SOLITUDE
LAKE MANAGEMENT

March 24, 2017

Mr. Stephen E. Cotton, President
Foster's Pond Corporation
19 Pomeroy Road
Andover, MA 01810

RE: Recommended Treatment Protocol for Diquat Herbicide Spot-Treatment of Invasive Aquatic Plants and Copper Sulfate Algaecide Treatment of Cyanobacteria (Blue-green algae) in Foster's Pond

Dear Mr. Cotton,

We reviewed our 2016 Foster's Pond Annual Aquatic Management Program Report, and the following document summarizes past management activities and details the spot-treatment program we are recommending.

Introduction and Management History

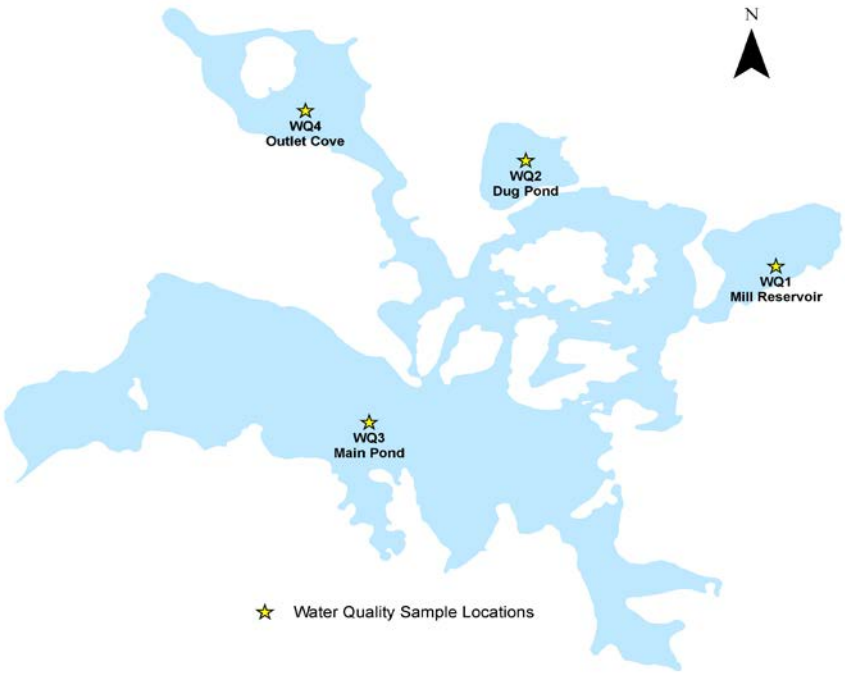
Four non-native and invasive submersed aquatic plants have been documented in Foster's Pond. Fanwort (*Cabomba caroliniana*) was the target of the Sonar (active ingredient: fluridone) herbicide treatment programs performed in 2005, 2007, 2011, and 2015. Brazilian elodea (*Egeria densa*) in the Glenwood Road Basin was spot-treated with fluridone in 2006; it was observed again in limited densities in later years. The third invasive plant, curlyleaf pondweed (*Potamogeton crispus*) was identified by the Foster's Pond Corporation (FPC) in prior years, but has not been observed in recent years' surveys. The fourth submersed invasive species in Foster's Pond, European or spiny naiad (*Najas minor*), was found by Geosyntec in 2009. This plant has rapidly spread through Massachusetts lakes and ponds over the last decade. Per Geosyntec's suggestion, spiny naiad was spot-treaded with Reward (active ingredient: diquat) herbicide in 2010. Additionally, Reward has been used for treatment of Brazilian elodea in 2011.

Three of the invasive plants currently found in Foster's Pond – spiny naiad, Brazilian elodea, and curlyleaf pondweed – are susceptible to Reward herbicide. Fluridone remains the only aquatic herbicide registered for annual use in Massachusetts that effectively controls fanwort.

Reduced water clarity has been common within the pond due to algae, suspended sediment and dissolved material (i.e. tannins) from the extensive adjacent wetlands areas. However, in recent years, algal blooms have increased in frequency and severity, including the presence of cyanobacteria, or blue-green algae. Late summer Secchi disk water clarity readings have historically been mediocre, but do fluctuate. Between 2004 and 2010, readings were anywhere from less than 1.0 meter to greater than 2.0 meters. During August of 2012, there was a microscopic cyanobacteria bloom in Foster's Pond. In recent years, algaecide treatments have helped mitigate water clarity issues due to algal growth.

Water quality sampling data collected over the years has shown that several sections of Foster's Pond suffer from elevated phosphorus concentrations. Phosphorus is usually the limiting nutrient in freshwater systems. Lakes and ponds are considered to be eutrophic (nutrient rich) if total phosphorus concentrations exceed 0.025 mg/L. Although phosphorus concentrations have varied over the last few years, Main Pond has frequently had results greater than 0.025 mg/L; although other sampled locations usually resulted in less than 0.025 mg/L total phosphorus, there have been instances where results were higher. In 2016, Main Pond was 0.036 mg/L, Mill Reservoir was 0.016 mg/L, Outlet Cove was 0.012 mg/L, and Dug Pond was ND (non-detect); sample locations can be seen in the map below. In-water phosphorus concentrations likely fluctuate considerably throughout the year, depending on environmental conditions, but there has been a trend toward elevated concentrations that are fueling nuisance algal blooms. The phosphorus within Foster's Pond is likely entering through stormwater runoff and is being internally recycled from the nutrient-rich bottom sediments. Although stormwater runoff is a contributing factor, oftentimes internal sediment nutrients are the greater contributing factor.

More extensive sampling and testing would be needed to determine if in-lake nutrient reduction measures such as phosphorus precipitation/inactivation treatments (alum treatments) can provide a cost-effective reduction in phosphorus concentrations and the associated algae growth. In the interim, FPC would like to be prepared to treat with copper sulfate algaecide if algae, specifically cyanobacteria, are approaching bloom conditions to mitigate potential public health hazards. Copper sulfate treatments were performed in 2013, 2015, and twice in 2016 due to elevated phosphorus concentrations and low Secchi disk readings.



Diquat Herbicide Treatment Program

Diquat is a contact-acting herbicide that controls actively growing stem and leaf tissue of susceptible plants. Treatments are typically performed in the late spring or early summer,

when target plants are in their most active growing phase, but before reaching peak biomass. A tentative treatment protocol for spot-treatment with diquat is as follows:

Herbicide Description and Mode of Action:

Diquat is a widely used contact herbicide that is applied to hundreds of lakes and ponds throughout the northeast US and throughout all of North America to control nuisance submersed aquatic plants. It is likely the most widely used aquatic herbicide in Massachusetts and other northeastern state. Diquat has been used to control nuisance submersed weed growth at three other Andover waterbodies over the past decades: Pomps Pond, Field Pond, and a private pond.

Diquat is translocated to some extent within the plant. Its rapid action tends to disrupt the leaf cuticle of plants and acts by interfering with photosynthesis. Upon contact with the soil, it is adsorbed immediately and thereby biologically inactivated.

To control nuisance spiny naiad, Brazilian elodea or curlyleaf pondweed growth found in Foster's Pond, diquat would be applied at the application rate of 1.0 - 1.5 gal/acre, which is less than the USEPA label's recommended maximum application rate of 2.0 gals. Temporary water use restrictions for Reward are 1) no drinking or cooking for 3 days, 2) no irrigation of turf/food crops for 5 days, and 3) no watering livestock for 1 day. There are no restrictions on swimming, boating or fishing listed on the EPA product label, but prudent pesticide management practices suggest that the pond be closed to all uses on the day of treatment.

Herbicide Toxicology and Environmental Fate:

Diquat is registered for use in Zone II, groundwater protection areas in Massachusetts. There are no well-water use restrictions or no-treatment setbacks required for aquatic diquat applications in Massachusetts. Diquat has a high adsorption coefficient and propensity to bind with sediment, which makes it relatively immobile in soil. We have been involved in dozens projects in NH, CT and MA where post-treatment well testing was a permit condition and we are not aware of a single positive detection of diquat in a well following an aquatic application.

Diquat is usually applied at 1 gallon per surface acre in waters averaging 4 feet in Massachusetts, which results in a water concentration of 0.1 ppm (MA Practical Guide, p. 123). Diquat residues in water rapidly decline to typically between 0.064 and 0.144 ppm ion eight hours after application and to below 0.01 ppm ion during the next five days. The Maximum Contaminant Level (MCL) for diquat established by the EPA is 0.02 ppm (mg/l). The primary route of dissipation of diquat in water is *adsorption*. Diquat rapidly disappears from water in natural systems by adsorption to sediment, aquatic vegetation, and dissolved and particulate organic matter (e.g. EPA, 2002; WHO, 1984). Upon introduction into water, diquat quickly binds to these matrices and is thereby removed from the water column, becoming essentially immobile and inactivated in the environment (EPA, 2002). The aquatic half-life of diquat in natural waters is approximately 1 – 2 days (EPA, 2002). Reward not adsorbed by the plants is tightly bound to soil, and rendered biologically unavailable. Because of its rapid dissipation, aquatic animal exposure to diquat would be limited to very short-term, acute durations (Washington State Department of Ecology, 2002). Because dissipation of diquat is so rapid, acute effects to organisms in the field are unlikely at rates used for vegetation control (GEIR, p. A-53).

Detailed information on diquat can be found at the Massachusetts Department of Conservation and Recreation, Lakes and Ponds Program website. There are links under the Publications tab to the "Generic Environmental Impact Report for Eutrophication and Lake Management in Massachusetts" and the "Practical Guide to Lake Management in Massachusetts."
http://www.mass.gov/eea/agencies/dcr/water-res-protection/lakes-and-ponds/eutrophication-and-aquatic-plant-management.html

Additional information can be found at the Massachusetts Department of Agricultural Resources website:
http://www.mass.gov/eea/agencies/agr/pesticides/aquatic-vegetation-management.html

Application Methodology:
Treatments will be performed by SŌLitude's MA Commercially Certified aquatic applicators. Treatments will be performed from either an Airboat or conventional spray boat powered by an outboard motor. The concentrated liquid formulation of diquat will first be diluted with pond water in a 50-gallon spray tank on board the boat. The herbicide solution will then be evenly injected subsurface through weighted hoses using a calibrated pumping system.

Treatment Timing:
Timing of the initial application will be determined following a pre-treatment inspection in June. Spiny naiad is an annual plant that develops from seed each year. In some instances, active plant growth is not evident until late June or July. Treatment would be scheduled to occur within approximately two weeks after active growth is confirmed and the treatment areas are finalized.

Treatment Areas:
Based on observations during the June survey, treatment areas will be determined; historically, this has been 5+/- acres. However, additional areas may be treated if spiny naiad is observed in other parts of the pond in the course of the pre-treatment inspection. Our final report that will be filed with the Conservation Commission pursuant to Special Condition 12.27 will document all areas treated in 2017.

Notification and Water Use Restrictions:
Although no restrictions on swimming, fishing or other recreational activities are required by the product label following treatment with Reward, we recommend the following temporary water use restrictions: no boating, fishing, or swimming in the treated water on the day of treatment; no use of treated water for drinking, watering livestock or irrigation for a period of 5 days following treatment. Accordingly, prior to all treatments, the shorelines of areas to be treated will be posted with signs that warn of the temporary water use restrictions.

Additional Permits:
This treatment program is subject to the existing Order of Conditions (DEP File # 090-0535). SŌLitude will prepare and file for a site-specific License to Apply Chemicals (BRP WM 04), which is issued by DEP annually on a project-specific basis. Pursuant to Special Condition 12.19, a copy of this License will be provided to the Conservation Commission prior to treatment.

Copper Sulfate Algaecide Treatment Program

Used as an algaecide for more than 60 years, copper remains the most commonly used algaecide in freshwater systems. The most common formulation is copper sulfate pentahydrate ($CuSO_4 \times 5H_2O$). Low doses of copper sulfate (0.3 ppm as copper sulfate or 0.075 ppm as copper) are typically used to control free-floating or planktonic algae in Massachusetts lakes and ponds. There are no water-use restrictions associated with copper-based algaecides. On an annual basis, SOLitude treats several direct, potable (drinking) water reservoirs, including Lake Cochichewick and a number of recreational waterbodies in the Commonwealth with these algaecides. The concentrated algaecides are first diluted with pond water and are then sprayed through the respective area(s). If applied, treatment will not exceed 50% of the pond volume, to prevent any sudden dissolved oxygen decreases that could potentially impact aquatic wildlife.

Impacts Specific to the Wetlands Protection Act using Copper[1]

- Protection of public and private water supply – Benefit (used to control algae)
- Protection of groundwater supply – Neutral (no significant interaction)
- Flood control - Neutral (no significant interaction)
- Storm damage prevention – Neutral (no significant interaction)
- Prevention of pollution - Generally neutral (no significant interaction), but could be a detriment if algae/plant die-off causes low oxygen at the bottom of the lake or causes release of taste and odor compounds or toxins

Detailed information on copper can be found at the Massachusetts Department of Conservation and Recreation, Lakes and Ponds Program website. There are links under the Publications tab to the "Generic Environmental Impact Report for Eutrophication and Lake Management in Massachusetts" and the "Practical Guide to Lake Management in Massachusetts."
http://www.mass.gov/eea/agencies/dcr/water-res-protection/lakes-and-ponds/eutrophication-and-aquatic-plant-management.html

Additional information can be found at the Massachusetts Department of Agricultural Resources website:
http://www.mass.gov/eea/agencies/agr/pesticides/aquatic-vegetation-management.html

Application Methodology:
Treatments will be performed by MA Commercially Certified aquatic applicators. Treatments will be performed from either an Airboat or conventional spray boat powered by an outboard motor. Copper sulfate is dissolved with lake water in a mixing tank on the spray boat. The diluted solution is then usually applied as a surface spray through fan-pattern nozzles. Transects or passes are then made usually 100 feet apart. GPS navigation is used to insure that an even application is made throughout the designated treatment areas.

1 Commonwealth of Massachusetts Executive Office of Environmental Affairs. *Practical Guide to Lake Management*: 2004. 122 p.

Treatment Timing:
Timing of the initial application will be determined by in-lake conditions. FPC will begin monitoring water clarity regularly using a Secchi disk. If water clarity drops below 5 feet (1.5 meters) and/or there is a visible surface scum of cyanobacteria, then samples will be collected and sent to SŌLitude for microscopic analysis. If elevated cyanobacteria concentrations are confirmed, then a treatment will likely be scheduled.

Treatment Areas:
Based on past observations, the Main Pond and Outlet Cove sections of Foster's Pond and the most likely areas that will be targeted with an algaecide application. The maximum total area treated during any single application will be one-half of the waterbody or 60 acres. If additional treatment is required, a follow-up application will be scheduled one to two weeks after the initial application in accordance with the product label directions and conditions of the annual DEP License to Apply Chemicals.

Notification and Water Use Restrictions:
Although no restrictions on swimming, fishing or other recreational activities are required by the product label following treatment with copper sulfate, we recommend closing the pond to all uses on the day of treatment. Accordingly, prior to all treatments, the shorelines of areas to be treated will be posted with signs that warn of the temporary water use restrictions.

Additional Permits:
This treatment program is subject to the existing Order of Conditions (DEP File # 090-0535). SŌLitude will prepare and file for a site-specific License to Apply Chemicals (BRP WM 04), which is issued by DEP annually on a project-specific basis. Pursuant to Special Condition 12.19, a copy of this License will be provided to the Conservation Commission prior to treatment.

We trust that this information will address most of the questions raised about the proposed spot-treatment with diquat herbicide and copper sulfate algaecide.

Please do not hesitate to contact our office if you have questions or require additional information.

Sincerely,

SŌLitude Lake Management

Kara Sliwoski
Aquatic Biologist