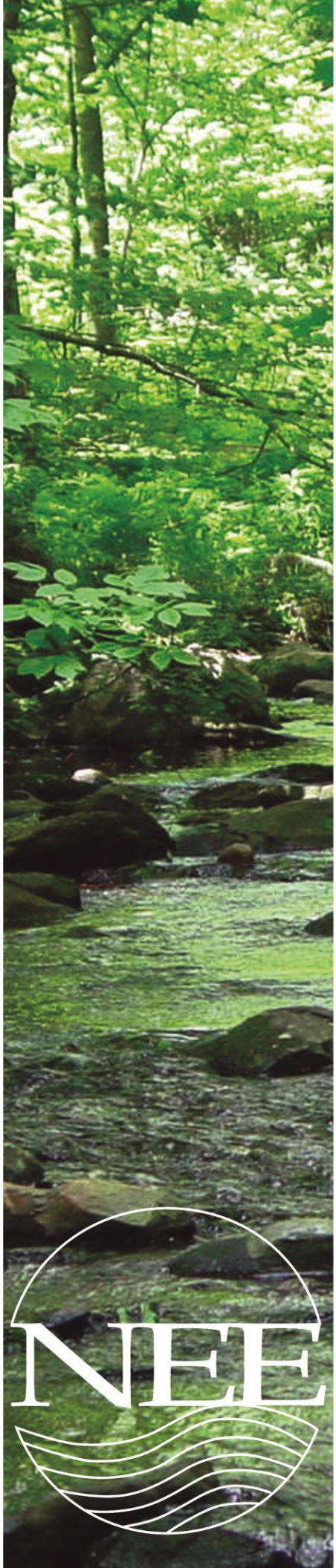

NEE environmental consulting

Lake Management Plan

Naomi Valentine
Scott Fisher
Mark June-Wells

Submitted: July 27, 2017

Prepared for;

Rogers Lake Authority
52 Lyme St.
Old Lyme, CT 06371

NEE Project No. 14-4467

New England Environmental, Inc.
Environmental Consulting
15 Research Drive
Amherst, MA 01002
(p) 413.256.0202
(f) 413.256.1092
www.neeinc.com

Table of Contents

FIGURES

APPENDICES

1.0 INTRODUCTION

Rogers Lake is a 260-acre recreational lake in Lyme and Old Lyme, Connecticut that is home to a diverse variety of plant and animal life as well as a few non-native and native nuisance plant species. Variable-leaf milfoil (*Myriophyllum heterophyllum*) and fanwort (*Cabomba caroliniana*) (two aggressive, non-native invasive species) and various lily species have taken over many high-traffic recreational areas around the lake, causing problems for many of the recreational users and residents of Rogers Lake. In an attempt to manage this growing problem, the Towns of Lyme and Old Lyme engaged New England Environmental, Inc. (NEE) to evaluate plant management options that would both restore areas for recreation use and increase the health of Rogers Lake by eliminating the threat of further invasive species infestation.

The study conducted by NEE began in the spring of 2014 with initiatives aimed at understanding the current and historical biological, chemical, and physical factors of Rogers Lake. Furthermore, it included ecological and human health risk assessments, which were intended to understand any potential negative impacts that might be associated with future plant management protocols. This document aims to provide a brief summary of past action items, (as fully documented in the previous report by NEE: *Rogers Lake Non-Chemical and Chemical Vegetative Control Assessment and Options*, which is posted as public record in both the Towns of Lyme and Old Lyme) as well as detail a comprehensive long-term management plan.

2.0 CURRENT AND HISTORICAL DATA

New England Environmental, Inc. conducted many studies throughout this year-long comprehensive invasive control research project. Below are brief summaries of the data collected and findings as compared to historical data. This information is what allowed NEE to come to a conclusion on the best management option for invasive and nuisance species in Rogers Lake.

2.1 Plant Community Findings

NEE established a baseline of data and a protocol for future data collection in the development of a Quality Assurance Project Plan (QAPP) during the plant community study in 2014. This protocol details all features that will be involved in all future vegetation monitoring and can be found in Appendix C. Our findings indicate that Rogers Lake houses 27 species of aquatic plants; two of which are non-native, three of which are nuisance lily species. The plant community exhibited richness and diversity qualities that were strongly related to depth. Unfortunately, the invasive and nuisance species are most prevalent in the area between one and two meters of water (the littoral zone), which was also found to be the most productive region of Rogers Lake. In fact, variable-leaf milfoil (*Myriophyllum heterophyllum*) and fanwort (*Cabomba caroliniana*) account for 32 percent of the littoral zone area, which was estimated to be about 94 acres in size (36 percent of Rogers Lake surface area). The lily species occupy approximately 5.15 acres of surface area on the lake.

Comparing these results to historical data suggests that the relative richness of Rogers Lake has increased between 2002 and 2014 (See ACT & NEAR 2003, CAES 2006, and NEAR 2012). The presence of variable-leaf milfoil has been documented since 2002; however, fanwort was not detected until 2010. The former has been relatively stable in population size since 2002

expanding only marginally. The latter species however, has expanded significantly since it was first detected in 2010. It was first found by NEAR in a small population that was restricted to the state boat launch area. It now intermingles with populations of variable-leaf milfoil throughout most of the 31 acres currently inhabited by non-native aquatic plants. NEE concluded that both the nuisance lily species and the invasive species must be controlled in order to effectively improve recreational use in Rogers Lake. However, the lily species provide valuable habitat for much wildlife within Rogers Lake, promoting species diversity, and therefore should only be selectively removed from the lake.

2.2 Water Quality Findings

NEE established a baseline of data and a protocol for future data collection in the development of a Quality Assurance Project Plan (QAPP) during the water quality study in 2014. This protocol details all features that will be involved in all future water quality monitoring and can be found in Appendix B. All details of the 2014 water quality study can be found in the *2014 Rogers Lake Water Quality Assessment Report,* which is available as public record in the Towns of Lyme and Old Lyme. Below is a brief summary of the conclusions of that document.

Overall NEE discovered good water quality during the summer of 2014, which has been relatively stable since 2002. The water system of Rogers lake can be classified as mesotrophic (of moderate productivity) based on a variety of factors. Oxygen is the major chemical constituent of lake ecosystems that drives the dynamics of numerous other biological and chemical phenomena. By August, the deepest portions of Rogers Lake are devoid of oxygen due to stratification and a low rate of mixing between layers. Therefore, the nutrients that are directly related to the concentration of oxygen (phosphorus, ammonia, TKN) exhibit a pattern of increasing concentration throughout the season in the deepest portions of the lake, while the nutrient level on the surface of the lake remains rather stable for most of the year.

In 2014 water clarity increased from two meters to 2.82 meters between May and October. Furthermore, the algal community was never dominated by planktonic blue-green algae during the 2014 summer season, which suggests that the nutrient balance in the system favors competition among numerous algal species. Water clarity in 2014 was less compared to 2002 but it was in line with other recent studies. It was significantly less than the measurements collected in 1938 and 1978, which is likely a result of cultural eutrophication and land use changes in the watershed. More recent (i.e. 1992 – 2014) fluctuations in water clarity are probably a result of natural variation both internal and external to the lake. But, this assertion should be confirmed in coming years. Additionally, the recent algal assessments, including those of this study, suggest that the algal community is consuming nitrogen compounds in the surface waters during the summer season and that the internal phosphorus load is not having a significant negative impact on the algal community of Rogers Lake. Future monitoring will confirm or refute these findings.

2.3 Well Study Findings

In order to understand any and all possible effects of vegetative management in Rogers Lake, Fuss & O'Neill conducted a well impact study in 2014, which is detailed in the *Domestic Well Impact Evaluation* report previously submitted to the Towns of Lyme and Old Lyme. Fuss & O'Neill conducted a windshield survey of the communities surrounding Rogers Lake, reviewed

the geology and hydrology of the region and reviewed available well logs for residents around Rogers Lake. They found that the topography surrounding the lake is such that groundwater flows down towards the lake in all areas with the exception of the south and southwest portions near the spillway to the Mill River. This means that water from Rogers Lake does not ever naturally flow from the Lake to the surrounding land. Furthermore, the well impact study showed that there is an extremely low chance that any water from Rogers Lake could possibly be pumped up into a domestic well. Therefore, NEE was able to eliminate the possibility of herbicide treatment in Rogers Lake effecting the drinking water of Lyme and Old Lyme residents.

2.4 Wildlife Habitat Findings

NEE conducted a wildlife habitat survey in order to understand pre-management habitat conditions of Rogers Lake. During these surveys both habitat and wildlife observed were documented and can be found in the *Wildlife Habitat Assessment for Rogers Lake* report as well as in the *Rogers Lake Non-Chemical and Chemical Vegetative Control Assessment and Options* report. The main takeaway from this survey is that the lilies and invasive species represent a large percentage of floating aquatic vegetation habitat for juvenile fish, juvenile turtles and amphibians as well as predators such as the great blue heron (*Ardea herodias*). Therefore it is very important to be cognizant of the density of vegetation being removed from the lake during control to avoid depletion of these habitats. NEE recommends that only selective lily removal be conducted in order to maintain floating vegetation habitat for the aforementioned wildlife.

2.5 Toxicology Findings

Herbicide control is a very effective method of management for the invasive species in question. O'Reilly, Talbot & Okun Associates, Inc. conducted a literature review of potential human toxicity related to the application of the three most effective candidates for chemical control: Fluridone, Flumioxazin and Carfentrazone. The details of these findings can be found in the *Rogers Lake Non-Chemical and Chemical Vegetative Control Assessment and Options* report. Generally it was confirmed that the Environmental Protection Agency (EPA), Connecticut Department of Public Health (CTDPH) and The Connecticut Department of Energy and Environmental Protection (CTDEEP) have very comprehensive procedures for registering, monitoring and reviewing chemicals for use as vegetative control as well as approving applications and permits for herbicide use in The State of Connecticut.

When considering the three aforementioned chemicals in question, it was concluded that all may be permitted for use within Rogers Lake, but that Flumioxazin had the shortest half-life (persists in water for the shortest period of time), only showed slight toxicity towards juvenile fish and invertebrates and no toxicity to humans at label application rates. Additional permitting restrictions of Flumioxazin reinforce the rates of the chemical application in order to further protect human health during application. It is the professional opinion of NEE and O'Reilly, Talbot & Okun Associates that Flumioxazin does not have any notable human or environmental health effects and therefore would be the best chemical option for treatment.

2.6 Overall Summary of Lake Conditions

Rogers Lake houses one of the most diverse plant communities in the state of Connecticut and the presence of invasive species in the lake could threaten this diversity over time. Furthermore, it is important to note the recreational value and use of Rogers Lake and how the overgrowth of invasive and native nuisance species is restricting the availability of recreational space. Vegetative management will restore recreational use and minimize the threat on native species.

Rogers Lake is also of overall good water quality according to the 2014 water quality survey as compared to historical data. It is unknown how plant management will affect the water quality of Rogers Lake, therefore annual water quality surveys should be conducted to monitor any changes. A modification in treatment may need to occur if there are any negative changes in water quality over the years of vegetative maintenance.

3.0 LONG-TERM PLANT MANAGEMENT PLAN

After the comprehensive study conducted in 2014 and meeting with the Towns of Lyme and Old Lyme, chemical management has been selected as the best option for controlling the invasive species within Rogers Lake and that selective hydroraking is the best management option for controlling lily species within Rogers Lake. The long-term management plans for both these control methods are outlined below along with a schedule including water quality monitoring.

3.1 Chemical Treatment of Invasive Species

Flumioxazin (Clipper™) has been selected as the best chemical option, based on fiscal responsibility, efficacy and human/environmental health effects, to treat variable-leaf milfoil and fanwort. The areas to be treated by Flumioxazin are highlighted in Figure 1 as proposed chemical treatment and total 31 acres. The entire 31 acres will be treated in 2016. The treatment area and need for additional management will be reevaluated each subsequent year. Management will be considered and evaluated based on available funding, the effect of previously implemented management techniques and prevalence of invasive species in Rogers Lake following each action. In order to control both species in these areas, which have an average depth of ~4ft, an effective herbicide concentration of 400ppb of Flumioxazin should be applied. This will require that roughly 8.5lb of Flumioxazin be applied to each treated surface acre. It is possible that a reduced concentration of the herbicide could be used to control the targeted species however it is believed that the higher concentration will provide a more sustained control level of the target species within Rogers Lake (lasting for a longer period of time).

Pilot studies of various concentration levels could be implemented at Rogers Lake to assess whether a reduction in the concentration has a negative result on the treatment or has a shorter control period following the application. A reduction in the herbicide concentration could allow a cost savings to the Towns per application.

Ideally chemical plant control should occur in early June to ensure that a full season of enhanced recreational access at Rogers Lake is achieved. If mechanical (hydro-raking) control of lily species is scheduled to occur within a growing season, herbicide treatments should

occur prior to any mechanical control to minimize any fragmentation of the non-native species.

Surveys to assess the herbicide application should be conducted at two different intervals during the growing season to determine the effectiveness of non-native species control and to assess the success of the herbicide on the target species. These surveys should occur prior to application (to establish a baseline) and 2 weeks following the application, to assess the treatment.

This herbicide application should be conducted by a third party selected through an RFP response protocol or under the State Contract 13PSX0212 and should be overseen by a professional well experienced in Lake and Pond Management to ensure "best practices" are used by the herbicide applicators.

3.2 Mechanical Treatment of Nuisance Species

As chemical control is not very effective on lily species, NEE has recommended hydroraking as a method of control based on past success. This will provide a path for boats to the open water areas of the lake and significantly enhance the lake experience for other recreational users of the lake. Great care must be taken when hydroraking lily species because many areas with high densities of lilies also consist of high densities of invasive species. The company executing the control must either implement a schedule of precise chemical and mechanical treatment sequencing or deploy a turbidity curtain and boom to separate the hydroraking area from the rest of the lake by some means in order to avoid fragmentation and dissemination of the invasive species throughout the lake. Fragmentation could cause the spread of invasive species in these areas and would be counterproductive to these management efforts.

As stated previously, NEE recommends only selective removal of lily species by hydroraking in order to maintain a moderate level of floating vegetation habitat for the thriving wildlife in Rogers Lake. The areas for hydroraking lily populations are highlighted on Figure 1 as proposed lily hydroraking. Hydroraking will only occur when necessary as decided by the Towns of Lyme and Old Lyme. No hydroraking is scheduled to occur in the 2016 growing season.

3.3 Water Quality Monitoring

The nutrient results derived from the water quality study compared to those of previously conducted studies suggest that the overall water quality of Rogers Lake is relatively stable in the meso-eutrophic range (midsection). There were no clear water quality issues detected during the water quality study. It is recommended that water quality monitoring be continued in an effort to develop a long-term data set. This data set can be used to develop long-term nutrient dynamics models. Furthermore, those data can be used to identify significant nutrient trends and develop dynamic water quality management initiatives as necessary.

Specific water quality parameters (dissolved oxygen, pH, and conductivity) should be monitored prior to and following herbicide applications to ensure that there is no significant derivation of the water quality within Rogers Lake as a result of the plant management (herbicide) activities. Monitoring should occur prior to the treatment and be continued weekly for one month following the treatment. It should also be conducted at three locations within

the treatment areas. This will provide a real-time view of water chemistry during each treatment.

If water quality concerns are raised either by the towns, residents or discovered during sampling events the towns should consider conducting a full watershed study to determine the nutrient load that watershed activities are imparting on the system. Results from this study could also help educate people on their impact to their lake and watershed. During the study potential strategies for improved watershed infrastructure should be identified. An EPA 9 Key Elements Watershed Studies would examine the following water quality elements:

1. Identify causes/sources of pollution that need to be controlled
2. Determine nutrient load reductions that are needed
3. Develop management measures to achieve goals
4. Develop an implementation schedule
5. Set milestones to track implementation
6. Develop criteria to evaluate the program
7. Develop monitoring component
8. Develop and information education component
9. Identify technical/financial assistance necessary to implement plan

3.4 Lake Bottom Soil Monitoring

There are many factors that contribute to the health of a water body and soil quality may be among them. Regular testing of deep lake sediment may help derive current total phosphorus data as well as create a baseline of lake nutrient information prior to and throughout treatment. Chemical herbicide byproduct accumulation has also been a concern for some residents of Rogers Lake. Soil testing would allow the towns of Lyme and Old Lyme to identify the amount of harmful by products, if any, building up in the sediment in Rogers Lake. If somehow unforeseen byproducts begin persisting in the soil, the Towns of Lyme and Old Lyme should reassess the invasive species treatment protocol and chemical herbicide in question.

3.5 Community Outreach/Education

An important component of lake management is to create an interested and educated community. It is important that the residents acknowledge and recognize the effort being put forth to manage water quality and invasive plant species within Rogers Lake. It is equally as important for the residents to comprehend how their actions on their property can influence the overall health of Rogers Lake. This can be achieved through a persistent, information driven public outreach campaign.

NEE recommends that either a newsletter or pamphlet supplied by the Conservation Commissions and/or Rogers Lake Authority be distributed and readily available including information on the treatments and treatment dates as well as the information about lawn care items, such as fertilizers, and how they can affect the health of Rogers Lake. An example pamphlet is provided in Appendix B and Connecticut-specific information can be found at on the DEEP website or throughout the following link:
http://www.ct.gov/deep/lib/deep/water/lakes/Caring_for_Our_Lakes.pdf

3.6 Schedule of Long-Term Maintenance

Action Item	Description	Date
Water Quality Survey	• Follow QAPP	Monthly May-October, 2016
Flumioxazin Treatment	• Covering 31 acres • Application Rate 400ppb	Early June 2016
Water Quality Survey	• Follow QAPP	Weekly after June 2016 treatment (for one month)
Vegetative Survey	• Throughout the Lake • New/regrowth of species	One month after June 2016 treatment
REEVALUATE TREATMENTS	• Adjust if necessary o Application Rate o Application Area o Target Species	Prior to April 30, 2017
Water Quality Survey	• Follow QAPP	Monthly May-October, 2017
Flumioxazin Treatment	• Rate TBD • Area TBD	Early June 2017
Water Quality Survey	• Follow QAPP	Weekly after June 2017 treatment (for one month)
REEVALUATE TREATMENTS	• Adjust if necessary o Application Rate o Application Area o Target Species	Prior to April 30, 2018
This schedule should be repeated each year, as deemed necessary by the Towns of Lyme and Old Lyme.		