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MEMORANDUM

To: The Lake Hopatcong Foundation
From: F.S. Lubnow, Ph.D., Princeton Hydro, LLC
cc: Lake Hopatcong Commission
Date: 29 August 2013
Subject: **Mid-year 2013 water quality monitoring for Lake Hopatcong**
# of Pages: five

This memorandum is a concise summary of the water quality conditions of Lake Hopatcong during the 21 May, 24 June, 29 July and 20 August 2012 monitoring events. A more comprehensive analysis of the 2013 water quality database will be conducted in the year-end report, after the September sampling event is completed 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 described in detail 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 2013 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. It should also be noted that all Secchi depths were equal to or greater than the 1.0 meter threshold (or to the bottom of the lake) during the May and June in-lake monitoring events.

During the July monitoring event, Secchi depths were either greater than the 1.0 meter threshold or to the bottom, with the exceptions being Stations #1 and #10. By August 2013 Stations #1, #3 and #10 all had Secchi depths below the 1.0 meter threshold. These reduced Secchi depths were attributed to the wet spring, followed by a warm and sunny summer season, stimulating high rates of phytoplankton (free-floating algae) growth.

Station	May 2013 Secchi depth (meters)	June 2013 Secchi depth (meters)	July 2013 Secchi depth (meters)	August 2013 Secchi depth (meters)
1	2.0b	1.2	0.9	0.7
2	2.9	2.6	2.9	2.0
3	2.1b	1.7	1.2	0.6
4	2.3	2.2	2.0	1.3
5	3.0	1.8	1.9	1.2
6	2.3b	2.6b	1.7	1.6
7	1.9b	1.5	2.5b	1.8b
8	2.5	2.8	3.0	2.3
9	2.3	2.9	2.8	2.3
10	1.7b	1.0	0.9	0.8
11	1.2b	1.5b	1.1b	1.0b

b stands for "to bottom of lake"

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, the deep, mid-section of the lake (Station #2) was strongly thermally stratified during the May through August 2013 sampling events.

Lake Hopatcong was well oxygenated (DO > 5 mg/L) from the surface to 11 m (36.3 ft) during the May 2013 monitoring event. However, by June 2013 well oxygenated waters were found from the surface to 6.0 m (19.8 ft) and anoxic conditions (DO < 1 mg/L) were established from 10 meters (33 ft) to the bottom. In July 2013 well oxygenated waters were found from the surface to 5.0 m (16.5 ft) and anoxic conditions were still found at depths equal to or greater than 10 meters. By August 2013, the well oxygenated zone expanded from the surface to a depth of 7.0 meters (23.1 ft) and anoxic conditions remained at depths of 10 meters or greater.

During the May 2013 monitoring event, pH values typically varied from the low 7.0's to the mid 8.0's. The exception to this was the elevated pH values (> 9.0) measured at Station #3, which is indicative of excessive amount of photosynthesis; similar conditions were observed in 2012. In contrast, pH values during the June 2013 monitoring event varied between the mid 6.0's and the mid 8.0's. During the July 2013 monitoring event pH values varied between the upper 6.0's and the upper 7.0's. By August 2013 pH values varied between the low 7.0's and the upper 8.0s, which is indicative of elevated rates of algal / plant photosynthesis. Since the 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, with a few exceptions linked to elevated rates of algal / plant photosynthesis.

Please note that at the time this report is being written only the May through July 2013 discrete water quality data were available for review. During the 21 May 2012 sampling event, all surface water total phosphorus (TP) concentration were 0.02 mg/L; the exception was Station #2 where the TP concentration was 0.01 mg/L. During the 24 June 2013 sampling event, surface water TP concentrations varied between 0.02 and 0.04 mg/L with a mean of 0.03 mg/L. By 29 July 2013, surface water TP concentrations varied between 0.02 and 0.05 mg/L. Most stations were at or below the 0.03 mg/L with the exceptions being Station #10 (0.04 mg/L) and Stations #1 and #3 (0.05 mg/L).

Surface water NO_3-N concentrations were variable throughout Lake Hopatcong over the May through July 2013 sampling events. In May NO_3-N concentrations were generally moderate except for those stations located in Jefferson Township where concentrations were as high as 0.16 mg/L (Station #10). By June 2013 NO_3-N concentrations were generally low except for those in Jefferson where concentrations were slightly elevated (Stations #7 and #11 NO_3-N concentrations were 0.08 and 0.09 mg/L, respectively). A similar pattern of moderate NO_3-N concentrations in the Jefferson sampling stations was also observed in July 2013. It should be noted that Jefferson Township is the only municipality within the Lake Hopatcong watershed that is not sewered. Thus, more than likely these elevated nutrient, particularly NO_3-N, concentrations are attributed to leachate moving from the septic system leachfields into the receiving waterway.

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 usually perceived by the layperson as being "dirty" or "muddy". During the May 2013 sampling event all surface water TSS concentrations were less than 2 mg/L except for Station #1 where the measured concentration was 2 mg/L. TSS concentrations were generally low in June 2013 as

well, where concentrations varied between < 2 and 6 mg/L. A similar pattern was observed in July 2013, where concentrations varied between < 2 and 8 mg/L. None of the measured TSS concentrations from May through June 2013 were greater than 8 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 chlorophyll *a* concentrations during the May 2013 sampling event were consistently low, varying between 2.3 and 7.1 mg/m^3.

In contrast to the results of May 2013, chlorophyll *a* concentrations varied from low to high during the June 2013 sampling event. It is interesting to note that those sampling stations in Jefferson Township have chlorophyll *a* concentrations that varied between 12.2 and 26.5 mg/m^3, with the highest value from Station #10. All in-lake sampling stations not in Jefferson Township, with the exception of one, had low chlorophyll *a* concentrations that varied between 2.4 and 6.6 mg/m^3. The exception was Station #3 (River Styx / Crescent Cove section of the lake), which consistently has elevated chlorophyll *a* concentrations (16.2 mg/m^3) over the summer season.

The general distribution of chlorophyll *a* concentrations in July 2013 was similar to that observed in June, with a higher degree of variability. The highest concentrations were observed in Stations #10 (36.3 mg/m^3), #1 (36.2 mg/m^3) and #3 (25.1 mg/m^3), respectively. Once again, lower water quality conditions tended to be found in the northern end of the lake, as well as the River Styx / Crescent Cove section.

Near-shore, Non-Point Source (NPS) Monitoring Stations

In addition to the baseline in-lake monitoring stations, there are an additional five in-lake stations to monitor near-shore conditions adjacent to watershed sites where stormwater BMPs have been or will be installed. These sites include:

1. The southern end of Crescent Cove in the Borough of Hopatcong (NPS-1).
2. Along the eastern shoreline of the lake, in the Township of Jefferson, just south of Brady's Bridge (NPS-2).
3. Ashley Cove in the Township of Jefferson (NPS-3).
4. King Cove in the Township of Roxbury (NPS-4).
5. Southern end of the public beach at the Hopatcong State Park (NPS-5).

Details on these near-shore sampling stations will be provided in the year-end sampling report. 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.