LAKE HOPATCONG
WATER QUALITY MONITORING
ANNUAL REPORT 2011

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1.0 INTRODUCTION

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2011 growing season (May through September). This monitoring program represents a continuation of the long-term monitoring program of Lake Hopatcong. However, it should be noted that the 2010, 2011 and 2012 water quality monitoring programs are being funded through the NJDEP, SFY10, Non-Point Source (319(h) of the Clean Water Act) grant program (Project Grant RP10-087)

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 project 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 2011 sampling dates were 26 May, 21 June, 20 July, 24 August and 13 October. A Eureka Amphibian PDA with Manta multi-probe unit was used to monitor the *in-situ* parameters dissolved oxygen (DO), temperature, pH, and conductivity during each sampling event. Data were recorded at 1.0 m increments starting at 0.5 m below the water's surface and continued to within 0.5 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 phosphorous-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 2011

In addition to the standard, long-term, in-lake monitoring program, supplemental in-lake data were collected during the 2011 monitoring program. From 2006 to 2008 three, near shore, in-lake sampling sites were established and monitored. These additional in-lake sampling sites were located immediately adjacent to drainage areas that were receiving a structural BMP as part of an existing 319(h) grant (SFY05; Grant RP05-080). The three near-shore, in-lake sampling stations include:

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 2011 monitoring programs.

For the remaining two supplemental in-lake sampling stations, monitoring occurred during the May through September 2011 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 conductivity. 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 will be 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 three SFY10 earn-shore sampling stations during each of the five 2011 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 2011-growing season were generally consistent with values recorded in previous years' monitoring programs. By late May 2011, the lake was very weakly stratified between 6 and 7 meters. From surface to bottom (14 meters), the temperature decreased from 19.13°C at the surface to 9.81°C at the bottom (Appendix B).

During the remaining four monitoring events the lake was strongly stratified at Station #2 with the thermocline migrating through the water column over the growing season. In June the thermocline was between 3 and 8 meters and by mid-October it was near the bottom between 10 and 13 meters (Appendix B).

Other than Station #2, the only other long-term monitoring stations that exhibited some degree of thermal stratification were Stations #8 (Great Cove) and #9 (Byram Cove). These coves were stratified from to late August 2011 but were completely mixed by 13 October 2011 (Appendix B). More than likely these monitoring stations were mixed immediately after Hurricane Irene in late August and/or Tropical Storm Lee in mid-September 2011.

Similar to what was observed in 2010 four of the five near-shore 319 sampling stations were thermally stratified in late May 2011 in spite of their relatively shallow depths (Appendix B). By June 2011the only near-shore 319 sampling station that exhibited thermal stratification was NPS-1 and in late July 2011, NPS-1 and NPS-3 exhibited thermal stratification. By late August 2011, NPS-1 was once again the only near-shore 319 sampling station that exhibited some degree of thermal stratification. However, by October 2011 none of the near-shore 319 sampling stations were thermally stratified (Appendix B).

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 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.

During the 26 May 2011 sampling event, DO concentrations were above the 5.0 mg/L threshold throughout the eleven standard, in-lake monitoring stations at Lake Hopatcong. Similar conditions were observed in May 2010. These well oxygenated (> 5 mg/L) conditions from surface to bottom at all of the sampling stations persisted into late June 2011, with the exception being the deeper waters (equal to or greater than 2.0 meters) of Station #5 where DO concentrations were less than 5 mg/L (Appendix B).

The surface and mid-depth waters of the lake still had DO concentrations well above the 5.0 mg/L threshold during the July 20110 event. However DO concentrations fell below this threshold at depths equal to or greater than 5 meters throughout the lake, with the exception being Station #4 where the DO fell below the threshold at a depth of 3.0 meters (Appendix B).

By late August 2011 the lake was generally well oxygenated but fell below the 5.0 mg/L threshold at depths greater than 6.0 meter at Station #2. In addition, bottom water DO concentrations at both Stations #8 and #9 were less than 3 mg/L. However, it should be noted that no anoxic (DO < 1 mg/L) conditions were established, even in the deepest sections of the lake.

DO concentrations at Station #2 during the October 2011 events were above the 5.0 mg/L threshold from the surface down to a depth of 10 meters. Below 9 meters the DO concentrations varied between 0.34 and 1.45 mg/L. The rest of Lake Hopatcong, at least at the in-lake monitoring stations, was well oxygenated (> 5.0 mg/L) from surface to bottom (Appendix B).

It should be noted that the only time anoxic (DO concentrations less than 1 mg/L) conditions were found in Lake Hopatcong was at depths greater than 11 meters (Station #2) during the October 2011 event. The lower duration and magnitude of anoxic conditions experienced in 2010 and 2011 were attributed to the relative wet and stormy growing season.

Similar to 2010, all five 319 sampling stations were well oxygenated from surface to bottom during all five 2011 monitoring events. DO concentrations varied from 4.53 to 18.02 mg/L (Appendix B).

pH

The optimal range of pH for most freshwater organisms is between 6.0 and 9.0. For the most part, the pH throughout the water column of Lake Hopatcong was within this optimal range over the 2011 growing season. The exception to this was at Station #3 (River Styx / Crescent Cove), where the pH was equal to (August 2011) or exceeded (May and June 2011) the upper limit of 9.0. Such temporary elevated pH values at Station #3 were attributed to high rates of algal and/or aquatic plant photosynthesis. As algae and plants photosynthesize, they produce DO as a by-product and will produce an increase in the pH of their immediate environment. However, by mid-October the pH throughout the entire lake was within the optimal range for aquatic life, varying between 6.92 to 7.82 (Appendix B).

The pH among the five NPS in-lake sampling stations was consistency below the 9.0 upper threshold through the 2011 growing season. The exception to this was the surface waters of NPS-1 during the 26 May 2011 monitoring event (Appendix B). NPS-1 is located in the southern end of Crescent Cove and as previously mentioned, this part of Lake Hopatcong frequently experiences excessive amounts of algal and aquatic plant photosynthesis.

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 depth was equal to or greater than the 1.0 meter threshold at all eleven in-lake stations during the May, June and July 2011 monitoring events. During the August 2011 monitoring event, Secchi depth was again equal to or greater than the 1 meter threshold with the exception of Station #3, where the Secchi depth was 0.5 meter. This low Secchi depth value was indicative of an algal bloom in this part of the lake in August 2011. By October 2011, the Secchi depth at all monitoring stations were greater than 1.0 meter. At Station #3 the Secchi depth was 1.3 meters.

At the near-shore 319 sampling stations, Secchi depth was either equal to or greater than 1.0 meter or was to the bottom, which at some locations was less than a meter deep. The exception to this was again NPS-1, located in the southern end of Crescent Cove. During the July and August 2011 sampling events, the Secchi depth was less than 1.0 meter even though the total depth was greater than 1.0 meter. Similar to Station #3, these Secchi depth data indicate that this section of Lake Hopatcong experiences nuisance algal blooms.

Ammonia-Nitrogen (NH_4-N)

Surface water NH_4-N concentrations above 0.05 mg/L tend to stimulate elevated rates of algal growth. During the May 2010 sampling event four of the five most northern sampling stations in Jefferson Township had surface water NH_4-N concentration was above 0.05 mg/L (Appendix C). The exception to this was Stations #1 (Woodport Bay station; adjacent to Liffy Island). Station #6 (Henderson Cove) and #11 (Jefferson Canals) had the higher surface water NH_4-N concentrations, both higher than 0.1 mg/L.

In sharp contrast to May 2011, all surface water NH_4-N concentrations were below the 0.05 mg/L, varying between < 0.01 and 0.02 mg/L, during the 21 June 2011 sampling event (Appendix C). Surface water NH_4-N concentrations remained low among all sampling stations, throughout the rest of the monitoring events, never exceeding 0.03 mg/L.

Bottom water NH_4-N concentrations were monitored seasonally at the mid-lake sampling site (Station #2). Bottom water NH_4-N concentrations varied widely between 0.03 and 3.10 mg/L through the 2011 growing season (Appendix C). Bottom water NH_4-N concentrations are typically elevated during the summer season, as a result of lower concentrations of DO. Under such conditions, bacterial decomposition of organic matter results in an accumulation of NH_4-N. The severe limitation of light in the bottom waters exacerbates these conditions through the negligible uptake of NH_4-N by algae. Thus, this seasonal accumulation of NH_4-N is common occurrence in Lake Hopatcong.

The extremely large variation in 2011 bottom water NH_4-N concentrations reflects its unusual weather patterns; a somewhat prolonged winter, followed by a wet spring, short but intense summer and wet late summer / fall.

Nitrate-Nitrogen (NO_3-N)

Surface water NO_3-N concentrations throughout the 2011 sampling season of Lake Hopatcong varied between 0.03 mg/L and 0.18 mg/L. While there was a considerable amount of variation both among the sampling stations and between sampling events, the northern sampling stations tended to have higher NO_3-N concentrations relative to the rest of the lake (Appendix C). In addition, Station #3 (Crescent Cove / River Styx) had elevated surface water NO_3-N concentrations in May (0.14 mg/L) and October (0.33 mg/L) 2011.

The elevated surface water NO_3-N concentrations at Station #3 during the spring and fall events of 2011 were due to high rates of runoff. Both seasons had higher than normal amounts of precipitation. In contrast, surface water NO_3-N concentrations were usually consistently elevated in the northern sampling stations, frequently being above 0.1 mg/L. As has been identified in past monitoring events the elevated NO_3-N concentrations in the northern end of the lake are primarily due to the nearshore, on-site wastewater treatment systems (septic systems) in the Township of Jefferson. In particular, elevated NO_3-N concentrations have been measured at Station #11 during previous monitoring years and these historically high concentrations have been attributed to the horizontal movement of leachate from near-shore septic system leachfields. In 2011, surface water NO_3-N concentrations at Station #11 varied between 0.07 and 0.014 mg/L with a season mean of 0.11 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.

During the 256May 2011 sampling event, TP concentrations throughout the lake were relatively consistent and had a lake-wide mean value of 0.02 mg/L. In fact, all sampling stations had a TP concentration of 0.02 mg/L, except for Station #2 (mid-lake) where the TP concentration was 0.03 mg/L.

During the 21 June 2011 sampling event, TP concentrations throughout Lake Hopatcong varied between 0.01 mg/L and 0.04 mg/L with a lake-wide mean value of 0.03 mg/L. A similar pattern was observed during the 20 July 2011 event where TP concentration again varied between 0.01 and 0.04 mg/L with a lake-wide mean value of 0.03 mg/L.

During the 24 August 2011 sampling event, TP concentrations in the surface waters varied between 0.02 mg/L and 0.05 mg/L with a lake-wide mean value of 0.03 mg/L. Finally, during the 13 October 2011 sampling event, surface water TP concentrations varied between 0.01 mg/L and 0.05 mg/L with a lake-wide mean value of 0.02 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 2011, the mean TP concentration at Station #2 (Mid-lake) was 0.016 mg/L, while the Station #3 mean was 0.034 mg/L. It should also be noted that the mean TP concentration at Station #11 (Jefferson Canals) was 0.032 mg/L.

Similar to past monitoring years, higher TP concentrations tend to be found at Station #3. However, the mean TP concentration at this Station has been exhibiting a slight decline over the last few years. For example, the mean TP concentrations at Station #3 in 2009, 2010 and 2011 were 0.042, 0.038 and 0.034 mg/L, respectively. These data may indicate that long-term reductions may be underway in this part of the lake.

Bottom water TP concentrations at the mid-lake sampling station (Station #2) varied between 0.02 and 033 mg/L from May through October of 2011. The elevated TP concentrations in the deep waters were attributed to the depressed DO concentrations and the lack of mixing with the atmosphere during the summer season.

TP concentrations in four of the five 319 in-lake sampling stations (NPS-2 – NPS-5) were generally low, varying between < 0.01 and 0.03 mg/L throughout the 2011 growing season. In contrast to stations NPS-2 through NPS-5, NPS-1 (southern end of Crescent Cove) had variable TP concentrations over the 2011 growing season, ranging from 0.01 to 0.09 mg/L with a mean value of 0.036 mg/L (see Table 1). Since NPS-1 directly receives runoff from a section of the Lake Hopatcong watershed where a number of restoration measures have been implemented over the last few years, a specific analysis of the NPS-1 inter-annual database was conducted.

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.

Thus, 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 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.

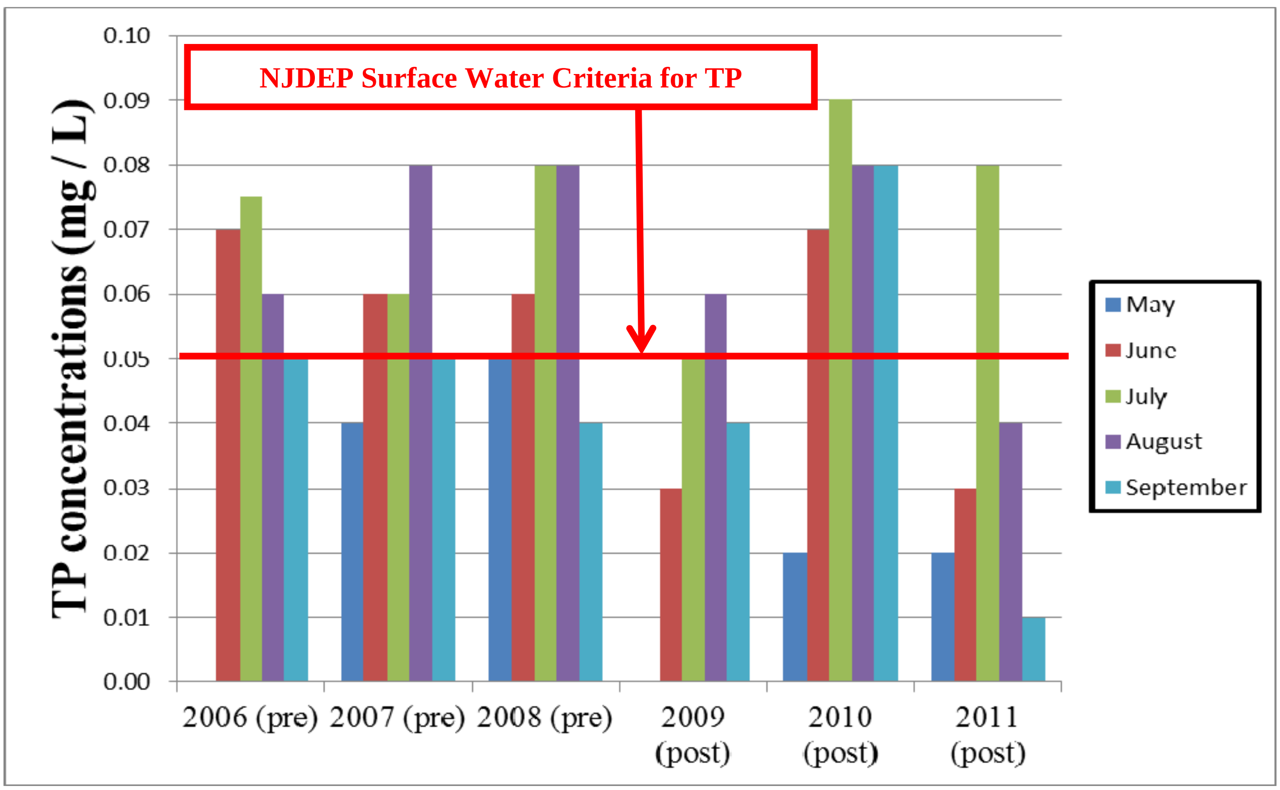
However, in sharp contrast to the 2009 results, during the 2010 growing season, only one of the five sampling events were below the Sate Standard at NPS-1. The mean TP concentration at NPS-1 in 2010 was 0.068 mg/L slightly above the mean values measured prior to the installation of the Aqua-Filter (2006-08). 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. 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 six year 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). As with the first Aqua-Filter unit, the second one will also need to be routinely inspected and cleaned out of particulate material. In addition, to maximum the removal of phosphorus, the filter pillows will need to be replaced sometime next year. However, based on the results of the six year database the two Aqua-Filter MTDs had a positive impact on the lake by reducing TP concentrations. However, 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)

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 mg/m^3. Based on the findings of the refined TMDL, the existing average seasonal chlorophyll *a* concentration under current conditions is 15 mg/m^3, while the maximum seasonal value is 26 mg/m^3. 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 mg/m^3, respectively.

Of the five 2011 lake-wide chlorophyll *a* mean values only the May 2011 value less than targeted mean of 8 mg/m^3. Typically, the May and sometimes June are the only months in Lake Hopatcong that are in compliance with the targeted mean chlorophyll *a* concentration

While none of the May 2011 chlorophyll *a* concentrations exceeded the targeted seasonal maximum of 14 mg/m^3, three of the four most northern stations (#7, #10 and #11) exceeded the maximum value during the June 2011 monitoring event. In contrast, only Stations #1 and #3 exceeded the targeted seasonal maximum in July 2011. During the August 2011 event, all stations exceeded the targeted seasonal maximum except for Stations #7 and #11. Finally, four of the nine Stations exceeded the targeted seasonal maximum during the October 2011 event.

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 is 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 2011. Algal abundance was high on 26 May 2011 with the dominant algae being the diatom *Tabellaria*, the chrysophyte *Dinobryon*, and the blue-green alga *Coelosphaerium*. A wide variety of green algae, the dinoflagellates *Ceratium* and *Peridinium*, and several blue-green algae were identified as well, including *Oscillatoria* and *Anabaena*.

Algal diversity and abundance was relatively high during the 21 June 2011 sampling event, with the blue-green algae *Anabaena* and *Aphanizomenon* being the dominant algae. A variety of green algae, chrysophytes and the dinoflagellate *Ceratium* were also identified.

Again, algal diversity was high and abundance was moderate during the 20 July 2011 sampling event, with the blue-green algae *Anabaena* and *Aphanizomenon* continuing to be the dominant algae. A wide variety of other algae including several diatoms (*Melosira* and *Synedra*) and other blue-green algae (*Coelosphaerium* and *Microcystis*) were also identified (Table 1).

Algal abundance and diversity was relatively high in Lake Hopatcong during the 13 October 2011 sampling event. In spite of being in fall, the blue-green alga *Anabaena* was the dominant algal genus. The diatom Tabellaria was a sub-dominant genus, with several green algae, four other blue-greens, the chrysophyte *Dinobryon*, and the dinoflagellate *Ceratium* also being identified (Table 1).

While algal abundance was moderate to high, algal diversity was high as well. Blue-green algae, some of the genera known to produce nuisance surface scums, were common, as well as several other algal groups including green algae, diatoms and chrysophytes. It should be noted that in contrast to 2010 but similar to previous monitoring years, blue-green algae were the dominant algal group in Lake Hopatcong. This dominance emphasizes the need to continue to implement both watershed-based and in-lake measures to minimize the amount of phosphorus available for algal growth.

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.

During the 26 May 2011 sampling event, small-bodied zooplankton that feed primarily on bacteria and detritus were the dominant forms. No herbivorous zooplankton were identified in the May 2011 sample. In contrast, one herbivorous zooplankter, the cladoceran *Ceriodaphnia*, was identified in the 21 June 2011 sample. The dominant zooplankton at this time were the rotifer *Conochilus* and juvenile copepods, called nauplii.

By 20 July 2011 zooplankton abundance was moderate while diversity was high with the dominant genus being the small-bodied zooplankter Bosmina. Two herbivorous zooplankton (*Diaptomus* and *Ceriodaphnia*) were present as well as nauplii and several rotifers.

Zooplankton abundance was moderate, the dominant zooplankter was the rotifer *Keratella*, with nauplii being relatively common. Two herbivores (*Diaphanosoma* and *Ceriodaphnia*) were present along with other genera including a cladoceran, a copepod and several other rotifers. By mid-October 2011, zooplankton abundance was low, with not one genus being dominant. Two herbivorous zooplankton (*Diaptomus* and *Ceriodaphnia*) were present along with *Cyclops*, *Bosmina* and several rotifers.

Similar to past monitoring years, herbivorous zooplankton were present in Lake Hopatcong but not in high numbers 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 (i.e. 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 2011 Growing Season

Sampling Date	Phytoplankton
26 May 2011	Algal abundance was high. The dominant algae were the diatom *Tabellaria*, the chrysophyte *Dinobryon* and the blue-green alga *Coelosphaerium*. A wide variety of green algae were present as well as the dinoflagellates *Peridinium* and *Ceratium*, the diatom *Fragilaria* and two additional blue-greens (*Oscillatoria* and *Anabaena*).
21 June 2011	The dominant genera were the blue-green algae *Anabaena* and *Aphanizomenon*. Other identified algae included a variety of green algae (such as *Pediastrum* and *Gloeocystis*), two chrysophytes (*Mallomonas* and *Dinobryon*) and the dinoflagellate *Ceratium*.
20 July 2011	Diversity was high and abundance was moderate. The dominant algae continued to be the blue-green algae *Anabaena* and *Aphanizomenon*. A wide variety of green algae, several diatoms (*Melosira* and *Synedra*) and several additional blue-green algae (*Microcystis* and *Coelosphaerium*) were identified.
24 August 2011	Abundance and diversity was high with the dominant algae being the blue-green alga *Anabaena* and the diatom *Tabellaria*. The blue-green alga *Aphanocapsa* was also relatively common. A number of green algae, the chrysophyte *Dinobryon*, the diatoms *Fragilaria* and *Melosira* and several other blue-green algae (*Microcystis* and *Coelosphaerium*) were identified.
13 October 2011	Abundance and diversity was high; the dominant alga was the filamentous blue-green alga *Anabaena*. The diatom *Tabellaria* was a sub-dominant genus. Four additional blue-green were identified, as well as two additional of diatoms, the dinoflagellate *Ceratium*, the chrysophyte *Dinobryon* and several green algae.

Table 2
Zooplankton in Lake Hopatcong during the 2011 Growing Season

Sampling Date	Zooplankton
26 May 2011	Zooplankton numbers were moderate and the dominant genus was the small-bodied cladoceran *Bosmina*. Another small-bodied cladoceran (*Cydorus*) and juvenile copepods (known as nauplii) were also found in the sample. In addition, several rotifers (*Keratella*, *Conochilus*, *Asplanchna*, *Polyarthra*) were identified.
21 June 2011	Zooplankton numbers were moderate with the dominant ones being the rotifer *Conochilus* and juvenile copepods (called nauplii). One herbivorous (algae-eating) cladoceran *Ceriodaphnia* was identified as well as the small-bodied copepod *Cyclops* and several rotifers (*Polyarthra* and *Keratella*).
20 July 2011	Zooplankton abundance was moderate and diversity was high with dominant genus being the small-bodied cladoceran *Chydorus*. Other common zooplankton were the herbivorous copepod *Diaptomu*s and the rotifer *Conochilus*. Nauplii were also present, as well as the herbivore *Ceriodaphnia* and a few more rotifers (*Keratella* and *Asplanchna*).
24 August 2011	Zooplankton abundance was moderate with the most common genus being the rotifer *Keratella*. Nauplii were common as well. Two herbivorous cladocerans (*Ceriodaphnia* and *Diaphanosoma*) were present along with the cladoceran *Bosmina* and the copepod *Cyclops*. Several rotifers (*Asplanchna*, *Trichocera pilla* and *Keratella*) were also present.
13 October 2011	Zooplankton abundance was low; not one genus dominated the community. Two herbivores were identified (*Diaptomus* and *Ceriodaphnia*) along with the copepod *Cyclops*, the cladoceran *Bosmina* and several rotifers.

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 2011 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 identified throughout the entire water column in Lake Hopatcong during the 26 May 2011 and the 21 June 2011monitoring events (Appendix B).

By 20 July 2011, optimal / carry over brown trout habitat was limited to depths between 4.0 and 5.0 meters (13 and 16.5 feet). However, it should be noted that carry over brown trout habitat was also identified at depths around 5.0 meters at both Station #8 (Great Cove) and Station #9 (Byram Cove).

In sharp contrast to July, optimal brown trout habitat was re-established by 24 August 2011 from the surface to 6 meters (20 ft). By mid-October 2011, optimal brown trout habitat was re-established throughout the entire water column (Appendix B). Similar to past monitoring years, the *in-situ* data revealed that varying levels of acceptable brown trout habitat persisted through the entire 2011 growing season in Lake Hopatcong.

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.

Unfortunately, the minimal amount of available funds for mechanical weed harvesting resulted in a severe limitation in the amount of harvesting that could be conducted in 2011. Essentially, harvesting in 2011 was only conducted from mid-July to mid-September (essentially two months). Thus, using the result of the 2006 plant biomass / phosphorus study, it was estimated that the 2011 mechanical weed harvesting program only removed 26 lbs (12 kg) of total phosphorus from the lake. In turn, this only accounted for 0.4% of the TP load targeted for removal under the TMDL. This is the lowest amount of weed biomass and phosphorus removed since the Commission has been in operation. If this removed phosphorus was utilized by filamentous and planktonic algae, it would have the potential to generate approximately 28,700 lbs of wet algae 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 2011. The annual mean values for Station #2 were graphed, along with the long-term, "running mean" for the lake.

The 2011 mean Secchi depth was 2.3 meters, which was similar to the Secchi depth means in 2007 and 2008 (Figure 2 in Appendix A). While there appears to be some long-term, inter-annual cycling variability, since the mid-1990's, Secchi depth has exhibited a trend of slightly increasing water clarity. For example, the mean Secchi disk value through the 1990's was 1.9 m, while the mean value through the 2000's was 2.2 m. To date, the mean Secchi disk value for the 2010's (two years of data) is 2.4 m. 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 2011 chlorophyll *a* concentration was 11.6 mg/m^3 in contrast to the 2010 mean value of 6.1 mg/m^3. Thus, while the 2010 mean was less than the targeted mean endpoint of 8 mg/m^3 as per the TMDL, the 2011 mean was slightly higher than the targeted mean endpoint.

While the 2011 mean TP concentration (0.016 mg/L) at Station #2 was higher relative to the 2010 mean value (0.011 mg/L), it was still below 0.020 mg/L. The mean TP concentration has been below 0.020 mg/L at Station #2 since 2008 (Figure 4 in Appendix A). Based on these data, the level of productivity in Lake Hopatcong in 2011 was higher relative to 2010; the Secchi depth was slightly lower, while chlorophyll a and TP concentrations were higher. This increase in productivity from 2010 to 2011 was attributed to the wet spring, warm mid-summer season, followed by a series of intense storms over the late summer / early fall seasons.

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 total phosphorus, 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 and implementation will continue into 2012. 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 2011 analysis, the mid-lake (Station #2) and Crescent Cover / River Styx (Station #3) 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

As previously mentioned, the mean 2011 chlorophyll *a* concentration for Station #2 was 11.6 mg/m^3 which is above the mean endpoint of 8 mg/m^3. In addition, the maximum 2011 chlorophyll *a* concentration at Station #2 (23.2 mg/m^3) was also greater than the maximum chlorophyll *a* concentration endpoint. In contrast, the mean 2011 TP concentration was 0.016 mg/L was below the targeted mean TP concentration under the TMDL.

While both the mean and maximum 2011 chlorophyll *a* concentrations for Station #3 (Crescent Cove / River Styx Station) were above their respective TMDL endpoints, the mean TP concentration for this station was at the targeted mean TMDL concentration of 0.03 mg/L. The lower TP concentration at Station #3 was attributed to the installation of a second Aqua-Filter unit within that drainage basin. These data are supported by the analysis of the TP data collected at NPS-1 (Table 1 and Figure 1). Thus, in spite of 2011 being a relatively wet year, conveying a larger pollutant load to the lake relative to other years, the stormwater Manufactured Treatment Devices installed within the Crescent Cove drainage basin contributed toward lower TP concentrations in this section of Lake Hopatcong.

4.0 SUMMARY

This report documents the findings of the 2011 Lake Hopatcong water quality monitoring program. This section provides a summary of the 2011 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. The 2011 growing season was relative cool and wet during the spring, had a hot mid-summer season and was again very wet during the late summer fall (Hurricane Irene and Tropical Storm Lee). These climatic conditions contributed to the oxic conditions (dissolved oxygen equal to or greater than 1 mg/L) throughout the entire water column during four of the five monitoring events.

1. 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 increased amount of algal and/or aquatic plant biomass. TP concentrations in the surface waters of Lake Hopatcong typically varied between <0.01 mg/L and 0.04 mg/L with two instances of the TP concentration being 0.05 mg/L. Similar to past monitoring years Station #3 (River Styx/Crescent Cove) and the 319 Crescent Cove station displayed the highest TP concentrations, however, many of the northern sampling stations had similar concentrations.

2. Overall TP concentrations were generally low in Lake Hopatcong. For example, the mean 2011 TP concentration at the mid-lake station was 0.016 mg/L. This is one of the lowest TP mean value out of the entire over the last nine years.

3. Based on the *in-situ* conditions, carry-over brown trout habitat was available throughout the entire 2011 growing season, although this habitat was limited to depths between 4 and 5 meters in July. In contrast, all or most of the water column was carry-over habitat over the other four monitoring events. Such results are consistent with those measured in previous monitoring years at Lake Hopatcong.

4. Approximately 1,231 cubic yards (73.2 tons) of aquatic plant biomass was removed in 2011 through the mechanical weed harvesting program; this accounted for approximately 0.4% of the TP load targeted for removal under the TMDL. Harvesting in 2011 was limited to mid-July to mid-September (essentially two months), which explained the low amount of material harvested. The harvesting program must increase in size, scope and duration in order to more adequately address nuisance plant conditions within select sections of the lake, as well as increase the amount of phosphorus removed from the lake through harvesting.

5. 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). The obvious "outlier" to this trend was 2009, which was an unusually wet and cool year. These long-term data collected from the mid-lake sampling station, as well as some of the other water quality data, indicate that the lake has been trending toward better water quality conditions. However, there are still some locations that require additional attention

6. An Aqua-Filter, a large Manufactured Treatment Device, was installed in the Crescent Cove drainage basin in November / December 2008. Thus, 2009 was the first year the lake was monitored after this stormwater structure was installed. Overall TP concentrations in the southern end of Crescent Cove were lower in 2009 after the installation of the Aqua-Filter, in spite of it being a wetter year. As shown below only one sampling event displayed a TP concentration greater than the State's TP water quality standard in 2009.

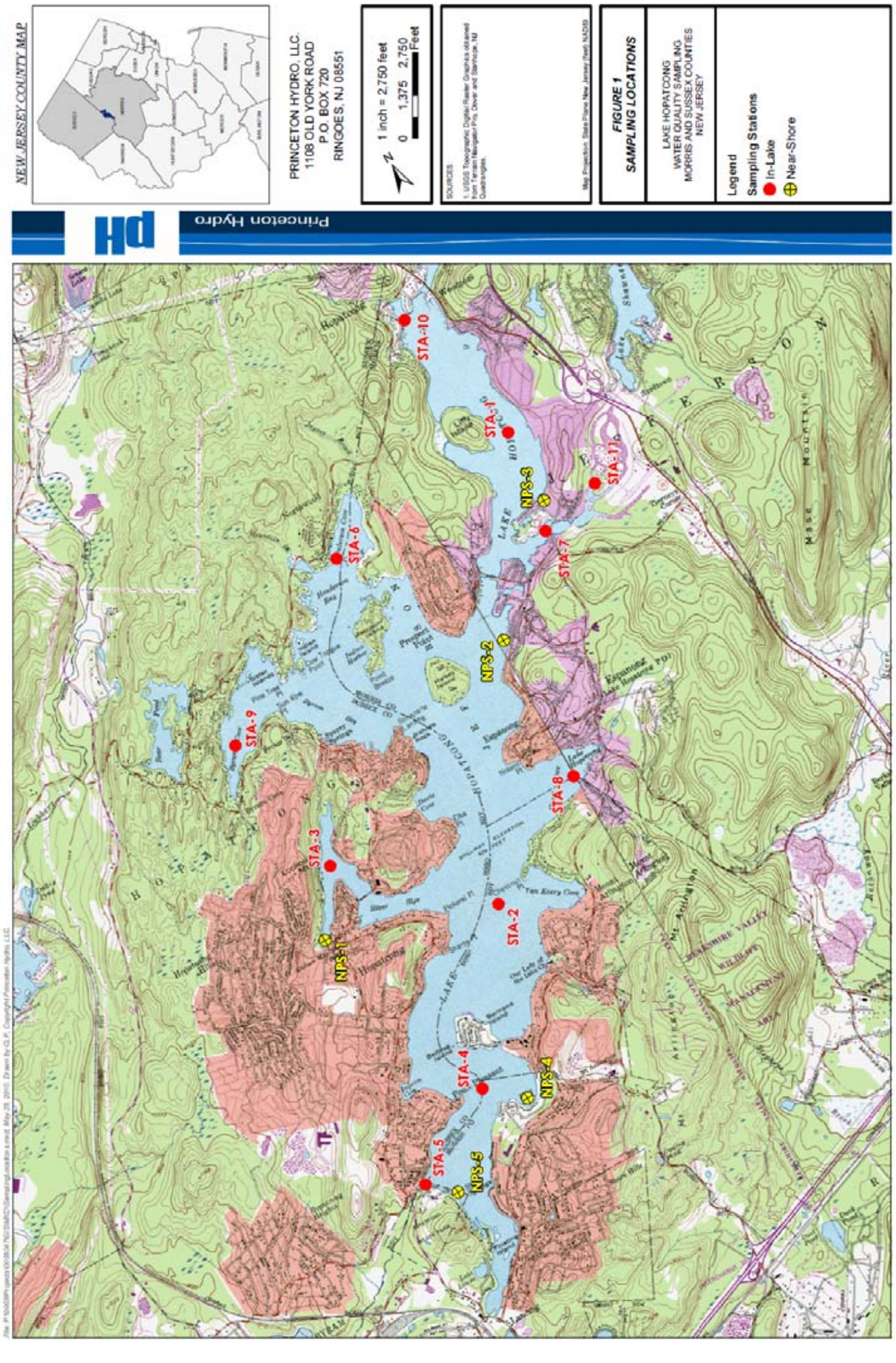
7. In contrast, in 2010 four of the five sampling events at the southern end of Crescent Cove were greater than the State's TP water quality standard. Based on these results, it is more than likely that the Aqua-Filter unit installed in late 2008 needs to be cleaned out and/or the filter pillows need to be replaced.

8. After the second Aqua-Filter was installed in the end of June 2011, TP concentrations were high in July 2011 but were below State's TP water quality standard in August and October 2011. Both Aqua-Filter systems need to be maintained in order to ensure their optimal level of pollutant removal efficiency. At a minimum, the Aqua-Swirl portion of these systems must be cleaned out on an annual basis.

9. Finally, it should be noted that 2012 is the last year Lake Hopatcong is being monitored under the existing SFY2010 NPS, 319-grant. Lake Hopatcong have one of the longer, continuous limnological databases in New Jersey (has been continuous monitored since 1991). Unless funding is secured in some manner, 2012 will be the last monitoring year for the lake. This comes at a critical time when water quality improvements are beginning to be documented as a result of the watershed-based measures. Thus, the Commission and NJDEP should discuss continuing the monitoring of the lake beyond 2012.

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

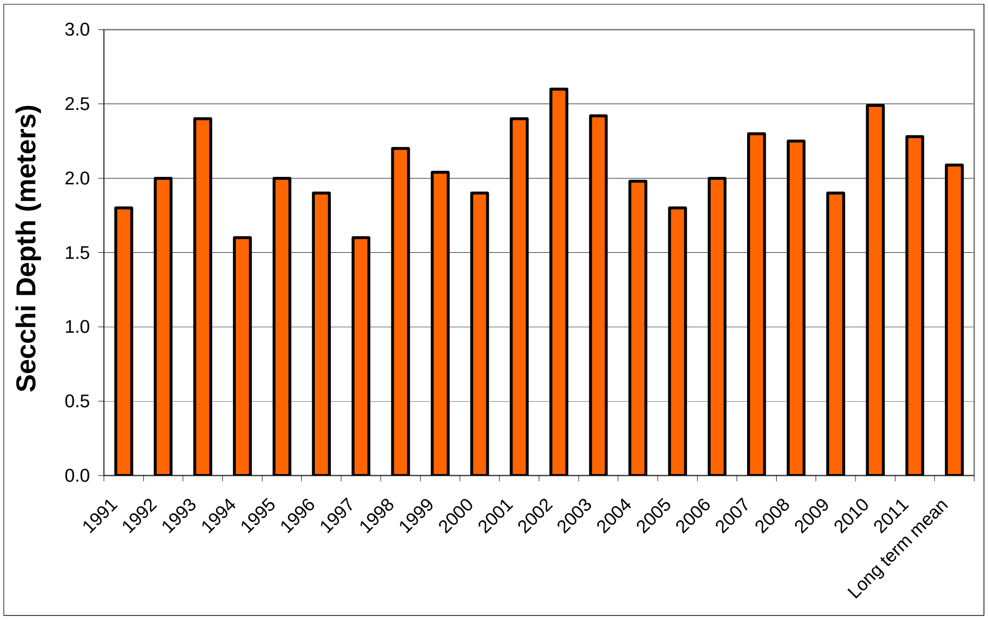


Figure 2 - Lake Hopatcong Long-Term Secchi Depth (meters)

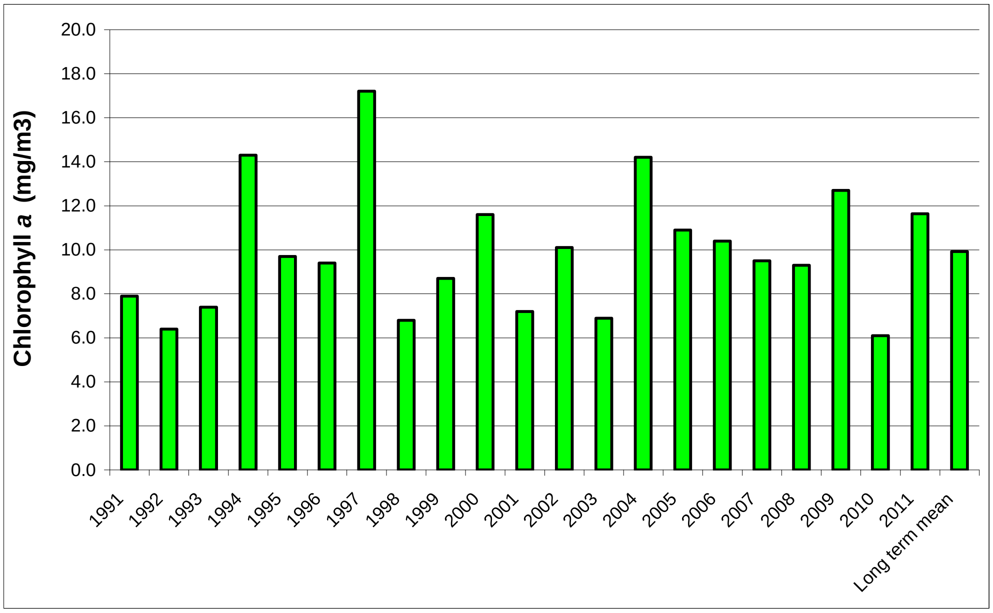


Figure 3 - Lake Hopatcong Long-Term Chlorophyll a Concentrations (mg/m3)

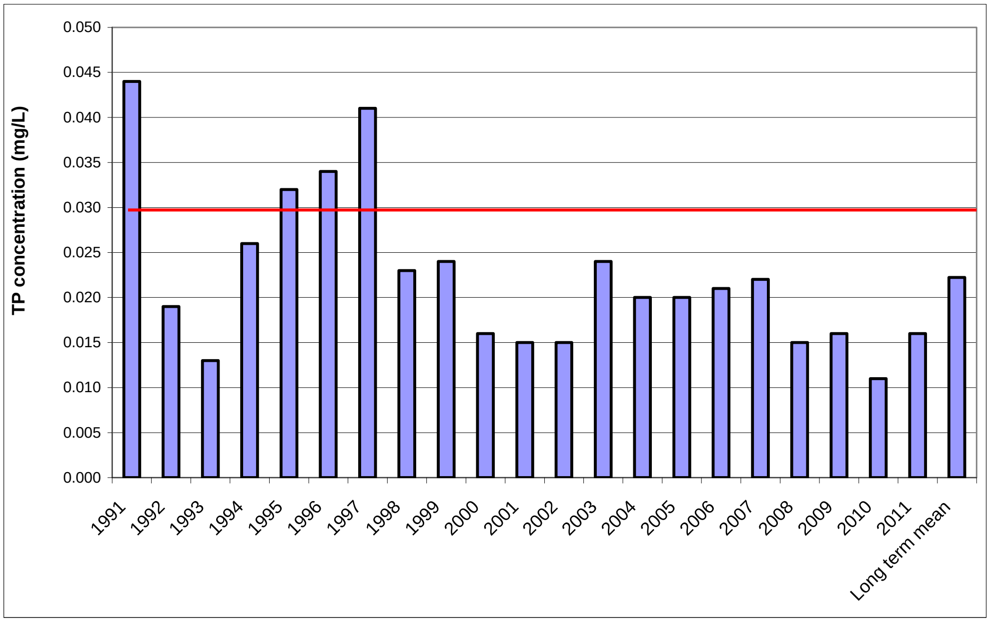


Figure 4 - Lake Hopatcong Long-Term Total Phosphorus Concentrations (mg/L)

APPENDIX B

IN-SITU DATA

In-Situ Monitoring for Lake Hopatcong 5/26/11								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
ST-1	**2**	**1.8**	**Surface**	21.47	0.306	11.63	8	133.85
			1.0	20.64	0.306	11.62	7.99	131.57
			2.0	18.21	0.308	11.72	7.97	126.43
ST-2	**13.9**	**2.5**	**Surface**	19.13	0.351	18.39	7.99	202.02
			1.0	18.99	0.351	17.35	7.97	190.09
			2.0	18.48	0.35	16.58	8.03	179.72
			3.0	17.5	0.346	15.92	8	169.17
			4.0	16.92	0.349	14.87	7.93	156.09
			5.0	16.13	0.351	13.09	7.78	135.12
			6.0	15.44	0.353	11.98	7.66	121.87
			7.0	14.18	0.354	11.25	7.6	111.42
			8.0	13.33	0.354	10.65	7.54	103.52
			9.0	12.41	0.353	10.39	7.51	98.89
			10.0	11.9	0.353	9.72	7.46	91.49
			11.0	11.46	0.354	9.54	7.41	88.88
			12.0	10.28	0.356	8.07	7.34	73.21
			13.0	10.14	0.357	7.29	7.27	65.89
			13.5	9.81	0.367	5.41	7.22	48.51
ST-3	**2.1**	**1.5**	**Surface**	22.4	0.436	12.8	9.08	149.92
			1.0	21.31	0.453	13.98	9.37	160.44
			2.0	17	0.722	7.22	7.93	76.01
ST-4	**3.1**	**2.5**	**Surface**	20.31	0.359	15.72	8.02	176.85
			1.0	20.05	0.359	14.77	8.1	165.31
			2.0	17.61	0.351	14.47	8.1	154.15
			3.0	16.54	0.354	12.84	7.91	133.73
ST-5	**3.6**	**2.6**	**Surface**	20.72	0.367	14.51	8.75	164.49
			1.0	19.59	0.363	14.34	8.55	159.01
			2.0	17.9	0.361	13.58	8.15	145.52
			3.0	16.61	0.362	16.47	7.75	171.85
			3.5	16.51	0.363	15.44	7.55	160.75
ST-6	**2.5**	**2**	**Surface**	22.15	0.321	18.77	8.12	218.84
			1.0	21.35	0.319	18	8.2	206.56
			2.0	19.19	0.292	17.58	8.09	193.3
			2.5	17.72	0.285	13.13	7.76	140.18
ST-7	**1.8**	**1.8**	**Surface**	21.94	0.131	11.12	7.49	129.03
			1.0	19.55	0.143	10.34	7.3	114.5
			1.5	18.46	0.151	8.99	7.21	97.44
ST-8	**7.5**	**2.5**	**Surface**	19.66	0.346	12.37	7.95	137.34
			1.0	18.22	0.345	12.68	7.91	136.73
			2.0	17.71	0.344	12.11	7.92	129.24
			3.0	17.28	0.348	11.64	7.92	123.18
			4.0	16.95	0.35	11.51	7.9	120.93
			5.0	16.42	0.351	10.81	7.8	112.33
			6.0	15.94	0.352	10.67	7.76	109.81
			7.0	14.63	0.354	9.63	7.66	96.29
			7.5	14.21	0.355	9.05	7.56	89.71
ST-9	**8.1**	**2**	**Surface**	20.83	0.339	12.43	8.07	141.21
			1.0	20.35	0.338	12.29	8.07	138.32
			2.0	19.84	0.337	12.15	8.09	135.33
			3.0	19.55	0.336	11.9	8.12	131.84
			4.0	19.16	0.339	11.71	8.08	128.7
			5.0	18.55	0.365	11.72	8.03	127.26
			6.0	16.21	0.352	10.57	7.94	109.3
			7.0	14.23	0.355	9.89	7.87	98.08
			8.0	13.42	0.357	7.88	7.69	76.8
ST-10	**1.7**	**1.7**	**Surface**	21.32	0.315	13.46	8.54	154.37
			1.0	21.04	0.33	13.44	8.67	153.38
			1.5	20.69	0.345	13.84	8.82	156.85
ST-11	**1.1**	**1.1**	**Surface**	21.48	0.11	16.5	7.41	189.75
			1.0	18.92	0.12	16.72	7.29	182.71

In-Situ Monitoring for Lake Hopatcong 6/21/11								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
ST-1	**1.9**	**1.6**	**Surface**	25	0.305	10.89	7.64	133.92
			1.0	24.74	0.304	10.86	7.61	132.93
			2.0	24.35	0.308	10.42	7.52	126.6
ST-2	**14.1**	**2.1**	**Surface**	23.7	0.348	9.58	8.5	114.99
			1.0	23.52	0.348	9.61	8.55	115
			2.0	23.34	0.347	9.54	8.53	113.78
			3.0	23.24	0.348	9.42	8.49	112.18
			4.0	21.95	0.349	8.39	8.21	97.45
			5.0	20.17	0.35	6.29	7.87	70.6
			6.0	18.45	0.352	5.47	7.63	59.34
			7.0	15.39	0.355	3.32	7.42	33.75
			8.0	13.48	0.357	3.51	7.36	34.26
			9.0	12.54	0.357	5.33	7.28	50.94
			10.0	11.9	0.357	6.02	7.24	56.67
			11.0	11.38	0.36	5.71	7.19	53.15
			12.0	10.98	0.36	5.79	7.18	53.36
			13.0	10.6	0.368	5.91	7.17	53.97
			14.0	10.51	0.383	6.18	7.15	56.32
ST-3	**2.1**	**1.8**	**Surface**	25.05	0.549	13.15	8.96	161.96
			1.0	24.4	0.586	14.18	9.09	172.56
			2.0	22.05	0.708	5.61	7.71	65.37
ST-4	**2.9**	**1.5**	**Surface**	24.25	0.358	8.57	7.79	104.02
			1.0	24.25	0.358	8.52	7.76	103.4
			2.0	24.18	0.357	8.67	7.79	105.04
			3.0	22.61	0.35	7.87	7.68	92.56
ST-5	**3.5**	**1.5**	**Surface**	24.35	0.369	8.15	7.65	99.03
			1.0	24.18	0.364	7.78	7.56	94.29
			2.0	23.21	0.37	3.02	7.29	36.01
			3.5	21.63	0.38	1.39	7.1	16.04
ST-6	**2.5**	**2.4**	**Surface**	24.74	0.339	11.14	7.97	136.41
			1.0	24.59	0.338	11.28	8.08	137.66
			2.0	24.21	0.336	11.3	8.1	136.93
ST-7	**1.7**	**1**	**Surface**	24.54	0.161	10.09	7.43	122.97
			1.0	23.75	0.154	9.35	7.26	112.32
			1.5	23.55	0.159	8.57	7.1	102.54
ST-8	**7.2**	**2.5**	**Surface**	24.51	0.351	12.9	8.58	157.31
			1.0	24.37	0.349	12.82	8.62	155.85
			2.0	24.25	0.349	12.63	8.59	153.22
			3.0	24.08	0.349	12.48	8.53	150.88
			4.0	23.15	0.347	11.83	8.22	140.55
			5.0	19.3	0.35	8.71	7.83	96.03
			6.0	18.29	0.351	7.58	7.63	81.89
			7.0	15.76	0.36	5.64	7.35	57.82
ST-9	**8**	**2.2**	**Surface**	24.29	0.347	12.13	8.64	147.21
			1.0	23.81	0.348	12.55	8.75	150.98
			2.0	23.39	0.35	12.86	8.81	153.56
			3.0	23.12	0.345	12.09	8.43	143.62
			4.0	22.79	0.344	11.6	8.17	136.89
			5.0	21.04	0.349	10.33	7.92	117.83
			6.0	19.26	0.349	8.33	7.68	91.8
			7.0	16.37	0.354	6.65	7.51	69.04
			8.0	14.32	0.396	5.39	7.33	53.59
ST-10	**1.5**	**1.2**	**Surface**	25.23	0.319	11.36	8.18	140.29
			1.0	24.88	0.319	10.93	8.05	134.08
			1.5	24.04	0.384	12.7	8.63	153.45
ST-11	**1**	**0.8**	**Surface**	24.05	0.127	10.32	7.54	124.62
			1.0	22.64	0.191	7.45	7.17	87.61

In-Situ Monitoring for Lake Hopatcong 7/20/11								
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	pH	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(units)	(%)
ST-1	2	1	Surface	28.76	0.305	7.97	7.81	104.86
			1.0	28.62	0.305	7.67	7.7	100.7
			2.0	28.17	0.307	7.09	7.54	92.3
ST-2	13.8	2.7	Surface	27.6	0.348	9.18	8.04	118.43
			1.0	27.57	0.348	8.83	8	113.86
			2.0	27.39	0.347	8.67	7.96	111.34
			3.0	26.68	0.349	8.6	7.94	109.11
			4.0	25.96	0.355	7.33	7.65	91.81
			5.0	24.02	0.346	4.92	7.27	59.51
			6.0	20.48	0.35	3.04	7.11	34.35
			7.0	16.98	0.355	2.84	7.09	29.93
			8.0	14.99	0.357	2.84	7.12	28.62
			9.0	12.88	0.36	2.85	7.18	27.49
			10.0	12.05	0.361	2.86	7.2	27.07
			11.0	11.61	0.363	2.87	7.23	26.85
			12.0	11.25	0.366	2.81	7.23	26.09
			13.0	10.72	0.375	2.8	7.25	25.66
			13.5	10.5	0.387	2.75	7.36	25.05
ST-3	2	1.1	Surface	29.38	0.554	12.15	8.91	161.69
			1.0	28.94	0.533	11.92	8.91	157.43
			2.0	26.92	0.601	4.46	7.42	56.91
ST-4	3.1	1.7	Surface	28.02	0.363	7.22	8.21	93.81
			1.0	27.98	0.363	7.11	8.12	92.34
			2.0	27.56	0.361	7.19	8.02	92.72
			3.0	25.75	0.354	4.83	7.53	60.29
ST-5	3.6	1.7	Surface	28.37	0.365	9.19	8.12	120.08
			1.0	28.31	0.365	9.12	8.13	119.12
			2.0	28.14	0.365	8.77	8.04	114.2
			3.0	27.1	0.365	6.23	7.44	79.63
			3.5	26.86	0.366	5.04	7.22	64.1
ST-6	2.2	1.7	Surface	27.98	0.348	9.58	7.94	124.35
			1.0	27.91	0.348	9.36	7.91	121.31
			2.0	26.93	0.348	8.22	7.67	104.74
ST-7	1.7	1.7+	Surface	29.07	0.243	9.41	7.56	124.48
			1.0	27.74	0.246	9.42	7.43	121.71
			1.5	27.3	0.249	8.86	7.4	113.56
ST-8	7.3	2.5	Surface	27.63	0.347	7.86	8	101.45
			1.0	27.27	0.347	8.07	8.02	103.44
			2.0	26.94	0.347	8.08	8	103.03
			3.0	26.68	0.349	7.92	7.95	100.52
			4.0	26.24	0.348	7.39	7.73	93.03
			5.0	25.02	0.346	6.05	7.5	74.47
			6.0	18.85	0.352	3.11	7.23	34.01
			7.0	16.18	0.359	2.92	7.13	30.19
ST-9	8	2.2	Surface	28.6	0.348	8.2	8.25	107.6
			1.0	28.38	0.348	8.23	8.25	107.67
			2.0	27.76	0.347	8.23	8.21	106.46
			3.0	26.93	0.347	8.59	8.44	109.47
			4.0	26.09	0.346	7.39	8	92.81
			5.0	25.29	0.344	5.82	7.6	72
			6.0	23.29	0.345	3.7	7.33	44.16
			7.0	17.39	0.356	2.58	7.28	27.38
			8.0	14.98	0.371	2.91	7.26	29.36
ST-10	1.5	1	Surface	28.82	0.314	9.66	8.03	127.27
			1.0	28.75	0.314	9.52	8.04	125.26
			1.5	28.36	0.319	9.63	8.13	125.84
ST-11	1	1.0+	Surface	27.68	0.199	8.44	7.68	108.97
			1.0	26.92	0.199	7.41	7.36	94.36

In-Situ Monitoring for Lake Hopatcong 8/24/11								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
ST-1	**2**	**1**	**Surface**	24.17	0.3	7.74	8.1	93.7
			1.0	24.14	0.3	7.69	7.95	93.15
			2.0	23.89	0.3	7.31	7.8	88.04
ST-2	**14.6**	**2**	**Surface**	23.9	0.344	8.02	8.14	96.69
			1.0	23.88	0.344	7.99	8.12	96.32
			2.0	23.85	0.344	7.92	8.11	95.4
			3.0	23.77	0.344	7.89	8.07	94.92
			4.0	23.71	0.343	7.81	8.02	93.76
			5.0	23.65	0.343	7.72	7.91	92.65
			6.0	23.38	0.344	6.84	7.59	81.63
			7.0	19.19	0.354	2.91	7.11	32.1
			8.0	14.85	0.367	2.55	7.1	25.66
			9.0	13.46	0.369	2.32	7.14	22.62
			10.0	12.57	0.37	2.39	7.18	22.87
			11.0	11.82	0.375	2.45	7.22	23.09
			12.0	11.31	0.379	2.47	7.28	23
			13.0	11	0.382	2.27	7.36	20.99
			14.0	10.55	0.392	2.27	7.39	20.75
			14.5	10.44	0.577	2.23	7.39	20.37
ST-3	**2.1**	**0.5**	**Surface**	24.78	0.434	8.94	9	109.53
			1.0	24.2	0.432	8.43	8.75	102.19
			2.0	23.65	0.437	6.56	8.06	78.75
ST-4	**3.1**	**1.5**	**Surface**	23.79	0.345	8.67	8.16	104.27
			1.0	23.75	0.344	8.59	8.07	103.19
			2.0	23.74	0.344	8.73	8.06	104.9
			3.0	23.64	0.345	8.27	7.87	99.21
ST-5	**3.5**	**1.3**	**Surface**	23.77	0.343	9.23	7.86	111.02
			1.0	23.54	0.343	9.11	7.75	109.06
			2.0	23.35	0.343	8.9	7.71	106.16
			3.0	23.12	0.343	8.57	7.64	101.78
			3.5	23.12	0.35	8.33	7.41	98.97
ST-6	**2.4**	**1.5**	**Surface**	24.16	0.333	11.29	8.57	136.68
			1.0	24.24	0.333	10.68	8.51	129.58
			2.0	23.81	0.331	10.8	8.6	129.98
			2.5	23.81	0.333	10.74	8.6	129.2
ST-7	**1.5**	**1.5+**	**Surface**	23.31	0.221	8.28	7.87	98.64
			1.0	23.13	0.22	7.85	7.6	93.19
			1.5	22.5	0.218	8.55	7.51	100.38
ST-8	**7.5**	**1.8**	**Surface**	24.37	0.342	7.59	8.08	92.33
			1.0	24.32	0.342	7.75	8.05	94.12
			2.0	24.22	0.343	7.87	8.02	95.44
			3.0	24.1	0.344	7.71	7.96	93.24
			4.0	24.05	0.343	7.6	7.92	91.91
			5.0	24.02	0.344	7.46	7.86	90.18
			6.0	23.97	0.345	7.4	7.81	89.37
			7.0	20.2	0.35	4.81	7.51	53.97
			7.5	19.12	0.398	2.66	7.17	29.26
ST-9	**8.1**	**1.8**	**Surface**	24.33	0.346	8.39	8.39	101.91
			1.0	24.1	0.345	8.37	8.25	101.21
			2.0	24.01	0.345	8.34	8.24	100.79
			3.0	23.74	0.346	7.93	8.05	95.29
			4.0	23.7	0.346	7.83	7.99	94.08
			5.0	23.63	0.347	7.61	7.93	91.32
			6.0	23.46	0.348	7.14	7.79	85.35
			7.0	22.71	0.346	5.06	7.52	59.61
			8.0	18.63	0.476	2.85	7.15	31.06
ST-10	**1.6**	**1**	**Surface**	23.91	0.316	8.62	8.38	103.97
			1.0	23.86	0.316	8.52	8.34	102.65
			1.5	23.73	0.319	8.48	8.36	101.82
ST-11	**1.1**	**1.1+**	**Surface**	22.51	0.155	9.28	7.52	108.91
			1.0	21.47	0.158	9.16	7.28	105.38

In-Situ Monitoring for Lake Hopatcong 10/13/11								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
ST-1	**2**	**1.2**	**Surface**	16.83	0.212	9.07	7.48	93.5
			1.0	16.8	0.212	8.8	7.47	93.4
			2.0	16.48	0.219	8.88	7.46	86.1
ST-2	**14.4**	**2.1**	**Surface**	17.29	0.284	8.47	7.82	89
			1.0	17.29	0.287	8.3	7.71	87.1
			2.0	17.27	0.286	8.08	7.68	85.2
			3.0	17.25	0.286	8.05	7.65	85
			4.0	17.23	0.287	8.05	7.63	84.7
			5.0	17.2	0.287	7.99	7.6	84
			6.0	17.18	0.288	7.88	7.59	82.7
			7.0	17.17	0.287	7.76	7.57	81.6
			8.0	17.15	0.285	7.72	7.54	80.9
			9.0	16.91	0.283	7.32	7.52	72.9
			10.0	16.69	0.284	5.26	7.48	52
			11.0	15.69	0.314	1.45	7.38	10.1
			12.0	12.76	0.392	0.5	7.23	4.5
			13.0	11.67	0.397	0.4	7.18	3.7
			14.0	10.9	0.474	0.34	6.92	3
ST-3	**2.1**	**1.3**	**Surface**	17.28	0.368	9.85	7.46	104.4
			1.0	17.32	0.373	9.87	7.5	102.8
			2.0	16.97	0.408	9.77	7.57	102
ST-4	**3.1**	**2.1**	**Surface**	17.22	0.293	9.15	7.79	94.6
			1.0	17.22	0.293	8.79	7.75	91.8
			2.0	17.2	0.296	8.62	7.71	91
			3.0	17.2	0.293	8.09	7.69	81.5
ST-5	**3.3**	**2.1**	**Surface**	17.09	0.298	9.33	7.68	96.8
			1.0	17.08	0.299	9.02	7.63	93.8
			2.0	17.07	0.295	8.96	7.6	93.1
			3.0	17.09	0.298	8.75	7.59	92.3
ST-6	**2.3**	**2**	**Surface**	17.3	0.267	9.51	7.61	102.9
			1.0	17.18	0.273	9.13	7.58	93.8
			2.0	17.05	0.277	8.23	7.54	84.5
ST-7	**1.5**	**1.25**	**Surface**	16.01	0.145	8.46	7.31	85.3
			1.0	15.73	0.177	8.01	7.27	80.8
ST-8	**7.5**	**2.9**	**Surface**	17	0.282	7.47	7.21	76.6
			1.0	16.98	0.282	7.04	7.2	73.3
			2.0	16.93	0.282	6.73	7.19	68.5
			3.0	16.85	0.28	6.29	7.18	63.9
			4.0	16.75	0.283	6	7.17	60.6
			5.0	16.75	0.281	5.78	7.16	60.2
			6.0	16.69	0.282	5.65	7.15	58.2
			7.0	16.59	0.283	5.18	7.13	52.3
ST-9	**8.2**	**1.75**	**Surface**	17.66	0.279	9.4	7.53	97.6
			1.0	17.61	0.283	9.11	7.54	94.3
			2.0	17.58	0.279	8.74	7.53	92.7
			3.0	17.57	0.283	8.67	7.52	91.9
			4.0	17.58	0.281	8.49	7.51	91
			5.0	17.56	0.282	8.55	7.5	90.9
			6.0	17.55	0.281	8.8	7.49	92.5
			7.0	17.27	0.288	8.27	7.48	85.9
			8.0	17.18	0.291	6.22	7.42	64.7
ST-10	**1.5**	**1.25**	**Surface**	17.05	0.229	9.75	7.4	101.4
			1.0	16.86	0.232	9.58	7.41	100.7
ST-11	**1.1**	**1.1+**	**Surface**	15.61	0.123	9.16	7.48	88.4
			1.0	15.54	0.123	8.22	7.38	83.1

In-Situ **Monitoring for Hopatcong 319 Stations 5/26/11**									
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
NPS 1	**1.4**	**1.4+**	**Surface**	21.83	0.666	13.44	9.15	155.9
			1.00	18.58	0.866	15.27	8.9	166.15
			1.50	16.76	1	18.02	9.06	188.87
NPS 2	**0.9**	**0.9+**	**Surface**	22.67	0.225	10.02	7.31	118
			0.75	20.56	0.229	10.8	7.33	122.06
NPS 3	**1**	**1.0+**	**Surface**	22.3	0.312	11.93	7.71	139.5
			0.80	20.29	0.343	14.69	8.22	165.09
NPS 4	**1.3**	**1.3+**	**Surface**	19.63	0.371	12.36	7.63	137.19
			1.00	18.48	0.36	12.74	7.7	138.14
			1.25	18.43	0.36	12.56	7.76	136.09
NPS 5			**Surface**	21.74	0.372	17.55	8.94	202.98

In-Situ **Monitoring for Hopatcong 319 Stations 6/21/11**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
NPS 1	**1.3**	**1**	**Surface**	24.29	0.687	14.73	8.8	179.04
			1.00	22.51	0.789	13.88	8.39	163.18
NPS 2	**1**	**1.0+**	**Surface**	24.59	0.304	11.43	8.18	139.51
			1.00	24.32	0.298	12.54	8.71	152.29
NPS 3	**0.5**	**0.5+**	**Surface**	25.24	0.305	10.29	7.89	127.13
			0.50	24.3	0.308	11.15	8.52	135.35
NPS 4	**1.4**	**1.3**	**Surface**	24.7	0.379	8.14	7.8	99.64
			1.25	24.52	0.38	7.91	7.68	96.42
NPS 5	**1.7**	**1**	**Surface**	24.63	0.378	7.34	7.54	89.7
			1.00	24.52	0.378	6.85	7.48	83.55
			1.50	24.43	0.38	4.53	7.26	55.21

***In-Situ* Monitoring for Hopatcong 319 Stations 7/20/11**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
NPS 1	**1.4**	**0.8**	**Surface**	30.06	0.602	9.49	8.72	127.87
			1.00	28.11	0.603	7.86	8.18	102.31
			1.25	27.77	0.624	5.9	7.73	76.35
NPS 2	**0.9**	**0.9+**	**Surface**	28.58	0.308	10.71	8.74	140.56
			0.75	28.07	0.308	10.96	8.99	142.5
NPS 3	**0.9**	**0.9+**	**Surface**	29.45	0.3	9.84	8.57	130.99
			0.75	28.28	0.308	10.42	8.59	135.9
NPS 4	**1.3**	**1.3+**	**Surface**	27.78	0.369	7.29	7.93	94.34
			1.00	27.71	0.369	7.25	7.86	93.7
			1.25	27.7	0.369	7.02	7.81	90.76
NPS 5	**2.1**	**1.7**	**Surface**	28.41	0.37	8.18	8.46	107.04
			1.00	28.37	0.369	8.26	8.46	107.92
			2.00	27.85	0.371	5.56	7.64	72.01

***In-Situ* Monitoring for Hopatcong 319 Stations 8/24/11**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
NPS 1	**1.5**	**0.4**	**Surface**	24.11	0.487	8.99	8.88	108.87
			1.00	22.51	0.532	9.22	8.56	108.27
			1.50	22.07	0.579	8.59	8.28	100.05
NPS 2	**1.1**	**1.1+**	**Surface**	23.58	0.254	8.07	8.07	96.68
			1.00	23.34	0.254	8.5	8.34	101.35
NPS 3	**0.85**	**0.85+**	**Surface**	23.82	0.29	8.42	8.27	101.38
			0.75	22.97	0.288	9	8.51	106.61
NPS 4	**1.4**	**1.4+**	**Surface**	23.9	0.354	8.54	8.43	102.94
			1.00	23.69	0.353	9.21	8.79	110.61
			1.25	23.53	0.372	5.34	7.11	63.91
NPS 5	**1.75**	**1.5**	**Surface**	23.98	0.343	8.72	8.31	105.27
			1.00	23.92	0.344	8.78	8.31	105.92
			1.75	23.73	0.343	8.72	8.22	104.76

In-Situ **Monitoring for Hopatcong 319 Stations 10/13/11**								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
NPS 1	**1.3**	**1.2**	**Surface**	17.12	0.444	9.58	7.62	101.5
			1.00	16.83	0.484	10.09	7.64	106.7
NPS 2	**1.1**	**1.1+**	**Surface**	16.2	0.195	8.85	7.26	90.8
			1.00	16.15	0.198	8.65	7.23	88.7
NPS 3	**1**	**1.0+**	**Surface**	16.63	0.225	8.23	7.32	84.8
			1.00	16.23	0.225	8.14	7.32	82.8
NPS 4	**1.4**	**1.4+**	**Surface**	16.88	0.344	9.06	7.65	93.1
			1.00	16.76	0.334	8.72	7.64	90.8
NPS 5	**1.4**	**1.4+**	**Surface**	16.99	0.306	9.46	7.78	98.1
			1.00	16.98	0.303	8.92	7.74	92.7

APPENDIX C

WATER QUALITY DATA

HOPATCONG
26-May-2011

STATION	Chlorophyll (mg/m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	7.5	0.01	0.09	0.02	ND <2
ST-2	5.4	0.02	0.04	0.03	ND <2
ST-3	6.1	ND <0.01	0.14	0.02	ND <2
ST-4	4.8	0.03	0.05	0.02	ND <2
ST-5	7.7	0.04	0.03	0.02	ND <2
ST-6	6.9	0.30	0.07	0.02	ND <2
ST-7	2.2	0.06	0.13	0.02	ND <2
ST-10	8.6	0.09	0.10	0.02	2
ST-11	2.3	0.13	0.14	0.02	ND <2
ST-2 DEEP		0.47	0.10	0.02	2
MEAN	**5.7**	**0.08**	**0.09**	**0.02**	**1.1**

HOPATCONG
21-Jun-11

STATION	Chlorophyll (mg/m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	10.6	ND <0.01	0.02	0.02	4
ST-2	6.7	0.01	ND <0.02	0.01	ND <2
ST-3	10	0.02	0.03	0.03	2
ST-4	7	0.02	0.04	0.02	ND <2
ST-5	9.4	0.02	0.10	0.03	ND <2
ST-6	6	0.01	0.03	0.02	ND <2
ST-7	24.9	0.02	0.18	0.04	3
ST-10	15.9	0.02	0.03	0.03	4
ST-11	29.4	0.02	0.14	0.04	3
ST-2 DEEP		0.51	0.11	0.02	3
MEAN	**13.3**	**0.02**	**0.06**	**0.03**	**2.2**

HOPATCONG
20-Jul-11

STATION	Chlorophyll (mg/m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	20.4	ND <0.01	0.06	0.03	7
ST-2	6.9	ND <0.01	ND <0.02	0.01	ND <3
ST-3	27.9	0.01	0.04	0.04	5
ST-4	12.2	0.02	ND <0.02	0.02	4
ST-5	12.4	ND <0.01	ND <0.02	0.02	4
ST-6	10	0.01	ND <0.02	0.02	3
ST-7	5.2	ND <0.01	0.07	0.02	ND <3
ST-10	20	ND <0.01	0.03	0.04	6
ST-11	8.4	0.01	0.09	0.03	ND <3
ST-2 DEEP		0.44	0.11	0.13	3
MEAN	**13.7**	**0.01**	**0.04**	**0.03**	**3.7**

HOPATCONG
24-Aug-11

STATION	Chlorophyll (mg/ m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	46	0.02	0.04	0.04	12
ST-2	23.2	0.02	0.05	0.02	3
ST-3	66.3	0.03	0.04	0.05	12
ST-4	23.8	0.02	0.04	0.02	4
ST-5	29.4	0.03	0.03	0.03	8
ST-6	16.6	0.03	0.02	0.02	ND <3
ST-7	9.4	0.03	0.05	0.02	ND <3
ST-10	32.2	0.03	0.12	0.04	8
ST-11	11.9	0.03	0.07	0.02	ND <3
ST-2 DEEP		1.10	0.10	0.33	6
MEAN	**28.8**	**0.03**	**0.05**	**0.03**	**5.7**

HOPATCONG
13-Oct-11

STATION	Chlorophyll (mg/ m^3)	NH3-N (mg/L)	NO3-N (mg/L)	TP (mg/L)	TSS (mg/L)
ST-1	21	0.01	0.12	0.03	< 3
ST-2	16	0.01	0.07	0.01	< 3
ST-3	21	< 0.01	0.33	0.03	< 3
ST-4	12	< 0.01	0.05	0.02	< 3
ST-5	11	0.01	0.04	0.01	< 3
ST-6	10	< 0.01	0.06	0.01	< 3
ST-7	20	0.02	0.12	0.02	< 3
ST-10	17	0.01	0.14	0.01	< 3
ST-11	12	< 0.01	0.11	0.05	< 3
ST-2 DEEP		3.10	0.10	0.16	9
MEAN	**15.6**	**0.01**	**0.12**	**0.02**	**< 3**

319 Sampling for 2011

5/26/2011

Station	TP (mg/L)	TSS (mg/L)	CHL *a* (mg/m³)
NPS 1	0.02	ND <2	
NPS 2	0.02	ND <2	
NPS 3	0.02	3	9.4
NPS 4	0.02	8	23.5
NPS 5	0.02	ND <2	4.4

6/21/2011

Station	TP (mg/L)	TSS (mg/L)	CHL *a* (mg/m³)
NPS 1	0.03	3	
NPS 2	0.02	ND <2	
NPS 3	0.02	2	7.9
NPS 4	0.02	2	9.3
NPS 5	0.02	ND <2	8.3

7/20/2011

Station	TP (mg/L)	TSS (mg/L)	CHL *a* (mg/m³)
NPS 1	0.08	9	
NPS 2	0.03	4	
NPS 3	0.02	4	8.9
NPS 4	0.02	5	11.5
NPS 5	0.02	14	15.5

8/24/2011

Station	TP (mg/L)	TSS (mg/L)	CHL *a* (mg/m³)
NPS 1	0.04	11	
NPS 2	0.01	ND <3	
NPS 3	0.02	9	37.5
NPS 4	0.01	4	21.6
NPS 5	ND <0.01	ND <3	20

10/13/2011

Station	TP (mg/L)	TSS (mg/L)	CHL *a* (mg/m³)
NPS 1	0.01	3	
NPS 2	ND <0.01	ND <3	
NPS 3	0.01	ND <3	7.7
NPS 4	ND <0.01	ND <3	7
NPS 5	ND <0.01	ND <3	7.7