LAKE HOPATCONG
WATER QUALITY MONITORING
ANNUAL REPORT 2013

PREPARED FOR:

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

and

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

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

120 East Uwchlan Avenue
Suite 204
Exton, Pennsylvania 19341
(P) 610.524.4220 • (F) 610.524.9434

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1.0 INTRODUCTION

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2013 growing season (May through September). This monitoring program represents a continuation of the long-term monitoring program of Lake Hopatcong. While the 2010, 2011 and 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.

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 Project. 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 a 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 of 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 2013 sampling dates were 21 May, 24 June, 29 July, 20 August and 17 September. 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 mid-depth 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 2013

In addition to the standard, long-term, in-lake monitoring program, supplemental in-lake data were collected during the 2013 monitoring program. From 2006 to 2013 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 structural BMP was being 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 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 2013 monitoring programs.

For the remaining two supplemental in-lake sampling stations, monitoring occurred during the May through September 2013 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 are being 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 near-shore, 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 2013 monitoring events. However, one addition to the SFY10 sampling program was the collection of an additional set of discrete samples for the analysis of chlorophyll *a*, a photosynthetic pigment all algae possess.

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 2013 growing season were generally consistent with values recorded in previous years' monitoring programs. By the late May event Station #2 exhibited thermal stratification with the epilimnion extending to 6.0 m and the thermocline between 6.0 m and 8.0 m. Thermal stratification was also present at other stations with sufficient depth (i.e. stations 8 and 9). Stratification persisted throughout the rest of the sampling season with seasonally maximum values observed in July 2013.

In contrast to past monitoring years, a moderate amount of thermal stratification was evident at the 319 sampling sites in May through August 2013, in spite of their shallow depths. Water temperatures at the shallow 319 sampling sites reached their maximum values in August and began to cool by the September event.

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 concentrations at Station #2 during the May event were stratified throughout the water column, ranging from a minimum of 3.46 mg/L at the bottom to a maximum of 9.92 mg/L at 2.0 m (6.6 ft). DO concentrations were below the 5.0 mg/L threshold from 12.0 m to the lake bottom. DO was generally adequate at the remaining sampling stations in May 2013.

DO stratification persisted at Station #2 throughout the sampling season. Hypolimnetic anoxia (DO < 1 mg/L) was detected at depths equal to or greater than 10.0 m (33 ft) in June and remained so through July and August. DO concentrations began to increase throughout the water column at Station #2 by the September event, which was characterized by anoxic conditions from 12.0 m to the lake bottom.

DO at the other 10 stations was generally adequate with concentrations greater than 5.0 mg/L throughout all 2013 monitoring events. DO concentrations at the NPS monitoring stations were adequate with the DO measurements frequently being at or near 100% saturation. There were no instances of DO less than 5.0 mg/L at the NPS monitoring stations.

Overall, depression of DO was limited to the hypolimnion of Station #2. 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. pH values greater then 7 are termed alkaline while those less then 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 State water quality standard for pH is for an optimal range between 6.5 and 8.5.

The pH values during the May 2013 sampling event were generally acceptable throughout the lake with the exception being Station #3 where pH values ranged from 8.77 to 9.69. A similar pattern was observed in June 2013; pH values were generally in the optimal range with the exception being some pH values at Station #3 being greater than 8.5. In contrast, all pH values were within the State’s optimal range during the July 2013 event. During the August 2013 event all pH values were within the State’s optimal range except for values at Station #6, which were consistently greater than 8.8. The same pattern was observed in September 2013; pH values were within the State’s optimal range except for Station #6 where they were consistently greater than 8.6. The elevated pH values in the surface waters of Lake Hopatcong were attributed to high rates of algal productivity.

During the May 2013 sampling event the NPS-1 and NPS-5 stations had pH values greater than 8.5. In June 2013 only NPS-2 had pH values greater than 8.5. In July all NPS stations had acceptable pH values, while in August some elevated values were measured at NPS-2. By September 2013 elevated pH values were detected in NPS-1 and NPS-5. In contrast to the deeper, open water sampling stations, the elevated and unacceptable pH values at the NPS stations was attributed primarily to high rates of photosynthesis from aquatic plants and filamentous mat algae.

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). Secchi depths were consistently greater than the 1.0 m threshold throughout the lake during the May and June 2013 events. In contrast, lower Secchi depth values (< 1.0 m) were observed at Stations #1 and #10 during the July 2013 event. In August 2013 these sampling stations still had Secchi depths less than 1.0 m in addition to Station #3. By September 2013 all Secchi depths were consistently greater than the 1.0 m threshold.

Secchi depth at the NPS stations was routinely measured to the lake bottom due to the shallowness of these stations. The exception was NPS-1 which had a Secchi depth less then 1.0 m during the August sampling event.

Ammonia-Nitrogen (NH_4-N)

Surface water NH_4-N concentrations above 0.05 mg/L tend to stimulate elevated rates of algal growth. Ammonia concentrations measured during the May 2013 event were generally low in the surface waters with moderately high concentrations measured at Stations #1, #2, #7, #10 and #11. After May 2013, surface water NH_4-N concentrations were consistently low (< 0.05 mg/L) for the rest of the growing season. Station #2 deep samples were elevated, due to the anoxic (no DO) hypolimnion, with concentrations varying between 0.33 and 0.59 mg/L.

In summary, surface concentrations of ammonia-N were low throughout the 2013 growing season, particularly after May. Elevated hypolimnetic concentrations of ammonia-N were due to hypolimnetic anoxia (no DO).

Nitrate-Nitrogen (NO_3-N)

Nitrate-N concentrations measured in the surface and mid-depth waters during the May 2013 sampling event ranged from non-detectable (ND < 0.02 mg/L) to 0.16 mg/L (at Station #10) with a mean concentration of 0.07 mg/L. Concentrations in the deep waters of Station #2 were 0.09 mg/L. Slightly elevated nitrate-N concentrations at Stations #10 and #11 were attributed to near-shore septic systems.

Nitrate-N concentrations measured in the surface waters during the June event ranged from non-detectable at Station #2 to a maximum of 0.09 mg/L at Station #11. Concentrations in the surface waters, while slightly variable, were within a normal range for the support of a healthy aquatic ecosystem and were of no cause for concern. Concentrations in the deep waters of Station #2 were low (< 0.02 mg/L).

In July nitrate-N concentrations varied from 0.02 to 0.06 mg/L and were generally low, while during August nitrate-N concentrations were consistently low throughout the lake. By September the variability in nitrate-N concentrations increased with values ranging from < 0.02 to 0.05 mg/L. Deep water concentrations at Station #2 ranged from <0.02 mg/L to 0.17 mg/L.

In summary, nitrate-N concentrations were low but exhibited a marginal amount of spatial or temporal variability in Lake Hopatcong throughout the 2013 growing season. However, all in-lake concentrations were consistently below the State and Federal drinking water standard of 10.0 mg/L.

Total Phosphorous (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 average, 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 2013 sampling event ranged from 0.01 mg/L to 0.02 mg/L with a surface water mean concentration of 0.02 mg/L. The deep water TP concentration at Station #2 was 0.03 mg/L. Thus, May 2013 TP concentrations were consistently below the State and TMDL thresholds.

TP concentrations in the surface waters during the June 2013 event and ranged from 0.02 mg/L to 0.04 mg/L with a mean concentration of 0.03 mg/L. The elevated values of 0.04 mg/L were from Stations #3 and #10. Additionally, the elevated TP concentration occurred at the same time the pH values at Station #3 were above the State's upper threshold.

TP measured during the July 2013 event ranged from 0.02 mg/L to 0.05 mg/L in the surface waters. The TP concentration at Station #10 was 0.04 mg/L but the concentrations at both Stations #1 and #3 were 0.05 mg/L, which is are all in exceedance of the State's water quality standard.

In August 2013, TP concentrations ranged from 0.01 mg/L to 0.04 mg/L with a mean surface water TP concentration of 0.02 mg/L. Station #3 was the only sampling site with a TP concentration of 0.04 mg/L during the August event. By September TP concentrations were low, varying between 0.01 and 0.03 mg/L throughout the lake.

Deep water TP concentrations at Station #2 varied between < 0.01 and 0.30 mg/L.

It has been well documented in past reports that Station #3 (River Styx / Crescent Cove) consistently has the highest TP concentrations among the standard eleven monitoring stations in Lake Hopatcong. Since the long-term monitoring of Lake Hoaptcong was initiated in the 1980's, elevated TP concentrations in the River Styx / Crescent Cove section of the lake is a re-occurring condition. For example in 2013, the mean TP concentration at Station #2 (Mid-lake) was 0.014 mg/L, while the Station #3 mean was 0.034 mg/L. It should also be noted that the mean TP concentration at Station #10 was 0.032 mg/L.

Similar to past monitoring years, higher TP concentrations tend to be found at Station #3 relative to the rest of the lake. However, in 2013, of the five TP samples collected over the growing season, only one was in exceedance of the State's water quality threshold and the seasonal mean (0.034 mg/L) was only slightly greater than the TMDL targeted growing season threshold of 0.03 mg/L. As previously mentioned, the elevated TP of 0.04 mg/L in June at Station #3 occurred at the same time the pH was in exceedance of the State's water quality standard.

Bottom water TP concentrations at the mid-lake sampling station (Station #2) varied between less than the analytical detection limit and 0.30 mg/L from May through September of 2013 with a mean concentration of 0.124 mg/L, lower than the 2012 mean concentration of 0.17 mg/L. The elevated TP concentrations in the deep waters during the latter half of the growing season were attributed to the anoxic conditions and the lack of mixing with the atmosphere during the summer season.

TP concentrations at the NPS stations NPS-2 through NPS-5 were generally acceptable, varying between 0.01 and 0.03 mg/L over the 2013 growing season. The exception to this was NPS-1, which consistently had TP concentrations greater than 0.03 mg/L, with four of the five TP concentrations being equal to or greater than the State Surface Water Quality Standard of 0.05 mg/L. The growing season mean TP concentration for NPS-1 was 0.054 mg/L. Clearly, additional stormwater / watershed management work is required within the immediate drainage areas surrounding NPS-1 (Borough of Hopatcong, Sussex County, NJ).

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 2013 were after the second Aqua-Filter was installed.

As shown in Table 1, before the first Aqua-Filters installed the mean growing season (May – September) TP concentration in Crescent Cove varied between 0.063 to 0.065 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.

However, 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 0.068 mg/L slightly above 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 indicate that the first Aqua-Filter needs to be maintained. Specifically, the filter pillows need to be replaced and the Aqua-Swirl portion of the structure needs 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 growing season TP concentration for NPS-1 was 0.036 mg/L, the lowest mean value of the entire 2006 - 2013 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 0.054 mg/L, slightly 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. This trend continued in 2013, where the mean June - September TP concentration was 0.058 mg/L (Table 1) and only the May concentration was below the State standard (Figure 1).

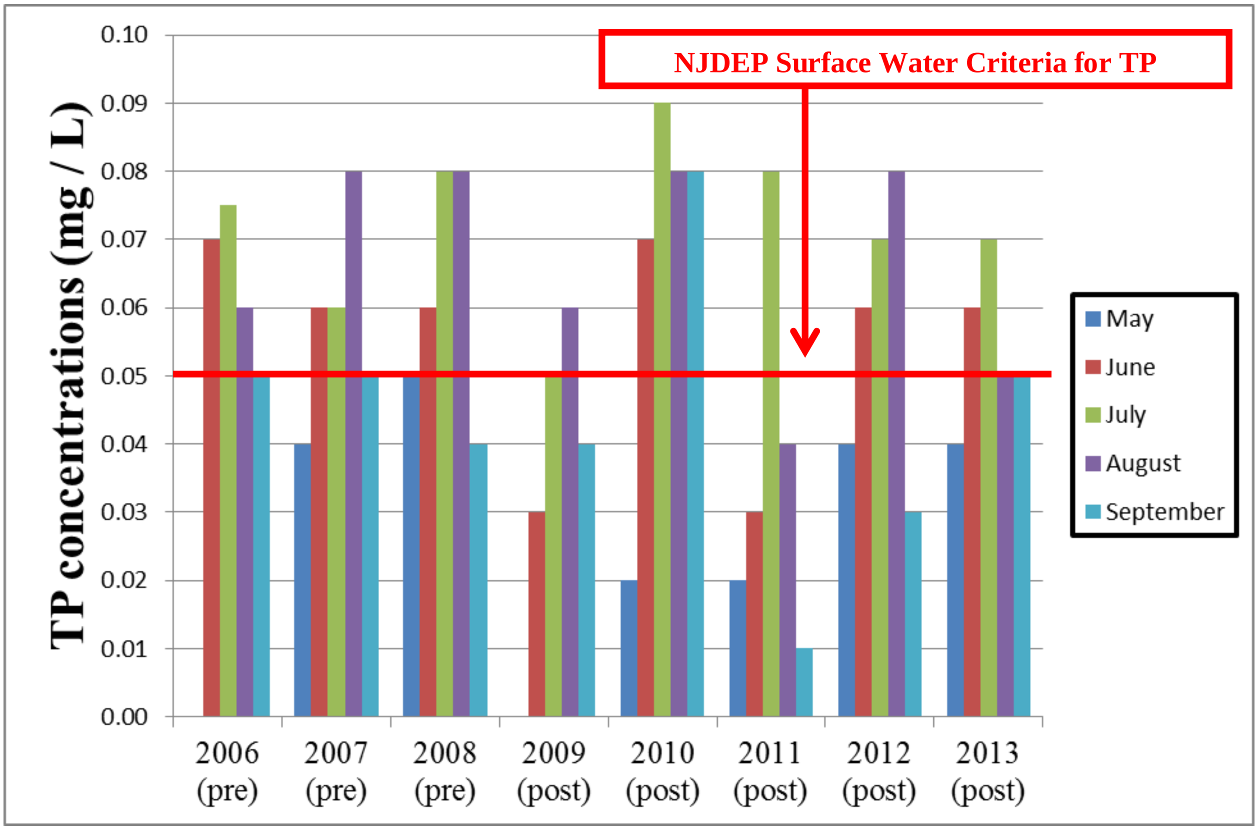
Based on these resulting data both Aqua-Filter structures need to, at a minimum, be cleaned out of accumulated suspended sediments in the spring of 2014. In addition, to maximize the removal of phosphorus, the filter pillows should be replaced after the Aqua-Swirl portion of the structures are cleaned out. Based on this eight year dataset, the installed Aqua-Filters can have a positive impact on water quality by reducing TP and TSS (see below) concentrations. However, as previously stated, to maximize the efficiency of this removal, the units do need to be routinely inspected and cleaned out.

Table 1
The Mean and Range of TP and TSS Concentrations for Crescent Cove From June through September of Each Monitored Year

Monitoring Year	TP mean and range	TSS mean and range
2006 (pre-installation)	0.064 mg/L (0.05 – 0.09 mg/L)	12 mg/L (6 – 15 mg/L)
2007 (pre-installation)	0.063 mg/L (0.05 – 0.08 mg/L)	7 mg/L (3 – 11 mg/L)
2008 (pre-installation)	0.065 mg/L (0.04 – 0.08 mg/L)	18 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)	0.068 mg/L (0.02 – 0.09 mg/L)	8 mg/L (1 -15 mg/L)
2011 (post-installation)	0.036 mg/L (0.01 – 0.08 mg/L)	5 mg/L (1 – 11 mg/L)
2012 (post-installation)	0.054 mg/L (0.03 – 0.08 mg/L)	6 mg/L (3 – 10 mg/L)
2013 (post-installation)	0.058 mg/L (0.05 – 0.07 mg/L)	7 mg/L (2 – 15 mg/L)

While not discussed in detail, it should be noted that there has been a measurable decline in 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 18 mg/L. In contrast, after the Aqua-Filters were installed, TSS concentrations ranged from 1 to 15 mg/L, with growing season means ranging from 5 to 8 mg/L (Table 1). Thus, in-lake 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 should be cleaned out at least once a year.

Figure 1 – TP Concentrations at Crescent Cove



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 event ranged from 2.3 µg/L at Station #3 to 7.1 µg/L at Station #7 with a mean concentration of 5.4 µg/L. The mean value for 2013 was approximately half the chlorophyll *a* concentration measured in May of 2012. In addition, all concentrations were below the TMDL targeted values previously described.

Chlorophyll *a* concentrations increased by the June event with concentrations ranging from 2.4 µg/L at Station #6 to 26.5 µg/L at Station #10 with a mean concentration of 11.8 µg/L. The targeted mean concentration was exceeded and the targeted maximum concentration was exceeded at four of the nine sample sites.

Chlorophyll *a* continued to increase by the late July event with concentrations ranging from 5.1 µg/L at Station #2 to 36.3 µg/L at Station #10 with a mean concentration of 16.9 µg/L. While the mean July concentration exceeded the targeted mean of 8 µg/L, the maximum threshold concentration was only exceeded in three of the nine sampling stations (Stations #1, #3 and #10).

In late August chlorophyll *a* concentrations varied between 4.1 µg/L at Station #6 to 23.3 µg/L at Station #3 with a mean concentration of 12 µg/L. In addition, the same three sampling stations that exceeded the maximum threshold concentration in July also exceeded this value in August (Stations #1, #3 and #10).

In mid-September chlorophyll *a* concentrations varied between 4.0 µg/L at Station #11 to 25.8 µg/L at Station #3 with a mean concentration of 13.3 µg/L. In September four of the nine sampling stations had concentrations that exceeded the maximum threshold concentration (Stations #1, #2, #3 and #10).

Chlorophyll *a* concentrations at the NPS stations were low during the May event (4.4 µg/L – 6.8 µg/L) and increased to maximum values during the July and August events. The single highest NPS chlorophyll *a* concentration was at NPS-4 on 29 July 2013, which was 11.1 ug/L. It should be noted the targeted maximum of 14 µg/L was not exceeded by any of the NPS sampling stations over the 2013 growing season.

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 2013. Algal abundance was low during the 21 May 2013 event with the community comprised primarily of the diatom *Fragilaria* and the green alga *Spirogyra*.

The phytoplankton community increased in species richness and diversity through the 24 June 2013 sampling event although densities still remained relatively low. Co-dominance in the community was exerted between the diatom *Fragilaria* and the blue-green algae *Anabaena*.

Phytoplankton densities increased by the 29 July 2013 event where abundance was dominated by the cyanobacteria (blue-green alga) *Anabaena*. Other notable algae during this event included the diatoms *Melosira* and *Fragilaria* and the green algae *Pediastrum*.

A bloom of *Anabaena* was noted during the 17 September 2013 event. The diatom *Asterionella* was also present in high densities during this event.

Finally, it should be noted that while the blue-green alga *Anabaena*, which is well known to generate nuisance surface scums, was fairly common in the phytoplankton community of Lake Hopatcong, large-scale, nuisance blooms did not occur. The fact that more Secchi depth throughout the lake were greater than the 1.0 m (3.3 ft) threshold support this fact.

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 21 May 2013 sampling event showed co-dominance exerted across the three main groups of freshwater zooplankton. The rotifer *Asplanchna*, the copepod *Cyclops* and the small-bodied cladoceran *Bosmina* were all listed as ‘abundant’ throughout this event. The herbivorous cladoceran *Daphnia* was also identified but in lower densities.

During the 24 June 2013 sampling event co-dominance was exerted between *Bosmina* and *Cyclops*. The herbivorous cladoceran *Daphnia* was again identified but in lower numbers than what was observed during the May 2013 event.

Moderate zooplankton densities were noted during the 29 July 2013 event where co-dominance was shared among *Bosmina*, *Diaptomus* and *Cyclops*. *Daphnia* was again present and in slightly higher densities than what was identified during the June 2013 event.

Zooplankton densities remained moderate during the 17 September 2013 event where co-dominance was shared among the cladocerans *Daphnia* and *Bosmina* and the copepods *Cyclops* and *Diaptomus* (an herbivorous copepod). The rotifer *Asplanchna* was also identified in low numbers.

Similar to past monitoring years, herbivorous zooplankton were present in Lake Hopatcong but not in high densities and none attained large sizes (total length). 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 1
Phytoplankton in Lake Hopatcong during the 2013 Growing Season

Sampling Date	Phytoplankton
21 May 2013	Algal abundance was low. The dominant alga was the diatom *Fragilaria* and the green algae *Spirogyra*.
24 June 2013	Total algal abundance was low with co-dominance exerted between the blue-green alga *Anabaena* and the diatom *Fragilaria*. In addition, the diatom *Navicula*, the green alga *Pediastrum* and the chrysophyte *Dinobryon* were identified in low densities.
29 July 2013	Algal abundance was moderate with dominance exerted by the blue-green *Anabaena*. Lower densities of diatoms (*Melosira* and *Fragilaria*) and greens (*Pediastrum*) were also noted. Small numbers of the blue-green *Oscillatoria* and the dinoflagellate *Ceratium* were also identified.
17 September 2013	Abundance was high and diversity was low with a bloom of the blue-green *Anabaena*. In addition, a dense assemblage of the diatom *Asterionella* was noted. Lower densities of *Oscillatoria* and *Pediastrum* were also identified.

Table 2
Zooplankton in Lake Hopatcong during the 2013 Growing Season

Sampling Date	Zooplankton
21 May 2013	Zooplankton numbers were high and co-dominance was exerted between the rotifer *Asplanchna*, the copepod *Cyclops* and the small-bodied cladoceran *Bosmina*. *Daphnia* was also listed as "common" but was not as prolific as the other zooplankters.
24 June 2013	A bloom of the small-bodied cladoceran *Bosmina* and the copepod *Cyclops* was present. *Daphnia* was identified in low numbers while numbers of the rotifer *Asplanchna* and copepod nauplii were higher.
29 July 2013	Moderate zooplankton abundance was noted during this event with co-dominance between *Bosmina, Diaptomus* and *Cyclops*. *Daphnia* was listed as 'common' but was not as prolific as the three previously mentioned genera.
17 September 2013	The zooplankton community exhibited moderate abundance with *Daphnia*, *Bosmina*, *Cyclops* and *Diaptomus* all listed as 'common.' *Asplanchna* was listed as present during this event.

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 criterion 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 2013 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 in the uppermost 11.0 m (36.3 ft) of the water column during the May 2013 sampling event at Station #2. Optimal habitat during the June 2013 event was found between 1.0 m (3.3 ft) and 6.0 m (20 ft). By late July 2013 optimal habitat was no longer found in Lake Hopatcong but carryover habitat was found between the surface and 5.0 m (16.5 ft). By the August 2013 sampling event, optimal habitat was re-established from the surface to 7.0 m (23.1 ft) and in September 2013 this optimal habitat expanded from the surface to a depth of 9.0 m (29.7 ft).

Similar to past monitoring years, the *in-situ* data revealed that varying levels of optimal and acceptable brown trout habitat persisted through the entire 2013 growing season in Lake Hopatcong. The only month where optimal habitat was not present was July; however, carryover habitat was present in July 2013. In contrast, optimal habitat was present during the rest of the 2013 growing season.

Mechanical Weed Harvesting Program

Many of the more shallow 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 and late start up date. In turn, this resulted in only 1.2% of the plant biomass 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; this was primarily due to the fact that the program was initiated earlier in the year of 2013 relative to 2012. NJDEP has directly overseen the operation of the weed harvesting program for the last three years and each year displays a higher rate of removal, which was attributed to becoming more familiar with the operations and lake-specific conditions. In addition, the operations staff have been excellent at maximizing high rates of efficiency during harvesting operations.

The mechanical weed harvesting program at Lake Hopatcong over the 2013 growing season resulted in the removal of approximately 2,299 cubic yards of wet plant biomass, which resulted in the removal of 49 lbs (22 kg) of phosphorus. In turn, this accounted for 0.7% of the TP load targeted for removal under the TMDL. During the 2011 and 2012 harvesting events these removal rates were 0.3% and 0.6%, respectively, of the TP load targeted for removal under the TMDL. The 49 lbs of TP removed through the 2013 weed harvesting program had the potential to generate up to 53,627 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 2013. The annual mean values for Station #2 were graphed, along with the long-term, “running mean” for the lake.

The 2013 mean Secchi depth was 2.5 meters, which was the same as the mean for 2010 and higher than the 2011 and 2013 mean values (Figure 2 in Appendix A). This is the fourth year in a row that the mean Secchi depth has been greater 2.0 meters. In addition, the long-term Secchi depth mean remains slightly above 2 meters.

Unlike Secchi depth, chlorophyll *a* concentrations exhibited a wide range of variability at Lake Hopatcong (Figure 3 in Appendix A). The mean 2013 chlorophyll *a* concentration was 8.0 mg/m^3; the chlorophyll *a* mean has been on decline since 2011. In addition, it should be noted that the 2013 mean attained the TMDL’s targeted mean endpoint of 8 mg/m^3.

The 2013 mean TP concentration (0.014 mg/L) at Station #2 was the lowest mean since 2010. In addition, the mean TP concentration at Station #2 has been less than 0.03 mg/L since 1998 and less than 0.02 mg/L since 2008 (Figure 4 in Appendix A). The mean TP concentration at Station #2 has also been consistently below the TMDL targeted mean of 0.03 mg/L since 1998.

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.

Given the undesirable water quality conditions experienced in select portions of Lake Hopatcong, NJDEP conducted a Total Maximum Daily Load (TMDL) analysis for TP, the primary nutrient limiting algal and plant growth in the lake. This TMDL was revised by Princeton Hydro, who also developed a Restoration Plan for the lake and watershed. The revised TMDL and associated Restoration Plan were approved by NJDEP in 2006 and have been used to obtain grant funding through both NJDEP and US EPA to implement various watershed-based projects to reduce the existing phosphorus loads. Some of these projects were completed in 2008-10, others were completed in 2013 and another set will be completed in 2014. Thus, continuing the long-term monitoring program and augmenting it with near-shore, in-lake and stormwater sampling will provide a means of quantifying the water quality improvements associated with the implementation of these projects.

As described in detail in the 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 2013 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 seasonal mean and single TP concentrations at Station #2 were all consistently below the targeted mean TP concentration, recognized under the TMDL (0.03 mg/L).

As previously mentioned, the mean 2013 chlorophyll *a* concentration for Station #2 was 8.0 mg/m^3 which is just at the mean endpoint of 8 mg/m^3. Additionally, only the September 2013 chlorophyll *a* concentration at Station #2 (17.7 mg/m^3) exceeded the maximum chlorophyll endpoint of 14 mg/m^3. Both the Station #3 and #10 TP concentrations in June and July exceeded the 0.03 mg/L values and the Station #3 August concentration also exceeded this value.

The mean chlorophyll *a* concentrations at Stations #3 and #10 (18.5 and 2.18 mg/m^3, respectively) were greater than the threshold mean concentration of 8 mg/m^3 and the maximum concentration of 14 mg/m^3.

TP concentrations in 2013 were equal to or greater than 0.03 mg/L in three of the five events at Station #3 and four of the five events at Station #10. In addition, an analysis of the past eight years of water quality data TP concentrations at Station #3 exceeded the 0.03 mg/L TMDL threshold from 60% to 100% of the time each year. For Station #10, TP concentrations exceeded the 0.03 mg/L TMDL threshold from 50% to 100% of the time each year. In contrast, for Station #2 (mid-lake), TP concentrations exceeded the 0.03 mg/L TMDL threshold from 0% to 20% of the time each year.

4.0 SUMMARY

This section provides a summary of the 2013 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. The lake was well mixed and well oxygenated from surface to bottom in May, with anoxic (DO less than 1 mg/L) conditions observed at depths of 10 meters and deeper from June through August. By September anoxic conditions were observed at depths of 12 meters and deeper.

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, with three instances of the TP concentration being 0.05 mg/L and one instance of the TP concentration being 0.06 mg/L. During the 2013 growing season Station #3 (River Styx/Crescent Cove) tended to have the highest TP concentrations with a growing season mean of 0.044 mg/L (similar to 2012), above the TMDL-based threshold for Lake Hopatcong of 0.03 mg/L. However, elevated TP concentrations were also occasionally measured at both Station #10 (Northern Woodport Bay) and #11 (Jefferson Canals).

3. In spite of the elevated concentrations at Station #3, open water TP concentrations were generally low in Lake Hopatcong. For example, the mean 2013 TP concentration at the mid-lake station was 0.014 mg/L. This is the lowest mean TP concentration since 2010 and is well below the TMDL-based threshold value (0.03 mg/L).

4. Based on the *in-situ* conditions, carry-over brown trout habitat was available throughout the entire 2013 growing season. Optimal brown trout habitat was also present in May and June, was not present in July but was re-established in August and September 2013. Such results are consistent with those measured in previous monitoring years at Lake Hopatcong.

5. NJDEP continued to increase its efficiency in mechanical weed harvesting at Lake Hopatcong. During the 2013 harvesting program approximately 2,299 cubic yards of wet plant biomass was removed. This resulted in removing 49 lbs of TP, accounting for 0.7% of the TP targeted for removal under the TMDL. It should be noted that the amount of TP removed in 2013 was twice the amount harvested in 2011.

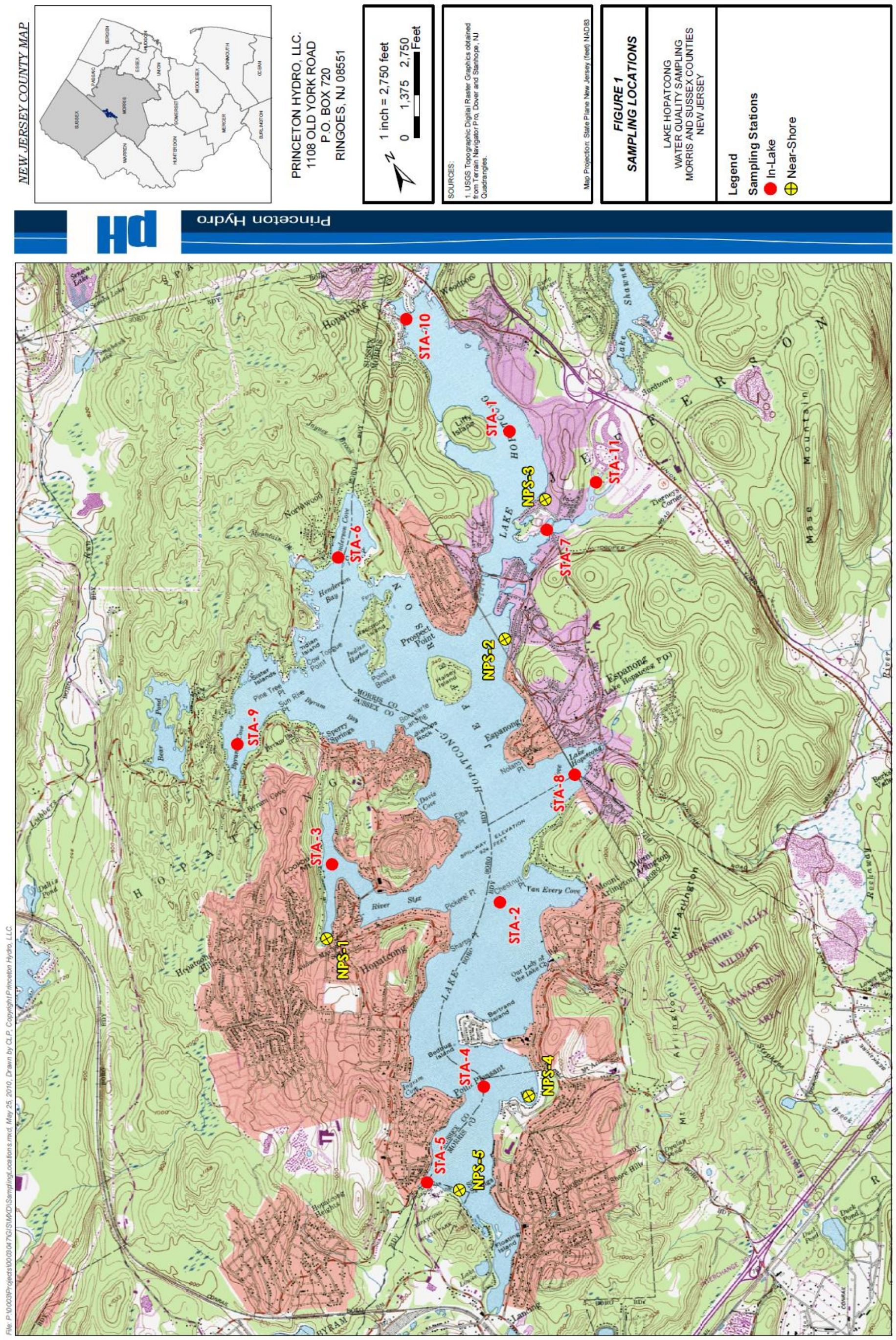
6. Within recent years there has been a general trend of lower TP concentrations (since 2007), lower chlorophyll *a* concentrations (since 2004) and improved water clarity (since 2005). These long-term data were collected from the mid-lake sampling station and indicate that the lake has been trending toward better water quality conditions. However, there are still some locations that require additional attention (River Styx / Crescent Cove; northern end of the lake in Jefferson Township).

7. Over the last eight years, TP concentrations at Station #2 (mid-lake) exceeded the TMDL targeted concentration of 0.03 mg/L only 0 to 20% of the time each year. In contrast, TP concentrations at Station #3 (River Styx / Crescent Cove) were at or above the 0.03 mg/L for 60 to 100% of time each year. Conditions were similar at Station #10 (Northern Woodport Bay), where TP concentrations were equal to or greater than the 0.03 mg/L TMDL threshold for 50 to 100% of the time. TP concentrations in the River Styx / Crescent Cove section of the lake also frequently exceeded the State's Surface Water Quality criteria of 0.05 mg/L.

8. Based on a long-term analysis of all watershed-based and in-lake activities (installation of stormwater structures and BMPs, banning non-phosphorus fertilizers, initiation of the septic management plan in the Township of Jefferson, partial sewering of the Borough of Hopatcong and the annual harvesting / removal of aquatic plants / mat algae), by the end of 2014 Lake Hopatcong will be in compliance with approximately 33% of its TMDL-based targeted load in TP. While improvements in water quality have been realized, particularly in the open water sections of the lake, other sections of the lake still violate both the endpoints established in the TMDL as well as the State's established Surface Water Quality Standard for phosphorus. In addition, the elevated phosphorus in certain sections of the lake stimulate high rates of algal / aquatic plant photosynthesis, which in turn increases the pH causing the documented impairment (303(d) list) for Lake Hopatcong. In order to preserve and protect Lake Hopatcong, as well as remove the lake from the State's Impaired List, watershed-based efforts much continue to reduce the lake's annual TP load.

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
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

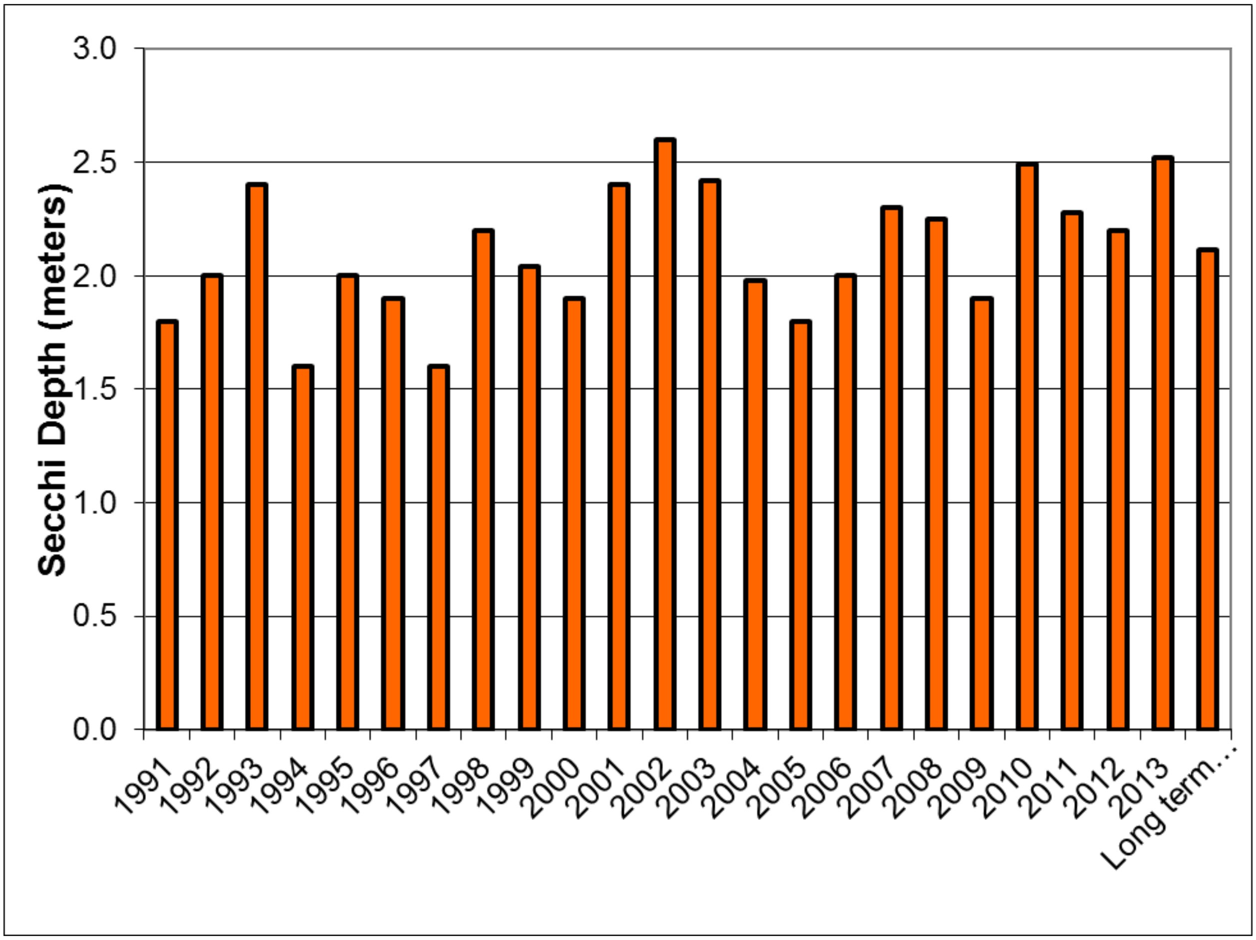


Figure 2 - Lake Hopatcong Long-Term Secchi Depth (meters)

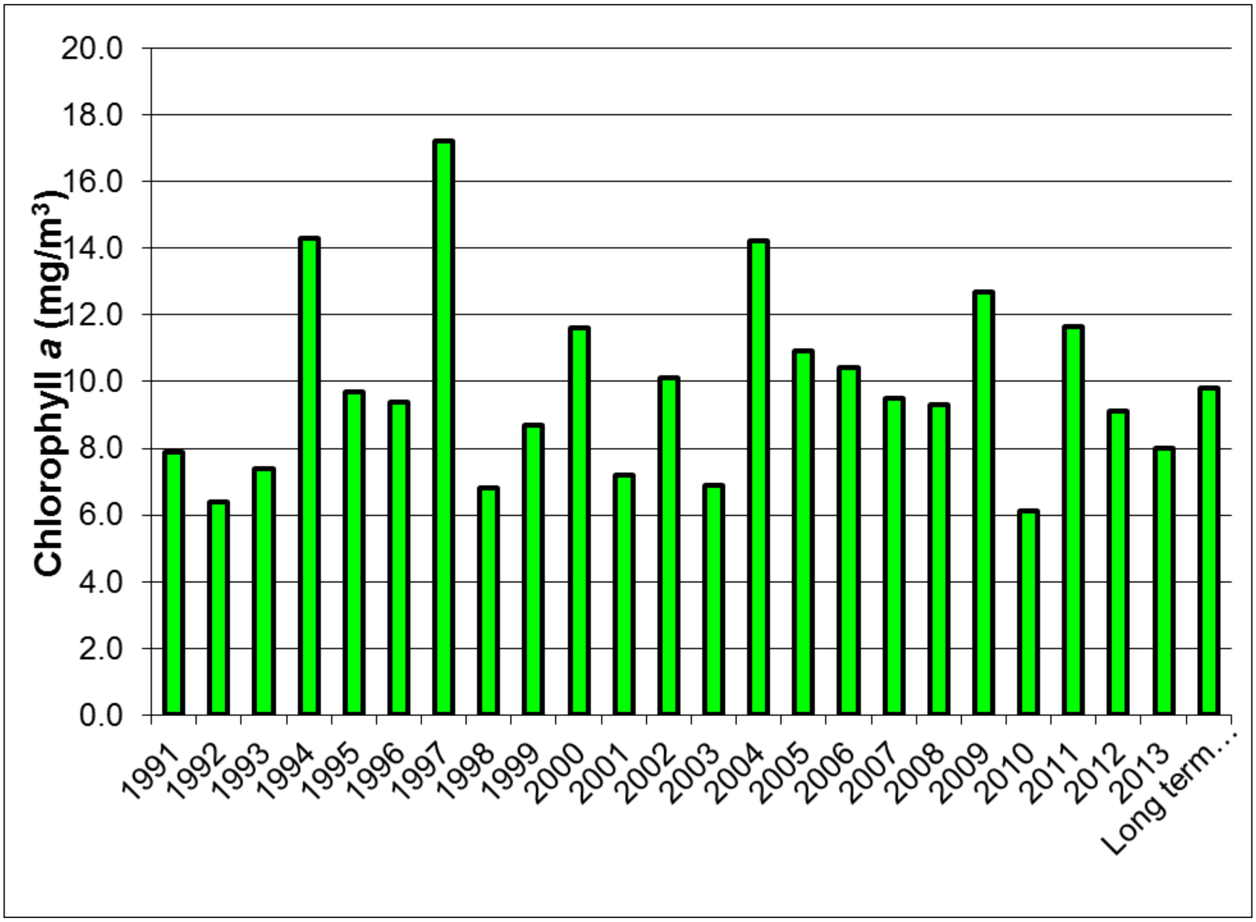


Figure 3 - Lake Hopatcong Long-Term Chlorophyll a Concentrations (mg/m^3)

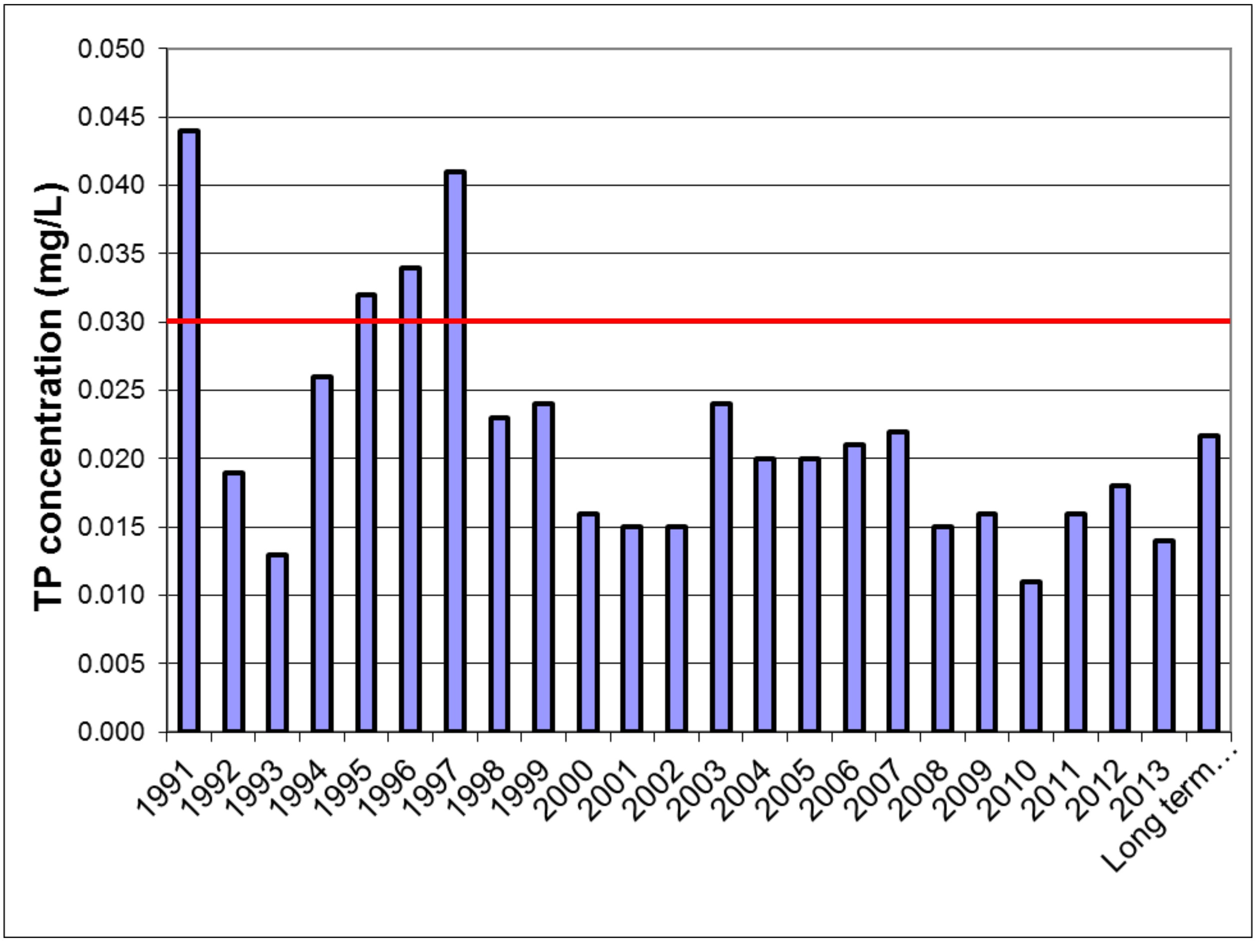


Figure 4 - Lake Hopatcong Long-Term Total Phosphorus Concentrations (mg/L)

APPENDIX B

IN-SITU DATA

In-Situ Monitoring for Lake Hopatcong 5/21/13

Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen
	Total	Secchi	Sample	(°C)	(µmhos/cm)	(units)	(mg/L)	(%)
ST-1	2	2.0+	Surface	20.9	355.1	7.76	8.99	104.7
			1.0	20.14	362.3	7.86	9.41	108
			2.0	17.89	377.3	7.58	8.61	94.4
ST-2	13.8	2.9	Surface	18.23	330.5	8.08	9.87	108.9
			1.0	17.99	330.6	8.1	9.87	108.4
			2.0	17.52	329.9	8.07	9.92	108
			3.0	17.08	329.7	8	9.94	107.1
			4.0	16.56	328.8	7.89	9.83	104.8
			5.0	15.8	328.5	7.79	9.54	100.1
			6.0	14.78	327.2	7.53	8.23	84.5
			7.0	13.39	326.2	7.46	7.95	79.1
			8.0	11.71	325.4	7.32	6.49	62.2
			9.0	11.1	325.1	7.28	6.02	56.9
			10.0	10.83	325.1	7.24	5.57	52.3
			11.0	10.42	325.2	7.19	5.1	47.4
			12.0	10.21	326.4	7.13	4.55	42.2
			13.0	10.04	327.1	7.09	4.1	37.8
			13.5	9.9	332.8	7.03	3.46	31.8
ST-3	2.1	2.1+	Surface	22.56	600.6	9.53	10.43	125.5
			1.0	19.62	731	9.69	11.45	130.2
			2.0	17.34	715.8	8.77	12.66	137.3
ST-4	3	2.3	Surface	19.09	339.5	8.49	9.42	105.8
			1.0	18.91	339.4	8.53	9.67	108.2
			2.0	17.33	333.6	8.33	9.91	107.4
			3.0	16.55	330.6	7.83	9.19	97.9
ST-5	3	3	Surface	19.65	345.3	8.44	8.84	100.5
			1.0	18.36	338.8	8.7	9.04	100
			2.0	17.47	340.4	8.58	9.17	99.7
			3.0	16.86	351.4	8.27	9.13	98
ST-6	2.3	2.3+	Surface	20.92	326.3	8.26	9.86	114.9
			1.0	20.35	326.8	8.48	10.34	119.2
			2.0	17.49	302.5	8.22	10.84	117.8
ST-7	1.9	1.9+	Surface	20.93	198.4	7.36	8.64	100.6
			1.0	19.84	198.9	7.25	8.59	97.9
			1.5	18.67	227.8	7.13	8.29	92.4
ST-8	7.5	2.5	Surface	18.78	329.9	7.84	9.57	106.9
			1.0	18.76	329.9	7.92	9.69	108.1
			2.0	18.37	329.9	7.97	9.82	108.7
			3.0	17.44	329	7.98	9.99	108.5
			4.0	17.1	329.8	7.94	10.01	107.9
			5.0	16.63	330	7.86	9.87	105.4
			6.0	15.21	332.7	7.76	9.73	100.8
			7.0	13.34	326.7	7.28	6.11	60.7
			7.5	12.7	326.2	7.25	6.12	60
ST-9	8	2.3	Surface	19.06	331.9	7.88	9.6	107.7
			1.0	18.05	333.5	7.98	10.03	110.3
			2.0	17.08	329.5	7.98	10.24	110.3
			3.0	16.63	328.4	7.86	10.09	107.7
			4.0	16.49	329.3	7.73	9.89	105.3
			5.0	16.25	331	7.64	9.55	101.2
			6.0	13.85	328.6	7.42	8.01	80.6
			7.0	11.84	328.9	7.22	5.79	55.7
			8.0	11.52	329.3	7.02	3.01	28.8
ST-10	1.7	1.7+	Surface	20.86	389.6	7.65	9.21	107.2
			1.0	20.25	391.9	7.71	9.41	108.2
			1.5	19.69	417.6	7.7	9.48	107.8
ST-11	1.2	1.2+	Surface	21.47	134.3	7.28	8.55	100.7
			1.0	18.42	183.5	7.09	9	99.7

In-Situ **Monitoring for Lake Hopatcong 6/24/13**

Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen
	Total	Secchi	Sample	(°C)	(µmhos/cm)	(units)	(mg/L)	(%)
ST-1	2	1.2	Surface	27.15	348.2	7.71	9.02	118.2
			1.0	26.68	349.4	7.76	9.4	122.1
			2.0	25.81	343.3	7.63	9.61	122.9
ST-2	14	2.6	Surface	24.27	333.3	7.62	8.97	111.4
			1.0	23.97	331.4	7.64	9.03	111.6
			2.0	23.69	329.3	7.68	9.12	112
			3.0	23.21	331.6	7.69	9.22	112.3
			4.0	22.91	329.7	7.69	9.21	111.5
			5.0	21.64	325.8	7.55	8.67	102.4
			6.0	19.39	326	7.18	6.03	68.1
			7.0	17.22	326.8	6.92	3.54	38.2
			8.0	14.5	328.5	6.81	2.26	23
			9.0	13.28	328.2	6.78	1.48	14.7
			10.0	12.37	328.7	6.76	0.94	9.1
			11.0	11.91	329.4	6.75	0.64	6.2
			12.0	11.4	332.5	6.73	0.45	4.3
			13.0	10.8	337.7	6.7	0.25	2.3
			14.0	10.61	371.1	6.66	0.16	1.5
ST-3	2.1	1.7	Surface	28.33	657.4	8.59	9.72	130.1
			1.0	25.9	614.3	8.58	10.98	140.7
			2.0	22.71	751.7	7.9	11.59	140
ST-4	3	2.2	Surface	24.83	337.3	7.35	8.28	103.9
			1.0	24.58	340.2	7.35	8.41	105
			2.0	24.23	336.2	7.36	8.38	104
			3.0	21.42	327.8	7.27	7.93	93.3
ST-5	3.2	1.8	Surface	24.64	335	7.38	7.76	97
			1.0	24.28	334.8	7.34	8.11	100.8
			2.0	23.64	332.8	7.22	8.24	101.1
			3.0	22.27	333.1	7.06	6.07	72.6
ST-6	2.6	2.6+	Surface	27.21	317.7	7.86	8.09	106
			1.0	26.79	317.3	7.96	8.8	114.6
			2.0	25.29	311.6	7.84	9.15	115.8
			2.5	24.57	309.8	7.48	8.57	107
ST-7	1.6	1.5	Surface	27.77	207.8	7.28	8.42	111.4
			1.0	26.31	197.4	7.2	8.88	114.4
			1.5	24.96	198.3	7.06	9.19	115.6
ST-8	7.5	2.8	Surface	25.03	330.9	7.82	8.93	112.5
			1.0	24.89	330.8	7.85	9.04	113.7
			2.0	24.65	330.5	7.9	9.24	115.6
			3.0	23.63	327.6	7.87	9.39	115.2
			4.0	23.48	327.3	7.78	9.23	113
			5.0	20.87	327.2	7.7	9.53	111
			6.0	19.53	325.3	7.51	8.08	91.5
			7.0	18.05	326.1	7.19	5.26	57.9
			7.5	16.18	329.6	7.08	4.69	49.6
ST-9	8	2.9	Surface	25.92	328.3	7.82	7.9	101.1
			1.0	25.47	328	7.84	8.22	104.5
			2.0	24.44	326.7	7.94	8.87	110.5
			3.0	23.64	329.6	7.89	9.24	113.4
			4.0	22.4	330.3	7.82	9.47	113.6
			5.0	20.22	327.2	7.55	8.37	96.2
			6.0	18.73	326.8	7.33	6.96	77.6
			7.0	17.22	327.1	7.15	4.57	49.4
			8.0	13.87	339.9	6.93	3.1	31.2
ST-10	1.7	1	Surface	27.8	360	8.02	8.9	117.9
			1.0	25.83	354.8	8.04	10.34	132.2
			1.5	25.39	354.5	7.88	10.42	132.2
ST-11	1.5	1.5+	Surface	26.31	145	7.51	8.23	106.1
			1.0	23.95	171.5	7.33	9.01	111.2
			1.5	22.89	196.3	7.19	9.46	114.5

***In-Situ* Monitoring for Lake Hopatcong 7/29/13**

Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(µmhos/cm)	(units)	(mg/L)	(%)
ST-1	2	0.9	Surface	25.59	346.3	7.69	8.21	104.5
			1.0	25.52	346.4	7.66	8.24	104.7
			2.0	24.92	345.2	7.65	8.31	104.5
ST-2	13.8	2.9	Surface	25.42	335.1	7.45	7.45	94.6
			1.0	25.34	335.1	7.44	7.39	93.6
			2.0	25.26	334.9	7.42	7.31	92.5
			3.0	25.23	334.8	7.41	7.24	91.6
			4.0	25.19	334.6	7.39	7.18	90.7
			5.0	25.14	334.6	7.36	7.08	89.4
			6.0	24.5	333.9	7.15	4.89	61
			7.0	19.62	325.5	6.92	2.34	26.6
			8.0	16.03	337.9	6.82	1.96	20.6
			9.0	14.07	334.7	6.8	1.28	12.9
			10.0	13	337	6.76	0.84	8.3
			11.0	12.31	340	6.76	0.62	6
			12.0	11.58	346.6	6.81	0.33	3.1
			13.0	10.92	358.8	6.85	0.21	2
			13.5	10.71	500.9	6.9	0.13	1.2
ST-3	2.1	1.2	Surface	26.13	569.2	7.49	7.95	102.2
			1.0	25	533.7	7.6	7.83	98.6
			2.0	24.49	549.4	7.49	7.61	95
ST-4	2.8	2	Surface	25.07	339.4	7.47	7.76	97.8
			1.0	24.92	338.6	7.44	7.69	96.7
			2.0	24.82	338.5	7.43	7.66	96.1
			2.5	24.78	338.3	7.4	7.62	95.5
ST-5	3.1	1.9	Surface	25.24	343.8	7.61	7.66	96.9
			1.0	24.67	342.6	7.6	7.77	97.2
			2.0	24.41	343	7.56	7.72	96.1
			3.0	24.37	342.8	7.46	7.24	90.1
ST-6	2.5	1.7	Surface	26.31	330.8	7.6	7.89	101.8
			1.0	26.17	328.4	7.63	7.91	101.7
			2.0	25.13	327.2	7.62	8.11	102.4
			2.5	25.15	327.5	7.57	8.11	102.4
ST-7	2.5	2.5+	Surface	25.07	314.1	7.11	6.84	86.2
			1.0	23.79	305.2	7.09	6.76	83.2
			2.0	23.36	302.8	7.06	6.61	80.7
			2.5	23.39	317.9	6.91	6.42	78.5
ST-8	7.5	3	Surface	25.65	335.1	7.29	7.37	93.9
			1.0	25.39	334.9	7.31	7.35	93.3
			2.0	25.32	334.6	7.31	7.27	92
			3.0	25.29	334.7	7.32	7.19	91
			4.0	25.28	334.6	7.32	7.16	90.6
			5.0	25.26	334.6	7.32	7.12	90.1
			6.0	25	338.4	7.3	7.08	89.2
			7.0	16.69	337.8	7.17	4.55	48.7
			7.5	16.46	341.3	7.02	4.13	44
ST-9	8.1	2.8	Surface	26.53	335.6	7.46	7.54	97.7
			1.0	25.98	335	7.45	7.57	97
			2.0	25.58	334.4	7.43	7.55	96.1
			3.0	25.45	333.8	7.41	7.51	95.4
			4.0	25.22	333.7	7.36	7.32	92.6
			5.0	24.62	337.3	7.3	7.1	88.7
			6.0	20.23	329.9	7.17	6.51	74.9
			7.0	17.26	340	6.99	3.97	43
			8.0	15.88	462.3	6.79	1.77	18.6
ST-10	1.5	0.9	Surface	25.9	354.2	7.75	8.33	106.7
			1.0	25.03	354	7.82	8.45	106.5
			1.5	24.51	355.2	7.74	8.53	106.4
ST-11	1.1	1.1+	Surface	24.31	224.8	7.5	7.08	87.9
			1.0	23.39	224.8	7.32	6.99	85.4

***In-Situ* Monitoring for Lake Hopatcong 8/20/13**

Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen
	Total	Secchi	Sample	(°C)	(µmhos/cm)	(units)	(mg/L)	(%)
ST-1	2	0.7	Surface	24.28	348	7.72	8.69	108
			1.0	24.19	348.1	7.59	8.48	105.1
			2.0	23.85	346	7.52	8.06	99.4
ST-2	13.9	2	Surface	23.89	336.7	8.04	8.71	107.5
			1.0	23.83	336.7	8	8.79	108.3
			2.0	23.56	336.3	7.93	8.78	107.6
			3.0	23.35	335.9	7.89	8.7	106.2
			4.0	23.31	335.9	7.84	8.65	105.6
			5.0	23.25	337.4	7.76	8.46	103.1
			6.0	22.72	334.1	7.58	7.38	89
			7.0	21.59	334	7.38	6.04	71.3
			8.0	18.04	331.2	7.15	1.65	18.2
			9.0	14.03	340.4	7.11	1.41	14.2
			10.0	12.94	346.5	7.08	0.94	9.2
			11.0	12.32	347.6	7.06	0.59	5.7
			12.0	11.86	348.9	7.06	0.4	3.8
			13.0	11.28	358.5	7.09	0.14	1.3
			13.5	10.84	374.7	7.1	0.08	0.8
ST-3	2	0.6	Surface	25.74	508.8	7.89	8.65	110.5
			1.0	24.06	480.7	8.02	9.15	113.2
			2.0	23.36	523.4	7.34	7.18	87.8
ST-4	2.7	1.3	Surface	24.06	341.4	8.09	8.55	105.7
			1.0	23.76	341.4	8.06	8.68	106.9
			2.0	23.56	342	8.03	8.85	108.5
			2.5	23.5	340.2	8.01	8.86	108.5
ST-5	3	1.2	Surface	24.03	342.5	7.9	8.66	107.1
			1.0	23.25	342.2	8.23	8.78	107
			2.0	23.07	343.3	8.39	8.96	108.9
			3.0	22.97	345.5	8.11	8.88	107.7
ST-6	2.3	1.6	Surface	25.45	330.9	8.8	9.29	117.9
			1.0	24.62	330.9	8.91	9.93	124.1
			2.0	23.68	330.8	8.89	10.55	129.7
ST-7	1.8	1.8+	Surface	23.77	305.4	7.26	8.12	99.9
			1.0	22.91	300.8	7.24	8.34	101
			2.0	22.36	291.2	7.25	8.36	100.1
ST-8	7	2.3	Surface	24.04	336.1	7.81	8.48	104.9
			1.0	24.04	336.1	7.82	8.6	106.3
			2.0	23.84	336.1	7.84	8.65	106.6
			3.0	23.73	336.1	7.82	8.66	106.5
			4.0	23.64	335.1	7.81	8.65	106.2
			5.0	23.42	335.6	7.76	8.6	105.1
			6.0	22.46	334.5	7.64	7.63	91.6
			7.0	21.08	334.8	7.37	6.73	78.6
ST-9	8	2.3	Surface	24.65	336.4	8.02	8.61	107.7
			1.0	24	335.5	7.95	8.84	109.2
			2.0	23.6	335	7.94	8.89	109.1
			3.0	23.37	334.9	7.93	8.94	109.2
			4.0	23.28	335.1	7.9	8.95	109.1
			5.0	23.21	335.5	7.84	8.77	106.8
			6.0	22.87	334.4	7.69	8.52	103
			7.0	20.77	335.5	7.45	7.21	83.8
			8.0	18.17	355.7	7.13	4.12	45.4
ST-10	1.5	0.8	Surface	24.47	363.6	8.33	9.78	121.9
			1.0	23.36	358.4	8.12	9.86	120.4
			1.5	23.23	359.7	8.04	9.55	116.3
ST-11	1	1.0+	Surface	22.36	214.8	7.37	8	95.8
			1.0	21.88	214	7.32	7.97	94.6

In-Situ Monitoring for Lake Hopatcong 9/17/13								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(°C)**	**(µmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
ST-1	**2**	**1.2**	**Surface**	19.08	349.7	8.03	9.65	108.3
			1.0	19.06	348.8	7.97	9.35	105
			2.0	18.55	344.5	7.92	9.3	103.4
ST-2	**14**	**2.2**	**Surface**	20.49	333.5	7.76	9.28	107.2
			1.0	20.5	333.4	7.63	8.73	100.8
			2.0	20.51	333.5	7.53	8.54	98.8
			3.0	20.51	333.5	7.45	8.46	97.8
			4.0	20.51	333.5	7.39	8.42	97.3
			5.0	20.51	333.4	7.29	8.43	97.4
			6.0	20.51	333.4	7.24	8.34	96.4
			7.0	20.51	333.4	7.23	8.32	96.1
			8.0	20.49	333.3	7.21	8.3	95.9
			9.0	20.39	333.6	7.2	7.99	92.1
			10.0	14.61	347.5	7.03	4.07	41.6
			11.0	12.98	348.6	7.08	2.9	28.6
			12.0	11.93	357.3	7.15	0.84	8.1
			13.0	11.31	629.1	7.07	0.43	4.1
			14.0	11.28	459	7.07	0.16	1.6
ST-3	**2**	**1.2**	**Surface**	19.7	466.7	7.78	9.83	111.8
			1.0	19.23	466	8.13	9.89	111.5
			2.0	19.12	472.6	7.73	6.2	69.8
ST-4	**3**	**2**	**Surface**	18.86	335.6	8.3	9.64	107.8
			1.0	18.85	335.8	8.18	9.51	106.3
			2.0	18.85	335.7	8.12	9.47	105.8
			3.0	18.96	337.9	7.99	6.92	77.5
ST-5	**2.5**	**2.5+**	**Surface**	18.38	337.4	7.52	10.2	112.9
			1.0	18.44	337.7	7.98	9.84	109.1
			2.0	18.42	337.7	8.08	9.73	107.8
ST-6	**2.2**	**2.2+**	**Surface**	19.49	334.9	8.61	9.84	111.5
			1.0	19.48	334.9	8.76	10.15	115
			2.0	19.38	334.2	8.79	10.38	117.2
ST-7	**1.2**	**1.2+**	**Surface**	18.67	358.9	7.49	8.58	95.5
			1.0	18.39	358.8	7.48	8.29	91.8
ST-8	**7.7**	**2.1**	**Surface**	20.49	333.6	7.43	9.06	104.7
			1.0	20.5	333.5	7.46	8.69	100.4
			2.0	20.49	333.5	7.48	8.51	98.3
			3.0	20.46	333.3	7.49	8.44	97.5
			4.0	20.4	333.2	7.49	8.36	96.4
			5.0	20.36	333.2	7.49	8.29	95.5
			6.0	20.29	333.1	7.47	8.2	94.4
			7.0	20.07	332.9	7.42	7.49	85.8
			7.5	20.07	333.4	7.29	6.88	78.8
ST-9	**8**	**2**	**Surface**	20.6	333.6	8.22	9.19	106.4
			1.0	20.55	333.5	7.96	8.52	98.5
			2.0	20.45	333.4	7.89	8.18	94.4
			3.0	20.39	333.5	7.8	7.92	91.3
			4.0	20.36	333.5	7.71	7.8	89.9
			5.0	20.34	333.4	7.64	7.73	89.1
			6.0	20.3	333.5	7.61	7.75	89.2
			7.0	20.27	333.5	7.58	7.83	90
			8.0	19.85	425.1	7.23	3.82	43.6
ST-10	**1.5**	**1.2**	**Surface**	18.52	355	7.99	9.83	109.2
			1.0	18.42	355.7	8.03	9.68	107.3
			1.5	18.41	355.9	8.06	9.65	107
ST-11	**1**	**1.0+**	**Surface**	17.28	318.4	7.45	9.3	100.6
			1.0	17.21	319.3	7.41	9.13	98.7

In-Situ Monitoring for Hopatcong 319 Stations 5/21/13									
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(µmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
NPS 1	**1.5**	**1.5+**	**Surface**	20.89	968.3	9.05	12.4	144.7
			1.00	18.39	1037	9.25	17	188.6
			1.50	17.64	1060	9.39	20.53	224.4
NPS 2	**1.1**	**1.1+**	**Surface**	19.79	327.6	7.55	9.01	102.7
			1.00	19.73	327.5	7.62	9.16	104.2
NPS 3	**0.8**	**0.8+**	**Surface**	22.44	323.4	7.52	8.18	98.2
			0.50	20.51	314.2	7.45	8.77	101.3
NPS 4	**1.5**	**1.5+**	**Surface**	20.69	340	8.45	9.08	105.3
			1.00	18.88	362	8.46	9.57	107.1
			1.50	18.17	502.3	7.99	9.49	104.7
NPS 5	**2.1**	**2.1+**	**Surface**	20.4	355.3	8.54	8.93	103
			1.00	18.66	346.5	8.76	9.34	104
			2.00	16.93	353.6	8.02	7.47	80.3

In-Situ **Monitoring for Hopatcong 319 Stations 6/24/13**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(µmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
NPS 1	**1.7**	**1.5**	**Surface**	26.79	819.5	8.38	8.48	110.5
			1.00	23.92	876.1	8.41	10.18	125.8
			1.50	23.65	887.7	8.18	10.42	128.2
NPS 2	**1.2**	**1.20+**	**Surface**	27.24	276.5	7.38	7.72	101.2
			1.00	25.79	314.2	8.69	8.07	103.1
NPS 3	**0.9**	**0.9+**	**Surface**	28.62	336	7.51	7.84	105.4
			0.50	25.97	349	7.48	8.86	113.6
NPS 4	**1.8**	**1.80+**	**Surface**	26.05	362.7	8.04	9.12	117.1
			1.00	25.19	366.4	8.12	9.49	119.9
			1.50	21.94	606.8	8.43	10.35	123.1
NPS 5	**2.7**	**1.8**	**Surface**	25.24	337.3	7.34	7.71	97.5
			1.00	24.53	336	7.31	8.2	102.4
			2.00	23.97	333.8	7.24	8.08	99.8
			2.50	23.3	334.8	7.14	7.83	95.5

In-Situ Monitoring for Hopatcong 319 Stations 7/29/13									
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(µmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
NPS 1	**1.5**	**1.1**	**Surface**	25.45	586.4	7.95	8.45	107.4
			1.00	23.75	574.8	8.16	8.77	107.9
			1.50	23.85	579.8	8.01	8.81	108.7
NPS 2	**1**	**1.0+**	**Surface**	25.33	308	7.48	8.34	105.7
			1.00	24.47	301.6	7.85	8.81	109.8
NPS 3	**0.95**	**0.95+**	**Surface**	24.95	332.1	7.79	8.28	104.2
			0.50	24	332.4	7.76	8.41	103.9
NPS 4	**1.7**	**1.7+**	**Surface**	24.79	346.5	7.36	7.64	95.9
			1.00	24.7	348.1	7.32	7.57	94.9
			1.50	24.51	352.9	7.28	7.62	95.1
NPS 5	**2.5**	**1.8**	**Surface**	24.96	347.2	7.63	8.07	101.5
			1.00	24.64	348	7.73	8.12	101.6
			2.00	24.37	347.9	7.72	8.18	101.8
			2.50	24.37	348.4	7.48	8.12	101.1

In-Situ Monitoring for Hopatcong 319 Stations 8/20/13								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(µmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
NPS 1	**1.5**	**0.75**	**Surface**	26.16	533.3	8.11	8.6	110.6
			1.00	23.37	598.5	8.23	9.3	113.7
			1.50	23.05	606.2	8.04	9.27	112.7
NPS 2	**1**	**1.0+**	**Surface**	24.31	323.7	7.62	8.33	103.6
			1.00	23.52	322.6	8.71	9.79	120
NPS 3	**0.75**	**0.75+**	**Surface**	24.36	334.1	7.61	8.53	106.2
			0.50	23.52	333.4	7.76	9.11	111.6
NPS 4	**1.25**	**1.25+**	**Surface**	24.33	349.8	8.2	8.93	111
			1.00	23.78	358.7	8.5	9.27	114.1
NPS 5	**2.6**	**1**	**Surface**	24.1	342.6	8.43	8.7	107.7
			1.00	23.51	346.4	8.87	8.99	110.1
			2.00	23.25	345.4	8.83	9.45	115.2
			2.50	23.27	344.5	8.8	9.61	117.1

***In-Situ* Monitoring for Hopatcong 319 Stations 9/17/13**									
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(µmhos/cm)**	**(units)**	**(mg/L)**	**(%)**
NPS 1	**1.5**	**1.2**	**Surface**	19.26	481	8.27	10.12	114.1
			1.00	19.03	482.8	8.57	10.45	117.3
			1.50	18.31	492.1	8.72	10.8	119.5
NPS 2	**1.3**	**1.3+**	**Surface**	18.22	334.1	7.5	9.71	107.2
			1.00	18.19	334	7.64	9.81	108.2
NPS 3	**0.8**	**0.8+**	**Surface**	17.29	346.8	8.05	9.79	106
			0.50	17.07	344.5	8.24	9.82	105.9
NPS 4	**1.2**	**1.2+**	**Surface**	17.5	345.2	8.32	9.45	102.8
			1.00	16.92	346.9	8.36	9.44	101.4
NPS 5	**2.5**	**2.5+**	**Surface**	18.22	342.3	8.53	10.04	110.9
			1.00	18.24	342.3	8.63	9.82	108.4
			2.00	18.21	341.9	8.6	9.78	107.9
			2.50	18.25	345.2	8.47	9.64	106.4

APPENDIX C

WATER QUALITY DATA

HOPATCONG

21-May-2013 STATION	**Chlorophyll *a* (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	4.8	0.29	0.05	0.02	2
ST-2	5.3	0.11	ND <0.02	0.01	ND <2
ST-3	2.3	0.07	0.03	0.02	ND <2
ST-4	6.1	0.03	0.02	0.02	ND <2
ST-5	5.0	0.01	0.07	0.02	ND <2
ST-6	6.2	0.02	0.02	0.02	ND <2
ST-7	7.1	0.07	0.08	0.02	ND <2
ST-10	6.1	0.08	0.16	0.02	ND <2
ST-11	6.0	0.09	0.12	0.02	ND <2
ST-2 DEEP		0.44	0.09	0.03	2
MEAN	**5.4**	**0.09**	**0.07**	**0.02**	**2.00**

24-Jun-2013 STATION	**Chlorophyll *a* (mg/m^3)**	**NH3-N (mg/L)**	**NO3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
ST-1	**16.2**	0.01	0.03	0.03	6
ST-2	5.7	ND <0.01	ND <0.02	0.02	ND <2
ST-3	**16.2**	0.01	0.04	**0.04**	3
ST-4	6.6	0.01	0.04	0.02	2
ST-5	5.8	ND <0.01	0.05	0.02	2
ST-6	2.4	ND <0.01	0.02	0.02	ND <2
ST-7	**14.6**	ND <0.01	0.08	0.03	ND <2
ST-10	**26.5**	ND <0.01	0.05	**0.04**	5
ST-11	12.2	ND <0.01	0.09	0.03	ND <2
ST-2 DEEP		0.43	ND <0.02	ND	3
MEAN	**11.8**	**0.01**	**0.05**	**0.03**	**3.60**

29-Jul-2013 STATION	Chlorophyll *a* (mg/m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	**36.2**	0.04	0.06	**0.05**	8
ST-2	5.1	0.01	0.02	0.02	ND <2
ST-3	**25.1**	0.02	0.04	**0.05**	4
ST-4	12.0	ND <0.01	0.02	0.03	3
ST-5	10.5	0.01	0.02	0.02	2
ST-6	11.2	0.02	0.05	0.03	4
ST-7	8.3	0.02	0.06	0.03	ND <2
ST-10	**36.3**	0.01	0.04	**0.04**	8
ST-11	7.8	0.01	0.06	0.03	ND <2
ST-2 DEEP		0.34	0.05	0.30	6
MEAN	**16.9**	**0.05**	**0.04**	**0.03**	**5.00**

20-Aug-2013 STATION	Chlorophyll *a* (mg/m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	**24.4**	0.02	0.02	0.03	14
ST-2	6.2	ND <0.01	ND <0.02	0.01	2
ST-3	**23.3**	0.02	ND <0.02	**0.04**	7
ST-4	10.3	0.01	ND <0.02	0.02	3
ST-5	9.6	0.01	ND <0.02	0.02	5
ST-6	4.1	ND <0.01	ND <0.02	0.02	3
ST-7	6.3	ND <0.01	ND <0.02	0.02	ND <2
ST-10	**19.9**	0.01	ND <0.02	0.03	8
ST-11	4.3	0.02	0.03	0.02	3
ST-2 DEEP		0.33	ND <0.02	0.11	4
MEAN	**12.0**	**0.06**	**0.03**	**0.02**	**5.44**

17-Sep-2013	**Chlorophyll *a***	**NH3-N**	**NO3-N**	**TP**	**TSS**
STATION	**(mg/m^3)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
ST-1	**22.6**	0.01	0.05	0.03	9
ST-2	**17.7**	0.02	0.03	0.01	2
ST-3	**25.8**	0.02	0.04	0.02	9
ST-4	11.0	0.01	ND <0.02	0.02	3
ST-5	9.4	0.04	0.02	0.02	3
ST-6	5.0	0.01	ND <0.02	0.02	ND <2
ST-7	4.2	0.02	0.04	0.02	ND <2
ST-10	**20.2**	0.01	0.05	0.03	8
ST-11	4.0	0.03	0.04	0.01	ND <2
ST-2 DEEP		0.59	0.17	0.17	10
MEAN	**13.3**	**0.08**	**0.06**	**0.02**	**6.29**

Lake Hopatcong 319(h) Water Quality Sampling for 2013

5/21/2013			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	**0.04**	2	x
NPS 2	0.02	ND <2	x
NPS 3	0.02	ND <2	5.6
NPS 4	0.02	2	6.8
NPS 5	0.02	ND <2	4.4
6/24/2013			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	**0.06**	9	x
NPS 2	0.03	ND <2	x
NPS 3	0.02	ND <2	9.7
NPS 4	0.02	ND <2	6.3
NPS 5	0.02	3	9.2
7/29/2013			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	**0.07**	4	x
NPS 2	0.02	ND <2	x
NPS 3	0.02	2	8.7
NPS 4	0.02	2	11.1
NPS 5	0.02	ND <2	9.3
8/20/2013			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	**0.05**	7	x
NPS 2	0.01	ND <2	x
NPS 3	0.02	4	9.9
NPS 4	0.02	7	9.6
NPS 5	0.02	5	9
9/17/2013			
Station	**TP (mg/L)**	**TSS (mg/L)**	**CHL *a* (mg/m^3)**
NPS 1	**0.05**	15	x
NPS 2	0.01	3	x
NPS 3	0.02	2	5.5
NPS 4	0.02	2	8.5
NPS 5	0.02	2	7.5