January 2, 2002

Nabnasset Lake Preservation Association
c/o Mr. Dan Doherty
16 Byrne Ave.
Westford, MA 01886

Re: Report on Aquatic Plant Survey of Nabnasset Lake and Management Recommendations

Dear Dan:

This report presents the results of the aquatic plant survey and inspection of the lake that I performed on November 14th. As you'll recall, I toured the entire shoreline of the lake, accompanied by yourself and several other Officers/Directors from the Lake Association. While mid-November is not the optimal time to perform this work, some types of aquatic plants were still standing in the water column and other plants were in the process of annual "die-back" and decay. Sufficient remains of these plants were found to give me an overall picture of the plant community we'd expect to find during mid-summer. We will re-check the plant community during late spring or summer of 2003 to confirm our findings.

Aquatic plants were inventoried by employing several methods. Plants that were visible from the water surface were identified and their location was noted on the attached map. Submersed plants were obtained by using a special "throw rake" and an underwater "Aqua-Vu" camera system. The dominant plants and relative density/abundance are shown on the attached map.

Two native plants, tapegrass or wild celery (*Vallisneria*) along with largeleaf pondweed (*P. amplifolius*) were co-dominant. The bulk of these plants would be found in normal, summer water depths of between approximately 4-8 feet, although some sparse growth was noted in depths of 2-3 feet. These two plants were considerably more prevalent along the northern and eastern shoreline of the lake. Plant growth was generally quite sparse along much of the southern shore but this lack of vegetation may have been partially the result of plants having already died-back for the winter, whereas the LEC Report shows considerably more plant growth along this stretch of shore. Other plants also observed during our November inspection, included, elodea or waterweed (*Elodea*), robbins pondweed (*P. robbinsii*), curlyleaf pondweed (*P. crispus*), watermilfoil (*Myriophyllum*), coontail (*Ceratophyllum demersum*), spatterdock or yellow waterlily (*Nuphar*), white or fragrant waterlily (*Nymphaea*) and a macro-algae called stonewort/muskgrass (*Nitella*). Curlyleaf pondweed is an exotic and invasive species in MA and throughout the northeast. It has an unusual growth cycle in that the plant grows rapidly during late spring (typically May and June) but by early July this pondweed dies-back and may not be seen again until the following spring. If curlyleaf pondweed is found during late summer/fall, it usually appears as "dwarf" plants growing just 6-12 inches off the bottom. The only location where we found this pondweed was throughout the shoal area, located

in the central portion of the lake. Watermilfoil was found in Shipley Swamp and in one small area, a southwest cove. Lacking fruit (seeds) in November, we could not tell if the milfoil was the native species *M. humile* or the exotic/invasive milfoil species variable watermilfoil (*M. heterophyllum*). Based on its size and shape we believe it's quite likely to be the invasive *M. heterophyllum*. It was certainly not the other exotic species of milfoil, Eurasian watermilfoil (*M. spicatum*) which we understand is continuing to increase in nearby Long- Sought- For -Pond, despite an aggressive program of introducing a biological control agent (weevils) there. The few milfoil plants that we observed in the main body of Nabnasset could easily be hand-pulled, providing that care is taken so as to remove the entire plant and root system and that no plant fragments escape collection. This should be done in late spring, before the plant matures and motor boats potentially fragment and spread the milfoil. Given that the lake level was down a foot or more at the time of my inspection along with the high frequency of stumps throughout Shipley Swamp, we were unable to ascertain the extent of milfoil growth throughout the swamp, although considerably more than just a few scattered plants of milfoil were observed near the confluence with the lake.

Limited water quality data is found for Nabnasset Lake in the ESS (June 2002) Evaluation of Drawdown Report and LEC's (2001) Notice of Intent. Phosphorus and phosphate levels measured in samples collected in the summers of 1998, 1999 and 2001, reveal generally low concentrations. Water clarity or Secchi Disk depths are reported at 12'2" which is actually very good. Lower Secchi Disk readings contained in LEC's Table 1 are presumably measurements to the pond bottom and are not reflective of the true maximum clarity. While mention is made in these reports of algae blooms occurring in the lake, we've not seen the data that supports this claim. Rooted plants obtain the bulk of their nutrients from the sediments and not the water column. We're not aware of sediment data for Nabnasset, however, the literature reports that the abundance/density of rooted plant growth in a lake, does not correlate well with sediment nutrient data. Suffice it to say that most any bottom substrate other than a clean sand will contain sufficient phosphorus and nitrogen to support rooted plants.

MANAGEMENT RECOMMENDATIONS

We understand the primary goals of the Nabnasset Preservation Association are to maintain a balance between insuring that the lake remains suitable for recreational uses (i.e., swimming, boating and fishing) while also preserving the habitat for fish, wildlife and other organisms. We understand from our meetings with the Officers/Directors that rooted plant growth has increased considerably over the past decade and currently this growth is impairing use of the lake for these active recreational pursuits.

While native plant species are presently causing this use impairment and warrant management, two probable exotic/invasive species, variable watermilfoil and curlyleaf pondweed, are also now found in the lake and warrant an aggressive program to potentially eradicate them from the lake or at least contain their further spread.

In-lake management alternatives for Nabnasset are discussed in length in ESS's Proposed Drawdown Evaluation Report. While we have great respect for ESS's capabilities, assessing and implementing nuisance aquatic vegetation programs is our specialty and annually we work on some 400 ponds/lakes, employing a wide range of both chemical and non-chemical techniques. Our opinion on drawdown after seeing the lake, is that lowering of approximately 3.5 feet will do very little to address the current problem of rooted, submersed vegetation since the weeds are most abundant and problematic in depths of between approximately 4 and 8 feet. It's true that a partial drawdown of 3.5 feet would expose a considerable amount of shoreline for raking/cleaning but it would not get at much of the problem weed growth. A nominal drawdown of 3.5 feet would seem to carry most all of the environmental concerns and potential negative effects with minimal benefit in so far as controlling the target plants. If drawdown is to be pursued, we recommend seeking approval for a maximum 8 foot drawdown to be implemented in a phased manner over a period of several years. With this program, you would start with a drawdown of say 3-4 feet in the first year and progressively increase the depth of drawdown to then 6 and 8 feet over the next two years, respectively. Each drawdown would be accompanied by an annual monitoring program to try and identify significant adverse ecological or use effects. If adverse effects are identified and determined to be unacceptable by the Association or regulatory community then the program of drawdown would need to be re-examined. Construction of either a temporary or permanent water level control structure for Shipley Swamp, probably should be incorporated into the drawdown program. We recall that ESS provided an initial estimate of cost for engineering design, permitting and construction of $40,000. You should re-confirm this with ESS before moving ahead further with the drawdown option. Remember that the two dominant plants, largeleaf pondweed and tapegrass/wild celery, may increase or decrease in response to drawdown, therefore, even a deeper drawdown may not solve your weed problem and you may still need to initiate additional nuisance plant control measures. This deeper drawdown, however, would facilitate substantial shoreline clean-up and possibly some dry-dredging of accumulated shoreline sediments if the proper permits can be obtained.

Chemical (Herbicide) Treatment

The use of USEPA/MA registered aquatic herbicides is by far the most commonly employed technique to manage nuisance aquatic plants and often the most effective, both short and long-term in our experience. Based on our inspection of the lake, herbicides may not be necessary to use at this point at Nabnasset, if in fact the invasive milfoil and curlyleaf pondweed are limited in distribution as they appear to be. We really won't know this until we're able to take another look at these plants during next summer. If the cover of these two species is beyond reasonable hand-pulling or else the use of bottom (benthic) barriers, then treatment with an aquatic herbicide should be pursued. Whatever negligible or perceived risk herbicide use may pose, is far less than the potential ecological havoc and use impairment these invasive plants can potentially have on the lake if they are allowed to spread. The fact is that documented adverse effects following herbicide treatments are exceedingly rare. Treatment costs targeting either milfoil or

curlyleaf pondweed are typically in the range of ~$3,000, given a 5 acre treatment minimum, plus permitting.

Herbicide treatment of largeleaf pondweed can be very effective. The herbicide of choice is called Aquathol K (dipotassium salt of endothall). While we've measured the lake area at 124 acres in area (minus Shipley Swamp), there's roughly only 20-25 acres of total vegetation in the lake and probably no more than about 15 acres of this pondweed that needs to be managed in high use recreational areas. When using Aquathol K there is a 3 day restriction on fish consumption post-treatment, a 14 day restriction on using the treated water for irrigation and a 1 day restriction on swimming. Aquathol K, however, will not likely provide good control of the wild celery/tapegrass. This latter species can be very difficult to control with herbicides. We anticipate treating a small lake in CT in 2003 with another herbicide called Nautique (a liquid copper formulation with herbicidal properties) to try and control this species. If treatment were to occur at Nabnasset this year with Nautique, we'd only suggest performing a treatment of a small area as a "pilot test" to evaluate the results. Treatment with Aquathol K for pondweed will run about $11,000 plus permitting to treat ~15-20 acres of high use shoreline. Good control of the pondweed is typically achieved for two years post-treatment. Treatment of a ~ 5-10 acre area with Nautique for tapegrass would cost about $3,000-$4,500 plus permitting. There are no temporary water use restrictions with Nautique, although we would recommend and require closing the treated area(s) to swimming on the day of treatment.

Mechanical Cutting and Harvesting

Mechanical cutting and harvesting can provide effective short-term control of nuisance aquatic vegetation. Most harvesting machines cut to a maximum depth of between 6 and 7 feet. Harvesting works best in waters deeper than ~ 3 feet when they can operate parallel to shore and don't have to "nose-in" around docks/piers where harvesting is considerably less effective and inefficient. Harvesting is most effective when used on true annual plants like water chestnut (*Trapa*) which reproduce from seed. At the Charles River Lakes District in Waltham/Newton, a sustained annual program of harvesting over the past 6-7 years carried out by our company for the MDC, has nearly eradicated this noxious plant from this reach of the Charles. Harvesting is also reported to provide some longer term control of plants like largeleaf pondweed when harvested annually over a period of successive years, although this is not well documented. Harvesting will also control tapegrass/wild celery but we've not seen evidence of providing lasting control. Specific high use and high density areas of the lake's shoreline would be targeted for harvesting. We'd estimate a maximum harvest area of about 15-20 acres. While we charge hourly for our harvesting services at between $145-$165/hr., (engine hours) plus a "lump sum" equipment mobilization fee of $600-$800, the unit cost for harvesting will usually work out to about $600-$700/acre/cutting plus trucking and disposal which is the responsibility of the client. Actual harvesting costs will naturally vary depending upon, vegetative density, frequency of bottom obstructions and distance to an on-shore off-loading site(s). In your case, perhaps you can get the Town to load and truck the harvested weds away. If not, we suggest budgeting an additional ~ 25-33% or about $150-200/acre if you have to hire a local contractor to load and haul the weeds away.

Estimated cost for a ~20 acre harvest at Nabnasset is in the range of $13,000 plus disposal. This work would likely occur during July or early August, when we understand the plants are approaching the water surface. Harvesting should be avoided in areas of watermilfoil, which reproduces primarily from vegetative fragmentation.

Mechanical Hydro-Raking

Hydro-Raking rakes the lake/pond bottom to remove the plant stems and foliage along with their root systems. The Hydro-Rake has no on-board storage, therefore, each rake-full must be deposited directly on-shore or else onto a secondary Harveter/Transport vessel. The rake attachment can reach to a maximum depth of ~ 12 feet to collect aquatic vegetation, leaf littter and other bottom debris. The duration of nuisance plant control following Hydro-Raking is largely dependent on the mode of plant reproduction. Plants with fine root systems like watermilfoil will often regrow by the end of the summer. Plants like waterlilies and cattails that have large, well defined root systems (rhizomes) that can be throroughly removed, may be controlled for 2-3 years or longer, following a single raking. Tapegrass and largleaf pondweed probably fall somewhere between this range. Our best projection of control is that raking of areas dominated by tapegrass and largeleaf pondweed would need to be raked annually with some reduction in density and raking effort (more-so for the pondweed) seen in the years following the initial raking. While we've not encountered difficulty in raking pondweed, the tapegrass is difficult for the rake attachment to remove and collect because of its shape and the fact that the stems are not branched. Raking works far better than mechanical cutting/harvesting in and around the more shallow dock/pier areas and along swimming beaches, however, most of the problem weed growth at Nabnasset appears to occur in depths greater than 3-4 feet where a Harvester can do a more thorough job.

Our charge rate for Hydro-Raking is $165/hr., plus a lump sum equipment mobilization fee of $600. We require a 20 hr., minimum contract. Unit costs for raking will probably work out to between ~ $2,000-$3,000/acre, given the same variables cited under the discussion of mechanical harvesting. If a separate Transport/Harvester must also be used with the Hydro-Rake, then the hourly charge rates will about double, along with doubling of the unit costs shown above. A separate Harvester/Transport will be necessary if the travel distance to a shoreline off-loading site exceeds ~ 150-200 feet. Costs for loading and trucking of the material to an upland disposal site should be about the same as for cutting/harvesting.

Permitting

Permitting for any of the management activities discussed above, will be required from the Westford Conservation Commission. Harvesting, mechanical raking, chemical treatment and drawdown will certainly require permits from Conservation. In addition, chemical treatment requires that we obtain a License to Apply Chemicals from MA DEP, Office of Watershed Management. Additional permits for drawdown may be required as discussed in the ESS Report. We would try and seek a three year approval from Conservation for the management program that we mutually agree upon to put forth.

For chemical treatment we charge a nominal $200 to file and obtain the License to Apply Chemicals. We can usually obtain this permit given ~ 4-6 weeks lead time. The Notice of Intent (NOI) process with Conservation, will typically require at least a 90 day lead time for preparation and Conservation review and processing. The cost for us to assemble and file an NOI and attend one meeting of the Conservation Commission, is estimated at $1,500 plus expenses (i.e. filing fees, certified mailings, copying costs, legal notices, etc.,) estimated at an additional $1,000 or so, given Nabnasset's lengthy list of abutters. This $2,500 total estimate is for a program of mechanical harvesting, hydro-raking and possibly some limited herbicide treatment. Additional costs will be incurred by us if we pursue permitting a program of drawdown. We would need to have ESS preferably involved (or other suitable engineering/environmental consultant) to address the drawdown program and particularly the design/construction aspects of the water level control structure for Shipley Swamp. Our costs would likely increase to $3,500 or so and we're uncertain as to ESS's costs but we'd expect them to be at least $2,000 and substantially more for any engineering or construction design work.

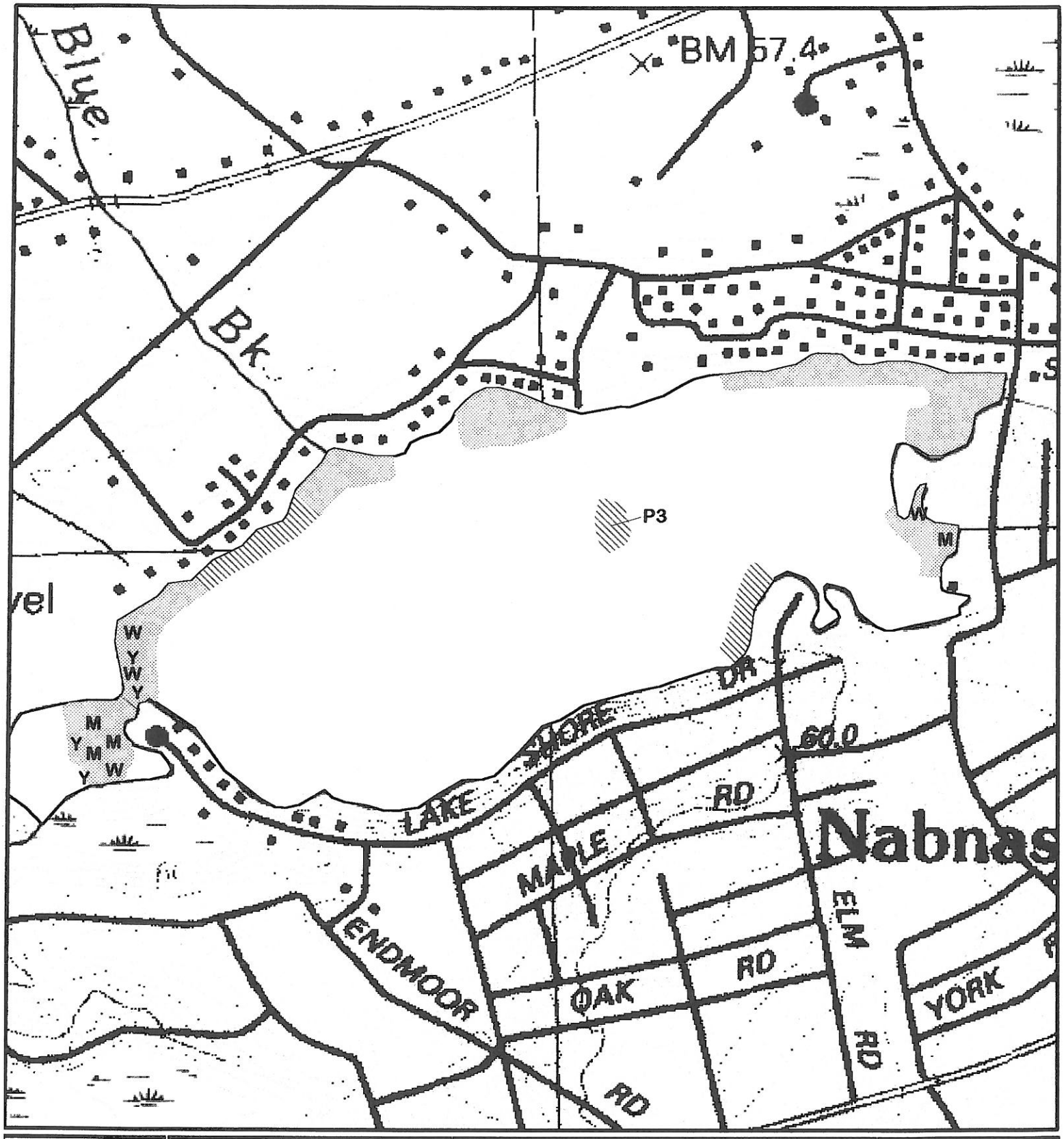
SUMMARY

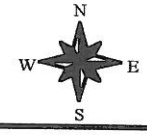
After you've had a chance to distribute and review this report, we recommend that we meet again soon to try and finalize a Management Program.

We believe a shallow drawdown of just 3.5 feet, affords very little benefit for nuisance plant control with most all of the potential negative effects and objector concerns. Deeper drawdown has some potential benefits for nuisance plant control and some secondary benefit with respect to shoreline clean-up and potential to dry dredge certain areas of the lake. Opponents to drawdown have raised a number of issues, most that seemingly could be addressed by construction of a water level control structure at Shipley Swamp. There are legitimate concerns with a deeper drawdown on aesthetics and effects on winter uses of the lake. You experienced a deep drawdown some years ago, therefore, you should have a good "reading" on the sentiments of your membership if a deep drawdown of the lake were to occur again and perhaps be repeated once every two years thereafter. Drawdown will carry an initial higher cost for permitting, design and construction of the inlet water control structure. Ongoing monitoring costs should be moderate in cost, depending upon the agencies rulings and permit conditions imposed, assuming approval is granted. Additional expenditures for annual weed control may still be necessary, as drawdown alone may not adequately control the nuisance vegetation.

If drawdown is to be "tabled" for now, then cutting/harvesting would be a more cost/effective approach to manage tapegrass and largeleaf pondweed at Nabnasset than is Hydro-Raking. Hydro-Raking could be employed at some point in the future if the harvesting is found to be inadequate along the shallow, shore-front areas.

Herbicides probably don't need to be used at present to control invasive watermilfoil and curlyleaf pondweed but we'll need to check their distribution next spring/summer to confirm this. Herbicides could be effectively used to selectively treat "higher use" areas of pondweed, while preserving other areas important for fish/wildlife habitat. The





Nabnasset Lake

Westford, MA

Vegetation

FIGURE	SURVEY DATE	MAP DATE
1	11/14/02	12/31/02

LEGEND

Higher Density - Vallinseria and largeleaf pondweed co-dominant with lesser amounts of elodea, Robbins pondweed and muskgrass/ stonewort

Lower Density - Vallinseria and largeleaf pondweed co-dominant with lesser amounts of elodea, Robbins pondweed and muskgrass/ stonewort

P3 - Low density of invasive curlyleaf pondweed

M - Scattered watermilfoil thought to be the invasive variable milfoil species

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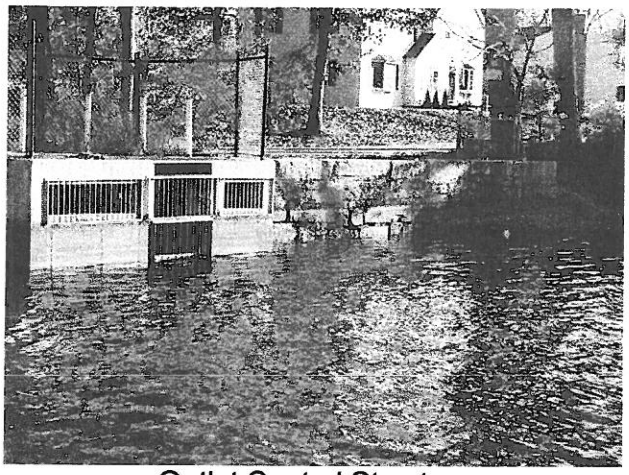
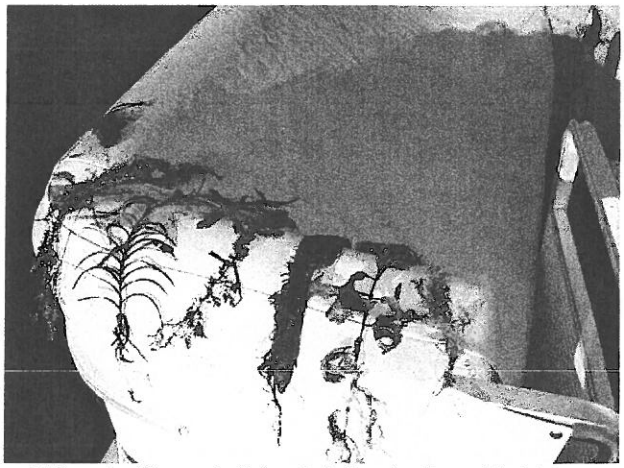
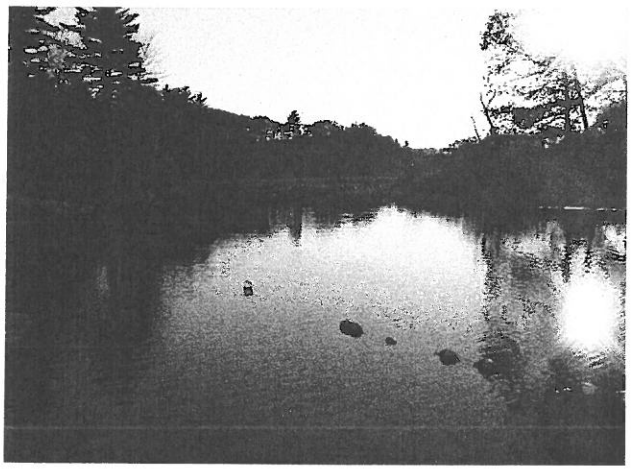
Nabnasset Lake **Photo Date: 11/16/02**



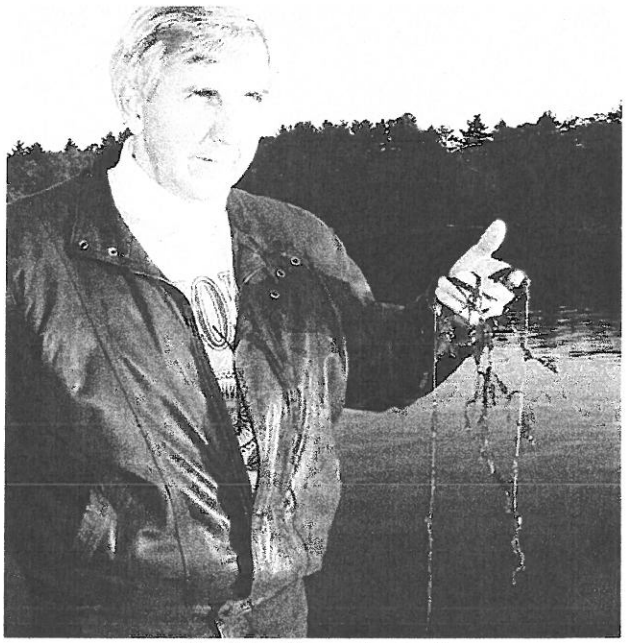
Outlet Control Structure



Weeds (from left to right): elodea, Robbins pondweed, coontail, largeleaf pondweed, and stonewort/muskgrass



Looking west into the Shipley Swamp



Curlyleaf pondweed

Aquathol treatment might also possibly take-out and "thin" some of the tapegrass but don't count on it. The initial unit costs for treatment would be roughly the same as for a single cutting/harvest but chemical treatment should control the pondweed for two growing seasons while harvesting will not entirely control the pondweed for even one full summer. Chemical treatment of tapegrass this year would be somewhat experimental with no good assurance of effectiveness.

I will be out of state next week and returning on January 9th. I will also be out of the country from January 23 –February 3rd. Please call me or send me an e-mail with some dates during the evening that we could possibly meet. If I'm not available, please speak with Dominic Meringolo, our Environmental Engineer, with regards to any questions on the depth (bathymetric) mapping aspects of our work. Our invoice for my inspection/report and for the depth mapping work, is also enclosed.

We look forward to working with you and the Association during the months ahead.

Sincerely,

AQUATIC CONTROL TECHNOLOGY, INC.

Gerald N. Smith
President/Aquatic Biologist