# Lake Sagamore – 2014 Water Quality and Macrophyte Survey

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## Contents

## Executive Summary

Princeton Hydro conducted a single water quality monitoring event and aquatic plant survey of Lake Sagamore on 21 August 2014. Data collected from this event showed low phosphorus concentrations, high water clarity, and low aquatic plant growth. As such, water quality conditions were excellent for the 2014 season in relation to usages of swimming, boating and general aesthetics.

In a historical sense, water quality conditions in the past few years have been as good as ever. Transparency remains high, phosphorus concentrations are low and aquatic plant growth has been controlled, in large part, due to the restocking of the lake with sterile grass carp. Water quality data collected in 2014 was very similar to that measured in 2013. Plant growth during the 2014 season showed a small uptick compared to the non-existent plant growth in 2013. Very small amounts of chara (*Chara* sp.), a macroalgae, and thin-leaf pondweed (*Potamogeton pusillus*) were identified in 2014.

Continued monitoring, on an annual basis, should be continued in order to continue to track any changes in key lake parameters and to collect the data necessary to pursue state permits should additional carp stocking be necessary.

## 1.0 Lake Sagamore – Historic and Pertinent Water Quality Data

Lake Sagamore is an approximately 110 acre waterbody located in the town of Kent, Putnam County, New York. Created in 1947, the lake is an impoundment of numerous small streams and serves not only as the focal point of the community but as a critical source of drinking water for New York City via Boyds Corner Reservoir. Princeton Hydro has served as the lake manager for the lake for numerous years. In this capacity we routinely collect pertinent water quality data and use this data to make informed decisions regarding management measures.

As a lake manager it is necessary to take into account all of the various uses of the lake in designing a sampling program and in using this data to properly manage the waterbody. The question arises, what are the primary uses of the lake and what type of data should we collect in order to provide for informed management decisions that have a tangible impact on improving the lake?

For Lake Sagamore we look at upholding appropriate conditions for swimming, boating and general aesthetics while maintaining water quality for consumptive end use. As such, it is necessary to ensure that the lake does not suffer from high levels of nutrients, such as phosphorus, nitrogen and sediment, which will lead to high levels of plant and algae growth. It should be noted that every lake has nutrients, they are necessary for a healthy lake, but, excessive nutrients are commonly related to things we can control and will create lake poor lake conditions.

We have historically tracked total phosphorus in Lake Sagamore as increases in phosphorus lead to increases in plant and algae growth. Increases in this nutrient are commonly associated with watershed sources such as improper stormwater management, improperly designed and maintained septic systems, excessive densities of waterfowl and lack of shoreline buffers. Historic phosphorus concentrations at Lake Sagamore are as follows:

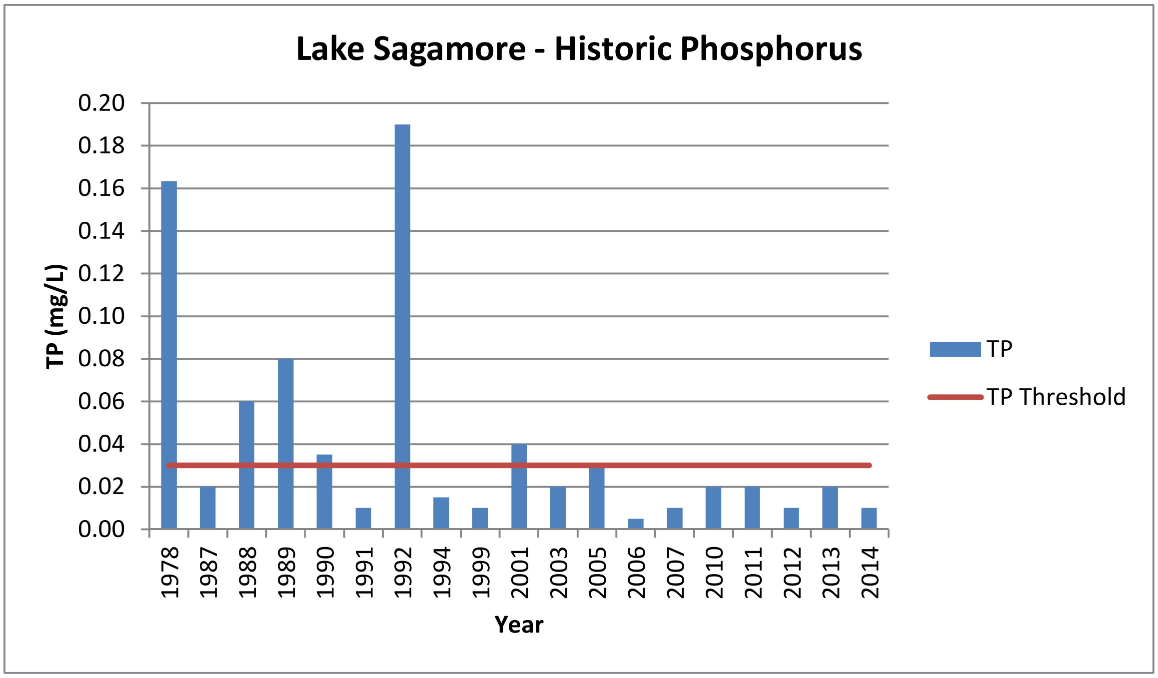


**Figure 1.1: Historic TP Concentrations at Lake Sagamore**

The above figure shows that, for the most part, total phosphorus concentrations in Lake Sagamore are well below the threshold established by Princeton Hydro of 0.03 mg/L. The exceptions to this were spikes in TP which occurred in 1978 and 1992. New York State water quality guidelines are narrative in nature for phosphorus, that is, phosphorus should not be present in concentrations that lead to growths of algae and plants that will impair waters for their best usages. We have found that concentrations above 0.03 mg/L tend to lead to these aforementioned conditions. Phosphorus concentrations are low in Lake Sagamore primarily because of the relatively undisturbed nature of the watershed. We will discuss how to keep this trend going later in this document.

Another parameter we look at is Secchi disk transparency. This is simply a measure of the clarity of the water and is determined through the lowering of a Secchi disk throughout the water column until it is just barely visible. Secchi depth is important in Lake Sagamore because increases in planktonic algae, due to excessive nutrients, will cause a reduction in clarity and indicates declining water quality conditions related to swimming and aesthetics. Conversely, high transparency will indicate good water quality but also means that ample light is reaching the lake bottom thereby promoting plant growth. Generally, Secchi depths greater than 1.0 m are indicative of acceptable water clarity while depths of 2.0 m and greater are ideal for swimming. Historical Secchi depth from Lake Sagamore is presented below.

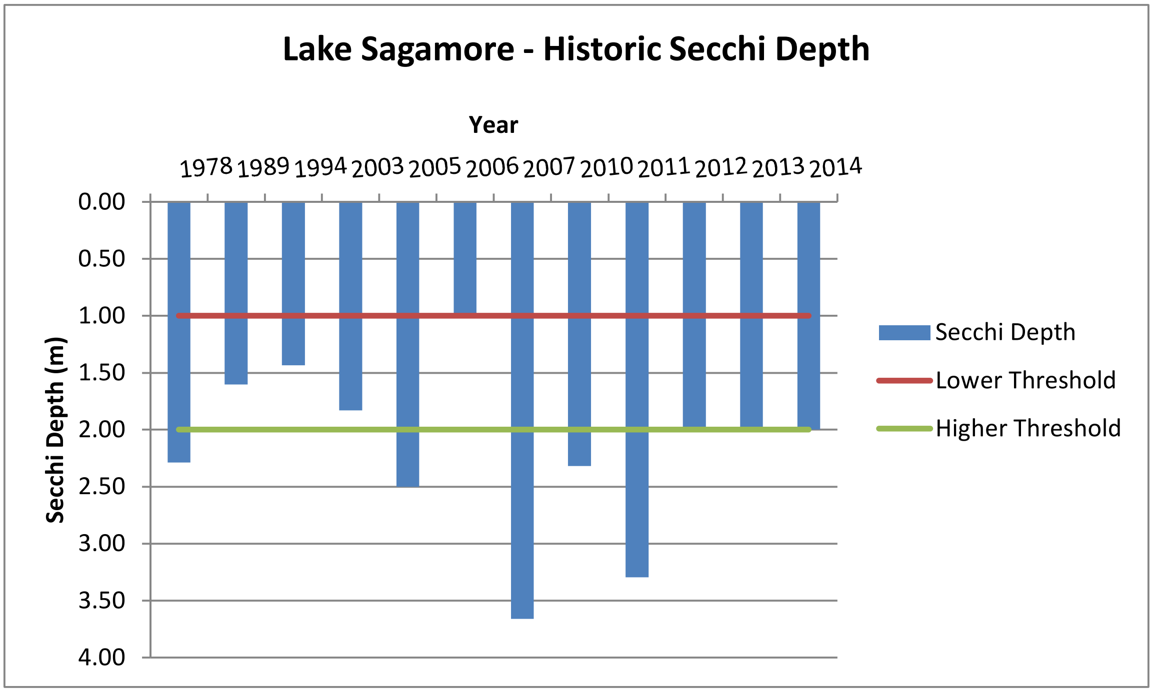


**Figure 1.2: Historic Secchi Depth at Lake Sagamore**

Secchi depth at Lake Sagamore has been equal to or greater than the lower threshold of 1.0 m throughout the entire historical dataset and depths have been greater than the higher threshold of 2.0 m in 1978, 2005 and 2007-2011. More recently, transparency has hovered around 2.0 m thereby indicating excellent conditions for swimming. As previously mentioned, high Secchi depth is great for swimming conditions and optimal aesthetics but it means that ample light can reach the sediments. Such conditions are suitable for heavy growth of aquatic plants. The following data provides a glimpse at the amount of plant growth observed throughout Lake Sagamore during the historical monitoring period.

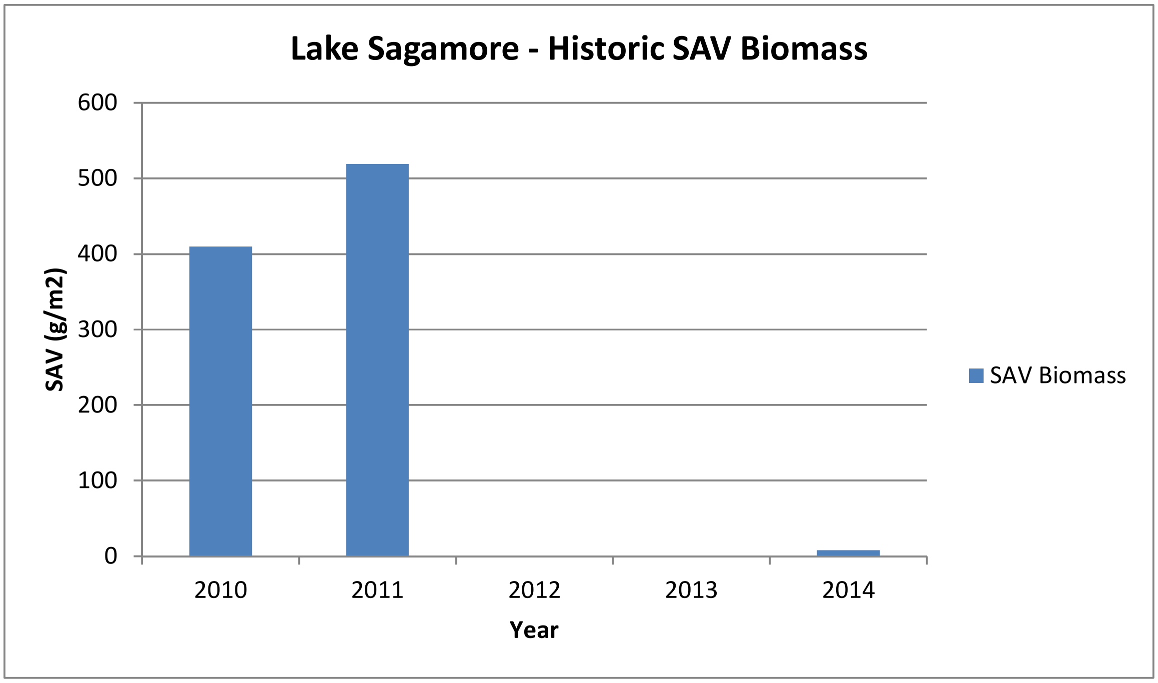


**Figure 1.3: Historic Plant Densities at Lake Sagamore**

A review of Princeton Hydro's quantitative SAV dataset in conjunction with information provided by the Lake Sagamore Community Association has shown that the lake suffered from elevated densities of pondweeds from 2001-2003. This plant growth was subsequently cleared due to the addition of sterile grass carp with low plant growth noted from 2005-2006. Subsequently, bladderwort became the dominant plant with increasing growth in 2010-2011. Additional grass carp stocking has brought weed densities to zero during the 2013 season. A very slight increase, to 8 g/m$^2$, was measured during the 2014 season. At this time there is not problematic plant growth in the lake.

The continued monitoring of SAV has documented changes not only in the densities of plants in the lake but also in the species. This data has proved invaluable in terms of providing the scientific data necessary to secure state permits for the addition of sterile grass carp which have served as the primary management measure in maintaining Lake Sagamore as a community resource.

## 2.0 Recommendations for Maintaining the Quality of Lake Sagamore

The review of the historic data in section 1 has shown that Lake Sagamore is in excellent condition for its designated uses. Phosphorus concentrations are low while transparency is high and nuisance plant growth is minimal. The following section will touch briefly on what the community can do to ensure the lake is in as good or better condition for future generations.

The focus for maintaining acceptable lake water quality will be on making sure excessive nutrients do not enter the lake from the watershed. There are many things a homeowner can do to facilitate this goal. The following provides a very brief synopsis of basic steps a homeowner can make to ensure excellent lake quality.

### Septic System Management

Septic systems at lakefront homes may contribute excessive phosphorus to lakes due to site constraints, proximity to the seasonal water table and improper maintenance. Simple measures such as water conservation practices and routine system pump outs (approximately every 3 years) can go a long way to maintaining properly functioning septic systems that will not contribute phosphorus or fecal coliforms to the lake.

### Shoreline Buffers

Establishment or maintenance of an area of native plants and grasses in an approximately 100 foot buffer along the lake shore can enhance nutrient filtering all while increasing vital habitat for the lakes inhabitants. Creating such a buffer can help to intercept sediment and phosphorus before it flows into the lake thereby helping to reduce nutrient pollution. Furthermore, this shoreline habitat is crucial in a properly functioning aquatic ecosystem.

### Fertilizer Management

Applications of lawn fertilizers and other lawn chemicals may directly run into the lake when it rains. Before conducting any fertilizer applications take a soil sample and determine what nutrients are necessary for a healthy growing lawn. These services are often offered at low or no cost through the local soil and conservation service or agricultural extension. Many companies are now offering phosphorus free fertilizers that are becoming ever popular in lake communities. To tell if the fertilizer you are using is phosphorus free, look at the N-P-K ratio, this tells you how much nitrogen – phosphorus – potassium is in the fertilizer. A ‘zero’ in the middle will indicate you have found a lake-friendly (phosphorus free) fertilizer.

### Salt Management

The basic principal behind salt management is the same as fertilizer management. Any salt applied to asphalt for ice control will be transported to the lake once the snow melts. Increasing lake salinity will then result along with changes to the ecosystem. Reduce the amount of salt that is used or utilize alternative agents such as cindering.

### Impervious Area and Stormwater Management

Increases in impervious areas, such as driveways and roofs, serves to alter the way water flows in a watershed. Increased impervious areas in a watershed reduce percolation while increasing the speed of the water entering the lake thereby increasing its potential for erosion. This basically translates to increased nutrient transport to the lake and such conditions have caused the decline of numerous waterbodies throughout the region and the country.

Some basic things the community can do to combat these conditions is to limit future development of impervious areas and capture the rainwater that is running off current parcels of impervious areas. This can be done through the implementation of rain barrels which are simply barrels placed at the end of downspouts that collect stormwater before it enters the lake. The collected water can be utilized on-site for watering plants and flowers. Also, the community can install rain gardens. Rain gardens are basically gardens that are strategically placed to intercept stormwater. The vegetation in a rain garden serves to slow the flow of water and in doing so phosphorus and sediments to settle out of the stormwater before it enters the lake.

All of the aforementioned measures may seem like relatively minor steps but can, if taken in conjunction, serve to uphold the water quality of the lake and may actually serve to cause noticeable improvements.

## 3.0 Summary of 2014 Water Quality and Plant Data

Princeton Hydro collected water quality and macrophyte data at Lake Sagamore on 21 August 2014. Stations were consistent with those in the past. Specifically, water quality data was collected at two in-lake stations; L2 (near the dam) and L3 (south end of lake). Macrophyte data was collected at five 20’ intervals along five transects throughout the lake (Appendix II).

*In-situ* data was collected through the use of a calibrated Hach MS5 meter which was utilized to measure temperature, dissolved oxygen, specific conductance, pH and chlorophyll *a* at 1.0 m increments throughout the water column. Discrete water samples were collected at L2 and L3 and analyzed for nutrients which are pertinent to lake management. Specifically, those parameters were total phosphorus, soluble reactive phosphorus, chlorophyll *a*, ammonia, nitrate and total suspended solids. Environmental Compliance Monitoring of Hillsborough, NJ conducted the analysis. In addition, phytoplankton and zooplankton samples were collected and analyzed by Princeton Hydro.

***In-situ***

*In-situ* data showed the lake to be slightly thermally stratified at L2 during sampling with temperatures ranging from 24.54°C in the surface to 20.22°C at the bottom. Thermal stratification is a normal phenomenon in lakes during the summer months whereby the surface waters are warmer than the deep waters. A direct result of thermal stratification is the stratification of dissolved oxygen. This was the case in Lake Sagamore with dissolved oxygen ranging from a minimum of 0.0 mg/L (0.0%) at the bottom to 8.11 mg/L (97.4%) at the surface. Dissolved oxygen was greater than the New York threshold of 4.0 mg/L from the surface to 2.0 m. Oxygen was below this standard from 3.0 m to the bottom. pH values ranged from a minimum of 6.56 at the lake bottom to 7.36 at the surface. NY state water quality criteria for lakes specify pH values to be within 6.5 – 8.5. As such, pH values were within this range and did not point to any issues related to water quality. Chlorophyll *a*, as measured *in-situ,* ranged from 3.02 µg/L at 3.0 m to 9.81 µg/L at 2.0 m. All concentrations were below the 20 µg/L threshold and as such represented low-medium algal productivity.

Secchi transparency measured at Lake Sagamore was 2.0 m at the time of sampling. This measure is excellent and is indicative of a low amount of algae or suspended silt or dirt in the water column that would otherwise serve to make the water column cloudy or less transparent.

**Discrete**

Ammonia and nitrate, both forms of nitrogen, were low at Lake Sagamore and not indicative of nitrogen pollution. Total phosphorus concentrations at the two stations ranged from 0.01 mg/L – 0.03 mg/L. These concentrations are consistent with a low-medium level of algae growth and are totally normal for this lake. Soluble reactive phosphorus, the form of phosphorus most easily assimilate by algae for growth, was non-detectable (ND < 0.002 mg/L). Total suspended solids concentrations ranged from non-detectable (ND < 3 mg/L) to 4 mg/L. These concentrations were consistent with low particulate matter in the water column. Discrete chlorophyll *a* concentrations were 5 µg/L in the surface waters of the dam station and 10 µg/L in the surface waters of the south station. These measures were low to moderate.

**Plankton**

The phytoplankton community of Lake Sagamore represents the algae that are fed upon by zooplankton which in turn are fed upon by fish. As such, plankton forms the base of a lake's food web. Furthermore, excessive phytoplankton cause water quality problems and generally stem from excessive phosphorus in the lake.

The phytoplankton community in the lake was a mixture of chlorophytes, cyanobacteria, diatoms, chrysophytes and dinoflagellates. The community assemblage was typical for a moderately productive lake in the summer months. That is, there were no major densities of blue-green algae which tend to be prevalent in lakes that are impaired. The chrysophyte *Dinobryon* and the diatom *Asterionella* were dominant.

Zooplankton densities were moderate and comprised of a healthy mix of rotifers, copepods and cladocerans. Large-bodied *Daphnia* were present in abundance. This is important in this lake as these organisms serve to actively graze upon the standing crop of algae and therefore help uphold clarity.

Overall, the plankton community was representative of a system with low nutrients with a healthy balance of 'good' algae in conjunction with an abundance of cladoceran herbivores.

**Macrophyte Data**

The macrophyte community of Lake Sagamore was surveyed at the five historically established transects. Plant growth was low at the time of sampling. Plant growth consisted primarily of low densities of chara which ranged from 'present' (<10% of $1m^2$) to 'common' (20-50% of $1m^2$) with densities of 2 $g/m^2$ to 20 $g/m^2$. In addition, a single small patch of thin-leaf pondweed was identified at T-1 and a small patch of spatterdock (*Nuphar* sp.) was identified in the southern tip of the lake.

As such, it seems that the grass carp have continued to exert control over the plant community of Lake Sagamore. There was no noted instance of submerged bladderwort (*Utricularia* sp.) which has previously grown in expansive patches throughout the lake.

## 4.0 Summary

Princeton Hydro collected standard water quality and aquatic plant data which would provide the most useful insight towards upholding the designated usages of Lake Sagamore. This data has shown low phosphorus concentrations, low to moderate algal productivity, high clarity and a lack of nuisance plant growth.

The current management measure of sterile grass carp seems to be providing for optimal water quality in the lake through the reduction of elevated levels of plant growth. Observations made in 2014 showed a very low level of macroalgae growth which was absent in 2012 and 2013.

Continued monitoring should be conducted on an annual basis in order to track any changes in plant community structure and to continue the empirical water quality database for the lake. Securing State permits for re-stocking will be dependent on the basis of need demonstrated by the aforementioned plant surveys.

# **Appendix I**
Water Quality Data

| **Lake Sagamore - *In-situ* Data - 8/21/14** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Station** | **Max** | **Secchi** | **Sample** | **Temp** | **SpC** | **DO** | **DO%** | **pH** | **Chl *a*** |
| | **(m)** | **(m)** | **(m)** | **(°C)** | **(mS/cm)** | **(mg/L)** | **(%)** | **(units)** | **(µg/L)** |
| Dam | 4.5 | 2.0 | 0.1 | 24.54 | 0.181 | 8.11 | 97.4 | 7.36 | 4.76 |
| | | | 1 | 24.09 | 0.182 | 7.98 | 95.0 | 7.35 | 5.62 |
| | | | 2 | 22.95 | 0.179 | 6.89 | 80.3 | 7.14 | 9.81 |
| | | | 3 | 22.00 | 0.178 | 3.19 | 36.5 | 6.80 | 3.02 |
| | | | 4 | 20.22 | 0.186 | 0.00 | 0.0 | 6.56 | 7.78 |
| South | 0.9 | 0.9 | 0.5 | 23.91 | 0.183 | 7.60 | 90.1 | 7.30 | 8.98 |

| Lake Sagamore - Discrete Data - 8/21/14 | | | | | | |
|---|---|---|---|---|---|---|
| Station | Chl *a* | $NH_3$-N | $NO_3$-N | SRP | TP | TSS |
| | (µg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Dam - Surface | 5 | 0.04 | 0.08 | ND <0.002 | 0.01 | ND <3 |
| Dam - Deep | x | x | x | ND <0.002 | 0.03 | x |
| South | 10 | 0.02 | 0.04 | ND <0.002 | 0.02 | 4 |

| Sagamore Dam (Tow) | | | |
|---|---|---|---|
| **Phyto / Zooplankton Community Composition - 8/21/14** | | | |
| **Phytoplankton** | | **Zooplankton** | |
| **Organism** | **Abundance** | **Organism** | **Abundance** |
| | | | |
| **Chrysophytes** | | **Copepods** | |
| *Dinobryon* | A - Dominant | *Cyclops* | C |
| | | | |
| **Diatoms** | | **Rotifers** | |
| *Melosira* | C | *Keratella* | C |
| *Navicula* | P | *Asplanchna* | C |
| *Asterionella* | A | | |
| | | **Cladocerans** | |
| **Green Algae** | | *Daphnia* | A - Large |
| *Pediastrum* | C | | |
| | | | |
| **Blue-Green Algae** | | | |
| *Anabaena* | P | | |
| *Microcystis* | C | | |
| | | | |

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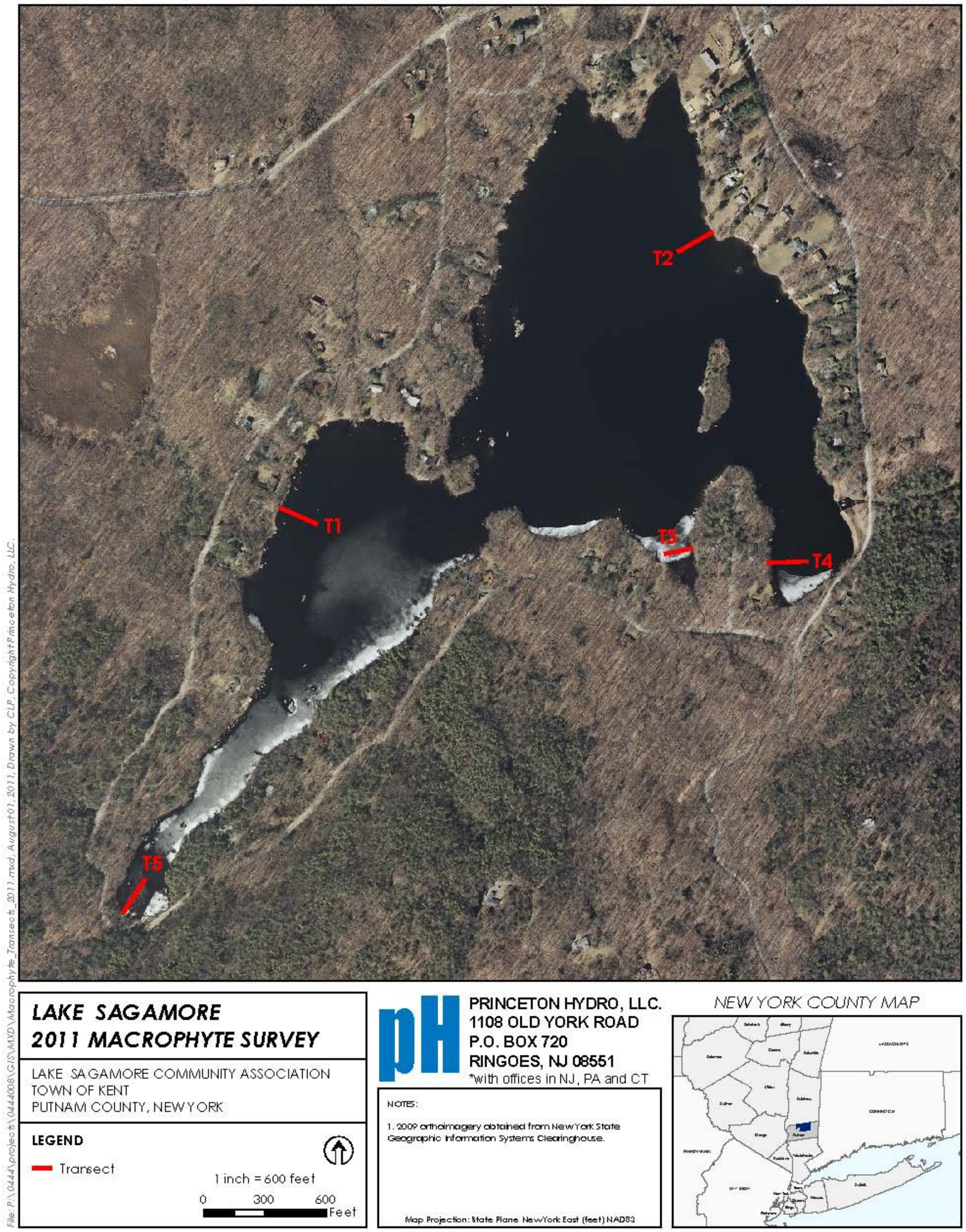
| Sagamore South (Tow)<br>Phyto / Zooplankton Community Composition - 8/21/14 | | | |
|---|---|---|---|
| **Phytoplankton** | | **Zooplankton** | |
| **Organism** | **Abundance** | **Organism** | **Abundance** |
| | | | |
| **Chrysophytes** | | **Rotifers** | |
| *Dinobryon* | A - Dominant | *Keratella* | A |
| | | *Asplanchna* | P |
| **Diatoms** | | *Polyarthra* | A |
| *Melosira* | P | | |
| *Asterionella* | A - Dominant | **Copepods** | |
| | | nauplii | C |
| **Green Algae** | | | |
| *Volvox* | P | **Cladocerans** | |
| *Pediastrum* | C | *Daphnia* | P |
| *Golenkinia* | P | *Bosmina* | P |
| | | | |
| **Blue-Green Algae** | | | |
| *Anabaena* | P | | |
| *Microcystis* | P | | |
| | | | |
| **Dinoflagellates** | | | |
| *Ceratium* | C | | |
| | | | |

# Appendix II

## Macrophyte Survey Transect Locations


T1
T2
T3
T4
T5
LAKE SAGAMORE
2011 MACROPHYTE SURVEY
LAKE SAGAMORE COMMUNITY ASSOCIATION
TOWN OF KENT
PUTNAM COUNTY, NEW YORK
LEGEND
Transect
1 inch = 600 feet
0 300 600
Feet
PRINCETON HYDRO, LLC.
1108 OLD YORK ROAD
P.O. BOX 720
RINGOES, NJ 08551
*with offices in NJ, PA and CT
NOTES:
1. 2009 orthoimagery obtained from New York State Geographic Information Systems Clearinghouse.
Map Projection: State Plane New York East (feet) NAD83
NEW YORK COUNTY MAP
File: P:\0444\projects\0444008\GIS\MXD\Macrophyte_Transects_2011.mxd, August 01, 2011, Drawn by CLP, Copyright Princeton Hydro, LLC.