LAKE HOPATCONG
WATER QUALITY MONITORING
ANNUAL REPORT 2007

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1.0 INTRODUCTION

Princeton Hydro, LLC conducted general water quality monitoring of Lake Hopatcong during the 2007 growing season (May through September). This monitoring program represents a continuation of the long-term monitoring program of Lake Hopatcong. 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 current water quality monitoring program is valuable in terms of continuing the inter-annual, baseline database of the lake, identifying long-term trends 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 (Figure 1 in 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 2007 sampling dates were 24 May, 19 June, 24 July, 23 August and 28 September. 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 site (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 recent 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 2007

In addition to the standard, long-term, in-lake monitoring program, additional data were collected in the Lake Hopatcong watershed in 2007. These data were collected for various reasons including refining the lake's phosphorus TMDL, obtaining a better understanding of the baseflow and storm event pollutant loads entering Lake Hopatcong and developing a water quality database to assess the pollutant removal capacity of the structural BMPs that will be installed as part of the existing Non-Point Source (319(h)) grant.

Stormwater Monitoring Program

As part of the 319(h) grant awarded to the Lake Hopatcong Commission the operations staff was trained by Princeton Hydro to collect composite stormwater samples from locations that have been selected for the installation of specific structural BMPs. Again, a QAPP was developed, submitted to and approved by NJDEP so the resulting data will be accepted by the State.

A total of four stormwater sampling stations were established, each one located at a site where stormwater samples will be collected flowing into and out of an installed structural BMP during post-installation events. However, it should be noted that pre-installation stormwater sampling was conducted as well. The four stormwater sampling sites included:

1. Runoff that flows over and under the Hopatcong Beach Club's parking lot, which drains into Crescent Cove, Borough of Hopatcong.
2. Runoff from the Bell Avenue drainage area that flows over and under Lakeside Boulevard and into Crescent Cove, Borough of Hopatcong.
3. Runoff from a roadside swale along Dupont Avenue, which drains into the southern end of Crescent Cove, Borough of Hopatcong.
4. Runoff flow over and under Castle Rock Road, which then enters Lake Hopatcong in the Township of Jefferson.

A minimum of three pre-installation and three post-installation of the BMPs stormwater sampling events were to be conducted by the operations staff. Through 2007 a total of two pre-installation stormwater sampling events were conducted from July to September. This is in addition to the two qualifying storm-sampling events that occurred in 2006. All storm water samples were analyzed for TP, TDP, SRP and TSS.

Additional In-Lake Monitoring

In addition to stormwater sampling, the long-term in-lake water quality monitoring program was expanded to include near-shore, in-lake sampling stations at locations immediately adjacent to the drainage area that will receive the structural BMPs. The three near-shore, in-lake sampling stations include:

1. The southern end of Crescent Cove in the Borough of Hopatcong.
2. Ingram Cove, located in the Borough of Hopatcong.
3. Along the eastern shoreline of the lake, in the Township of Jefferson, just south of Brady's Bridge.

It should be noted that originally one of the 319 structural BMPs was planned to be installed in the Ingram Cove drainage area. However, due to site specific limitations associated with existing utilities, it was decided to move the BMP to the Crescent Cove drainage area. However, monitoring of the Ingram Cove sampling station continued through 2007. From June through September 2007, four sampling events were conducted at each 319 in-lake sampling station. 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.

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 2007-growing season were generally consistent with values recorded in previous years' monitoring programs. During the 2007 sampling season, the presence of an established thermocline or metalimnion was particularly distinct. This can be attributed to the relatively low frequency of storm events during the 2007-growing season, especially in the later summer months. The minimum number of individual storm events allowed thermal stratification to remain consistently established through the growing season.

On 24 May 2007, Lake Hopatcong was already thermally stratified, demonstrating a very narrow thermocline at a depth between 6 and 8 meters. From surface to bottom (14.5 meters), the temperature decreased from 18.2°C at the surface to 8.3°C at the bottom (Appendix B).

By 19 June 2007, thermal stratification was strong and well established at the mid-lake sampling station (Station #2). The epilimnion was located from the surface to 5 meters (16.5 ft). The metalimnion was located between 6 and 8 meters (20 and 26.4 ft), while the hypolimnion began at a depth greater than 9 meters.

During the 24 July 2007 and 23 August 2007 sampling events, the epilimnion was located from the surface to 6 meters and 7 meters, respectively. The thermocline was located between 6 and 8 meters, with the hypolimnion being below 8 meters.

The surface waters of Lake Hopatcong were cooler on 28 September relative to 23 August. The lake was mixed from the surface to 8 meters, while the thermocline was distributed between 8 and 9 meters. This is slightly different than in years past due to the prolonged warmer weather experienced in the region through the end of September.

Station #2 (mid-lake) was the only monitoring station that was stratified from May through September. The other moderately deep sampling stations (> 5 meters), Station #8 (Great Cove) and #9 (Byram Cove), were stratified in June and July. The remaining eight (8) sampling stations were well mixed through the entire sampling season. These well-mixed conditions were the result of relatively shallow water depths (< 3 meters) and exposure to winds.

It is interesting to note that the three near-shore in-lake sampling stations, particularly the Jefferson station, that were monitored for the 319 grant were periodically weakly stratified, in spite of being generally less than 3 meters in total depth.

Thermal stratification can effectively "seal off" the bottom waters from the surface water 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 levels 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 surface 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 24 May 2007 sampling event, DO concentrations were above the 5.0 mg/L threshold throughout most of Lake Hopatcong. Only the deepest water (> 14 meters) of Station #2 (mid-Lake) had depressed concentrations of DO (< 4.0 mg/L).

The surface waters of Lake Hopatcong were also generally well oxygenated (> 5.0 mg/L) during the 19 June 2007 sampling event. Anoxic conditions (DO concentrations < 1 mg/L) were identified at depths greater than 14 meters.

During the 24 July 2007 sampling event, Lake Hopatcong was well oxygenated from the surface to a depth of about 6 meters. At the Mid-Lake sampling station, anoxic conditions were identified from 6 meters to the bottom of the lake during the late July sampling event. At Station #9 anoxic conditions were measured from 7 meters to the bottom.

During the 23 August 2007 sampling event, from the surface to 8 meters the lake was well oxygenated, while anoxic conditions were measured at depths greater than 9 meters. Typically, anoxic conditions in the bottom waters persist through the summer season in Lake Hopatcong. This condition was intensified in 2007 by the minimum number of storm events during the late summer season, similar to 2006. The general lack of large storm events resulted in a minimum amount of mixing through the water column. Such conditions maintain the anoxic conditions in the bottom waters through the growing season by preventing the transfer of oxygenated water to the deeper sections of the lake.

On 28 September 2007, anoxic conditions persisted in sections of Lake Hopatcong greater than 9 meters in depth (Appendix B). In contrast, from the surface to 9 meters, Lake Hopatcong was well oxygenated, with DO concentrations typically being greater than 7.0 mg/L (Appendix B).

The three, 319 near-shore sampling stations were well oxygenated from surface to bottom during the 24 May 2007, 19 June and 24 July 2007 sampling events. On 23 August 2007, the Crescent

Cove and Ingram Cove near-shore sampling stations were well oxygenated with DO concentrations greater than 10 mg/L observed. These high DO concentrations in late August were indicative of elevated rates of algal and/or aquatic plant photosynthesis. In sharp contrast, the near-shore Jefferson sampling station was well oxygenated in the surface waters with substantially lower DO concentrations at depths greater than 3 meters. However, all three 319 near-shore sampling stations were well oxygenated from surface to bottom during the last monitoring event, 28 September 2007.

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. The exception was the pH at the River Styx (Station #3) and the Northern Woodport Bay (Station #10) sampling stations during the 24 May 2007 monitoring event, when the pH was greater than 9. Such temporarily elevated pH values in the surface waters can be attributed to high rates of algal and/or aquatic plant photosynthesis. As algae and plants photosynthesize, they produce DO as a by-product, as well as increase the pH of their immediate environment. In spite of these temporarily elevated pH values, the pH of Lake Hopatcong through most of the 2007 growing season was within the optimal range for most aquatic organisms.

At the three 319 near-shore sampling stations pH values were generally within the optimal range for most freshwater life. The exception to this was during the 19 June 2007 sampling event when the surface water pH values at the Jefferson and Ingram Cove sampling stations were greater than 12. Such high pH values, in conjunction with the high DO concentrations, measured at the Jefferson and Ingram Cove sampling stations on 19 June 2007, were indicative of extremely high rates of photosynthesis. In addition, large amounts of submerged vegetation and algal mats were observed at both stations during the 19 July 2007 sampling event, approximately one month after the elevated DO concentrations and pH values.

Water Clarity (as measured with a Secchi disk)

Water clarity or transparency, as measured with a Secchi disk, was generally acceptable at all of the sampling stations during the 2007 sampling season. Based on Princeton Hydro’s in-house long-term database of lakes in northern New Jersey, water clarity is considered acceptable for recreational activities when the Secchi depth is equal to or greater than 1.0 m (3.3 ft). Secchi depth measurements throughout almost all of Lake Hopatcong were greater than 1.0 meter in 2007. For example, at the mid-lake sampling station (Station #2), the Secchi depth varied from 1.9 to 2.6 meters (6.2 to 8.5 ft) through the course of the 2007 sampling season. The exception to these acceptable water clarity measurements was the Crescent Cove / River Styx (Station #3) sampling station, where Secchi depth fell below the 1.0 meter threshold during the August sampling event (Figure 2) and the Jefferson Canals (Station #11) sampling station, where Secchi depth fell below the 1.0 meter threshold during the June sampling event (Figure 2).

Of the eleven sampling stations, the Crescent Cove / River Styx (Station #3) sampling station historically tends to have the lowest water clarity and quality, particularly in July and August. During these months, Secchi depths are typically below the 1.0 m threshold. Such conditions were again observed during the 2007 sampling season. Secchi depths at Station #3 averaged 0.9 meters through July and August in 2007. Over this same time period, TSS (total suspended solids) concentrations were moderate (between 8 and 9 mg/L) relative to high chlorophyll-*a* concentrations (between 28.4 and 54.7 mg/m^3). These observed conditions indicate that the sub-optimal July and August Secchi depths at Station #3 were primarily due to algal blooms. Annually, Station #3 has the lowest Secchi depths relative to the other sampling stations of the lake; both algal blooms and excessive densities of aquatic plants typically plague this section of the lake during the summer season. Such unacceptable water quality conditions have directed the watershed-based restoration measures to focus on the portion of the Borough of Hopatcong that directly drains into the Crescent Cove / River Styx section of the lake. Thus, three of the four stormwater BMP projects being implemented under the existing 319 grant, will be installed within the Crescent Cove drainage area.

The 319 near-shore Crescent Cove station's Secchi depth was consistently below the 1.0 meter threshold during the 2007 sampling events. Again, this section of the lake was selected for the installation of the majority of the 319 grant structural BMPs due to its low water quality. The Secchi depth at the near-shore Jefferson station was consistently greater than 2.0 meters. With the exception of the 16 June 2006 sampling event, the Ingram Cove near-shore station also had Secchi depths greater than 1.0 meter and was generally measured to the bottom of the cove.

Ammonia-Nitrogen (NH_4-N)

Surface water NH_4-N concentrations above 0.05 mg/L tend to stimulate elevated rates of algal growth. Over the 2007 monitoring season, surface water NH_4-N concentrations throughout Lake Hopatcong varied between <0.01 mg/L and 0.07 mg/L. All eight (8) of the stations generally had NH_4-N concentrations less than the 0.05 mg/L threshold in 2007. The exception to this was at Station 1 (Woodport Bay) during the 24 May event and at Station 3 (River Styx/Crescent Cove) during the 25 July sampling event.

Bottom water NH_4-N concentrations are monitored seasonally at the mid-lake sampling site (Station #2). The bottom water NH_4-N concentrations remained above the 0.05 mg/L threshold, throughout 2007, ranging from 0.18 mg/L to 1.60 mg/L. Bottom water NH_4-N concentrations are typically elevated during the summer season, as a result of a depletion of dissolved oxygen. 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.

Nitrate-Nitrogen (NO_3-N)

NO_3-N concentrations throughout the 2007 sampling season of Lake Hopatcong varied between <0.02 mg/L and 0.13 mg/L. While there was a considerable amount of variation both among the sampling stations and between sampling events, the NO_3-N concentrations measured in July were considerably lower relative to the June concentrations. Most of the NO_3-N concentrations measured in July were at or below the analytical detection limit of 0.02 mg/L. In contrast, during the June sampling event, the surface water NO_3-N concentrations varied between 0.03 and 0.08 mg/L.

On 28 September 2007, the NO_3-N concentrations at all of the sampling stations were less than or equal to 0.05 mg/L. In 2007, differing from the other water quality parameters, the Station #11 (Jefferson Canals) sampling station consistently had the highest NO_3-N concentrations, including the highest measurement of 2007, 0.13 mg/L. Such elevated NO_3-N concentrations have been measured at Station #11 during previous monitoring events and these historically high concentrations have been attributed to the horizontal movement of leachate from near-shore septic system leachfields.

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, a detailed in the lake's revised TMDL and associated Restoration Plan.

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

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

During the 24 May 2007 sampling event, TP concentrations throughout the lake generally varied between <0.02 mg/L and 0.03 mg/L.

During the 19 June 2007 sampling event, TP concentrations throughout Lake Hopatcong varied between 0.02 mg/L and 0.04 mg/L. Surface water TP concentrations during the 25 July 2007 sampling event were slightly higher when compared to June. During the July 2007 sampling event, the highest TP concentration was at Station #11 (Jefferson Canals), with a concentration of 0.05 mg/L.

During the 23 August 2007 sampling event, TP concentrations in the surface waters were somewhat lower relative to earlier sampling events, generally varying between <0.02 mg/L and 0.12 mg/L, with Station #3 having the highest concentration. Finally, during the 28 September 2007 sampling event, surface water TP concentrations again varied between <0.01 mg/L and 0.11 mg/L.

In general, TP concentrations in Lake Hopatcong were slightly elevated in the spring, highest in mid-summer and generally lower through the late summer, with the exception of Stations#3 and #11. The highest concentrations of TP usually occurred at Station #3 (River Styx/Crescent Cove). As previously identified such elevated TP concentrations in the smaller sections of the lake are a re-occurring condition. The elevated summer TP concentrations at these stations are most likely the result of the land use activities within the surrounding sub-watersheds, as well as the minimal amount of seasonal hydrologic flushing observed in the smaller bays and coves of the lake in 2007. Combined, these factors provide the opportunity for algae and aquatic plants to assimilate available phosphorus and produce the nuisance in-lake conditions typically observed in these portions of the lake.

Similar to 2006, the bottom water TP concentrations at the mid-lake sampling station (Station #2) were minimal during the first half of the growing season, consistently at 0.03 mg/L or less. However, during the 23 August and 28 September 2007 monitoring events, bottom water TP concentrations were 0.13 mg/L and 0.41 mg/L, respectively. (Appendix C). Such elevated TP concentrations in the deep waters are attributed to the establishment of anoxic conditions (DO < 1 mg/L) during the mid to late summer months. The accumulation of such high TP concentrations in the bottom waters were also attributed to the minimal number of storms experienced in the late summer of 2007, which allowed bottom water TP concentration to concentrate and remain in the lake's hypolimnion.

Dry growing seasons tend to strengthen the density difference between the epilimnion and hypolimnion and impede the transport of deep water TP to the surface. This allows for an accumulation of phosphorus in the bottom waters. In contrast, growing seasons that experience large and frequent storm events, such as 2003 and 2004, tend to have weakened thermal stratification, allowing for the transfer of deeper waters to the surface. In turn, bottom water TP concentrations tend to be lower relative to the bottom waters in dry growing seasons. However, this transfer of bottom water TP during "wet" years can fuel the development of algal blooms and surface scums.

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 existing 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.

The average chlorophyll *a* concentrations for May, June, July and September 2007 were below the long-term established mean concentration of 15 mg/m^3. In contrast, the July 2007 mean chlorophyll *a* concentrations was 18.0 mg/m^3, greater than the long-term established of 15 mg/m^3 but less than the long-term maximum seasonal value of 26 mg/m^3. The June 2007 chlorophyll *a* concentrations at Station #11 exceeded the maximum seasonal value of 26 mg/m^3. Also, the July and August 2007 chlorophyll *a* concentrations at Station #3 exceeded the maximum seasonal threshold value of 26 mg/m^3. These elevated chlorophyll *a* concentrations in June, July and August indicate that algal blooms were experienced within specific sections of Lake Hopatcong during the mid-summer season. While the majority of the 2007 concentrations did not attain the 30 mg/m^3 threshold, the measured concentrations in conjunction with some select shoreline observations made during the summer season (for details see below), were indicative of nuisance conditions. These results indicate that efforts must continue in complying with the targeted TP and chlorophyll *a* concentrations for Lake Hopatcong, as established in its TMDL.

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 2007. A bloom of chrysophyte *Dinobryon* was identified on the 24 May 2007 sampling date. This algal group tends to bloom in the spring and can give the water a brown, turbid appearance. Two diatoms (*Melosira* and *Fragilaria*), the green alga *Rhizoclonium* and the cyanobacteria *Oscillatoria* were also identified in the May 2007 sample (Table 1).

No dominant alga was observed during the mid-June 2007 sampling event. A diverse mix of algae was observed during this event, where several green algae (*Staurastrum*, *Bulbochaete*, etc.) and diatoms (*Asterionella*) were observed. Additionally, the chrysophyte *Dinobryon* was once again observed along with the dinoflagellate *Peridinium* and the Euglenoid *Trachelomonas*. The major difference observed between the May and June 2007 sampling events was the appearance of several genera of blue-green algae. These identified blue-green algae included *Coelosphaerium*, *Oscillatoria*, *Anabaena* and *Microcystis*; all four genera are well documented to produce nuisance blooms.

By 24 July 2007 the blue-green alga *Anabaena* and the chrysophyte *Dinobryon* were the dominant algae in Lake Hopatcong. Several other blue-green algae, *Microcystis*, *Coelosphaerium*, *Aphanocapsa* and *Oscillatoria*, were also identified in the lake at this time. A variety of green algae, several diatoms and two genera of dinoflagellates were also identified as well as two genera of chrysophytes.

Total algal densities were relatively high in Lake Hopatcong during the 23 August 2007 sampling event. The dominant alga at this time was the diatom *Tabellaria*, which was observed at bloom like densities. Two other genera of diatoms were also observed at relatively high levels of abundance, *Fragilaria* and *Melosira*, in Lake Hopatcong at this time. Three genera of blue-green algae were also common during this sampling event and included; *Anabaena*, *Pseudoanabaena* and *Microcystis*. Several genera of green algae, the dinoflagellate *Ceratium* and the chrysophyte *Dinobryon* were also identified in the lake.

By 27 September 2007 the dominant algal group shifted from the diatoms to blue-green algae. Specially, the blue-green alga *Anabaena* was the dominant genus in Lake Hopatcong at this time. However, several other blue-green algae were also observed including; *Coelosphaerium*, *Microcystis*, *Lyngbya* and *Pseudoanabaena*. A variety of diatoms and green algae were also identified in the late September 2007 sample as well as the chrysophyte *Dinobryon* (Table 1).

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.

Similar to past monitoring years, the zooplankton community of Lake Hopatcong was dominated by small-bodied cladocerans such as *Bosmina*, several genera of rotifers and/or predaceous copepods such as *Cyclops* through the course of the 2007 monitoring season. These types of zooplankton tend to feed on bacteria, detritus and in some cases other zooplankton. None of the dominant zooplankton were large bodied herbivores; that is, algae is not their primary source of food.

While herbivorous zooplankton were not common in Lake Hopatcong, two herbivorous genera were identified through the 2007 sampling season, which included the cladocerans *Diaphanosoma* and *Ceriodaphnia* (Table 2). Of these zooplankton, *Diaphanosoma* is the most efficient herbivore; this is primarily due to its potential to attain a larger length than *Ceriodaphnia*. The generally low densities of herbivorous zooplankton in Lake Hopatcong observed in 2007 is similar to conditions measured in 2006 as well as during past monitoring years. The relatively low densities of herbivorous zooplankton may indicate that resident zooplankton-eating fishes (i.e. minnows, alewives, young yellow perch, white perch) were heavily grazing on large-bodied zooplankton in 2007.

Table 1
Phytoplankton present in Lake Hopatcong during the 2007 Growing Season

Sampling Date	Phytoplankton
24 May 2007	The dominant algae was the chrysophyte *Dinobryon.* Two diatoms (M*elosira and Fragilaria*), the green alga *Rhizoclonium* and the blue-green alga *Oscillatoria* were also identified.
19 June 2007	No dominant algae was observed however, a variety of green algae, several diatoms, the chrysophyte *Dinobryon*, a dinoflagellate and a euglenoid. In addition several blue-green alga were observed; *Coelosphaerium*, *Oscillatoria*, *Anabaena* and *Microcysti*s.
24 July 2007	The dominant algae were the blue-green algae *Anabaena* and the chrysophyte *Dinobryon*. Other blue-green were identified and included *Microcystis*, *Coelosphaerium*, *Aphanocapsa* and *Oscillatoria.* The sample also included a variety of green algae (*Pediastrum*, *Gloeocystis*, several diatoms (*Melosira*, *Fragilaria*) and several dinoflagellates (*Ceratium*, *Peridinium*).
23 August 2007	Phytoplankton abundance was high where the dominant alga was the diatom *Tabellaria,* where a bloom was observed. Two other diatoms were observed as well as several green algae (*Pediastrum*, S*taurastrum*) the dinoflagellate *Ceratium* and the chrysophyte *Dinobryon* were identified in the sample. Several blue-green algae were also observed including *Anabaena*, *Pseudoanabaena* and *Microcystis*.
28 September 2006	The dominant algae observed was the blue-green *Anabaena*, which was observed at bloom like densities. Other blue-green algae observed included *Coelosphaerium*, *Microcystis*, *Lyngbya* and *Pseudoanabaena*. Several diatoms and green algae were also present as well as the chrysophyte *Dinobryon*.

Table 2
Zooplankton present in Lake Hopatcong
during the 2007 Growing Season

Sampling Date	Zooplankton
24 May 2007	The dominant zooplankton observed were the small-bodied cladoceran *Bosmina* and the rotifer *Asplanchna*. The predatory copepod (*Cyclops*) and juveniles (known as nauplii) were also found in the sample. In addition, other rotifers (*Keratella*, *Conochilus*) were also identified and the cladoceran *Chydorus*.
19 June 2007	The small-bodied cladoceran *Bosmina* was the dominant zooplankter. Several rotifers (*Trichocera*, *Kellicottia, Polyarthra, etc.*) and an herbivorous zooplankton (the cladocerans C*eriodaphnia*) were also identified in the sample. In addition, the predaceous copepod *Cyclops* was observed as well as juvenile nauplii.
25 July 2007	Zooplankton abundance was low at this time with no one genus being the dominant zooplankter. Several rotifers were observed including *Conochilus* and *Asplanchna*. The herbivorous cladoceran *Ceriodaphnia* was observed as was *Cyclops* and juvenile nauplii.
23 August 2007	Zooplankton abundance was relatively high during this time where the cladoceran *Bosmina* was the dominant zooplankter. Two herbivorous cladoceran (*Ceriodaphnia*, *Diaphanosoma*) were also observed, where *Ceriodaphnia* was commonly seen. The rotifers *Asplanchna*, and *Polyarthra* were also observed as were *Cyclops* and nauplii.
28 September 2007	Zooplankton abundance was relatively low with no one genus being the dominant zooplankter. The copepod *Cyclops* was observed as well as juvenile nauplii. Two cladoceran *Ceriodaphnia* (herbivore) and *Bosmina* were identified in the sample. The rest of the identified zooplankton were rotifers (*Keratella* and, *Asplanchna*).

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 2007 temperature and DO data for Lake Hopatcong were examined to identify the presence of optimal and acceptable brown trout habitat. As with previously monitoring reports, this analysis focused solely 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.

In May 2007 optimal brown trout habitat was identified from the surface to a depth of 13 meters (42.6 feet) in Lake Hopatcong (Appendix B). By 19 June 2007, the optimal brown trout habitat was found from the surface to a depth of 7 meters (23 feet).

By 24 July 2007, carry over brown trout habitat was found between the surface and 5 meters (16.5 feet). However, by 23 August 2007, the carry over brown trout habitat zone slightly increased from the surface to a depth of 7 meters (23 feet). By late September optimal brown trout habitat returned and was distributed from the surface to a depth of 7 meters (23 feet). Based on these data varying levels of acceptable brown trout habitat persisted through the entire 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 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 of 2006 and 2007, approximately 6-8% of the total phosphorus load targeted for reduction under the established TMDL is removed through the mechanical weed harvesting program.

During the 2007 growing season the Lake Hopatcong Commission's Operation Staff removed a total of 1,600 tons of aquatic vegetation from Lake Hopatcong. This roughly equates to 3.2 million pounds of wet plant biomass removed from the lake. Since 2005 the amount of plant material removed from the lake has increased, which is the result of increased harvesting efficiencies and milder winters resulting in higher densities of submerged vegetation.

Using the results of the 2006 plant biomass / phosphorus study, it was estimated that the 2007 mechanical weed harvesting program removed 571 lbs (259 kg) of total phosphorus from the lake. This accounted for approximately 7.8% of the amount of phosphorus targeted for removal under the lake's established TMDL. If this removed phosphorus was utilized by filamentous and planktonic algae, it would have the potential to generate approximately 628,000 lbs of wet algae biomass. Thus, the mechanical harvesting program of Lake Hopatcong contributes toward improving the water quality of the lake, as well as removing nuisance densities of submerged vegetation.

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 2007. The annual mean values for Station #2 were graphed, along with the long-term, “running mean” for the lake.

The mean 2007 Secchi depth at Station #2 was 2.3 meters, which revealed the second consecutive annual increase in Secchi depth recorded at Lake Hopatcong since 2002 (Figure 3). While the mean Secchi depth was above the 1.0-meter threshold for recreational waterbodies, it was the still not as high as some previous mean values measured at Lake Hopatcong. The lowest mean Secchi depth value at Lake Hopatcong was 1.6 meters, measured in both 1994 and 1997.

Similar to 2005 and 2006, the first half of the 2007 growing season experienced a high frequency of storm events, followed by extremely dry and hot conditions during the later half of the season. Thus, the lack of storms in the second half of the 2007 growing season allowed nutrients that entered the lake via the spring and early summer storms to remain “in place” and not be flushed from the lake. In turn, the elevated phosphorus load and lower seasonal flushing rate stimulated algal and plant growth.

Based on Princeton Hydro’s in-house database, Secchi depths greater than 1 m (3.3 ft) are considered acceptable for recreational waterbodies; Secchi depths less than 1 m are perceived as “dirty” or “cloudy” to the layperson. Thus, while the 2007 mean Secchi depth was lower than what has been measured in previous years (i.e. 2001-2002), Lake Hopatcong’s mid-lake water clarity again remained acceptable in terms of recreational use.

One of the major factors responsible for the observed water clarity of a lake is the amount of algal biomass in the water; the less algae in the water, the higher the water clarity. An effective way of quantifying algae biomass is to measure the amount of chlorophyll *a* in the water. Chlorophyll *a* is a photosynthetic pigment all algae possess, so measuring chlorophyll *a* provides a measurement of the amount of algae biomass in the open waters of a lake.

The increase in mean Secchi depth in 2007 correlated well with the relatively lower mean chlorophyll *a* concentration than had been previously observed in 2006. The 2007 annual mean chlorophyll *a* concentration for Station #2 was 9.5 mg/m^3 (Figure 4). While the 2007 chlorophyll *a* mean was slightly lower than the 2006 mean, it is still an elevated concentration since the long-term monitoring program was initiated in the early 1990’s (Figure 4). Elevated amounts of algal biomass in Lake Hopatcong can be attributed to an increase in phosphorus loading, coupled with a reduced flushing rate late in the growing season. Such conditions emphasize the need for watershed-based control measured to reduce the existing phosphorus loads entering Lake Hopatcong.

While the 2007 mean chlorophyll *a* concentration was relatively elevated, it was still below the 30 mg/m^3 threshold, when laypeople perceive water quality problems (i.e. algal blooms) in terms of recreational use. Neither the 2007 chlorophyll *a* mean, nor any of the actual concentrations measured at the mid-lake station (Station #2) were equal to or greater than 30 mg/m^3. However, some single chlorophyll *a* measurements, specifically at Station #3 and Station #11 during the mid-summer months, did exceed the 30 mg/m^3 threshold.

For most waterbodies in the northeastern portion of the United States, phosphorus is the primary nutrient limiting algal growth. This means that higher amounts of phosphorus entering a lake or pond, typically translates into more algae being produced. Past studies have demonstrated that phosphorus is the primary limiting nutrient for algae in Lake Hopatcong.

The 2007 annual mean TP concentration was again 0.022 mg/L, and was generally consistent with the 2005 and 2006 means (Figure 5). While the 2007 TP mean was again the second highest measured in Lake Hopatcong over the last six years (Figure 5), it is a relatively low concentration. The low mean TP concentration in 2007, relative to the slightly elevated chlorophyll *a* concentration and lower Secchi depth mean values, indicates that the algae at Station #2 may have originated from other sections of the lake (i.e. near shore) and were transported to the mid-lake area through wind and wave action. Similar observations were made in 2004 - 2006 and based on its proximity, it is more than likely that the River Styx / Crescent Cove section of the lake is the origin of a least a portion of the algae found in the mid-lake section.

Stormwater Monitoring Program

A total of two qualifying, pre-installation, stormwater sampling events were conducted in 2006 as part of the Commission's existing 319 grant. An additional two stormwater sampling events were conducted from July – September 2007. The composited stormwater samples were analyzed for SRP, TDP, TP and TSS.

The degree of variability of the stormwater water quality results was considerably larger than those measured during the 2007 baseline tributary monitoring program (Appendix C). For the 2007 pre-installation stormwater data, SRP concentrations varied between 0.024 and 0.055 mg/L, TDP concentrations varied between 0.04 and 0.09 mg/L, TP concentrations varied between 0.05 and 0.18 mg/L, and TSS concentrations varied between < 3 and 41 mg/L. These results indicate, as was expected, that the majority of the watershed-based phosphorus and TSS pollutant loads entering Lake Hopatcong originate from stormwater.

Based on other watershed studies, the majority (> 80%) of phosphorus in stormwater tends to be adsorbed onto sediment particles. However, based on the results of the Lake Hopatcong stormwater monitoring program, particulate phosphorus (i.e. adsorbed onto sediment particles) accounted for between 0 to 50% of the total phosphorus in the stormwater. The one exception to this was the Jefferson stormwater sampling station, where 86% of the total phosphorus was in a particulate form during the 13 December 2006 sampling event.

The pre-installation stormwater results indicate that conventional basins that rely on removing the bulk of stormwater phosphorus through settling will not be highly efficient. Given the fact that for the most part, the majority of the stormwater phosphorus entering Lake Hopatcong is in a dissolved form, structural Best Management Practices (BMPs) that include mechanisms to remove this fraction of phosphorus should be installed. Indeed, this is why the three larger BMPs that will be installed as part of the 319 grant are Aqua-Filters, which include filter media that remove dissolved forms of phosphorus from the incoming stormwater.

The two Aqua-Filters proposed for installation in the Borough of Hopatcong, as well as a bioretention swale, are scheduled for installation in the spring of 2008, while the Aqua-Filter proposed for installation in the Township of Jefferson is tentatively scheduled to be installed in the fall of 2008.

4.0 SUMMARY

This report documents the findings of the 2007 Lake Hopatcong water quality monitoring program. This section provides a summary of the 2007 water quality conditions, as well as recommendations on how to preserve the highly valued aquatic resources of Lake Hopatcong.

1. Based on the 2007 water quality database, and similar to past monitoring years, the water quality conditions of Lake Hopatcong were generally consistent with those of a meso- to slightly eutrophic ecosystem.

2. Lake Hopatcong was thermally stratified from mid-June through late-September 2007. The strength of this thermal stratification was strongest during July and August.

3. Overall, the surface waters (to approximately 5 meters) of Lake Hopatcong remained well oxygenated (dissolved oxygen concentrations > 4 mg/L) throughout the monitoring season. An anoxic zone (waters with DO concentrations less than 1 mg/L) developed along the lake's bottom by mid-June. This is in contrast to some of the previous monitoring years, when anoxic is typically first detected in May. By late July, this layer of anoxic water had reached a depth of 6 meters from the surface.

4. 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 <0.01 mg/L and 0.11 mg/L, consisting of concentrations both above and below the 0.06 mg/L bloom threshold. Station #3 (River Styx/Crescent Cove) typically displayed the highest TP concentrations as the summer months progressed.

5. While the chlorophyll *a* concentrations were not excessive at the mid-lake sampling station, other sections of the lake experienced nuisance algal blooms. As is typical each year, Station #3 (Crescent Cove / River Styx) experienced nuisance algal blooms through the summer months. Station #11 (Jefferson Canals) also experienced similar algal blooms, although more sporadic than Station #3.

6. Based on the *in-situ* conditions, carry over <u>brown trout</u> habitat was available throughout the entire 2007 growing season. Such results are consistent with those measured in previous monitoring years at Lake Hopatcong.

7. The annual average Secchi depth at the mid-lake sampling station was 2.3 meters. While this Secchi depth mean represents another increase since 2006 and is acceptable for a recreational waterbody, it is still one of the lowest mean values in Lake Hopatcong since 1997.

8. Similar to Secchi depth, the average chlorophyll *a* concentration for 2007 was acceptable for a recreational waterbody, however, relative to past monitoring years, it was one of the higher values measured in Lake Hopatcong. This elevated average chlorophyll *a* concentration was attributed to an elevated phosphorus load as a result of the high frequency of storm events early in the growing season, followed by relatively dry and hot conditions experienced during the later half of the growing season.

9. Approximately 1,600 tons of aquatic plant biomass was removed in 2007, an approximately 20% increase relative to the amount of plant biomass removed in 2006. The mechanical weed-harvesting program increases the recreational and ecological value of Lake Hopatcong, as well as removes a phosphorus source from the lake. Thus, this in-lake management technique should continue to be used at Lake Hopatcong.

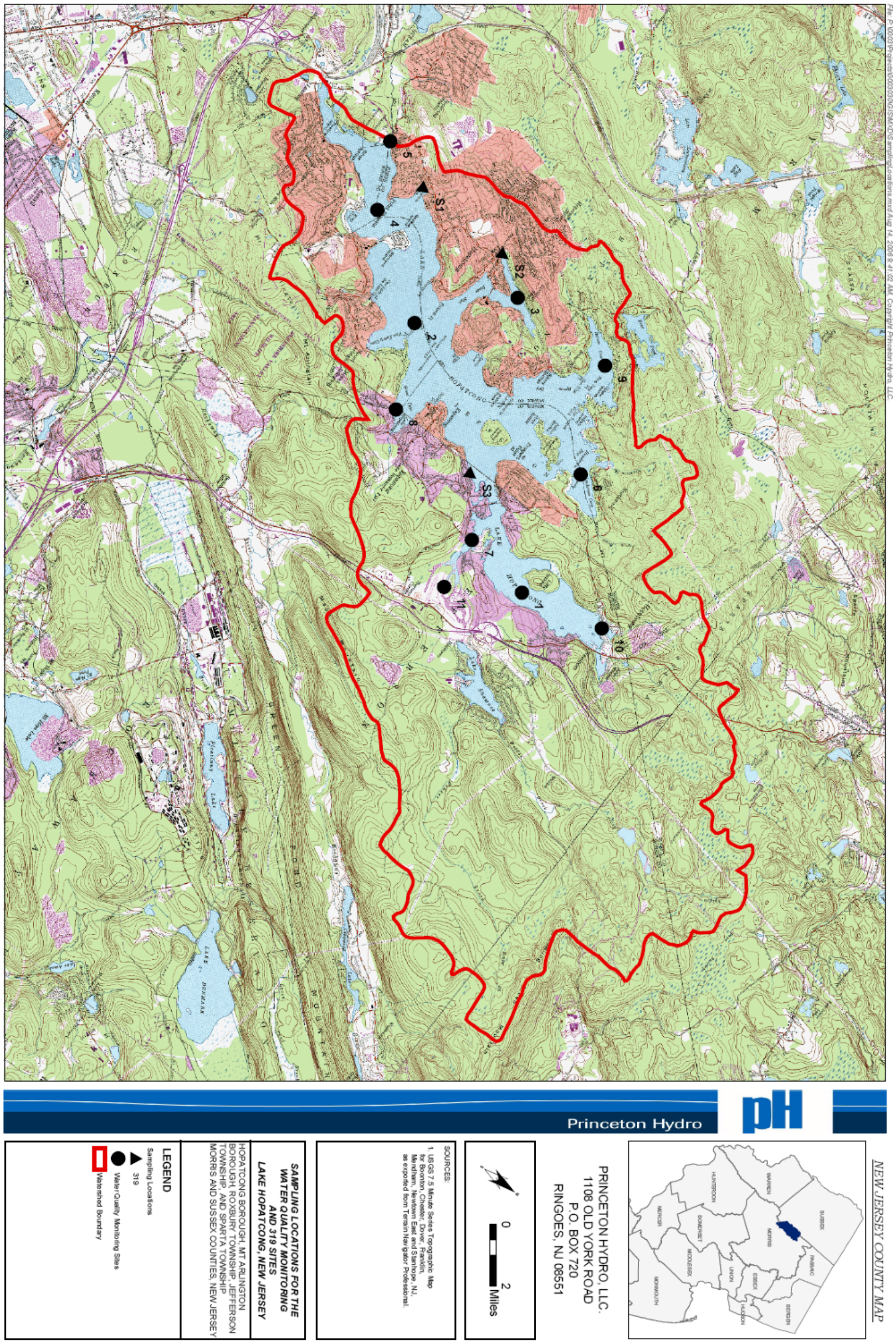
10. The 2006 aquatic plant-biomass TP study revealed that the plants appear to have more phosphorus per unit weight early in the growing season relative to later. In addition, based on the 2006 and 2007 aquatic plant database, approximately 6 to 8% of the TP load targeted for removal under the TMDL was removed through the mechanical weed harvesting program per year.

11. Baseline tributary concentrations of the various phosphorus species and TSS were generally low in Lake Hopatcong. The results of the tributary monitoring program indicates that baseline flow accounts for a minor portion of the phosphorus and TSS loads entering Lake Hopatcong.

12. Pre-installation stormwater phosphorus (SRP, TDP and TP) and TSS concentrations collected as part of the 319 grant were variable. In addition, a substantial fraction of the measured phosphorus in the monitored stormwater was in a dissolved form. These results indicate that BMPs that include mechanisms to reduce dissolved, as well as particulate, forms of phosphorus are required to substantially reduce the total phosphorus loads entering Lake Hopatcong.

APPENDIX A

FIGURES


S1
S2
S3
1
2
3
4
5
6
7
8
9
10
11
Princeton Hydro
pH
LEGEND
Sampling Locations
319
Water Quality Monitoring Sites
Watershed Boundary
SAMPLING LOCATIONS FOR THE WATER QUALITY MONITORING AND 319 SITES
LAKE HOPATCONG, NEW JERSEY
HOPATCONG BOROUGH, MT ARLINGTON BOROUGH, ROXBURY TOWNSHIP, JEFFERSON TOWNSHIP, AND SPARTA TOWNSHIP
MORRIS AND SUSSEX COUNTIES, NEW JERSEY
SOURCES:
1. USGS 7.5 Minute Series Topographic Map for Boonton, Chester, Dover, Franklin, Mendham, Newtown East and Stanhope, NJ, as exported from Terrain Navigator Professional.
0
2
Miles
PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
NEW JERSEY COUNTY MAP
HUNTERDON
WARREN
SUSSEX
MERCER
SOMERSET
MORRIS
PASSAIC
MIDDLESEX
UNION
ESSEX
MONMOUTH
HUDSON
BERGEN

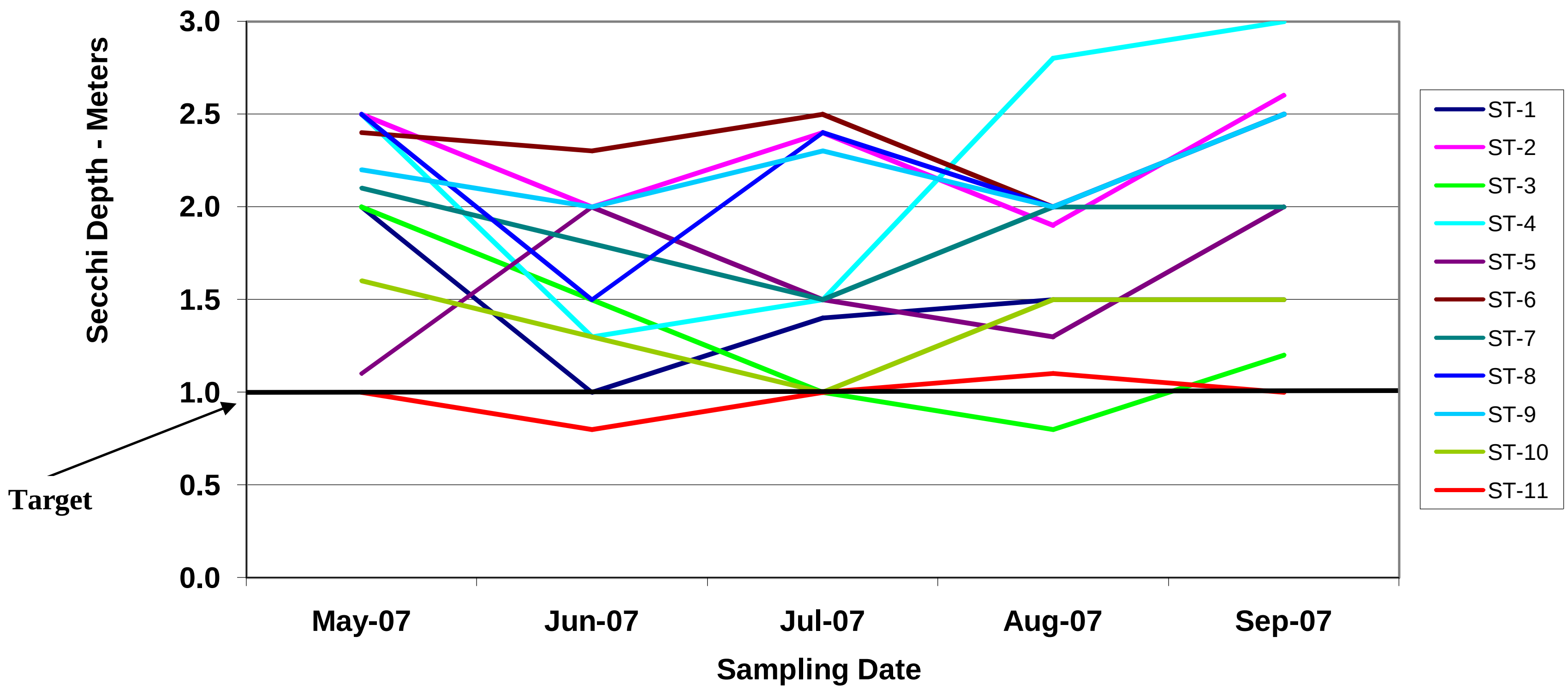


Figure 2 - Lake Hopatcong (ST-2) 2007 Secchi depth values

Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551

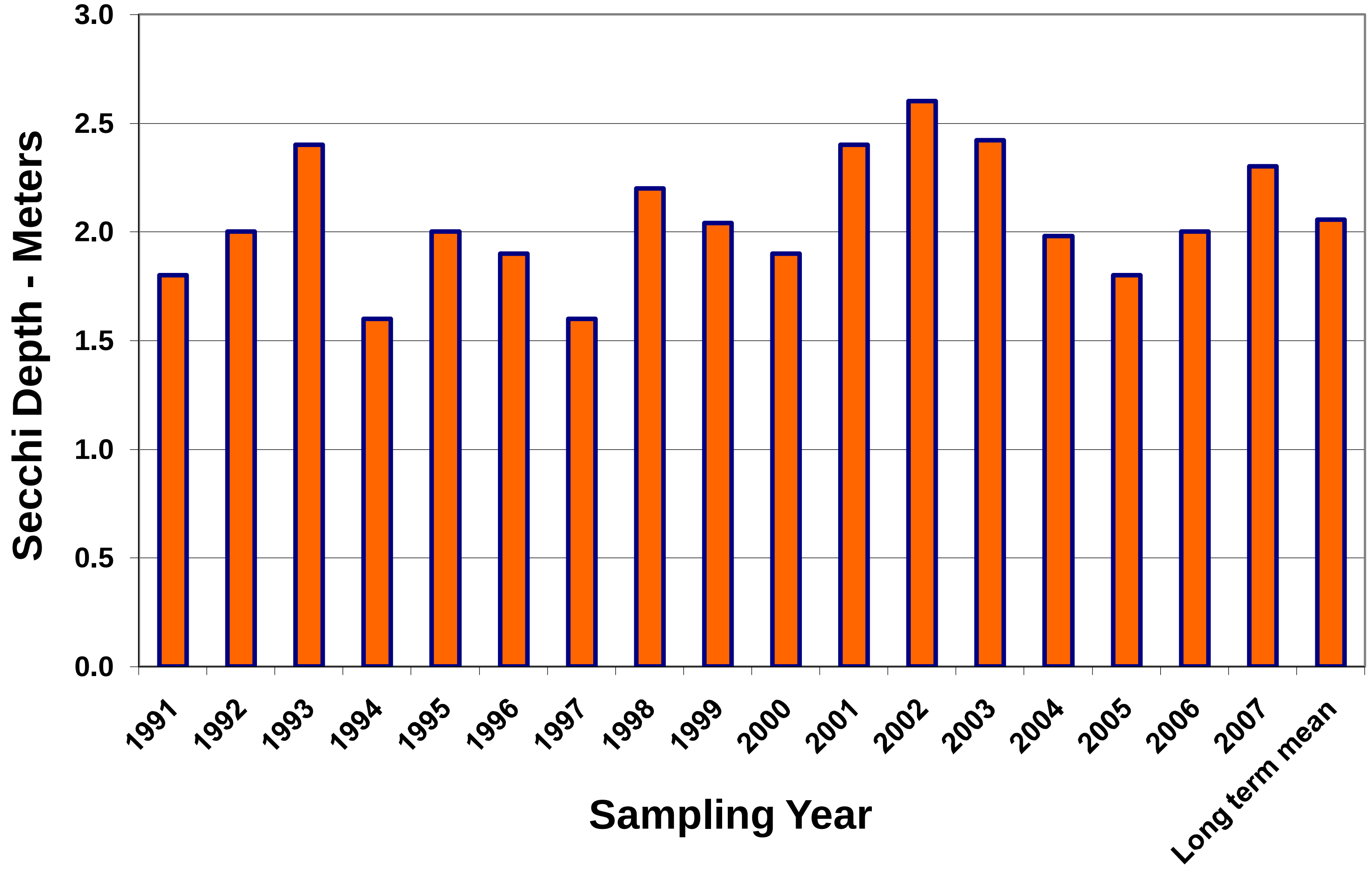


Figure 3 - Lake Hopatcong Long Term Secchi Depth Values at Station #2

pH
Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551

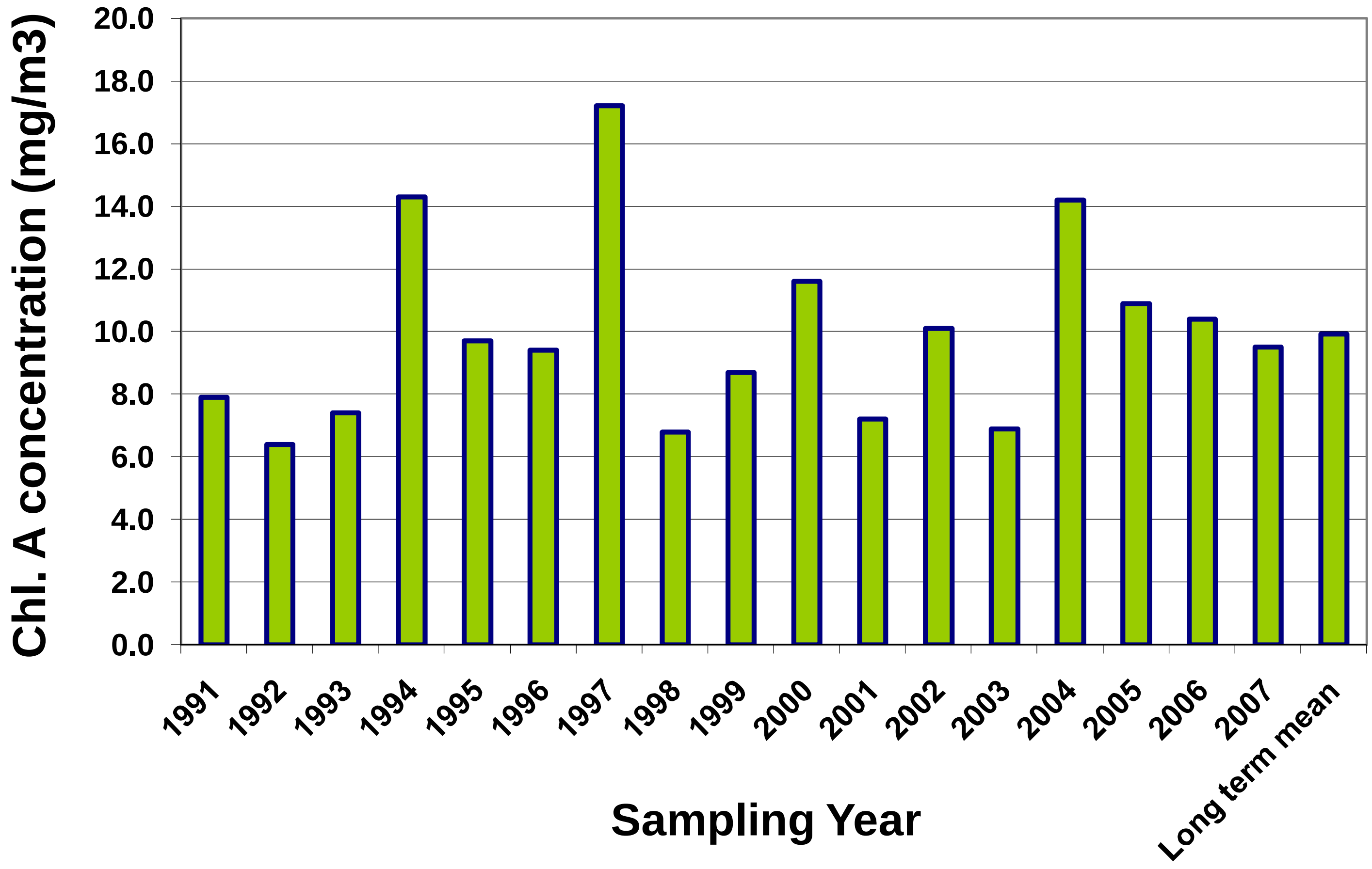


Figure 4 - Lake Hopatcong Long Term Chl A concentrations at Station #2

pH

Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551

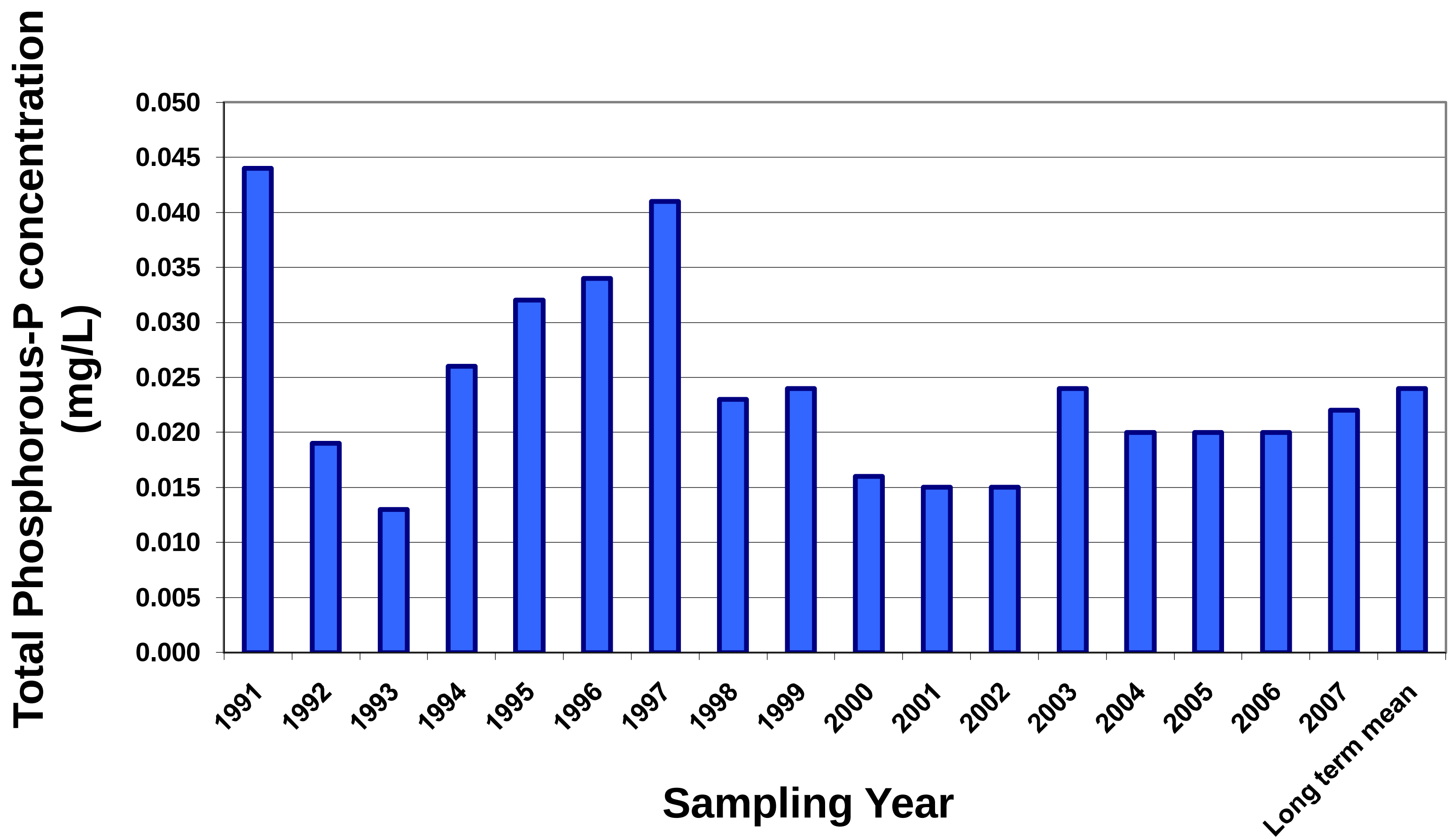
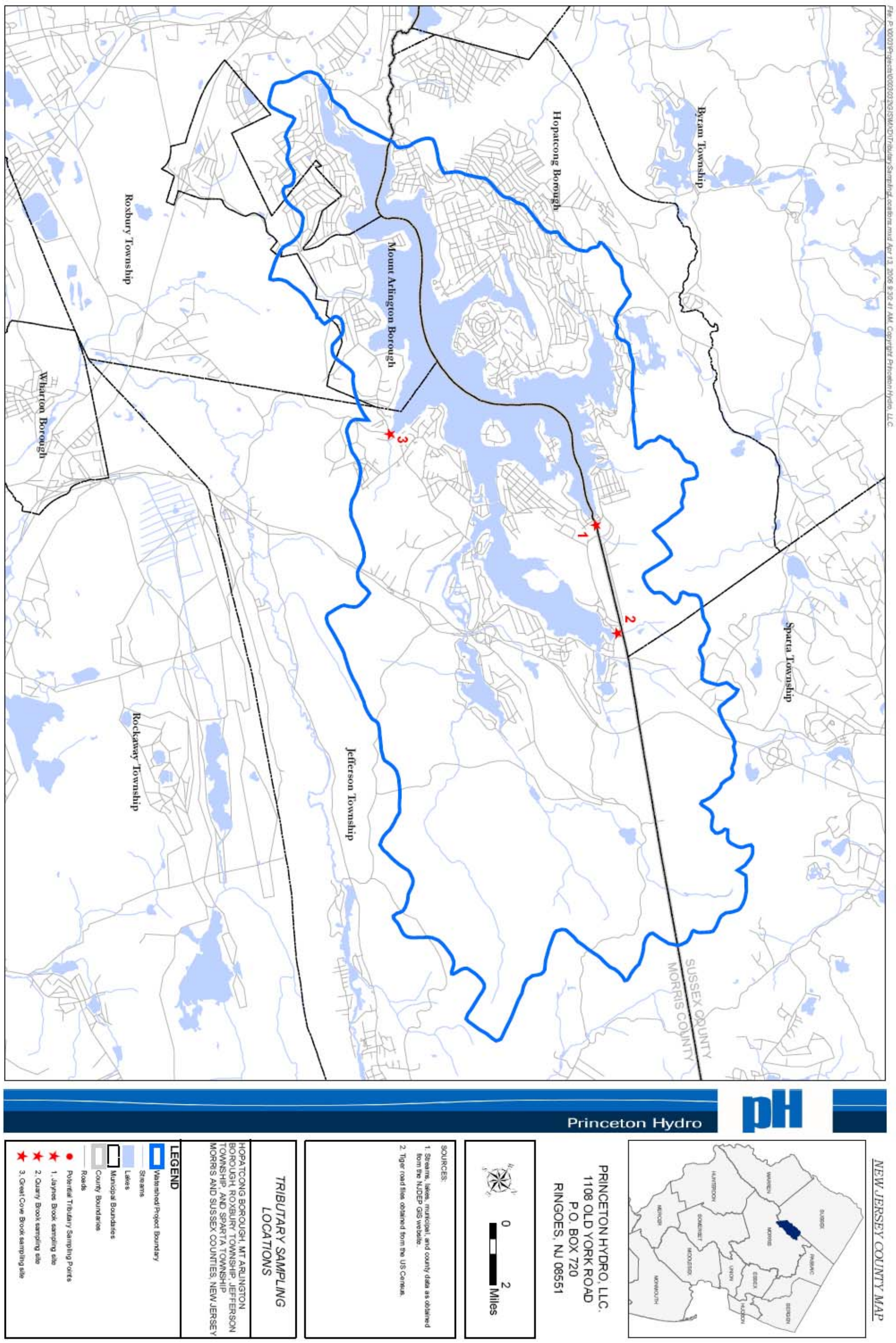


Figure 5 - Lake Hopatcong Long Term TP concentrations at Station #2

Princeton Hydro, L.L.C.
1108 Old York Road
Ringoes, N. J. 08551


Byram Township
Hopatcong Borough
Roxbury Township
Mount Arlington Borough
Wharton Borough
Sparta Township
Rockaway Township
Jefferson Township
SUSSEX COUNTY
MORRIS COUNTY
Princeton Hydro
pH
NEW JERSEY COUNTY MAP
PRINCETON HYDRO, LLC
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
0
2
Miles
SOURCES:
1. Streams, lakes, municipal, and county data as obtained from the NJDEP GIS website.
2. Tiger road files obtained from the US Census.
TRIBUTARY SAMPLING LOCATIONS
HOPATCONG BOROUGH, MT ARLINGTON BOROUGH, ROXBURY TOWNSHIP, JEFFERSON TOWNSHIP, AND SPARTA TOWNSHIP
MORRIS AND SUSSEX COUNTIES, NEW JERSEY
LEGEND
Watershed/Project Boundary
Streams
Lakes
Municipal Boundaries
County Boundaries
Roads
Potential Tributary Sampling Points
1. Jaynes Brook sampling site
2. Quarry Brook sampling site
3. Great Cove Brook sampling site

Princeton Hydro

SITE 1: CRESCENT COVE AQUAFILTER
SITE 2: BELL AVENUE AQUAFILTER
SITE 3: DUPONT BIORETENTION SWALE

BOROUGH OF HOPATCONG
SUSSEX COUNTY, NEW JERSEY

Legend

Project Site

0 240 feet
1 inch equals 240 feet

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

SOURCES:

1. New Jersey 2002 High Resolution Orthophotography obtained from the New Jersey Image Warehouse.

NEW JERSEY COUNTY MAP

File: P:\0003\Projects\0003030\GIS\MXD\Sites_1 through 3_082106.mxd Aug 21, 2006 10:00:04 AM, Copyright Princeton Hydro, LLC


McNabb Road
Spring Road
Castle Rock Road
Site 4:
Castle Rock Road
Princeton Hydro
pH
SITE 4: CASTLE ROCK ROAD
TOWNSHIP OF JEFFERSON
MORRIS COUNTY, NEW JERSEY
PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
SOURCES:
1. New Jersey 2002 High Resolution Orthophotography obtained from the New Jersey Image Warehouse.
NEW JERSEY COUNTY MAP
SUSSEX
PASSAIC
BERGEN
WARREN
MORRIS
ESSEX
HUDSON
UNION
HUNTERDON
SOMERSET
MIDDLESEX
MERCER
MONMOUTH
Legend
Project Site
0
240
feet
1 inch equals 240 feet

APPENDIX B

IN-SITU DATA

In-Situ Monitoring for Lake Hopatcong 5/24/07

Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(units)
ST-1	**2**	**2**	**Surface**	20.87	0.304	9.9	8.82
			1.0	20.78	0.303	9.74	8.75
			2.0	19.01	0.304	10.12	8.57
ST-2	**14.5**	**2.5**	**Surface**	18.19	0.332	10.1	7.75
			1.0	18.07	0.333	10	7.79
			2.0	17.52	0.332	10.08	7.79
			3.0	17.18	0.332	10.11	7.78
			4.0	16.69	0.331	9.99	7.74
			5.0	16.63	0.332	9.86	7.72
			6.0	16.34	0.33	9.69	7.71
			7.0	14.41	0.329	9.63	7.74
			8.0	12.06	0.327	9.09	7.57
			9.0	10.34	0.327	8.69	7.5
			10.0	9.41	0.328	8.21	7.51
			11.0	9.13	0.329	7.32	7.58
			12.0	8.75	0.329	6.7	7.73
			13.0	8.5	0.33	6.26	7.76
			14.0	8.32	0.369	5.03	7.78
ST-3	**2**	**2**	**Surface**	22.41	0.391	10.12	9.02
			1.0	19.95	0.384	11.85	9.12
			2.0	18.39	0.395	9.83	8.25
ST-4	**2.75**	**2.5**	**Surface**	18.78	0.34	10.51	8.77
			1.0	18.72	0.34	10.72	8.77
			2.0	18.33	0.34	10.61	8.58
			2.5	17.4	0.336	9.66	8.25
ST-5	**1.1**	**1.1**	**Surface**	20.54	0.343	9.99	8.54
			1.0	18.92	0.339	12.19	8.92
ST-6	**2.4**	**2.4**	**Surface**	20.41	0.333	10.5	8.85
			1.0	20.36	0.333	10.58	8.91
			2.0	18.67	0.331	9.89	8.4
ST-7	**2.1**	**2.1**	**Surface**	21.28	0.241	9.3	7.65
			1.0	21.23	0.24	9.15	7.65
			2.0	19.21	0.241	9.54	7.58
ST-8	**8**	**2.5**	**Surface**	18.95	0.333	9.86	7.78
			1.0	18.72	0.333	9.81	7.76
			2.0	18.5	0.333	9.86	7.75
			3.0	18.39	0.333	9.87	7.76
			4.0	18.31	0.333	9.73	7.75
			5.0	17.83	0.332	9.69	7.71
			6.0	15.45	0.33	9.65	7.6
			7.0	14.13	0.332	7.09	7.63
ST-9	**8**	**2.2**	**Surface**	18.93	0.334	10.32	8.06
			1.0	18.75	0.334	10.22	8.05
			2.0	17.85	0.332	10.24	7.98
			3.0	17.49	0.332	10.11	8.02
			4.0	17.19	0.331	10.09	8.04
			5.0	16.29	0.331	9.73	8.04
			6.0	15.21	0.33	9.71	8.04
			7.0	12.8	0.33	8.78	7.98
			8.0	11.47	0.333	7.13	7.96
ST-10	**1.6**	**1.6**	**Surface**	22.02	0.32	10.88	9.09
			1.0	20.49	0.317	11.7	9.26
			1.5	20.23	0.321	11.52	9.17
ST-11	**1**	**1**	**Surface**	21.91	0.185	10.53	8.44
			1.0	19.71	0.186	10.15	8.3

In-Situ Monitoring for Lake Hopatcong 6/19/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
ST-1	**2**	**1**	**Surface**	25.7	0.318	8.35	6.9
			1.0	25.6	0.319	8.38	7
			2.0	24.67	0.321	8.3	7.05
ST-2	**14**	**2**	**Surface**	24.08	0.342	9.01	8.79
			1.0	23.87	0.341	9.05	8.7
			2.0	23.5	0.34	9.19	8.7
			3.0	23.09	0.339	9.12	8.56
			4.0	22.23	0.338	8.83	8.39
			5.0	20.95	0.336	7.85	8.19
			6.0	18.86	0.332	6.52	7.94
			7.0	15.46	0.329	5.02	7.81
			8.0	13.04	0.329	4.31	7.85
			9.0	11.22	0.329	3.83	7.95
			10.0	10.46	0.329	3.55	8.09
			11.0	9.91	0.329	3.2	8.23
			12.0	9.37	0.33	2.83	8.31
			13.0	8.96	0.334	2.02	8.3
			14.0	8.72	0.36	1.19	8.36
ST-3	**2**	**1.5**	**Surface**	26.76	0.471	8.96	x
			1.0	25.78	0.435	9.39	x
			2.0	23.65	0.467	7.52	x
ST-4	**3**	**1.3**	**Surface**	24.46	0.353	7.99	7.62
			1.0	24.4	0.353	8.03	7.61
			2.0	23.94	0.348	8.02	7.58
			3.0	22.74	0.342	6.01	7.46
ST-5	**2**	**2**	**Surface**	24.91	0.36	7.65	6.89
			1.0	24.74	0.359	7.74	7.17
			2.0	24.61	0.36	7.41	7.26
ST-6	**2.5**	**2.3**	**Surface**	26.02	0.341	8.85	7.91
			1.0	25.94	0.341	8.9	7.92
			2.0	25.26	0.342	8.91	7.87
			2.5	24.91	0.344	8.35	7.83
ST-7	**2**	**1.8**	**Surface**	27.01	0.296	8.68	8.13
			1.0	25.19	0.297	8.96	8.03
			2.0	23.9	0.295	8.4	7.8
ST-8	**7**	**1.5**	**Surface**	24.88	0.341	9.02	7.81
			1.0	24.52	0.341	9.15	7.85
			2.0	24.09	0.342	9.31	7.95
			3.0	23.69	0.338	9.43	7.93
			4.0	23.01	0.338	8.52	7.74
			5.0	21.8	0.336	8.42	7.6
			6.0	17.71	0.333	6.76	7.31
			7.0	13.83	0.33	5.35	7.12
ST-9	**8**	**2**	**Surface**	25.59	0.34	9.35	8.83
			1.0	24.58	0.339	9.55	
			2.0	24.35	0.339	9.6	8.87
			3.0	24.03	0.339	9.63	8.86
			4.0	23.41	0.338	9.75	
			5.0	22.94	0.338	9.52	8.82
			6.0	20	0.335	8.67	
			7.0	15.38	0.332	5.92	8.62
			8.0	13.05	0.34	3.41	8.48
ST-10	**1.5**	**1.3**	**Surface**	26.2	0.327	9.94	x
			1.0	26.06	0.337	11.7	x
ST-11	**1.1**	**0.8**	**Surface**	24.84	0.256	8.83	8.08
			1.0	23.97	0.255	8.44	7.95

x = probe damaged

In-Situ Monitoring for Lake Hopatcong 7/24/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
ST-1	**2.2**	**1.4**	**Surface**	24.64	0.315	8.81	7.22
			1.0	24.18	0.309	9.03	8.08
			2.0	23.6	0.302	10.33	8.26
ST-2	**12.5**	**2.4**	**Surface**	24.3	0.332	7.88	7.63
			1.0	24.26	0.332	7.88	7.62
			2.0	24.2	0.331	7.82	7.61
			3.0	23.79	0.327	7.81	7.57
			4.0	23.18	0.323	7.55	7.51
			5.0	22.96	0.32	6.46	7.38
			6.0	21.73	0.312	5.51	7.29
			7.0	15.18	0.271	0.27	7.19
			8.0	13.73	0.259	0.34	7.23
			9.0	11.37	0.245	0.4	7.29
			10.0	10.35	0.243	0.49	7.32
			11.0	9.62	0.242	0.56	7.34
			12.0	9.42	0.275	0.77	7.21
ST-3	**1.5**	**1**	**Surface**	22.4	0.771	6.05	7.23
			1.0	21.81	0.351	6.47	7.33
ST-4	**2.5**	**1.5**	**Surface**	22.6	0.318	7.49	7.26
			1.0	22.29	0.315	7.27	7.39
			1.5	21.98	0.313	7.31	7.31
			2.0	21.93	0.312	6.86	7.42
ST-5	**3.5**	**1.5**	**Surface**	22.8	0.323	7.24	7.19
			1.0	22.55	0.321	7.2	7.21
			2.0	22.41	0.319	7.03	7.23
			3.0	22.55	0.319	6.94	7.26
			3.5	22.33	0.319	7.25	7.33
ST-6	**2.5**	**2.5**	**Surface**	23.52	0.319	7.21	7.25
			1.0	23.27	0.313	7.21	7.29
			2.0	22.53	0.311	7.84	7.33
ST-7	**1.5**	**1.5**	**Surface**	21.83	0.222	7.67	6.95
			1.0	21.73	0.242	7.62	6.9
			1.5	21.4	0.235	9.11	6.83
ST-8	**4.5**	**2.4**	**Surface**	24.4	0.331	8.18	7.72
			1.0	24.3	0.33	8.21	7.73
			2.0	24.13	0.329	8.27	7.74
			3.0	23.88	0.327	8.4	7.75
			4.0	23.78	0.327	8.5	7.76
ST-9	**7**	**2.3**	**Surface**	23.81	0.327	7.37	7.21
			1.0	23.76	0.326	7.38	7.21
			2.0	23.73	0.326	7.37	7.2
			3.0	23.32	0.323	7.32	7.18
			4.0	23.07	0.322	6.81	7.15
			5.0	22.84	0.321	5.91	7.14
			6.0	22.42	0.318	5.19	7.18
			7.0	16.42	0.293	0.37	6.98
ST-10	**1**	**1**	**Surface**	21.84	0.384	11.76	8.69
			1.0	20.43	0.425	16.71	8.77
ST-11	**1**	**1**	**Surface**	22.54	0.165	8.08	6.9
			1.0	21.54	0.187	7.5	6.85

In-Situ Monitoring for Lake Hopatcong 8/23/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
ST-1	**2**	**1.5**	**Surface**	20.22	0.323	8.68	7.84
			1.0	19.51	0.317	8.39	7.66
			2.0	19.08	0.311	8.22	7.62
ST-2	**13.5**	**1.9**	**Surface**	21.16	0.341	7.52	7.71
			1.0	21.16	0.341	7.44	7.73
			2.0	21.14	0.341	7.31	7.7
			3.0	21.12	0.341	7.14	7.65
			4.0	21.12	0.341	7	7.6
			5.0	21.12	0.342	6.98	7.56
			6.0	21.12	0.342	6.97	7.52
			7.0	21.01	0.342	5.9	7.5
			8.0	19.15	0.343	3	7.42
			9.0	15.92	0.351	<1.0	7.3
			10.0	13.45	0.353	<1.0	7.16
			11.0	12.1	0.355	<1.0	7
			12.0	10.75	0.36	<1.0	6.9
			13.0	9.93	0.373	<1.0	6.81
			13.5	9.72	0.38	<1.0	6.72
ST-3	**2.1**	**0.8**	**Surface**	19.95	0.386	9.37	7.95
			1.0	19.02	0.42	8.57	7.88
			2.0	18.78	0.463	5.6	7.64
ST-4	**3.1**	**2.8**	**Surface**	20.18	0.341	8.82	7.78
			1.0	20.12	0.341	7.88	7.74
			2.0	19.45	0.337	7.4	7.71
			3.0	19.43	0.339	7.37	7.66
ST-5	**1.3**	**1.3**	**Surface**	19.57	0.338	8.06	7.78
			1.0	19.47	0.339	8	7.76
ST-6	**2.5**	**2**	**Surface**	21.37	0.34	8.55	7.79
			1.0	21.24	0.34	8.4	7.68
			2.0	19.4	0.336	8.84	7.69
ST-7	**2**	**2**	**Surface**	18.44	0.244	6.8	7.95
			1.0	17.94	0.249	5.9	7.59
			2.0	17.72	0.251	5.5	7.41
ST-8	**8.1**	**2**	**Surface**	21.1	0.339	7.53	7.68
			1.0	21.06	0.34	7.31	7.69
			2.0	21.02	0.339	7.15	7.67
			3.0	21	0.34	6.94	7.6
			4.0	20.98	0.339	6.87	7.56
			5.0	20.96	0.34	6.79	7.52
			6.0	20.93	0.341	6.78	7.5
			7.0	20.88	0.34	6.71	7.46
			8.0	20.24	0.345	5.6	7.46
ST-9	**7.2**	**2**	**Surface**	21.21	0.342	7.75	7.82
			1.0	21	0.343	7.52	7.72
			2.0	20.95	0.343	7.1	7.64
			3.0	20.91	0.343	7.01	7.59
			4.0	20.9	0.343	6.86	7.54
			5.0	20.89	0.342	6.8	7.51
			6.0	20.88	0.343	6.72	7.44
			7.0	20.82	0.343	6.68	7.41
ST-10	**1.5**	**1.5**	**Surface**	20.5	0.328	8.39	7.78
			1.0	20.25	0.33	8.43	7.69
ST-11	**1.1**	**1.1**	**Surface**	18.25	0.206	7.76	8
			1.0	18.08	0.211	7.57	7.71

In-Situ Monitoring for Lake Hopatcong 9/28/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(units)**	**(mg/L)**
ST-1	**2**	**1.5**	**Surface**	22.92	0.334	8.23	10.28
			1.0	22.68	0.334	7.99	10.33
			2.0	21.9	0.336	7.83	10.27
ST-2	**13.7**	**2.6**	**Surface**	21.94	0.343	8.1	8.65
			1.0	21.97	0.343	8.04	8.7
			2.0	21.5	0.343	8.04	8.84
			3.0	21.35	0.343	7.96	8.76
			4.0	21.09	0.342	7.8	8.43
			5.0	20.96	0.342	7.67	8.1
			6.0	20.74	0.342	7.58	7.87
			7.0	20.55	0.342	7.47	7.21
			8.0	19.58	0.34	7.14	3.39
			9.0	17.56	0.345	6.95	1.46
			10.0	14.23	0.351	7.01	1.19
			11.0	12.07	0.355	7.11	1.13
			12.0	10.75	0.365	7.16	1.2
			13.0	10.2	0.375	7.24	1.24
			13.5	10.02	0.39	7.27	2.04
ST-3	**2**	**1.2**	**Surface**	23.84	0.414	8.64	10.8
			1.0	23.21	0.406	8.56	11.18
			2.0	22.04	0.411	7.68	8.22
ST-4	**3**	**3**	**Surface**	22.26	0.347	9.2	9.69
			1.0	22.17	0.347	9.03	9.59
			2.0	21.12	0.344	8.18	8.06
			3.0	20.97	0.343	7.75	7.34
ST-5	**3**	**2**	**Surface**	22.63	0.347	8.9	9.44
			1.0	22.44	0.345	9.07	10.13
			2.0	22.26	0.345	9.01	9.89
			3.0	22.18	0.345	8.95	9.51
ST-6	**2.5**	**2.5**	**Surface**	23.84	0.345	8.53	10.93
			1.0	23.72	0.346	8.62	11.12
			2.0	22.82	0.347	8.69	11.52
ST-7	**2**	**2**	**Surface**	23.15	0.344	7.8	9.93
			1.0	22.86	0.344	7.57	9.63
ST-8	**7.5**	**2.5**	**Surface**	22.7	0.346	8.06	9.61
			1.0	22.33	0.344	8.06	9.76
			2.0	21.94	0.343	8	9.76
			3.0	21.2	0.342	7.86	9.57
			4.0	20.94	0.342	7.71	9.09
			5.0	20.73	0.342	7.6	8.66
			6.0	20.52	0.341	7.44	7.97
			7.0	20.37	0.342	7.29	6.91
ST-9	**7.6**	**2.5**	**Surface**	23.15	0.343	8.44	10.63
			1.0	22.82	0.343	8.44	10.91
			2.0	22.44	0.343	8.44	11.02
			3.0	22.07	0.342	8.34	10.95
			4.0	21.96	0.342	8.24	10.8
			5.0	21.39	0.342	8.09	10.75
			6.0	20.96	0.341	7.85	10.04
			7.0	20.39	0.341	7.5	7.66
ST-10	**1.5**	**1.5**	**Surface**	23.66	0.346	8.63	11.27
			1.0	23.64	0.345	8.58	11.1
ST-11	**1**	**1**	**Surface**	21.84	0.349	7.59	8.77
			1.0	21.73	0.346	7.36	8.52

In-Situ Monitoring for Hopatcong 319 Stations 5/24/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
Crescent Cove	**2**	**1.5**	**Surface**	22.02	0.698	10.64	8.64
			1.00	19.69	0.639	12.75	9.09
			2.00	19.62	0.654	13.38	9.16
Jefferson	**3.1**	**2.3**	**Surface**	21.24	0.32	9.37	8.34
			1.00	20.62	0.319	9.48	8.3
			2.00	19.33	0.32	9.46	8.14
			3.00	18.33	0.324	9.33	8.08

In-Situ Monitoring for Hopatcong 319 Stations 6/19/07							
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(units)
Crescent Cove	1.5	0.9	Surface	26.26	0.555	7.56	6.56
			1.00	25.04	0.536	7.8	6.7
			2.00	24.65	0.541	7.19	6.74
Jefferson	3.8	2.3	Surface	26.46	0.327	9.13	11.25
			1.00	26.27	0.327	8.92	12.21
			2.00	23.24	0.327	8.07	8.21
			3.00	21.52	0.332	4.14	7.87
Ingram Cove	1.4	1.4	Surface	25.09	0.355	9.46	12.54
			1.00	24.8	0.35	10.14	10.96
			1.40	24.69	0.353	8.28	12.73

In-Situ Monitoring for Hopatcong 319 Stations 7/24/07							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
Crescent Cove	**1.5**	**1**	**Surface**	21.29	0.336	8.8	7.65
			1.00	19.7	0.362	8.41	7.63
Jefferson	**1**	**1**	**Surface**	24.04	0.312	9.23	7.82
			1.00	24.08	0.312	8.76	7.69
Ingram Cove	**1.5**	**1.5**	**Surface**	23.08	0.318	7	7.08
			1.00	21.28	0.293	7.2	7.07
			1.50	21.07	0.293	6.14	7.1

In-Situ Monitoring for Hopatcong 319 Stations 8/23/07							
Station	DEPTH (meters)			Temperature	Conductivity	Dissolved Oxygen	pH
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(mg/L)	(units)
Crescent Cove	1.5	0.3	Surface	19.25	0.445	10.54	8.39
			1.00	18.73	0.449	11.39	8.53
Jefferson	3.5	2.5	Surface	19.25	0.274	7.21	7.72
			1.00	19.05	0.272	6.68	7.64
			2.00	18.96	0.275	6.57	7.52
			3.00	18.95	0.275	5.8	7.49
Ingram Cove	1.3	1.3	Surface	20.12	0.343	8.8	7.81
			1.00	18.53	0.399	10.09	7.73

In-Situ Monitoring for Hopatcong 319 Stations 9/28/07							
Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(mmhos/cm)	(units)	(mg/L)
Crescent Cove	1.2	0.9	Surface	23.15	0.424	8.4	10.76
			1.00	22.19	0.431	8.1	10.6
Jefferson	2.8	2.5	Surface	23.58	0.336	7.78	8.85
			1.00	23.08	0.335	7.6	8.52
			2.00	21.85	0.332	7.54	8.65
			2.50	21.53	0.333	7.31	7.16
Ingram Cove	1.5	1.5	Surface	22.39	0.365	9.32	10.24
			1.00	21.87	0.356	8.9	9.66

APPENDIX C

WATER QUALITY DATA

HOPATCONG
24-May-2007

STATION	Chlorophyll *a*	NH3-N	NO3-N	TP	TSS
ST-1	5.2	0.08	0.08	0.02	ND <3
ST-2	4.9	0.05	0.04	ND <0.02	4
ST-3	2.6	0.05	0.04	ND <0.02	ND <3
ST-4	2.0	0.05	0.03	ND <0.02	ND <3
ST-5	3.3	0.05	0.03	ND <0.02	3
ST-6	4.3	0.05	0.02	ND <0.02	5
ST-7	2.6	0.05	0.04	0.03	4
ST-10	4.6	0.05	0.03	0.03	5
ST-11	4.2	0.05	0.05	0.02	ND <3
ST-2 DEEP					
MEAN	3.7	0.05	0.04	0.03	4.2

HOPATCONG
19-Jun-07

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	11.1	0.04	0.06	0.03	9
ST-2	5.5	0.02	0.02	0.02	ND <3
ST-3	3.9	0.07	0.08	0.02	ND <3
ST-4	6.9	0.03	0.03	0.02	ND <3
ST-5	5	0.02	0.03	0.02	ND <3
ST-6	3.4	ND <0.01	ND <0.02	0.02	4
ST-7	4.2	ND <0.01	0.04	0.02	ND <3
ST-10	18.1	0.01	0.03	0.03	ND <3
ST-11	38.7	ND <0.01	0.07	0.04	8
ST-2 DEEP		0.24	0.08	0.02	3
MEAN	10.8	0.06	0.05	0.02	6.0

HOPATCONG
25-Jul-07

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	14.3	0.01	ND <0.02	0.04	ND <3
ST-2	7.8	0.03	ND <0.02	0.03	ND <3
ST-3	28.4	0.23	0.04	0.04	8
ST-4	11.6	0.03	ND <0.02	0.01	7
ST-5	14.6	0.02	ND <0.02	0.02	7
ST-6	7.8	0.13	ND <0.02	ND <0.01	3
ST-7	4.3	0.11	0.08	0.02	ND <3
ST-10	12	0.03	0.04	0.01	3
ST-11	14	0.13	0.09	0.05	8
ST-2 DEEP		0.23	0.02	ND <0.01	7
MEAN	12.8	0.10	0.05	0.03	6.1

HOPATCONG
23-Aug-07

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	15.6	ND <0.01	0.03	0.02	3
ST-2	21.9	0.02	ND <0.02	0.02	3
ST-3	54.7	0.02	0.04	0.04	9
ST-4	13.8	0.02	ND <0.02	0.02	<3
ST-5	15.1	0.02	0.03	0.02	3
ST-6	10.4	0.02	ND <0.02	0.02	3
ST-7	2.4	0.06	0.08	0.02	ND <3
ST-10	15.4	0.02	ND <0.02	0.02	3
ST-11	12.9	0.02	0.12	0.02	3
ST-2 DEEP		0.18	0.10	0.13	7
MEAN	18.0	0.04	0.07	0.03	4.3

HOPATCONG
27-Sep-07

STATION	CHL A	NH3-N	NO3-N	TP	TSS
ST-1	6.6	0.02	0.05	0.03	3
ST-2	7.5	0.03	ND <0.02	0.03	3
ST-3	16.5	0.03	0.04	0.04	6
ST-4	4	0.04	ND <0.02	0.02	3
ST-5	5.7	0.03	0.05	0.11	ND <3
ST-6	5.7	0.03	0.03	0.03	ND <3
ST-7	4.2	0.03	0.03	0.04	ND <3
ST-10	6.7	0.02	0.03	0.06	4
ST-11	6	0.02	0.04	0.03	ND <3
ST-2 DEEP		1.60	0.13	0.41	11
MEAN	7.0	0.19	0.05	0.08	5.0

HOPATCONG TRIBUTARYS BASELINE SAMPLING

5/8/2007

SPL ID	SRP	TDP	TP	TSS
QUARRY BROOK #2	0.008	ND <0.01	0.03	ND <3
JAYNES BROOK #1	0.004	ND <0.01	0.02	ND <3
GREAT COVE #3	0.009	0.02	0.3	ND <3
FD			0.04	
RB-S9				ND <3

9/6/2007

SPL ID	SRP	TDP	TP	TSS
QUARRY BROOK #2	0.008	0.02	0.03	6
JAYNES BROOK #1	0.012	0.02	0.03	3
GREAT COVE #3	0.011	0.02	0.03	4
FD		0.04		
RB-S9	0.012			

9/27/2007

SPL ID	SRP	TDP	TP	TSS
QUARRY BROOK #2	0.008	0.02	0.13	21
JAYNES BROOK #1				
GREAT COVE #3	0.012	0.02	0.04	16
FD	0.011			
RB-S9				ND <3

HOPATCONG TRIBUTARYS STORMWATER SAMPLING

7/23/2007

Station	SRP	TDP	TP	TSS
ID #1	0.054	0.08	0.17	41
ID#2	0.037	0.05	0.08	3
ID #3	0.024	0.04	0.05	6
ID #4	0.049	0.06	0.18	37
FD			0.09	
S9-RB				ND <3

9/11/2007

SPL ID	SRP	TDP	TP	TSS
#4 CASTLE ROCK	0.03	0.04	0.18	30
#1 CRESCENT COVE	0.034	0.04	0.05	ND <3
#3 DUPONT AVE	0.055	0.09	0.13	13
#2 BELL AVE	0.038	0.06	0.08	ND <3
FD				ND <3
RB				ND <3

319 Sampling

5/24/2007

Station	TP	TSS
Crescent Cove	0.04	6
Jefferson	0.01	ND <3
Ingram Cove	NS	NS

6/19/2007

Station	TP	TSS
Crescent Cove	0.06	6
Jefferson	0.02	ND <3
Ingram Cove	0.02	ND <3

7/24/2007

Station	TP	TSS
Crescent Cove	0.06	7
Jefferson	0.02	3
Ingram Cove	0.02	ND <3

7/24/2007 **INGRAM COVE PLANT MATERIAL**

METAL	MG/KG (DRY)
Aluminum	90.1
Arsenic	ND <2.3
Barium	22.7
Cadmium	ND <0.29
Chromium	ND <1.2
Lead	ND <2.0
Mercury	ND <0.052
Selenium	ND <3.1
Silver	ND <1.0

8/23/2007

Station	TP	TSS
Crescent Cove	0.08	11
Jefferson	0.02	ND <3
Ingram Cove	0.02	3

9/27/2007

Station	TP	TSS
Crescent Cove	0.05	3
Jefferson	0.02	ND <3
Ingram Cove	0.02	ND <3