Culver Lake
Mid-Year Report
July 2007

Prepared by:

Princeton Hydro, LLC
1108 Old York Road, Suite 1
P.O. Box 720
Ringoes, New Jersey 08551

The following report provides a mid-year synopsis of the observations and data compiled to date by Princeton Hydro over the course of the 2007 lake monitoring program. The primary purpose of this sampling program is to conduct *in-situ* monitoring of key environmental parameters and collect samples for water quality, phytoplankton and zooplankton characterization. Princeton Hydro's efforts this year have again focused on the lake's biology, specifically the occurrence and density of nuisance, invasive aquatic macrophytes (weeds), the lake's phytoplankton community and the density and composition of the lake's zooplankton assemblage. To date, sampling was conducted on 11 May and 10 July 2007. Both *in-situ* monitoring and discrete water testing were conducted during each of these sampling events.

Although the *in-situ* data collected during both 2007 sampling events are discussed in this mid-year report, the laboratory data from the July event were not received in time for their inclusion. In addition, the lake was stocked with herbivorous zooplankton during the 11 July 2007 monitoring event and a detailed survey was conducted of the lake's weed community. The last in-lake sampling and zooplankton stocking event is scheduled for mid-September, and will coincide as best as possible with the lake's seasonal turn over. To date, we have received a limited amount of data collected by Ecosystem Consulting Services (ECS), but not from the community volunteers or Aquatic Analysts. Upon the receipt of all the lab data, as well as monitoring data compiled by ECS and Aquatic Analysts, Princeton Hydro will prepare an End-of-Year report and present our findings and conclusions to the Association.

1. WATER QUALITY - TEMPERATURE AND DISSOLVED OXYGEN

During the 11 May 2007 event the lake was already becoming thermally stratified. Specifically, at the time of sampling, a significant decrease in water temperature was measured from surface to bottom. However, no depressed dissolved oxygen (DO) concentrations (< 6 mg/L) were measured at any depths. Such conditions are common for the lake and are reflective of the late spring season, however changes in the thermal and dissolved oxygen profiles of the lake would soon occur. During the 10 July event, thermal and DO conditions were different relative to those observed during the 11 May event, with DO concentrations approaching anoxia (< 2 mg/L) at depths at or greater than 5 meters. Furthermore, DO concentrations in the "habitat zone" of the lake (depths between 4 and 7 meters) were low, especially below 5 meters. Based on these observed data, optimal cold water fishery habitat conditions were limited between 4.5 and 5.5 meters. As would be expected, between the May and July sampling events, surface water temperatures had risen, coinciding with warming

ambient air temperatures. More importantly though, was that during the 10 July event, thermal stratification was observed starting at a depth of 5 meters.

The pH in Culver Lake varied from 6.51 to 9.52 to this point in the 2007 monitoring season. The lowest pH values were measured on 10 July, while the highest values were also measured on 10 July. The elevated or alkaline pH values measured on 10 July were most likely due to elevated rates of algal photosynthesis in the surface waters. The alkaline pH value (9.52) displayed in the bottom waters of the Causeway Cove was most likely due to submerged macrophytes. As rates of photosynthesis increase, the pH of the surrounding waters will increase. The optimal range of pH for most aquatic organisms varies from 6.0 to 9.0. The pH of Culver Lake was, for the most part, within the optimal range for most aquatic life.

2. WATER CLARITY

Water clarity, as measured with a Secchi disk, in the open waters of the lake was exceptional in May. The lake's Secchi clarity at that time was 2.0 meters at the mid-lake station, and was to the bottom at the Stehr Tract and Causeway Inlet stations. Water clarity in the open waters of the lake was acceptable in July as well. The lake's Secchi clarity was again 2.0 meters at the mid-lake station, 1.5 meters at the Stehr Tract and 1.6 meters at the Causeway Inlet station. It should be noted that the Stehr Tract Secchi depth value would most likely have been higher if the disk had not been concealed by aquatic macrophytes. In terms of water clarity, the targeted goal for Culver Lake is to sustain Secchi depths of at least 1 m (3.3 ft) or greater throughout the course of the growing season (April through September). To date, this level of water clarity has been sustained and is higher than the respective 2006 Secchi values.

3. NUTRIENTS

Unlike 2006, the total phosphorus (TP) concentrations measured in the lake in May 2007 were above the detection limit of 0.02 mg/L in the surface, mid-depth and deep samples. Specifically, the concentrations were 0.06 mg/L, 0.07 mg/L and 0.06 mg/L, respectively. In spite of the acceptable water clarity, these measured TP concentrations were high for Culver Lake. TP concentrations equal to or greater than 0.06 mg/L tend to be associated with nuisance algal blooms. Thus, these elevated TP concentrations may have been the result of spring storms transporting watershed-based pollutants to the lake.

During the May monitoring event, nitrate-N concentrations were minimal (< 0.1 mg/l) at all stations, somewhat similar to previous spring monitoring events. The ammonia-N concentration in the bottom sample was elevated (> 0.15 mg/L) during the May event. This would be expected, as anoxia was beginning to develop in the hypolimnion. Under anoxic conditions, rates of ammonia-N generation due to bacterial decomposition substantially increase. Bottom water ammonia

concentrations are expected to increase through the course of growing season as anoxic conditions intensify.

4. PHYTOPLANKTON AND ZOOPLANKTON

During the 11 May 2007 sampling event, a high diversity of green algae, several chrysophytes, a cryptomonad and a blue-green alga were identified in Culver Lake. In the surface waters the green algae were the dominant group and the single dominant genus was the chrysophyte *Dinobryon*. The sole blue-green alga identified in the surface waters was *Pseudoanabaena*. In May 2007, mid-depth algal abundance and biomass values were lower than the respective surface water values. However, similar to the surface waters, the green algae was the dominant group and *Dinobryon* was single dominant genus in the mid-depth waters. No blue-green algae were identified in the mid-depth May sample.

During the 10 July 2007 sampling event, the green algae remained the dominant group in the surface waters of Culver Lake in terms of abundance. However, the blue-green algae was the dominant group in terms of biomass. The blue-green algae that were identified in the surface waters included *Pseudoanabaena*, *Anabaena* and *Chroococcus*. Mid-depth abundance and biomass values were substantially lower the respective surface water values. No blue-green algae were identified in the mid-depth sample and the dominant alga in terms of both abundance and biomass was the chrysophyte *Synura*.

During the 11 May 2007 sampling event, surface and mid-depth chlorophyll *a* concentrations were low, being less than 9 mg/m^3 (Table 3), while the mid-lake Secchi depth was 2.0 meters (6.6 feet). The measured chlorophyll *a* concentrations were substantially lower than the 30 mg/m^3 threshold; chlorophyll *a* concentrations greater than this identified threshold tend to be perceived by the layperson as generating nuisance blooms / scums that impact recreational use. Thus, the phytoplankton densities of 11 May 2007 were acceptable based on the measured chlorophyll *a* concentrations and the algal community was dominated by favorable genera that provided food for the zooplankton.

Zooplankton diversity, densities and biomass were moderate during the 11 May 2007 sampling event. Surface and mid-depth zooplankton values were similar to each other during the 11 May 2007 sampling event. In contrast to conditions observed in May of 2004 – 2006, herbivorous zooplankton were rare in Culver Lake during the May 2007 sampling event. Only one herbivore, the cladoceran *Ceriodaphnia*, was identified in the surface waters, while no herbivores were identified in the mid-depth waters. Rotifers were the most abundant group of zooplankton in the surface and mid-depth samples of Culver Lake in May 2007.

During the July 2007 sampling event, no herbivorous zooplankton were identified in the surface

waters of Culver Lake while four herbivores, the copepod *Diaptomus* and the cladocerans *Daphnia*, *Diaphniosoma* and *Diaptomus*, were identified in the mid-depth sampling event. In the surface waters the rotifers were the dominant zooplankton group in terms of both abundance and biomass. While the rotifers were also the dominant group in the mid-depth waters in terms of abundance, the copepods were the dominant group in terms of biomass. In fact, the single most abundant genus in the mid-depth July sample in terms of biomass was the herbivorous copepod *Diaptomus*. The herbivores accounted for 17% of the total zooplankton abundance in the mid-depth July 2007 sample. In contrast, the herbivores accounted for 10% of the total zooplankton abundance in the mid-depth July 2006 sample.

Similar to past monitoring years, mean total lengths of the herbivorous zooplankton in July were less than 1.0 mm, indicating that they were under grazing pressure by forage and/or young gamefish. To continue long-term efforts to facilitate the development of a zooplankton community dominated by large-bodied herbivorous genera in Culver Lake, approximately 500,000 herbivorous zooplankton were stocked in Culver Lake during the July 2007 sampling event. More specifically, these stocked zooplankton were *Daphnia*, varying in size between 0.9 and 1.5 mm, with an estimated population mean of 1.38 mm. A second zooplankton stocking event is scheduled during the mid-September sampling event. Thus, an estimated one million *Daphnia* will be stocked in Culver Lake during the 2007 growing season.

5. AQUATIC MACROPHYTES (PLANTS)

During both the May and July site visits, Princeton Hydro made qualitative assessments of the lake's aquatic macrophyte (plant) community. In May 2007, Eurasian watermilfoil (*Myriophyllum spicatum*) was the dominant species observed in the Owassa Lake/Stehr Tract areas. In addition, Eurasian watermilfoil was also the dominant plant observed in the Causeway Cove Inlet area of the lake. Scattered stands of Curly-leaved pondweed (*Potamogeton crispus*) were observed along areas of the north shore. Unlike past monitoring years, NO tape grass (*Vallisneria americana*) was identified at the mouth of the Causeway Cove Inlet.

In July, overall densities of Eurasian watermilfoil were higher relative to May observations in the Stehr Tract, however the height of these plants was lower due to mechanical weed harvesting which occurred between 19 and 25 of June 2007. Specifically, approximately 80% of the Stehr Tract was covered with Eurasian watermilfoil. Additionally, patches of lilies (*Nymphaea spp.*) were also present in the Stehr Tract cove. These lilies provided the necessary refuge habitat for the stocked zooplankton.

Eurasian watermilfoil was observed scattered throughout the North Shore areas. It appears this watermilfoil has advanced further in a direction along the shoreline from the Stehr Tract cove when compared to the last few monitoring years. Similar to the May 2007 monitoring event, NO tape

grass (*Vallisneria americana*) was observed in the Causeway Cove section of the lake during the July 2007 monitoring event. Instead, based on field observations, this Causeway Cove section again contained only Eurasian watermilfoil. Currently, hydroraking operations are underway in the swamp areas located on the opposite side of Culvers Avenue from the Causeway Cove section of the lake.

6. SUMMARY

Sampling of Culver Lake has thus far occurred in late spring and mid summer. To date, the quality of the lake was found to be acceptable, as defined by the established water quality thresholds, with regard to clarity. As noted above, Secchi Disk readings in May and July were well in excess of the 1 meter threshold value. However, the July DO data was of concern given the fact that very little optimal cold water habitat existed. The observed temperature profiles show the signs of the onset of stratification in May and pronounced stratification in July. These conditions are relatively the same as those observed over the past 4-6 years. The lake's conductivity and pH values were relatively constant from surface to bottom in May, as would be expected given the weakly stratified nature of the lake and the lack of extensive surface water warming. In July, pH levels in the surface waters had increased an order of magnitude in comparison to the bottom waters, indicating significantly increasing algal activity.

The green algae, blue-green algae and a few genera of chrysophytes were the dominant algae in Culver Lake during the May and July 2007 sampling events.

No decline in water clarity was observed from May to July in 2007. Both Secchi depths were greater than the 1 meter threshold; Secchi depths less than 1 meter are typically perceived by the layperson has being a major impairment to recreational use. In addition, chlorophyll a concentrations were relatively low, being less than 9 mg/m3, which is indicative of non-bloom, acceptable water quality conditions. In contrast, TP concentrations throughout the water column were excessive during the May 2007 sampling event.

In contrast to recent monitoring years (2004 – 2006), the occurrence of herbivorous zooplankton was somewhat rare in Culver Lake during the May and July 2007 sampling events. The exception to this was the mid-depth sample collected in July, where four herbivorous zooplankton genera accounted for approximately 17% of the total zooplankton abundance. Approximately half a million *Daphnia* were stocked in the lake in July, with another half a million to be stocked in September.

TABLE 1

May 2007 *In-Situ* Data

***In-Situ* Monitoring for Culver Lake 5/11/07**							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
Mid-Lake	**14**	**2**	**Surface**	18.93	0.176	10.14	6.59
			1.0	18.2	0.175	10.24	6.78
			2.0	16.75	0.174	10.8	6.89
			3.0	15.23	0.173	11.19	6.94
			4.0	13.32	0.172	11.32	6.91
			5.0	11.74	0.172	11.38	6.86
			6.0	10.91	0.172	11.15	6.8
			7.0	9.82	0.172	11.22	6.82
			8.0	8.71	0.172	10.82	6.86
			9.0	7.79	0.172	11.09	6.93
			10.0	7.35	0.172	10.9	7.01
			11.0	6.88	0.173	10.75	7.04
			12.0	6.6	0.173	10.6	7.08
			13.0	6.36	0.176	9.44	7.11
			14.0	6.31	0.176	9.01	7.14
Stehr Tract	**1.8**	**1.8**	**Surface**	19.13	0.176	10.49	7.65
			1.0	18.04	0.175	10.43	7.61
			1.5	17.7	0.175	10.03	7.58
Causeway Cove	**1.8**	**1.8**	**Surface**	19.28	0.175	11.01	8.09
			1.0	18.71	0.175	11.16	8.16
			1.5	16.82	0.175	11.5	8.23

TABLE 2

July 2007 *In-Situ* Data

***In-Situ* Monitoring for Culver Lake 7/10/07**							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**
Mid-Lake	**13.5**	**2**	**Surface**	26.45	0.187	8.84	8.81
			1.0	25.6	0.186	8.91	8.78
			2.0	24.95	0.186	9.14	8.65
			3.0	23.92	0.185	9.19	8.17
			4.0	22.61	0.184	7.96	7.37
			5.0	20.59	0.183	5.58	6.88
			6.0	13.73	0.177	2.4	6.75
			7.0	12.82	0.177	2.01	6.57
			8.0	11.85	0.176	2.09	6.53
			9.0	11.16	0.176	2.09	6.51
			10.0	10.62	0.175	2.18	6.52
			11.0	10.11	0.176	1.92	6.52
			12.0	9.02	0.177	1.96	6.53
			13.0	7.99	0.189	1.58	6.78
			13.5	8.04	0.231	0.66	7.01
Stehr Tract	**1.8**	**1.5**	**Surface**	26.62	0.186	8.93	8.56
			1.0	24.78	0.186	9.28	8.1
			1.5	24.24	0.188	8.3	7.63
Causeway Cove	**2**	**1.6**	**Surface**	27.64	0.188	9	8.74
			1.0	25.47	0.187	9.26	8.88
			1.5	24.87	0.188	9.25	9.52

Table 3 **Discrete Water Quality Data** **Culver Lake - Mid-Lake Sampling Station** **11 May 2007**		
SURFACE (0.5 m)	**Chlorophyll *a***	6.6 mg/m^3
	NH3-N	0.03 mg/L
	NO3-N	0.03 mg/L
	TP	0.06 mg/L
MID (9.5 m)	**Chlorophyll *a***	8.4 mg/m^3
	NH3-N	0.05 mg/L
	NO3-N	0.04 mg/L
	TP	0.07 mg/L
DEEP (12.0 m)	**NH3-N**	0.16 mg/L
	NO3-N	0.09 mg/L
	TP	0.06 mg/L