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# Memorandum

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| To | Janet Bowser, Steve Fader, Jan Kaseta | Page | 1 |
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| Subject | 2008-2009 Morses Pond Management Summary | | |
| From | Ken Wagner and Sarah MacDougall | | |
| Date | April 6, 2010 | | |

This memorandum provides a progress update of the implementation of the 2005 Comprehensive Morses Pond Management Plan through 2009. AECOM has assisted the Town of Wellesley with the following the pond management projects: 1) phosphorus inactivation, 2) plant harvesting, 3) low impact development demonstration, 4) education, and 5) dredging. The summary is fairly concise, but accompanying tables, figures and appendices are extensive.

## Phosphorus Inactivation

AECOM assisted in the establishment of the phosphorus inactivation system in the north basin of Morses Pond and operated that system in 2008 and 2009. The chemical pump station was established at the Town of Wellesley Dale Street Pump Station. General Environmental Systems, contracted by the Town, designed and installed the system, with assistance from AECOM. Four chemical lines were run from the pump station into the north basin in 2008. The phosphorus inactivation chemicals used were alum (aluminum sulfate) and aluminate (sodium aluminate). AECOM tested the system in 2008 and then operated the system as intended in 2009. After 2008 testing but prior to 2009 operation, AECOM moved two chemical lines with single diffusers in the north basin to the inlets of Bogle and Boulder Brooks to facilitate inlet treatment. Figure 1 shows the original deployment locations of the four lines in black, with the 2009 changes to the phosphorus inactivation set-up depicted in red.

In the 2008 test year, AECOM treated the north basin during six storm events during the late spring and early summer: June 24, June 26, July 14, July 21, July 22, and July 23. Normally, treatment past early July is not planned, but since the system was not installed until mid-June, testing in 2008 proceeded later into the summer. A total of 2,000 gallons of alum and 1,000 gallons of aluminate were used in 2008 test treatments.

In 2009, the phosphorus inactivation treatment of two main inlets and the northern basin occurred in May, June, and the beginning of July. The maximum anticipated aluminum dose was applied in the very wet spring of 2009. AECOM treated the tributaries and north basin during or immediately after fourteen 2009 storm events occurring on May 14-15, May 18, May 27, May 29, June 9, June 10, June 12, June 15, June 18-19, June 23, June 25, June 26, July 1, and July 9. The target ratio of alum to aluminate of 2:1 by volume was not achieved in early 2009 treatments, a consequence of a problem with the alum pump. After the pumping system was repaired in May 2009, the alum to aluminate ratio dosage remained close to the 2:1 ratio, applied to limit pH changes. Based on delivery of chemicals, AECOM applied a total of 6,002 gallons of alum and 2,900 gallons of aluminate in spring 2009. The

Holland Company of North Adams, MA, supplied the aluminum compounds. Table 1 provides a breakdown of recorded chemical usage by storm event.

AECOM conducted water quality monitoring before and/or after alum treatments of six events in 2008 and four events in 2009. AECOM attempted to collect pre-treatment stormwater samples prior to the beginning of each storm event, but overnight storms sometimes precluded pre-storm sampling. Water samples were collected at the inlets (Boulder and Bogle Brooks), the north basin chemical lines, the transition zone by the islands, and the Wellesley town beach. Figures 2 and 3 provide the sampling locations for 2008 and 2009 phosphorus inactivation monitoring, respectively. Composite samples were sometimes created within the north basin, transition zone, and beach area, such that a single value was derived for each water quality variable for each of the three defined areas for each sampling event. AECOM scientists also measured pH in the field near the chemical diffusers to assess the pH immediately and allow adjustment of the chemical feed as warranted to minimize pH fluctuations. Water samples were sent to Berkshire Enviro-Labs, a Massachusetts State Certified Laboratory, and analyzed for dissolved aluminum as well as total and dissolved phosphorus. The 2008 and 2009 water quality monitoring results are included in Tables 2 and 3, respectively.

The 2008 and 2009 field pH measurements during the aluminum treatment remained between 6 and 8 after initial adjustments. In 2008, staff adjusted ports for aluminate to equalize discharge due to a differential from one end of the line to the other on lines with four diffusers. By the end of the 2008 testing period, pH measurements ranged from 6.5 to 7.7, which is within the optimum pH range for minimizing aluminum toxicity to aquatic organisms and close to the normal pH level in Morses Pond. In 2009, pH values fluctuated between 6.8 and 9 before the pump was repaired on May 27$^{th}$. Even when imbalances caused pH fluctuations outside the 6-8 range during testing, staff observed no fish mortality and the fish did not appear affected by the aluminum treatment. No fish or invertebrate mortality was observed in association with the aluminum additions in 2008 or 2009.

The 2008 water chemistry results indicate a small difference in phosphorus concentrations before and after treatment, but there is a lot of variability in the data. Pre-treatment total phosphorus concentrations in the North Basin ranged from 14 to 44 ug/L with a mean of 27 ug/L. Post-treatment total phosphorus concentrations ranged from 10 to 23 ug/L with a mean of 18 ug/L. Elevated dissolved aluminum concentrations were observed shortly after treatment. The summer total phosphorus concentration (July 22) at the Wellesley Town Beach was relatively low at 12 ug/L. Phosphorus levels should have been influenced by treatment, but treatment is not the sole contributor to low phosphorus values in 2008; flushing from storms can also lower phosphorus levels, and summer 2008 included multiple substantial storms. It cannot therefore be conclusively stated that the treatments reduced phosphorus to the observed levels, but the results are encouraging.

As testing was conducted later in the summer than normally planned, and plant growths (especially water lilies) were dense in the north basin, even distribution of aluminum was not observed and efficiency of treatment is not believed to have been maximal. Re-alignment of two of the chemical feed lines to allow treatment at the inlets from Bogle and Boulder Brooks was performed to help overcome this perceived problem. Treatment earlier in the year, before dense plant assemblages form, was also expected to help improve treatment efficiency in 2009.

In 2009, the treatment resulted in variable concentrations over the two month period, with high inflows overwhelming treatment capacity several times, but recovery through treatment was also observed. Measured phosphorus concentrations in the inlets were elevated. Pre-treatment total phosphorus concentrations at the Bogle Brook inlet ranged from 34 to 48 ug/L, with a mean of 41 ug/L. The Boulder Brook inlet pre-treatment total phosphorus ranged from 36 to 105 ug/L with a mean of 55 ug/L. Post-treatment total phosphorus concentrations at the Bogle Brook inlet ranged from 29 to 78 ug/L, with a mean of 49 ug/L. The Boulder Brook inlet post-treatment total phosphorus ranged from 27 to 104 ug/L with a mean of 54 ug/L. The post-treatment total phosphorus concentrations do not reflect treated water, but tributary water flowing into Morses Pond following a treatment event. The treated tributary water would be observed in the North Basin rather than the tributaries during the post-treatment sampling. The similar inlet phosphorus concentrations before and after storm events suggests that the water quality was

similar during the treatment process. Much higher first flush values for phosphorus would be expected and were not assessed in this program, but the associated water should have been treated in the north basin, as detention time there is long enough to facilitated successful treatment several hours after the first flush from a storm event. The dissolved phosphorus component, or the portion available for algal growth, consisted of 30-93% of total phosphorus in Bogle Brook and 27-79% in Boulder Brook after the storm events. The range is typical and underscores stormwater quality variability.

The pre-treatment North Basin total phosphorus concentrations ranged from 35 to 49 ug/L while post-treatment concentrations ranged from 23 to 57 ug/L. Post-treatment total phosphorus concentrations were generally lower than pre-treatment concentrations for individual storm events. The May 27th storm is the exception (higher post-treatment total phosphorus), but the short duration of sampling makes comparison within the North Basin difficult anyway. Reactions that inactivate phosphorus may proceed for some time after treatment, while sampling was almost immediate. In the case of May 27, the treatment pump also needed repair during the storm.

The dissolved phosphorus component consisted of 41 to 93% before treatment, compared to 33 to 62% of total phosphorus in the North Basin after treatment. However, there is variability in the data, and reactions would not have been complete at the time of most sampling in the North Basin. Overall, dissolved aluminum concentrations were higher after treatment (no change to an increase of 0.395 mg/L), but only temporarily, and no adverse impacts were observed on biota.

Pre- and post-treatment total phosphorus values in the Transition Zone between the islands were similar. Pre-treatment total phosphorus concentrations ranged from 35 to 42 ug/L (43 to 69% dissolved phosphorus) and post-treatment concentrations ranged from 31 to 53 ug/L (34 to 84% dissolved phosphorus). The treated water in the North Basin likely had not reached the Transition Zone when the post-treatment sampling occurred. The only storm event with elevated dissolved aluminum concentrations in the Transition Zone was the 5/14-15/09 event.

Total phosphorus concentrations at the Wellesley Town Beach ranged from 37 ug/L (June 17th) to 10 ug/L (July 9th). The magnitude and frequency of storms during spring 2009 was sufficient to overwhelm the capacity of the treatment system to maintain low phosphorus concentrations on a regular basis. However, the combined effect of repeated treatment during the spring and effective treatment during the last two weeks of June appears to have yielded a total phosphorus concentration of 10 ug/L on July 9th at the Wellesley Town beach, which is the target level for the end of treatment.

No algae problems were encountered in summer of 2009 and no algaecide treatments were necessary. Flushing by numerous storms in 2009 was a substantial factor in the condition of Morses Pond, and may have helped prevent algal blooms much as suspected in 2008. Based on monitoring conducted by ACT/ESS later in the summer, total phosphorus increased to 27 ug/L by mid-August, and the algal community started to shift toward bloom species, but no blooms formed. Despite the high phosphorus levels in the stormwater discharging to Morses Pond in 2009, the water quality at the beach in early July, a week after the last treatment, was very desirable from the perspective of swimming and overall appearance, and effects carried well into summer. The aluminum treatment may not be sole factor controlling algae in 2009, but the apparent success of the treatment, even under difficult weather conditions, was again encouraging.

Based on results to date, it appears that the treatment is most effective when the inlets can be treated from the beginning of the storm using the two single diffuser lines that are positioned at the Bogle and Boulder Brook inlets. When storms are unexpected or arrive when a crew cannot be present, treatment later in the storm should focus on the north basin using the two lines with four diffusers each. AECOM will watch, forecast, and time treatment in 2010 to use less chemical, focusing on June storms. It appears that treatment of enough inflow to represent approximately the volume of Morses Pond is sufficient to achieve the desired phosphorus level in the southern basin of the lake going into summer. However, this is not an exact science due to the unpredictability of the weather, and adaptive management is warranted. Monitoring will focus on a more meaningful comparison of pre- and post-treatment water quality in 2010.

## Plant Harvesting

### Harvesting Strategy

The Town of Wellesley initiated the enhanced Morses Pond harvesting program with the purchase of the new harvester in 2007. The zoned harvesting strategy originates from the 2005 pilot program and comprehensive management plan written that year. For the pilot program, Morses Pond was divided into seven zones in order to better track the harvesting process. Figure 4 shows these zones and Morses Pond bathymetry. Harvesting began later than desired in 2007 and various issues with harvester operation caused 2007 to be largely a training and testing year for the new approach to harvesting.

In 2008, plant harvesting occurred in June in the North Basin, which is not typical of the harvesting program, but was done in order to facilitate the alum treatments. The main body of the pond was harvested in late June through the summer. Both the old and new harvesters were used for the 2008 effort, as the effort expended on the North Basin in June put the program behind the planned schedule. Harvesting in Zone 6, the portion of the southwestern cove in Wellesley, resulted in substantial fragments reaching the beach and east shore. Overall, the late timing of the harvesting was less than ideal due to the concern over fragment generation and dense growths did limit access, but the harvesting did keep plant growth in control and aided recreational use of the pond.

In 2009, adjustments were made to the harvesting plan based on observations and experiences in 2008. This revised strategy allowed generation of fewer plant fragments and overall greater success. The plant harvesting program began with cutting Zone 6, followed by cutting in Zone 3, and finally cutting in Zones 4 and 2. This first harvesting round was completed by the July 4$^{th}$ weekend, with Zones 6 and 3 cut well before the beach opened for summer. The early harvesting timing and avoidance of cutting at an angle to the wind minimized drifting plant fragments during the early swim season. A second round of harvesting in August was performed to maintain control and exert selective pressures that favor low-growing, seed-producing, more desirable species. There were no fragment complaints, even by passive users, in 2009. Due to the greater overall success in 2009, AECOM recommends that the Town of Wellesley repeat the plant harvesting strategy applied in 2009 again in 2010. It may take several years of successful application before any shift in plant species can be detected, and monitoring of the plant community on an annual basis should continue.

Data from harvesting logs were provided to AECOM and are summarized in Appendix A. The 2009 overall cutting rate was 3.6 hrs per load, which means it took the harvester operator 3.6 hours of actual cutting time to harvest one load. The seasonal cutting rate was 3.8 cutting hrs per load in the spring and 3.4 cutting hrs per load in late summer. In the spring round, the harvester operators spent a total of 27 days (209.5 hrs) harvesting approximately 40 loads (35 full and 8 partial loads). In the late summer round, the harvester operator spent 28 days (189 hrs) harvesting approximately 45 loads (38 full and 10 partial loads). Including all time devoted to harvester operations, this translates to 5.3 hours per load in the spring and 4.2 hours per load in late summer. The greater efficiency of the late summer harvest (more loads generated in fewer hours) is partly due to the greater percentage of time spent actually cutting in the late summer than the spring. Weather and necessary maintenance were key factors in efficiency. Harvesting efforts in 2008 and 2009 were similar in terms of hours applied and weight of plants harvested. However, the timing and rotation of areas of the pond were different in 2009, and resulted in fewer complaints about fragments in the swimming area and along the eastern shore. It is recommended that the 2009 approach be repeated in 2010.

### Plant Surveys

AECOM conducted plant surveys in early May in 2008 and 2009 prior to plant harvesting to determine the assemblage features. These surveys also identify areas supporting very dense aquatic plant growths and helps set priorities for harvesting. Shoreline surveys were also performed to guide localized plant control by shoreline residents, including proposed hydroraking. A demonstration of benthic barrier use was conducted in 2008, but no further application occurred. Hydroraking of shallow areas was

desired by many shoreline residents, and was planned for 2009. However, equipment problems precluded execution of hydroraking beyond the beach area.

***Methods***

The vegetation surveys occurred on May 7 and 8 of 2008 and May 4, 6, and 8 of 2009. During the 2008 and 2009 surveys, AECOM used the point-intercept method, resulting in 306 survey points on Morses Pond. These same points were utilized during the 2005 vegetation survey. The point-intercept methodology is intended to document the spatial distribution and percent cover and biovolume of aquatic plants at specific re-locatable sites. At each point, AECOM recorded the following:

- GPS waypoint
- Water depth using a metal graduated rod or a mechanical depth finder
- Plant cover and biovolume
- Relative abundance of plant species

For each plant species, staff recorded whether the species was present at trace (one or two sprigs), sparse (a handful of the plant), moderate (a few handfuls of the plant), or dense (many handfuls of the plant) levels at each site. Plant cover represents the total surface area covered in plants (2 dimensions). For cover, areas with no plants were assigned a "0," areas with approximately 1-25% cover were assigned a "1," a "2" for 26-50%, a "3" for 51-75%, a "4" for 76-99%, and a "5" for 100% cover. Like plant cover, a quartile scale was used to express plant biovolume, defined as the estimated volume of living plant material filling the water column (3 dimensions). For biovolume, 0= no plants, 1= 1-25%, 2=26-50%, 3=51-75%, 4=76-99%, and 5=100% of plants filling the water column.

AECOM also conducted shoreline surveys. For the 2008 shoreline survey, the shoreline was divided into 62 zones, representing different property owners. The 2009 survey consisted of only shoreline segments where property owners expressed interest in shoreline plant harvesting, around the northern islands, and along northern conservation areas of interest. The surveys were performed generally within the 0-5 ft depth range along the shoreline. For each zone, plants were identified, and the average density of each plant within the zone, was recorded. For example, if a plant was sparse in two areas within the zone, it was labeled as sparse, even though the plant may not necessarily be sparse throughout the zone. Similarly, if a plant species were very dense in one small area, but not present throughout the rest of the zone, this plant was recorded as sparse. Note that for early season surveys, values for cover and biovolume are expected to be much lower than might be encountered during summer, so some extrapolation is needed when assessing management needs.

***Results***

Overall, Morses Pond had moderate to dense vegetation cover and biovolume in 2008 and 2009. With the exception of the deeper South Basin (Zone 7), 2009 spring plant cover had an average ranking of 3 (51-75% coverage), while the spring 2008 cover ranking was between 3 and 5 (51-100% coverage). In both 2008 and 2009, the average biovolume for a majority of the pond was ranked as 2 to 3 (plants taking up between one and three quarters of the water column), and this was for early season survey data. Vegetation coverage and biovolume in Morses Pond was densest in Zones 3 and 4 in 2008 and 2009,but was sufficient to impede recreation and compromise habitat in all harvested zones. Harvesting in 2008 and 2009 improved recreational conditions in those respective years, but impacts beyond the year of harvesting have not yet been observed. The 2008 plant cover and biovolume maps are included in Appendix B. The 2009 data were not appreciably different.

In the 2008 and 2009 shoreline surveys, the majority of Morses Pond's shoreline ranked as a 0 or 1 for both cover and volume. The cover and biovolume for shoreline zones were never categorized above 3. However, because the survey was performed early in the growing season, there are several shoreline areas of the pond that may become overgrown later in the season due to the presence of the invasive species *Myriophyllum spicatum* (Eurasian milfoil), *Myriophyllum heterophyllum* (variable milfoil), and/or *Cabomba caroliniana (*fanwort). In 2008, the southwestern cove had dense algae mats and the three

invasive species throughout. The 2008 shoreline survey map is included in Appendix B. In 2009, AECOM acknowledged the appropriateness of shoreline hydroraking in front of several waterfront lots on the southern shore on College Road, the southeastern cove on Pickerel Rd and Pickerel Terrace, and the northwestern cove along Stovecleve Road. The shoreline of the islands and Pickle Point Conservation area also had sparse to moderately dense patches of one or all three of the common invasive species. The 2009 hydroraking recommendation map is also included in Appendix B, although the hydroraking was not conducted as a consequence of transport equipment problems.

For the point-intercept surveys, twenty plant species were encountered in the 2008 survey and twenty-two plant species were observed in 2009. The five invasive plant species encountered are:

- *Cabomba caroliniana* (Fanwort)
- *Lythrum salicaria* (Purple loosestrife)
- *Myriophyllum spicatum* (Eurasian watermilfoil)
- *Myriophyllum heterophyllum* (Variable watermilfoil)
- *Potamogeton crispus* (Curlyleaf pondweed)

*Trapa natans* (Water chestnut) is another invasive known from Morses Pond, but a volunteer harvesting program keeps this species at very low densities.

In the May 2008 and 2009 surveys, Eurasian watermilfoil and fanwort dominated the Morses Pond plant community. Only in the deeper southern basin of Morses Pond (Zone 7) were the two invasive species not dominant. Dominant species are defined as plant species that constitute 50% or greater frequency of occurrence (Tables 4 and 5). Another invasive, curlyleaf pondweed, was a dominant in the northeast and northeast coves (Zones 2 and 4) in 2008, but it was not dominant anywhere in 2009. Variable milfoil was a dominant in the northern basin (Zone 1) in 2008 and in the southwestern cove (Zone 5, in Natick and not subject to management under the Wellesley program) in 2009. An invasive wetland species, purple loosestrife, was observed on the northern basin shoreline but is restricted to the periphery of the pond.

Native species are also abundant in Morses Pond. *Nymphaea odorata* (white water lily) and *Ceratophyllum demersum* (coontail) were dominants in the northern basin (Zone 1) for both 2008 and 2009 surveys. Filamentous green algae mats were abundant in the northern basin and northeastern cove (Zones 1 and 2). *Potamogeton robbinsii* (Robbins' pondweed) was dominant in the southwestern cove (Zones 5 and 6) for both annual surveys. *Nitella flexilis* (common naiad) was dominant in Zones 3 and 6 in 2008, but not in 2009.

Plant species that were not encountered during the 2009 and 2008 surveys, but were encountered in the 2005 survey include:

- *Potamogeton pulcher* (Spotted pondweed)
- *Utricularia gibba* (Bladderwort)
- *Wolffia columbiana* (Watermeal)
- *Spirodela polyrhiza* (Big duckweed)

Note that the 2005 survey was performed during summer, while the 2008 and 2009 surveys were conducted during spring. This shift can affect detection of some species. For example, spotted pondweed tends to bloom between June and August, which may be why this species was not encountered during the 2008 or 2009 survey. Likewise, curlyleaf pondweed usually dies back by early July, limiting its detection in summer surveys. However, the spring community is most important in guiding management efforts in Morses Pond, and later surveys would be impacted by harvesting efforts, so the adoption of spring surveys is considered appropriate.

See Appendix B for the tabular results of the 2008 and 2009 plant surveys.

***Conclusions***

Monitoring in spring 2010 and beyond will be necessary to determine if there is any lasting impact of the harvesting. Two years is too short a timespan to detect plant population shifts and any prolonged reduction in plant cover and biovolume.

## Low Impact Development Demonstration

The Town of Wellesley selected the Upham Elementary School property to be the watershed Low Impact Development (LID) demonstration project out of thirteen properties evaluated by AECOM as sites where LID practices could be most beneficial and cost-effectively retrofitted. The Upham site will provide an educational opportunity for the school children as well as the greater community. The project also serves as a model for other organizations and communities for planning, coordinating, and funding this type of project.

The LID retrofit will address the parking lots near the playing fields and adjacent to the school. The attached conceptual plans in Appendix C illustrate the stormwater improvements currently planned at each location. Finalization of these plans is expected in spring of 2010, so some changes may occur.

Pre-project sampling in 2008 and 2009 confirm that the runoff has elevated nutrient levels (Table 6). Total phosphorus concentrations in the stormwater flowing into the catchbasin by the playing fields were extremely high at 2,580 ug/L in 2008 and 1,385 ug/L in 2009. The total phosphorus concentrations of stormwater flowing into the catchbasin in front of the school were similarly high (2,530 ug/L in 2008 and 395 ug/L in 2009).

Currently, the Town of Wellesley is in the process of reviewing the AECOM conceptual plans and deciding the appropriate vegetation cover for the bio-retention water quality swales. Once the Town of Wellesley settles on a vegetation choice (native vegetation vs. grass), AECOM can finalize the conceptual plans and school committee letter. Construction is anticipated to begin during summer 2010 to avoid disruption of school functions.

## Education

The website for education regarding residential and commercial property management to reduce impacts on Morses Pond (and really to all water resources) has been developed and augmented this year. Several small adjustments are still needed and are in progress. These include:

- Incorporating more content and add more links about lake history, natural resources (including bird and fish lists), and recommended lawn care companies (that use eco-friendly approaches)
- Performing quality checks to verify working links

The website can be viewed at
http://www.ci.wellesley.ma.us/Pages/WellesleyMA_NRC/MorsesPond/Page1,
but it is not widely known. A spring 2010 promotion is planned as we enter lawn maintenance season.

## Dredging

AECOM worked with Town staff to draft a Request for Proposals and assisted with interviewing candidate firms for the North Basin dredging project. The Town of Wellesley selected Apex of Boston to provide design and permitting services for the project. It is anticipated that the actual dredging will begin in fall 2010 or spring 2011. Design considerations and related permitting issues have been discussed further, and the contractor is aware of needs and constraints as the design phase begins.

The bathymetry of the north basin and in fact the entire pond has been updated by sophisticated means, providing better mapping of water depth than has been available for many years. Sediment depths are being calculated, initial sediment tests have been completed and additional testing is underway. Considerable progress is expected in the first quarter of 2010, with development of the dredging plan and filing of permit applications.

During the process, the question arose whether or not Chapter 91 regulations applied to Morses Pond. DEP listed Morses Pond as a Great Pond on its website as of 2006. AECOM and Town staff researched the issue and determined that Morses Pond is not a Great Pond as it was dammed for saw mills in the early 1700's. Maps used by the DEP to reclassify Morses Pond as a Great Pond were from the late 1700s, too recent to accurately characterize the pond. The Town had reached this conclusion on at least two previous dates, and has sent a letter to the DEP requesting that the pond be removed from the Great Pond list.

## Other activities

AECOM supported the Town by attending various meetings, reviewing budget documents, considering current monitoring programs, and assisting with arrangements for hydroraking (although equipment issues forced cancellation of activities beyond the town beach for 2009). AECOM also prepared a Sec 319 grant application for DEP in support of the dredging operation, but it was not successful. For educational purposes, particularly to aid the harvesting crew, AECOM also created an aquatic plant identification guide (Appendix D) specifically for Morses Pond.