MORSES POND ANNUAL REPORT: 2012

Prepared for the Wellesley Natural Resources Commission

BY WATER RESOURCE SERVICES, INC.

DECEMBER 2012

This report documents the implementation of the 2005 Comprehensive Morses Pond Management Plan through 2012. Program elements include: 1) phosphorus inactivation, 2) plant harvesting, 3) low impact development demonstration, 4) education, and 5) dredging.

Phosphorus Inactivation

Operational Background

A phosphorus inactivation system was established in the spring of 2008, in the north basin of Morses Pond. After testing and initial adjustment in 2008, the system has been operated in the spring and early summer of 2009 through 2012. The chemical pump station is portable, but is stationed for the treatment period at the Town of Wellesley Dale Street Pump Station. Four sets of lines run from the pump station into the north basin (Figure 1), each set consisting of an air feed line and two chemical feed lines. The phosphorus inactivation chemicals used for the treatment are aluminum sulfate (alum) and sodium aluminate (aluminate). Both are flocculating agents responsible for the inactivation of phosphorus, with alum creating acidic conditions and aluminate shifting the pH to a more basic level; both are added at a roughly 2:1 ratio (alum to aluminate, by volume) to balance the pH of treatments.

Two lines with single diffusers and sets of chemical ports near the end of each line run within the north basin to the mouths of Boulder Brook and Bogle Brook. This facilitates inlet treatment, generally considered the most effective means of inactivation, given mixing and settling as the streams proceed into the north basin. The other two lines, each with four diffusers and corresponding chemical ports, are spaced within the north basin itself to allow treatment of water in that basin. This allows treatment if operation is not possible from the start of a storm, or if additional treatment in the basin appears necessary. However, as spring progresses, dense vegetation within the north basin limits horizontal mixing and overall system efficiency.

After a year of initial testing (2008), alum and aluminate have been added to the north basin in May through early July to achieve a target total phosphorus level in the south basin of <20 ppb and preferably close to 10 ppb near the 4th of July (Table 1). Traditionally, algal blooms started about that time, necessitating copper treatments to regain water clarity and keep the beach open. It was thought that additional treatment during summer might not be necessary if the starting phosphorus level was low enough. No problems were noted in 2009, but algal blooms developed in August of 2010 and 2011. Responsive treatment helped, but was considered too late to prevent some loss of clarity. In 2010 the chemicals were available to respond to declining clarity in late July, but no action was taken. In 2011 the chemicals were not available when a response was deemed appropriate in late July, and it took two weeks to obtain the necessary chemicals. In 2012, sufficient chemical was on hand to respond to reductions in water clarity during summer, but system functionality problems limited the effectiveness of treatment.

Figure 1 Phosphorus Inactivation System for Morses Pond

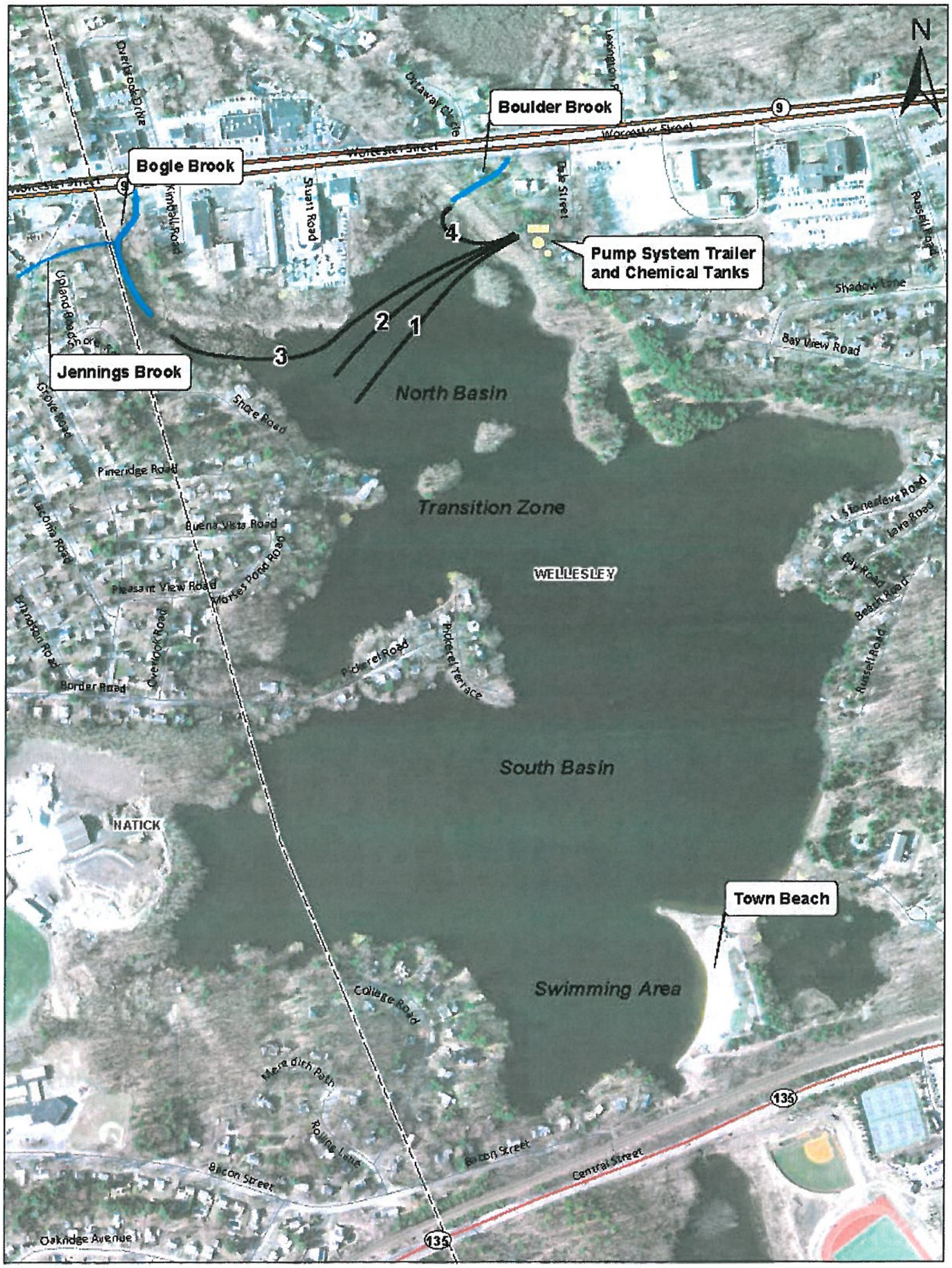

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Table 1. Summary of Phosphorus Inactivation Effort, 2008-2012

Year	Applied Alum (gal)	Applied Aluminate (gal)	Period of Application	# of Treatment Days	Notes
2008	2000	1000	6/24 to 7/23	5	Testing and adjustment phase
2009	6002	2900	5/14 to 7/9	16	Very wet spring and summer
2010	4100	2080	5/11 to 7/9 + 8/24 & 8/25	13	Average spring, leftover chemical applied in late August.
2011	5000	2475	5/15 to 7/8 + 8/10 & 8/16	14	Wet spring and summer, attempted August treatments in response to bloom
2012	6000	3000	5/4 to 7/23 + 8/6 to 8/22	19	Poor system functionality hampered dosing during treatment

Analysis of Program to Date

Water quality is assessed prior to the start of treatment, normally in May, early summer, and later in the summer in three areas: the north basin, the transition zone to the south basin just south of the islands, and near the town beach at the south end of the pond. A summary is provided (Table 2) to put the treatments and results in perspective. It is intended that total phosphorus will decrease through the treatment, such that values in the south basin, assessed in the swimming area near the outlet of the pond, will be lower than in the north basin, with the transition zone exhibiting intermediate values. Based on data collected since the early 1980s, total phosphorus in the south basin in excess of 20 ug/L tends to lead to algal blooms, while values <20 ug/L minimize blooms and values near 10 ug/L lead to highly desirable conditions.

Although treatment in 2008 started late and was largely experimental, results for total phosphorus at the end of the initial treatment period for 2008 were <20 μg/L. Similar results were achieved in 2009 and 2010; throughout these three years values approached the ideal 10 μg/L level in early summer. Total phosphorus remained somewhat elevated in early summer of 2011; we do not know if there was some lab error associated with the 2011 early summer values, but the water was the clearest it has been in many years at that time, so available phosphorus had to be very low.

Dissolved phosphorus, summarized in previous annual reports, tends to decline more sharply than total phosphorus, a likely indication that the aluminum is effectively binding phosphorus. Dissolved aluminum concentrations have been highly variable, sometimes rather high in the north basin and measurable in the south basin, but there is no evidence of any toxicity to fish or invertebrates in Morses Pond, despite extensive observation during treatment periods. The focus is on total phosphorus, as the long-term data base supports it use as the primary indicator of algal bloom potential.

Table 2. Water Quality Testing Results Relating to the Phosphorus Inactivation System

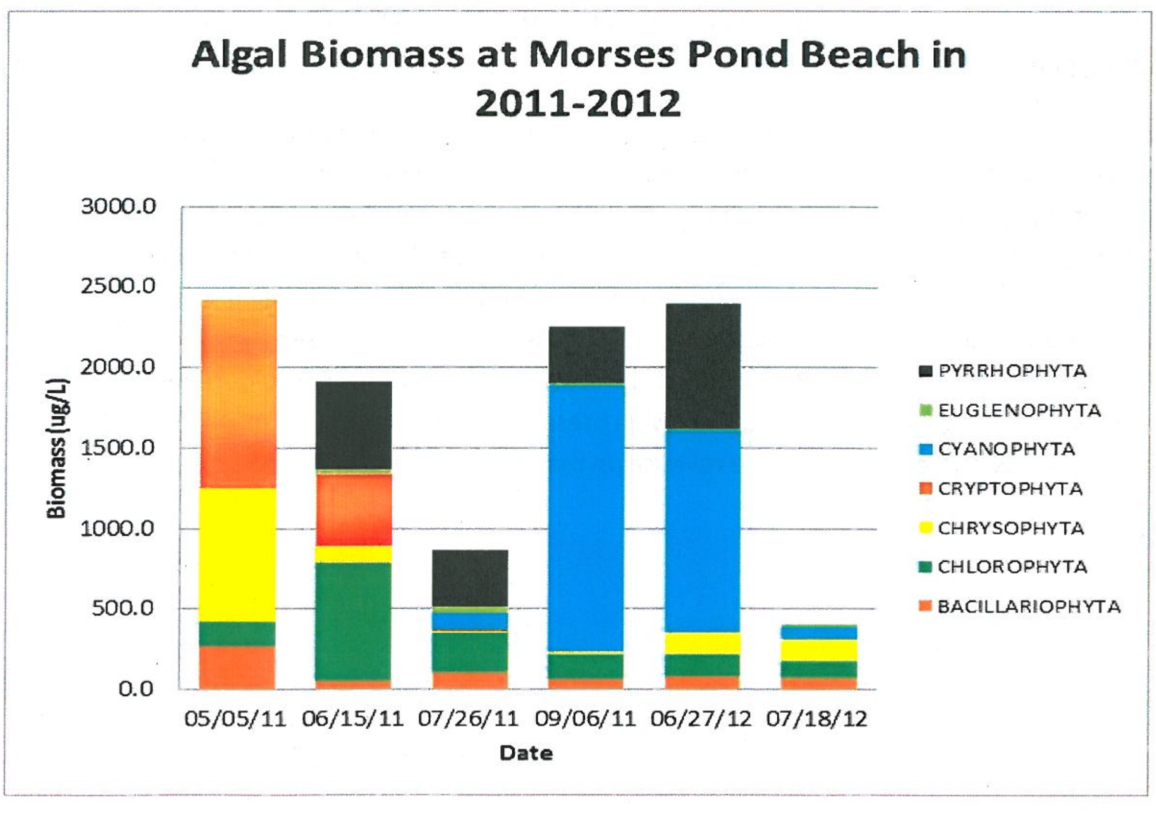
Year	Location	Pre-Application TP (ug/L)	Early Summer TP (ug/L)	Late Summer TP (ug/L)	Algae Issues
2008	North Basin	28	18		Mats observed, some cloudiness, early summer is really July 23 at end of treatment
	Transition Zone	31	22		Some cloudiness, brownish color, early summer is really July 23 at end of treatment
	Swimming Area	21	12		Relatively clear, no blooms, early summer is really July 23 at end of treatment
2009	North Basin	35	40	63	Cloudy, some mats
	Transition Zone	35	39		Cloudy
	Swimming Area	15	10	27	Generally clear, no blooms
2010	North Basin	26	46	53	Cloudy, mats evident
	Transition Zone	28	21	32	Brownish color, minimally cloudy
	Swimming Area	19	15	43	Generally clear, no blooms until late August
2011	North Basin	53	33	130	Cloudy, mats evident
	Transition Zone	48	29	95	Slightly brownish
	Swimming Area	30	29	60	Clearest water in years in late June, but short-lived cyanobloom in early August
2012	North Basin	32	24	48	Very dense plant growth
	Transition Zone	28	37	28	Brownish most of summer
	Swimming Area	20	27	24	Had bloom in mid-July

Total phosphorus increased in early summer; treatment problems were encountered on most treatment days, as different parts of the system failed. Frequent and timely repairs kept the treatments going, but they were not as efficient and apparently not as effective as in the last three years. Detention capacity of the north basin is limited by shallow depth resulting from years of sediment deposition; although reductions in phosphorus are still expected as water passes through the north basin, removal is not maximal. Consequently, the combination of treatment and detention was insufficient to prevent a bloom from forming in mid-July, and the phosphorus level in the south basin was >20 ug/L.

A copper treatment was conducted in the swimming area to reduce algae and increase clarity in mid-July, but a major storm within a few days resulted in a major flushing of the lake. The storm inputs were treated with aluminum, and no further algal blooms occurred in the summer of 2012. However, it is not at all certain that treatments were any more important than the pattern of flushing in 2012.

Algal data for 2011-2012 illustrate processes in Morses Pond over the summer (Figure 2). Moderate densities of mainly coldwater forms in spring give way to lower densities more typical late spring forms such as green algae in June, with those densities further reduced and species composition further altered by the aluminum treatments, such that relatively low biomass of largely innocuous forms is observed in July of 2011. Lack of treatment allows algal densities to rebound over the rest of the summer, with blue-greens becoming dominant by September 2011. In 2012, conditions at the end fo June were already similar to those in September of 2011, and algal density increased for the next two weeks, resulting in a bloom (there is no strict definition of a bloom, but biomass in excess of 5000 ug/L would be a reasonable threshold). No sample was collected during the mid-July 2012 bloom, as there was a major storm just before we arrived at the lake, and it was thoroughly flushed. This resulted in low algal biomass on July 18, 2012, and was not the result of treatment. Biomass remained below late summer 2011 or early summer 2012 values for the rest of the summer of 2012, which may be due to the treatment of storms during summer of 2012. However, those treatments were not as efficient as they should have been, owing to frequent equipment malfunctions. Maintaining the algal assemblage features of mid-July 2011 is an appropriate goal for the phosphorus inactivation project.

Figure 2. Algal Data for 2011-2012



Repairs to the distribution lines were necessitated in 2010 by damage done while harvesting the north basin to support sampling and measurement for dredging planning. Lines were cut in several places, and new hose sections were inserted where needed. Additional repairs were made in 2011. A thorough inspection of the lines was conducted prior to initiation of pumping for the 2012 season. The lines appeared generally in good repair, and the diffusers and chemical ports were cleaned, but the flow of air and chemicals was impeded at times, and various breaks and blockages were encountered, especially in the lines serving the north basin. Treatment for 2012 therefore focused on the two lines serving the inlets from Bogle and Boulder Brooks in order to adequately treat inflows via these main water sources. This is actually the most desirable approach, as it provides the best mixing and reaction efficiency, plus more travel time through the north basin. The level of phosphorus in the inflows is therefore better reduced and aluminum floc is therefore better captured upstream of the south basin. However, even the lines to the two inlets suffered problems as summer 2012 progressed, and treatment was sometimes much slower than desired. Additionally, there was no effective way to treat flows that had passed the inlets before the treatment crew could arrive on site in response to a storm.

The record of treatment in 2012 is provided in Table 3, supported by the rainfall record and related treatment activities listed in Table 4. A total of 19 storm events covering 25 days occurred, and 76.5 hours of treatment were conducted, applying 5800 gallons of alum and 2930 of aluminate. Three chemical deliveries were taken, each roughly 2000 gallons of alum and 1000 gallons of aluminate. The ratio of alum to aluminate applied was very close to 2:1 overall, but varied by storm between 0.8 and 4.4, not an acceptable ratio control. No toxicity problems were noted as a result, and the dilution of the chemicals was substantial, so none would be expected, but the problems with pumps and lines are evident in this widely varying chemical ratio. The application rate averaged 76 gallons of alum per hour and 38 gallons of aluminate per hour, but these values are about 63% of pump capacity, further indicating pump problems.

There are several sources of problems with the phosphorus inactivation system. The age of the system, corrosive tendencies of the chemical and exposure to the elements appear to have aged the system faster than anticipated. As a result, numerous problems were encountered throughout the summer, including low or no pump flow, overheating of the air compressor, leaks in the on-shore piping system, clogs in the lines, low airflow through diffuser plates, and uneven flow of aluminum chemicals. As a result, significant time was spent repairing the system, and this compromised the ability to appropriately treat in response to rain events. Prior to the 2013 season, significant repairs to or redesign of the pumping system is warranted. A system redesign presents the opportunity to mechanize more of the pumping process, thereby reducing the reliance on man hours on site.

Table 3. 2012 phosphorus inactivation system operation record.

Date	Storm Date	Treatment Hours	Alum Start level	Alum Used (g)	S.A Start level	S.A. used (g)	Notes
5/4/2012	5/4 - 5/5	3	1800	70	1050	80	
5/9/2012	5/9 - 5/10	5	1730	430	970	190	Maintenance to clear blockage in Alum pump
5/14/2012	5/14 - 5/17		1300	220	780	100	
5/15/2012	5/14 - 5/17	4.5	1080	300	680	280	Pumped intermittently due to maintenance
5/16/2012	5/14 - 5/17		780	30	400	0	System maintenance
5/21/2012	5/22	3.5	750	750	400	170	Alum tank empty
5/30/2012		4	2050	400	1020	190	
6/2/2012	6/2 - 6/5	4	1650	370	830	180	
6/7/2012	6/7	4	1280	430	650	150	Ran compressor intermittently due to pressure build up
6/13/2012	6/12 - 6/13	5	850	550	500	270	
6/25/2012	6/25 - 6/26	3.5	300	300	270	270	Both tanks empty
7/18/2012	7/18	6	1950	490	1050	330	Boulder Bk scaled back to allow more chemical to reach Boggle
7/23/2012	7/23 - 7/24		1460	260	720	160	Intermittent pumping due to AS pump issues
7/24/2012	7/23 - 7/24		1200	0	560	0	AS system maintenance
7/25/2012			1200	0	560	0	AS system maintenance
7/26/2012	7/27 - 7/29		1200	0	560	0	AS system maintenance
8/6/2012	8/6	2	1200	80	560	100	AS system maintenance
8/9/2012	8/10		1120	120	460	30	Pumped intermittently due to maintenance
8/10/2012	8/10	3	1000	100	430	80	
8/11/2012	8/12 - 8/13	8	900	150	350	50	intermittent maintenance
8/15/2012	8/15	7	750	120	300	80	
8/21/2012	8/21	2	630	0	220	0	Pumps not functioning properly
8/22/2012	8/23	3	630	250	220	0	Pumps not functioning properly
8/23/2012	8/23	3	380	0	220	0	System maintenance
8/27/2012	8/28	6	380	380	220	220	Final treatment, tanks empty
Total	**19**	**76.5**		**5800**		**2930**	

Table 4. Rainfall record and related treatment actions in 2012.

Date(s)	Total Rainfall (in)	Events	Treatment
Tuesday, May 01, 2012	0.47	Rain	N
Friday, May 04, 2012	0.01	Rain	Y
Saturday, May 05, 2012	0.04	Rain	N
Tuesday, May 08, 2012	0.15	Rain	N
Wednesday, May 09, 2012	0.27	Rain	Y
Thursday, May 10, 2012	0.97	Rain	N
Monday, May 14, 2012	0.01	Rain	Y
Tuesday, May 15, 2012	0.45	Rain	Y
Wednesday, May 16, 2012	0.08	Rain	Y
Thursday, May 17, 2012	0.01		N
Tuesday, May 22, 2012	0.42	Rain	pre-treat on 5/21
Wednesday, May 23, 2012	0.01		N
Sunday, May 27, 2012	0.01	Fog	N
Tuesday, May 29, 2012	0.12	Rain-Thunderstorm	5/30
May Total Rainfall	**3.02**		
Saturday, June 02, 2012	0.68	Rain	Y
Sunday, June 03, 2012	0.01		N
Monday, June 04, 2012	0.47	Rain	N
Tuesday, June 05, 2012	0.11	Fog-Rain	N
Thursday, June 07, 2012	0.18	Rain	Y
Saturday, June 09, 2012	0.03		N
Tuesday, June 12, 2012	0.03	Rain	N
Wednesday, June 13, 2012	0.47	Rain	Y
Friday, June 22, 2012	0.18	Fog-Rain-Thunderstorm	N
Saturday, June 23, 2012	0.06	Rain-Thunderstorm	N
Monday, June 25, 2012	1.47	Fog-Rain-Thunderstorm	Y
Tuesday, June 26, 2012	0.04	Fog-Rain	N
Friday, June 29, 2012	0.1	Rain	N
June Total Rainfall	**3.83**		
Sunday, July 01, 2012	0.08	Rain-Thunderstorm	N
Monday, July 02, 2012	0.1	Fog-Rain	N
Wednesday, July 04, 2012	0.34	Rain	N
Wednesday, July 18, 2012	0.56	Rain-Thunderstorm	Y
Monday, July 23, 2012	0.01	Rain	Y
Tuesday, July 24, 2012	0.09	Rain-Thunderstorm	Blackout, no chemical in tanks
Friday, July 27, 2012	0.01		
Saturday, July 28, 2012	1.57	Fog-Rain-Thunderstorm	
Sunday, July 29, 2012	0.01		
July Total Rainfall	**2.77**		
Wednesday, August 01, 2012	1.04	Fog-Rain	
Friday, August 03, 2012	0.01		
Sunday, August 05, 2012	0.13	Rain	
Monday, August 06, 2012	0.04		Y
Friday, August 10, 2012	0.54	Rain-Thunderstorm	8/9 and 8/10
Sunday, August 12, 2012	0.03	Rain	8/11
Monday, August 13, 2012	0.01	Fog	N
Wednesday, August 15, 2012	1.39	Fog-Rain-Thunderstorm	Y
Thursday, August 16, 2012	0.01		N
Saturday, August 18, 2012	0.19	Fog-Rain	N
Sunday, August 19, 2012	0.01	Fog	N
Tuesday, August 21, 2012	0.01		N
Thursday, August 23, 2012	0.01	Fog	Y, but no chem. flow
Tuesday, August 28, 2012	1.34	Fog-Rain	Pre-treat on 8/27
Thursday, August 30, 2012	0.01		N
August Total Rainfall	**4.77**		

Notes:

Daily Observation Data obtained from Station KOWD - Norwood Memorial in Norwood, MA

Blue background denotes rain event occuring during weekend hours

Pink background denotes rain events occuring only outside of normal business hours/overnight

From known issues at this time and four years of experience, the following adjustments are proposed:

1. The compressor needs to be checked and repaired as necessary; it built up excessive back pressure even with no air lines attached, so the problem appears to be in the compressor itself. While we anticipate lesser reliance on the compressor in the future, it will still be needed.
2. Move to use of only the inlet lines; now that dredging has been conducted, reserve the north basin for detention. Treatment at the inlets is preferable, but requires greater responsiveness to catch most of each storm.
3. Use the best parts of all current lines in the pond to create two sets of lines, one to each of Bogle Brook and Boulder Brook. The current Boulder Brook line may be in acceptable condition, but the Bogle Brook line requires some replacement. Route the Bogle Brook line along the northern shoreline, in the water but away from possible boat traffic or harvester operations. This will enhance servicing as well as limit potential damage.
4. Remove the diffusers and install a manifold at the end of each chemical line, allowing multi-port injection of alum and aluminate at each inlet. This will require 4 sections of pipe, one for each of two chemical feeds at each of two locations. Set the ports so that the pressure will enhance mixing when injected into the stream. This will eliminate the use of the compressor except to fill the airline to float the chemical lines for inspection and repairs, and to flush the chemical lines at the end of the season.
5. Maintain the two pumps. They may or may not require replacement. No obvious problems were noted at the end of the season, but the alum pump was not achieving its maximum output, limiting the rate of treatment.

If the above changes are made, the system will run mostly through simple pumping of aluminum chemicals to two inlet locations. As this requires only electricity, and not combustion compressor operation, the system will be quieter. Running a permanent electric line from the pump station to the trailer is desirable, but not necessary in the coming year while the new system is being tested. However, if permanent electricity can be routed to the pumps, the next logical step is to install a control system that allows the pumps to be turned on by rainfall or controlled by telemetry from a distance (on or off). Ultimately, this would allow automatic and remote control of the system, saving manpower. We suggest adjusting the system as described above for 2013, retaining the trailer arrangement and manual operation. If successful, the trailer can be eliminated and the system housed in a small, secure box on site along with the chemical tanks. The only issue would be the compressor, which is not needed most of the time, and might just be brought on site when needed. Such details can be worked out later.

Plant Harvesting

Harvesting Strategy

The Town of Wellesley initiated the enhanced Morses Pond vegetation harvesting program in 2007. The zoned vegetation 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 3 shows these zones and Morses Pond bathymetry. Harvesting protocols have been adjusted through experience to maximize effectiveness and minimize undesirable impacts, such as free fragments that accumulate along shore. The refinement process was detailed in the 2010 annual report. The current approach is to harvest all areas by the end of June, sometimes using both harvesters, with a cutting order and pattern that limits fragment accumulation, especially at the town swimming beach. A second cutting occurs in August and sometimes into September.

The keys to successful harvesting include:

- Initiating harvesting by the Memorial Day weekend.
- Cutting the southwest cove (Area 6) first, then proceeding through Areas 2, 3 and 4 in order of
- Cutting with or against the wind, but not perpendicular to the wind, to aid fragment collection.
- Limiting harvesting on very windy days (a safety concern as well as fragment control measure).

The second, older harvester has been used mainly to collect fragments released by the larger, newer harvester, and this approach has worked well.

Harvesting Record

Records provided by the Town of Wellesley indicate the harvesting effort expended on Morses Pond (Table 3). Although the record is not always complete, records have been kept since 2007. Between late May and early September, from 2007 through 2011, harvesting was conducted on a range of 43 to 61 days. This represents a range of 303 to 414 total hours devoted to some aspect of the harvesting program, and 223 to 291 hours of actual harvesting time, or an average of 5.1 to 5.5 hours per day of harvesting. Approximately another 2 hours per day are expended on hauling plants, harvester maintenance, and related tasks other than actual cutting or offloading, accounting for the larger total time commitment. The harvesting effort has resulted in the removal of 224,000 to 292,000 pounds of plants (wet weight) per year, excluding plant material removed by hydroraking.

The weight per load is fairly constant at around 2900 lbs, and the hours of cutting performed per day is also fairly consistent at slightly more than 5 hr/day, so total weights are largely a function of days spent harvesting. Even then, 2011 was a more productive year, owing to the operation of the second harvester most of the time. Plant density may also affect harvesting rates and yield, with 2011 having very dense growths. Harvesting has started a little later than desired in most years, about a week after Memorial Day instead of slightly before or right after that holiday weekend, but the goal of one complete harvest before the 4th of July weekend has been achieved in each of the last three years. Harvesting in August and September has also occurred as planned.

Figure 3. Plant Management Zones for Morses Pond.

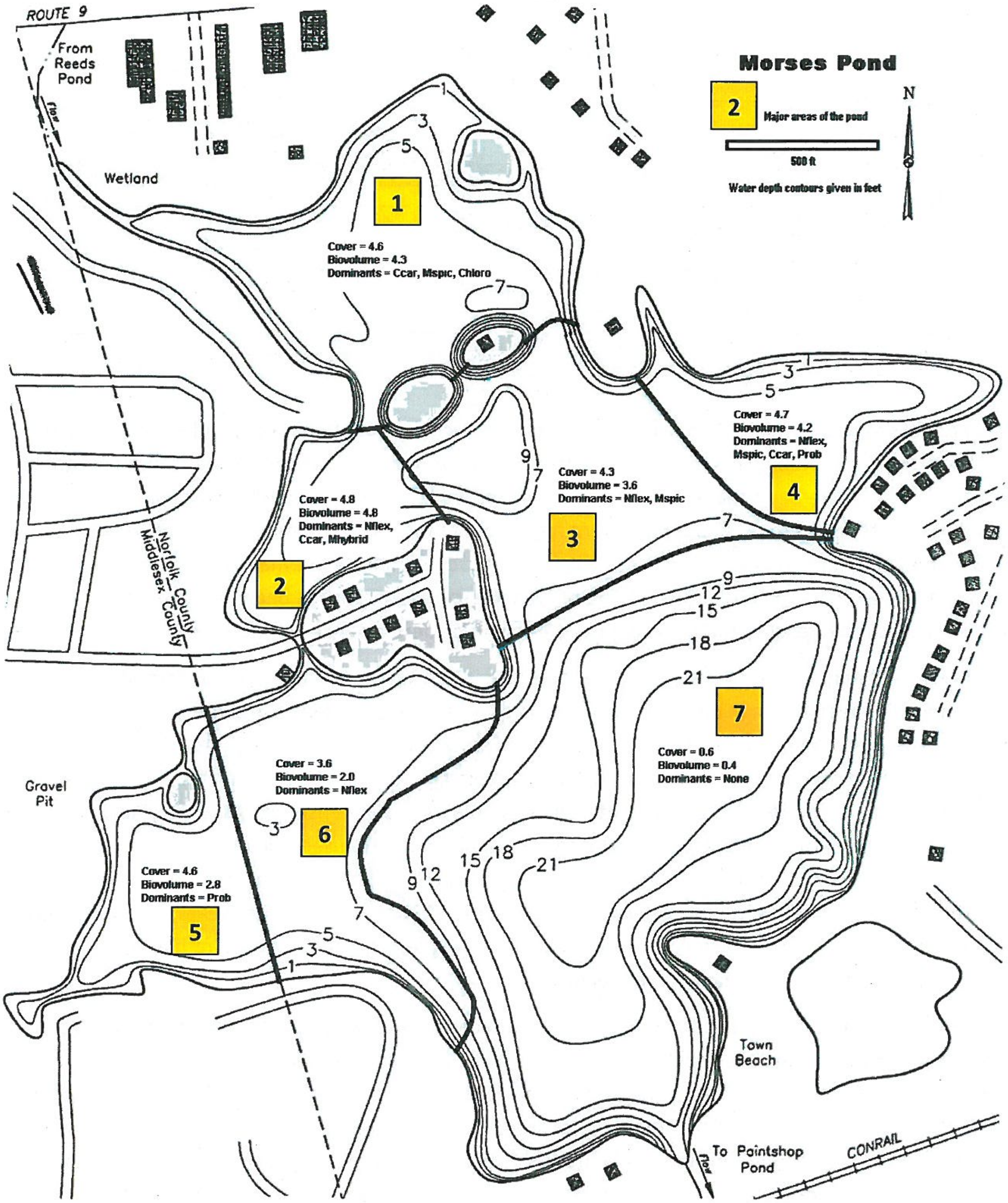


Table 5. Harvesting Record for Morses Pond.

Year	Days of Harvesting per Year	Total Hours per Year	Cutting Hours per Year	Total Hr/Day	Cutting Hr/Day	Total Loads	Total Weight	Weight/ Day	Weight/ Load	Weight/ Total Hr	Weight/ Cutting Hr
	(Days)	(Hr)	(Hr)	(Hr)	(Hr)	(Load)	(Pounds)	(Pounds)	(Pounds)	(Pounds)	(Pounds)
2007	49	359	255	7.3	5.2	109	NA	NA	NA	NA	NA
2008	43	NA	NA	NA	NA	NA	270320	6287	NA	NA	NA
2009	57	390	304	6.8	5.3	78	224060	3931	2891	575	738
2010	44	303	223	6.9	5.1	78	226960	5278	2900	749	1017
2011	54	414	291	7.7	5.4	102	292000	5407	2863	706	1003

For 2009 total hours, assumes 1.5 hr/harvesting day of non-cutting time, based on values for those days with total and cutting hours.
For 2010 total weight, assumes 202,000 pounds resulting from hydroraking, based on values for days when hydroraking occurred.

We are missing plant weight data from 2007 and hourly activity data from 2008, and the identification of plants being targeted by harvesting is not always consistent with what has been observed by staff in the field. There have been changes in personnel and procedures, so continued training should be emphasized. There were problems with plant fragment creation and accumulation along shorelines in 2009, and while some fragment release is unavoidable, adjustments were made that greatly improved performance in 2010 and 2011. Overall, the plant harvesting program has been proceeding well, achieving desirable results, and being adjusted to enhance performance as warranted.

There was a change in the primary harvester operator in 2012. The new operator was trained and WRS personnel did meet with him on-site to discuss the program, independent of his internal training. There were unspecified complaints early in the season, and inspection of the lake suggested some issues with high turbidity creation during harvesting, but the harvesting operation was conducted in a manner consistent with past efforts. The mild winter resulted in earlier and denser plant growth, slowing harvester progress to some degree, and this may have alarmed lake users. However, a complete cut was achieved before the 4th of July, the normal target, and a second cutting was conducted in August and September. Again, weed growth was faster and denser in 2012 than most other years, so conditions may have been considered less appealing despite the harvesting effort, but evaluation of harvesting results was generally positive (see plant survey section).

There have been some plant controls additional to mechanical harvesting with "standard" weed cutters. A benthic barrier was installed at the swimming beach in 2008 as a pilot study, but no further application occurred. As of 2011, the original benthic barrier was still in place, but is mostly buried in the sand. 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. Hydroraking of peripheral areas was conducted in 2010, with residents paying for those services off their shoreline parcels. Hand harvesting of water chestnut is practiced each spring by a group of volunteers supported by the town. This effort has kept water chestnut in check, with only scattered plants found and removed each year.

Plant Surveys

Plant surveys were conducted in early to mid-May of 2008, 2009, and 2010 prior to plant harvesting to determine the assemblage features and facilitate recommendation of any program adjustments. These surveys have helped to 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. In 2011, with the harvesting program protocols generally well known to the DPW staff involved in the project, we opted to survey the plants at selected stations during the harvesting, allowing some comparison among harvested areas as a consequence of harvesting. This process was repeated in 2012 for a second comparison of harvested vs unharvested areas.

Methods

Surveys applied the point-intercept method, resulting in 306 survey points on Morses Pond the same as utilized during the 2005 vegetation survey that set the stage for the comprehensive plan as relates to plant control in Morses Pond. 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 the following information is recorded:

- The GPS waypoint.
- Water depth using a metal graduated rod or a mechanical depth finder.
- Plant cover and biovolume ratings using a standardized system.
- 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=76-100%, and 5= 100% of plants filling the water column.

Shoreline surveys to support hydroraking were described in the 2010 annual report. No such surveys were conducted in 2011 and 2012.

Multi-Year Results

Overall, Morses Pond exhibits moderate to dense vegetation cover and biovolume prior to harvesting each year. With the exception of the deeper southern basin (Zone 7), plant cover had an average ranking of at least 3 (>50% coverage) in each year and average biovolume for a majority of the pond was ranked between 2 to 3 (plants taking up about half of the water column). As an early season survey, this represents a plant assemblage sure to interfere with swimming and boating during summer without some form of control. Harvesting is perceived by most lake users to have improved recreational conditions, but we have yet to see any ongoing control of plants, particularly invasive species.

For the point-intercept surveys, 35 species are known from Morses Pond, with 23 plant species detected in 2005, 20 plant species encountered in the 2008 and 2009 surveys, 24 in 2010 and 2011 and 25 species in 2012. The complete list is provided in Table 6. The five invasive plant species routinely encountered are:

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

Note that *Trapa natans*, water chestnut, is also known from Morses Pond, but owing to the efforts of volunteer water chestnut pullers, it has never been found in the standard survey. It does appear that species richness is increasing over time, possibly as a consequence of harvesting, but many species are represented by few individuals, and the dominant species of the last two decades remain the dominant species. Fanwort is the most abundant invasive, with both Eurasian and variable milfoil also common to abundant. It appears that Eurasian milfoil has been declining in recent years in favor of variable milfoil, a shift we have observed previously in both directions. It is somewhat unusual for these two invasive species to co-occur, so slight changes in water quality or other habitat variables may alter the balance between them. The natives coontail, common naiad, bigleaf pondweed, waterweed and white water lily remain common. The native Robbins pondweed appears to be declining, which is unfortunate, as this is a desirable species. It is not clear that the harvesting is impacting this species, which is outcompeted by fanwort and milfoils in most lakes infested with those invasive plants.

Another invasive, curly leaf pondweed, can be a dominant in the spring, but tends to die back during summer and not create major issues for swimming and fishing during summer. An invasive wetland species, purple loosestrife, was observed on the northern basin shoreline in all survey years. Note that the original 2005 survey was performed during summer, while the 2008-2012 surveys were conducted during spring. This shift can affect detection of some species. For example, spotted pondweed tends to bloom between June and August, limiting detection in spring surveys, while curly-leaf pondweed usually dies back by early July, limiting its detection in summer surveys.

Table 6. Plant Species Found in Morses Pond, 2005-2012.

		Plant Rating for Year					
Scientific Name	**Common Name**	**2005**	**2008**	**2009**	**2010**	**2011**	**2012**
Callitriche sp.	Water starwort	P		P			
Cabomba caroliniana	Fanwort	A	A	A	A	A	A
Ceratophyllum demersum	Coontail	C	C	C	A	C	C
Chlorophyta	Green algae	C	C	C	A		P
Cyanobacteria	Blue green algae		P		C	P	P
Decodon verticillatus	Swamp loosestrife	C	P		P	P	
Elodea canadensis	Waterweed	C	C	C	C	C	C
Lemna Minor	Duckweed	P	P	P	P	P	P
Lythrum salicaria	Purple loosestrife	P	P	P	P	P	P
Myriophyllum heterophyllum	Variable watermilfoil	P	C	C	A	A	A
Myriophyllum spicatum	Eurasian watermilfoil	A	A	A	A	C	C
Najas flexilis	Common naiad	C	C	C	C	P	P
Nymphaea odorata	White water lily	C	C	C	C	C	C
Nuphar variegatum	Yellow water lily	C	P	P	P	P	P
Polygonum amphibium	Smartweed	P	P	P	P	P	P
Pontederia cordata	Pickerelweed	P		P	P		
Potamogeton amplifolius	Broadleaf pondweed	C	C	C	C	C	C
Potamogeton crispus	Crispy pondweed		C	C	C	P	P
Potamogeton epihydrus	Ribbonleaf pondweed		P	P	P	P	P
Potamogeton perfoliatus	Claspingleaf pondweed					P	P
Potamogeton pulcher	Spotted pondweed	P			P	P	P
Potamogeton pusillus	Thinleaf pondweed					P	P
Potamogeton robbinsii	Fern-leaf pondweed	C	C	C	C	P	P
Potamogeton zosteriformis	Flatstem pondweed						P
Ranunculus sp.	Water crowfoot						
Salix sp.	Willow				P		
Sagittaria gramineus	Submerged arrowhead	P	P	P		P	P
Sparganium sp.	Burreed						
Spirodela polyrhiza	Big duckweed	P				P	
Typha latifolia	Cattail			P			
Trapa natans	Water chestnut						
Utricularia geminiscapa	Bladderwort	P	P		P		P
Utricularia gibba	Bladderwort	C				P	
Valisneria americana	Water celery				P	P	P
Wolffia columbiana	Watermeal	P			P		P
	# of Species	23	20	20	24	24	25
	P=Present, C=Common, A=Abundant						

Assessment of Harvesting Impacts

The 2011 and 2012 surveys were conducted during the spring harvesting effort, allowing a comparison between harvested and unharvested areas. Harvesting was only about halfway through the spring effort, so this affects which zones are characterized as harvested or unharvested. Ultimately, zones 2, 3, 4 and 6 are harvested, with zone 1 being the north basin and zone 5 being the Natick portion of the western cove. Zone 7 is the deep central area, where few plants grow, although sometimes the shoreline area along the southeast and southwest portions of zone 7 needs attention.

Cover (Figure 4) is not greatly altered, as the harvester does not cut to the very bottom of the pond and this measure is two-dimensional. This graph is slightly different than that generated from 2011 data; zone 2 had not yet been harvested when the survey was conducted, and the difference between harvested and unharvested area was greater in 2012. The earlier growth after the mild winter of 2011-2012 leads to more cover in unharvested areas, and it appears that the harvester was set closer to the bottom in the spring of 2012, removing more vegetation. The higher than normal turbidity noted during the survey in areas 3 and 4 is consistent with the cover impact.

Biovolume (Figure 5) assesses the portion of the water column filled by plants in three dimensions, and is more directly relevant to how people perceive pond condition. The 2012 data is similar to the 2011 data and shows considerable reduction between harvested and unharvested zones. It is apparent that harvesting, even just the first half of the spring effort, has a major impact on plant biovolume.

Discernible frequency reductions from harvesting are fewer in 2012 than in 2011. White water lily (Figure 6) and yellow water lily (Figure 7) showed decreases, while no apparent change is observed for the major invasive species fanwort (Figure 8), variable milfoil (Figure 9), and Eurasian milfoil (Figure 10). Since harvesting does not remove the whole plant in most cases, it is not surprising that more changes are not observed. Those species that are reduced in frequency are more susceptible to harvesting; the bulk of the plant biomass is at the surface for water lilies.

Conclusions Relating to Plants

The plant community of Morses Pond is still too dense in most areas and is dominated by invasive species. Harvesting with the new harvester and an adjusted approach appears to be causing some shifts in the plant community, but no drastic changes. Harvesting keeps areas open for habitat and recreational use, greatly reducing plant biovolume, but must occur each year to maintain those gains. Harvesting effort in 2012 was as great as in recent years, but plant abundance, particularly fanwort, was still excessive in many areas. Harvesting is a reliable maintenance technique, but has not yet been demonstrated as a strong force in shaping the plant community in Morses Pond.

Figure 4. Cover Comparison Between Harvested and Unharvested Zones of Morses Pond.

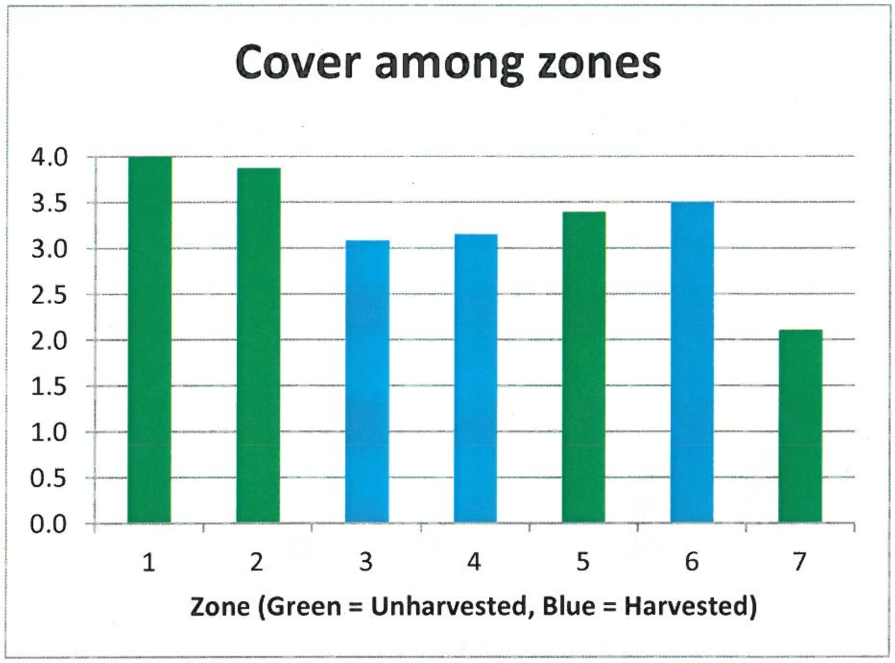


Figure 5. Biovolume Comparison Between Harvested and Unharvested Zones of Morses Pond.

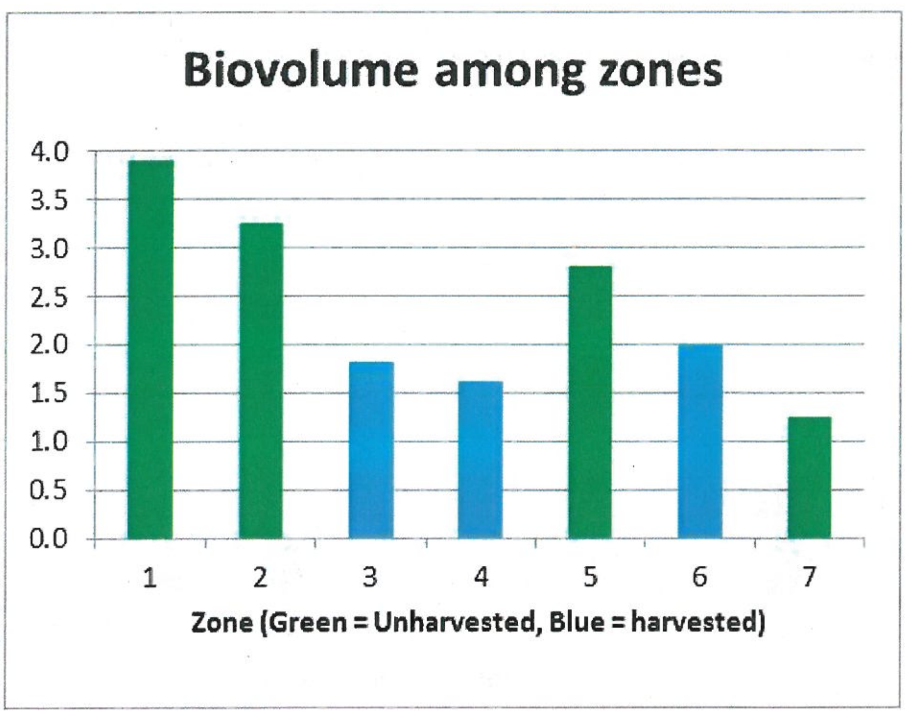


Figure 6. Comparison of White Water Lily Frequency Between Harvested and Unharvested Zones.

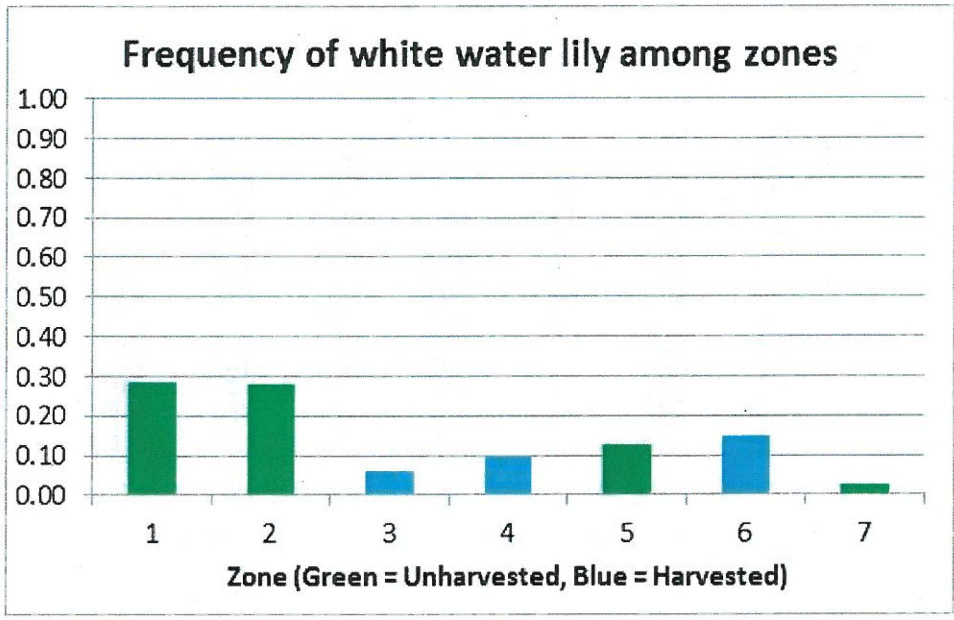


Figure 7. Comparison of Yellow Water Lily Frequency Between Harvested and Unharvested Zones.

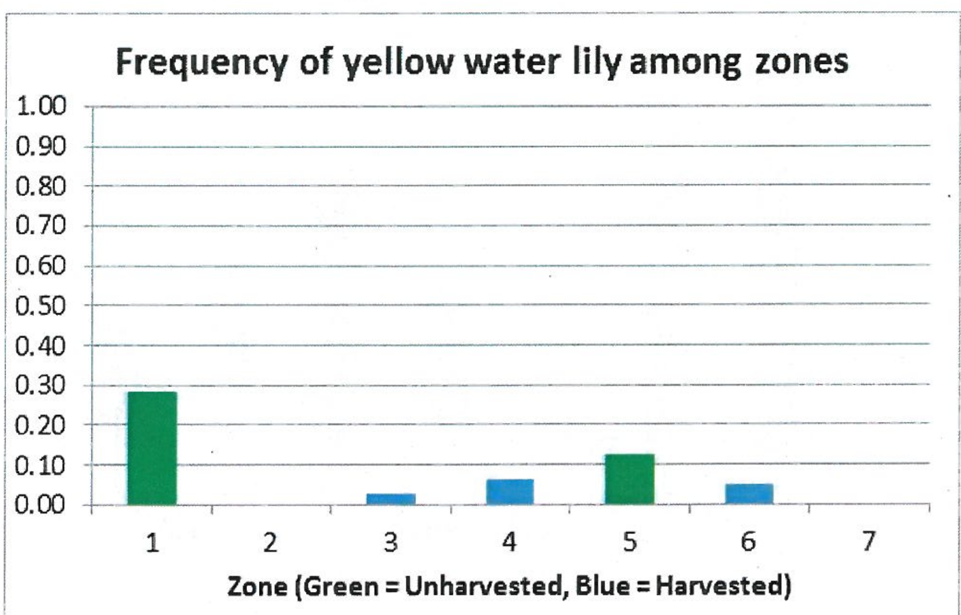


Figure 8. Comparison of Fanwort Frequency Between Harvested and Unharvested Zones.

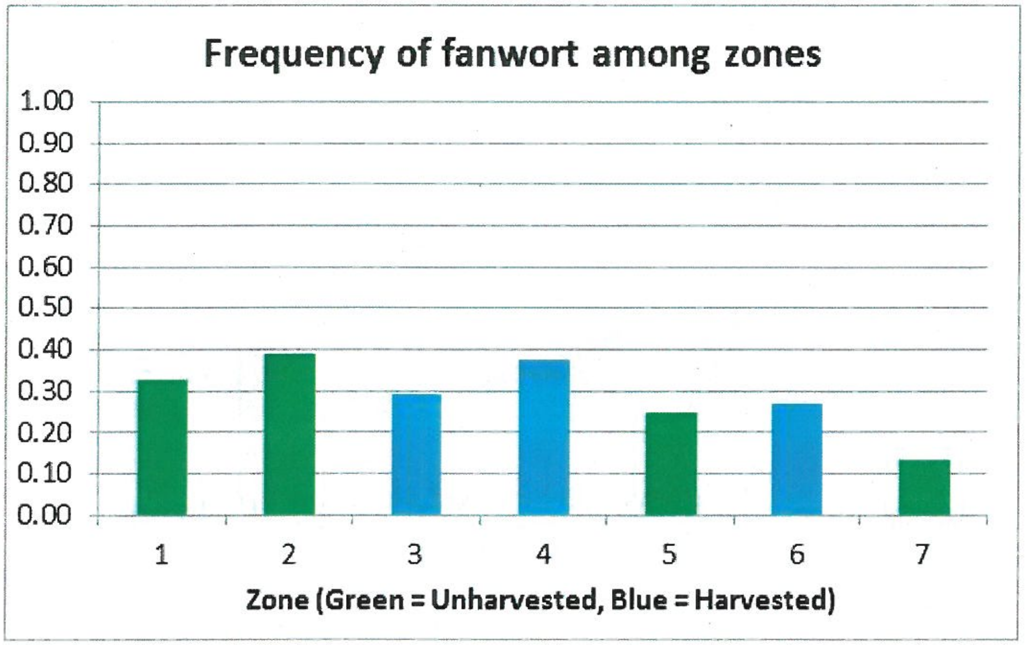


Figure 9. Comparison of Variable Milfoil Frequency Between Harvested and Unharvested Zones.

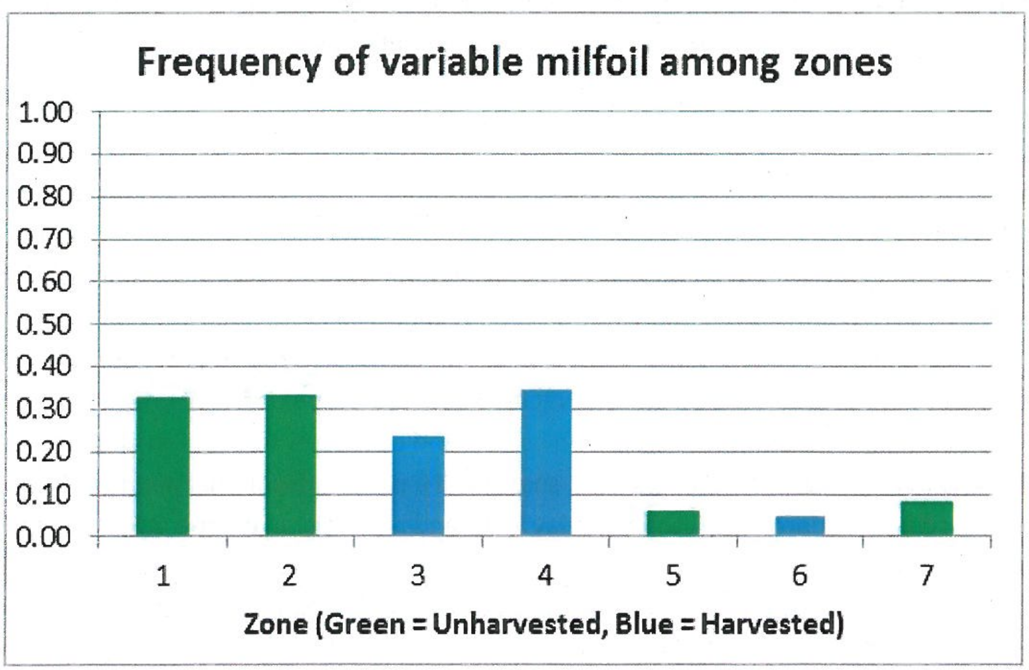
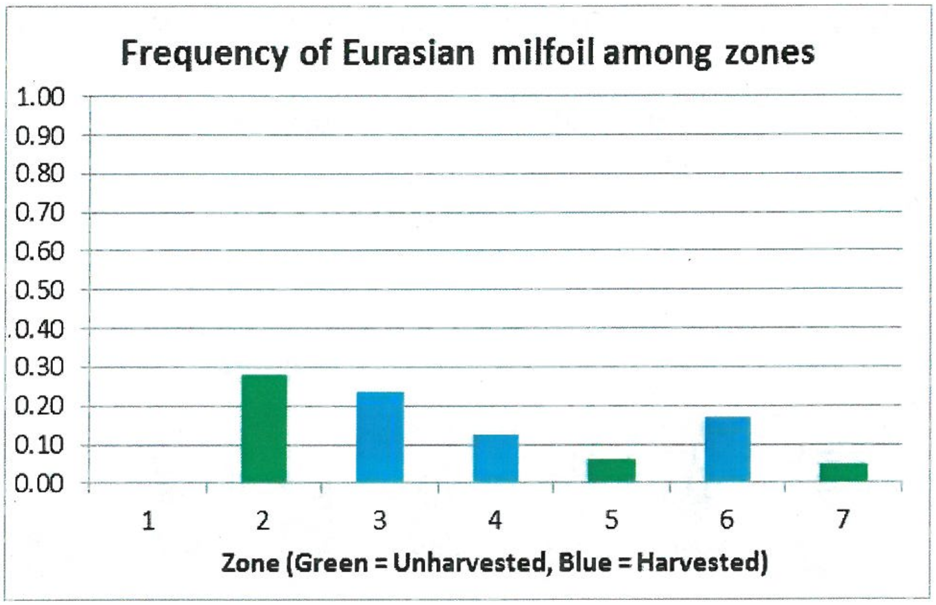


Figure 10. Comparison of Eurasian Milfoil Frequency Between Harvested and Unharvested Zones.



Low Impact Development Demonstration

In the spring of 2008, AECOM evaluated public sites within the Morses Pond watershed for future application of Low Impact Development (LID) techniques. A desktop analysis was conducted on the approximately 60 parcels identified. Out of the 60 parcels, 13 locations were identified for further field investigation. Based on the field investigation, the Upham Elementary School and Bates Elementary School were chosen as the best properties for a LID demonstration.

The Upham Elementary School was selected for further design, and in 2009 preliminary design plans and specifications were prepared. The design included conversion of grassed islands and a portion of the paved play yard in front of the school to a series of water quality swales with added bioretention filtration of stormwater. The design also included a larger biorentention area behind the school by the ball field parking. AECOM worked with Wellesley DPW and the Natural Resource Commission (NRC) on fine tuning the design to provide a demonstration project that would provide water quality treatment with minimal maintenance requirements. In early 2011 the plans were rejected by the school board due to impacts to trees in the area. As a result, the NRC evaluated other potential sites and worked with its consultant to design, permit and construct a rain garden and other Low Impact Development projects near the beach house at Morses Pond. The NRC sponsored a public educational program on how to create a backyard rain garden at the library in May 2012 and also held an on-site workshop at Morses Pond at the time the rain garden and LID elements were installed in late May 2012. These events were very well attended and the NRC developed educational information on rain gardens and LID projects that has been widely distributed to residents and landscapers. The NRC will be working to install additional rain gardens in 2013.

Education

The Town of Wellesley produced an informative brochure on the importance of phosphorus control many years ago, and continues to use this tool in resident education. The brochure is not outdated, but the extent of distribution and the effectiveness of this mode of education are uncertain. The Town also has bylaws relating to lawn watering and other residential activities that affect water quality in streams and lakes, including Morses Pond. The extent to which residents understand these regulations is also uncertain. The right messages are being sent, but reception and reaction have not been gauged.

In 2006 a survey was conducted by AECOM on behalf of the Town to assess resident awareness and practices. It appeared that more people handled their own lawn care than expected, and that most were anxious to learn about approaches that might have less impact on water quality. Most homeowners had little background knowledge of issues relating to fertilizer use and other residential management practices.

It was determined that a website would be a better or at least effective additional means of communicating with residents on their role in protecting water quality through desirable residential practices. Morses Pond pages were constructed to be incorporated into the Town's website. Layout and content were adapted from existing materials and subject to review. Revision has been underway since summer of 2011, but town staff time for review and direction has been very limited over the last year. Expenditure of time and funds on the phosphorus inactivation system in 2012 limited resources by the Pond Manager to devote to this effort as well.

Dredging

The Town of Wellesley arranged for the North Basin to be dredged in the late 1970s; no dredging had been conducted since 1979, and both natural and anthropogenic sources of sediment have causes considerable infilling of the North Basin since that time. Dense growths of submergent and emergent vegetation limit recreational utility and habitat value in the North Basin, although some forms of water-dependent wildlife benefit from these conditions. While dense vegetation does provide some filtering capacity, the overall loss of depth limits detention time and facilitates resuspension during storms, threatening water quality in the main body of the pond. It was determined as part of the comprehensive planning process that the North Basin should be dredged again to restore detention capacity.

In 2009 the Town hired Apex Inc. to develop dredging plans and shepherd them through the dredging process. Sediment quantity and quality were assessed, plans were developed, and permits were secured. A number of complications arose, including the need to document yet again that Morses Pond was not a Great Pond under the laws of the Commonwealth and therefore not subject to Chapter 91, an additional regulatory process. That effort was ultimately successful.

More troublesome was the detection of metals and hydrocarbon contamination in the north basin, something not observed previously. However, dredging regulations and related contamination thresholds had changed since the previous sediment assessment in 2004, and not all the same tests were run in earlier sampling. The result was that the permitting process took longer than hoped and the cost to dispose of the sediment was considerably higher than initially expected. The targeted area was reduced to about two acres to both avoid areas of greater contamination and to attempt to keep the cost within the allocated amount.

An agreement was secured from the Catholic Diocese of Massachusetts to utilize the parking lot of the "closed" Catholic Church on Rt 9 as a dredged material processing area. However, material had to be removed by March of 2011, and delays in the permitting process caused bids to be secured for the work in September, with an anticipated starting date of early November 2010. Contractors were clearly uncertain about dredging in late autumn and achieving adequate dewatering over the winter to clear the parking area by spring. As a result, fewer contractors submitted bids, and the lowest bid was approximately twice the amount allocated for the dredging.

It was decided that no bid would be accepted and that the dredging project would be revisited in a year or two, when additional funds could be secured and when the timing of the project could be potentially made more advantageous. No further action occurred in 2011, but additional funds to pursue dredging were allocated in 2012 and the project was put out to bid successfully. Cashman Construction was the successful bidder, and Apex has acted as the Town's agent in the process. The Pond Manager has had minimal involvement with the dredging project and has limited information about progress, but dredging has now been completed. Soft sediment is drying in geotubes on the adjacent property (former St. James parish, eventually to be a town facility) until spring, when it will be hauled away. The coarser sediment (mostly sand) was used for beach nourishment in the town swimming area.

The dredging of the north basin is an expensive project and only a few acres of area have actually been dredged. Any sediment removal increases detention capacity of the north basin, an important settling and pollutant processing area within the pond, and is highly desirable. A smaller area was dredged to a deeper depth, expecting that other material will slough into the depression and result in a less topographically severe slope over time, but still providing increased detention time (about 20% more). The amount of plant control to be achieved remains to be seen; the dredged area will probably have few plants for a year or two, but most of the north basin will still have dense growths. It may be desirable to hydrorake a channel through the dense growths to direct inflow from Bogle Brook to the newly deepened area, but this may not be necessary. Evaluation of flow path is warranted in 2013.

Financial Summary

As of the last invoice in September of 2012, more of the FY13 allocation for the Pond Manager was expended than is usual at that point in the fiscal year (Table 7). This is a consequence of continued and more active phosphorus inactivation work through the summer, involving much more staff time and additional water quality monitoring. The remaining key task for FY13 is the operation of the phosphorus inactivation system in the spring of 2013, up until July 1st, so we have minimized expenditures to this point to ensure adequate funds to meet that obligation. Since the date of the last invoice, expenses have totaled $2489.50, so we have $21,747.35 from the Pond Manager account, $6100.50 from the Monitoring account, and $7500.00 from the P Inactivation account (a total of $35,347.85) to expend between now and June 30th of 2013. We believe that this will be adequate, but with needed repairs to the system and other desirable activities (plant monitoring, website upgrade), we have proceeded cautiously with expenses.

Table 7. Project financial progress through September 2012.

Account	Task	% complete as of this invoice	$ Invoiced by WRS	$ Allocated to WRS	% Allocation Expended
Pond Manager (FY13)	Support for Morses Pond Management	33%	$26,783.16	$51,020.00	52.5%
Monitoring (FY13)	Water quality tracking	20%	$1,039.50	$7,140.00	14.6%
P Inactivation (FY13)	Treatment at inlets to reduce phosphorus	0%	$0.00	$7,500.00	0.0%
		Total	$27,822.66	$65,660.00	42.4%

2013 Work Plan

The phosphorus inactivation and harvesting programs should proceed as in recent years. The education and LID programs should be dovetailed and advanced via the town website and follow up public actions. Such actions could focus on rain barrels and rain gardens to minimize runoff, but some action is needed to start moving residential practices in a desirable direction. Emphasis on lawn services that will limit phosphate fertilizer use is also desirable. Fortunately, phosphate lawn fertilizers are expected to be phased out over the next five years, but it may take another decade before the residual quantities in the watershed are exhausted.

The following actions are suggested:

Phosphorus Inactivation

February – Assess system components, particularly the chemical pumps and the compressor, repair as needed. Arrange for reconstruction of the chemical and air feed manifold (existing one is too corroded for further use).

March – Apply for permits necessary for 2012 application of aluminum to Morses Pond; this includes the License to Apply Chemicals from the DEP, but may also include a renewed Order of Conditions from the Wellesley Conservation Commission for 2013. This needs to be verified.

April – restore in-lake components of the system (air and chemical feed lines) and construct injection manifold at end of each of 4 chemical feed lines (2 each at Bogle and Boulder inlets). Hook up and test refurbished pumps and compressor.

May – Arrange for alum and aluminate delivery. Initiate treatment at inlets in response to storm events. Continue into summer as needed.

Harvesting

May – Get harvesters on the lake prior to Memorial Day if at all possible. Hold harvesting staff field meeting if needed to discuss the approach and ensure that common species can be identified.

May-June – Conduct spring harvesting program. Emphasize fragment minimization and maximum removal of invasive species.

Late June – Conduct plant survey, compare harvested and unharvested areas. Assess conditions going into the summer and adjust any priorities for the August-September harvesting effort.

August-September – Conduct summer harvesting program.

Education

Jan-Feb – Convene a group to go over the web pages and request any final format adjustments.

April-May – Finalize content.

June – Web pages available publicly.

July-October – Receive feedback, adjust content.

Stormwater Control/LID Program

No action by Pond Manager planned; can support town effort as desired and requested.

Dredging

No action by Pond Manager planned; can support contractor and consultant effort as desired and requested.