Bare Hill Pond Watershed Management Committee
Town of Harvard
Harvard, MA 01451

August 10, 2013

Conservation Commission
Town of Harvard
Town Hall
Harvard, MA 01451

Re: 2013 Report and Fall 2013 Drawdown Plans

Dear Commissioners:

On behalf of the Bare Hill Pond Watershed Management Committee, we are pleased to submit our 2013 annual report under our current Order of Conditions. As discussed last year, we engaged an aquatic biologist, Wendy Gendron to visit the Pond this summer to supplement our volunteer monitoring efforts. Ms. Gendron collected and analyzed samples for phosphorus and water quality in April and June, and will conduct a final monitoring trip in late August. She also joined us on a tour of the Pond in late July focusing on the concerns raised by the Bowers Road residents. See interim phosphorous and Secchi disk results in Exhibit A. Wendy Sisson of the Conservation Commission and Will Stevenson of Lycott Environmental Inc. were also able to join us for the tour in July. Ms. Gendron's report for the work to date is attached.

This year has been an active onefor the Committee as we continued to improve the collection of data regarding the draw down, monitored the overall health of the Pond and its watershed, worked with the Park and Recreation Commission to remove sediment from the swimming area during the last draw down, and then completed construction of the last two BMPs for collection of storm water at the boat ramp and beach area at the end of Pond Road. We also continue to engage in outreach and education activities to encourage best management practices by watershed residents, and through these collective activities reduce invasive species and phosphorous in the Pond.

Draw Down Observations

The draw down in Fall 2012 enabled us to continue to learn how to minimize the impact of lower water levels on the use of the Pond while retaining the benefits of the draw down to the protection and restoration of native habitat. Notably, our findings this past year continue to confirm a significant reduction of phosphorous in the Pond. In both the April and June 2013 readings, the level of phosphorous was 50% below the goal of our Section 319 grant (0.30 *ug/*l). This level is approaching one that would be expected in a developed watershed, specifically 0.20 *ug/l* or less. See the Wagner Presentation. Attached as Exhibit B. A completely undeveloped watershed is normally 5-10 *ug/l* and it would be difficult to get much lower than this given the bound phosphorous in the Pond bottom. Still the 1998 TDML measured the level at 0.44 ug/l.

The improvement in water clarity based on Secchi disk readings is also likely to be attributable to this reduction in phosphorous.

Our hypothesis, which I discussed with both Wendy Gendron and Ken Wagner when he spoke on this subject at COLAP 2 years ago, is that we are washing shallower areas of the Pond bottom during the draw down, reducing the available phosphorous and diluting the phosphorous in the water column from the draw down and refill process.

In 2012, we experienced the impact of a 6-week drought and a heavy rainstorm that washed significant phosphorous into the Pond in a single dose. There was a significant algal response that reduced water clarity as a result, we believe, of a short term significant increase in phosphorous. The levels in the Pond did not spike so high at that time to result in observable eutrophication and loss of oxygen to trigger a fish kill or other habitat destruction. The benefit of maintaining healthy phosphorous levels is that we can mitigate these types of events and retain a healthy habitat for much or all of the year.

During our tour of the Pond in July, we focused on the south end of the Pond, near Bowers road where the stream enters the Pond from the marsh on the southwest end of the Pond. Here is a photo of the location during the draw down last year.

The extent of the draw down and the path of the stream is clearly evident. This area had significant milfoil growth in the past and was traditionally harvested prior to the draw downs – likely creating cuttings and making the milfoil problem worse even if the cutting provided temporary relief. Residents in that area of the Pond have been concerned that the draw down was making the situation worse. Therefore, over the past year, we invited them to discuss the matter at Pond Committee meetings(which they did) , conducted a site walk during the draw down last fall, and toured the area by boat in the summer, as noted above. The residents reported that the problem was much worse now due to the draw down. We asked Wendy Gendron to evaluate the situation as well as Will Stevenson, the owner of Lycott Environmental, a lake and pond management firm.

Will discussed the options with both the Pond Committee and the residents earlier this year and recommended that we look at it this summer. His firm is licensed to apply herbicides, perform

harvesting, do barge assisted plant raking/pulling/vacuuming, etc. His initial thinking, like ours, was that the residents might be right that the draw down was not working in that area due to the continual stream flow that interfered with the freezing and drying of the invasive species occurring on the rest of the Pond where the draw down is having a positive impact. He advised us that there are currently new spot herbicide treatments or that weed raking/pulling/vaccuming might be an option. He wanted to see the site first however. His firm currently treats portions of the lake that Wendy Gendron lives on in central Massachusetts as well as Lake Boon, and numerous other lakes and pond in the Northeast.

In late July we visited the site and sampled the plant growth. We confirmed there were invasive iris along the shoreline. He indicated there was little one could do to control them and that they only grow along the shoreline and not in water deep enough for recreational use. The iris might have always been there but the draw down appears to have favored their expansion in that area, as in the Clapps Brook shoreline area. Here is a photo from Clapps Brook:

The residents were not really concerned with those plants when asked. Their principal concern was the presence of plants growing in the deeper water zones that they use to access the Pond from their shoreline docks. Wendy and Will sampled the plants and the surprising finding was the relative absence of invasive species. We had been assuming that the plants causing the nuisance were the milfoil and fanwort that remained in the absence of draw down efficacy. Instead we observed a wide variety of native species that had returned to the habitat. These plants unlike milfoil and fanwort are not problematic elsewhere in the Pond because they are lower growing and less dense than the invasives. The challenges in the Bowers brook area are that it abuts the alluvial fan of the input streams, is quite shallow, and is becoming shallower each year as the stream deposits sediment. It is a highly fertile plant bed and because the draw down favors native plants (even with the wet conditions in winter), it created space for the habitat to restore itself.

When asked by the residents, Will Stevenson did not recommend herbicide treatment in this area or raking/pulling. He noted that while he conducted restoration activities on Lake Boon, he did not recommended doing it in areas of Lake Boon that were similar to this area. The residents then discussed the possibility of operating the harvester to remove plants in the summer months by harvesting channels to from the docks to the Pond, as had been done prior to the draw downs when there was milfoil in this area. They are exploring that possibility. This would be a volunteer effort on their part, like that by Rick Dickson, where they would train someone to use the harvester. We understand from Liz Allard that this kind of activity would be subject to a permitting process as an activity in the wetlands. If the residents choose to proceed, we will assist them as we did Rick Dickson in accessing and maintaining the harvester. They have not yet indicated interest in proceeding with the harvester.

We should have Wendy Gendron's final transect survey results for the September 5 Conservation Commission meeting. She is doing the formal 3 year measurements as well as the final phosphorous and the outflow measurements during the last week of August. The date is consistent with transect surveys from previous years.

The draw down went smoothly this year and was limited to 6 feet. There appeared to have been a sufficient freeze in late December/early January and the refill proceeded in a timely manner. The schedule that limited the depth to 3.5 feet in October and starting pumping in November was sufficient to achieve 6 feet by Thanksgiving last year. As noted below, we plan to further reduce the depth of the draw down this year to 5.5 feet. If acceptable to the Commission, our plan is to continue to reduce the depth incrementally, just as we increased it incrementally, to retain to the extent possible the phosphorous reduction and invasive species control, while minimizing the depth of the draw down.

We do not believe that a radical change (i.e., taking a year off) is appropriate given the phosphorous reduction and the success we have seen to date. A negative impact of failing to conduct a draw down for even one year would be the potential establishment of mussel populations in a future draw down zone. It is critical that mussels form their beds in the deeper areas of the Pond so that they survive draw down events. By reducing the level of the draw down incrementally, we are able to observe how less deepdraw downs can maintain the lower phosphorous levels and the invasive species control. We are then able to increase it incrementally if the data warrant in future years.

100 Foot Segments and Additional Photos: Exhibit C contains the site photos showing the 100 foot segments post-draw down. Also included are photos showing mussel observations, Clapps Brook

Volunteer Monitoring:

During the draw down process we stopped at 5 feet to check mussel counts. We found a comparable number of mussels, including juveniles, as compared to the previous year(s?). This data suggest that the mussels are adapted to the draw down. The improvement in water clarity also indicates that the mussel population is not adversely affected. These results are consistent with the advice we received at the Concord Conservation Commission meeting in 2011 where we spoke with a mussel biologist who identified the mussels in Bare Hill Pond as a common species that is well adapted to changing water levels and which would be present at all depths in our Pond.

Downstream wetlands continue to appear healthy with the one observation showing an increase in the prevalence of cattails. The draw down pumping site does not appear to be gauging? or impairing plant growth as there are healthy sedges and wetland plants.

After approximately8 years, Jeff Ritter transferred responsibilityof frog monitoring to TomGormley of the Pond Committee who continued to perform annual frog counts in 2013. Tom recruited Don Soja to provide organizational and data support. Don is pulling together over 10 years of records and will analyze the data this winter.. Until now our reports have been qualitatively descriptive based on observations. Don plans to chart out the frog species and counts for each species from year to year. It is a big project involving many data sheets.

With Tom's leadership, Don held several training sessions and invited many folks to participate this year. He was successful in holding 4 counting events to capture the species as they emerge from winter. The first counts in March are generally wood frogs and peepers, while the later counts will find pickerel frogs, American toads, green frogs and in the summer bull frogs. This year we continued to hear large numbers of wood frogs and peepers. One noticeable change for 2013 was an increase in the number of pickerel frogs. Individual comparisons of American toads, green frogs and bull frogs is difficult to do until Don completes his work. In the past few years we did not have enough data in June and July to really know the differences between these species. With Tom's leadership and the rejuvenation of the counting events we hope to have better data over time.

Morey Kraus conducted turtle observations during his regular early evening kayaking. Unlike previous years, the shoreline in Clapps Brook is no longer a suitable site for observing turtles due to the growth of the Iris along the shoreline which either obscures their view or removes their sunning locations. Morey reports that he reliably sees clans of painted turtles in Clapps Brook and snappers throughout the Pond. He sees them painted turtles in groups of up to 5-7 turtles. Last year the groups were smaller. Still, he reports that these findings are consistent with his observations in prior years.

Of note, we saw a young otter swimming in the Pond during our July tour near Clapps Brook.

Several fishing derbies reported results for the spring and summer of 2013. Merrimack Valley Bass Tournament included 14 anglers (15 in 2012) who caught 69 bass (71 bass in 2012) and returned 67 (69 in 2012) alive. The greatest weight was 5.9 pounds (6 lbs in 2012). For comparison, 24 bass were caught in 2011. This tournament is a regular derby, and in conversations with fishermen, they continue to report that Bare Hill Pond is one of their favorite ponds for fishing.

As reported this spring, there was a fish kill during spawning season which was also reported around the same time on a number of lakes and ponds Massachusetts. Spawning fish kills are the result of too many fish competing for normal levels of oxygen in shallow spawning areas. While to a casual observer the sight of the fish kill was alarming, the Mass DCR official, who is responsible for monitoring fish kills, estimated that the 100 or so fish observed were a very small fraction of the fish population in the pond (which he estimates in the tens of thousands). During June, both Rick Dickson and I observed large schools of fish fry in the Pond with numbers way too high to count. These high densities of fish fry potentially indicate a significant spawning season, and the fish kill may suggest that the fishing habitat has improved in the Pond as the population may have approached or is approaching its limit.

Rick Dickson continues to pursue invasive water chestnut plants. Due to his success over the past several years, he did not seek volunteer help for a weed pull. The water chestnuts are under control as the density of plants is low as reflected in how difficult it is to find them throughout the Pond. . The dramatic reduction of water chestnuts in Bare Hill Pond is an amazing success story.

In summary, the Pond Committee believes the draw down is having a positive effect on the health of the Pond. We look forward to improved frog count data and reporting methods. The data support our hypothesis that the effect of the draw down is incremental in nature, and that as a result, it allows for the successful restoration of habitat as native species replace invasive species and as water quality improves. This year, we are particularly pleased to see continued improvement in phosphorous levels and water clarity results as well as the restoration of native plants in the Bowers brook area.

Draw Down Plan

In 2012 we conducted an incrementally shallower draw down at 6 feet and had acceptable results. Summer of 2013 was one year after the excavation, and the results from the beach were excellent.

We also believe, as noted last year, that we should continue to incrementally decrease the draw down level to determine the appropriate level at which phosphorous concentrations can remain low and invasive species can remain under control. We are proposing a 5.5 foot draw down this year which would provide greater flexibility in timing and preserve additional days/weeks for recreational use.

Date	Depth Target (Measured from the top surface of the dam)	
	2013	2012
9/24	22”	22”
10/1	22”	34”
10/15	34”	46”
10/24	46”	52”
10/28	52”	58”
Nov 30 or freeze	5.5’	6’

Pumping would begin only when needed to maintain the rate during October but be necessary after reaching approximately 3 feet. The rate would not exceed 2 inches per day per the Order of Conditions. We think this approach will preserve Pond levels in September and October for recreational use and still achieve the beneficial draw down effects. If we are unable to achieve the 5.5 foot draw down by November 30, 2013 or a freeze occurs, we will stop or discuss it with the Commission if we have an alternative recommendation.

As in prior years, we would initiate the refill of the Pond on or before February 1, 2014 following notice to the Commission and the abutters. Because snowmelt timing is variable and it is important to timely refilling of the Pond, our experience indicates that deferring the refill beyond February 1 is unwise to ensure the habitat is restored for amphibians, fish and reptiles.

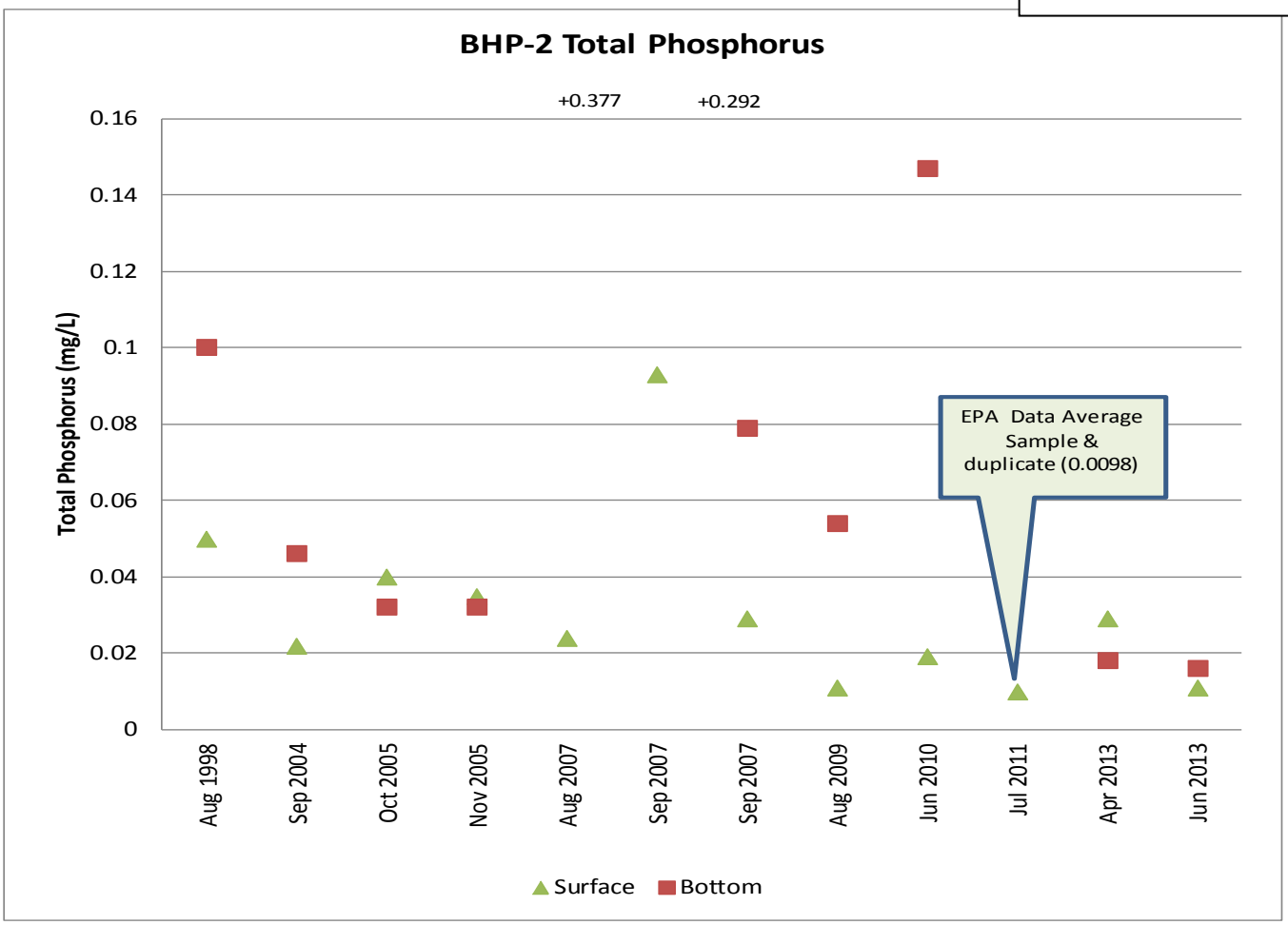
We appreciate the time the Commission has taken, and the effort made to understand, and help manage the project. We look forward to the meeting on September 5.

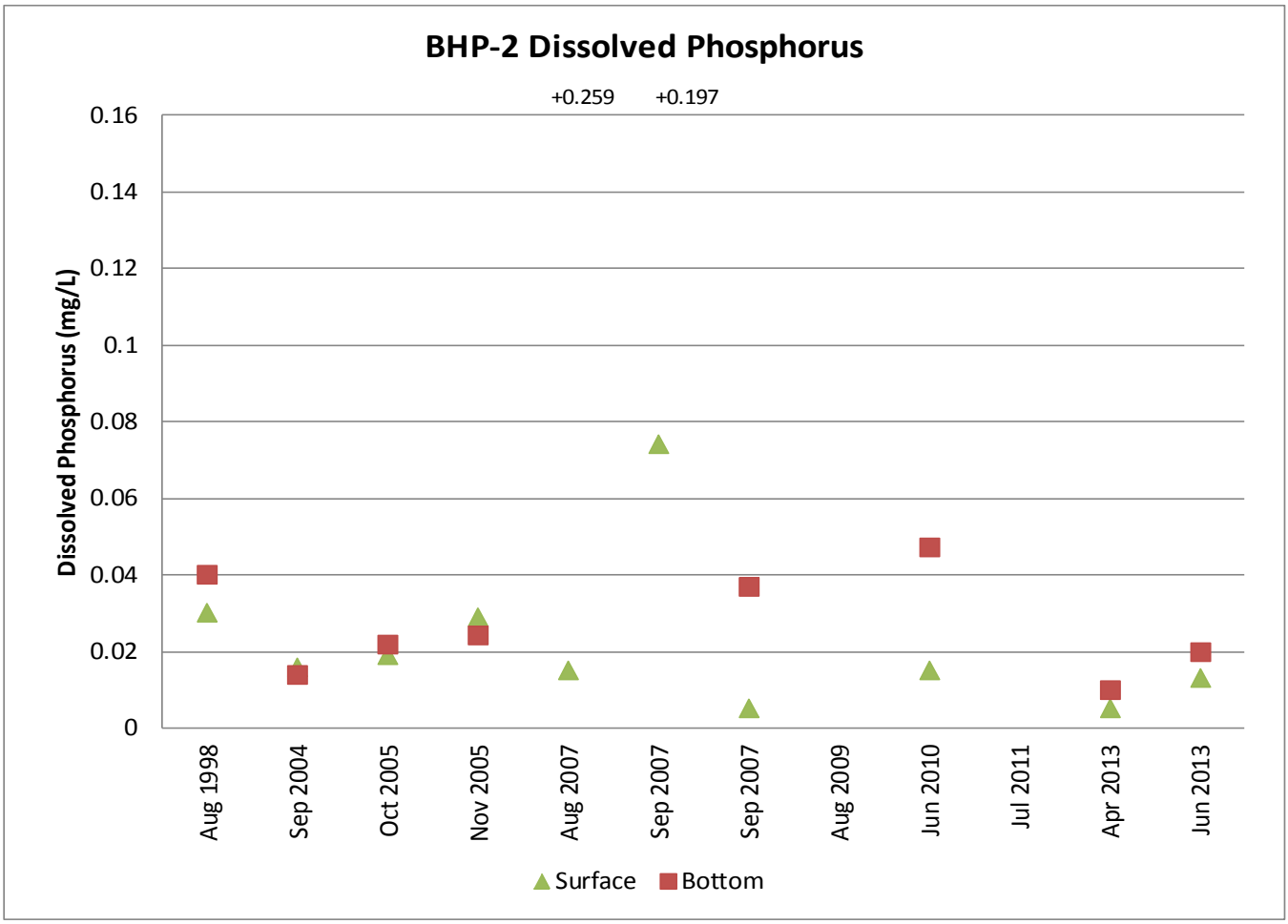
Sincerely,

Bruce A. Leicher
Chair, Bare Hill Pond Watershed Management Committee

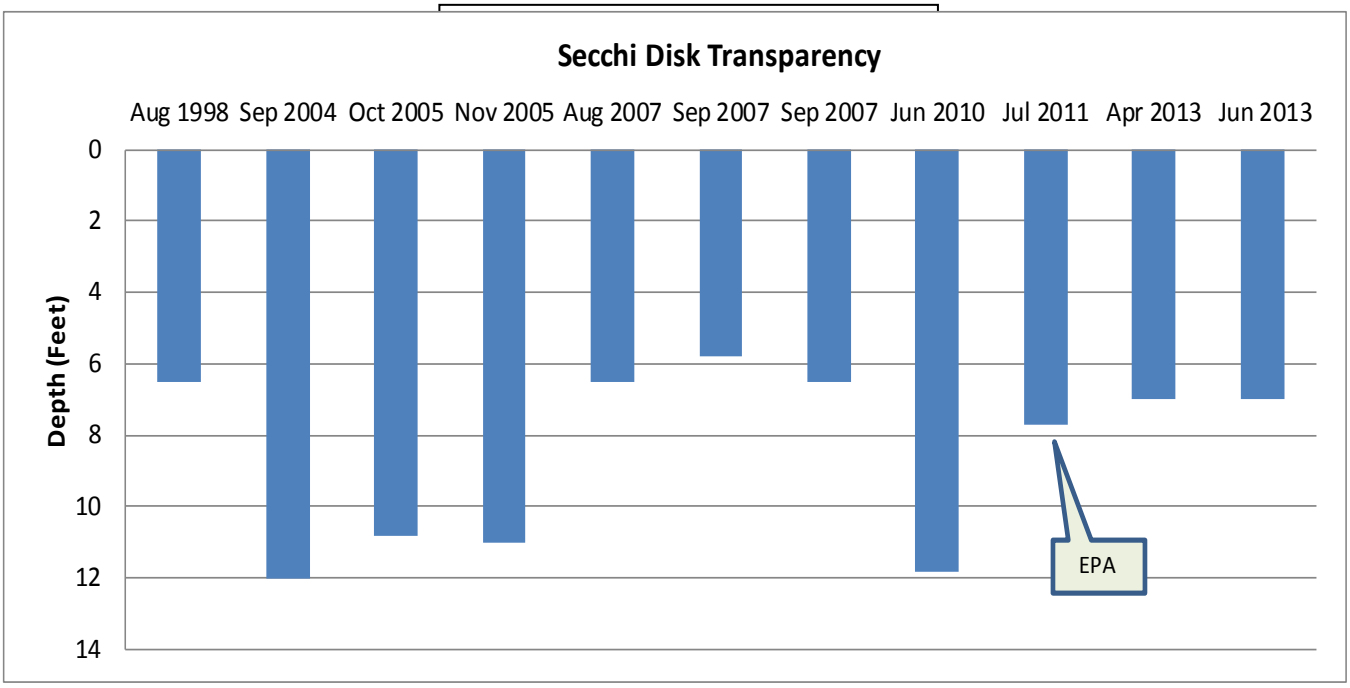
Cc: Conservation Commission Members
Bare Hill Pond Watershed Management Committee Members
Board of Selectmen

Exhibit A


BHP-2 Total Phosphorus
+0.377
+0.292
Total Phosphorus (mg/L)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
EPA Data Average Sample & duplicate (0.0098)
Aug 1998
Sep 2004
Oct 2005
Nov 2005
Aug 2007
Sep 2007
Sep 2007
Aug 2009
Jun 2010
Jul 2011
Apr 2013
Jun 2013
Surface
Bottom


BHP-2 Dissolved Phosphorus
+0.259
+0.197
Dissolved Phosphorus (mg/L)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Aug 1998
Sep 2004
Oct 2005
Nov 2005
Aug 2007
Sep 2007
Sep 2007
Aug 2009
Jun 2010
Jul 2011
Apr 2013
Jun 2013
Surface
Bottom

Exc


Secchi Disk Transparency
Aug 1998
Sep 2004
Oct 2005
Nov 2005
Aug 2007
Sep 2007
Sep 2007
Jun 2010
Jul 2011
Apr 2013
Jun 2013
Depth (Feet)
0
2
4
6
8
10
12
14
EPA

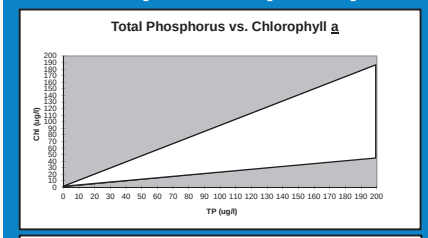
Exc

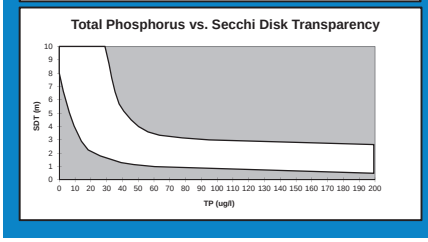
Station	Date	Time	TP (mg/L)	DP (mg/L)	TSS (mg/L)	Secchi (ft)
2S	9/16/2004	11:01	0.022	0.016		12
2B	9/16/2004	11:04	0.046	0.014		
1S	9/16/2004	8:59	0.022	0.022		
1B	9/16/2004	9:01	0.022	0.022		
2S	10/4/2005	12:50	0.040	0.019		10.8
2B	10/4/2005	13:11	0.032	0.022		
1S	10/4/2005	12:25	0.027	0.019		8.7 (bottom)
1B	10/4/2005	12:29	0.032	0.022		
2S	11/3/2005	12:50	0.035	0.029		11
2B	11/3/2005	13:06	0.032	0.024		
1S - Duplicate	11/3/2005	11:25	0.024	0.024		
1S	11/3/2005	11:25	0.029	0.024		
1B	11/3/2005	11:29	0.051	0.024		
BHP-BK	8/28/2007	9:30	<0.010	<0.010		
BHP-2S	8/28/2007	13:14	0.024	0.015		6.5
BHP-2B	8/28/2007	13:15	0.377	0.259		
BHP-1S-DUP	8/28/2007	12:11	0.024	<0.010		
BHP-1S	8/28/2007	12:10	0.031	0.01		4.5 (bottom)
BHP-1B	8/28/2007	12:12	0.039	0.016		
BHP-2S	9/7/2007	14:01	0.093	0.074		5.8
BHP-2B	9/7/2007	14:02	0.292	0.197		
BHP-1S	9/7/2007	13:10	0.091	0.086		4.5 (bottom)
BHP-1B	9/7/2007	13:11	0.092	0.069		
BHP-2S	9/20/2007	9:30	0.029	<0.010		6.5
BHP-2B	9/20/2007	9:32	0.079	0.037		
BHP-1S	9/20/2007	9:10	0.037	0.018		4.8 (bottom)
BHP-1B	9/20/2007	9:11	0.037	<0.010		
2S	8/30/2009	15:15	0.011	NA	<5	
2B	8/30/2009	15:00	0.054	NA	51	
2S	6/21/2010	19:15	0.019	0.015	1	11.8
2B	6/21/2010	19:15	0.147	0.047	14	
1S	6/21/2010	18:48	0.022	0.015	0.5	11.5
BH01 (EPA; close to BHP-1S)	7/19/2011	14:29	0.007			
BHP02 (EPA)	7/19/2011	14:48	0.0056			
BHP03 (EPA; close tp BHP-2S)	7/19/2011	15:06	0.0086			
BHP030 (EPA; Dup of BHP03)	7/19/2011	15:06	0.011			
BHP04 (EPA)	7/19/2011	15:15	0.012			
BHP-2S	4/17/2013	17:30	0.029	<0.01	<5	7
BHP-2B	4/17/2013	17:20	0.018	<0.02	<5	
BHP-1S	4/27/2013	17:55	0.020	<0.02	<5	4.5 (bottom)
BHP-2S	6/25/2013	18:15	0.011	0.013	<5	7
BHP-2B	6/25/2013	18:20	0.016	0.02	<5	
BHP-1S	6/25/2013	18:45	0.013	0.014	<5	4.5 (bottom)
NA = not available, problem with laboratory analysis						
"Bottom" indicates the Secchi disk reached the pond bottom						

Seeing the Big Picture: Options and Limits for Management to Enhance Lakes

Ken Wagner, PhD, CLM
Water Resource Services

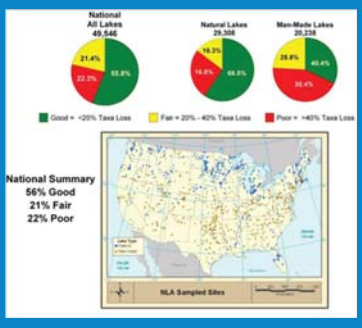
The impact of phosphorus





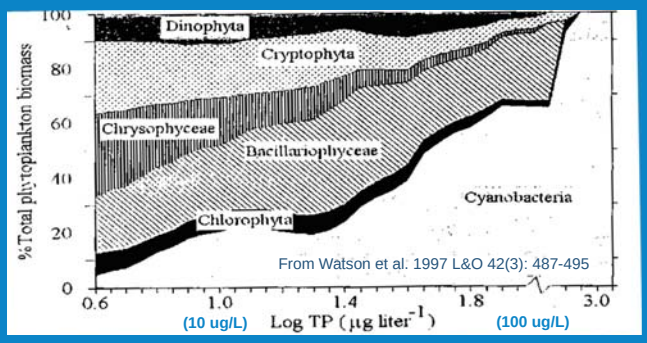
- More P leads to more algae
- More algae leads to lower water clarity

How are we doing with lake management?



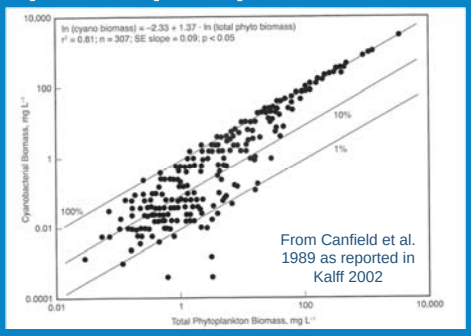
According to the National Lakes Assessment last year, almost half of our lakes are in less than good shape nationwide as a consequence of nutrient pollution

The impact of phosphorus



- High P also leads to more cyanobacteria, possible health effects therefore linked to high P

The impact of phosphorus



– As algal biomass rises, a greater % of that biomass is cyanobacteria. So more P = more algae = more cyanobacteria.

The impact of development

– Ratio of impervious surface area to developed area varies (and becomes the basis for some desirable management), but tends to be on the order of 1:2.

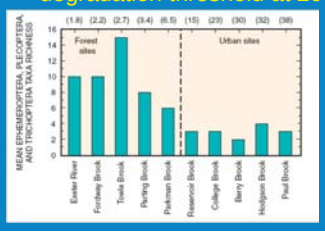
– So as a rough guide, halve the developed portion of a watershed to get an estimate of impervious surface

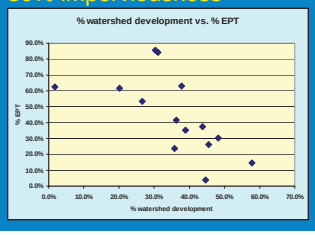
The impact of development

– Latest study by USGS indicates 33% change in insect community of streams with 10% impervious cover in watershed (http://water.usgs.gov/nawqa/urban/)

– Study in CT demonstrated observable changes in stream quality at impervious surfaces >6%

– Older CWP study suggested observable impact at 10%, severe degradation at 25%; other estimates: severe degradation threshold at 20-30% imperviousness



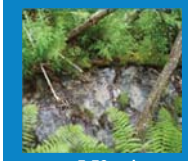


The impact of development

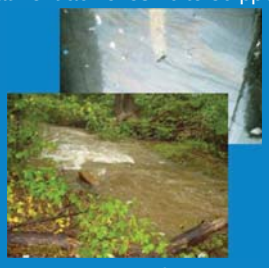
– Background concentrations for P: 5-50 ppb, with an apparent threshold of impact between 10 and 20 ppb

– Runoff P concentrations: 50 to 5000 ppb, median >370 ppb

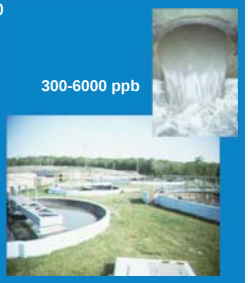
– Wastewater treatment effluent P: usually 300 to 6000 ppb, very best treatment achieves 20 to 50 ppb



5-50 ppb

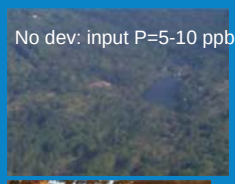


50-5000 ppb



300-6000 ppb

The impact of development



Lake George,NY: 5% developed watershed contributes same P load as remaining undeveloped 95%

75% dev:
input P= >140 ppb

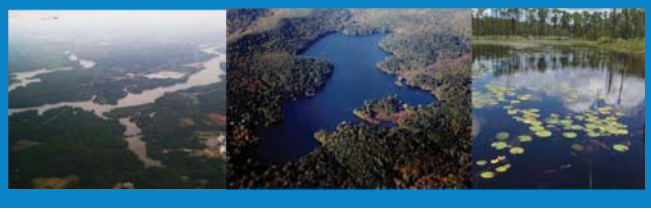
Watershops Pond, MA has 75% developed watershed, input P averages 193 ppb.

How do we counter development impacts?

- Source and Activity Controls - Eliminate or reduce sources which generate pollutants
- Transport Reduction - Capture and remove or convert pollutants before they enter target resource
- Instream/Inlake Treatments– enhancing internal processes for pollutant inactivation
- **Ecosystem Restoration- Repair damage to resources when controls fail**

The impact of development

- How lakes process the incoming P varies substantially; flushing rate, depth, internal recycling, biological structure, inorganic suspended solids load, and other factors affect in-lake P concentration and related algal densities
- Nevertheless, higher input P leads to higher in-lake P and the problems related thereto; it is desirable to address the problems in the watershed rather than in the lake
- Note that agriculture is not being explicitly considered here, but processes (and many of the results) are the same

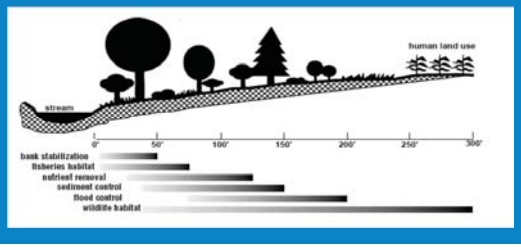


Source Controls

- Land use restrictions
- Material storage restrictions
- Product use limitations
- Education

Pollutant Trapping

– Buffer strips: a lot more to know than just leaving some vegetated land



Pollutant Trapping

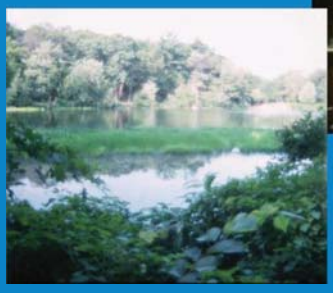
– Detention systems, infiltration basins, filtration systems

Pollutant Trapping

– Wide range of structural options – construction aids like silt fence, passive guards like swales, range of stormwater processing devices

Instream/Inlake Treatment

Creating detention within a lake or chemically treating runoff or streamflows



Aluminum treatments becoming more common and fairly effective in short and intermediate timeframes

Doing the math on watershed controls

– Can we get the land on the right to act like it is land on the left?

Boiling it down

With reasonable implementation of Best Management Practices in a watershed, one can expect to achieve about a 50% reduction in P loading, with a probable maximum around 67%, unless extreme measures like chemical treatment or extensive infiltration are applied

Range and Median ( ) for Expected Removal (%) for Key Pollutants by Selected Management Methods, Compiled from Literature Sources for Actual Projects and Best Professional Judgment Upon Data Review.

	TSS	Total P	Soluble P	Total N	Soluble N	Metals
Street sweeping	5-20	5-20	<5	5-20	<5	5-20
Catch basin cleaning	5-10	<10	<1	<10	<1	5-10
Buffer strips	40-95 (50)	20-90 (30)	10-80 (20)	20-60 (30)	0-20 (5)	20-60 (30)
Conventional catch basins (Some sump capacity)	1-20 (5)	0-10 (2)	0-1 (0)	0-10 (2)	0-1 (0)	1-20 (5)
Modified catch basins (deep sumps and hoods)	25 (25)	0-20 (5)	0-1 (0)	0-20 (5)	0-1 (0)	20 (20)
Advanced catch basins (sediment/floatables traps)	25-90 (50)	0-19 (10)	0-21 (0)	0-20 (10)	0-6 (0)	10-30 (20)
Porous Pavement	40-80 (60)	28-85 (52)	0-25 (10)	40-95 (62)	-10-5 (0)	40-90 (60)
Vegetated swale	60-90 (70)	0-63 (30)	5-71 (35)	0-40 (25)	-25-31 (0)	50-90 (70)
Infiltration trench/chamber	75-90 (80)	40-70 (60)	20-60 (50)	40-80 (60)	0-40 (10)	50-90 (80)
Infiltration basin	75-80 (80)	40-100 (65)	25-100 (55)	35-80 (51)	0-82 (15)	50-90 (80)
Sand filtration system	80-85 (80)	38-85 (62)	35-90 (60)	22-73 (52)	-20-45 (13)	50-70 (60)
Organic filtration system	80-90 (80)	21-95 (58)	-17-40 (22)	19-55 (35)	-87-0 (-50)	60-90 (70)
Dry detention basin	14-87 (70)	23-99 (65)	5-76 (40)	29-65 (46)	-20-10 (0)	0-66 (36)
Wet detention basin	32-99 (70)	13-56 (27)	-20-5 (-5)	10-60 (31)	0-52 (10)	13-96 (63)
Constructed wetland	14-98 (70)	12-91 (49)	8-90 (63)	6-85 (34)	0-97 (43)	0-82 (54)
Pond/Wetland Combination	20-96 (76)	0-97 (55)	0-65 (30)	23-60 (39)	1-95 (49)	6-90 (58)
Chemical treatment	30-90 (70)	24-92 (63)	1-80 (42)	0-83 (38)	9-70 (34)	30-90 (65)

Doing the math on watershed controls

– USEPA 1999 – summarizes capture efficiency of many pollutant trapping devices

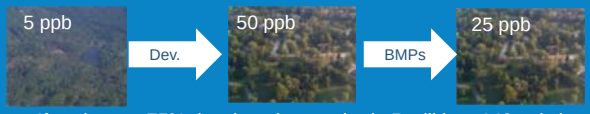
– Center for Watershed Protection 2003 – more summary, rationale and key factors

– USEPA stormwater management database – current – documented case histories from which one can infer reliable results

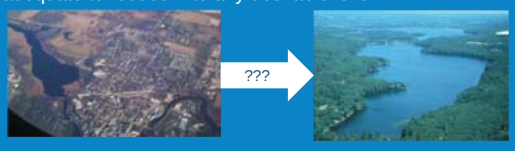
Wide range of possible outcomes, means and medians provide a feel for likely results, range shows importance of understanding key factors

Doing the math on watershed controls

– So if we have a 20% developed watershed that has gone from 5 ppb to 50 ppb as a consequence of runoff impacts, and we apply reasonable BMPs, we expect to lower P to about 25 ppb – not bad, but hardly back to "natural" – we can flirt with restoring function in watersheds with low development %



– If we have a 75% developed watershed, P will be >140 ppb (could be >300 ppb), and even a 67% reduction by BMPs will not be adequate to reduce P to any desirable level



Can we achieve our goals?

- If we are to meet CWA mandates through stormwater management, we have to do way better than even the highest "reasonable" level expected based on experience to date
- We are going to need a different approach, or an emphasis on the techniques that yield very high removal rates (= infiltration or chemical treatment) if TMDLs are to be achieved, and many may not be realistically achievable

Low Impact Development (LID)

- LID techniques seek to minimize the generation of runoff and transport of pollutants off properties
- Focus on the source, widespread application, and creativity of approaches are important aspects of LID
- A lot of good work being done, suggests higher "removal" rates than conventional pollutant trapping
- Likely to be essential if we are to counter impacts of existing and future development

Lawn fertilizer issue

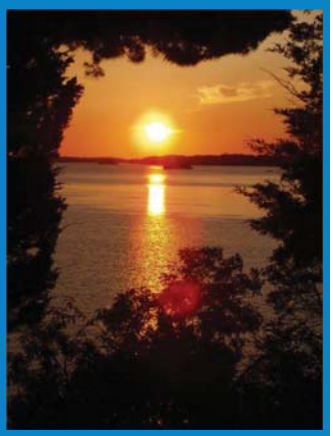
- Cities banned or reduced fertilizer P starting in 1990s, whole states moving toward restrictions in 2000s.
- Dodson 2008 in Lake and Reservoir Management:

  Watershed feature most correlated to poor conditions was % lawn
- Lehman et al. 2009 in Lake and Reservoir Management:

  Ban on P in fertilizer produced 25% decrease in stream P concentration in first year. Follow up research in review, supports this assessment

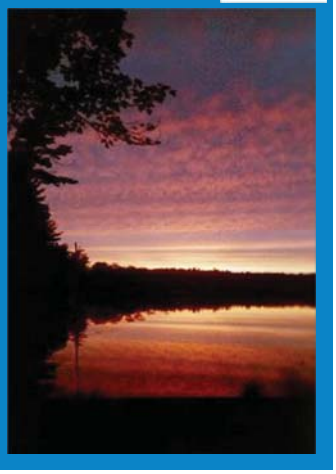
Conclusions

- There is a mismatch between impacts of development and countermeasures as traditionally applied; degradation outstrips remedial actions most of the time
- Other than preventing development above some threshold (10%?), there are only a few options that provide the needed level of P control
- Targeted source control, LID, and chemical treatment have the greatest applicability



Conclusions

- TMDLs for severely eutrophied systems may not be realistically achievable with existing tools at application levels that are feasible and affordable
- Protecting lakes with currently desirable conditions would appear to deserve higher priority than some restoration efforts
- Rehabilitating lakes to meet designated uses may differ in approach from restoration or meeting a TMDL



The End

Location
Ten 100' Segment Sites

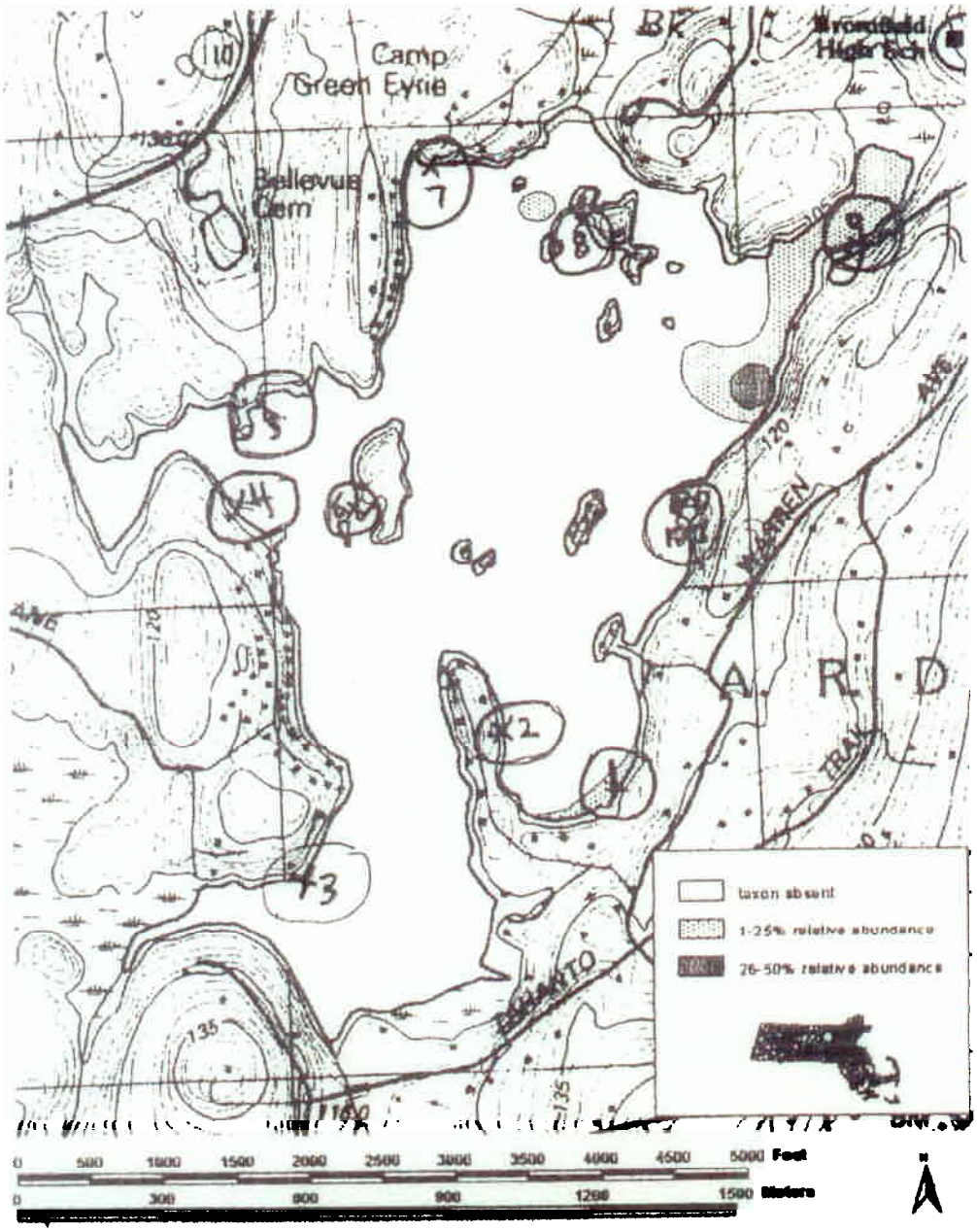


Figure 5. Distribution and relative abundance of fanwort (*Cabomba caroliniana*) in Bare Hill Pond in October 2001, from data in Appendix A.