17 August 2012

Scientists, Engineers & Environmental Planners Designing Innovative Solutions for Water, Wetland and Soil Resource Management

Ms. Patricia Strother, Secretary
Cedar Lake Property Owners, Inc.
91 Cedar Lake East
Denville, New Jersey, 07834

Re: Interim Lake Report
Transmitted by Email

Dear Ms. Strother:

I have prepared the interim lake assessment report that follows specifically to address specific questions raised about the lake's aquatic weed and algae growth. The report also provides an opportunity for me to review the overall water quality of Cedar Lake as based on data compiled between May and July of this year. In advance of the September 21 CPLO Board meeting I prepare and distribute a more comprehensive assessment of lake conditions that includes a thorough review of all of the water quality data collected by Princeton Hydro and the treatment efforts implemented by Aquatic Technologies (AT). The report that follows reflects observations made through 12 August, and addresses the three basic questions that were posed to me:

1. In your opinion, as lake manager for the CLPO, what is going on with the lake?

Overall, the lake's water quality is very good. This is backed by the data that we have collected from May through July of this year (refer to the tables at the end of this report). In addition to the three comprehensive sampling events that we have thus far conducted, Princeton Hydro personnel (including myself) have conducted three additional informal, shoreline inspections of the lake. These were conducted in June, July and early August. The purpose of each of these informal inspections was to evaluate conditions preceding or following the lake's treatment by Aquatic Technologies (AT) or to inspect the lake as a result of issues raised by community.

The field data collected during each of the comprehensive surveys can be summarized as follows: The lake's clarity is outstanding, ranging from 3.8 M (12.5 ft) to 2.5 M (8.25 ft). Except for right near the bottom of the lake, dissolved oxygen levels are constantly well above that needed to support a healthy fishery (5.0 mg/L). I will discuss the depressed DO conditions (refer to May data) measured at the bottom of the lake in Princeton Hydro's September report, but this condition does not appear to be significantly impacting the lake's water quality. The data also show that the lake is thermally uniform from surface to bottom. That is, from month to month water temperature from surface to bottom are fairly similar (refer to the mid-lake station temperature data in the accompanying tables). This means that the water column is not stratified, meaning that it can vertically mix fairly easily. This is a desirable condition.

The concentrations of phosphorus, nitrogen and Chlorophyll a measured in May, June and July have been consistently low. The measured concentrations of these parameters are characteristic of a moderately productive lake ecosystem.

To date the lake's phytoplankton community (microscopic free floating algae) has been composed of non-bloom forming species. Phytoplankton densities have been relatively low and again consistent with what we would expect given the lake's temperature/DO profiles, nutrient concentrations and water column clarity.

In summary all of the data thus far collected are reflective of an ecologically balanced, environmentally healthy lake ecosystem.

Between May and the beginning of August, Aquatic Technologies (AT) was on the lake at least seven times (17 May, 7 June, 11 June, 28 June, 18 July, 19 July and Early August). As per the May Service Report submitted by AT, conditions at the onset of the growing season were as follows:

> "Minor growth of curly leaf pondweed, Eurasian water milfoil and naiad growth. Growth minor at this time and treatment for nuisance levels will occur as populations increase in densities. Observed a minor growth of filamentous algae along the benthic areas of the lake."

The initial treatment of the lake's weeds was conducted in the latter part of June and another treatment, to control mostly Naiad growth, was conducted in July. Filamentous algae treatments were also conducted in June, July and August. With the exception of the Naiad, which reached nuisance densities in July, and some of the water lily growth around the northern island and along the northwest shore, weed densities in the lake have not been excessive as per the AT service reports submitted between May and August. **To me this shows that the lake's weeds can be adequately controlled using the contact treatment program. Can improvements be made? Yes. This is the first year of the program and we will collectively learn how to project and respond better to the lake's weed growth issues.**

The bigger problem pertains to mat algae growth. I reviewed AT's service reports and end of year reports from 2001 through 2011. Over the past 10 years, according to these reports, there has consistently been the need to treat mat algae growth, with most of the treatments conducted along the western side of the lake and around the beach area. Princeton Hydro's observations last year and this year confirm that the highest densities of mat algae occur along the western and northern shorelines of the lake. **The density of this growth is unacceptable along the majority of the north shore and much of the western shore.** We also observed high densities of mat algae along the southwest side of the southern island, but the mats were patchier as opposed to those observed along the northwest and north shorelines. **This is a problem that will need to be addressed differently and more aggressively moving forward.** But, a distinction needs to be made between the types of algae mats that dominate the northern shoreline and those occurring along the western and southwestern shorelines. Along the western and southwestern shorelines most of the mats are *Pithophora* and *Spirogyra*, two common benthic, filamentous, green algae.

These mats develop on the lake bottom and rise to the surface as they increase in density. *Pithophora* and *Spirogyra* mats are usually easily controlled with spot treatments of a copper based algacide. Conversely the mats in the north end of the lake (and portions of the northwestern shoreline) are dominated by *Lyngbya*, a course, filamentous, benthic blue-green algae. *Lyngbya* mats are more difficult to control than the *Pithophora* and *Spirogyra* mats. We made note of existence of dense and expansive *Lyngbya* mats in Princeton Hydro's 2011 report to the CLPO. The following is taken directly from that report:

> Additionally, in 2011 there reportedly were problems with the surfacing of benthic bluegreen algae (cyanobacteria) mats of the genus *Lyngbya*. Reportedly these mats were most problematic in the lake's northern end. During the September survey of the lake, dense mats of *Lyngbya* were observed on the bottom of the lake, with samples collected in the lake's northern end……We also observed a large accumulation of leaf litter and associated organic debris in north end of lake, the same area reportedly plagued by the *Lyngbya* mats in the summer of 2011.

Our recommendation was to hydrorake the lake's north end (approximately 5 acre area) to remove the accumulated organic material (leaf litter, detritus, decomposed aquatic plants and algae mats). We suggested that this work be done either in the late fall/early winter or in early spring immediately following ice-out. I continue to support this approach and will elaborate on this further in the September report.

For now, AT needs to continue to treat the mat algae occurring along portions of the western and southern shorelines (or where ever *Pithophora* and *Spirogyra* surface mats attain nuisance densities). With that said, I am still stressing that restraint needs to be taken with the use of copper sulfate in the lake. However, as noted above, between 2001 and 2011 mat algae issue were consistently cited in the AT reports, and control of those growths achieved through the selective application of copper based algaecides. A well designed and implemented mat algae control plan should be able to control *Pithophora* and *Spirogyra* surface mats without compromising the overall water quality of the lake.

2. Is the switch from Sonar to a contact herbicide contributing to the change in lake quality?

Overall I would say no. My review of the data compiled over the past ten years, shows that mid-summer (July/August) Secchi depth transparencies are typically in the range of 7-9 feet; the same as observed this year. So I do not feel that the lake's clarity has taken a significant "hit" from this change in treatment strategy.

There has been more weed growth, which we knew would occur. Based on both Princeton Hydro's observations and the AT service reports, the majority of the weed growth is of desirable species, such as the broad leaf pond weed. While the growth of Naiad reached non-desirable densities in some areas of the lake, AT demonstrated that this plant can be easily controlled. We are all adapting to the lake's response to the switch from a systemic-based control program to a contact-based control program. AT demonstrated (through the treatments they conducted in

July) that the contact herbicides can effectively control weed growth. I feel that the more important matter at hand is improving our prediction of when problem weed growth will occur and developing a more adaptive strategy and more refined treatment schedule.

It would appear from the comments received from lake users and our observations of the lake that there has been an increase in the frequency and density of mat algae (*Pithophora* and *Spirogyra*). Admittedly, some of these mat algae problems are in part tied to the change in the weed treatment program. As noted in the AT reports, the *Pithophora* and *Spirogyra* were observed clinging on the treated and decaying weeds. Obviously these mat algae problems can be better addressed going forward. However, the entire mat algae problem is not a new problem. As noted above, mat algae treatments have been routinely conducted over the past decade. Additionally, the floating mats of *Lyngbya* (the darker, denser mats) reached problematic densities in 2011 (see above). While the greater frequency and density of the *Pithophora* and *Spirogyra* mats are likely linked in part to the change in weed treatment strategy, this is an issue that can be addressed through a change in the algae control strategy. I do not feel however that the increased occurrence of the *Lyngbya* mats is due to the switch from systemic to contact herbicides. There is nothing about this algae's natural history and growth patterns that would suggest so. Unlike the *Pithophora* and *Spirogyra* mats, *Lyngbya* mats tend to stay on the bottom of a lake, rarely surfacing. The more frequent occurrence of this algae at the lake's surface may be in part due to the lower water level of the lake. It could also be a condition triggered by the build up of organic debris on the lake bottom. Again, we raised this issue in our 2011 report and feel that the control of the *Lyngbya* mats can be addressed through a concerted hydroraking program.

3. Given the low water level of the lake, lack of rain and extreme heat, would we be having these issues even if we had used Sonar at the start of the season?

This has been a very trying year for many of the lakes in New Jersey (and throughout the region). For the majority of the lakes we manage or maintain, the weather patterns of 2012 have increased the frequency of algae blooms. However, as discussed above not all of the changes observed this year in Cedar Lake are solely a function of the weather. I do feel that that weed and algae problems in the lake's shallower areas are being exacerbated by the lower level of the lake. From my observations the lake appears to be about 6"-9" lower than normal. While this does not impact the deeper areas of the lake it does have a decisive effect on the north and south shore and the majority of the western shoreline. Additionally, it was an abnormally mild winter. This could have affected mat algae growth and weed growth. Overall though, the primary problem with the lake, mat algae growth, is not a totally a function of switching from systemic to contact weed control. I can point to numerous lakes that are treated with Sonar that have mat algae problems and as reflected in the AT services reports from the past decade, mat algae growth has always been an issue for Cedar Lake.

Cattail Growth at Lake's North End

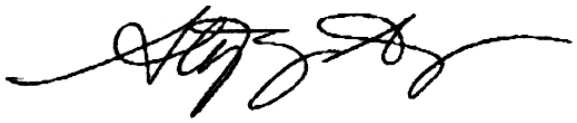
I was also asked to evaluate what can be done about the stand of cattails in the northern end of the lake. The property owner would like to have this stand partially controlled (enough to

improve access and visibility, but not so much as to eliminate the privacy afforded by the cattails). This can be achieved through the selective application of an appropriate herbicide by AT. I have been informed that this stand was treated earlier this week.

I trust that this answers the questions that were posed to me about the existing state of the lake. In summary, the lake's water quality continues to be excellent and is not being affected by the switch in the treatment program. This is supported by the accompanying 2012 data, the data compiled by Princeton Hydro in 2011, and my review of the data provided in the 2012 AT service reports and End of Year reports from 2001 through 2010. Further modifications of the treatment program will need to be made in 2013, but overall with the exception of the mat algae problems, the suspension of the Sonar program has not led to the rampant growth of aquatic weeds throughout the lake. It has also not impacted the lake's trophic state as reflected in the clarity, DO/thermal profile, nutrient and Chlorophyll data.

If there are any questions or comments concerning this report, please contact me.

Sincerely,



Stephen J. Souza, Ph.D.
President, Princeton Hydro, LLC

In-Situ Monitoring for Cedar Lake 5/30/12								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
North End	**1.30**	**1.3+**	**Surface**	27.01	0.274	7.04	7.03	89.4
			0.5	27.01	0.274	6.74	7.01	84
			1.0	26.89	0.277	5.37	6.96	63.8
			1.2	26.84	0.278	4.23	6.86	54.4
Mid-Lake	**4.20**	**3.80**	**Surface**	26.7	0.275	7.35	7.24	93.2
			1.0	26.71	0.275	7.76	7.21	96.2
			2.0	25.48	0.276	7.3	7.15	86.7
			3.0	22.29	0.279	7.01	7.11	81.2
			4.0	20.38	0.291	1.85	6.93	22.3
South End	**1.20**	**1.2+**	**Surface**	25.71	0.273	7.63	7.17	92.7
			0.5	25.71	0.273	7	7.13	85.4
			1.0	25.65	0.27	8.13	7.16	100.5
			1.2	25.59	0.273	6.86	7.02	83.6

In-Situ Monitoring for Cedar Lake 6/27/12								
Station	**DEPTH (meters)**			**Temperature**	**Conductivity**	**Dissolved Oxygen**	**pH**	**Dissolved Oxygen**
	Total	**Secchi**	**Sample**	**(^{0}C)**	**(mmhos/cm)**	**(mg/L)**	**(units)**	**(%)**
North End	**1.25**	**1.25+**	**Surface**	24.02	0.28	9.18	6.22	111.8
			1.0	23.94	0.282	9	7.94	110.8
			1.2	23.93	0.281	9.42	7.7	114.9
Mid-Lake	**3.90**	**2.50**	**Surface**	25.15	0.279	7.75	6.32	96.5
			1.0	24.99	0.279	7.46	6.53	92.6
			2.0	24.55	0.278	7.29	6.62	89.7
			3.0	24.22	0.278	7.17	6.68	87.8
			3.5	24.09	0.277	7.01	6.69	85.8
			3.8	23.27	0.354	4.66	6.14	51.8
South End	**1.10**	**1.1+**	**Surface**	23.86	0.278	8.37	6.24	101.8
			1.0	23.74	0.277	7.95	6.71	96.3

In-Situ **Monitoring for Cedar Lake 7/30/12**

Station	DEPTH (meters)			Temperature	Conductivity	pH	Dissolved Oxygen	Dissolved Oxygen
	Total	Secchi	Sample	(^{0}C)	(µmhos/cm)	(units)	(mg/L)	(%)
North End	1.10	1.1+	Surface	26.42	281.8	6.41	5.82	74.3
			0.5	26.27	283	6.55	5.41	68.9
			1.0	25.98	283.6	6.54	5.07	64.3
Mid-Lake	4.00	3.00	Surface	27.22	283.9	6.42	7.56	98
			1.0	27.02	283.4	6.59	7.2	93
			2.0	26.82	283.7	6.65	6.82	87.8
			3.0	26.77	283.7	6.69	6.53	84
			3.5	26.7	284.3	6.62	5.76	74
			4.0	25.85	366.2	6.35	4.51	57.1
South End	1.20	1.2+	Surface	26.79	281.2	6.54	5.52	71
			0.5	26.64	280.7	6.59	5.58	71.6
			1.0	26.65	280.2	6.62	5.71	73.3