

March 1, 2011

Pembroke Watershed Association
 c/o Mr. Ray Holman, President
 P.O. Box 368
 Pembroke, MA 02359

Re: 2010 Project Completion Report

Dear Ray:

This report provides an overview and summary of the past year's Aquatic Management Program at Furnace Pond. A chronology of the 2010 Management Program activities follows:

- ◆ *Issuance of License to Apply Chemicals permit from MA DEP* June 10th
- ◆ *Algal Sample Collection by the Pembroke Watershed Association* weekly May 25th -August 30th
- ◆ *Initial Algaecide Treatment* June 22nd
- ◆ *Follow-up Algaecide Treatment* August 9th

Algae Monitoring Program:

Weekly water samples were collected by the Pembroke Watershed Association from the middle of Furnace Pond, between late-May and late August. The collected samples were shipped to Aquatic Control for dominant algae species identification and enumeration. Fresh samples were generally examined within a day or two of receipt and then preserved for further analyses at a later date.

Among the algal groups represented in the samples collected Chlorophytes (green algae) were generally the most prevalent with cell densities reaching nearly 70,000 cells/ml in late May and again in late July. Cyanophytes (blue-green algae) and bacillariophytes (diatoms) followed chlorophytes as prevalent taxonomic groups in most samples. Some cyanophytes or blue-green algae species are of particular importance to management as members of this genus have the ability to produce toxins that can be harmful to the pond ecology and human health. The only blue-green algae genus encountered in Furnace Pond in 2010 was *Microcystis*. Many *Microcystis* species produce a toxin appropriately named microcystin. The acute effects of exposure to this toxin can include skin and mucous membrane irritation, nausea, vomiting, diarrhea and severe thirst. The extent of the effects experienced depends on a number of factors including toxin concentration, exposure time, number of exposures and subject sensitivity. No instances of microcystin exposure were reported for Furnace Pond in 2010. As a result of the management program we were able to keep the *Microcystis* and all other blue-green algae species at relatively low densities throughout the growing season. In fact, the total blue-green algae density never rose above about 12,000 cells/ml during the 2010 season, which is significantly less than the near

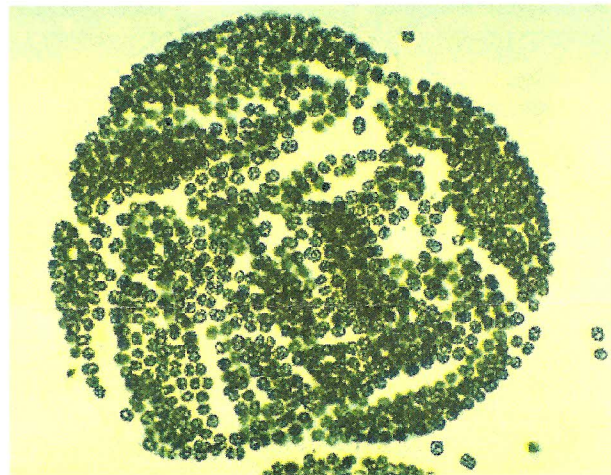
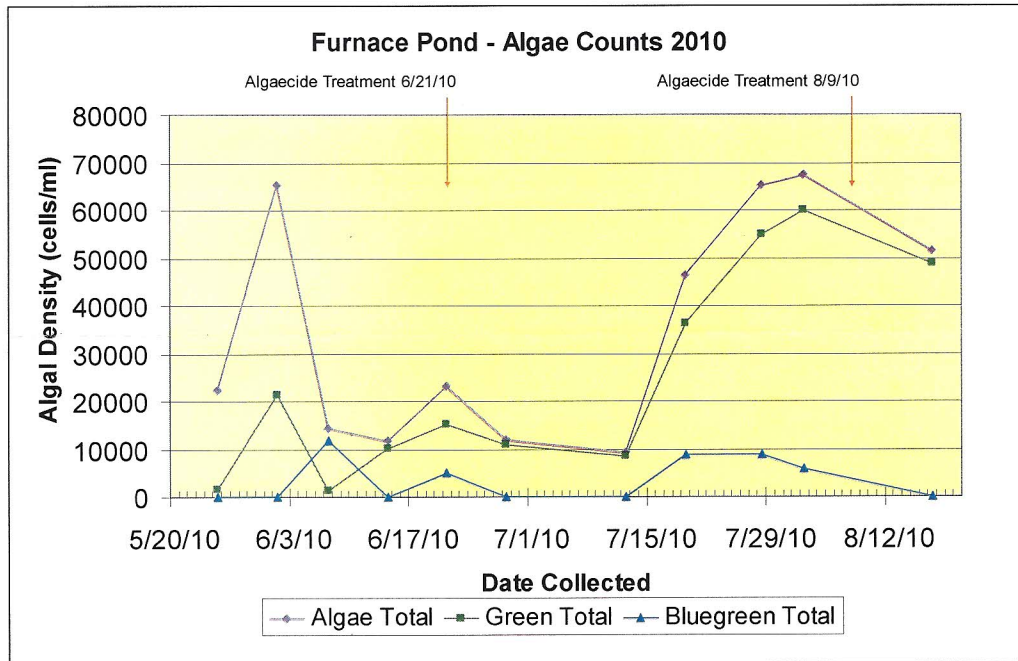


Figure 2: Image of a microcystis colony, courtesy of the Botany Department at the University of Hawaii

40,000 cells/ml observed in the fall of 2009. Maintaining low blue-green and total algae densities are important to maintaining suitable conditions for recreation and fish and wildlife habitat. Overall the program provided good control and helped to maintain acceptable algae growth densities.

Figure 1: Algae Counts from Furnace Pond Samples Collected Mid-Lake Weekly in 2010



The results of the weekly algae identification and enumeration are presented in the table above. The results and graphic representation of the dynamic microscopic algae assemblage in Furnace Pond in 2010 is somewhat misleading due to the high abundance of large colonial Chlorophytes (green algae) present. The amplification factors necessary for enumerative cell counts of these species can sometimes cause an over estimation of the true cell count. For example the early June samples show an increase in large colonial species such as *Zygnema* and *Botryococcus*, which in response to the amplification factors applied resulted in cell counts significantly higher than the mid to late June samples. It is our belief that algae biomass continued to rise at a moderate rate during this period without the drastic increase and decline in cell density depicted in early June. The limited Secchi disk data during this period remain relatively stable, but continue to fall to the point where treatment is required in mid to late June (6/21/10).

A significant growth of green algae resulted in a dramatic increase in cell density in mid to late July. As can be seen in the graph the green algae species comprises the bulk of the cell density increase leading up to the algaecide treatment performed on 8/9/10. The green algae that dominated the assemblage leading up to the treatment was *Eudorina* species, which is also a colonial alga that may have again resulted in an over estimation of the total cell density. Despite the possibility of an over estimated cell density, the increase in algae growth was visually evident leading up to treatment.

Algaecide Treatments:

Furnace Pond was treated twice during the summer of 2010. Treatments were scheduled based on algal densities observed in samples collected by the Pembroke Watershed Association and analyzed by Aquatic Control Technology as well as reports from the Association.

The first treatment was conducted on June 22, 2010. At the time of the treatment a Secchi disk reading was taken as a measure of water clarity. The reading on June 22 was 4.0 feet, indicating low clarity due to algal populations in the water column. The dominant taxa were green algae and diatoms. Colonies were visible in the water column throughout the pond and most dense along the windward shorelines. A temperature and dissolved oxygen profile, measured prior to treatment, indicated that oxygen levels were high enough to permit treatment with minimal risk of problematic oxygen depletion. Copper sulfate was applied to the entire surface of the pond evenly from our specially designed spray boat. Following treatment algal densities remained relatively low until late July.

Due to the receipt of a few algal samples with increasing algal density a follow-up algaecide treatment was conducted on August 9, 2010. At the time of the treatment a Secchi disk reading was taken as a measure of water clarity. The reading in August was approximately 1.0 foot, indicating a severe decline in water clarity due to high algal density. The dominant taxa were green algae and blue-green algae. Again colonies were visible in the water column throughout the pond and most dense along the windward shorelines. Due to the densities of algae observed it was determined that large scale treatment would pose too high a risk of wide spread oxygen depletion. As such, copper sulfate was applied to the surface of the northern third to a half of the pond in the same manner as the previous treatment. The southern-most portion of the pond was left untreated to guard against possible negative impacts to fish and wildlife. The treatment was successful at reducing algal population and no adverse effects of oxygen depletion were reported. Despite the immediate reduction of the algae population following treatment, late August samples indicated a significant amount of green algae regrowth. However, due to the lateness of the season and budget no additional treatment was performed.

Management Recommendations:

Due to the relative success of the 2010 Management Program, we would recommend a similar program for 2011. We do, however, feel that with a good season long baseline of algae data that we can relax algae sampling/monitoring component of the program. Monitoring of the changes in algae density for determining the need for and timing of copper sulfate treatments can likely be effectively accomplished at this point with weekly Secchi disk readings and a few discretionary rounds of algae sample identification and enumeration. We have developed a proposal/agreement for the continuation of the Furnace Pond Algae Management Program for the Association's review and consideration. If you are interested in moving forward with the program as outlined in the attached proposal please return a signed copy to our office at your earliest convenience.

We have enjoyed working with the Pembroke Watershed Association and look forward to working with you again in the future. If you have any questions regarding this report please do not hesitate to contact our office

Sincerely,

AQUATIC CONTROL TECHNOLOGY, INC.



Keith Gazaille
Senior Biologist