MEMORANDUM

To:	The Lake Hopatcong Commission
From:	F.S. Lubnow, Ph.D., Princeton Hydro, LLC
Date:	17 September 2009
Subject:	**Mid-year 2009 water quality monitoring for Lake Hopatcong**
# of Pages:	four

This memorandum is a concise summary of the water quality conditions of Lake Hopatcong during the 29 May, 30 June, 30 July and 28 August 2009 monitoring events. It should be noted that discrete water samples were collected during each sampling event but only the May through July data were available at the time this memo was written. A more comprehensive analysis of the 2009 water quality database will be conducted in the year-end report, after the September sampling event and all of the laboratory results have been received.

For the Lake Hopatcong monitoring program, a variety of physical, chemical, and biological data were collected from 11 sampling stations throughout the lake:

Station	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* data only

It should be noted that all field protocol and laboratory methodology have been explicated described and have been accepted by NJDEP through an approved QAPP. Also, Princeton Hydro is State-certified for the collection of *in-situ* data and discrete samples (State ID # 10006).

A calibrated Eureka Amphibian with Manta multi-probe or similar instrument was used to collect *in-situ* data from all 11 stations and included dissolved oxygen (DO), pH, conductivity, and temperature. The *in-situ* data were collected at 0.5 to 1.0 meter intervals from surface to bottom. In addition, sub-surface discrete water samples were collected and analyzed for ammonia-N, nitrate-N, total phosphorus (TP), total suspended solids (TSS), and chlorophyll *a*. Vertical net tows were conducted for phytoplankton (free-floating algae) and zooplankton (micro-animals, some of which feed on phytoplankton) at the mid-lake sampling station (Station #2).

The table below provides data on water clarity, as measured with a Secchi disk, for Lake Hopatcong during the May through August sampling events. Typically, a lake is perceived by a layperson as being “dirty” or “scummy” when the Secchi depth is less than 1.0 meter (3.3 feet). Please note that a “b” after a Secchi value indicates that the disk reached the bottom. While Secchi depth values were for the most part at or greater than the 1.0 meter threshold from May through July, four of the eleven stations during the August event had Secchi depths less than 1.0 meter (in red). In addition, the August 2009 Secchi depth value at Station #2 was approximately half of the respective value measured at Station #2 in August 2008. These generally lower Secchi depths during the height of the summer season were attributed to the high frequency of storm events during the 2009 growing season, which transport nutrients and suspended solids to the lake.

Station	May Secchi depth (meters)	June Secchi depth (meters)	July Secchi depth (meters)	August Secchi depth (meters)
1	1.25b	1.2	1.0	**0.9**
2	2.5	2.3	2.0	1.2
3	1.6b	2.0b	1.0	**0.5**
4	2.5b	2.1	1.2	1.0
5	2.3	2.1	1.1	**0.8**
6	1.4	2.0	1.5	1.0
7	0.75b	1.4	1.5b	1.75
8	2.5	2.3	1.9	1.25
9	2.1	2.3	1.5	1.6
10	1.3	1.5b	**0.8**	**0.8**
11	0.6b	1.5b	1.1b	1.0

Temperature changes greater than 1^{o}C over 1 meter (3.3 feet) through the water column indicate that the lake is thermally stratified, which has a profound impact on the physical, chemical, and biological components of a lake ecosystem. Based on the collected *in-situ* data, Station #2 was thermally stratified between 5 and 6 meters below the surface in May, was strongly thermally stratified between 3 and 9 meters in June, strongly thermally stratified between 4 and 10 meters in July and strongly thermally stratified between 5 and 10 meters in August.

Overall, Lake Hopatcong was well oxygenated from surface to bottom during the May, June and July monitoring events, with dissolved oxygen (DO) concentrations generally being greater than 4.0 mg/L throughout the water column and greater than 7 mg/L at the surface. However, it should be noted the DO concentrations measured in August 2009 at Station #2, particularly at depths between 7.0 and 13.0 meters, have been flagged as questionable since concentrations appeared to be unusually high.

Through the May to August monitoring events, pH values typically varied from the mid 6.0's to the mid 8.0's. Since optimum range for pH for most aquatic organisms is between 6.0 and 8.5, the water quality of Lake Hopatcong was generally acceptable relative to pH.

Conductivity is a measure of the capacity of water to carry an electrical charge, based on the amount of dissolved ions (i.e. nutrients and salts) in the water. A waterbody with an extremely low level of productivity will tend to have a conductivity less than 0.1 mmhos / cm, while a highly productive waterbody can have conductivity values greater than 0.5 mmhos / cm. The conductivity through most of Lake Hopatcong in May – August 2009 varied from the upper 0.3's to the lower 0.4's with some exceptions. For example, the conductivity at Station #3 (River Styx) varied between 0.56 and 0.73 mmhos / cm, which is indicative of more productive conditions. In addition, the Canal stations in the northern end of the lake (Stations #7 and #11) had lower conductivities, varying between 0.14 and 0.29 mmhos / cm, which are indicative of lower amounts of productivity.

During the 29 May 2009 sampling event, total phosphorus (TP) concentrations varied from 0.02 to 0.05 mg/L (average 0.03 mg/L; same as the 20 May 2008 event). The highest TP concentration on 29 May 2009 was 0.05 mg/L at the River Styx station (#3). During the 30 June 2009 sampling event TP concentrations varied from 0.01 to 0.03 mg/L, while during the 30 July 2009 sampling event TP concentrations varied from 0.02 to 0.5 mg/L with the River Styx station again having the highest TP concentration. Bottom water TP concentrations were high during the June and July 2009 sampling events, being 0.16 and 0.15 mg/L, respectively.

The targeted average in-lake TP concentration is 0.03 mg/L, as stated in the TMDL Restoration Plan for Lake Hopatcong. Thus, all of the in-lake and watershed-based projects that are and will be implemented at Lake Hopatcong are designed to attain this targeted in-lake TP concentration. During the May, June and July 2009 sampling events, the surface water TP concentrations were at or below 0.03 mg/L for 89%, 100% and 56% of the collected samples, respectively. Thus, while the May and June conditions were generally in compliance with the TMDL, approximately half of the July samples exceeded the targeted in-lake TP threshold of 0.03 mg/L.

TSS is essentially a measurement of the amount of particulate matter or "dirt" in the water. For most lakes and ponds, TSS concentrations during baseline (non-storm event) conditions are typically less than 25 mg/L. Thus, TSS concentrations greater than 25 mg/L are typically perceived by the layperson as being "dirty" or "muddy". TSS concentrations were low during the May through July sampling events, varying between < 3 to 7 mg/L.

Measuring the amount of chlorophyll *a* in is an excellent means of measuring algal biomass. Based on our in-house database of Mid-Atlantic waterbodies, when chlorophyll *a* concentrations exceed 30 mg/m^3, the general perception by the layperson is that the water is "scummy" or "dirty" relative to recreational use. The lake-wide mean chlorophyll *a* concentrations in May and June 2009 were 6.8 and 9.1 mg/m^3, respectively, both well below the 30 mg/m^3 threshold.

However, the July 2009 mean chlorophyll *a* concentration was 20.2 mg/m^3, with the Station #10 (Northern Woodport Bay) value being above the 30 mg/m^3 threshold (37.1 mg/m^3).

The "brown" alga (a diatom) *Tabellaria* was the dominant genus in Lake Hopatcong during the May 2009 event. Diatoms are frequently the dominant algae in temperate lakes during the spring and fall seasons. In contrast, from June through August 2009, the dominant algae in Lake Hopatcong (at least from samples collected from Station #2) where various genera of blue-green algae. Specifically, *Anabaena* and *Oscillatoria* were the dominant algae in June and July 2009, while *Anabaena* was the dominant alga in August 2009. A variety of other algae were identified during each sampling event, however, the blue-green algae were the dominant group. Blue-green algae are considered an undesirable group of algae since they produce nuisance blooms and surface scums and are a low-quality source of food for zooplankton.

As has been identified during pervious monitoring years, the most abundant zooplankton in Lake Hoaptcong were the small-bodied cladoceran *Bosmina*, which feeds primarily in bacteria and detritus, and the predaceous copepod *Cyclops*. While some larger, herbivorous (algae-eating) zooplankton such as *Daphnia* and *Diaptomus* were present, their numbers and body lengths were relatively low, which does not a strong degree of control over phytoplankton densities. Similar conditions within the zooplankton community have been documented at Lake Hopatcong over the last 10-15 years. It is hypothesized that these conditions are at least partially caused by a large number of zooplankton-eating fishes (i.e. alewife, golden shiners, young white perch).

During the June 2009 monitoring event, the invasive species Eurasian watermilfoil (EWM) was the dominant plant throughout most of the shallower areas of Lake Hopatcong. In addition, there was an approximately 50 / 50 mix of EWM and Curley-leaved pondweed, another invasive species, in the River Styx, while the benthic, filamentous blue-green alga *Lyngbya* was identified in the northern (Woodport Bay) and southern ends (off Point Pleasant) of the main body of the lake. It should be noted that native tapegrass, typically one of the dominant species in Lake Hopatcong, was not identified in the lake during the June 2009 sampling event.

As always, if you have any questions or comments, please feel free to contact Princeton Hydro at 610-524-4220 or by e-mail (flubnow@princetonhydro.com). Thank you for your time.