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Princeton Hydro

LAKE PEEKSKILL 2014 WATER QUALITY MONITORING REPORT

Prepared for:

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Introduction and Sampling Methodology

The Town of Putnam Valley requested Princeton Hydro conduct a water quality monitoring event of Lake Peekskill over the summer season of 2014. Specifically, concern was raised over nuisance algal blooms and the appearance of a large number of snails found in the near-shore sections of the lake.

On 22 July 2014, Princeton Hydro conducted a water quality monitoring event at Lake Peekskill. During the site visit, Princeton Hydro collected *in-situ* data with a YSI meter at a mid-lake sampling location. The *in-situ* data were collected from surface to bottom, at 0.5 – 1.0 meter intervals. The *in-situ* parameters included temperature, pH, dissolved oxygen (DO), and conductivity. Additionally, a Secchi disk was used to measure water clarity at the mid-lake sampling station.

In addition to the *in-situ* monitoring, discrete sub-surface samples were collected at the mid-lake sampling station and analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), nitrate-N (NO₃-N) and chlorophyll *a*. An additional discrete sample was collected from the bottom waters and analyzed for TP. The samples were appropriately preserved, iced and transported to Environmental Compliance Monitoring Inc. (ECM) for analysis. Princeton Hydro also collected a near-shore water sample for the Town to be mailed to NYS DEC for an analysis of cyanotoxins.

Vertical plankton net tows were conducted near the mid-lake station for the collection and identification of phytoplankton (free-floating algae) and zooplankton (micro-animals) that live in the open waters of the lake. General observations were made of the resident community of aquatic plants as well. Finally, some snail shells were collected for identification. All biological samples were processed and analyzed at Princeton Hydro's biological laboratory.

Results

The *in-situ* data are provided in Table 1. Lake Peekskill was well mixed from the surface to a depth of 2.0 meters (6.6 ft). However, the lake was strongly thermally stratified (i.e. where the water temperature difference within a depth of 1 meter is greater than 1°C) from 2.0 meters to the bottom (Table 1). The strong degree of thermal stratification results in a depletion of dissolved oxygen (DO) in the bottom waters.

In general, DO concentrations greater than 4.0 – 5.0 mg/L are indicative of a healthy ecosystem. Once DO falls below 4 mg/L more sensitive species (such as trout) are stressed and when concentrations fall below 2 mg/L more warm-water species (such as bass) are stressed. Once DO concentrations fall below 1 mg/L, only certain types of bacteria can exist under such conditions. In addition, when DO concentrations fall below 1 mg/L over the sediments, the bond between iron and phosphorus is broken and in turn dissolved phosphorus moves from the sediments and into the overlying waters where it can be utilized by nuisance blue-green algae.

Thus, the depletion of DO in the bottom water a lake impacts both potential fishery habitat and increases the mobilization and availability of phosphorus for additional algal growth.

The surface waters of Lake Peekskill were well oxygenated varying in DO concentrations from 9.09 to 12.39 mg/L (Table 1). However, once thermal stratification was established there was a sharp depletion of DO, where concentrations were less than 1 mg/L (Table 1).

The pH of Lake Peekskill was strongly alkaline in the surface waters, varying between 8.38 and 8.95, while bottom water pH values were close to neutral, varying between 7.30 and 7.62 (Table 1). In general, both DO concentrations and pH will increase as algae and aquatic plants photosynthesize. Both of these parameters were relatively high in the surface waters, indicating high rates of algal photosynthesis, but were lower in the bottom waters, indicating no algal photosynthesis but high rates of bacterial decomposition.

Conductivity, a measure of the capacity of water to carry an electrical charge, is based on the amount of dissolved ions (such as nutrients and salts) in the water. A waterbody with an extremely low level of productivity typically has conductivity values less than 0.1 mmhos /cm; while a highly productive waterbody can have conductivity values greater than 0.5 mmhos /cm. The conductivity values measured throughout Lake Peekskill varied between 0.450 and 0.461 with higher values measured in the deeper waters.

Water clarity was measured using a Secchi disk at the mid-lake sampling station. Based on Princeton Hydro's in-house database of Mid-Atlantic lakes, most laypeople perceive a waterbody as being "dirty," "scummy", and/or unacceptable for recreational use if the Secchi depth is less than 1 meter (3.3 feet). The Secchi depth at Lake Peekskill on 22 July 2014 was 0.9 m (3.0 ft), which is one of the lowest Secchi depth measured at the lake.

In spite of the nuisance blooms being experienced at Lake Peekskill, total phosphorus (TP) concentrations were relatively low. The surface water TP concentration was 0.02 mg/L, while the bottom water TP concentration was 0.03 mg/L. Typically, once TP concentrations are 0.05 to 0.06 mg/L nuisance blooms are anticipated. Additionally, given that the bottom waters were anoxic (DO concentrations > 1 mg/L) deep water TP concentrations were expected to be higher. However, more than likely thermal stratification was a recent event at Lake Peekskill, from a seasonal perspective, and TP concentration will only increase in the bottom waters, making more of this nutrient available for algal growth.

In addition to TP, soluble reactive phosphorous (SRP) was also measured in the surface waters of Lake Peekskill on 22 July 2014. If TP can be considered "food" for algae, the SRP can be considered "candy." It is the dissolved, inorganic fraction of phosphorus most readily available for algal assimilation. Not surprising was the fact that surface water SRP concentrations were below the analytical threshold. All of the existing algae are using up the available phosphorus.

In addition to phosphorus, nitrate-N was measured in the surface waters of Lake Peekskill. On 22 July 2014, the mid-lake, surface nitrate-N concentration was 0.04 mg/L (Table 2). Surface water nitrate-N concentrations in unpolluted systems tend to vary between < 0.03 and 5.0 mg/L,

depending on the time of year, while the State and Federal drinking water standard for nitrate-N is 10 mg/L. Thus, the nitrate-N concentration was not excessive in Lake Peekskill.

A mid-lake water sample was also collected and analyzed for chlorophyll *a*, a photosynthetic pigment used by all algae and plants. Measuring the amount of chlorophyll *a* in lake water is an excellent means of measuring algal biomass. Based on Princeton Hydro's in-house database of Mid-Atlantic waterbodies, when chlorophyll *a* concentrations exceed 20 - 30 mg/m³, the general perception by the layperson is that the water is "scummy" or "dirty" relative to recreational use.

The mid-lake chlorophyll *a* concentration at Lake Peekskill was 26 mg/m³. Thus, the measured concentration exceeds the recreational threshold and is indicative of a eutrophic (highly productive system). In addition, based on Walmsley and Butty's lake-user perception guide shown below (1979), the chlorophyll *a* concentration measured in Lake Peekskill can be categorized as "nuisance conditions encountered."

Nuisance Value - Chlorophyll Concentration ((mg / m³))

- No problems evident - 0 to 10
- Algal scums evident - 10 to 20
- Nuisance conditions encountered - 20 to 30
- Severe nuisance conditions encountered - >30

**TABLE 1 - *In-situ* Data Collected at Lake Peekskill
 Putnam County, New York on 22 July 2014**

| Sampling Depth meters and feet | Temperature (°C) | Dissolved Oxygen (mg/L) | pH (units) | Conductivity (mmhos/cm) |
|-----------------------------------|---------------------|----------------------------|---------------|----------------------------|
| 0.0 (0.0 ft) | 27.31 | 11.62 | 8.88 | 0.453 |
| 1.0 (3.3 ft) | 26.31 | 12.39 | 8.95 | 0.450 |
| 2.0 (6.6 ft) | 25.73 | 9.09 | 8.38 | 0.451 |
| 3.0 (9.9 ft) | 22.81 | 0.82 | 7.62 | 0.461 |
| 3.5 (11.6 ft) | 17.51 | 0.36 | 7.30 | 0.461 |

Total depth at mid-lake sampling site was 3.7 m (12.2 ft)

Secchi depth at mid-lake sampling site was 0.9 m (3.0 ft)

Water had a distinctly turbid and greenish tinge to it.

**TABLE 2 - Discrete Data Collected at Lake Peekskill
 Putnam County, New York on 22 July 2014**

| Mid-Lake Parameter | Value |
|---|------------------------|
| Total Phosphorus (mg / L) | 0.02 mg/L |
| Soluble Reactive Phosphorus (mg / L) | <0.002 mg/L |
| Nitrate-N (mg / L) | <0.04 mg/L |
| Bottom Water Total Phosphorus (mg / L) | 0.03 mg/L |
| Chlorophyll <i>a</i> (mg/m ³) | 26.0 mg/m ³ |

While elevated (> 20 mg/m³) chlorophyll *a* concentrations have been measured at Lake Peekskill in the past, such “blooms” tend to occur later in the growing season (after the 1st of September) and would typically originate from mat and/or benthic algae growing along the shallow sections of the lake. In contrast, this year’s bloom occurred in mid-summer and was a planktonic blue-green algal bloom.

In total eight (8) genera of algae were identified in the surface waters of Lake Peekskill, which included five green algae (*Chlorella*, *Chlamydomonas*, *Staurastrum*, *Haematococcus* and *Gloeocystis*), the dinoflagellate *Ceratium* and two blue-green algae (*Anabaena* and *Coelosphaerium*). It should be noted that the blue-green alga *Anabaena* was clearly present in bloom densities.

A mid-depth sample was also collected for the identification of phytoplankton. Seven (7) genera were identified and total algal densities were lower relative to the surface waters. The seven genera included three green algae (*Chlamydomonas*, *Pediastrum*, and *Cosmarium*), the euglenoid

Euglena, and three blue-green algae (*Anabaena* and *Coelosphaerium* and *Aphanocapsa*). Once again, *Anabaena* was the dominant genus.

A net tow of the plankton was also collected from 2 meters to the surface to identify any zooplankton (micro-animals that live in the open waters of a lake or pond) in Lake Peekskill. Some zooplankton are herbivorous (algae-eaters) and thus can be an effective, natural way of controlling algae. Unfortunately, no herbivorous genera of zooplankton were identified in Lake Peekskill. Only two genera of rotifers were identified, which feed on bacteria (like *Conochilus*) or each other (like *Asplanchna*).

Discussion and Conclusions

Very little to no aquatic vegetation was observed in Lake Peekskill during the 2014 sampling event. This has been the case for previous years as well. While sterile grass carp were stocked in the lake back in 1993 to control nuisance aquatic plant growth, all of the carp must have died by now since they live for approximately 12 – 15 years. Thus, aquatic vegetation continues to no longer be a water quality issue of concern for Lake Peekskill.

In the recent past (within the past 10 years), aquatic vegetation growth has been minimal due to the sterile grass carp but sizable mats of algae have been identified in the shallow sections of the lake. During the 3 August 2005 sampling event these bright, dark green mats were identified to be the blue-green alga *Spirulina*. The water was clear enough to stimulate the mat algae growth and by the end of the growing season many of these mats would float to the surface and decompose. However, overall water quality and lake conditions were generally acceptable under these conditions. To demonstrate this data collected in 2005 were compared to the 2014 data (Table 3).

**TABLE 3 – Comparison of Data Collected at Lake Peekskill
 Putnam County, New York on 3 August 2005 and 22 July 2014**

| Water Quality Parameter | 3-Aug 2005 | 22-Jul 2014 |
|---|------------|-------------|
| Secchi depth (water clarity) | 6.9 ft | 3.0 ft |
| Total Phosphorus (mg/L) | 0.03 | 0.02 |
| Chlorophyll <i>a</i> (mg/m ³) | 5.4 | 26 |
| Bottom water dissolved oxygen (mg/L) | 4.18 | 0.36 |

Note that in spite of surface TP concentrations being slightly lower in 2014 relative to 2005, chlorophyll *a* concentrations were representative of bloom conditions in 2014. Additionally, water clarity was substantially lower in 2014 due to the algal bloom. Bottom water dissolved oxygen concentrations were anoxic (< 1 mg/L) in 2014 but were oxygenated in 2005, indicating that internal phosphorus loading may be contributing to the observed bloom.

It should also be noted that while Princeton Hydro conducted its monitoring on 22 July 2014, near-shore samples were also collected for the analyses of cyanotoxins, to be conducted through the State's monitoring program. The sample was collected by Princeton Hydro and a local volunteer and immediately shipped to State laboratory. The final results of that analysis revealed that measurable amounts of cyanotoxins were detected in the near-shore sample and included a mixture of microcystin RR (66%) and microcystin LR (33%); both are common variants of cyanotoxins found in New York waters. The total toxin concentration of the near-shore sample was 14 ug/L. The drinking water threshold for the toxin is 1 ug/L, while the State's recreational threshold for contact use is 20 ug/L. Thus, the measured, near-shore concentration was below the recreational threshold.

Additional information was provided by the State, which indicated that mid-lake samples collected on 24 July and 2 August 2014 came up negative for all toxins. Based on these results it appears that mid-lake waters are acceptable for recreational use but some caution should be used in some of the near-shore areas, particularly those located along wind-ward shorelines. The slightly elevated toxin concentrations measured on 22 July 2014 resulted in the local beach closings at Lake Peekskill.

Given how cyanotoxin concentrations can vary greatly from open waters to near-shore, Princeton Hydro recommends that any future sampling for cyanotoxin analysis be collected from the beach areas. In fact, it is recommended that, unless otherwise already conducted by the State, that a sample be collected early this week for the analysis of cyanotoxins. Hopefully the results can be received before the end of this week in order to make a decision on the keeping the beaches open or closed. However, please keep in mind that Princeton Hydro may not be aware of more recent developments at Lake Peekskill, such as additional, near-shore sampling already conducted in mid-August or the recent collapse of the bloom and more favorable water quality conditions.

Additional recommendations, which come largely from the State, include avoid exposure in waters that are discolored due to algae and/or contain surface scums, avoid eating fish caught in such areas and rinse any gear, equipment or skin exposed to such blooms. While the measured cyanotoxin concentration was below the recreational threshold of 20 ug/L, lake residents should still avoid discolored / highly turbid water – “when in doubt, stay out.”

Finally, the Town may want to consider an update / revision of the Management Plan that was conducted and developed in the early 1990's for Lake Peekskill. Given the large, ecosystem-based changes that have occurred since the early 1990's, a revised Management Plan would provide updated recommendations in addressing such water quality issues on both a reactive and, more importantly, pro-active perspective.