Culver Lake
Mid-Year Report
July 2008

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 2008 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. In addition, beginning with this growing season, *in-situ* and water quality data has been collected from the lake's two main inlets, the Causeway Cove Brook and Owassa Brook. To date, sampling was conducted on 27 May 2008 (late spring) and 9 July 2008 (mid-summer). Both *in-situ* monitoring and discrete water testing of the lake and its inlets were conducted during each of these sampling events.

Although the *in-situ* data collected during both 2008 sampling events are discussed in this mid-year report, the laboratory data for the July event were not received in time for their inclusion. In addition, the lake was stocked with herbivorous zooplankton during the 27 May 2008 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 the data collected by Ecosystem Consulting Services (ECS) and the *in-situ* data from the community volunteers. However, to date we have received no data from Aquatic Analysts. Upon the receipt of the entire lab data set, 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 27 May 2008 event the lake was already becoming thermally stratified, albeit weakly. Specifically, at the time of sampling, a significant decrease in water temperature was measured from surface to bottom. In addition, depressed dissolved oxygen (DO) concentrations (< 6 mg/L) were measured at depths greater than 13.0 meters. Such conditions are common for the lake and are reflective of the late spring/early summer season, with continued changes in the thermal and dissolved oxygen profiles of the lake expected to occur soon. During the 9 July event, thermal and DO conditions were different relative to those observed during the 27 May event, with DO concentrations approaching anoxia (< 2 mg/L) at depths at or greater than 10.0 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 3.0 and 4.0 meters. As would be expected, between the May and July sampling events, surface water temperatures had risen, coinciding with the warming ambient air temperatures. More importantly though, was that during the 9 July event, thermal stratification was observed starting at a depth of 4.0 meters.

The temperatures of the inlets were also reflective of the local ambient conditions. The stream temperatures are more susceptible to change than the waters of the lake based on the flow, size and volume differences between the two. The dissolved oxygen concentrations in both of the inlets was somewhat reduced, especially during the 9 July 2008 monitoring event. This is most likely the result of reduced base flows in conjunction with the recent higher temperatures and lack of consistent precipitation events.

The pH in Culver Lake varied from 6.56 to 8.29 to this point in the 2008 monitoring season. Both the lowest and highest pH values were measured on 9 July. The elevated or alkaline pH values measured on 9 July were most likely due to elevated rates of algal photosynthesis in the surface waters. 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. Thus, to date, the pH of Culver Lake was within the optimal range for most aquatic life.

The pH of the inlets, as can be expected, was nearly neutral, ranging from 6.90 to 7.59 during the two 2008 monitoring events. Based upon their flows, the inlets may not have the habitat necessary for large scale algae and vegetation growth. As a result, the pH swings that are seen occurring with photosynthesis in the lake may not necessarily be observed in the inlet streams.

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 1.5 meters at the mid-lake station, 1.2 meters at the Stehr Tract and 1.5 meters at the Causeway Inlet station. It should be noted that the Causeway Cove 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 nearly identical to the respective 2007 Secchi values of the same timeframe.

3. NUTRIENTS

Unlike the 2007 season, the total phosphorus (TP) concentrations measured in the lake in May 2008 were at the detection limit of 0.02 mg/L in the surface, mid-depth and deep samples. These measured TP concentrations were consistent with the long term concentrations that have been previously observed for Culver Lake in the last few years. TP concentrations equal to or greater than 0.06 mg/L tend to be associated with nuisance algal blooms. While the May 2008 TP concentrations were minimal, the potential for elevated TP concentrations resulting from summer thunder storms transporting watershed-based pollutants to the lake remains high, especially based on recent weather patterns.

During the May monitoring event, nitrate-N concentrations were minimal (< 0.1 mg/l) at all stations, similar to previous spring monitoring events. During the May 2008 event, the ammonia-N concentration in the all of the sample depths was minimal (< 0.05 mg/L). However, as anoxia begins to develop in the hypolimnion throughout the summer, the deep ammonia-N concentration is expected to rise. Under anoxic conditions, rates of ammonia-N generation due to bacterial decomposition substantially increase. As a result, bottom water ammonia concentrations are expected to increase through the course of growing season as anoxic conditions intensify.

The TP concentrations in the inlets were also minimal, with the detections being at or below 0.03 mg/L, slightly higher concentrations than were observed in the open waters of the lake. The nitrate-N concentrations in the inlets were minimal as well, with the detected concentrations all less than 0.05 mg/L. Lastly, total suspended solids (TSS) concentrations were also fairly minimal, with concentrations less than 10 mg/L. TSS concentrations greater than 25 mg/L can give an appearance of "muddy" or "turbid" water. The TSS concentration is important, as TP concentrations can also increase as TSS concentrations increase, as TP can be carried on the soil particles that can comprise TSS.

4. PHYTOPLANKTON AND ZOOPLANKTON

During the 27 May 2008 sampling event, a high diversity of green algae, a cryptomonad and 2 genera of blue-green algae and diatoms were identified in Culver Lake. In the surface waters the blue-green algae were the dominant group and the single dominant genus was *Coelosphaerium*. The other blue - green alga identified in the surface waters was *Anabaena*. In May 2008, mid-depth algal abundance and biomass values were lower than the respective surface water values. However, similar to the surface waters, the blue-green algae were the dominant group and *Coelosphaerium* was the dominant genus in the mid-depth waters. Relatively high amounts of diatoms were present in both the mid-lake and surface waters. The dominant diatom in the surface water was *Melosira* and the dominant genus at mid-depth was *Tabellaria*.

During the 9 July 2008 sampling event, the blue-green algae remained the dominant group in the surface waters of Culver Lake in terms of abundance and biomass. The blue-green algae that were identified in the surface waters included *Anabaena, Coelosphaerium,* and *Aphanizomenon*. Mid-depth phytoplankton abundance was nearly identical to the surface abundance; however biomass values were much higher for the surface sample. Similar to the surface samples, blue-green algae was the dominant genera for the mid-lake samples. The blue-green algae identified in the mid-lake samples were similar to the surface samples.

During the 27 May 2008 sampling event, surface and mid-depth chlorophyll *a* concentrations were low, being at or less than 8 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 27 May 2008 were acceptable based on the measured chlorophyll *a* concentrations.

Zooplankton diversity, densities and biomass were moderate during the 27 May 2008 sampling event. Surface and mid-depth zooplankton biomass values were somewhat similar to each other during the 27 May 2008 sampling event; however the number of zooplankton per liter was much higher at the mid-depth location. This is due to the high amount of rotifers, especially *Keratella,* present at the mid-depth location. In contrast to conditions observed in May of 2004 – 2006, herbivorous zooplankton was non-existent in Culver Lake during the May 2008 sampling event. Only one cladoceran, *Bosmina*, was identified in the surface and mid-lake waters. *Bosmina* feeds mainly on bacteria and detritus. No herbivores were identified in the mid-depth or surface waters. Rotifers were the dominant zooplankton at the mid-depth location while the cladoceran *Bosmina* was the dominant zooplankton at the surface.

During the 9 July 2008 sampling event, no herbivorous zooplankton was identified in the surface or mid-depth waters of Culver Lake. In the surface waters the rotifers were the dominant zooplankton group in terms of abundance; however the cladoceran *Bosmina* was the dominant zooplankton in terms of biomass. In the mid-depth waters, *Bosmina* was the dominant zooplankton in terms of both abundance and biomass. This stands in contrast to previous years where the herbivores accounted for 17% of the total zooplankton abundance in the mid-depth July 2007 sample.

The absence of herbivores may indicate that they are 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 May 2008 sampling event. More specifically, these stocked zooplankton were *Daphnia*. 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 2008 growing season.

Lastly, Princeton Hydro analyzed several algal samples collected by shoreline residents. These samples were collected at the peak of a bloom of blue-green algae. Specifically, these samples contained high densities of Anabaena with some scattered Lyngbya mixed in as well. These samples also contained some scattered diatoms and had very little occurrence of green algae.

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 2008, Curly-leaf pondweed (*Potamageton crispus*) was the dominant species observed in both the Owassa Lake and Stehr Tract areas. In addition, Curly-leaf pondweed was also the dominant plant observed in the Causeway Cove Inlet area of the lake. Unlike past monitoring years, NO tape grass (*Vallisneria americana*) or Eurasian watermilfoil (*Myriophyllum spicatum*) was identified in the Stehr Tract, along the North Shore or at the mouth of the Causeway Cove Inlet.

In July, overall densities of macrophytes were lower relative to May observations in the Stehr Tract, most likely due to mechanical weed harvesting conducted by Aquatic Analysts during the early portion of July 2008. No submerged aquatic vegetation was observed in the Stehr Tract with the exception of sporadic patches of lilies (*Nymphaea spp.*) present on the surface, near the shoreline areas. These lilies also provided the necessary refuge habitat for the 27 May 2008 stocked zooplankton.

No macrophytes were observed scattered throughout the North Shore areas. Similar to the May 2008 monitoring event, NO tape grass (*Vallisneria americana*) was observed in the Causeway Cove section of the lake during the July 2008 monitoring event. Instead, based on field observations and similar to the Stehr Tract, this Causeway Cove section contained no observable macrophytes. Previously (2007) hydroraking and harvesting operations were underway in the Causeway Cove section of the lake.

6. SUMMARY

Sampling of Culver Lake has thus far occurred in both the 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 5-7 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 blue-green algae and a few genera of chrysophytes were the dominant algae in Culver Lake during the May and July 2008 sampling events, especially in the surface waters.

A decline in water clarity was observed from May to July in 2008. However, 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 8 mg/m3, which is indicative of acceptable water quality conditions. Similarly, TP concentrations throughout the water column were minimal during the May 2008 sampling event.

In contrast to recent monitoring years (2004 – 2007), the occurrence of herbivorous zooplankton was somewhat rare in Culver Lake during the May and July 2008 sampling events. The absence of herbivores may indicate that they are under grazing pressure by forage and/or young gamefish. Approximately half a million *Daphnia* were stocked in the lake in May, with another half a million to be stocked in September.

TABLE 1

May 2008 *In-Situ* Data

***In-Situ* Monitoring for Culver Lake 5/27/08**							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(units)**	**(mg/L)**
Mid-Lake	**15**	**2**	**Surface**	17.37	0.196	8.21	10.36
			1.0	17.36	0.196	8.17	10.19
			2.0	16.22	0.196	8.14	10.43
			3.0	15.73	0.195	8.08	10.29
			4.0	14.86	0.195	7.99	10.13
			5.0	14.13	0.196	7.88	9.69
			6.0	13.71	0.196	7.84	9.68
			7.0	12.97	0.196	7.77	9.41
			8.0	12.3	0.195	7.67	8.96
			9.0	11.19	0.196	7.54	8.36
			10.0	9.6	0.195	7.41	7.59
			11.0	7.5	0.195	7.37	7.89
			12.0	7.11	0.195	7.29	7.13
			13.0	6.57	0.198	7.18	5.5
			14.0	6.31	0.205	7.11	3
			14.5	6.28	0.206	7.17	1.91
Stehr Tract	**2**	**2**	**Surface**	17.11	0.195	8.13	10.53
			1.0	16.25	0.192	8.06	10.54
			2.0	15.3	0.196	7.76	9.47
Causeway Cove	**1.5**	**1.5**	**Surface**	19.09	0.198	8.21	10.04
			1.0	18.59	0.198	8.09	9.93
			1.5	16.84	0.195	8.15	10.74
Owassa Brook	**N/A**	**N/A**	**Surface**	21.95	0.129	6.9	6.04
Causeway Cove Brook	**N/A**	**N/A**	**Surface**	21.25	0.202	7.59	8.28

TABLE 2

July 2008 *In-Situ* Data

***In-Situ* Monitoring for Culver Lake 7/9/08**							
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(pH)**	**(mg/L)**
Mid-Lake	**14.5**	**1.5**	**Surface**	25.92	0.207	7.88	9.25
			1.0	25.91	0.206	8.16	8.64
			2.0	25.9	0.206	8.29	8.65
			3.0	24.13	0.202	8	6.8
			4.0	22.6	0.203	7.55	4.72
			5.0	19.32	0.202	7.44	2.9
			6.0	14.32	0.197	7.37	3.12
			7.0	13.21	0.199	7.13	3.22
			8.0	12.74	0.199	7	3.15
			9.0	11.77	0.199	6.92	2.8
			10.0	10.74	0.203	6.86	1.9
			11.0	9.77	0.2	6.83	1.7
			12.0	8.94	0.202	6.78	1.4
			13.0	8.2	0.209	6.73	<1.0
			14.0	7.29	0.225	6.56	<1.0
Stehr Tract	**1.2**	**1.2**	**Surface**	25.88	0.206	7.52	7.78
			1.0	24.95	0.206	7.48	7.15
Causeway Cove	**1.7**	**1.5**	**Surface**	26.65	0.206	7.55	8.2
			1.0	26.64	0.205	7.96	7.88
			1.5	26.05	0.208	7.72	5.15
Owassa Brook	**N/A**	**N/A**	**Surface**	22.27	0.151	7.06	6
Causeway Cove Brook	**N/A**	**N/A**	**Surface**	26.24	0.209	6.98	5.64

Table 3 **Discrete Water Quality Data** **Culver Lake - Mid-Lake Sampling Station** **27 May 2008**		
SURFACE (0.5 m)	**Chlorophyll *a***	5.2 mg/m^3
	NH3-N	0.02 mg/L
	NO3-N	ND <0.02 mg/L
	TP	0.02 mg/L
MID (6.0 m)	**Chlorophyll *a***	8.0 mg/m^3
	NH3-N	ND <0.01 mg/L
	NO3-N	0.02 mg/L
	TP	0.02 mg/L
DEEP (14.0 m)	**NH3-N**	0.01 mg/L
	NO3-N	0.05 mg/L
	TP	0.02 mg/L
CAUSEWAY COVE BROOK	**NO3-N**	ND <0.02 mg/L
	TP	0.02 mg/L
	TSS	ND <3 mg/L
OWASSA BROOK	**NO3-N**	0.04 mg/L
	TP	0.03 mg/L
	TSS	8 mg/L