 2
ST-2 DEEP		0.08	0.05	0.005	0.05	ND < 2
ST-3	3.5	0.04	0.12	ND<0.002	0.02	2
ST-4	6.2	0.02	0.02	0.003	0.02	ND < 2
ST-5	2.7	0.03	0.02	0.003	0.01	ND < 2
ST-6	8.2	0.01	0.02	ND<0.002	0.01	ND < 2
ST-7	6.5	0.04	0.10	0.002	0.02	ND < 2
ST-10	9.3	0.03	0.09	0.002	0.03	ND < 2
ST-11	3.6	0.02	0.09	0.002	0.02	ND < 2
Surface Mean	**6.3**	**0.03**	**0.066**	**0.002**	**0.020**	**1.1**

Discrete Data 6/22/2022						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	12.0	ND<0.01	0.04	ND<0.002	0.04	10
ST-2 SURFACE	12.0	ND<0.01	0.01	ND<0.002	0.02	5
ST-2 MID	9.0	ND<0.01	0.01	ND<0.002	0.02	2
ST-2 DEEP		0.35	0.03	ND<0.002	0.04	2
ST-3	13.0	0.01	0.06	ND<0.002	0.04	8
ST-4	7.2	ND<0.01	0.01	ND<0.002	0.02	4
ST-5	7.3	ND<0.01	0.01	ND<0.002	0.03	ND<2
ST-6	10.0	ND<0.01	0.01	ND<0.002	0.02	5
ST-7	9.1	ND<0.01	0.05	ND<0.002	0.03	ND<2
ST-10	17.0	ND<0.01	0.04	ND<0.002	0.05	9
ST-11	7.8	ND<0.01	0.07	0.002	0.05	4
Surface Mean	**10.6**	**0.01**	**0.033**	**0.001**	**0.033**	**5.2**

Discrete Data 7/25/2022

STATION	Chlorophyll a (ug/L)	NH3-N (mg/L)	NO3-N (mg/L)	SRP (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	23.0	0.13	0.10	ND<0.002	0.04	18
ST-2 SURFACE	15.0	0.02	0.01	ND<0.002	0.01	5
ST-2 MID	13.0	0.02	0.01	ND<0.002	0.02	2
ST-2 DEEP		1.40	0.12	ND<0.002	0.20	5
ST-3	63.0	0.35	0.06	ND<0.002	0.07	ND<2
ST-4	13.0	0.02	0.02	ND<0.002	0.02	6
ST-5	26.0	0.02	0.65	ND<0.002	0.03	4
ST-6	14.0	0.01	0.02	ND<0.002	0.02	10
ST-7	13.0	0.01	0.25	ND<0.002	0.03	8
ST-10	35.0	0.13	0.07	ND<0.002	0.06	36
ST-11	12.0	0.01	0.06	ND<0.002	0.03	7
Surface Mean	**23.8**	**0.08**	**0.138**	**0.001**	**0.034**	**10.6**

Discrete Data 8/24/2022

STATION	Chlorophyll a (ug/L)	NH3-N (mg/L)	NO3-N (mg/L)	SRP (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	36.0	ND<0.01	0.04	ND<0.002	0.02	11
ST-2 SURFACE	16.0	ND<0.01	0.01	ND<0.002	0.01	4
ST-2 MID	9.7	ND<0.01	ND<0.01	ND<0.002	0.01	3
ST-2 DEEP		0.52	0.17	ND<0.002	0.18	5
ST-3	55.0	0.01	0.05	ND<0.002	0.04	2
ST-4	24.0	ND<0.01	0.01	ND<0.002	0.02	4
ST-5	25.0	ND<0.01	0.01	ND<0.002	0.03	2
ST-6	17.0	0.01	0.01	ND<0.002	0.02	2
ST-7	20.0	ND<0.01	0.05	ND<0.002	0.03	7
ST-10	43.0	0.01	0.06	ND<0.002	0.04	28
ST-11	7.6	ND<0.01	0.04	ND<0.002	0.02	2
Surface Mean	**27.1**	**0.01**	**0.031**	**0.001**	**0.026**	**6.9**

Discrete Data 10/6/2022						
STATION	**Chlorophyll a (ug/L)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**SRP (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	24.0	0.08	0.04	ND<0.002	0.01	ND<2
ST-2 SURFACE	8.0	0.16	0.03	ND<0.002	0.01	ND<2
ST-2 MID	8.8	0.07	0.10	ND<0.002	0.01	ND<2
ST-2 DEEP		0.60	0.12	ND<0.002	0.17	2
ST-3	11.0	0.09	0.05	ND<0.002	0.01	ND<2
ST-4	10.0	0.14	0.03	ND<0.002	0.01	ND<2
ST-5	6.4	0.01	0.03	ND<0.002	ND<0.01	ND<2
ST-6	5.9	0.16	0.03	ND<0.002	0.01	ND<2
ST-7	3.4	0.09	0.12	ND<0.002	0.01	ND<2
ST-10	9.5	0.08	0.08	ND<0.002	0.01	ND<2
ST-11	2.6	0.02	0.12	ND<0.002	0.01	ND<2
Surface Mean	**9.0**	**0.09**	**0.059**	**0.001**	**0.009**	**1.0**

APPENDIX D

Plankton Data

Phytoplankton and Zooplankton Community Composition Analysis																	
Sampling Location: Lake Hopatcong						**Sampling Date: 5/25/22**						**Examination Date: 6/3/22**					
Site 1: ST-2 Surface Phyto			**Site 2: ST-2 Mid Phyto**			**Site 3: ST-3 Surface Phyto**						**Site 4: ST-2 Surface Zoo**	**Site 5: ST-2 Deep Zoo**				
Phytoplankton																	
Bacillariphyta (Diatoms)	**1**	**2**	**3**	**4**	**5**	**Chlorophyta (Green Algae)**	**1**	**2**	**3**	**4**	**5**	**Cyanophyta (Blue-Green Algae)**	**1**	**2**	**3**	**4**	**5**
Asterionella	P	R				*Actinastrum*		R				*Aphanizomenon*	34,683	18784	2748		
Eunotia			P			*Akinstrodesmus*			P			*Chroococcus*			220		
Fragilaria	C	C	C			*Chlorella*	P					*Dolichospermum*	462				
Melosira		P	P			*Chlorogonium*	P	P	P								
Nitzschia		P				*Coelastrum*			P								
Pinnularia		R				*Dicellula*	P	P	P								
Stephanodiscus		R				*Dictyosphaerium*		R				**Euglenophyta (Euglenoids)**					
Synedra	R	R				*Eudorina*	P		R			*Colacium*	P				
Tabellaria	C	C				*Koliella*	P		P			*Euglena*					
						Oocystis			R			*Trachelomonas*	P	P	R		
						Pediastrum	P	R	P								
						Scenedesmus	P	P	P								
						Sphaerocystis			P								
Chrysophyta (Golden Algae)						*Staurastrum*	P	P	P								
Dinobryon	R	R	P			**Cryptomonads**											
						Cryptomonas	C		C								
Zooplankton																	
Cladocera (Water Fleas)	**1**	**2**	**3**	**4**	**5**	**Copecoda (Copepods)**	**1**	**2**	**3**	**4**	**5**	**Rotifera (Rotifers)**	**1**	**2**	**3**	**4**	**5**
Bosmina				A	A	*Cyclops*					P	*Asplanchna*					R
Chydorus				P	P	*Diaptomus*				P	P	*Conochilus*					R
						Nauplii				P	P	*Keratella*				A	A
												Ascomorpha				C	C
												Polyartha				C	C
Sites:	**1**	**2**	**3**	**4**	**5**	**Comments:**											
Total Phytoplankton Genera	18	18	19														
Total Cyanobacteria (cells/mL)	35,145	18,784	2,968														
Total Zooplankton Genera				7	10												
						Phytoplankton Key: Bloom (B), Common (C), Present (P), and Rare (R)											
						Zooplankton Key: Dominant (D), Abundant (A), Present (P), and Rare (R); Herbivorous (H) or Carnivorous (C)											

Phytoplankton and Zooplankton Community Composition Analysis																	
Sampling Location: Lake Hopatcong						**Sampling Date: 6/22/22**						**Examination Date: 6/30/22**					
Site 1: ST-2 Surface Phyto			**Site 2: ST-2 Mid Phyto**			**Site 3: ST-3 Surface Phyto**						**Site 4: ST-2 Surface Zoo**	**Site 5: ST-2 Deep Zoo**				
Phytoplankton																	
Bacillariphyta (Diatoms)	**1**	**2**	**3**	**4**	**5**	**Chlorophyta (Green Algae)**	**1**	**2**	**3**	**4**	**5**	**Cyanophyta (Blue-Green Algae)**	**1**	**2**	**3**	**4**	**5**
Asterionella		P	P			*Actinastrum*		R				*Aphanizomenon*	55,199	53277	25497		
Fragilaria		R	C			*Akinstrodesmus*	P	P	P			*Aphanocapsa*	2760		283		
Melosira	P	P	C			*Brachiomonas*	P	P	P			*Coelosphaerium*			567		
Nitzschia			P			*Chlamydomonas*		P				*Dolichospermum*		6177	5666		
Pinnularia			R			*Chlorella*	P	P	P			*Lyngbya*					
Stephanodiscus	R		P			*Chlorogonium*	P		P			*Microcystis*	920		170		
Synedra			A			*Coelastrum*	R		R			*Pseudanabaena*	64399	5405	3683		
Tabellaria	P	C	C			*Dicellula*		P				**Euglenophyta (Euglenoids)**					
						Eudorina						*Euglena*					
						Golenkinia			P			*Phacus*	R				
						Mougeotia	R					*Trachelomonas*	C	C	C		
						Oocystis	P		P								
						Pediastrum	P	P	C								
						Scenedesmus	C	C	C								
						Sphaerocystis	P		P								
						Staurastrum	R	P	P								
Chrysophyta (Golden Algae)						*Tetraspora*			P			**Dinoflagellates**					
Dinobryon	R		R			**Cryptomonads**						*Ceratium*	P	R	P		
						Chroomonas			P			*Gymnodium*			P		
						Cryptomonas	A	C	A			*Peridinium*	P				
Zooplankton																	
Cladocera (Water Fleas)	**1**	**2**	**3**	**4**	**5**	**Copecoda (Copepods)**	**1**	**2**	**3**	**4**	**5**	**Rotifera (Rotifers)**	**1**	**2**	**3**	**4**	**5**
Bosmina				P	C	*Cyclops*				P	P	*Ascomorpha*					P
Ceriodaphnia				R	P	*Diaptomus*					P	*Asplanchna*				R	
Daphnia				R		Nauplii				P	C	*Conochilus*				R	P
												Fillinia				R	
												Keratella				C	P
												Notholca				P	P
												Polyartha				C	C
												Trichocerca				P	P
Sites:	**1**	**2**	**3**	**4**	**5**	**Comments:**											
Total Phytoplankton Genera	24	19	32														
Total Cyanobacteria (cells/mL)	123,278	64,859	35,866														
Total Zooplankton Genera				12	11												
						Phytoplankton Key: Bloom (B), Common (C), Present (P), and Rare (R)											
						Zooplankton Key: Dominant (D), Abundant (A), Present (P), and Rare (R); Herbivorous (H) or Carnivorous (C)											

Phytoplankton and Zooplankton Community Composition Analysis																	
Sampling Location: Lake Hopatcong						**Sampling Date: 7/25/22**						**Examination Date: 7/26/22**					
Site 1: ST-2 Surface Phyto			**Site 2: ST-2 Mid Phyto**			**Site 3: ST-3 Surface Phyto**						**Site 4: ST-2 Surface Zoo**	**Site 5: ST-2 Deep Zoo**				
Phytoplankton																	
Bacillariphyta (Diatoms)	**1**	**2**	**3**	**4**	**5**	**Chlorophyta (Green Algae)**	**1**	**2**	**3**	**4**	**5**	**Cyanophyta (Blue-Green Algae)**	**1**	**2**	**3**	**4**	**5**
Fragilaria			3577			*Chlamydomonas*	100		1,533			*Aphanizomenon*	47,718.9	53,733.1	36,792.5		
Melosira	199.7	2477.6	3066			*Chlorella*	599	155	511			*Cylindrospermopsis*	4,791.9	2,322.8	680,149.4		
Synedra	299.5	619.4				*Cosmarium*		155				*Dolichospermum*	798.6	154.9			
Tabellaria	1198	1238.8				*Crucigenia*	799	1549	2044			*Microcystis*	499.2	2,013.1	1,022.0		
						Eudorina	300	464				*Pseudanabaena*	13,676.7	10,065.3	28,616.4		
						Gloeomonas	1897	1582	1533			*Woronichinia*	499.2		3,066.0		
						Scenedesmus			5110.1								
						Sphaerocystis	898		3577			**Euglenophyta (Euglenoids)**					
						Staurastrum	200					*Trachelomonas*	99.8	154.9			
						Tetraedron			511			*Phacus*		511			
						Treubaria	100	155									
Chrysophyta (Golden Algae)												**Dinoflagellates**					
Chrysosphaerella						**Cryptomonads**											
Mallomonas					155	*Chroomonas*	499.2										
						Cryptomonas	99.8	619.4	2044								
Zooplankton																	
Cladocera (Water Fleas)	**1**	**2**	**3**	**4**	**5**	**Copecoda (Copepods)**	**1**	**2**	**3**	**4**	**5**	**Rotifera (Rotifers)**	**1**	**2**	**3**	**4**	**5**
Bosmina				C	P	*Diaptomus*					R	*Asplanchna*				R	
Ceriodaphnia				P	P	*Microcyclops*				C	P	*Conochilus*				A	A
Chydorus				R	P	Nauplii				P	C	*Filinia*				R	
												Keratella				C	C
												Polyartha				P	P
												Pompholyx				P	P
												Trichocerca				P	P
Sites:	**1**	**2**	**3**	**4**	**5**	**Comments:**											
Total Phytoplankton Genera	20	17	15														
Total Cyanobacteria (cells/mL)	67,985	68,289	749,646														
Total Zooplankton Genera				12	11												
						Phytoplankton Key: Bloom (B), Common (C), Present (P), and Rare (R)											
						Zooplankton Key: Dominant (D), Abundant (A), Present (P), and Rare (R); Herbivorous (H) or Carnivorous (C)											

Phytoplankton and Zooplankton Community Composition Analysis																	
Sampling Location: Lake Hopatcong						**Sampling Date: 8/24/22**						**Examination Date: 9/1/22**					
Site 1: ST-2 Surface Phyto			**Site 2: ST-2 Mid Phyto**				**Site 3: ST-3 Surface Phyto**					**Site 4: ST-2 Surface Zoo**	**Site 5: ST-2 Deep Zoo**				
Phytoplankton																	
Bacillariphyta (Diatoms)	**1**	**2**	**3**	**4**	**5**	**Chlorophyta (Green Algae)**	**1**	**2**	**3**	**4**	**5**	**Cyanophyta (Blue-Green Algae)**	**1**	**2**	**3**	**4**	**5**
Cyclotella		P	P			*Actinastrum*			P			*Aphanizomenon*	19,183	2,789	4,392		
Fragilaria	R	P				*Akinstrodesmus*	P	P	C			*Cylindrospermopsis*	203,820	102,286	439,253		
Melosira	P	P	P			*Chlorella*	P	P	P			*Dolichospermum*	6,594	1,860	2,196		
Pinnularia		R				*Coelastrum*	R		P			*Lyngbya*			1,098		
Synedra	P	C	P			*Cosmarium*	R					*Merismopedia*		2,976			
Tabellaria	P	P	P			*Crucigenia*		R				*Microcystis*			2,636		
						Franceia		P	C			*Pseudanabaena*		1,860	17,570		
						Gleomonas	P					**Euglenophyta (Euglenoids)**					
						Oocystis	P		R			*Euglena*			P		
						Pediastrum			C			*Phacus*		R			
						Scenedesmus		P	C			*Trachelomonas*	C	C	C		
						Sphaerocystis	P										
						Staurastrum	P	P	P								
						Tetraspora	P	R									
Chrysophyta (Golden Algae)												**Dinoflagellates**					
						Cryptomonads						*Ceratium*			R		
						Cryptomonas	P	P	C			*Gymnodium*	P	P			
Zooplankton																	
Cladocera (Water Fleas)	**1**	**2**	**3**	**4**	**5**	**Copecoda (Copepods)**	**1**	**2**	**3**	**4**	**5**	**Rotifera (Rotifers)**	**1**	**2**	**3**	**4**	**5**
Chydorus					P	*Cyclops*				R	P	*Anuraeopsis*				R	R
						Nauplii					P	*Ascomorpha*				P	P
												Brachionus				P	P
												Conochilus					P
												Keratella				P	P
												Polyartha				P	P
Sites:	**1**	**2**	**3**	**4**	**5**	**Comments:**											
Total Phytoplankton Genera	19	22	23														
Total Cyanobacteria (cells/mL)	229,597	111,771	467,145														
Total Zooplankton Genera				6	9												
						Phytoplankton Key: Bloom (B), Common (C), Present (P), and Rare (R)											
						Zooplankton Key: Dominant (D), Abundant (A), Present (P), and Rare (R); Herbivorous (H) or Carnivorous (C)											

Sampling Location: Lake Hopatcong						**Sampling Date: 10/6/22**						**Examination Date: 10/14/22**					
Site 1: ST-2 Surface Phyto			**Site 2: ST-2 Mid Phyto**					**Site 3: ST-3 Surface Phyto**				**Site 4: ST-2 Surface Zoo**	**Site 5: ST-2 Deep Zoo**				
Phytoplankton																	
Bacillariphyta (Diatoms)	**1**	**2**	**3**	**4**	**5**	**Chlorophyta (Green Algae)**	**1**	**2**	**3**	**4**	**5**	**Cyanophyta (Blue-Green Algae)**	**1**	**2**	**3**	**4**	**5**
Asterionella			P			*Akinstrodesmus*	P	C	C			*Aphanizomenon*	19,965	19,847	15,919		
Cyclotella		P	P			*Chlorella*	P		P			*Dolichospermum*	633	601	1,910		
Fragilaria	C	C	C			*Gleomonas*	P					*Pseudanabaena*	5,701	2,105	5,731		
Melosira	P	P	P			*Koliella*		P									
Synedra	C	C	C			*Pediastrum*	R	P	C								
Tabellaria	P	P	P			*Scenedesmus*	R	P	C								
						Staurastrum	P	P	P								
												Euglenophyta (Euglenoids)					
												Trachelomonas	C	C	P		
												Phacus					
Chrysophyta (Golden Algae)												**Dinoflagellates**					
Dinobryon			P			**Cryptomonads**						*Ceratium*	R				
						Cryptomonas	C	C	C								
Zooplankton																	
Cladocera (Water Fleas)	**1**	**2**	**3**	**4**	**5**	**Copecoda (Copepods)**	**1**	**2**	**3**	**4**	**5**	**Rotifera (Rotifers)**	**1**	**2**	**3**	**4**	**5**
Bosmina					P	*Cyclops*					P	*Ascomorpha*				P	P
Daphnia				R		Nauplii					P	*Asplanchna*					P
												Brachionus				R	P
												Gastropus				P	
												Keratella				P	C
												Polyartha				P	C
												Pompholyx				C	A
												Trichocerca				P	P
Sites:	**1**	**2**	**3**	**4**	**5**	**Comments:**											
Total Phytoplankton Genera	16	15	17														
Total Cyanobacteria (cells/mL)	26,299	22,553	23,560														
Total Zooplankton Genera				8	10												
						Phytoplankton Key: Bloom (B), Common (C), Present (P), and Rare (R)											
						Zooplankton Key: Dominant (D), Abundant (A), Present (P), and Rare (R); Herbivorous (H) or Carnivorous (C)											