AQUATIC CONTROL TECHNOLOGY, INC.
POND AND LAKE MANAGEMENT SPECIALISTS

October 27, 2011

Long Sought For Pond Protective Association
Mr. Douglas Bell, President
98 Dunstable Road
Westford, MA 01886

Re: 2011 Year-End Report for the Aquatic Management Program at Long Sought For Pond

Dear Association Members:

Please accept this as our Year-End Report for the 2011 Aquatic Management Program at Long Sought For Pond. Since the successful 2004 whole-lake treatment with Sonar herbicide to control Eurasian watermilfoil (*Myriophyllum spicatum*), the annual management program has focused on vegetation/water quality monitoring and control of curlyleaf pondweed (*Potamogeton crispus*).

Treatment Program

The Sonar (fluridone) herbicide treatment conducted in 2004 continues to provide excellent control of the Eurasian watermilfoil in Long Sought For Pond. With the exception of a few individual milfoil plants, there has been no other evidence of milfoil re-growth through this season. Another non-native, invasive plant curlyleaf pondweed (*Potamogeton crispus*) became the primary target of management in 2006. Early season treatments have been shown to be the key to managing curlyleaf pondweed. Although complete eradication is rarely achievable, aggressively treating all occurrences of curlyleaf pondweed with treatment in late April/early May has brought the infestation to a minimal level. Two consecutive years of “spot” treatment with Reward (diquat) herbicide (totaling ~ 20-acres out of the 100-acre pond) in 2006 and 2007 were performed to bring the infestation under control. Another treatment was conducted in 2009, but since then growth of curlyleaf pondweed has been minimal. We continue to monitor growth each spring and will recommend treatment as necessary.

Monitoring Program

This year, planned sampling visits were conducted on May 10th and September 28th. At your request, we also came out on July 19th to collect an algae sample and perform a temperature/dissolved oxygen profile. This extra round was requested to further investigate mid summer conditions that may be contributing to trout mortalities, which were observed last summer and to a lesser extent this summer.

During the May and September visits, the pond’s aquatic vegetation was documented using a combination of visual observation, an Aqua-Vu underwater camera and sub-surface collection with a specially designed throw-rake. Water samples were collected from three stations and a temperature/dissolved oxygen profile and Secchi disk water clarity reading were measured over the deepest point in the pond.

Vegetation Distribution

Figure 1 & 2 depict the distribution of plants as observed during the May and September surveys, respectively. The spring vegetation assemblage was dominated by Robbins pondweed with only several areas of sparse curlyleaf pondweed as indicated on the map. Robbins pondweed was fairly well distributed on the pond bottom except in areas of deeper water (>~ 15-feet). A moderate amount of muskgrass (*Chara sp*.), a beneficial, rooted macro-algae, was observed to be co-habitating the areas of Robbins pondweed especially in deeper water. Widely scattered occurrences of largeleaf pondweed (*Potamogeton amplifolius*) were also observed. Small to moderate sized patches of white waterlilies (*Nyphaea odorata*) were observed to be emerging in the coves. No Eurasian milfoil was observed.

In the fall, most shoreline areas exhibited growth of tapegrass (*Vallisneria americana*) along with the Robbins pondweed. The tapegrass becomes more noticeable in the late summer when the plant sends up a spiral stalk containing reproductive structures. Bladderwort (*Utricularia spp*.) was also observed growing sparsely along with the Robbins pondweed and tapegrass. Scattered patches of largeleaf pond were again observed in the same areas as the spring survey. One small area of coontail (*Ceratophyllum demersum*), a native plant, and one area of ribbonleaf pondweed (*Potamogeton epihydrus*), also a native plant, was also noted. The same areas of waterlilies were also noted. No curlyleaf pondweed or Eurasian milfoil was observed.

Water Quality Observations

Water quality samples were collected during the survey at three stations (see Figure 1). The following section presents the results of the laboratory testing with interpretation:

TABLE 1 - WATER QUALITY RESULTS (2011)

Station	Date	PH (S.U.)	Alkalinity (mg/L)	Turbidity (NTU)	Total Kjeldal Nitrogen (mg/l)	Nitrate Nitrogen (mg/l)	Ammonia (mg/l)	Phosphorus (mg/l)	Apparent Color (NTU)	True Color (NTU)	Total Coliform Bacteria (CFU/100 ml)	Fecal Coliform Bacteria (CFU/100 ml)
# 1 (North End)	May 10th	6.52	6.60	0.430	0.200	<0.400	<0.100	<0.0100	8.00	4	300	<10
	Sept. 28th	6.87	9.50	1.40	<0.100	<0.100	<0.0500	<0.0100	10	10	ND	<10
# 2 (South End)	May 10th	6.65	6.40	0.440	0.600	<0.400	<0.100	0.0110	8.00	5	300	<10
	Sept. 28th	6.84	9.00	1.5	0.400	<0.100	<0.0500	0.0100	10.0	10	50	20.0
# 3 (Inlet)	May 10th	5.80	4.00	0.670	0.400	<0.400	<0.100	0.0375	90.0	75	3200	<10
	Sept. 28th	5.67	16.5	1.60	0.400	<0.100	<0.050	0.0570	150	120	1200	20
Hypo-limnion	Sept. 28th	6.54	34.0	-	0.400	<0.100	0.813	0.0350	225	180	-	-

pH – The pH measurement scale is from 0 to 14, where zero is extremely acidic, 7 is neutral, and 14 is the most basic. pH is related to the concentration of H^+ (hydrogen ions) in solution and can affect many different aspects of water chemistry. The values obtained at LSFP were slightly acidic, except for the inlet sample station, which was noticeably more acidic than the lake water. This may indicate influence from the surficial geology of this stream's watershed or possibly due to decomposition of humic material in the stream bed. A pH range of about 5.5 – 8.5 is desired for maintaining a healthy fishery. The hypolimnetic sample pH was only slightly lower than the surface water samples in September.

Total Alkalinity – Alkalinity is a measure of the buffering capacity of a waterbody against acid additions such as acid rain and pollution, which can be detrimental to wildlife populations. Total alkalinity measures the presence of carbonates, bicarbonates and hydroxides. Values below 20 mg/l are a signal that the pond may be susceptible to fluctuations in pH. Alkalinity at LSFP is low, like many ponds in the region owing to the natural geology and soils in the area. Hypolimnetic water showed higher alkalinity values likely due to dissolved and particulate matter that had settled near the bottom of the lake.

Turbidity - Turbidity is a relative measurement of the amount of suspended material in the water. It is measured through a process involving light diffraction of the pond sample as compared to a series of prepared samples. Turbidity values can range from less than one to thousands of units, however, values in most ponds and lakes rarely rises above 5 NTU. The turbidity values at the pond were desirable and show a low-level of suspended material. This value can vary significantly with stormwater influence and algae growth.

Nitrogen **-** Nitrogen is a vital nutrient in the pond environment for plant and algae growth. Nitrogen exists in water as various compounds, with relative amounts governed by such things as atmospheric influence, precipitation, biological activity and water chemistry. Total Kjeldal nitrogen (TKN) is a measure of the nitrogen contained in organic compounds, such as proteins and amino acids, and as ammonia. It is created from biological growth and decomposition. A concentration of 1.0 mg/l or below is considered desirable. Both the in-lake and tributary samples were within this desirable threshold.

Nitrate is another form of nitrogen in the water. Nitrate nitrogen is usually the most prevalent form of inorganic nitrogen in the water and results from such things as natural aerobic bacterial activity and fertilizer use. For most lakes, levels of nitrate over 0.3 mg/l is considered elevated. This year's values at LSFP were all desirably below this threshold. Ammonia is a transitional byproduct of the conversion from organic nitrogen to nitrate and is relatively short-lived in oxygen rich environments. There should be no detectable ammonia in surface lake water, although it may be expected in the bottom layer of stratified lakes. The hypolimnetic sample collected in September did show ammonia due to the lack of oxygen.

Total Phosphorus – Phosphorus is generally considered to be the limiting nutrient for plant and algae growth, with concentrations of 0.03 mg/l or more being sufficient to stimulate algae blooms. The phosphorus level in LSFP was desirably below this level at all the surface in-lake stations although the sampling at the inlet showed slightly elevated levels. Water column phosphorus does not generally relate to rooted plant growth as they obtain most of their nutrients from the pond sediment. In the hypolimnion, low oxygen levels can promote the release of phosphorus from the bottom sediments, which may build up over the summer due lack of transfer to the upper layer of the lake. Under prolonged layering and highly organic substrates, the build-up can be significant (on the order of 0.5-1.0 mg/l or more) and later cause algae blooms when the lake mixes in the fall. The hypolimnetic sample showed some buildup of phosphorus as compared to the surface samples, but not to any significant level. We recommend continuing with this hypolimnetic sampling in the future to monitor this potential nutrient buildup.

Total & Fecal Coliform Bacteria – Coliform bacteria are naturally occurring in pond systems as well as resultant from human and animal inputs. While total coliform can be partly attributed to naturally occurring bacteria, fecal coliform is an indicator of the presence of human or animal waste inputs. In general, acceptable values in "swimmable waters" for total coliform is less than 1000 organisms per 100 ml, while for fecal coliform its 200 organisms per 100 ml. Bacteria tests were well within these acceptable limits, except for the total coliform counts from the inlet. Since it's not fecal coliform that was high, this is less of a concern and likely due to the low flow evident in this stream along with the highly organic nature of the streambed and surrounding landscape.

Dissolved oxygen (DO) is very important in the pond system. Not only do fish and other aquatic fauna require adequate levels of oxygen, but it also controls many aspects of water chemistry. Values below 5.0 mg/l are undesirable for most aquatic life, however lower values are not uncommon near the sediment layer where oxygen demand is great and oxygen influx is at a minimum. Under extreme anoxic conditions (<1.0 mg/l), phosphorus can be released from the sediment and stimulate algae blooms. Under stratified conditions, which occur in many deeper lakes like LSFP, oxygen depletion can occur in a significant portion of the water column, possibly endangering fish populations, especially coldwater species.

Temperature/dissolved oxygen profiling at LSFP was performed in the southern end of the pond over the “deep hole”. Measurements taken during the May survey showed that the layering was already setting up at around 5-6 meters based on temperature, but the oxygen was still at desirable levels except right at the bottom (9-10 meters). During the July measurements, the lake was strongly stratified with the boundary layer (thermocline) set up between 3-4 meters. The lake water below the thermocline was essentially devoid of oxygen while oxygenated water was at a temperature of > 80°F. By the September survey, the water was cooling and stratification had already begun breaking down and a weaker thermocline was present between 6 and 7 meters.

It is highly likely that recent trout mortality is being caused by a lack of suitable coldwater habitat. Coldwater species like trout prefer water temperatures in the 50°-65°F degree range and may tolerate higher temperatures even up to 70-75°F for shore periods of time, although this does cause significant stress. Low or no oxygen in the cold water hypoliminion cause trout to escape to warmer layers which under high temperature conditions (like what was experienced the last couple of summer) can cause mortality.

Water clarity measurements were taken with a standard Secchi disk during each of the sampling rounds. The May water clarity was ~ 19.5-feet while the July and September clarity was 9’ 3” and 9’ 5” respectively. This clarity is somewhat less than what we typically expect for Long Sought For Pond, however its still better than a majority of lakes in the region.

Microscopic examination of samples collected during each visit to the pond is used to identify algal species presents and estimate cell density. Sample collected in May and July show a low level of algae (<10,000 cells/ml) in the water column dominated by a variety of chlorophyte (green) species. The September sample was significantly higher than earlier samples (~50,000 cells/ml) but still non indicative of moderate or heavy bloom conditions. Again the sample was dominated by green algae, but this time there was evidence of some blue-green species, albeit at low levels

Management Recommendations

After observing the continued milfoil control this year from the 2004 treatment, we see little chance of milfoil re-growth in 2012. In the event that some localized milfoil growth is observed in 2012, we may recommend some alternative methods of control including diver handpulling and/or benthic barrier. These methods are much more suitable for small infestation (<1/2 acre) and may help to prolong the duration of control before another treatment is required. More sizable infestations (> 1-acre) or one located along with curlyleaf pondweed should be “spot” treated with the Reward (diquat) herbicide. If the Association decides to manage smaller areas of re-growth with hand-pulling, barriers or treatment, you may want to budget a contingency amount of ~$5,000-$7,500 to do so.

Past experience suggests that the curlyleaf pondweed population should be kept in check with periodic treatments. Continued periodic treatments of curlyleaf pondweed, performed before the plant produces its reproductive structures (called “turions”) has shown at some waterbodies to result in a gradual, long term reduction of this highly invasive plant. A pre-treatment survey will be used to confirm if treatment is required in 2012. If needed, we estimate the cost of such a treatment to be in the range of $6,000-$7,000.

For 2012, we also strongly recommend continuing with an early & late summer vegetation/water quality survey. The vegetation surveys will be important to monitor for re-growth of milfoil and document the presence and extent of other species in the pond. We recommend that you budget $3,500 for the two vegetation surveys and water quality monitoring sampling rounds. Continued monitoring of the pond is not only prudent but was also alluded to, if not required, by the Order of Conditions permit issued by the Town for this project. In the event that the Association moves forward with treatment of the curly-leaf pondweed, the cost of monitoring will be somewhat reduced as we can perform some of the monitoring tasks during our visits to the pond as part of the treatment program.

In regards to the depletion of oxygen in the hypolimnion and the potential for trout mortality and phosphorus release, we recommend continued assessment of the situation by permanently including a July sample round in the program and including hypolimnetic testing during all sample rounds. There are potential remedies for the situation, but it will be necessary to collect more data before any recommendations can be made. Remediation of this type is typically complex and costly.

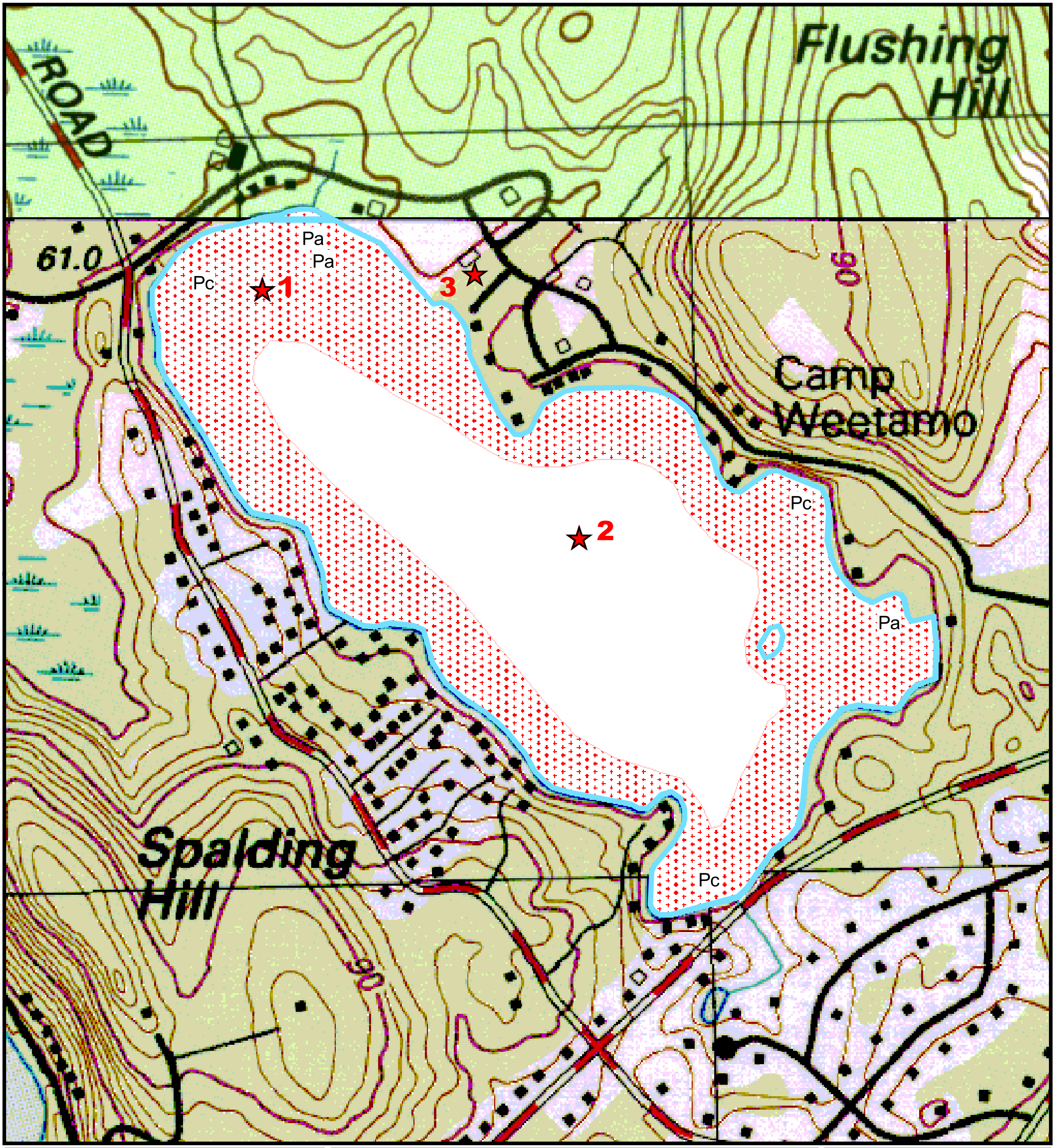
Important Note....*Starting in 2012 there will be a new permit process on the federal level (through the US Environmental Protection Agency) in addition to the local and State permits that we already have to obtain. Although it's been in the works for several years, we still haven't received final procedures and requirements. It is court mandated to go into affect in October of 2011 and may add some level of additional work and cost to lake management projects such as that at Long Sought For Pond. Once we get the final details, we will let you know what's involved.*

We appreciate your cooperation with this past year's program and look forward to working with you again next year. If you have any questions, please feel free to give me a call. Please be sure to forward a copy of this report to the Conservation Commission.

Sincerely,
AQUATIC CONTROL TECHNOLOGY, INC.

Dominic Meringolo

Dominic Meringolo
Senior Environmental Engineer



Long Sought For Pond

Westford, MA

Spring Vegetation Distribution (2011)

FIGURE:	SURVEY DATE:	MAP DATE:
1	5/10/11	11/2011

Legend:

Sparse to moderate low growth of Robbins Pondweed

Pc - curlyleaf pondweed
Pa - largeleaf pondweed

0 190 380 760 1,140 1,520 Feet

N

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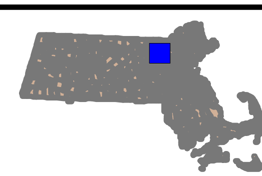

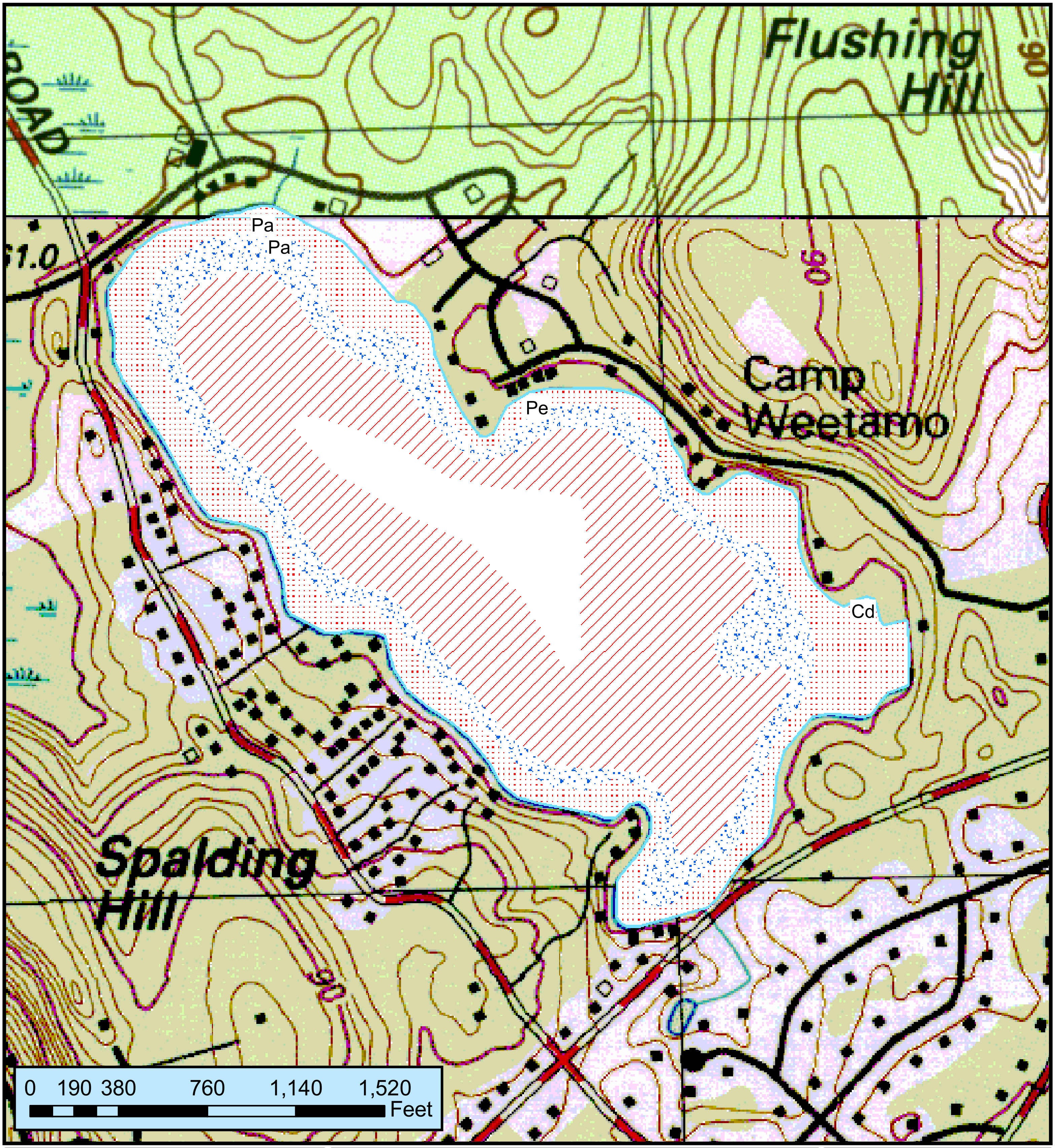

Long Sought For Pond

Westford, MA

Fall Vegetation Distribution (2011)

FIGURE:	SURVEY DATE:	MAP DATE:
2	9/28/11	11/2011

Legend:

N

Generally sandy with sparse growth of tapegrass and Robbins pondweed

Moderate to dense growth of tapegrass with bladderwort and robbins pondweed common

Robbins pondweed common with sparse bladderwort and stonewort

Pa - largeleaf pondweed
Pe - ribbonleaf pondweed
Cd - coontail

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