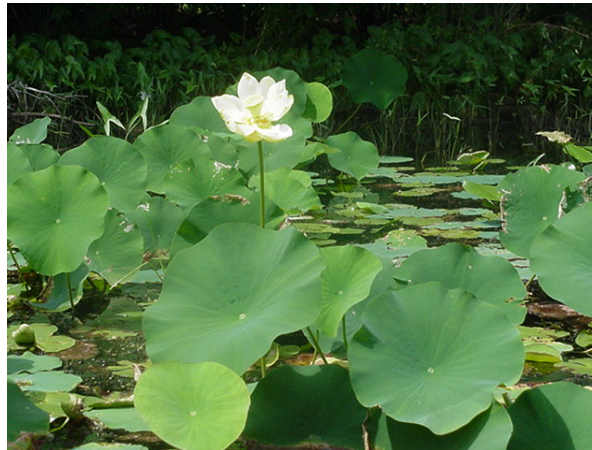


**SURVEY REPORT**  
**FAIRYLAND POND INVENTORY AND**  
**MANAGEMENT PLAN – CONCORD, MA**

**November 2004**



**Prepared for:**

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c/o Natural Resources Commission  
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## **INTRODUCTION AND POND DESCRIPTION**

Fairyland Pond is an approximate 2.75 acre man-made impoundment created in the late 1800's by damming the historic Brister's Spring. The pond lies on the north/south axis between the Cambridge Turnpike and Walden Street (see Figure 1 – Site Locus Map). The pond is primarily fed by surface water run-off from its surrounding watershed as well as storm water flow from Walden Street.

The earthen dam structure is located at the northern end of the pond. The dam contains a small 1.5 ft.-2.0 ft wide concrete spillway that is flashboard controlled. At the time of the field inspection the water level was approximately 0.5 inches above the 12 inch flashboard. The presence of the single flashboard allows for limited water level manipulation; however, there is a considerable drop in elevation immediately after the spillway that may permit simple gravity siphoning to alter in-pond water levels.

Fairyland Pond is quite shallow throughout with an average depth of only 2.5 ft. and a maximum depth of just 4.0 ft. The pond was likely created to serve some agricultural function during a time when streams were often dammed and allowed to flood cleared unexcavated land. This action resulted in the formation of shallow, fertile, waterbodies that undoubtedly had optimal characteristics for the propagation of excessive aquatic vegetation growth. Casual observations of Fairyland Pond indicate widespread infestation of both floating leaf and submersed plant species, which are likely symptomatic of its origin. Dense contiguous plant growth can have multiple adverse impacts to the "health" of an aquatic ecosystem. For example, fisheries size classes can become stunted by limited predator/prey interaction and water quality can deteriorate from a lack of water circulation. Drastic diurnal fluctuations in dissolved oxygen can also occur, which can also be detrimental to resident fish and wildlife.

The following report will outline our field survey data as well as provide a discussion of the most appropriate and cost effective management strategies for Fairyland Pond.

## **METHODS**

The field survey data collection was performed on August 12, 2004 by two Aquatic Control Biologists. The survey consisted of four main tasks, vegetation inventory, bathymetry (water depth) & unconsolidated sediment measurement and analysis, water quality sampling, critical wildlife habitat identification and general site evaluation. Each task and the procedures followed are outlined in the following paragraphs:

### *Vegetation Mapping & Bathymetry and Sediment Measurements*

The vegetation, sediment, and bathymetry data collection were performed at the same time, due to the similar operating procedures for each task. The above survey information was collected by first predetermining representative transect lines throughout the pond. Samples sites were then chosen as points along each transect line

and geo-spatially referenced using a hand-held GPS unit (see Figure 2 – Transect & Sample Site Locations). At each sample site a flat weight was lowered on a measuring tape to gauge water depth. Sediment thickness was determined using a graduated steel rod. The rod was forced through the unconsolidated sediment layer to the hard inorganic refusal layer and the length of penetration recorded. Vegetation samples were collected by dragging a long handled rake along the pond bottom. Dislodged vegetation was identified, at least to the genus level, and recorded. All the data collected was recorded under its corresponding sample site and transect line and presented in tabular format (see Appendix B).

#### *Sediment and Water Sample Collection*

Two water sampling stations were established, one located in the central portion of the pond and the other at the outlet end of the pond (see Figure 2 - Transect & Sample Site Locations). Two rounds of surface grab (1.0 –2.0 ft. below the surface) water samples were collected from each sample site (5/6/04 & 8/12/04). The water samples were then analyzed for a suite of common water quality parameters, which included: pH, total alkalinity, total Kjeldal nitrogen, nitrate nitrogen, total phosphorus, true color, apparent color, and *E. coli* bacteria.

A single composite sediment sample representative of the top 0.5 ft. of sediment was collected. The sample consisted of approximately 4-6 individual sediment extractions that were pooled (mixed) together for analysis. The sample was then analyzed by the University of Massachusetts Soil and Plant Tissue Testing Laboratory for grain size, pH, and general nutrient and chemical composition.

#### *Critical Wildlife Habitat Information*

This task consisted of basic qualitative observation of the various resource areas associated with the pond and documenting actual wildlife utilization, if observed. Specific features potentially important to the area habitat value were also photo-documented and classified by their typical habitat function.

## **RESULTS & DISCUSSION**

### **Vegetation Distribution**

The Pond had well-established populations of submersed and floating leaf vegetation. The vegetation growth was at or near 100% bottom cover throughout much of the pond, with only small pockets of open water (see Figure 3 – Dominant Vegetation Distribution Map). The plant species found throughout the pond are listed in the following table:

**TABLE 1 – DOMINANT AQUATIC PLANTS IN FAIRYLAND POND**

Scientific Name	Common Name	Field & Map Abbreviation	Plant Type	Distribution
<i>Nelumbo lutea</i>	American Lotus	NL	Floating-Leafed	Abundant – dominant coverage at northern end of the pond
<i>Nuphar variegatum</i>	Yellow Waterlily	Nu	Floating-Leafed	Abundant – Dominated growth at southern end of the pond
<i>Nymphaea odorata</i>	White Waterlily	Ny	Floating-Leafed	Abundant – extensive beds in western half of pond, scattered patches and shoreline growth elsewhere
<i>Brasenia schreberi</i>	Watershield	B	Floating-leafed	Common – Scattered growth throughout more prevalent lotus and yellow lily stands
<i>Ceratophyllum demersum</i>	Coontail	Cd	Submersed	Abundant – most prevalent submersed plant throughout pond
<i>Callitriche sp.</i>	Water Starwort	C	Submersed	Sparse – along wetland area at southern end of the pond
<i>Utricularia sp.</i>	Bladderwort	U	Submersed	Abundant – Varying distribution throughout pond
<i>Potamogeton pusillus</i>	Thin-leaf Pondweed	Pp	Submersed	Common – Growing in shallow areas of the southern end of the pond
<i>Potamogeton natans</i>	Floating-Leaf Pondweed	Pn	Submersed	Sparse – confined to inlet area
<i>Potamogeton epihydrus</i>	Ribbon-leaf Pondweed	Pe	Submersed	Sparse – scattered growth along margins of pond
<i>Potamogeton robbinsii</i>	Robbins Pondweed	Pr	Submersed	Sparse – Isolated growth at northern end of pond
<i>Najas flexilis</i>	Naiad	Na	Submersed	Sparse – Small isolated areas of growth mixed with other submersed species
<i>Lemna minor</i>	Duckweed	Lm	Floating	Common – Trapped in floating-leaf growth along shorelines of pond
<i>Wolffia sp.</i>	Watermeal	W	Floating	Common – Similar density and distribution to duckweed
<i>Nitella</i>	Stonewort	Ni	Submersed Macro-Algae	Abundant – found in most areas of the pond with greatest densities in the southern end
---	Filamentous Algae	F	Floating & Submersed Mats	Scattered/Common – most prevalent in areas with dense submersed plant growth and less lily coverage
<i>Lythrum salicaria</i>	Purple Loosestrife	Ls	Emergent (Non-Native)	Scattered/Common – highest concentration of plants located in wetland area at southern end of the pond
<i>Spartanium sp.</i>	Bur-reed	S	Emergent	Sparse – low density plants extending from inlet to northern side of Boy Scout Island
<i>Pontederia cordata</i>	Pickerelweed	Pc	Emergent	Sparse – mixed in with lily growth in southeast corner of pond

The surface canopy was primarily comprised of both yellow waterlilies and American lotus. The majority of the yellow waterlily growth was located at the southern end of the pond, while the lotus growth was more dominant at the northern end.

The understory or submersed plant community was very dense throughout most of the pond's 2.75 acres. Only a few small areas of open water, totaling a few thousand square-feet, were observed at the time of the survey. The submersed growth was dominated by robust growth of coontail and stonewort. In most areas the submersed plant growth was occupying the majority of the water column, with growth extending to the water surface.

**Sediment Distribution & Analysis**

The unconsolidated sediments were a combination of organic rich muck and inorganic sand or silt. This sediment type is typically high in nutrients and capable of supporting aquatic plant growth. Nutrient rich sediments are constantly added to an aquatic system by the annual decay of aquatic vegetation, algae and leaf litter. The unconsolidated sediment layer in Fairyland Pond is typical of a eutrophic waterbody suffering from excessive plant growth. The thickness of this layer ranged from 0.0 ft. to >5.5 ft. with the greatest volume of sediment located in the southern area of the pond (see Figure 4 – Unconsolidated Sediment Thickness & Distribution Map). A sedimentation delta comprised of what appeared to be a higher degree of sand material was noticeable adjacent to the inlet at the southern end of the pond. It is probably the result of sediment deposition from the inlet waters. The heavier and larger sand grains settle out of suspension soon after entering the pond and the smaller and lighter silts and clay remain in suspension until flow velocities are further reduced upon entering the central and northern area of the pond; therefore, creating a distinct segregation of sediments based on grain size.

Results from the laboratory analysis of the composite sediment sample is presented in Table 2, with the original laboratory reports provided in Appendix B. The results of the testing are discussed below.

**TABLE 2 – SEDIMENT ANALYSIS RESULTS**

Sample ID.	Physical Composition	Nutrient/Chemical Composition							
		pH	Phosphorus	Magnesium	Ammonium	Nitrate	Lead	Chromium	Cadmium
		S.U.	ppm	ppm	ppm	ppm	ppm	ppm	ppm
<b>S1</b>	<b>Sand = 13.3%</b> <b>Silt = 70.8%</b> <b>Clay = 15.9%</b>	5.3	9	528	45	11	8	0.5	0.4

The physical characteristics of the sample were classified using USDA criteria, as silt loam due to the high fraction of silt particles. The average grain size of the sample is

typical of unconsolidated pond/lake sediments. The majority of the sediment particles were smaller than 0.05 mm in size.

The results of the nutrient and chemical testing indicated that none of the levels observed are excessive and cause for immediate management concern. However, additional more detailed sediment sampling would likely be required if dredging were to be conducted in the future. State and/or Federal regulations would also require additional testing of total petroleum hydrocarbons (TPH) and other industrial or combustion based pollutants.

### **Wildlife Habitat Features**

Fairyland Pond contains many different habitat features that likely provide suitable nesting, basking, and/or perching sites for resident wildlife species. Wildlife utilization of this wetland resource appeared to be diverse, as a variety of bird species, warm-water fish species, amphibians, and turtles were observed at the time of the field survey.

Photographs of the habitat features of specific concern at Fairyland Pond have been provided in Appendix C. In the following paragraphs the wildlife habitat characteristics will be discussed by photograph.

#### *Photo 1 – Emergent Cattail Growth*

The inlet end of the pond contains a significant stand of cattails, with scattered growth of invading purple loosestrife. This area provides desirable nesting, and perching habitat for bird species such as Red-winged Blackbirds and other species that prefer freshwater marsh nest sites. Cattails also provide escape cover for a variety of mammalian species and are likely forage and den construction materials for Muskrats.

#### *Photo 2 & 3 – Deadfall Trees*

Deadfall trees submerged and emergent within the littoral zone provide a number of potential uses for resident wildlife. In fact, at the time of survey several Eastern Painted Turtles (*Chrysemys picta picta*) were observed basking along the trunk of the deadfall depicted in Photo 3. In addition to basking these trees provide perching sites for bird species like the Great Blue Heron and the Double-Crested Cormorant.

The submerged portion of the tree provides excellent underwater structure that is particularly important to warm-water fish species. These areas are typically utilized as ambush sites for predatory species like Largemouth Bass.

#### *Photo 4 – Overhanging Vegetation*

Overhanging vegetation provides perching sites for piscatory bird species like the Black-Crowned Night Heron, Belted Kingfisher, and/or Osprey. The overhanging vegetation also provides cover from predatory avian species to resident fish.

*Photo 5 & 6 – “Edge” Habitat*

Edge habitat is particularly important to predator/prey interaction. The transition area between vegetated areas and open water (“Edge”) are important feeding areas for both wading bird species and predatory fish. In fact, a Great Blue Heron (*Ardea herodias*) was observed wading along the edge of vegetation depicted in Photo 5. The dense vegetation provides excellent escape cover and desirable juvenile fish nursery habitat.

A review of the Natural Heritage and Endangered Species Program (NHESP) data-layers for rare and endangered species and habitat indicated the presence of both significant wildlife habitat and priority habitat down gradient of Fairyland Pond. In addition, there is a certified vernal pool immediately southwest of the pond within the Hapgood Wright Town Forest.

Fairyland Pond and its surrounding area contains suitable habitat characteristics for a variety of wildlife. The in-pond submersed and floating-leaf vegetation, however, have reached widespread distribution and excessive densities. If left unmanaged, the dense vegetation growth may have detrimental impacts to resident fish populations and the wildlife species that depend upon them. It is typically recommended that 20%-40% vegetation cover be maintained to provide optimal warm-water fisheries habitat. Vegetation coverage at that rate allows ample vegetation for nursery habitat, escape cover, stable dissolved oxygen levels, a greater amount of “edge” habitat, and most importantly expansive areas of open water that allow proper predator/prey interaction both on the fisheries level and predation of the fishery by other species.

**Water Quality Analysis**

Water sampling was conducted at Fairyland Pond in order to establish baseline water quality data. The results of the two water quality sampling rounds are provided in Table 3. The original laboratory reports are provided in Appendix B. Each water quality parameter is discussed in greater detail in the following paragraphs.

**TABLE 3 – WATER QUALITY ANALYSIS RESULTS**

Sampling Location	Round	pH	Alkalinity	Kjeldal Nitrogen	Nitrate Nitrogen	Phosphorus	True Color	Apparent Color	E.coli Bacteria
	Units:	S.U.	mg/l	mg/l	mg/l	mg/l	Pt-Co	Pt-Co	Org/100 ml
Mid-Pond (WQ1)	May	6.8	25	0.39	0.43	0.012	13	27	<10
	August	6.9	40	<0.30	0.56	<0.010	20	35	10
Outlet (WQ2)	May	6.7	27	<0.30	0.63	<0.010	6	12	<10
	August	7.0	39	0.41	0.49	<0.010	20	40	<10

**pH** – pH is a measurement scale used to designate the degree of the acid or alkaline condition of a solution. The scale ranges from 0, being the most acidic, to 14, being the most basic or alkaline. The pH value of 7 is considered to be neutral. A pH range of 5.5-

8.5 is necessary to maintain a healthy fishery. The pH values obtained at Fairyland Pond (mean 6.9) were well within the acceptable range and should be quite favorable to fish populations.

**Nitrogen** – Nitrogen exists in ponds and lakes in several forms. Kjeldahl nitrogen testing results are representative of the amounts of organic or biomass nitrogen and ammonium. Nitrate Nitrogen, however, is representative of the nitrogen form that is most readily usable by plants and algae. Nitrate nitrogen, in the presence of oxygen, is the breakdown product of ammonia, which is released during the decomposition of organic material. The results from the two sampling rounds indicate elevated levels of nitrogen, as it is generally thought that inorganic nitrogen levels in excess of 0.30 mg/l are sufficient to support algae blooms.

The results also show an increase of nitrate nitrogen and a decrease of Kjeldahl nitrogen in the August sampling round. This is not uncommon, as the conversion of ammonia to nitrate occurs more rapidly with higher water temperatures.

Equally important as the sheer amount of available nitrogen is the ratio of total nitrogen to total phosphorus (N:P). The ratio of nitrogen to phosphorus is important for determining how algae growth will be limited. Systems that have N:P ratios less than 10:1 are typically nitrogen limited and those that have ratios in excess of 15:1 are considered phosphorus limited. Like most freshwater systems Fairyland Pond is phosphorus limited, as the total phosphorus values averaged below detectable limits during all sampling rounds.

**Total Phosphorus** – Phosphorus is often considered the limiting nutrient essential to plant and algae growth in freshwater systems. Typically a value of 0.03 mg/l is sufficient to stimulate excessive plant and algae growth. The levels obtained from Fairyland Pond were on average below detectable limits (<0.010 mg/l), which is well below the 0.03 mg/l threshold. It is important to understand, however, these samples represent a limited view of the ever-fluctuating phosphorus levels. In order to establish more meaningful baseline values, additional and more frequent sampling would be required. The excessive growth of coontail and *Nitella* may contribute to lower phosphorus levels, as these plants are loosely rooted in the substrate and are capable of drawing nutrients directly from the water column. They therefore may be functioning as a sort of bio-filter, limiting the amount of available phosphorus for other uses, such as algae growth.

**True and Apparent Color** – True and apparent color illustrate how the water is colored. For example, apparent color is the measure of the color that is caused by substances that are in solution and by substances that are suspended in the water. Whereas, true color is the measure of the color that is produced by substances that are in solution only. Therefore, the apparent color value is determined directly from the raw sample and true color is obtained from filtered (in order to remove any particles in suspension) sample water. All of the results from Fairyland Pond show that the color of the water is equally the result of both materials in solution and in suspension.

***E. coli* Bacteria** – *E. coli* is one of many naturally occurring bacteria found within the intestine of healthy humans and animals. The presence of *E. coli* in pond and/or lake water is indicative of recent sewage or animal waste contamination. The Massachusetts Department of Public Health has standards for the presence of *E. coli* in “swimable waters”. The current standard for freshwater is no single sample shall exceed 235 colonies per 100 ml. All values from the Fairyland Pond sampling effort were at or below detectable limits (10 per 100 ml), indicating little or no fecal contamination.

**Dissolved Oxygen** – The dissolved oxygen levels at both the spring and late summer sampling rounds were at the saturation point at the upper level of the water column, which is expected in ponds with normal algae production. A dip in dissolved oxygen was observed near the sediment water interface, which is likely the result of normal microbial breakdown of organic material. Secchi disk transparency at both visits (May & August) were to the pond bottom, indicating good transparency and low levels of suspended materials. The low levels of suspended materials is further reflected in the low turbidity values from the water quality sampling.

**Algae Identification & Enumeration**

Water samples were collected for microscopic identification and enumeration of planktonic or free-floating algae. Water clarity was quite good during both inspections and no visible blooms of planktonic algae were observed. There was some epiphytic, filamentous algae coating some of the aquatic plants, but no floating mats of algae were observed.

The following table shows estimates of the dominant algal abundance at Fairyland Pond during the two inspections in 2004. Samples were analyzed under 20X magnification in a Sedgewick-Rafter counting cell. The number of asterisks in each column represent the algal density (\* present, \*\* common, \*\*\* abundant, \*\*\*\* very abundant).

**TABLE 4 – MICROSCOPIC ALGAE COMPOSITION**

ALGAE TAXON	5/6/04	8/12/04
Cyanophyta (Bluegreens)		
- <i>Gloethece</i>		*
Chlorophyta (Greens)		
- <i>Clorococcum</i>	**	**
- <i>Closterium</i>		*
Bacillariophyta (Diatoms)		
- <i>Synedra</i>	**	*
- <i>Fragilaria</i>	**	*
- <i>Navicula</i>	**	
Chrysophyta & Pyrrhophyta		
- <i>Mallomonas</i>	*	
- <i>Peridinium</i>	*	
Algal Density Rank	1	2
Estimated Algal Cell Density	1,250 cells/ml	2,275 cells/ml

The planktonic algal density was low during both inspections. Diatoms were dominant on 5/16/04, which is fairly typical for cooler water conditions in the early spring. Greens were more prevalent on 8/12/04. Some very small colonial bluegreens were present in the 8/12/04 sample that inflated the cell density numbers. Still, estimated algal cell densities were low both times the pond was inspected. With the mix of planktonic algae seen in Fairyland Pond, cell densities would need to be well in excess of 10,000 cells/ml for visible algal blooms to be present.

The low algal density is likely due to the excessive vascular aquatic plant growth. Nutrients are probably utilized by the submersed and floating plant species, before they stimulate excessive algae growth.

## **MANAGEMENT NEEDS AND OBJECTIVES**

It is important when designing an aquatic management program to first identify the desired goal. This goal should be consistent with the intended uses and natural functions of the waterbody and be realistically attainable. Selected management activities must also comply with environmental regulations that are put in place to preserve the pond's ecology and adjacent wetlands.

The primary objective of any active management at Fairyland Pond should be the restoration and maintenance of optimal wildlife habitat values. The pond likely does not provide traditional active recreational opportunities (swimming, boating, and fishing), but rather more passive pursuits, such as wildlife viewing, occasional shoreline fishing, and natural aesthetics. Therefore, the focus of a recommended management plan would be on restoring areas of open water to optimize fisheries habitat, thereby, providing conditions that may foster a more desirable warm-water fishery and potentially increase utilization of the resource by wildlife species that prey upon fish populations.

In the following paragraphs we will discuss various management alternatives and provide insight and recommendations as to the best and most feasible techniques for the management of Fairyland Pond.

### **Watershed Management**

The Fairyland Pond watershed consists of approximately 60 acres, the majority of which are located within the borders of the Hapgood Wright Town Forest. As a result, the bulk of the pond's watershed remains undeveloped natural areas. However, the watershed boundary does extend southwest of Walden Street to incorporate a small amount of residential development adjacent to Route 2.

Because no stormwater sampling or tributary sampling was performed as part of the scope of this project, it is difficult to determine to what extent external nutrient loading from the watershed contributes the eutrophication of the pond. However, based on the size of the watershed and the pond basin to drainage basin ratio (~20:1) it can be assumed that in-pond water quality is significantly influenced by land-use and management

activities within the watershed. It is therefore important to continue to limit potentially high risk land-uses (industrial, commercial, and even high use agricultural) within the watershed area.

The pond does receive stormwater from the adjacent Walden Street via a sediment/detention basin. At the time of the survey evidence of increased sediment deposition was observed in the area of the inlet that qualitatively appeared to have a higher constituency of sand-like material. Although no detailed investigation of the watershed and existing mitigation structures was performed, maintenance of the sedimentation basin, in the form of periodic excavation of accumulated materials, is important to ensure that the basin functions at optimal capacity and limits the introduction of suspended materials and possible contaminants into Fairyland Pond.

Prior to the implementation of any focused watershed management techniques we recommend performing a more detailed investigation, inclusive of multiple rounds of baseflow tributary sampling, in-pond and tributary stormflow sampling, as well as field confirmation of the watershed delineation and current land-uses. These data will provide additional insight into the potential watershed management issues facing the pond and how best to address them.

Improving water quality and in-pond conditions through watershed management is a slow and difficult process because there are likely multiple sources contributing to the overall nutrient load to the pond. Although significant reduction of in-pond vegetation growth is unlikely as a result of even large-scale watershed management, the implementation of generic watershed improvement measures or Best Management Practices (BMP's) are always recommended.

### **Physical Techniques**

Physical management strategies generally utilize an alteration to the physical environment to eliminate, control, or reduce nuisance aquatic vegetation populations. Several accepted methods are available and have been widely implemented; however, each technique has its particular application; therefore, like any other management strategy, the feasibility, efficacy and potential adverse impacts should be investigated prior to use in a management program.

#### *Benthic Vegetation Barriers*

The use of bottom weed barriers (i.e. Aquatic Weed Net™ or Palco™) are effective for small dense patches of nuisance vegetation, but are not cost effective or feasible for large areas. Weed barriers are expensive to install and maintain at ~ \$1.00 \$1.25/ft<sup>2</sup> (1 acre expanse would cost in the range of \$43,560 -\$54,450 material & installation). Semi-annual maintenance to retrieve, clean and re-deploy the barriers would be expensive and time consuming. Also covering expansive areas of the pond bottom may also have detrimental impacts on invertebrates or other types of wildlife.

### *Winter Drawdown*

Drawdown for the control of nuisance aquatic vegetation involves the lowering of the pond's water level during the fall and winter of the year to expose nuisance vegetation infestations. Exposing aquatic plant species to the elements for long periods of time (>6-8 weeks) facilitates desiccation and freezing of the plants and their root systems.

Drawdown is not a feasible management alternative at Fairyland Pond due to the contiguous plant growth and the shallow bottom contours of the pond. In order to expose all the areas of dense vegetation and achieve any degree of success it would be necessary to drain a majority of the water out of the pond, leaving insufficient water to sustain resident fish and wildlife populations. In addition, the existing outlet structure does not allow for simple gravity dewatering.

### *Hand-Pulling/Harvesting*

Hand-Pulling or hand-harvesting is an effective low-impact, non-chemical alternative to controlling a variety of unwanted vegetation species. Because hand-pulling is labor intensive on a large scale it best suited for very low plant densities. The purple loosestrife infestation at Fairyland Pond appears to be in the beginning stages and only consisted of a dozen or so plants at the southern end of the pond, at the time of the survey. We therefore feel that hand-pulling is an appropriate means of controlling and/or potentially eradicating this non-native plant from the resource area before it becomes too wide spread.

Hand-pulling of non-native plants such as purple loosestrife are often excellent public volunteer projects. Projects such as this are excellent educational opportunities for the public, as they promote public awareness of non-native wetland invaders and also instills an important sense of stewardship for local wetland environs.

### **Biological Controls**

There has been a good deal of research done on stem boring weevils (*Euhrychiopsis lecontei*) for the control of Eurasian watermilfoil (*Myriophyllum spicatum*). The results of their introduction to milfoil infestations have been mixed. These weevils are exclusively for the control of Eurasian watermilfoil and therefore not applicable to the management of the plant assemblage found in Fairyland Pond.

Leaf eating beetles (*Galerucella* spp.) and root eating beetles (*Hylobius* sp.) have also been studied for their impacts to purple loosestrife (*Lythrum salicaria*). Reportedly these insects have been released at several sites throughout the northeast with promising results. Aquatic Control, in fact, recently (2002) initiated a pilot program for the Town of Ayer for the control of purple loosestrife in Flannagan's Pond. Although the long-term monitoring for this project has not been completed, the preliminary observations seem to indicate impacts to the purple loosestrife population as a result of the beetle introduction. Unfortunately, much of the beetle work for the control of purple loosestrife has

demonstrated that the insects do not disperse readily and appear only to be effective on dense isolated infestations; therefore, they may not be appropriate for the scattered shoreline infestation of purple loosestrife found lining Fairyland Pond.

Triploid (sterile) grass carp have also been used for the management of submersed vegetation in various parts of the country. However, in the state of Massachusetts grass carp can not be legally introduced for any purpose.

### **Mechanical Techniques**

Mechanical control techniques have proven useful in controlling nuisance aquatic vegetation. These techniques, mechanical harvesting and mechanical raking, are particularly advantageous in situations that will benefit from area selective management and where the waterbody's morphological characteristics (i.e. depth, outlet structure, flow rates, etc.) deter the use of other techniques.

#### *Mechanical Hydro-Raking*

The mechanical Hydro-Rake can best be described as a "floating backhoe" with a York Rake attachment. The barge is paddle wheel driven to facilitate operation in shallow water (<2 feet) and it can effectively work to depths of about 12 feet. The Hydro-Rake is most effective at removing plants with large/well defined root systems, typically floating-leafed and emergent species. It works from the water, thereby avoiding damage to sensitive shoreline habitat and property. This machine "rakes" the upper sediment layer collecting plants and their attached root systems.

In the case of Fairyland Pond the hydro-rake would be best suited for the removal of dense waterlily and lotus infestations throughout the pond. The selective removal of designated areas of growth will create a greater amount of valuable open water habitat, increase water circulation, improve the aesthetic quality of the area, and reduce the amount of vegetative biomass available for annual decomposition. The machine is capable of area selective management, making it possible for the removal of specific stands of growth and even specific portions of a particular infestation. This feature is particularly attractive for the removal of waterlily growth because small designated areas can be preserved to serve as valuable fish and wildlife habitat. The removal of the vegetative biomass may subsequently cause a reduction in the dissolved nutrients/phosphorus levels that are derived from decaying organic material. Not to mention the removal of the waterlily's robust root systems will likely provide multiple seasons of plant control.

It is our opinion that suitable shoreline access for machine launching and spoils stockpiling can be achieved via the existing access path/road. A hydro-raking project to remove waterlilies and lotus in designated areas (see Figure 6 – Recommended Hydro-Raking Areas) would require approximately 60-80 hrs. of raking. A Hydro-Raking project of this size is expected to yield approximately 200-300 cubic yards of removed plant biomass, root systems and attached hydrosols. The disposal site of the

removed spoils will ultimately need to be approved by the Concord Natural Resources Commission; however, it can likely be trucked to a town composting facility or other upland site for permanent disposal. If town personnel and equipment were capable of handling the shore-based hauling and disposal, significant cost savings can be realized.

### *Mechanical Harvesting*

Mechanical cutting or harvesting on the other hand is not a recommended management technique. Mechanical harvesters have large cutting heads that cut the vegetation off just above the bottom of the pond. This technique is generally used for the control of plants that propagate primarily through seed production. The method is to remove the vegetative portion of the plant before it has an opportunity to produce seeds. However, the dominant plant species present in Fairyland Pond are perennial plants that re-grow each year from the same root system; therefore, cutting the plants and leaving the root system would provide little if any long-term control. It has been our experience that due to the rapid growth rate of many of the plant species present that multiple cuttings would be required for even season long control, thereby significantly reducing the cost effectiveness of a harvesting project.

### **Chemical Treatment**

Chemical treatment is often the most cost-effective means of control of nuisance aquatic vegetation. Chemical treatment offers both species and area specific control, and often longer duration of control of certain plant species. Although Hydro-Raking will remove the vegetative part of the submersed plant growth within the designated raking area, and provide temporary control (one season or less), the small, “hair-like” root systems will be left behind. Because the Hydro-Rake is ineffective at removing submersed plant root systems, many of the plants will be able to regenerate from remaining root stock. It therefore, may be necessary to chemically treat the areas of open water established by a Hydro-Raking effort in subsequent years to discourage excessive recolonization by neighboring submersed vegetation. The use of herbicides as a follow-up/maintenance technique will reduce management costs and result in less impact to the aquatic system over the long-term.

### *Reward (Diquat)*

When selecting the appropriate herbicide for a particular project it is necessary to take many outside variables into consideration. For instance, in the case of Fairyland Pond the two most influential factors in determining the proper herbicide was the potential for high water flows through the system and the types of vegetation that would be targeted for control. After considering all of the variables it was determined that Reward® (active ingredient diquat) was best suited for future submersed plant control. Reward is quickly absorbed into target plants and is therefore not as severely impaired by the flushing of high flows. It has a relatively low level of mobility in the water column allowing for area specific application, and it is extremely effective on all of the submersed nuisance plants present in the pond.

We feel that Reward herbicide treatment in conjunction with the initial Hydro-Raking of floating leaf waterlilies will work well to control the problematic densities of nuisance plant growth and restore open water in the pond. A single treatment in the late spring (i.e. May/June period) of the year is typically sufficient to control the target plants for the entire growing season. Reward, however, is a contact herbicide, killing only the vegetative portion of plant; therefore, annual or bi-annual (once every two years) treatment will likely be required to maintain desirable conditions.

#### *Rodeo (Glyphosate)*

As some waterlily and lotus growth will be maintained for fish and wildlife habitat, maintenance of areas of open water created by the hydro-raking effort will be required in future years. The least disruptive means of managing encroaching waterlily and lotus growth in these areas is with the systemic herbicide Rodeo® (active ingredient glyphosate). Rodeo is foliar active, which means that the active ingredient is only active when on vegetation foliage and has no activity in surrounding soil or water. This property allows for very area selective management. Rodeo is a systemic herbicide that is translocated throughout the plant killing both the vegetative portion and its root system.

The treatment of floating leaf waterlilies is most effective later in the season when the plants have begun to flower; therefore to optimize effectiveness treatment should take place during July and August. Due to the fact that the herbicide must be in contact with the exposed plant foliage for proper control to occur, it may be necessary to perform an additional follow-up treatment to insure that targeted control is achieved.

Although Hydro-Raking is the preferred method for the restoration open water habitat at Fairyland Pond, Rodeo treatment alone could effectively reduce the waterlily and lotus canopy in designated areas. Using Rodeo as the primary management technique would likely require multiple treatments (2-3) to achieve desired results. Treatment of dense waterlily and/or lotus growth in ponds with muck type bottom sediments does, however, have the potential to cause the formation of unwanted “floating islands”. Floating islands are essentially lily rhizomes and attached hydrosols made buoyant by trapped gases produced via the microbial breakdown of the root material post-treatment. Often these floating masses sink back to the bottom once microbe activity reduces in the fall/winter, but sometimes remain and need to be removed. Because of the risk of floating island formation as a result of widespread treatment a multi-year staged approach, may be more appropriate if Rodeo treatment alone is used to manage the lotus and waterlily growth.

#### **Dredging**

The removal of nutrient rich sediments and the subsequent deepening of waterbodies is sometimes used to control rooted aquatic vegetation. When utilizing dredging as a vegetation control method there are two primary objectives. The first is to remove the

organic nutrient rich sediment to eliminate an internal source of nutrients, and the second, is to increase the depth of the water to a minimum of 8-10 ft., which is typically sufficient depth to preclude adequate light from penetrating to the pond bottom. By changing these morphological features of the pond the area that can be colonized by rooted vegetation is reduced. It is also important to understand that dredging does not always eliminate nuisance aquatic vegetation problems, therefore, requiring additional in-pond management activities to gain adequate control.

Fairyland Pond would undoubtedly benefit to some degree from a dredging project. The pond has a considerable layer of unconsolidated sediment and very shallow water depths; however, in order to achieve the recommended depth of 8-10 ft. a significant portion of the ponds hard packed refusal layer (sand, gravel, and clay) would need to be removed. Removal of the accumulated unconsolidated sediment alone would require a significant time and financial commitment and removal of a portion of the ponds consolidated refusal layer would further add to that commitment.

The feasibility of a dredging project at Fairyland Pond is questionable. Potential obstacles or problems are the lack of an outlet structure that would allow simple gravity dewatering of the pond, and the potential for moderate to heavy storm water inflow from the surrounding watershed. In addition to these obvious project design considerations dredging carries with it a complex multi-tiered permitting process with local, state and federal agencies not to mention potentially cost prohibitive operational expenses. We would anticipate that the design and permitting expenses alone for a project of this size would range between \$10,000-\$15,000. The actual operational costs depend on the amount of material removed. Reasonable unit cost estimates for a conventional dry dredging project may run between \$15-\$20 per cubic yard of material removed. Therefore, to remove an average of 6.0 ft of sediment over approximately 2.0 acres of the pond would generate approximately 19,300 yds<sup>3</sup> of removed spoils, hence the total operational cost to remove 6.0 ft. of sediment over 2.0 acres is in the range of \$289,500-\$386,000. Costs may also run higher, depending upon certain permit conditions and other complicating factors.

## **SUMMARY**

Fairyland Pond is significantly impacted by dense aquatic vegetation growth. The dense vegetation, if left unmanaged, will continue to degrade water quality, impact the pond's fish and wildlife populations. The pond management plan for Fairyland Pond should, therefore, focus on controlling excessive aquatic vegetation to restore optimal fish and wildlife habitat and preserve the pond as an open water wetland resource area.

The recommended approach for the mitigation of floating leaf waterlilies, American lotus and the dense submersed vegetation includes a combination of mechanical and chemical techniques. Integrating these methods will improve the efficacy of the nuisance vegetation control efforts, while at the same time reduce the amount of plant biomass that

is available for decomposition, thereby reducing sedimentation rates and the potential for excessive internal nutrient recycling. It is our recommendation that the program begin with extensive Hydro-Raking to reclaim approximately 60% of the pond surface area as open water area, followed by area selective maintenance herbicide treatments, as required in subsequent years.

The following specific management activities are suggested for consideration or inclusion in the development of a long-term management plan for Fairyland Pond.

- Reduce the amount of vegetation growing throughout the pond. The most appropriate techniques are mechanical Hydro-Raking for floating leaf waterlily and lotus control and Reward herbicide treatment for the control of the submersed plant community.
- Maintain waterlily and lotus encroachment through spot application of Rodeo as required. This should be done in previously hydro-raked areas. This would provide a low impact method for maintaining areas of removed growth over time.
- Implement volunteer hand-pulling effort to control the scattered growth of the non-native and invasive plant purple loosestrife.
- Implement annual or biannual monitoring and sampling program to document the rate of regrowth and identify the possible introduction of exotic and invasive vegetation species. Water sampling to establish baseline water quality values and identify seasonal nutrient fluctuations to aid in the timing of appropriate management measures.
- Perform more detailed watershed investigation in order to determine potential watershed management concerns and establish baseline data that will potentially aid in the development of focused management alternatives.

On the following page is a cost summary for a recommended three year Management Program. We encourage you to contact us if you have any question or would like to discuss alternatives to the proposed tasks.

## COST SUMMARY FOR THE RECOMMENDED THREE YEAR PROGRAM

### Year 1 - 2005

<u>Management Technique</u>	<u>Associated Cost</u>
<b>• Permitting</b>	
DEP License to Apply Chemicals .....	\$250
NOI with Concord Natural Resources Commission .....	\$1,500+expenses <sup>1</sup>
<b>• Reward Treatment</b>	
Reward Application for the control of submersed vegetation .....	\$2,500
<b>• Mechanical Hydro-Raking</b>	
Equipment Mobilization/Demobilization .....	\$750/machine
Hydro-Rake & Operator (50-60 hrs. @ \$170/hr.) .....	\$8,500-\$10,200
Transport/Harvester & Operator (50-60 hrs. @ \$140/hr.) .....	\$7,000-\$8,400
Estimated Disposal Costs (~30-40% of raking cost) .....	\$2,250-\$4,080 <sup>2</sup>
<hr/>	
<b>Total Estimated Cost .....</b>	<b>\$23,500-\$28,430</b>

<sup>1</sup> – cost includes our preparation & filing of the NOI application and supporting information as well as our attendance at one public hearing. Expenses consist of direct reimbursable costs such as filing fees, certified mailing, copying, etc...and typically do not exceed an additional \$1,000.

<sup>2</sup> – these costs are estimated and may vary, as this task would be performed by either the Town or a local contractor.

### Year 2 – 2006

<u>Management Technique</u>	<u>Associated Cost</u>
<b>• Chemical Treatment</b>	
Reward Maintenance Treatment .....	\$2,000
Annual Monitoring/Sampling & Report (optional) .....	\$1,000
<hr/>	
<b>Total Estimated Cost .....</b>	<b>\$3,000</b>

### Year 3 – 2007

<u>Management Technique</u>	<u>Associated Cost</u>
<b>• Chemical Treatment</b>	
Reward Maintenance Treatment .....	\$1,500
Rodeo Maintenance Treatment .....	\$850
Annual Monitoring/Sampling .....	\$1,000
<hr/>	
<b>Total Estimated Cost .....</b>	<b>\$3,350</b>

---

## **APPENDIX A**

*Figure 1 – Site Locus Map*

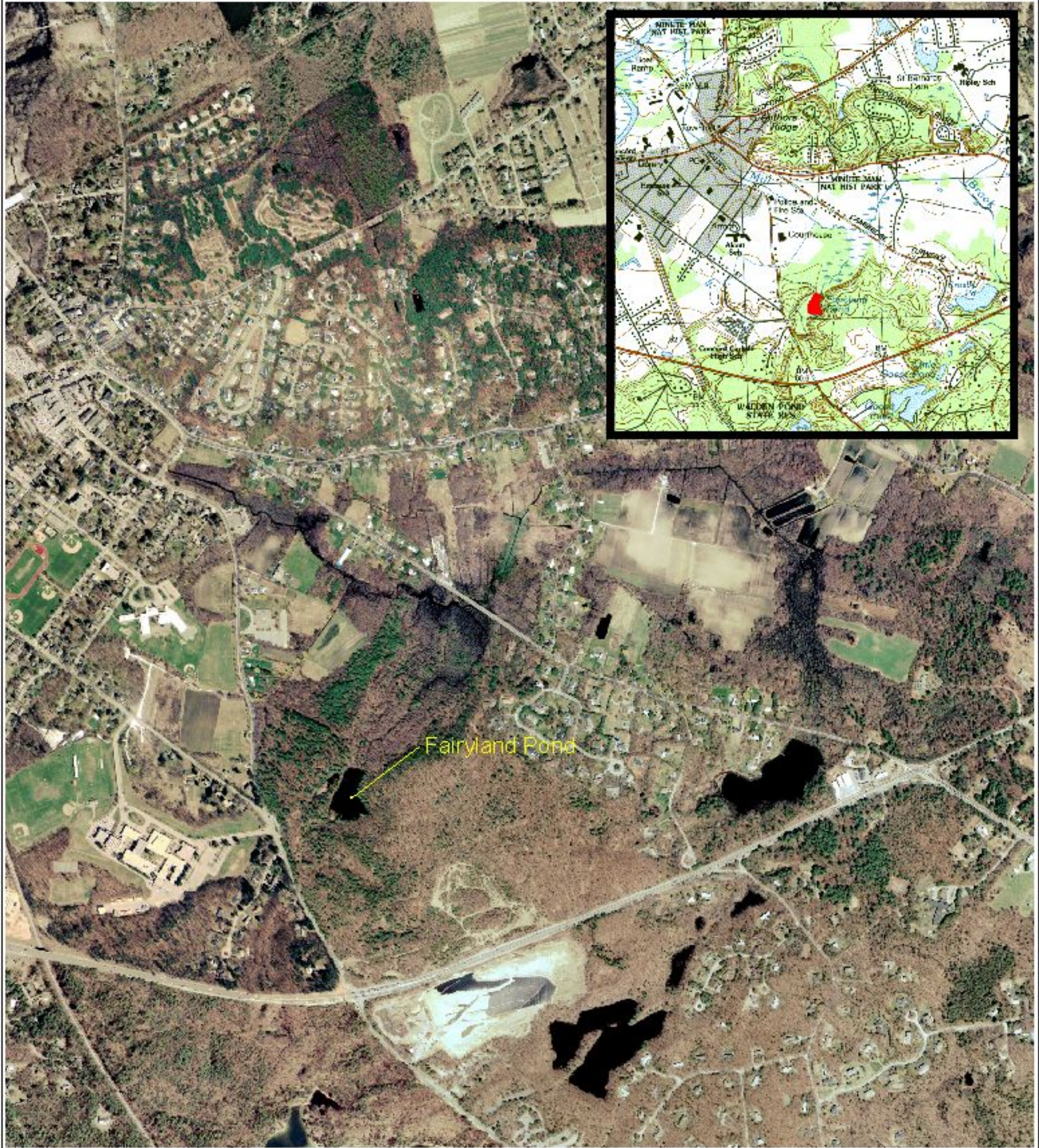
*Figure 2 – Transect & Sample Site Locations*

*Figure 3 – Dominant Vegetation Distribution Map*

*Figure 4 – Unconsolidated Sediment Thickness & Distribution Map*

*Figure 5 – Bathymetry Map*

*Figure 6 – Recommended Hydro-Raking Areas*



Fairlyland Pond



Concord, MA

# SITE LOCUS MAP

FAIRYLAND POND  
Concord, MA



AQUATIC CONTROL TECHNOLOGY, INC.

USGS 7.5 Minute Series  
Concord, MA Quadrangle

Figure 1

Scale:

200 0 200 400 Feet



N



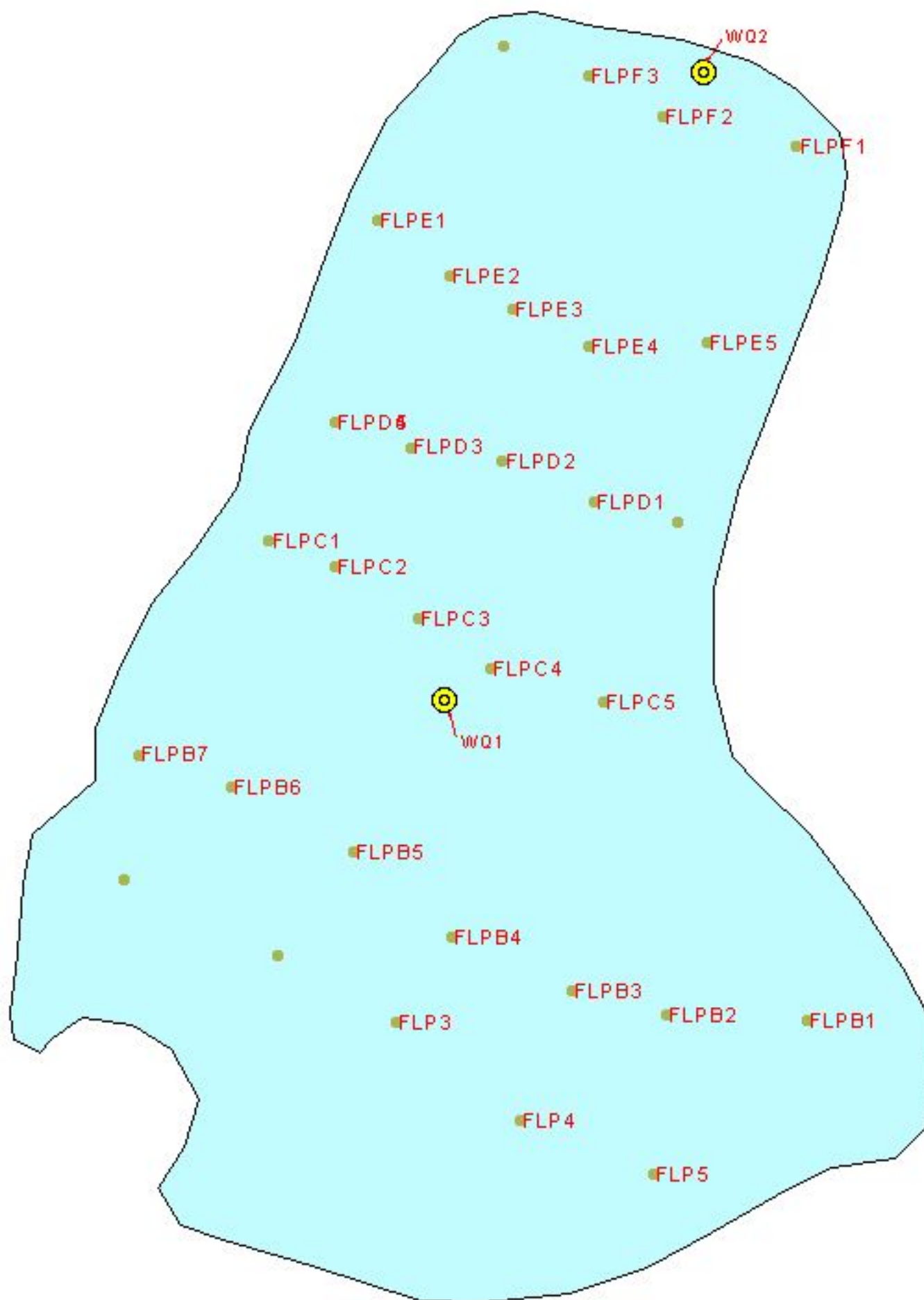


FIGURE 2  
Transect & Sample Site Map  
**Fairyland Pond  
Concord, MA**

FIGURE	SURVEY DATE	MAP DATE
2	8/12/04	11/11/04

**LEGEND**

- FLP1-FLPF4 Randomly selected vegetation, sediment thickness, and water depth sampling points (31 points in total).
- ⊙ Water quality sampling stations - W Q1 = mid pond and W Q2 = outlet

\* - Transect sampling points indicated without a label are points sampled, but not properly recorded by handheld GPS.

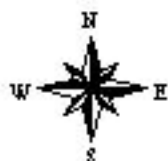
**AQUATIC CONTROL TECHNOLOGY, INC.**  
POND AND LAKE EROSION CONTROL SPECIALISTS

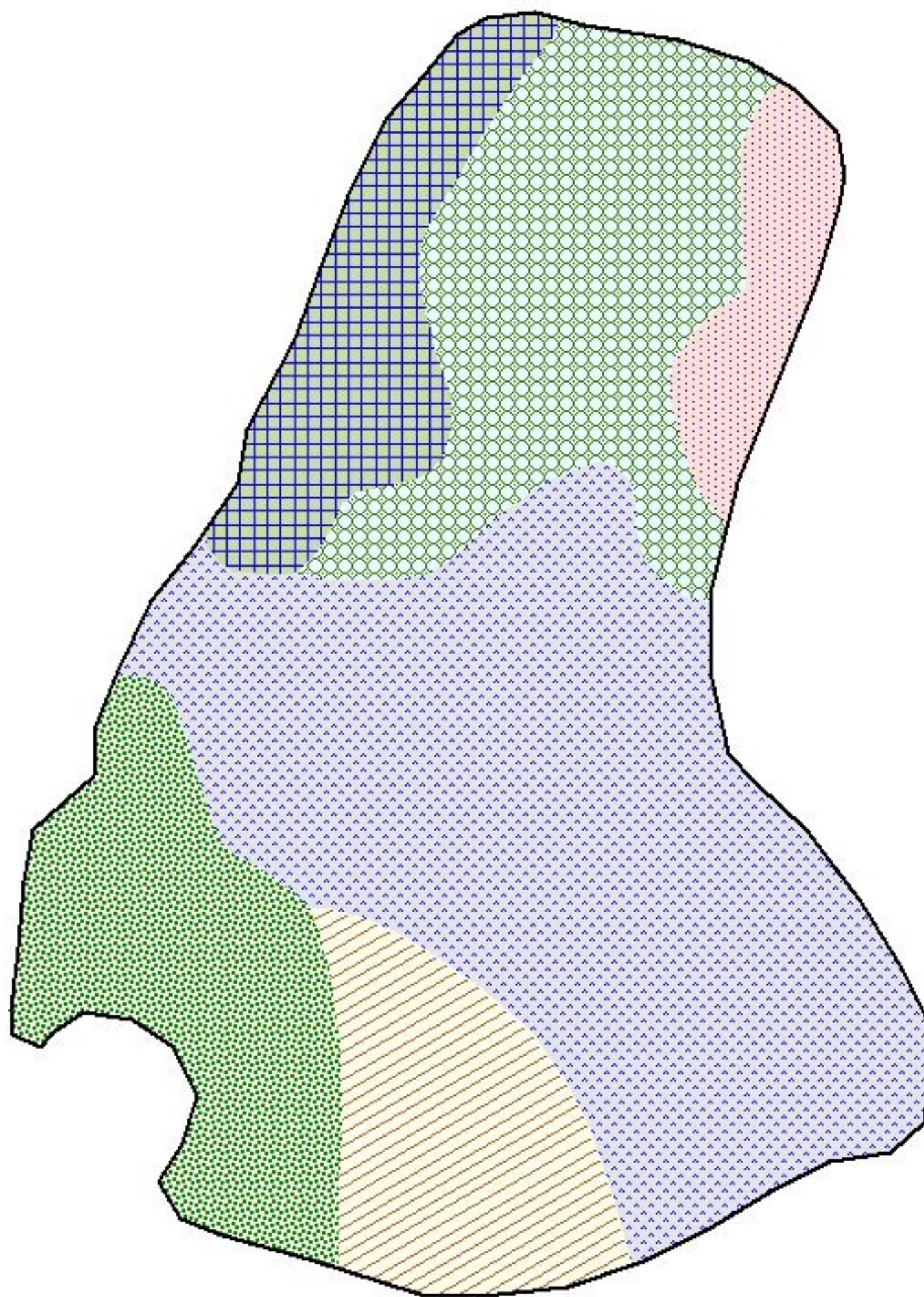
11 John Road  
Sutton, Massachusetts 01550  
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SCALE:  
20 0 20 40 Feet



Concord, MA











**FIGURE 3**  
**Dominant Vegetation**  
**Distribution Map**

Fairyland Pond  
 Concord, MA

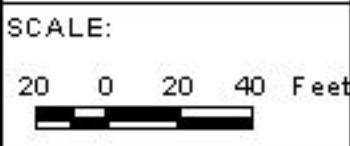
FIGURE	SURVEY DATE	MAP DATE
3	8/12/04	11/11/04

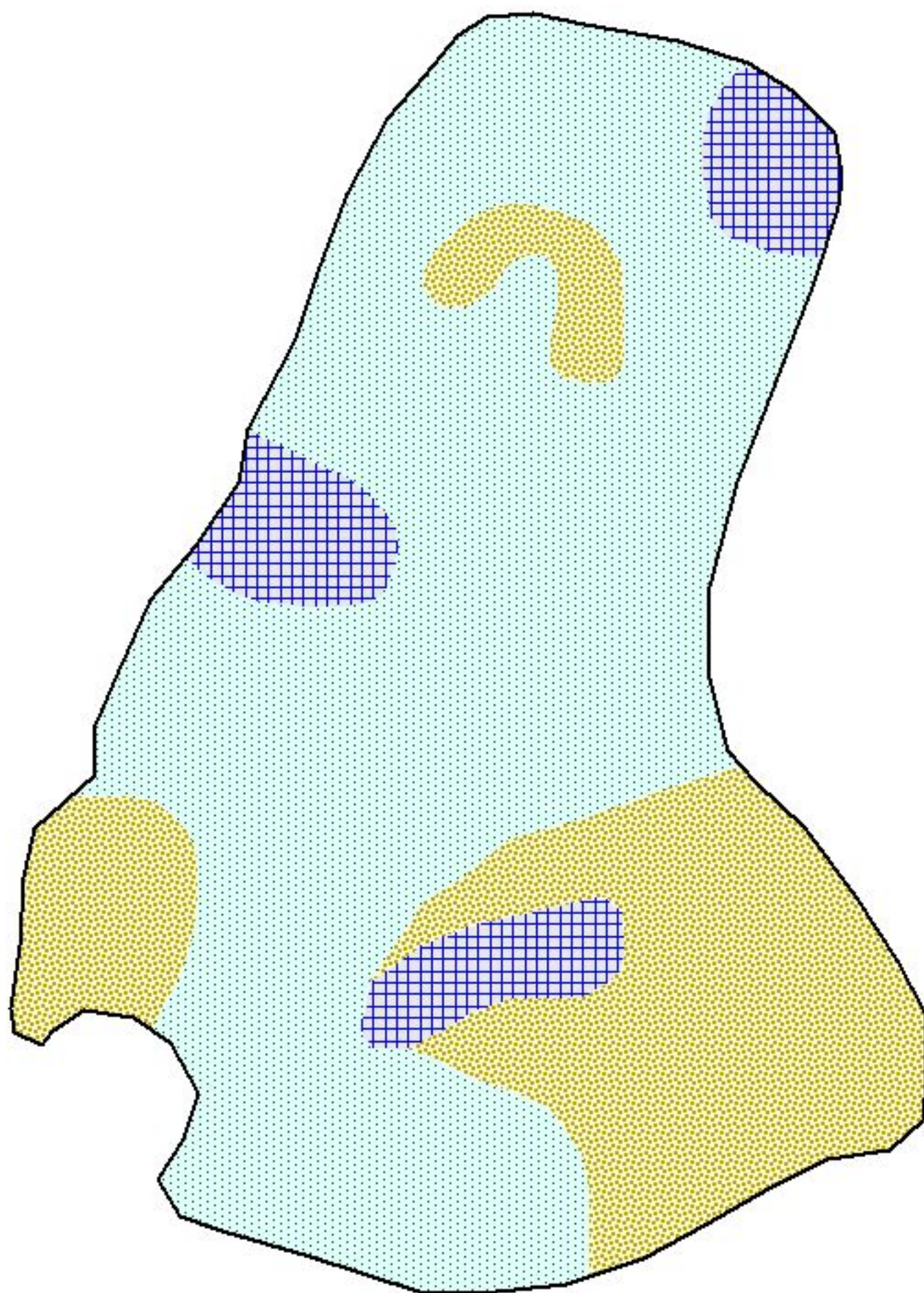
-  Scattered canopy of yellow water lilies with dense submerged vegetation dominated by coontail.
-  Dense canopy of yellow water lilies with dense submerged vegetation dominated by coontail.
-  Dense canopy of American lotus with scattered submerged vegetation dominated by coontail.
-  Sparse canopy of American lotus with dense submerged vegetation dominated by Nitefla & coontail.
-  Dense to moderate canopy of yellow water lilies with dense submerged vegetation dominated by Nitefla.
-  Dense to moderate canopy of American lotus with dense submerged vegetation dominated by Nitefla and bladderwort.



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**FIGURE 4**  
**Sediment Thickness & Distribution Map**

Fairyland Pond  
 Concord, MA

FIGURE	SURVEY DATE	MAP DATE
4	8/12/04	11/11/04


LEGEND

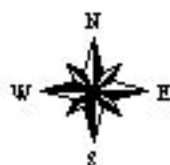
-  < 1.0 ft. Sand & Gravel
-  1.0-3.0 ft. Muck
-  >3.0 ft. Muck

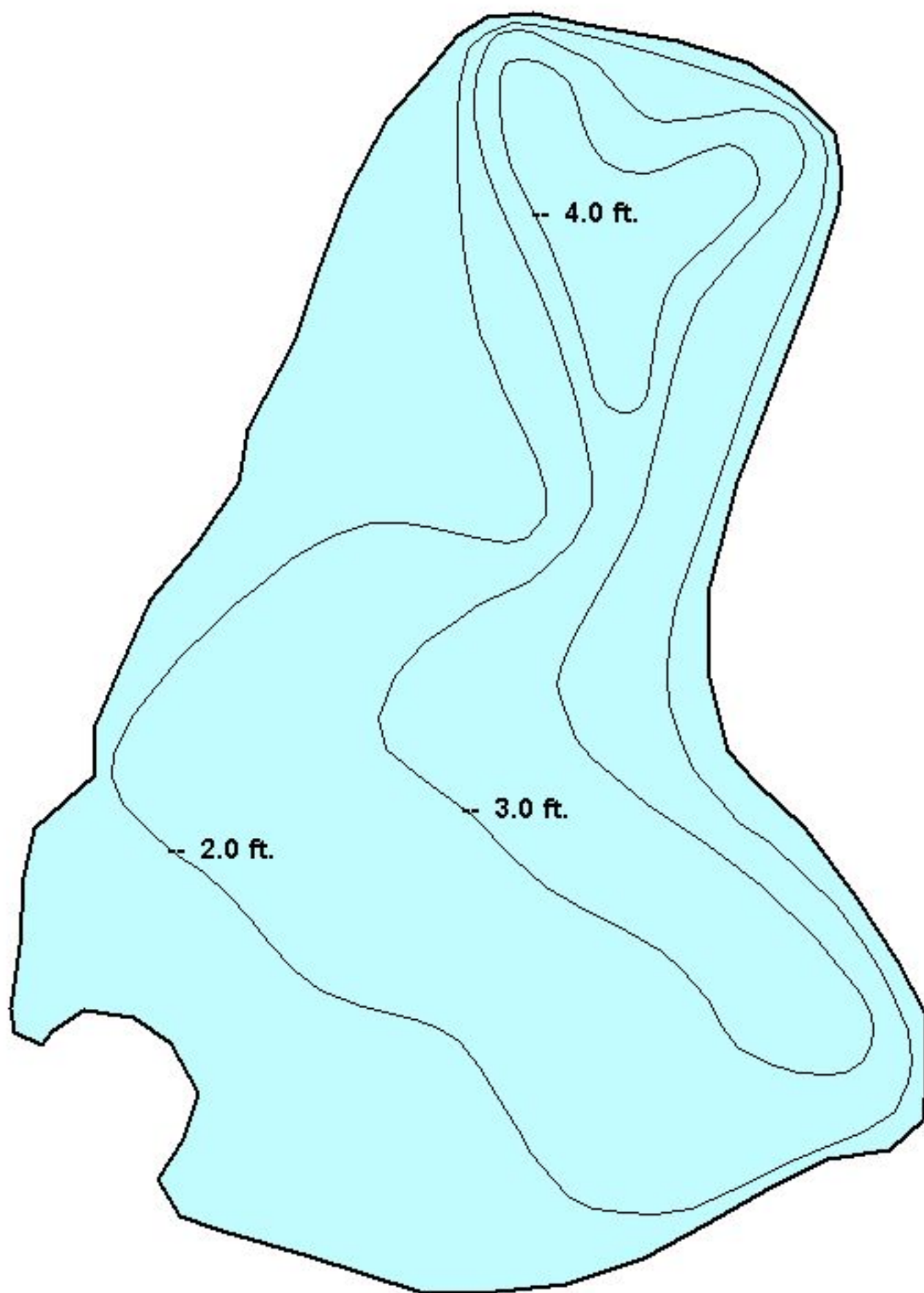
 AQUATIC CONTROL TECHNOLOGY, INC.  
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SCALE:

20 0 20 40 Feet  







## FIGURE 5 Bathymetry Map

Fairyland Pond  
Concord, MA

FIGURE	SURVEY DATE	MAP DATE
5	8/12/04	11/11/04


### LEGEND

-  = Depth contours measured in feet (2.0 ft. - 4.0 ft.)
- average water depth approximately 2.5-3.0 ft.

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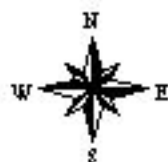
11 John Road  
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PHONE: (508) 285-1000  
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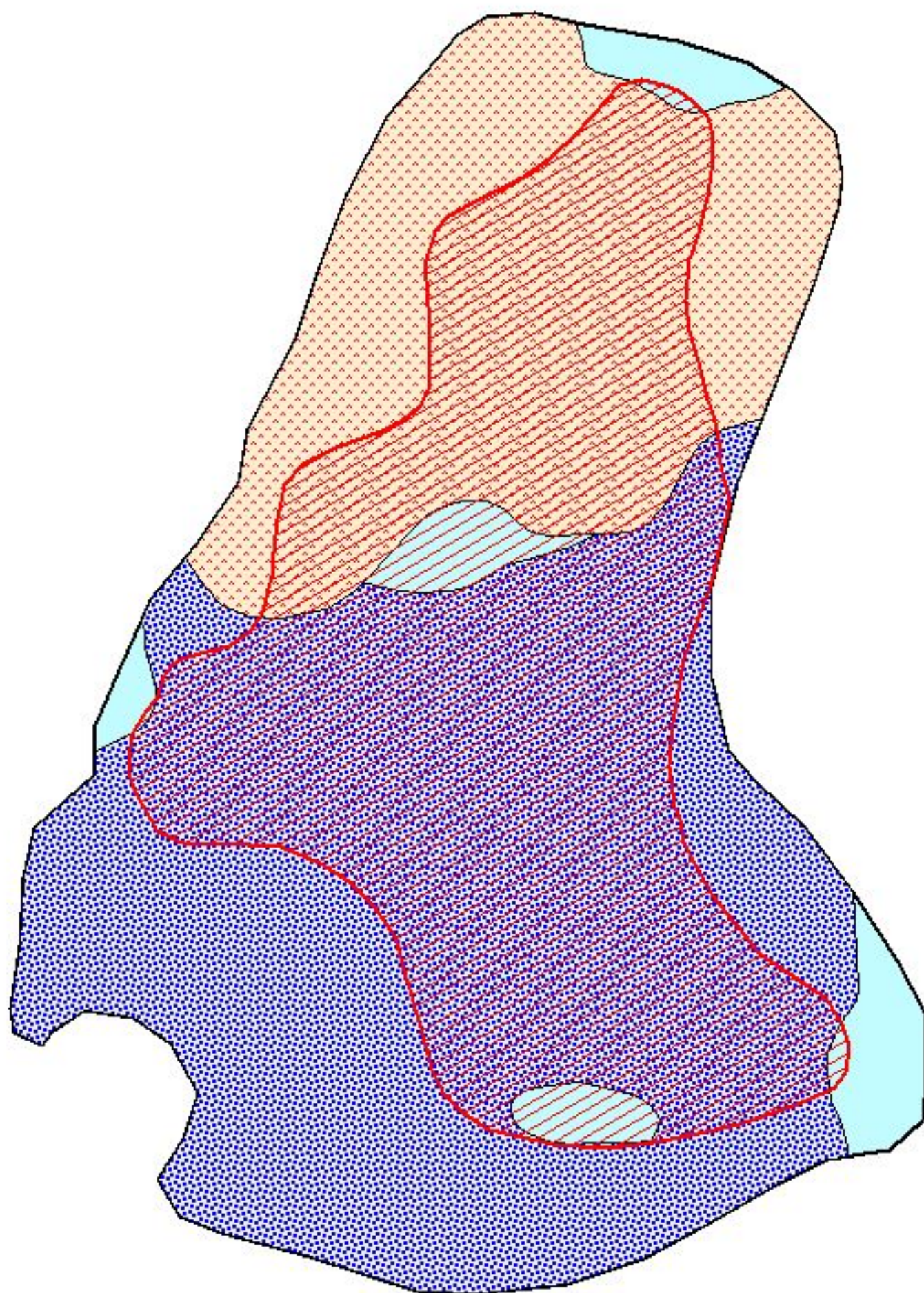
SCALE:

20 0 20 40 Feet  




Concord, MA









### FIGURE 6 Recommended Hydro-Raking Areas

Fairyland Pond  
Concord, MA

FIGURE	SURVEY DATE	MAP DATE
6	8/12/04	11/11/04


**LEGEND**

-  Area dominated by American lotus growth - approximately 0.85 acres.
-  Area dominated by yellow waterlily growth - approximately 1.75 acres.
-  Recommended Hydro-Raking area to restore open water and enhance fish and wildlife habitat - approximately 1.45 acres.
-  Areas of existing open water - approximately 0.15 acres.

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**SCALE:**  
20 0 20 40 Feet



---

## **APPENDIX B**

*Vegetation Survey Data*  
*Sediment Analysis Lab Sheets*  
*Water Quality Analysis Lab Sheets*

		8/12/04 Survey Data					
Transect	Data Point	Sediment Type	Water Depth	Sediment Thickness	Vegetation	Percent Vegetation Cover	Biomass Index
A	1	M	1.5	4.0	Cd, Nu, W, Lm	100	4
A	2	M	2.0	3.0	Cd, Nu, C, U, Lm, W	100	4
A	3	S	2.0	0.5	Nu, Cd, U, Pp, Lm, W	80	4
A	4	M	2.0	3.0	Nu, Cd, Ni, Pp	100	4
A	5	M	2.5	6.0	Ni, Nu, U, Cd, Lm, W, FA	100	4
B	1	M	3.5	>5.5	Ni, Cd, U, Lm, W	100	4
B	2	M	2.5	4.5	Ni, Nu, U, Cd, Lm, W, FA	100	3
B	3	S	2.0	0.0	Ni, Nu, U,	100	3
B	4	M	2.0	4.0	Ni, Nu, Cd	100	4
B	5	G	2.0	1.0	Nu, Ni, U, Pp	100	4
B	6	M	2.5	2.5	Nu, Ni, Cd, U, Lm, W	100	4
B	7	M	2.5	2.5	Cd, Nu, Ni, Na, FA, Lm	100	4
C	1	G	2.0	0.0	L, Nu, Ni, Na, U, Lm	100	4
C	2	G	2.5	0.0	L, Ni, U, Cd, B	100	4
C	3	M	2.5	3.0	Ni, Nu, NL	100	4
C	4	M	3.0	2.5	Ni, Nu, U, FA	100	4
C	5	M	2.5	2.5	Ni, Nu, Pe, Cd	100	4
D	1	M	2.5	2.5	NL, Ni, U	100	4
D	2	M	3.0	2.5	Ni, U, Nu, NL	100	4
D	3	M	2.0	3.0	Ni, L, Cd, U, Pp	100	4
D	4	M	2.0	2.5	Cd, NL, Nu, Na, Pr	100	4
D	5	M	2.0	3.0	NL, Cd, Na, Pr	100	4
E	1	M	2.0	2.5	NL, Cd, Lm	100	4
E	2	M	2.0	3.5	Ni, NL	100	4
E	3	M	2.5	2.5	Ny, NL, Ni	100	4
E	4	M	4.0	3.5	Ny, Ni	100	4
E	5	M	2.5	1.0	Ni, Pe, Na, NL, Cd, U, Pr, Lm	100	4
F	1	M	3.5	0.5	Cd, NL, U	100	4
F	2	M	3.0	1.0	NL, U	100	4
F	3	M	4.0	1.0	NL, U, Cd	100	4
F	4	M	3.5	2.5	NL, Cd, U, Lm	100	4
		<b>Averages</b>	<b>2.5</b>	<b>2.4</b>		<b>99.35</b>	<b>3.94</b>

---

## **APPENDIX C**

*Wildlife Habitat Features – Photos 1-6*



Photo 1 – Emergent cattail growth.



Photo 2 – Deadfall tree



Photo 3 – Deadfall tree



Photo 4 – Overhanging shoreline vegetation



Photo 5 – “Edge” habitat.



Photo 6 – Dense floating-leaf and submersed vegetation growth.