LAKE HOPATCONG
WATER QUALITY MONITORING
ANNUAL REPORT 2016

PREPARED FOR:

The Lake Hopatcong Commission
P.O. Box 8515
Landing, New Jersey 07850

and

The Lake Hopatcong Foundation
37 Nolan's Point Park Rd.
Lake Hopatcong, NJ 07849

PREPARED BY:

Princeton Hydro, LLC
1108 Old York Road, Suite 1
P.O. Box 720
Ringoes, New Jersey 08551
(P) 908.237.5660 • (F) 908.237.5666

203 Exton Commons
Exton, Pennsylvania 19341
(P) 610.524.4220 • (F) 610.524.9434

December 2016
Princeton Hydro, LLC Project No. 3.49

Table of Contents

1.0 INTRODUCTION

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2016 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 have been funded 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. However, remaining funds in the 319(h) grant were made available for the 2014, 2015 and 2016 water quality monitoring programs.

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 two NJDEP 319 grants and a US EPA Targeted Watershed grant.

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 will be an important component in evaluating the long-term success of the implementation of the phosphorus TMDL-based Restoration Plan, which was approved by NJDEP in April of 2006.

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 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

The 2016 sampling dates were 17 May, 28 June, 2 August, 1 September and 3 October. A Eureka Amphibian PDA with Manta multi-probe unit was used to monitor the *in-situ* parameters: dissolved oxygen (DO), temperature, pH, and specific conductance during each sampling event. Data were recorded at 1.0 m increments starting at 0.25 m below the water's surface and continued to within 0.5-1.0 m of the lake sediments at each station during each sampling date. 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 at 0.5 m below the lake surface and 0.5 m above the sediments at the mid-lake sampling site (Station #2). Discrete samples were collected from a sub-surface (0.5 m) position at the remaining six (6) original sampling stations (Stations #1, 3, 4, 5, 6 and 7) and additionally at the Northern Woodport Bay and Jefferson Canals sites (Stations #10 and #11, respectively) on each date. 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
- nitrate-N
- ammonia-N
- chlorophyll *a*

All laboratory analyses were performed in accordance with *Standard Methods for the Examination of Water and Wastewater, 18th Edition* (American Public Health Association, 1992). Monitoring at the Great Cove (Station #8) and Byram Cove (Station #9) sampling stations consisted of collecting *in-situ* and Secchi disk data; no discrete water samples were collected from these two stations for laboratory analyses. It should be noted that prior to 2005, Station #10 had been monitored for *in-situ* observations only. However, due to observations made at Station #10 by the Lake Hopatcong Commission operations staff, it was decided that this sampling station should be added to the discrete sampling list.

During each sampling event, vertical plankton tows were also conducted at the deep sampling station (Station #2). A 50-µm mesh plankton net was used to sample the phytoplankton, while a 150-µm mesh plankton net was used to sample the zooplankton. The vertical tows were deployed starting immediately above the anoxic zone (DO concentrations < 1 mg/L) and conducted through the water column to the surface.

Additional Water Quality Data Collected in 2016

In addition to the standard, long-term, in-lake monitoring program, supplemental in-lake data were collected as part of the 2016 monitoring program. From 2006 to 2016 some select, near shore, in-lake sampling sites were established and monitored. These additional in-lake sampling sites were located immediately adjacent to drainage areas where a stormwater structure was installed as part of an existing 319(h) grant (SFY05; Grant RP05-080). The three near-shore, in-lake sampling stations included:

1. The southern end of Crescent Cove in the Borough of Hopatcong (NPS-1).
2. Ingram Cove, located in the Borough of Hopatcong (removed from monitoring program).
3. Along the eastern shoreline of the lake, in the Township of Jefferson, just south of Brady's Bridge (NPS-2).

Through the course of implementing the SFY05 319(h) grant, it was determined that no BMP would be installed in the Ingram Cove drainage basin; the Ingram Cove project was dropped from the grant project due to site specific limitations associated with existing utilities. Subsequently, the proposed Ingram Cove project was moved to the Crescent Cove drainage area. However, monitoring of the Ingram Cove sampling station continued through 2008 and was discontinued from 2009 through the 2016 monitoring programs.

For the remaining two supplemental in-lake sampling stations, monitoring occurred during the May through September 2016 in-lake monitoring events. Monitoring included collecting *in-situ* data at 0.5 – 1.0 meters from surface to bottom for temperature, dissolved oxygen, pH and specific conductance. Water clarity was also measured at each station with a Secchi disk. Discrete mid-depth water samples were collected and analyzed for TP and TSS. The Crescent Cove station is NPS-1, while the Township of Jefferson station is NPS-2; both are shown in Figure 1 as yellow circles with an "X" inside (Appendix A).

As part of the SFY10 319 grant, some additional watershed-based restoration projects were implemented to reduce the NPS pollutant load entering Lake Hopatcong, with an emphasis on TP and TSS. Similar to the SFY05 grant, three near-shore sampling sites were located immediately adjacent to drainage areas that were receiving a structural BMP or MTD as part of the SFY10 319(h) grant (Grant RP10-087). These three nearshore, in-lake sampling stations include:

1. In Ashley Cove in the Township of Jefferson (NPS-3).
2. In King Cove in the Township of Roxbury (NPS-4).
3. Southern end of the public beach at the Hopatcong State Park (NPS-5).

Similar to the SFY05 near-shore sampling program (NPS-1 and NPS-2), *in-situ* monitoring and discrete samples were collected for TP and TSS at the three SFY10 near-shore sampling stations during each of the five 2016 monitoring events. However, discrete samples were also collected for the analysis of chlorophyll *a*, a photosynthetic pigment all algae possess, at the SFY10 sampling stations.

3.0 RESULTS AND DISCUSSION

Thermal Stratification

Thermal stratification is a condition where the warmer surface waters (called the epilimnion) are separated from the cooler bottom waters (called the hypolimnion) through differences in density, and hence, temperature. Thermal stratification separates the bottom waters from the surface waters with a layer of water that displays a sharp decline in temperature with depth (called the metalimnion or thermocline). In turn, this separation of the water layers can have a substantial impact on the ecological processes of a lake (for details see below). Thermal stratification tends to be most pronounced in the deeper portions of a lake. Thus, for convenience, the discussion on thermal stratification in Lake Hopatcong focuses primarily on the deep, mid-lake (Station #2) sampling station.

In-situ measurements during the 2016 growing season were generally consistent with values recorded in previous monitoring programs. By the late May event, Station #2 exhibited thermal stratification with the epilimnion extending to 4.0 m and the thermocline located between 4.0 m and 9.0 m. Stratification persisted throughout the rest of the sampling season with seasonally maximum values observed on 2 August 2016. A similar, yet slightly weaker degree of thermal stratification was also present at the other stations with sufficient depth (i.e. Stations 8 and 9) during the June, August and September events. Shallower stations throughout the lake did not exhibit stratification, with the exception of Station #4 and Station #11 where slight stratification was observed in May and August, respectively.

All five 319 sampling sites were well mixed from May through October 2016.

Strong and extensive amounts of thermal stratification can effectively "seal off" the bottom waters from the surface waters and overlying atmosphere, which can result in a depletion of dissolved oxygen (DO) in the bottom waters. With the exception of a few groups of bacteria, all aquatic organisms require measurable amounts of DO (> 1 mg/L) to exist. Thus, once the bottom waters of a lake are depleted of DO, a condition termed anoxia, that portion of the lake is no longer available as viable habitat.

Dissolved Oxygen

Atmospheric oxygen enters water by diffusion from the atmosphere, facilitated by wind and wave action and as a by-product of photosynthesis. Adequate dissolved oxygen (DO) is necessary for acceptable water quality. Oxygen is a necessary element for most forms of life. As dissolved oxygen concentrations fall below 5.0 mg/L, aquatic life is put under stress. DO concentrations that remain below 1.0 – 2.0 mg/L for a few hours can result in large fish kills and loss of other aquatic life. Although some aquatic organisms require a minimum of 1.0 mg/L of DO to survive, the NJDEP State criteria for DO concentrations in surface waters is 5.0 mg/L or greater, for a healthy and diverse aquatic ecosystem.

In addition to a temporary loss of bottom habitat, anoxic conditions (DO < 1 mg/L) can produce chemical reactions that result in a release of dissolved phosphorus from the sediments and into the overlying waters. In turn, a storm event can transport this phosphorus to the upper waters and stimulate additional algal growth. This process is called internal loading. Given the temporary loss of bottom water habitat and the increase in the internal phosphorus load, anoxic conditions are generally considered undesirable in a lake.

DO at Station #2 decreased sharply with depth during all sampling events during the 2016 season. The bottom of the lake exhibited conditions below the recommended State threshold during the May sampling event, but were still "oxic" (with oxygen) with concentrations above 1.0 mg/L. However, by 28 June 2016, anoxic conditions (DO concentration < 1 mg/L) were established at Station #2 starting at 8 m (DO concentration of 0.43 mg/L). Station #2 was the only site that exhibited anoxic conditions during the month of June. Concentrations below the recommended threshold were noted in the deep waters of Station #9 in both May and June, and Station #11 during June.

This anoxia observed in June persisted through the rest of the season at Station #2. During the summer, anoxia began at 6 meters. As the season progressed, the portion of the water column that was anoxic continued to shrink. By the September event, only the bottom two meters had very low DO. Anoxic conditions were also observed in the bottom meters at Stations #8 and #9 during the August event. DO was below the recommended threshold at the shallower stations on various occasions. These include Stations #7 and #11 in August, Stations 8, 9 and 11 in September, and Station 9 in October

All five of the NPS sampling stations were well oxygenated (DO > 5 mg/L) from surface to bottom during all five 2016 monitoring events. DO concentrations never fell into anoxic conditions, but NPS 5 decreased to 2.92 mg/L in the deeper waters. In addition, DO concentrations were frequently highly saturated or super saturated, particularly during the months of May and September. Such conditions of super-saturation indicate the presence of high densities of algal and aquatic plant biomass and hence elevated rates of photosynthesis, which generates DO.

Overall, a depression of DO was mainly limited to the hypolimnion of Station #2, with instances of anoxic conditions in the bottom meter of Stations #8 and #9. Thus, the majority of the lake had a sufficient amount of DO to support a diverse and healthy aquatic ecosystem (Appendix B).

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.

Throughout the lake in May 2016, pH values were generally acceptable, with the exception at Stations #1 and #3, maxing out at 8.79 and 9.43, respectively. The pH was above the NJDEP State standard at these times. The pH was well within the optimal range by the June and August event, with all but a couple of measurement in the 7s. The pH during the September sampling event began to increase, but remained within the NJDEP standard. Values decreased across the whole lake, returning to similar pH values seen in June and August.

The near-shore sampling areas (NPS-1 through NPS-5) generally sustained higher pH values during various sampling events when compared to open water stations. This is primarily due to elevated rates of photosynthesis from rooted aquatic vegetation and mat algae, in addition to the free-floating planktonic algae. June, August and October pH values were similar to the open water stations, remaining well below the State standard. Elevated values were seen during the May and September sampling events. During the May event, NPS-1 yielded very high pH, values reaching 9.7. NPS-5 had elevated pH during September, reaching 9.06. Measurements in the entire water column surpassed the State standard at these two stations.

Overall, the open water stations general remained well within the NJDEP State optimal range of 6.5 and 8.5. The only deviations were seen at Stations #1 and #3 during the May event. Similar results were seen at the near-shore sampling stations.

Water Clarity (as measured with a Secchi disk)

Water clarity or transparency was measured at each in-lake monitoring station, during each monitoring event, with a Secchi disk. 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).

In May 2016, Secchi depths were all equal to or greater than 1 meter. In June, this persisted at all stations, with the exception of Station #10, which had a Secchi of 0.9 m. By the August sampling event, Secchi values once again were equal to or above 1 meter. This persisted through the end of the 2016 season. Clarity issues typically seen in past years at various stations were not present in 2016, even with the slightly low Secchi noted at Station #10.

Overall, the near-shore sampling stations (NPS-1 through NPS-5) had acceptable transparency throughout the season. During all events, NPS-4 and 5 remained well above the recommended Secchi of 1.0 m. Secchi ranged from 1.5 and 2.5 m, often with clarity to the sediment. NPS-2 and NPS-3 had visibility to the bottom during each sampling event, except NPS-3 during the August sampling, where Secchi was 0.1 m (total depth of 0.7 m). At NPS-1, Secchi depth fell below 1 meter during the months of June, August and September.

Ammonia-Nitrogen (NH_4-N)

Surface water NH_4-N concentrations above 0.05 mg/L tend to stimulate elevated rates of algal growth. Surface Ammonia concentrations measured during the May 2016 event were low throughout the lake and varied from 0.01 to 0.05 mg/L. Bottom water NH_4-N concentrations at Station #2 were elevated, reaching 0.28 mg/L. Elevated concentrations of NH_4-N are a natural occurrence in the bottom water of lakes due to the bacterial decomposition of organic material. By the June sampling event, ammonia-N concentrations ranged slightly from undetectable (<0.01 mg/L) to 0.08 mg/L. The only surface station above the recommended 0.05 mg/L threshold was

Station #11. Once again, deep waters at Station #2 were highly elevated, with a concentration of 0.42 mg/L.

By August 2016, six of the surface stations had undetectable NH4-N concentrations (< 0.01 mg/L). The only surface station to exceed the 0.05 mg/L threshold was Station #3. The deep station continued to have very elevated concentrations (0.37 mg/L). By the September sampling event, all surface stations had either undetectable concentrations or ammonia-N concentrations at 0.01 mg/L. Ammonia-N almost tripled since the August sampling event in the deep waters of Stations #2, reaching 0.90 mg/L. Undetectable levels only persisted at Station #1 in the October sampling event. The rest of the surface stations ranged between 0.01 and 0.04 mg/L. Ammonia increased to a seasonal high of 1.20 mg/L at the deep station.

In summary, the excessively high concentration of NH_4-N in the deep (hypolimnetic) waters at Station #2 was attributed to the depletion of DO and the bacterial decomposition of the organic matter raining to the bottom from the surface waters. Surface water NH_4-N concentrations were consistently low from June through September, with only two slight spikes, one at Station #11 in June and the other at Station #3 in August. Leachate from near-shore septic systems may have contributed to the slightly elevated NH_4-N concentrations in the surface waters of some stations. The watershed lands immediately adjacent to Stations #3 and #11 are known to have high densities of old (some > 50 years old), near-shore septic systems, which frequently contribute elevated pollutant loads (e.g. nitrogen, phosphorus, fecal coliform, and *E. coli*) to the lake. Ammonia-N concentrations seemed lower than previous years, indicating septic systems may be becoming less problematic during drier climatic conditions.

Nitrate-Nitrogen (NO_3-N)

Nitrate-N concentrations greater than 0.1 mg/L are considered excessive relative to algal and aquatic plant growth. In May 2015, nitrate-N concentrations were very low ranging from undetectable (ND<0.02 mg/L) to 0.03 mg/L. The exceptions to this were at Station #7 and in the deep waters at ST-2, where the measured nitrate-N concentrations were 0.12 and 0.14 mg/L, respectively. By 2016, all nitrate-N concentrations throughout Lake Hopatcong were below the 0.1 mg/L threshold, varying between <0.02 and 0.06 mg/L.

By August, the majority of measured nitrate-N concentrations, surface and deep, were below the 0.1 mg/L threshold, however, Station #7 had the highest measured concentration at 0.63 mg/L. By the September sampling event, all concentrations returned to below that recommended threshold, ranging between undetectable to 0.08 mg/L. This pattern persisted through October with low nitrate-N concentrations throughout all of Lake Hopatcong.

In summary, all in-lake nitrate-N concentrations were consistently below the State and Federal drinking water standard of 10.0 mg/L. Nitrate-N concentrations only exceeded the 0.1 mg/L threshold that stimulates elevated amounts of algal and aquatic plant growth in Station #2 DEEP in May and Station #7 in May and August. In 2014, exceedances typically occurred in those sections of the lake immediately adjacent to lands that have homes using septic systems (Borough of Hopatcong around Crescent Cove / River Styx; Township of Jefferson around Woodport and in the Canals). This indicates that aged, near-shore septic systems contribute to the pollutant load of Lake Hopatcong and thus have a direct impact on its water quality. This pattern was not as obvious during the past two growing seasons, more than likely due to the dry, late summer conditions.

Total Phosphorus (TP)

Phosphorus has been identified as the primary limiting nutrient for algae and aquatic plants in Lake Hopatcong. Essentially, a small increase in the phosphorus load will result in a substantial increase in algal and aquatic plant growth. For example, one pound of phosphorus can generate as much as 1,100 lbs of wet algae biomass. This fact emphasizes the continued need to reduce the annual phosphorus load entering Lake Hopatcong, as detailed in the lake's revised TMDL and associated Restoration Plan.

Studies have shown that TP concentrations as low as 0.03 mg/L can stimulate high rates of algal growth resulting in eutrophic or highly productive conditions. Based on Princeton Hydro's in-house database on northern New Jersey lakes, TP concentrations equal to or greater than 0.06 mg/L will typically result in the development of algal blooms / mats that are perceived as a nuisance by the layperson.

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 <u>average</u>, growing season TP concentration of 0.03 mg/L within the surface waters of Lake Hopatcong.

TP concentrations measured in the surface waters during the May 2016 sampling event ranged from 0.02 mg/L to 0.04 mg/L with a surface water mean concentration of 0.027 mg/L. The deep-water TP concentration at Station #2 was 0.05 mg/L. All but one surface station was less than or equal to the State and TMDL thresholds.

TP concentrations in the surface waters during the June 2016 event increased slightly to a range of 0.02 mg/L to 0.06 mg/L with a mean concentration of 0.031 mg/L. Station #2 DEEP decreased to 0.02 mg/L. Three surface station TP concentrations exceeded the State's Surface Water Quality Standard.

The surface water TP concentrations measured during the August event narrowed to a range of less than 0.01 mg/L to 0.03 mg/L, all less than the State's Water Quality Standard. This sampling had the lowest surface mean of any of the 2016 events. The TP concentration at ST-2 DEEP increased to 0.08 mg/L.

In September 2016, surface TP varied greatly, ranging from 0.02 to 0.20 mg/L. Spikes were seen at both Stations #3 and #4, but the very elevated concentrations of 0.20 mg/L were seen at Station #3. Deep water concentrations were also elevated with a TP concentration of 0.27 mg/L, but was a result of the depletion of DO immediately over the sediments. In the absence of DO, phosphorus normally adsorbed onto sediment particles, leaches into the overlaying waters.

In summary, surface concentrations were very consistent across the whole lake, with all but one station with a concentration of 0.02 mg/L. Station #5 had a TP measurement of 0.01 mg/L. Deep water concentrations of 0.27 mg/L persisted through this sampling, explained by the continuing anoxic conditions.

Deep water TP concentrations at Station #2 varied between 0.02 and 0.27 mg/L, peaking in September and October. Again, the deep water TP concentrations increased over the growing season once the bottom waters were depleted of DO.

The mean TP concentration was calculated for each surface water sampling station to determine if they complied with or exceeded the concentration of 0.03 mg/L established under the lake's TMDL. Of the nine standard, long-term water quality monitoring stations, all but one complied with the TMDL. That is, they each had a mean 2016 growing season concentration at or less than 0.03 mg/L. The only surface station that was out of compliance with the TMDL or the State's Surface Water Quality Standard was ST-3 (Crescent Cove/River Styx) with 0.07 mg/L. As past monitoring data have revealed, this section of the lake was in the highest need of restoration efforts in order to move the lake into compliance with its TMDL. These sections of the lake have some of the highest densities of residential housing and/or include lots with aged, near-shore septic systems, which contribute to the elevated TP loads and concentrations. The 2015 data showed Station #3 to be in compliance, but historically the station is frequently out of compliance.

As part of the existing SFY05 319 grant, two large Aqua-Filter Manufactured Treatment Devices (MTDs) were installed in the southern end of the Crescent Cove drainage basin to reduce a large portion of the TP and TSS loads that enter the lake from this section of the watershed. The first

MTD was installed in November of 2008, while the second was installed in June of 2011. The NPS-1 monitoring station was established in 2006 in order to assess how the implementation of these MTDs, as well as other restoration measures (i.e. sewering part of the drainage area; more wide-spread use of non-phosphorus fertilizers) have impacted this section of the lake.

The data collected from 2006 to 2008 were prior to the installation of the two large Aqua-Filters, while the data collected in 2009 and 2010 were after the first Aqua-Filter was installed and the data collected in 2011 through 2016 were after the second Aqua-Filter was installed.

As shown in Table 1, before the first Aqua-Filters was installed, the mean growing season (May – September) TP concentration in Crescent Cove was 0.06 mg/L; these mean values are greater than both the State's Surface Water Quality Standard of 0.05 mg/L for standing waterbodies, as well as the targeted TMDL concentration of 0.03 mg/L. However, after the first Aqua-Filter was installed in late 2008, the mean TP concentration declined to 0.045 mg/L (Table 1; 2009 monitoring year). While this value was still greater than the targeted TMDL concentration of 0.03 mg/L, it was below the State's Surface Water Quality Standard of 0.05 mg/L. In addition, only one of four TP measurements in 2009 was above the State standard.

Table 1
The Mean and Range of TP and TSS Concentrations for Crescent Cove Over the Growing Season of Each Monitored Year

Monitoring Year	TP mean and range	TSS mean and range
2006 (pre-installation)	0.06 mg/L (0.05 – 0.075 mg/L)	10 mg/L (6 – 15 mg/L)
2007 (pre-installation)	0.06 mg/L (0.04 – 0.08 mg/L)	7 mg/L (3 – 11 mg/L)
2008 (pre-installation)	0.06 mg/L (0.04 – 0.08 mg/L)	14 mg/L (1.5 – 48 mg/L)
2009 (post-installation)	0.045 mg/L (0.03 – 0.06 mg/L)	7 mg/L (1.5 – 8 mg/L)
2010 (post-installation)	0.07 mg/L (0.02 – 0.09 mg/L)	8 mg/L (1 -15 mg/L)
2011 (post-installation)	0.04 mg/L (0.01 – 0.08 mg/L)	5 mg/L (1 – 11 mg/L)
2012 (post-installation)	0.06 mg/L (0.03 – 0.08 mg/L)	6 mg/L (3 – 10 mg/L)
2013 (post-installation)	0.05 mg/L (0.04 – 0.07 mg/L)	7 mg/L (2 – 15 mg/L)
2014 (post-installation)	0.05 mg/L (0.03 – 0.09 mg/L)	8 mg/L (4 – 13 mg/L)
2015 (post-installation)	0.04 mg/L (0.03 – 0.05 mg/L)	4 mg/L (1.5 – 5 mg/L)
2016 (post-installation)	0.06 mg/L (0.02 – 0.16 mg/L)	10 mg/L (1.5 –33 mg/L)

In sharp contrast to the 2009 results, during the 2010 growing season, only one of the five sampling events was below the Sate Standard at NPS-1. The mean TP concentration at NPS-1 in 2010 was 0.07 mg/L greater than the mean values measured prior to the installation of the Aqua-Filter (2006-08). These conditions were in spite of the fact that 2010 had a relatively dry growing season. More than likely, these elevated TP concentrations indicated that the first Aqua-Filter needed to be maintained. Specifically, the filter pillows needed to be replaced and the Aqua-Swirl portion of the structure needed to be cleaned out. At a minimum, the Aqua-Filter should be inspected quarterly and accumulated material in the Aqua-Swirl should be vacuumed out several times a year. This would allow the structure to at least continue to remove accumulated sediments and the phosphorus adsorbed onto such particles. However, to maximize its phosphorus removal capacity, the filter pillows should be replaced as well.

The second Aqua-Filter was operating by the end of June 2011 and the resulting mean 2011 growing season TP concentration for NPS-1 was 0.04 mg/L, the lowest mean value of the entire 2006 - 2015 dataset (Table 1). Of the five 2011 sampling events, only one was above the State standard. In addition, three of the five had TP concentration at or below the TP concentration targeted under the TMDL (0.03 mg/L). However, by 2012 TP concentrations were again on the rise with a mean of 0.06 mg/L, again above the State threshold (Table 1 and Figure 1). Of the five measurements collected over the 2012 growing season, only two were below the State threshold. In 2013, the mean TP concentration was 0.05 mg/L (Table 1), with three of the five values at or below the State standard. The 2014 monitoring data were similar to that documented in 2013. That is, the mean TP concentration was 0.05 mg/L. Additionally, three of the five TP concentrations were below the State's standard.

In 2015, the mean concentration once again decreased to 0.04 mg/L, which is within the State standard of 0.05 mg/L. All of the five TP concentrations fell at or below this standard, while only one met the TMDL targeted concentration of 0.03 mg/L.

In 2016, the mean TP concentration increased to 0.06 mg/L, which is above the recommended State standard. Three of the five events exceeded this standard, tripling during the August event. The May and October samplings fell below the TMDL targeted concentration. A comparison of the overall pre-installation mean TP concentration (0.06 mg/L; 2006 to 2008) to the overall post-installation mean TP concentration (0.05 mg/L; 2009 to 2016) indicates that the Aqua-Filter stormwater systems have contributed toward an approximately 17% reduction in the in-cove phosphorus concentrations. While such reductions are a positive step, more work is required to further improve the water quality of this section of Lake Hopatcong and eventual compliance with the TMDL.

While not discussed in a high level of detail as TP, it should be noted that there has been a measurable decline in total suspended solids (TSS) concentrations once the Aqua-Filters were installed. Prior to their installation (2006 – 2008), TSS concentrations ranged from 1.5 to 48 mg/L, with growing season means ranging from 7 to 14 mg/L. In contrast, after the Aqua-Filters were installed, TSS concentrations ranged from 1 to 33 mg/L, with growing season means ranging from 4 to 10 mg/L (Table 1). Without the elevated TSS concentration of 33 mg/L in 2016, TSS only ranged from 1-15 mg/L over the post-installation sampling. It should be noted the excessive TSS concentration was measured during the same sampling event when the excessive TP concentration of 0.16 mg/L (Figure 1) was measured. This indicates that a large fraction of the phosphorus entering this part of the lake originates from surface runoff and stormwater, where phosphorus is typically adsorbed onto sediment particles.

The average TSS concentration in 2016 was the highest recorded since pre-installation samplings. A comparison of the overall pre-installation mean TSS concentration (10 mg/L; 2006 to 2008) to the overall post-installation mean TSS concentration (6.8 mg/L; 2009 to 2016) indicates that the Aqua-Filter stormwater systems have contributed toward a 32% reduction in the in-cove TSS concentrations. Thus, in-lake TP and TSS concentrations were lower in the southern end of Crescent Cove, once the Aqua-Filters were installed. However, it is worth repeating that in order to maximize pollutant removal efficiencies, both structures, at a minimum, should be cleaned out at least once a year.

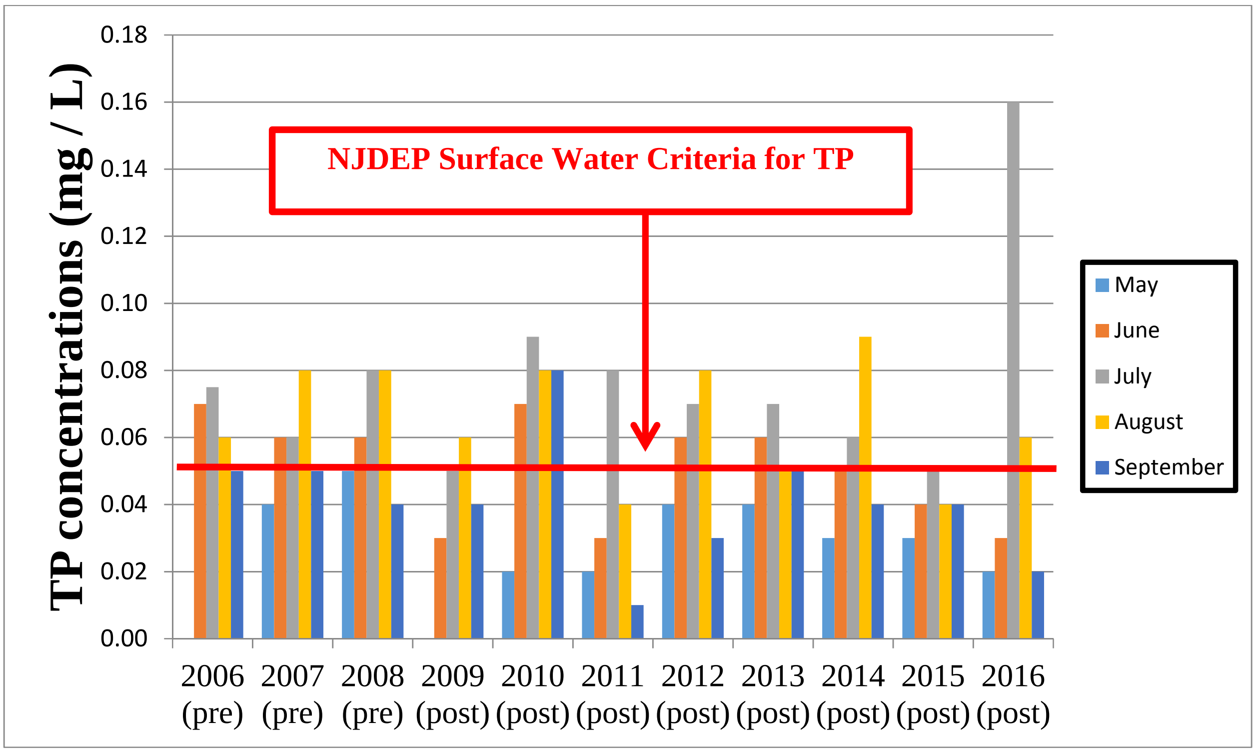
Based on some conversations over the last years, it is understood that the Borough of Hopatcong has been at least pumping out the Aqua-Swirl portion of the two stormwater structures in the Hopatcong Beach Club's parking lot. Routine clean-outs of these stormwater structures have directly contributed to these reduced TP and TSS concentrations in the southern end of Crescent Cove. However, in order to continue to reduce the concentrations and loads of these pollutants, the following must be conducted:

1. At a minimum, inspect the Aqua-Swirl portion of the Aqua-Filter 2-4 times a year and pump out the Aqua-Swirl portion of each structure at least once a year.

2. Inspect and clean out the Aqua-Filter chambers; in addition, if possible, replace the existing filter pillows with new ones (the filter pillows are designed to remove dissolved phosphorus from the stormwater).

Finally, while some reductions in TP and TSS concentrations have been made since the installation of the Aqua-Filter, there is still more pollutant loading that needs to be addressed in this part of the Lake Hopatcong watershed. Other sources of untreated stormwater and leachate from aged, near-shore septic systems continue to contribute to elevated concentrations of TP. Thus, additional restoration measures need to be considered moving forward to continue to improve upon the existing water quality conditions of Lake Hopatcong.

Figure 1
TP Concentrations in Crescent Cove (NPS-1) Over the Growing Season of Each Monitored Year from 2006 to 2016



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 30.0 µg/L. Based on the findings of the refined TMDL, the existing average seasonal chlorophyll *a* concentration under current conditions is 15 µg/L, while the maximum seasonal value is 26 µg/L. In contrast, the targeted average and maximum chlorophyll *a* concentrations, once Lake Hopatcong is in complete compliance with the TMDL, are predicted to be 8 and 14 µg/L, respectively.

Chlorophyll *a* concentrations during the May 2016 event ranged from 3.3 µg/L at Station #11 to 16.7 µg/L at Station #1 with a mean concentration of 7.6 µg/L. The mean value for May 2016 was below the targeted average, while the maximum value was above the targeted maximum. No values exceeded the existing maximum concentration (26 µg/L).

Chlorophyll *a* concentrations during the June sampling ranged from 3.9 µg/L at Station #6 to 31.0 µg/L at Station #3 with a mean concentration of 11.3 µg/L. The mean is above the targeted average and the maximum value is above the targeted maximum concentration. Of the nine June 2015 concentrations, only two (Stations #3 and #10) exceeded the targeted maximum concentration under the TMDL. Station #3 concentrations at this time were the second highest recorded during 2016.

Overall, chlorophyll *a* increased by the August event with concentrations ranging from 4.1 µg/L at Station #11 to 35.0 µg/L at Station #3 with a mean concentration of 13.8 µg/L. The mean July concentration exceeded the targeted mean of 8 µg/L, while the maximum threshold concentration was exceeded in three of the nine sampling stations; Woodport Bay, Crescent Cove/River Styx and Northern Woodport Bay sampling stations (Stations #1, #3 and #10).

In September chlorophyll *a* concentrations varied between 3.9 µg/L at Station #5 to 25.0 µg/L at Station #10 with a mean concentration of 12.7 µg/L, decreasing from the previous month. The average and six of the stations exceeded the targeted TMDL mean, while only three of the stations (#1, #3 and #10) exceeded the maximum threshold of 14 µg/L.

In October 2016 chlorophyll *a* concentrations decreased overall, varying from 3.3 µg/L at Station #11 to 19.0 µg/L at both Stations #10 with a mean concentration of 11.0 µg/L. At this time, three of the nine sampling stations had concentrations that exceeded the targeted maximum concentration.

Chlorophyll *a* concentrations at the NPS-3 station remained low throughout the growing season, ranging from a low of 3.1 µg/L in September and a high of 14 µg/L in August. The average, 8.54 µg/L, was just above the targeted mean and maximum values were 14 µg/L. These concentrations are below the existing TMDL average and maximum. NPS-4 was lowest during the August event with a concentration of 3.8 µg/L and a high of 5.4 µg/L during the June sampling, all well below the targeted mean and maximum values. NPS-5 remained below the targeted mean during all months, ranging from 3.7 to 6.9 µg/L

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.

Table 1 lists the dominant phytoplankton identified in Lake Hopatcong during each water quality monitoring event in 2016. Algal abundance was high during the 17 May 2016 event with a documented bloom of *Tabellaria* and *Fragilaria*. The green alga *Microspora* and the dinoflagellate *Ceratium* were present at this time. A few other plankton were noted as rare.

Total algal richness persisted during the 28 June 2016 sampling event with 6 genera. Various plankton were abundant at this sampling event, including a diatom (*Asterionella*), green algae (*Chlorella*) and blue-green algae (*Anabaena*). Three plankton were recorded as common, including genera in the diatoms, chrysophytes and blue green algal groups.

The 2 August 2016 event algal abundance was at a high, yielding 13 genera. Blue-green algae *Anabaena* and green algae *Chlorella* were abundant during this sampling event. Five other genera were listed as common, including *Fragilaria*, *Tabellaria*, *Dinobryon*, *Staurastrum* and *Phormidium*. Six other genera were listed as present, represented by the blue greens, diatoms, dinoflagellates and green algae.

By 1 September 2016 algal richness and diversity slightly decreased to 10 genera identified with the blue-green algae *Lyngbya* being most abundant. Four genera of plankton were identified as common (*Fragilaria*, *Tabellaria*, *Synedra* and *Anabaena*). Five genera were identified as present, represented by the green algae, chrysophytes, blue greens and dinoflagellates.

Total algal abundance and diversity were highest during the 13 October 2016 sampling event with 17 different genera identified. No algae were dominant at this time. Five genera of plankton were considered common, including three diatoms (*Fragilaria*, *Melosira* and *Tabellaria*), the green algae *Pediastrum* and the blue-green *Anabaena*. Twelve genera were identified as present, represented by diatoms, chrysophytes, green algae and blue-greens.

While blue-greens were present throughout the entire 2015 growing season, high densities were not seen. During three events, only one genera was labeled as abundant.

Table 1
Phytoplankton in Lake Hopatcong during the 2016 Growing Season

Sampling Date	Phytoplankton
17 May 2016	Algal abundance was high, but diversity was low. A bloom of *Tabellaria* and *Fragilaria* occurred at this time. Green algae *Microspora*, and dinoflagellate *Ceratium*, were listed as present. *Pediastrum* and the blue green *Anabaena* were listed as rare.
28 June 2016	Total algal abundance was moderately high. Abundant phytoplankton were the blue-green algae *Anabaena*, the diatom A*sterionella*, and the green algae *Chlorella*. In addition, *Fragilaria*, *Dinobryon* and *Aphanocapsa* were common at this time.
2 August 2016	Algal abundance was high, with the most common genera being the blue-green algae *Anabaena* and green algae *Chlorella*. Several green algae, chrysophytes, diatoms, dinoflagellates and blue-green algae were also noted in varying densities.
1 September 2016	Algal abundance was moderate to high with an abundance of the blue green *Lyngbya*. Also common were the blue-green algae *Anabaena* and diatoms *Fragilaria*, *Synedra* and *Tabellaria*. Five genera of green algae were identified as present. These were D*inobryon, Ceratium, Pediastrum, Snowella* and *Microcystis.*
13 October 2016	Diversity was high with 17 genera identified. Five genera were listed as common, including diatoms, green algae and blue-greens. In addition, several genera of green algae, chrysophytes, blue-greens and diatoms were identified as present.

Zooplankton

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 Station #2 during each monitoring event. The results of these samples are provided in Table 2.

The zooplankton community identified during the 17 May 2016 sampling event was very sparse. Two rotifers, K*eratella cochlearis* and K*ellicottia longispina*, were identified as common during this event. The only other genera present at this time was the cladoceran *Bosmina*.

During the 28 June 2016 sampling event, zooplankton abundance and diversity increased, yielding five different genera including cladocerans, copepods and rotifers. The most abundant zooplankton were the copepods *Cyclops* and nauplii (juvenile copepods) and the cladoceran *Bosmina*.

Richness increased to seven genera during the 2 August 2016 sampling event. No single genus was dominant at this time. Five of the seven genera were listed as common. These included the rotifers *Polyarthra* and *Brachionus*, copepods *Cyclops* and nauplii, and the herbivorous cladoceran *Daphnia*. *Bosmina* and *Trichocerca* were listed as present during this event.

Very low zooplankton densities were noted during the 1 September 2016 sampling event. Only two genera were identified at this time, including the cladoceran B*osmina* and the rotifer *Keratella*. Both of these genera were present but not particularly common.

During the 13 October 2016 sampling event, zooplankton abundance increased to seven recorded genera. Of these seven, four were listed as common, include two cladocerans (*Bosmina* and *Daphnia*) and two copepods (*Cyclops* and nauplii). Three rotifer genera, *Keratella*, *Asplanchna* and *Brachionus*, were also present during this sampling event.

Similar to past monitoring years, herbivorous zooplankton were present in Lake Hopatcong, but in low densities during spring. Such conditions are indicative of a fishery community dominated by a large number of small, zooplankton-feeding fishes (e.g. golden shiners, alewife, young perch), where large-bodied zooplankton cannot exert a high degree of algal control through grazing.

Table 2
Zooplankton in Lake Hopatcong during the 2016 Growing Season

Sampling Date	Zooplankton
17 May 2016	Zooplankton numbers were low, with only three genera represented. *Keratella cochlearis* and *Kellicottia longispina* were listed as common. The cladoceran B*osmina* was also present.
28 June 2016	Zooplankton abundance was moderate with good diversity (5 genera were identified). The cladoceran *Bosmina* and the copepods C*yclops and nauplii* were abundant. A couple of rotifers, including A*splanchna* and *Polyarthra* were also present.
2 August 2016	Zooplankton abundance was moderate, with high diversity. Common were two rotifers (*Polyarthra* and *Brachionus*), two copepods (*Cyclops* and *Nauplii*) and the cladoceran D*aphnia*. The cladoceran *Bosmina* and rotifer *Trichocerca* were present during this event.
1 September 2016	Low zooplankton abundance and diversity were noted during this event with only 2 genera recorded. Cladoceran *Bosmina* and rotifer K*eratella* were present during this event.
13 October 2016	The zooplankton community exhibited moderate abundance. No single genus was dominant at this time. Both *Daphnia* and *Bosmina* were common at this sampling. Copepods, *Cyclops* and nauplii were also listed as common. Three rotifers were present.

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 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 mg/L.

While all trout are designated as coldwater fish, trout species display varying levels of thermal tolerance. Brown trout (*Salmo trutta*) have an optimal summer water temperature range of 18 to 24^{o}C (65 to 75^{o}F) (USEPA, 1994). However, these fish can survive in waters as warm as 26^{o}C (79^{o}F) (Scott and Crossman, 1973), defined here as acceptable habitat. The 2016 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 mg/L and water temperatures less than 24^{o}C were considered optimal habitat for brown trout. In contrast, sections of the lake that had DO concentrations equal to or greater than 5 mg/L and water temperatures between 24 and 26^{o}C were considered carry over habitat for brown trout.

Optimal brown trout habitat was present from the surface waters to a depth of 11.0 meters (36 feet) at Station #2 during the May 2016 sampling event. By 28 June 2016, the optimal habitat decreased to depths between 4.0 to 6.0 meters. Carry over habitat was found from the surface to 4.0 meters (13 feet). Neither optimal or carry over habitat was present during the August 2016 sampling event as a result of a particularly dry and hot summer season. However, it should be noted that carry over habitat was re-established in early September as well as in Great Cove and Byram Cove (Stations #8 and #9, respectively) and even optimal trout habitat was found in Great Cove (Station #8) during the early September sampling event.

Optimal brown trout habitat was restored by the October sampling event, extending from the surface to 9 meters (30 feet).

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. In turn, this resulted in only 1.2% of the phosphorus associated with plant biomass being harvested in 2009. 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 four 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.

The mechanical weed harvesting program at Lake Hopatcong over the 2016 growing season, started on 24^{th} May and ended 20^{th} of October 2016 and removed a total of 4,024 cubic yards of wet plant biomass. This was more than 1,150 cubic yards of material than was removed in 2015. In turn, this accounted for 85 lbs of TP or 1.2% of the TP load targeted for removal under the TMDL. This is the first time since 2010 that the annual TP removed through mechanical harvesting exceeded a value of 1%. The 85 lbs of TP removed through the 2016 weed harvesting program had the potential to generate up to 93,865 lbs of additional wet algal biomass.

Inter-annual Analysis of Water Quality Data

Annual mean values of Secchi depth, chlorophyll *a* and total phosphorus concentrations were calculated for the years 1991 through 2016. The annual mean values for Station #2 were graphed, along with the long-term, "running mean" for the lake.

The 2016 mean Secchi depth was 2.4 meters, which is one of the higher Secchi depths recorded in Hopatcong's long-term data. Additionally, the Secchi depth has continued to increase over the past few years (Figure 2 in Appendix A).

The mean chlorophyll *a* concentrations (10.5 µg/L) for the 2016 season was just slightly above the long-term mean. While greater than 2015 mean, it was substantially lower than the 2014 mean value. The mean 2014 chlorophyll *a* concentration was the highest measured out of the entire 1991 – 2016 dataset. The 2014 growing season was cool but unusually wet, transporting watershed-based nutrients and solids into the lake, which more than likely stimulated additional algal growth.

In contrast, the drier and hot summer / early fall conditions of Lake Hopatcong in 2016 limited the amount of available nutrients, which in turn meant lower amounts of algal biomass (Figure 3 in Appendix A). Consequently, since water clarity (as measured with the Secchi disk) and algal biomass (as measure through chlorophyll *a*) were both lower, the abundance of submerged, rooted aquatic vegetation was higher in 2015 and 2016 relative to 2014.

The 2016 mean TP concentration was 0.017 mg/L. The mean TP value has remained consistent since 2014. The 2014-2016 mean TP concentrations were higher than those mean values of 2010, 2011 and 2013 but lower than the value for 2012 (Figure 4 in Appendix A). As previously stated, while some sections of Lake Hopatcong, such as River Styx / Crescent Cove and the northern parts such as Woodport, still occasionally exhibit nuisance algae and weed growth, the main body of the lake has shown improved water quality conditions relative to phosphorus reductions and acceptable amount of algal growth.

Water Quality Impairments and Established TMDL Criteria

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 endpoints, was established to identify compliance with the TMDL. For the sake of this 2016 analysis, the mid-lake (Station #2), Crescent Cover / 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 mg/m^3
Targeted maximum chlorophyll *a* concentration endpoint	14 mg/m^3

The 2016 seasonal mean and single TP concentrations at Station #2 were all consistently below or equal to the targeted mean TP concentration, recognized under the TMDL (0.03 mg/L). The seasonal mean chlorophyll *a* concentration exceeded the targeted mean chlorophyll a concentration of 8 mg/m^3. All but one of the chlorophyll *a* concentrations in Station #2 were below than the targeted maximum chlorophyll *a* concentration endpoint. Only the August event slightly exceeded the targeted maximum value.

For Station #3, the mean TP concentration in 2016 (0.07 mg/L) was above the targeted mean of 0.03 mg/L. Only two single TP concentrations were below the mean during the growing season. The May and June event slightly exceeded the target, with 0.04 and 0.06 mg/L, while the September sampling yielded 0.20 mg/L. In addition, the mean chlorophyll *a* concentration was well above the targeted mean, with a concentration of 20.12 mg/m^3. Both the May and October values were less than the maximum chlorophyll *a* concentration threshold. The middle three sampling events were highly elevated reaching 35 mg/m^3.

At Station #10, the mean TP concentration in 2016 was at the targeted mean of 0.03 mg/L. Only one sampling event exceeded this target. The mean concentration of chlorophyll *a* (21.38 mg/m^3) greatly exceeded the targeted mean concentration of 8 mg/m^3. All but one sampling event (May) had a value greater than the targeted maximum chlorophyll *a* concentration endpoint of 14 mg/m^3.

4.0 SUMMARY

This section provides a summary of the 2016 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. By mid May 2016 the lake was thermally stratified, but was well oxygenated from surface to 11 meters with DO concentrations greater than 5.0 mg/L. In June, this range of oxygenated water decreased to 6 meters. From August to October 2016 the lake remained thermally stratified to varying degrees with an anoxic zone varying between 6 and 12 meters.

2. 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 amount of algal and/or aquatic plant biomass. TP concentrations in the surface waters of Lake Hopatcong typically varied between 0.02 mg/L and 0.04 mg/L. In a few instances, TP concentrations were 0.05 and 0.06 mg/L. An unusually high concentration of TP was seen at Station #3 (0.20 mg/L) during the September sampling event.

3. The majority of the nine sampling stations had mean TP concentrations at or below the targeted mean concentration of 0.03 mg/L, as recognized under the TMDL. The exception was Crescent Cove/River Styx (Station #3), likely due to nearby septic systems and associated residential / commercial stormwater contributing to phosphorus loading.

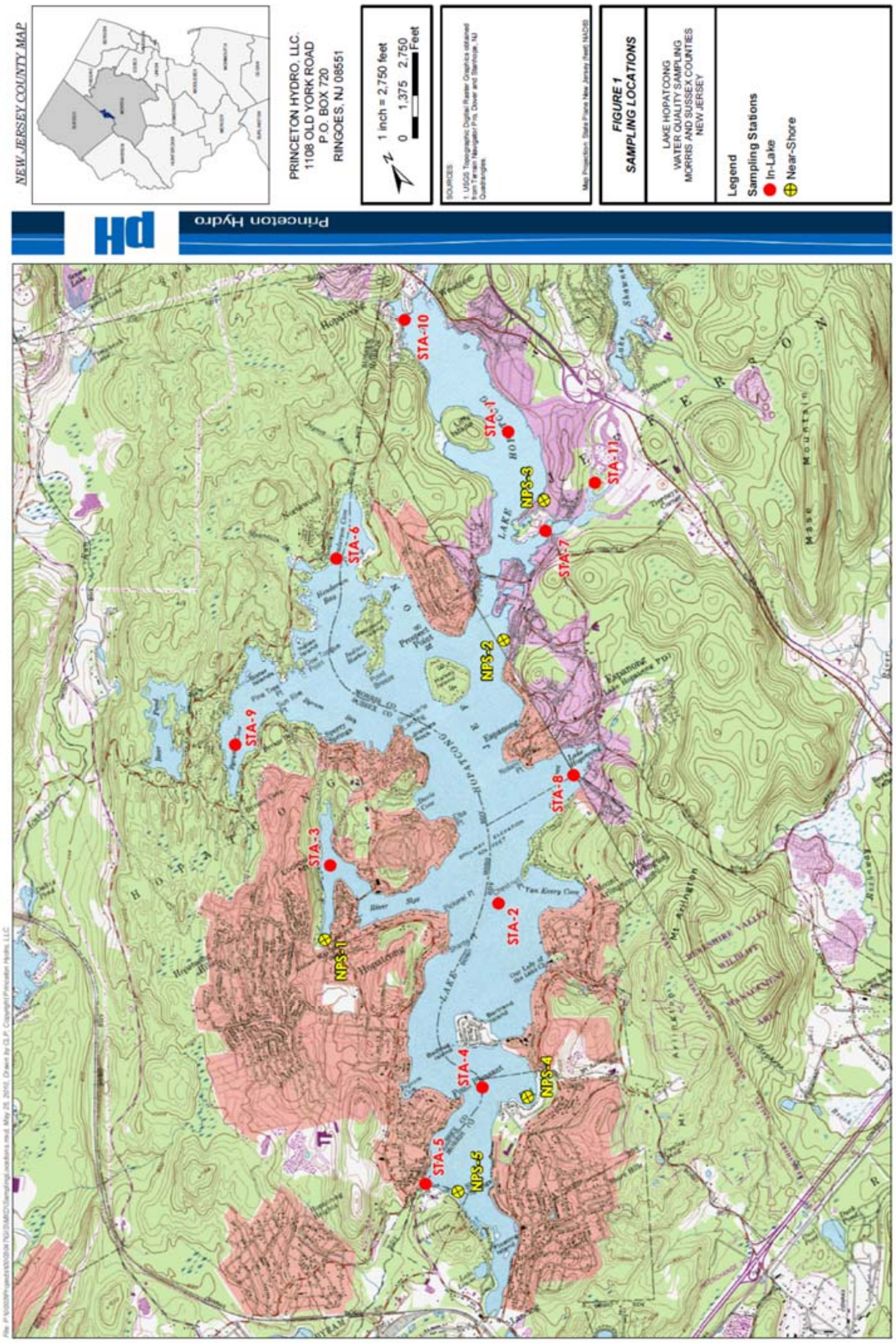
4. TP and TSS values increased at NPS-1 compared to previous years. In order to continue to maximize pollutant removal efficiencies, both structures should be inspected and maintained if necessary multiple times a year, as well as cleaned out at least once a year.

5. Based on the *in-situ* conditions, optimal brown trout habitat was available in May, June, and October 2016. Carry-over brown trout habitat was present during the June and September sampling events. Brown trout habitat was seen during all months in 2016, except for the August (1 September) sampling event at Station #2. However, carry over habitat was re-established by early September and optimal habitat was identified at Station #8 during this sampling event.

6. NJDEP continued to increase its efficiency in mechanical weed harvesting program at Lake Hopatcong. During the 2016 harvesting program, approximately 4,024 cubic yards of wet plant biomass was removed. This resulted in removing 85 lbs of TP, accounting for 1.2% of the TP targeted for removal under the TMDL. This was the highest percentage of TP removed through mechanical weed harvesting since 2010 when approximately 6% of the TP targeted under the TMDL was removed through harvesting.

APPENDIX A

FIGURES


NEW JERSEY COUNTY MAP
PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
1 inch = 2,750 feet
0 1,375 2,750 Feet
N
FIGURE 1
SAMPLING LOCATIONS
LAKE HOPATCONG
WATER QUALITY SAMPLING
MORRIS AND SUSSEX COUNTIES
NEW JERSEY
Legend
Sampling Stations
In-Lake
Near-Shore
Princeton Hydro
STA-1
STA-2
STA-3
STA-4
STA-5
STA-6
STA-7
STA-8
STA-9
STA-10
STA-11
NPS-1
NPS-2
NPS-3
NPS-4
NPS-5

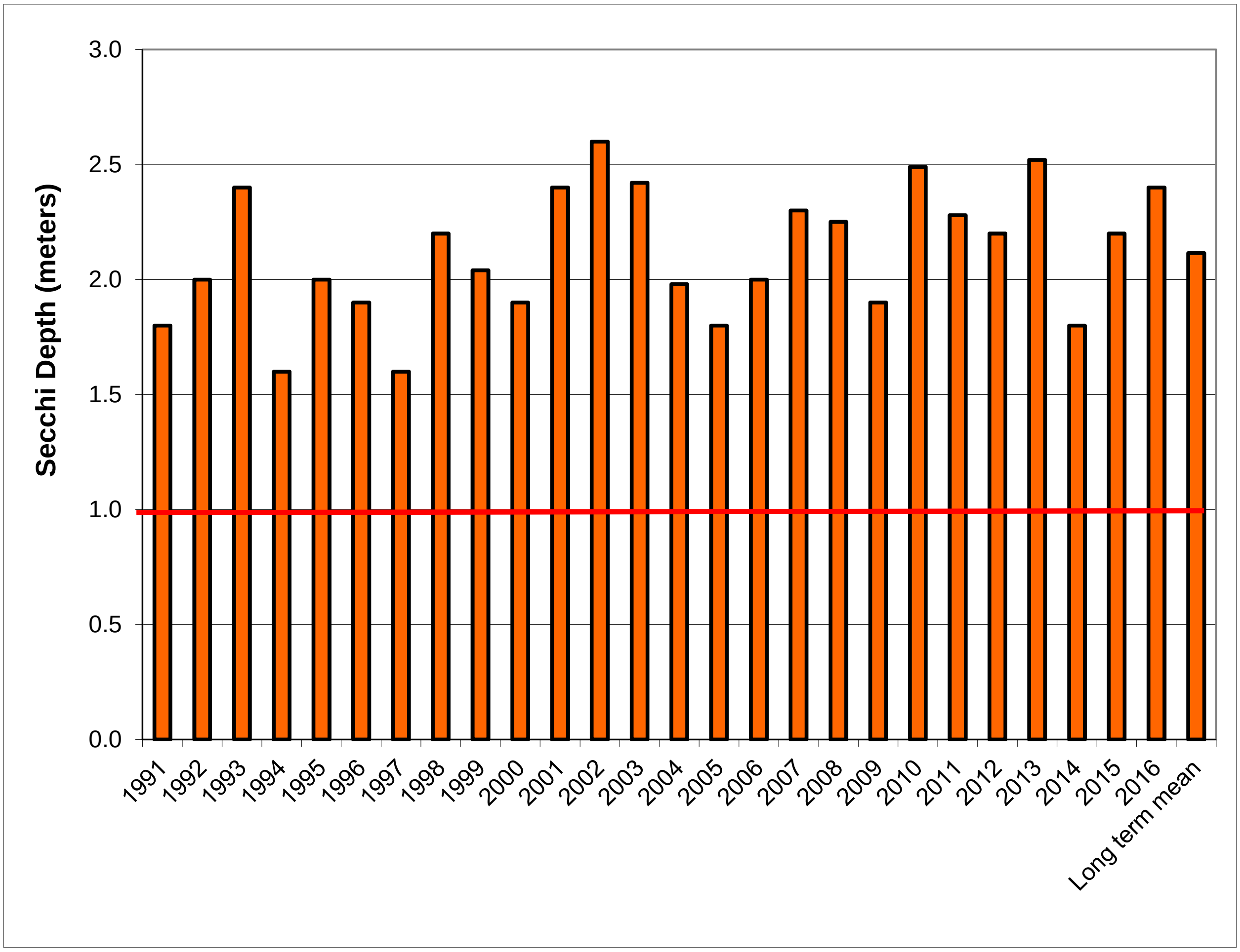


Figure 2 - Lake Hopatcong Long-Term Secchi Depth (meters)

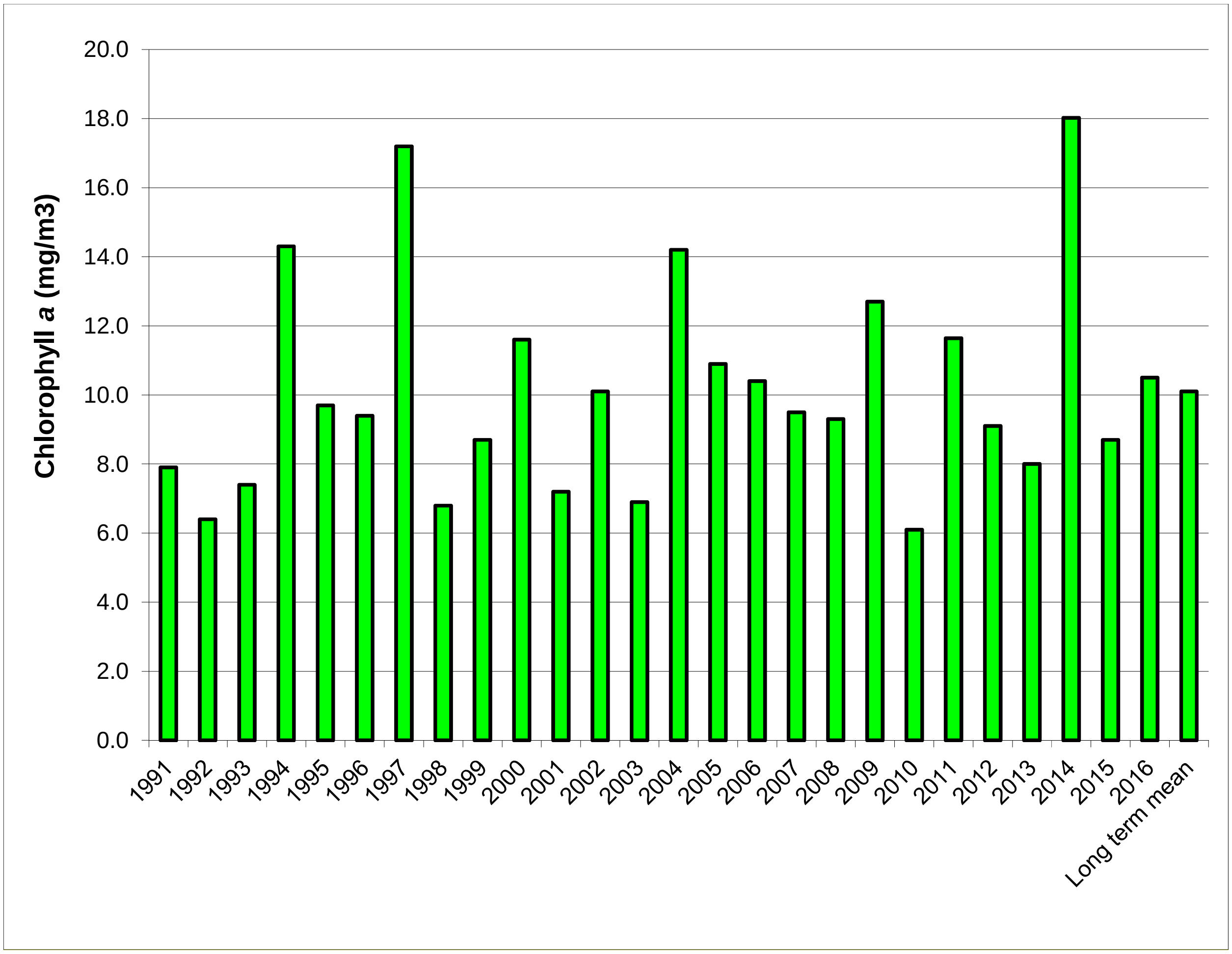


Figure 3 - Lake Hopatcong Long-Term Chlorophyll a Concentrations (mg/m^3)

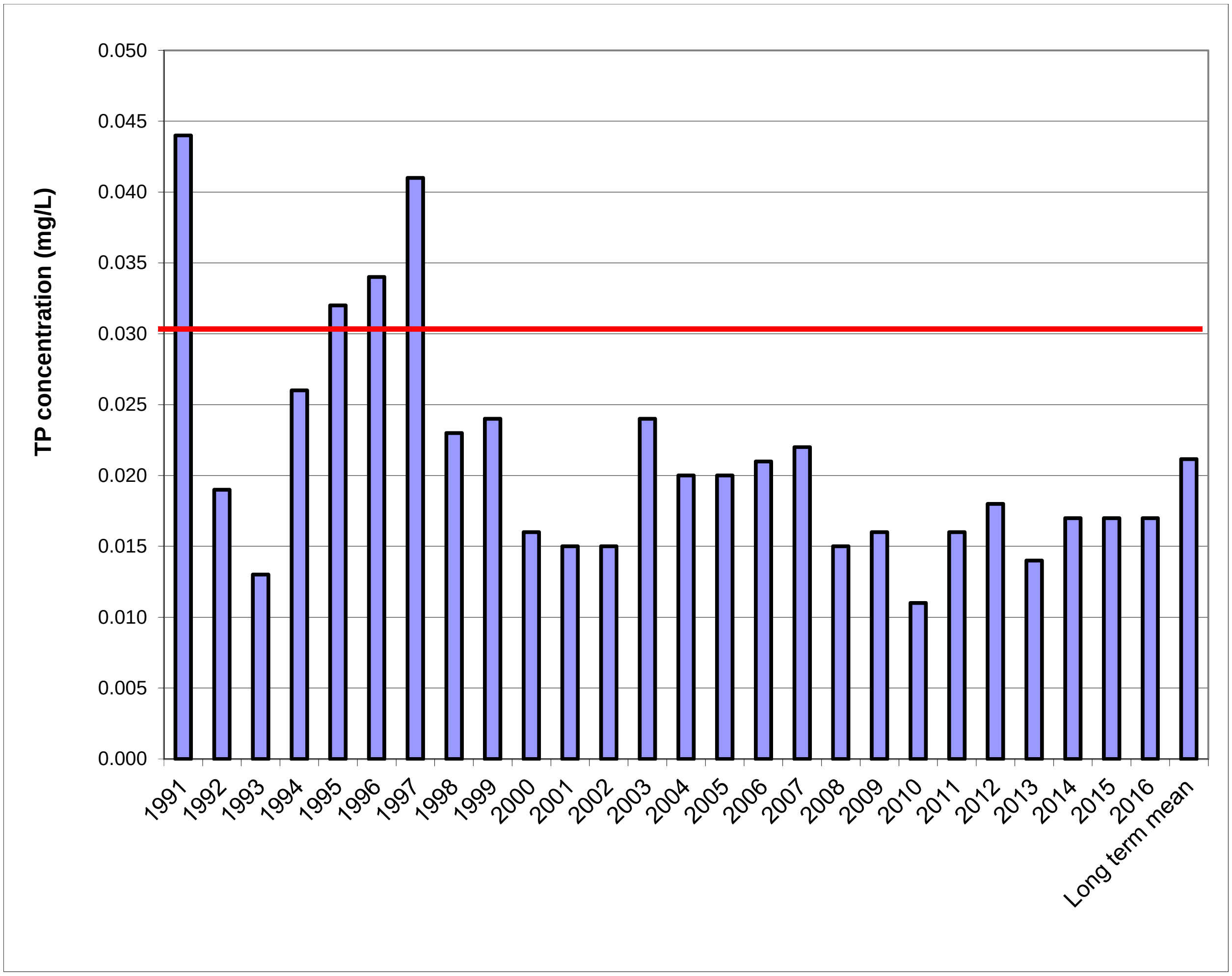


Figure 4 - Lake Hopatcong Long-Term Total Phosphorus Concentrations (mg/L)

APPENDIX B

IN-SITU DATA

In-Situ Monitoring for Lake Hopatcong 5/17/16								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(%)**	**(units)**
ST-1	**2**	**1.6**	**Surface**	15.28	0.453	10.36	104.2	8.68
			1.0	15.29	0.453	10.67	107.3	8.77
			2.0	14.69	0.425	10.82	107.3	8.79
ST-2	**14.2**	**2.2**	**Surface**	13.89	0.476	10.01	97.6	7.84
			1.0	13.8	0.476	9.96	97	7.8
			2.0	13.74	0.476	9.95	96.7	7.81
			3.0	13.72	0.477	9.91	96.3	7.83
			4.0	13.68	0.477	9.89	96	7.85
			5.1	13.67	0.477	9.86	95.7	7.85
			6.0	13.65	0.477	9.82	95.3	7.86
			7.1	13.29	0.476	9.27	89.2	7.84
			8.0	12.48	0.476	9.21	87.1	7.81
			9.0	11.26	0.475	8.42	77.4	7.77
			10.0	10.71	0.475	7.56	68.6	7.74
			11.0	9.28	0.477	5.76	50.5	7.66
			12.1	9.12	0.477	4.48	39.2	7.6
			13.1	9.1	0.477	3.44	30	7.53
			14.1	9.02	0.486	3.08	26.9	7.42
			14.2	9.07	0.494	2.69	23.4	7.36
ST-3	**2**	**1**	**Surface**	16.48	0.777	9.85	101.7	8.96
			1.1	15.7	0.796	10.3	104.6	9.43
			2.0	14.55	0.904	6.34	62.8	8.49
ST-4	**3**	**2**	**Surface**	13.93	0.482	10.09	98.4	7.99
			0.3	13.92	0.482	10.05	98.1	7.97
			1.1	13.92	0.482	10.03	97.9	7.91
			2.0	13.87	0.482	10.04	97.8	7.94
			3.0	13.85	0.485	9.84	95.9	7.83
ST-5	**3**	**2**	**Surface**	13.97	0.481	9.99	97.6	6.85
			1.0	13.9	0.482	10.14	98.9	6.97
			2.0	13.74	0.483	10.06	97.8	7.09
			3.0	13.58	0.483	9.06	87.7	7.12
ST-6	**2.5**	**1.8**	**Surface**	15.34	0.466	10.1	101.6	8.41
			1.0	15.33	0.466	10.12	101.8	8.28
			2.0	15.04	0.467	10.23	102.2	8.33
			2.3	15.02	0.468	10.22	102.2	8.24
ST-7	**1.5**	**1.5**	**Surface**	14.87	0.224	9.1	90.5	7.69
			1.1	14.83	0.224	8.91	88.6	7.41
			1.5	14.82	0.224	8.84	87.9	7.39
ST-8	**7.4**	**2**	**Surface**	14.07	0.473	9.86	96.5	7.68
			1.0	14.03	0.473	9.81	95.9	7.64
			2.0	13.95	0.473	9.82	95.9	7.64
			3.0	13.89	0.474	9.83	95.8	7.66
			4.1	13.88	0.474	9.82	95.7	7.69
			5.1	13.87	0.474	9.76	95.2	7.71
			6.1	13.86	0.475	9.74	94.9	7.72
			7.0	13.78	0.478	9.7	94.3	7.73
			7.3	13.54	0.468	6.77	65.5	7.47
ST-9	**8.2**	**1.8**	**Surface**	13.81	0.475	9.81	95.5	8.19
			1.0	13.79	0.475	9.58	93.2	8.03
			2.0	13.72	0.475	9.5	92.2	7.99
			3.0	13.45	0.475	9.46	91.3	7.98
			4.0	13.21	0.475	9.28	89.1	7.94
			5.0	13.16	0.475	9.09	87.2	7.92
			6.0	12.94	0.477	8.96	85.5	7.9
			7.1	12.72	0.478	8.72	82.9	7.85
			8.1	11.37	0.46	5.24	48.3	7.56
			8.2	11.37	0.46	3.52	32.4	7.49
ST-10	**1.5**	**1.5+**	**Surface**	15.54	0.478	10.12	102.3	8.17
			1.0	15.5	0.478	10.22	103.2	8.25
			1.5	15.35	0.479	10.3	103.7	8.35
ST-11	**1**	**1+**	**Surface**	15.25	0.183	9.57	96.1	7.96
			1.1	14.67	0.197	9.22	91.3	7.55

In-Situ Monitoring for Lake Hopatcong 6/28/16								
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(%)	(units)
ST-1	2	1.4	Surface	25.21	0.476	6.95	85.1	7.48
			1.0	25.21	0.476	6.48	79.3	7.42
			2.0	25.06	0.472	6.26	76.3	7.39
ST-2	14	2.6	Surface	24.16	0.484	8.79	105.5	7.69
			1.0	24.16	0.483	8.87	106.7	7.77
			2.0	24.16	0.484	8.94	107.3	7.88
			3.0	24.15	0.483	8.98	107.7	7.96
			4.0	23.35	0.482	8.80	104.5	7.96
			5.0	20.11	0.474	7.87	86.3	7.85
			6.0	17.85	0.471	5.00	53.0	7.68
			7.0	15.27	0.469	1.62	16.3	7.54
			8.0	13.3	0.468	0.43	4	7.46
			9.0	12.23	0.469	0.21	1.9	7.43
			10.0	11.55	0.47	0.13	1.2	7.41
			11.0	11.22	0.472	0.1	0.9	7.39
			12.0	10.71	0.476	0.07	0.7	7.36
			13.0	10.46	0.482	0.07	0.6	7.32
			14.0	10.32	0.486	0.07	0.6	7.31
ST-3	1.5	1.2	Surface	25.45	0.84	6.96	85.6	7.46
			1.0	25.43	0.836	6.64	81.7	7.53
			1.5	25.4	0.828	3.72	45.2	7.42
ST-4	2.5	2.1	Surface	24.85	0.488	8.12	98.7	7.36
			1.0	24.85	0.488	8.09	98.4	7.37
			2.0	23.69	0.484	8.11	96.7	7.47
			2.5	22.57	0.483	7.54	87.9	7.38
ST-5	1.5	1.5	Surface	25.64	0.495	7.46	92.7	7.71
			1.0	25.58	0.496	7.08	87.2	7.61
			1.5	25.56	0.496	7.04	86.8	7.57
ST-6	2	1.9	Surface	25.01	0.482	8.21	100.1	7.7
			1.0	25.03	0.482	7.91	96.5	7.65
			2.0	24.94	0.483	7.17	87.3	7.62
ST-7	1.2	1.2	Surface	25.72	0.353	7.21	89.1	7.78
			1.0	25.64	0.359	5.92	72.9	7.54
ST-8	4.5	2.4	Surface	24.38	0.485	8.87	106.9	7.65
			1.0	24.4	0.485	8.99	108.5	7.81
			2.0	24.38	0.485	9.05	109.2	7.89
			3.0	24.32	0.484	9.1	109.5	7.93
			4.0	23.04	0.482	8.66	101.6	7.89
			4.5	22.13	0.479	7.81	90.2	7.82
ST-9	8	2.2	Surface	24.87	0.482	9.28	112.8	8.03
			1.0	24.87	0.482	9.39	114.3	8.14
			2.0	24.86	0.481	9.39	114.2	8.2
			3.0	24.8	0.481	9.2	111.7	8.19
			4.0	24.68	0.482	9.02	109.3	8.13
			5.0	22.02	0.477	7.62	87.8	7.91
			6.0	18.08	0.472	5.1	54.4	7.75
			7.0	16.35	0.472	2.08	21.3	7.63
			8.0	15.27	0.477	1.34	13.5	7.48
ST-10	1	0.9	Surface	25	0.517	5.9	71.9	7.42
			1.0	25	0.526	5.06	61.7	7.39
ST-11	1	1	Surface	24.48	0.303	6.52	78.4	7.53
			1.0	24.39	0.296	3.76	44.9	7.12

In-Situ Monitoring for Lake Hopatcong 8/2/16 (JULY)								
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(%)	(units)
ST-1	1.8	1.2	Surface	25.59	0.462	6.91	85.1	7.46
			1.0	25.59	0.462	6.87	84.6	7.44
			1.5	25.4	0.459	6.86	84.2	7.45
ST-2	14	2.4	Surface	26.21	0.422	7.64	95.2	7.71
			1.0	26.25	0.486	7.61	94.9	7.59
			2.0	26.22	0.486	7.6	94.7	7.65
			3.0	26.22	0.485	7.59	94.6	7.69
			4.0	26.21	0.485	7.59	94.6	7.73
			5.0	26.18	0.485	7.59	94.5	7.74
			6.0	23.03	0.478	0.48	5.6	7.2
			7.0	19.14	0.472	0.32	3.4	7.2
			8.0	15.73	0.474	0.19	1.9	7.21
			9.0	13.75	0.475	0.13	1.2	7.22
			10.0	12.56	0.476	0.1	0.9	7.23
			11.0	11.86	0.479	0.08	0.8	7.24
			12.0	11.33	0.483	0.07	0.7	7.25
			13.0	10.76	0.491	0.07	0.6	7.27
			13.5	10.56	0.506	0.07	0.6	7.3
ST-3	2	1.3	Surface	25.9	0.668	6.75	83.6	7.62
			1.0	25.81	0.676	6.01	74.4	7.51
			2.0	25.72	0.69	3.03	37.5	7.12
ST-4	2.8	2.3	Surface	25.9	0.484	7.13	88.4	7.47
			1.0	25.93	0.484	7.06	87.5	7.45
			2.0	25.92	0.484	7.04	87.3	7.49
			2.5	25.92	0.623	7.03	87.2	7.42
ST-5	1.4	1.4	Surface	25.67	0.485	6.42	79.2	7.28
			1.0	25.71	0.485	6.3	77.9	7.29
			1.5	25.7	0.485	6.26	77.3	7.3
ST-6	3	2	Surface	26.31	0.481	8.04	100.4	7.79
			1.0	26.3	0.481	8.04	100.4	7.74
			2.0	26.01	0.48	7.96	98.9	7.78
			3.0	25.83	0.48	6.48	80.3	7.44
ST-7	1.2	1.2	Surface	24.42	0.221	4.52	54.4	7.33
			1.0	24.41	0.237	4.32	52	6.99
			1.5	24.43	0.238	4.24	51.1	6.99
ST-8	6.6	2.1	Surface	26.23	0.486	7.41	92.3	7.59
			1.0	26.24	0.485	7.3	91	7.51
			2.0	26.21	0.485	7.28	90.7	7.55
			3.0	26.21	0.485	7.27	90.6	7.58
			4.0	26.17	0.485	6.87	85.5	7.58
			5.0	25.14	0.483	3.22	39.3	7.3
			6.0	22.48	0.478	0.39	4.5	7.11
			7.0	20.6	0.478	0.21	2.4	7.03
ST-9	7.5	2.4	Surface	26.42	0.484	7.89	98.7	7.75
			1.0	26.42	0.484	7.83	98	7.69
			2.0	26.38	0.484	7.78	97.3	7.74
			3.0	26.36	0.484	7.67	95.9	7.76
			4.0	26.35	0.484	7.59	94.9	7.77
			5.0	26.26	0.484	7.54	94.1	7.77
			6.0	26.14	0.486	6.87	85.5	7.67
			7.0	18.84	0.482	0.64	6.9	7.26
			7.5	17.84	0.491	0.41	4.3	7.19
ST-10	1	1	Surface	24.03	0.497	8.77	105	7.97
			1.0	22.81	0.556	7.21	84.4	7.77
ST-11	1	1	Surface	24.48	0.161	4.41	53.2	7.21
			1.0	24.42	0.161	4.3	51.9	6.92

In-Situ Monitoring for Lake Hopatcong 9/1/16 (August)								
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(%)	(units)
ST-1	1.8	1	Surface	26.29	0.475	7.65	95.4	7.99
			1.0	26.21	0.473	7.44	92.7	7.8
			1.5	26.16	0.473	7.06	87.9	7.76
ST-2	14.5	2.5	Surface	25.91	0.494	8.23	102.1	8.15
			1.0	25.91	0.494	8.38	103.8	8.14
			2.0	25.91	0.494	8.41	104.2	8.17
			3.0	25.91	0.494	8.43	104.4	8.19
			4.0	25.91	0.494	8.42	104.4	8.21
			5.0	25.9	0.494	8.42	104.3	8.22
			6.0	25.31	0.492	7.18	88	8.03
			7.0	22.86	0.485	3.89	45.6	7.74
			8.0	17.39	0.487	1.3	13.7	7.64
			9.0	14.67	0.488	0.68	6.8	7.65
			10.0	13.34	0.491	0.47	4.5	7.65
			11.0	12.14	0.496	0.29	2.7	7.67
			12.0	11.5	0.499	0.17	1.6	7.71
			13.0	11.07	0.507	0.12	1.1	7.71
			13.5	10.88	0.516	0.1	0.9	7.65
ST-3	2	1.3	Surface	26.48	0.641	8	100.3	8.16
			1.0	26.35	0.636	7.94	99.3	8.08
			2.0	26.12	0.64	7.78	96.8	7.76
ST-4	3	3	Surface	26.09	0.499	8.16	101.4	8.21
			1.0	26.12	0.499	8.11	100.9	8.12
			2.0	26.1	0.499	8.13	101.2	8.14
			3.0	26.11	0.512	8.13	101.1	7.98
ST-5	3	3	Surface	26.05	0.497	7.7	95.6	8.07
			1.0	26.08	0.497	7.51	93.3	8.13
			2.0	26.05	0.497	7.66	95.2	8.24
			3.0	25.6	0.528	6.67	82.3	7.74
ST-6	2.2	1.5	Surface	26.34	0.494	7.84	97.9	8.03
			1.0	26.23	0.493	7.74	96.5	7.89
			2.0	26.12	0.493	7.4	92.1	7.84
ST-7	1.8	1.6	Surface	25.76	0.348	7.15	88.4	7.84
			1.0	25.65	0.346	6.99	86.2	7.61
			1.5	25.42	0.344	6.93	85.2	7.6
ST-8	8	2.8	Surface	26.28	0.495	8.01	99.9	8.15
			1.0	26.27	0.495	8.3	103.6	8.04
			2.0	26.26	0.495	8.35	104.2	8.08
			3.0	26.26	0.495	8.36	104.3	8.12
			4.0	26.25	0.495	8.33	103.9	8.15
			5.0	26.06	0.494	8.17	101.5	8.11
			6.0	25.19	0.492	6.64	81.2	7.95
			7.0	23.55	0.49	5.34	63.4	7.75
			7.3	22.93	0.512	3.27	38.4	7.49
ST-9	8	2.5	Surface	26.28	0.495	8.1	101.1	8.16
			1.0	26.18	0.495	8.34	103.9	8.1
			2.0	26.1	0.495	8.42	104.7	8.12
			3.0	26.03	0.495	8.23	102.2	8.1
			4.0	25.96	0.495	8.18	101.6	81
			5.0	25.92	0.495	7.47	92.6	7.96
			6.0	23.77	0.49	4.84	57.7	7.79
			7.0	21.4	0.482	3.41	38.8	7.67
			7.5	19.9	0.534	1.23	13.6	7.39
ST-10	1.5	1.2	Surface	26.27	0.48	8.38	104.5	8.13
			1.0	26.2	0.48	8.27	103	8.01
			1.5	26.2	0.48	7.96	99.2	7.96
ST-11	1.2	1.2	Surface	24.11	0.334	5.44	65.3	7.75
			1.0	23.98	0.325	4.47	53.5	7.46

In-Situ Monitoring for Lake Hopatcong 10/3/16 (September)								
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(%)	(units)
ST-1	1.7	1.5	Surface	16.99	0.474	8.44	88	7.51
			1.0	16.95	0.475	8.55	89	7.52
			1.5	16.82	0.473	8.6	89.3	7.55
ST-2	13.3	2.1	Surface	18.65	0.492	7.62	82.2	7.59
			1.0	18.63	0.492	7.74	83.5	7.56
			2.0	18.63	0.492	7.76	83.6	7.57
			3.0	18.61	0.492	7.76	83.6	7.58
			4.0	18.6	0.492	7.71	83	7.58
			5.0	18.6	0.492	7.69	82.8	7.57
			6.0	18.59	0.492	7.65	82.4	7.57
			7.0	18.59	0.492	7.61	82	7.56
			8.0	18.59	0.492	7.6	81.9	7.56
			9.0	17.72	0.492	6.15	65.1	7.5
			10.0	15.3	0.504	4.47	45	7.4
			11.0	12.36	0.501	1.88	17.7	7.32
			12.0	11.4	0.51	0.95	8.7	7.29
			13.0	10.98	0.539	0.55	5	7.25
			13.3	10.96	0.562	0.46	4.2	7.19
ST-3	1.9	1.9	Surface	17.1	0.587	8.65	90.4	7.62
			1.0	16.87	0.589	8.59	89.3	7.71
			1.7	16.94	0.664	8.54	89	7.58
ST-4	2.8	2.8	Surface	17.05	0.494	8.22	85.8	7.89
			1.0	16.48	0.497	8.49	87.5	7.87
			2.0	16.44	0.497	8.54	88	7.87
			2.5	16.55	0.491	7.67	79.2	7.74
ST-5	2.5	2.5	Surface	16.15	0.499	8.79	90	7.67
			1.0	16.08	0.499	8.64	88.3	7.69
			2.0	16.09	0.499	8.38	85.7	7.61
ST-6	2	1.8	Surface	17.98	0.491	8.75	93.1	7.56
			1.0	17.84	0.49	8.78	93.1	7.57
			2.0	16.92	0.491	8.85	92.1	7.6
ST-7	1	1	Surface	16.12	0.193	7.83	80	7.97
			1.0	16.12	0.197	7.11	72.7	7.73
ST-8	7	2	Surface	18.64	0.491	7.6	81.9	7.73
			1.0	18.64	0.491	7.37	79.4	7.68
			2.0	18.64	0.491	7.35	79.2	7.67
			3.0	18.59	0.491	7.33	78.9	7.66
			4.0	18.56	0.491	7.27	78.3	7.64
			5.0	18.55	0.491	7.15	77	7.62
			6.0	18.55	0.491	7.04	75.8	7.61
			6.5	18.43	0.492	5.05	54.2	7.44
ST-9	8	2	Surface	18.92	0.491	8.58	93.1	7.52
			1.0	18.8	0.491	8.42	91.1	7.54
			2.0	18.72	0.491	8.36	90.2	7.56
			3.0	18.66	0.491	8.32	89.7	7.57
			4.0	18.64	0.491	8.28	89.3	7.58
			5.0	18.61	0.491	8.21	88.5	7.58
			6.0	18.57	0.491	8.16	87.8	7.58
			7.0	18.53	0.491	8.01	86.2	7.57
			7.5	18.41	0.528	4.67	50.1	7.19
ST-10	1.7	1.5	Surface	17.29	0.481	8.04	84.3	7.48
			1.0	17.32	0.481	8.14	85.4	7.51
			1.5	17.26	0.481	8.17	85.6	7.52
ST-11	1	1	Surface	16.01	0.144	8.03	81.9	7.85
			1.0	16.02	0.144	7.65	78	7.71

***In-Situ* Monitoring for Hopatcong 319 Stations 5/17/16**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(%)**	**(units)**
NPS 1	**1.8**	**1.8+**	**Surface**	14.97	1.26	12.84	128.5	9.5
			1.03	14.91	1.209	14.57	145.6	9.67
			1.53	14.45	1.187	15.25	150.9	9.7
NPS 2	**1**	**1+**	**Surface**	14.13	0.44	10.36	101.5	7.96
			1.08	14.06	0.439	10.5	102.7	7.99
NPS 3	**0.85**	**0.85+**	**Surface**	15.19	0.306	10.03	100.6	7.89
			0.15	15.21	0.303	10.15	101.8	7.98
			0.88	14.78	0.304	10.31	102.5	7.92
NPS 4	**1.5**	**1.5+**	**Surface**	13.63	0.481	10.08	97.7	7.9
			1.03	13.52	0.483	10.03	97.1	7.84
			1.53	13.59	0.484	8.58	83.1	7.84
NPS 5	**2**	**2+**	**Surface**	14.68	0.484	9.93	98.5	7.48
			1.00	14.67	0.484	10.14	100.6	7.76
			2.18	14.59	0.484	10.05	99.5	7.85

***In-Situ* Monitoring for Hopatcong 319 Stations 6/28/16**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(%)**	**(units)**
NPS 1	**1.5**	**0.7**	**Surface**	24.82	0.966	7.06	85.9	7.6
			1.00	24.31	0.995	5.07	61.1	7.55
			1.50	24.14	1.019	4.26	51.2	7.38
NPS 2	**0.5**	**0.5**	**Surface**	25.27	0.451	7.71	94.3	7.96
			0.50	25.29	0.451	7.3	89.5	8.04
NPS 3	**0.7**	**0.7**	**Surface**	25.18	0.447	7.82	95.3	7.56
			0.50	25.13	0.449	6.59	80.1	7.5
NPS 4	**1.5**	**1.5**	**Surface**	25.41	0.497	7.95	97.5	7.39
			1.00	25.4	0.497	7.89	97	7.4
			1.30	25.4	0.507	6.42	79.6	7.36
NPS 5	**2.1**	**2.1**	**Surface**	25.54	0.498	6.52	80.2	7.28
			1.00	25.53	0.498	6.5	80.1	7.25
			2.00	25.5	0.503	2.92	34.7	6.94

In-Situ Monitoring for Hopatcong 319 Stations 8/2/16 (July)								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(⁰C)**	**(mmhos/cm)**	**(mg/L)**	**(%)**	**(units)**
NPS 1	**1.5**	**0.5**	**Surface**	25.52	0.731	7.99	98.4	7.72
			1.00	25.35	0.737	7.91	97.1	7.74
			1.50	25.32	0.739	7.45	91.4	7.65
NPS 2	**1**	**1**	**Surface**	25.22	0.461	5.65	69.1	7.37
			1.00	25.18	0.462	5.62	68.7	7.23
NPS 3	**0.7**	**0.6**	**Surface**	24.85	0.459	7.1	86.4	7.57
			0.50	24.19	0.452	5.96	71.5	7.29
NPS 4	**1.6**	**1.6**	**Surface**	25.59	0.506	6.89	85	7.53
			1.00	25.57	0.507	7.05	86.8	7.54
			1.50	25.57	0.508	7.26	89.5	7.57
NPS 5	**2.5**	**1.8**	**Surface**	25.93	0.485	6.93	86	7.45
			1.00	25.93	0.485	6.81	84.5	7.46
			2.00	25.92	0.485	6.41	79.5	7.45
			2.50	25.91	0.485	5.64	70	7.36

In-Situ Monitoring for Hopatcong 319 Stations 9/1/16 (August)								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(⁰C)**	**(mmhos/cm)**	**(mg/L)**	**(%)**	**(units)**
NPS 1	**1.1**	**0.9**	**Surface**	25.99	0.67	8.04	99.9	8.26
			1.00	25.34	0.698	7.84	96.3	8.15
NPS 2	**0.9**	**0.9**	**Surface**	25.69	0.458	7.98	98.5	8.27
			0.60	25.63	0.458	8.09	99.7	8.27
NPS 3	**1.1**	**1.1**	**Surface**	25.57	0.461	6.87	84.7	7.73
			0.80	25.6	0.461	6.56	80.9	7.51
NPS 4	**1.5**	**1.5**	**Surface**	25.98	0.537	7.5	93.1	8.1
			1.00	25.96	0.531	7.22	89.7	8.13
			1.30	25.82	0.543	5.51	68.2	7.75
NPS 5	**2.5**	**2.5**	**Surface**	26.15	0.498	8.69	108.1	8.82
			1.00	26.19	0.497	8.95	111.5	8.95
			2.00	26.18	0.497	9.09	113.3	9.06
			2.48	26.18	0.499	8.68	108.1	8.72

In-Situ Monitoring for Hopatcong 319 Stations 10/3/16 (September)								
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(%)	(units)
NPS 1	1.1	1.1	Surface	16.64	0.611	9.41	97.4	7.86
			1.00	16.4	0.609	9.92	102.1	8.18
NPS 2	1	1	Surface	16.83	0.478	8.85	91.9	7.83
			0.50	16.83	0.478	8.3	86.2	7.75
NPS 3	0.5	0.5	Surface	16.49	0.473	8.27	85.3	7.52
			0.50	16.52	0.473	8.54	88.1	7.53
NPS 4	1.5	1.5	Surface	16.18	0.518	8.54	87.5	7.73
			1.00	16.2	0.518	8.71	89.3	7.77
			1.30	16.13	0.518	8.8	90.1	7.77
NPS 5	2.5	2.5	Surface	16.14	0.5	8.96	91.8	7.79
			1.00	16.12	0.5	9.36	95.8	7.98
			2.00	16.1	0.5	9.43	96.4	8.01
			2.30	16.21	0.504	9.34	95.8	7.92

APPENDIX C

DISCRETE DATA

HOPATCONG					
17-May-2016					
STATION	**Chlorophyll (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	16.7	0.02	0.04	0.03	6
ST-2	6.4	0.02	ND <0.02	0.02	ND <3
ST-3	6.8	0.02	0.03	0.04	ND <3
ST-4	5.6	0.01	0.02	0.03	5
ST-5	6.1	0.02	0.02	0.03	7
ST-6	6.4	0.02	0.02	0.03	ND <3
ST-7	4.0	0.05	0.12	0.02	ND <3
ST-10	12.9	0.03	0.03	0.02	4
ST-11	3.3	0.03	0.16	0.02	ND <3
ST-2 DEEP		0.28	0.03	0.05	3
MEAN	**7.6**	**0.05**	**0.05**	**0.027**	**5.5**

28-Jun-2016					
STATION	**Chlorophyll (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	12.0	ND <0.01	0.02	0.03	3
ST-2	6.3	ND <0.01	ND <0.02	0.02	ND <3
ST-3	31.0	0.02	0.02	0.06	4
ST-4	6.6	0.04	ND <0.02	0.02	3
ST-5	6.7	0.03	ND <0.02	0.02	ND <3
ST-6	3.9	0.02	ND <0.02	0.02	4
ST-7	5.0	0.01	0.04	0.02	3
ST-10	24.0	0.03	0.06	0.06	12
ST-11	6.5	0.08	0.04	0.04	ND <3
ST-2 DEEP		0.42	0.06	0.02	ND <3
MEAN	**11.3**	**0.08**	**0.04**	**0.031**	**4.8**

8/2/16 (July)					
STATION	**Chlorophyll (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	17.0	ND <0.01	ND <0.02	0.01	5
ST-2	11.0	ND <0.01	0.06	ND <0.01	ND <3
ST-3	35.0	0.08	ND <0.02	0.03	5
ST-4	7.3	ND <0.01	ND <0.02	ND <0.01	ND <3
ST-5	6.9	ND <0.01	ND <0.02	ND <0.01	ND <3
ST-6	12.0	ND <0.01	0.07	ND <0.01	ND <3
ST-7	4.7	0.01	0.63	ND <0.01	ND <3
ST-10	26.0	ND <0.01	0.09	0.02	5
ST-11	4.1	0.03	0.06	0.01	ND <3
ST-2 DEEP		0.37	0.03	0.08	ND <3
MEAN	**13.8**	**0.04**	**0.16**	**0.018**	**5.0**

9/1/16 (August)					
STATION	**Chlorophyll (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	22.0	ND <0.01	0.06	0.04	7
ST-2	13.0	ND <0.01	ND <0.02	0.02	3
ST-3	21.0	ND <0.01	0.05	0.20	5
ST-4	4.6	ND <0.01	0.05	0.06	4
ST-5	3.9	0.01	0.08	0.02	3
ST-6	5.1	ND <0.01	0.02	0.02	3
ST-7	9.7	0.01	0.05	0.03	3
ST-10	25.0	ND <0.01	0.08	0.03	5
ST-11	9.6	0.01	0.06	0.03	3
ST-2 DEEP		0.90	0.08	0.27	6
MEAN	**12.7**	**0.23**	**0.06**	**0.072**	**4.2**

10/3/16 (Sept)					
STATION	**Chlorophyll (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	17.0	ND <0.01	0.03	0.02	3
ST-2	16.0	0.02	ND <0.02	0.02	3
ST-3	6.8	0.02	ND <0.02	0.02	10
ST-4	14.0	0.04	ND <0.02	0.02	5
ST-5	7.1	0.02	ND <0.02	0.01	ND <3
ST-6	13.0	0.01	ND <0.02	0.02	3
ST-7	2.4	0.02	0.04	0.02	ND <3
ST-10	19.0	0.01	0.05	0.02	5
ST-11	3.3	0.03	0.06	0.02	ND <3
ST-2 DEEP		1.20	0.08	0.27	8
MEAN	**11.0**	**0.15**	**0.05**	**0.044**	**4.8**

Lake Hopatcong 319(h) Water Quality Sampling for 2015

5/17/2016			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	0.02	ND <3	x
NPS 2	0.02	ND <3	x
NPS 3	0.02	4	13.8
NPS 4	0.02	3	4.9
NPS 5	0.02	ND <3	6.9

6/28/2016			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	0.07	7	x
NPS 2	0.01	ND <3	x
NPS 3	0.02	ND <3	6
NPS 4	0.02	ND <3	5.4
NPS 5	0.02	3	6.4

8/2/16 (July)			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	0.16	33	x
NPS 2	ND <0.01	ND <3	x
NPS 3	ND <0.01	3	14
NPS 4	ND <0.01	ND <3	3.8
NPS 5	ND <0.01	ND <3	6

9/1/16 (August)			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	0.06	6	x
NPS 2	0.03	3	x
NPS 3	0.02	ND <3	3.1
NPS 4	0.02	ND <3	4
NPS 5	0.02	ND <3	4

10/3/2016 (Sept)			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	0.02	ND <3	x
NPS 2	0.02	3	x
NPS 3	0.02	ND <3	5.8
NPS 4	0.01	ND <3	4.1
NPS 5	0.01	ND <3	3.7

APPENDIX D

Plankton Data

Phytoplankton and Zooplankton Community Composition Analysis

Sampling Location: Lake Hoptacong		**Sampling Date: 5/17/2016**		**Examination Date: 6/10/2016**	
Site 1: Station 2					
Phytoplankton					
Bacillariphyta (Diatoms)	**1**	**Chlorophya (Green Algae)**	**1**	**Cyanophyta (Blue-Green Algae)**	**1**
Achnanthes		*Actinastrum*		*Anabaena*	R
Asterionella		*Ankistrodesmus*		*Amphanizomen*	
Aulacoseira		*Chlamydomonas*		*Aphanocapsa*	
Cocconeis		*Botryococcus*		*Chroococcus*	
Cyclotella		*Chlorella*		*Cylindrospermum*	
Cymatopleura		*Coelastrum*		*Lyngbya*	
Cylindrotheca		*Eudorina*		*Microcystis*	
Cymbella		*Gloeocystis*		*Nostoc*	
Denticula		*Gonium*		*Pseudoanabaena*	
Fragilaria	B	*Hydrodictyon*		*Oscillatoria*	
Frustulia		*Monoraphidium*			
Gyrosigma		*Mougeotia*			
Melosira		*Micrasterias*			
Nedium		*Microspora*	P		
Rhizosolenia		*Ochromonas*			
Stauroneis		*Oedogonium*		**Euglenophyta (Euglenoids)**	
Stephanodiscus		*Oocystis*		*Colacium*	
Sururekka		*Scenedesmus*		*Euglena (Phacus sp)*	
Synedra		*Spirogya*		*Euglena sp*	
Tabellaria	B	*Staurastrum*		*Trachelomonas*	
		Treubaria			
Chrysophyta (Golden Algae)		*Pediastrum*	R	**Pyrrhophyta (Dinoflagellates)**	
Dinobryon		*Volvex*		*Ceratium*	P
Chromulina		*Zygnema*		*Peridinium*	
Mallomonas		*Klebsormidium*			
Synura		**Desmids (Green Algae)**			
		Hyalotheca			
		Staurastrum			
		Staurodesmus			
Zooplankton					
Cladocera (Water Fleas)	**1**	**Copecoda (Copepods)**	**1**	**Rotifera (Rotifers)**	**1**
Bosmina sp.	P	*Cyclops sp.*		*Keratella cochlearis* (H)	C
Daphnia sp.		*Dipatomus (H)*		*Keratella crassa (H)*	
Eubosmina sp.		*D Nauplius*		*Keratella quadrata* (H)	
Chydorus		*Skistodiaptomus oregonensis*		*Kellicottia longispina*	C
Diaphniosoma		*Microcyclops sp*		*Asplanchnopus sp.*	
Ceriodaphnia		*Limnocalanus macrurus*		*Polyarthra*	
Leptodora kindti		*Leptodiaptomus coloradensis*		*Hexarthra mira*	
Scapholeberis mucronata				*Conochilus sp*	
Bosmina longirostris				**Arthropoda (Arthropods)**	
Diaphnosoma brachyurum				*Chaoborus punctipennis*	
Diaphanosoma birgei				*Ostracoda*	
Sites:	**1**	**Comments: Large bloom of Tabellaria and Fragilaria are currently occuring. Abundance of zooplankton is low at this time**			
Total Phytoplankton Genera	6				
Total Zooplankton Genera	3				
Sample Volume (mL)		**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 Hoptacong				**Sampling Date: 6/28/16**				**Examination Date: 11/23/16**			
Site 1: Station 2											
Phytoplankton											
Bacillariphyta (Diatoms)	**1**			**Chlorophya (Green Algae)**	**1**			**Cyanophyta (Blue-Green Algae)**	**1**		
Achnanthes				*Actinastrum*				*Anabaena*	A		
Asterionella	A			*Ankistrodesmus*				*Amphanizomen*			
Aulacoseira				*Chlamydomonas*				*Aphanocapsa*	C		
Cocconeis				*Botryococcus*				*Chroococcus*			
Cyclotella				*Chlorella*	A			*Cylindrospermum*			
Cymatopleura				*Coelastrum*				*Lyngbya*			
Cylindrotheca				*Eudorina*				*Microcystis*			
Cymbella				*Gloeocystis*				*Nostoc*			
Denticula				*Gonium*				*Pseudoanabaena*			
Fragilaria	C			*Hydrodictyon*				*Oscillatoria*			
Frustulia				*Monoraphidium*							
Gyrosigma				*Mougeotia*							
Melosira				*Micrasterias*							
Nedium				*Microspora*							
Rhizosolenia				*Ochromonas*							
Stauroneis				*Oedogonium*				**Euglenophyta (Euglenoids)**			
Stephanodiscus				*Oocystis*				*Colacium*			
Sururekka				*Scenedesmus*				*Euglena (Phacus sp)*			
Synedra				*Spirogya*				*Euglena sp*			
Tabellaria				*Staurastrum*				*Trachelomonas*			
				Treubaria							
Chrysophyta (Golden Algae)				*Pediastrum*				**Pyrrhophyta (Dinoflagellates)**			
Dinobryon	C			*Volvex*				*Ceratium*			
Chromulina				*Zygnema*				*Peridinium*			
Mallomonas				*Klebsormidium*							
Synura				**Desmids (Green Algae)**							
				Hyalotheca							
				Staurastrum							
				Staurodesmus							
Zooplankton											
Cladocera (Water Fleas)	**1**			**Copecoda (Copepods)**	**1**			**Rotifera (Rotifers)**	**1**		
Bosmina sp.	A			*Cyclops sp.*	A			*Keratella cochlearis* (H)			
Daphnia sp.				*Dipatomus (H)*				*Keratella crassa (H)*			
Eubosmina sp.				*D Nauplius*	A			*Keratella quadrata* (H)			
Chydorus				*Skistodiaptomus oregonensis*				*Kellicottia longispina*			
Diaphniosoma				*Microcyclops sp*				*Asplanchnopus sp.*	P		
Ceriodaphnia				*Limnocalanus macrurus*				*Polyarthra*	P		
Leptodora kindti				*Leptodiaptomus coloradensis*				*Hexarthra mira*			
Scapholeberis mucronata								*Conochilus sp*			
Bosmina longirostris								**Arthropoda (Arthropods)**			
Diaphnosoma brachyurum								*Chaoborus punctipennis*			
Diaphanosoma birgei								*Ostracoda*			
Sites:	**1**			**Comments:**							
Total Phytoplankton Genera	6										
Total Zooplankton Genera	5										
Sample Volume (mL)				**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 Hoptacong				**Sampling Date: 8/2/16**				**Examination Date: 11/28/16**			
Site 1: Station 2											
Phytoplankton											
Bacillariphyta (Diatoms)	**1**			**Chlorophya (Green Algae)**	**1**			**Cyanophyta (Blue-Green Algae)**	**1**		
Achnanthes				*Actinastrum*				*Anabaena*	A		
Asterionella				*Ankistrodesmus*				*Amphanizomen*			
Aulacoseira				*Chlamydomonas*				*Aphanocapsa*			
Cocconeis				*Botryococcus*				*Chroococcus*			
Cyclotella				*Chlorella*	A			*Snowella*			
Cymatopleura				*Coelastrum*				*Lyngbya*			
Cylindrotheca				*Eudorina*				*Microcystis*			
Cymbella				*Gloeocystis*				*Nostoc*			
Denticula				*Gonium*				*Phormidium*	C		
Fragilaria	C			*Hydrodictyon*				*Oscillatoria*	P		
Frustulia				*Monoraphidium*							
Gyrosigma				*Mougeotia*							
Melosira	P			*Micrasterias*							
Nedium				*Microspora*							
Rhizosolenia				*Ochromonas*							
Stauroneis				*Oedogonium*				**Euglenophyta (Euglenoids)**			
Stephanodiscus				*Oocystis*				*Colacium*			
Sururekka				*Scenedesmus*	P			*Euglena (Phacus sp)*			
Synedra				*Spirogya*				*Euglena sp*			
Tabellaria	C			*Staurastrum*	C			*Trachelomonas*			
				Treubaria							
Chrysophyta (Golden Algae)				*Pediastrum*	P			**Pyrrhophyta (Dinoflagellates)**			
Dinobryon	C			*Sphaerocystis*	P			*Ceratium*			
Chromulina				*Zygnema*				*Peridinium*	P		
Mallomonas				*Klebsormidium*							
Synura				**Desmids (Green Algae)**							
				Hyalotheca							
				Staurastrum							
				Staurodesmus							
Zooplankton											
Cladocera (Water Fleas)	**1**			**Copecoda (Copepods)**	**1**			**Rotifera (Rotifers)**	**1**		
Bosmina sp.	P			*Cyclops sp.*	C			*Keratella* sp.			
Daphnia sp.	C			*Dipatomus (H)*				*Keratella crassa (H)*			
Eubosmina sp.				*D Nauplius*	C			*Keratella quadrata* (H)			
Chydorus				*Skistodiaptomus oregonensis*				*Kellicottia longispina*			
Diaphniosoma				*Microcyclops sp*				*Asplanchnopus sp.*			
Ceriodaphnia				*Limnocalanus macrurus*				*Polyarthra*	C		
Leptodora kindti				*Leptodiaptomus coloradensis*				*Brachionus*	C		
Scapholeberis mucronata								*Trichocerca*	P		
Bosmina longirostris								**Arthropoda (Arthropods)**			
Diaphnosoma brachyurum								*Chaoborus punctipennis*			
Diaphanosoma birgei								*Ostracoda*			
Sites:	**1**			**Comments: Abundance of small celled greens and chrysophytes**							
Total Phytoplankton Genera	13										
Total Zooplankton Genera	7										
Sample Volume (mL)				**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 Hoptacong				**Sampling Date: 9/1/16**				**Examination Date: 11/23/16**			
Site 1: Station 2											
Phytoplankton											
Bacillariphyta (Diatoms)	**1**			**Chlorophya (Green Algae)**	**1**			**Cyanophyta (Blue-Green Algae)**	**1**		
Achnanthes				*Actinastrum*				*Anabaena*	C		
Asterionella				*Ankistrodesmus*				*Amphanizomen*			
Aulacoseira				*Chlamydomonas*				*Aphanocapsa*			
Cocconeis				*Botryococcus*				*Chroococcus*			
Cyclotella				*Chlorella*				*Snowella*	P		
Cymatopleura				*Coelastrum*				*Lyngbya*	A		
Cylindrotheca				*Eudorina*				*Microcystis*	P		
Cymbella				*Gloeocystis*				*Nostoc*			
Denticula				*Gonium*				*Pseudoanabaena*			
Fragilaria	C			*Hydrodictyon*				*Oscillatoria*			
Frustulia				*Monoraphidium*							
Gyrosigma				*Mougeotia*							
Melosira				*Micrasterias*							
Nedium				*Microspora*							
Rhizosolenia				*Ochromonas*							
Stauroneis				*Oedogonium*				**Euglenophyta (Euglenoids)**			
Stephanodiscus				*Oocystis*				*Colacium*			
Sururekka				*Scenedesmus*				*Euglena (Phacus sp)*			
Synedra	C			*Spirogya*				*Euglena sp*			
Tabellaria	C			*Staurastrum*				*Trachelomonas*			
				Treubaria							
Chrysophyta (Golden Algae)				*Pediastrum*	P			**Pyrrhophyta (Dinoflagellates)**			
Dinobryon	P			*Volvex*				*Ceratium*	P		
Chromulina				*Zygnema*				*Peridinium*			
Mallomonas				*Klebsormidium*							
Synura				**Desmids (Green Algae)**							
				Hyalotheca							
				Staurastrum							
				Staurodesmus							
Zooplankton											
Cladocera (Water Fleas)	**1**			**Copecoda (Copepods)**	**1**			**Rotifera (Rotifers)**	**1**		
Bosmina sp.	P			*Cyclops sp.*				*Keratella* sp.	P		
Daphnia sp.				*Dipatomus (H)*				*Keratella crassa (H)*			
Eubosmina sp.				*D Nauplius*				*Keratella quadrata* (H)			
Chydorus				*Skistodiaptomus oregonensis*				*Kellicottia longispina*			
Diaphniosoma				*Microcyclops sp*				*Asplanchnopus sp.*			
Ceriodaphnia				*Limnocalanus macrurus*				*Polyarthra*			
Leptodora kindti				*Leptodiaptomus coloradensis*				*Hexarthra mira*			
Scapholeberis mucronata								*Conochilus sp*			
Bosmina longirostris								**Arthropoda (Arthropods)**			
Diaphnosoma brachyurum								*Chaoborus punctipennis*			
Diaphanosoma birgei								*Ostracoda*			
Sites:	**1**			**Comments:**							
Total Phytoplankton Genera	10										
Total Zooplankton Genera	2										
Sample Volume (mL)				**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 Hoptacong				**Sampling Date: 10.13.16**				**Examination Date: 12.6.16**			
Site 1: Station 2											
Phytoplankton											
Bacillariphyta (Diatoms)	**1**			**Chlorophya (Green Algae)**	**1**			**Cyanophyta (Blue-Green Algae)**	**1**		
Achnanthes				*Actinastrum*				*Anabaena*	C		
Asterionella	P			*Ankistrodesmus*				*Amphanizomen*			
Aulacoseira				*Chlamydomonas*	P			*Aphanocapsa*	P		
Cocconeis				*Botryococcus*				*Chroococcus*			
Cyclotella				*Chlorella*				*Snowella*			
Cymatopleura				*Coelastrum*				*Lyngbya*	P		
Cylindrotheca				*Eudorina*				*Microcystis*			
Cymbella				*Gloeocystis*				*Nostoc*			
Denticula				*Haematococcus*	P			*Pseudoanabaena*			
Fragilaria	C			*Hydrodictyon*				*Coelosphaerium*	P		
Frustulia				*Monoraphidium*				*Synechococcus*	P		
Gyrosigma				*Mougeotia*							
Melosira	C			*Micrasterias*							
Pinnularia	P			*Microspora*							
Rhizosolenia				*Ochromonas*							
Stauroneis				*Oedogonium*				**Euglenophyta (Euglenoids)**			
Stephanodiscus				*Oocystis*				*Colacium*			
Sururekka				*Scenedesmus*	P			*Euglena (Phacus sp)*			
Synedra	P			*Spirogya*				*Euglena sp*			
Tabellaria	C			*Staurastrum*	P			*Trachelomonas*			
				Treubaria							
Chrysophyta (Golden Algae)				*Pediastrum*	C			**Pyrrhophyta (Dinoflagellates)**			
Dinobryon	P			*Volvex*				*Ceratium*			
Chromulina				*Zygnema*				*Peridinium*			
Mallomonas				*Klebsormidium*							
Synura				**Desmids (Green Algae)**							
				Hyalotheca							
				Staurastrum							
				Staurodesmus							
Zooplankton											
Cladocera (Water Fleas)	**1**			**Copecoda (Copepods)**	**1**			**Rotifera (Rotifers)**	**1**		
Bosmina sp.	C			*Cyclops sp.*	C			*Keratella* sp.	P		
Daphnia sp.	C			*Dipatomus (H)*				*Keratella crassa (H)*			
Eubosmina sp.				nauplii	C			*Keratella quadrata* (H)			
Chydorus				*Skistodiaptomus oregonensis*				*Kellicottia longispina*			
Diaphniosoma				*Microcyclops sp*				*Asplanchnopus sp.*	P		
Ceriodaphnia				*Limnocalanus macrurus*				*Brachionus*	P		
Leptodora kindti				*Leptodiaptomus coloradensis*				*Hexarthra mira*			
Scapholeberis mucronata								*Conochilus sp*			
Bosmina longirostris								**Arthropoda (Arthropods)**			
Diaphnosoma brachyurum								*Chaoborus punctipennis*			
Diaphanosoma birgei								*Ostracoda*			
Sites:	**1**			**Comments:**							
Total Phytoplankton Genera	17										
Total Zooplankton Genera	7										
Sample Volume (mL)				**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)							