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MEMORANDUM

TO: William Turner, Westford Conservation Commission
DATE: September 15, 2009
FROM: Carl Nielsen, CLM
SUBJECT: Nabnasset Lake – Annual Report Card
PROJECT NO.: N458-000
COPY TO: David Brody, Nabnasset Lake Association

SUMMARY OF ANNUAL MONITORING WITH REPORT CARD

ESS Group, Inc. (ESS) completed our survey of Nabnasset Lake on September 1, 2009 per the conditions established previously by the Westford Conservation Commission. The attached "Nabnasset Lake Management Annual Report Card for 2009" summarizes our findings based on the conditions at the time of survey. ESS has also included Tables 1a, 1b and 1c summarizing the water quality testing results obtained on September 1 and Table 2 summarizing the Shipley Swamp plant plot data from this year and prior years for comparison. A photolog containing images of each plant plot is also attached. Figure 1 is provided to illustrate the areas of invasive plant cover observed in 2009.

Summary of findings:

Water Quality:

Based on the results of clarity, chemical, and nutrient analysis in 2009, water quality within Nabnasset Lake remains in good to excellent condition (Table 1a). A surface and bottom sample was collected from within Nabnasset Lake and a single surface sample was collected near the outlet of Shipley Swamp. In 2007, moderately elevated levels of nitrogen were observed; total nitrogen levels were much lower in 2009. Total phosphorus levels remain well below the threshold (0.02 mg/l) at which they begin to degrade water quality through nutrient enrichment and associated algal blooms. Dissolved oxygen and turbidity levels observed fall within the normal range that would be expected in a healthy Massachusetts lake (Table 1b). A temperature and dissolved oxygen profile collected from within the lake indicates that there is a thermocline between 5 and 6 meters below the water surface (Table 1c).

Invertebrate Community:

Invertebrates in the lake and swamp were comparable to communities observed during prior assessments with the exception of a slight decrease in the density of mussels in the some of the deeper sections of the lake. However, the mussel community in deeper waters still remained higher than mussel density in shallower waters. ESS did not find any mussels in Shipley Swamp, but did find other mollusks, including pisidiid fingernail clams and several species of snails in the swamp this year. Diversity of other invertebrates remained high within both the shallow and deep waters of Shipley Swamp and Nabnasset Lake.

Erosion:

Only slight evidence of erosion was observed in the area immediately downstream of the dam. This erosion is not believed to have been increased over prior years. No increase in shoreline erosion or shoreline sloughing was observed.

Plant Community:

ESS conducted an aquatic plant survey on September 1 within the five predefined areas of the pond: the north shore, south shore, shallow cove, outlet cove and submerged island (Figure 1). The results of the survey indicate that Nabnasset Lake continues to support a moderately diverse native aquatic plant community. Native species observed included tapegrass (Vallisneria americana), slender water-nymph (Najas flexilis), and hedge hyssop (Gratiola aurea).

Two aquatic invasive species, curly-leaf pondweed (Potamogeton crispus) and variable-leaf milfoil (Myriophyllum heterophyllum) have been documented in Nabnasset Lake. It is our understanding that curly-leaf pondweed in Nabnasset Lake was treated with herbicide in 2009. The treatment was reported to have been very effective, although spotty cover in the shallow cove and a cove along the north shoreline was observed in September for a total cover of approximately 0.5 acres (Figure 1). The lack of curly-leaf pondweed was also likely due to the timing of the survey; curly-leaf is typically at peak levels of growth in early June and quickly dies back by the end of June.

Very little variable-leaf milfoil was observed during the 2009 aquatic plant survey. A sparse patch of milfoil was observed in a cove along the north shoreline just downstream from the outlet of Shipley Swamp (Figure 1). This indicates that the most recent drawdown has effectively controlled the milfoil in the shallower waters. The milfoil bed found within Nabnasset Lake comprised only 0.14 acres in total coverage. Several scattered patches of milfoil were also observed in Shipley Swamp. However, these patches were relatively small and overall native species diversity in Shipley Swamp was high. A complete species list of those plants found within the vegetation plots in Shipley Swamp is provided in Table 2.

One new aquatic invasive species was observed in Nabnasset Lake this year. A small patch of spiny naiad (Najas minor) was observed just to the west of Edwards Beach (Figure 1). This species should be monitored closely as it spreads by both fragmentation and seed production. As is the case with other invasives, spiny naiad can form dense mats and exclude native plants which can be detrimental to aquatic life.

The remaining exotic species of concern is purple loosestrife (Lythrum salicaria). This emergent wetland species had relatively low cover in scattered patches along the shoreline. It was prevalent in various patches within Shipley Swamp. Purple loosestrife does not currently appear to have grown to nuisance levels but should be monitored closely and treated as needed to prevent further spread.

Given the low levels of invasive species observed, the existing treatment program of drawdowns and herbicide treatments appears to be effective in controlling the spread of invasives within Nabnasset Lake. ESS recommends that curly-leaf pondweed continue to be killed or removed prior to seed

formation, which typically occurs in early June. This can be done with herbicides, harvesting, or hand-pulling.

Winter drawdown is recommended for control of curly-leaf pondweed in areas less than six feet deep. This should limit the area of herbicide treatment required and provide good control.

Based on the limited coverage of milfoil this year, herbicide application for milfoil control in 2010 is not believed to be essential. The small patch of milfoil observed should be closely monitored in 2010 and if volunteers are available or budget permits, hand harvesting should be performed for milfoil control. Alternatively, if the herbicide treatment for curly-leaf pondweed is implemented again next spring for deeper areas of the lake, the existing milfoil bed should be treated at this time.

If you have any questions regarding the future management of this water resource, please call Carl Nielsen at ESS, (401) 330-1224. Thank you.

ESS Group, Inc.

NABNASSET LAKE MANAGEMENT ANNUAL REPORT CARD FOR 2009

(Completed annually by qualified lake expert)

RESOURCE	A	B	C	D	F	GRADE 2007	GRADE 2009
Nabnasset Lake							
Plant Community (<6' deep)							
Aquatic Native Plants	Dominant	Common	Occasional	Rare	Absent	B	B
Emergent Native Plants	Dominant	Common	Occasional	Rare	Absent	B	B
Aquatic Exotic/Invasive Plants	Absent	Rare	Occasional	Common	Dominant	B	B
Emergent Exotic/Invasive Plants	Absent	Rare	Occasional	Common	Dominant	B	B
Plant Community (>6' deep)							
Submerged Aquatic Native Plants	Dominant	Common	Occasional	Rare	Absent	B	A
Aquatic Exotic/Invasive Plants	Absent	Rare	Occasional	Common	Dominant	NS	B
Invertebrate Community (<6' deep)							
Freshwater Mussels	>0.5/ft^2	0.2-0.5/ft^2	0.1-0.2/ft^2	0-0.1/ft^2	Absent	D	D
Other Macroinvertebrates	>8 taxa	6-8 taxa	3-5 taxa	1-2 taxa	Absent	B	B
Invertebrate Community (>6' deep)							
Freshwater Mussels	>0.5/ft^2	0.2-0.5/ft^2	0.1-0.2/ft^2	0-0.1/ft^2	Absent	B	C
Other Macroinvertebrates	>8 taxa	6-8 taxa	3-8 taxa	1-2 taxa	Absent	B	B
Water Quality							
Clarity (turbidity/Secchi depth)	<1 NTU or >4 m	1-2 NTU or 3-4 m	2-5 NTU or 2-3 m	5-10 NTU or 1.2-2 m	>10 NTU or <1.2 m	A	B
Phosphorus Concentration (mg/L)	<0.01	0.01-0.02	0.02-0.03	0.03-0.05	>0.05	B	A
Nitrogen Concentration (mg/L)	<0.5	0.5-0.8	0.8-1.0	1.0-2.0	>2.0	D	B
Dissolved Oxygen @ surface (mg/L)	>10.0	7.0-10.0	6.0-7.0	5.0-6.0	<5.0	B	B
Erosion							
Shoreline	No evidence	Wave erosion only	Undercut banks	Bank failures	Numerous bank failings	B	B
Downstream of Dam	No evidence	Limited undercut banks	Extensive undercut banks	Loss of minor shoreline vegetation	Loss of trees and roots	B	B
Shipley Swamp							
Plant Community (<6' deep)							
Aquatic Native Plants	Dominant	Common	Occasional	Rare	Absent	A	A
Emergent Native Plants	Dominant	Common	Occasional	Rare	Absent	A	A
Aquatic Exotic/Invasive Plants	Absent	Rare	Occasional	Common	Dominant	B	B
Emergent Exotic/Invasive Plants	Absent	Rare	Occasional	Common	Dominant	C	C
Plant Community (>6' deep)							
Aquatic Native Plants	Dominant	Common	Occasional	Rare	Absent	B	B
Aquatic Exotic/Invasive Plants	Absent	Rare	Occasional	Common	Dominant	B	B
Invertebrate Community (<6' deep)							
Freshwater Mussels	>0.5/ft^2	0.2-0.5/ft^2	0.1-0.2/ft^2	0-0.1/ft^2	Absent	D	D
Other Macroinvertebrates	>8 taxa	6-8 taxa	3-8 taxa	1-2 taxa	Absent	B	B

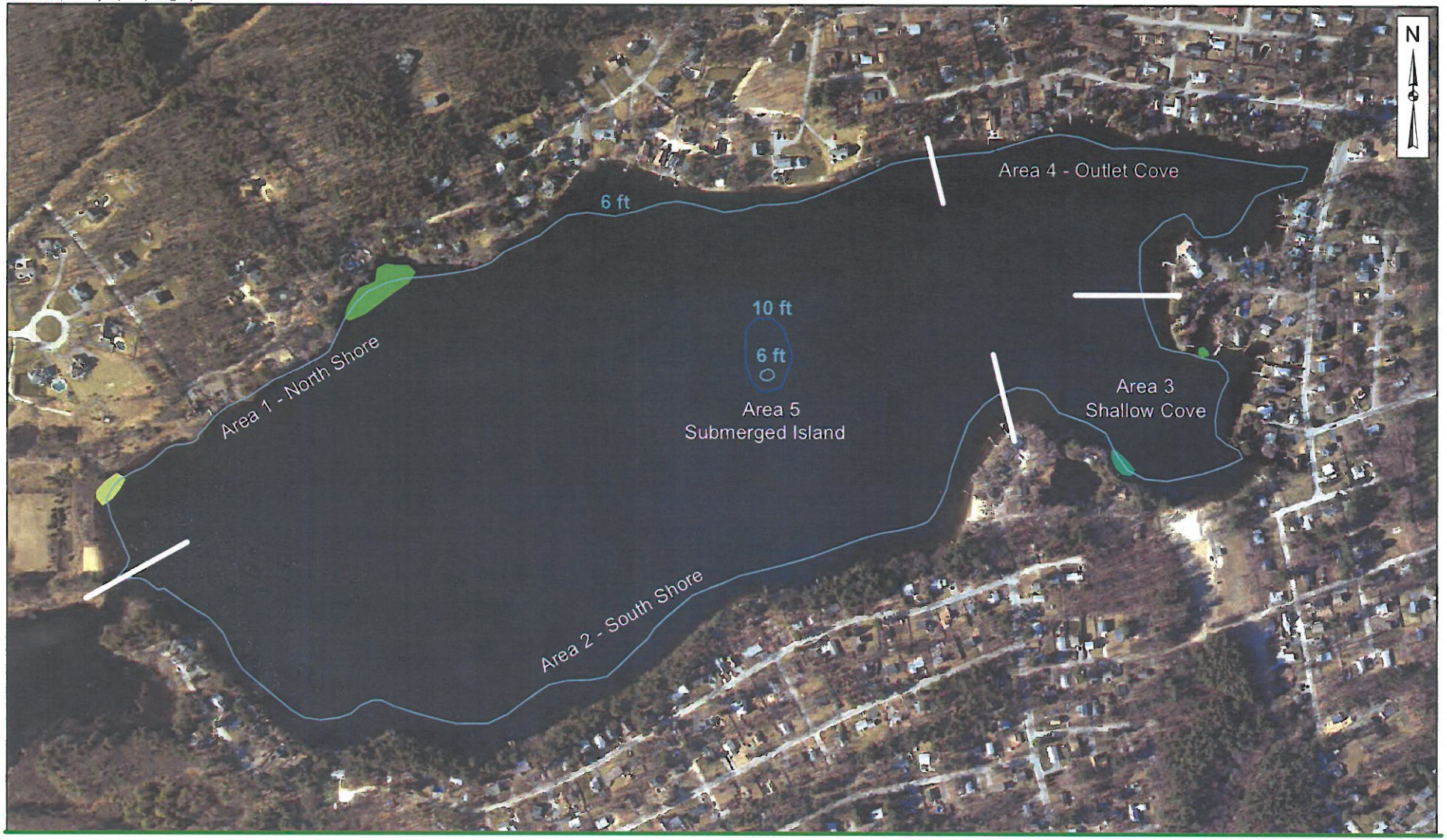
NS: Not scored

NOTES FOR COMPLETION OF REPORT

1. For the plant community assessment, the locations to be evaluated in Nabnasset Lake should include representative shoreline segments along the north and south shores, a shallow sloped cove, and the submerged island near the middle of the lake. For invertebrates, water quality, and erosion, the locations should be consistent with previous areas of assessment in order to compare with baseline data. In addition, water quality samples should be collected at the surface and bottom of the lake. Grades for each resource can be recorded for each individual area assessed in a field notebook, however, only a composite grade for the entire lake should be recorded on the report card.
2. Plant community assessment in Shipley Swamp should be consistent with the plant plot locations assessed during previous years. Macroinvertebrate sampling locations should also be consistent with sites sampled in the swamp previously. Grades for each resource can be recorded for each individual area assessed in a field notebook, however, only a composite grade for the entire swamp should be recorded on the report card.
3. Observations for plants and invertebrates made in shallow water (<6') should be made with appropriate gear including plant rakes, clam rake with ¼" mesh openings, and direct observation via aquascope® or snorkel gear. Observations made in deeper water (>6') must be made with either snorkel gear or underwater video camera.
4. A completed Report Card should be submitted to the Westford Conservation Commission and the Nabnasset Lake Preservation Association (NLPA) each year by no later than September 15th. Recommendations for the upcoming year should be provided along with the Report Card so that any management actions deemed necessary could be undertaken. Management recommendations are expected to focus on winter drawdown beginning in November, herbicide application the following June, a combination of drawdown and herbicide application, or no action.
5. Copies of any field notes, laboratory data, or other results used to derive the grade for each resource should be made available to the Conservation Commission and/or NLPA upon request.
6. Scoring for Plant Community Resources is based on an estimation the plant coverage within the littoral zone (lake area where light penetration reaches bottom) for each vegetation category listed on the Report Card. Scoring is defined as follows:

    - Absent — Vegetation category is not present at location observed
    - Rare — Vegetation category occupies <5% of the littoral bottom area
    - Occasional — Vegetation category occupies 5% to 10% of the littoral bottom area
    - Common — Vegetation category occupies 10% to 25% of the littoral bottom area
    - Dominant — Vegetation category occupies >25% of the littoral bottom area

Location: G:/GIS-Projects/N441/Plant_map.mxd



ESS Group, Inc.
Engineers
Scientists
Consultants

NABNASSET LAKE
Westford, Massachusetts

Scale = 1" = 500'

Source: 1) MassGIS, Color Ortho Photos, 2001
2) ESS, Plant cover data, 2009; 3) ACT, Bathymetry, 2002

Legend

Invasive Species Cover

- Curly-leaf pondweed (1%-25%)
- Spiny Naiad (1%-25%)
- Variable-leaf milfoil (1%-25%)

- 10 ft Contour
- 6 ft Contour

Invasive Species Survey
September 1, 2009

Figure 1

Table 1a. Laboratory Measured Water Quality Data for Nabnasset Lake, September 1, 2009

Sample ID	Date	Total Phosphorus (mg/L)	Nitrite Nitrogen (mg/L)	Nitrate Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Nitrogen (mg/L)
WQ-1 (Shipley Swamp)	9/1/2009	0.008	0.04	0.27	0.39	0.70
WQ-2S (Lake Surface)	9/1/2009	0.004	0.019	0.27	0.63	0.92
WQ-2B (Lake Bottom)*	9/1/2009	0.011	0.031	0.21	0.37	0.61

* Depth = 26'

Table 1b. Field Measured Water Quality Parameters for Nabnasset Lake, September 1, 2009

Sample ID	Date	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Conductivity (µmhos/cm)	Turbidity (FTU)	Temperature (°C)	pH (SU)
WQ-1 (Shipley Swamp)	9/1/2009	7.96	91.1%	319.5	1.10	22.3	7.8
WQ-2S (Lake Surface)	9/1/2009	7.48	89.0%	319.7	1.08	23.5	7.7
WQ-2B (Lake Bottom)*	9/1/2009	0.04	0.4%	392.4	1.50	16.3	7.4

* Depth = 26'

Table 1c. Dissolved oxygen, temperature profile at in-lake sampling station (WQ-2), September 1, 2009.

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)
0.0	23.5	7.5	89.0
1.0	23.4	7.3	86.1
2.0	23.3	7.3	85.4
3.0	23.1	7.2	83.0
4.0	23.1	7.2	84.4
5.0	23.0	7.0	81.5
6.0	19.5	0.1	0.9
7.0	16.3	0.0	0.4

Table 2. Plant plot survey data from April 2002, August 2004, June 2007 and September 2009 showing percent plant cover* in each 4 m² plot

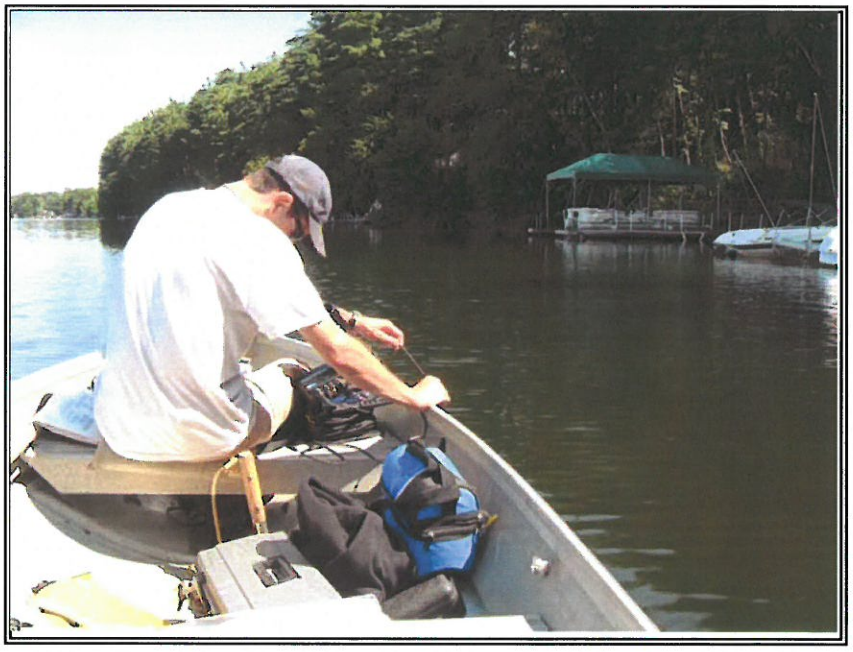
Common Name	Scientific Name	2002 (April)			2004 (August)			2007 (June)			2009 (September)		
		Plot A	Plot B	Plot C	Plot A	Plot B	Plot C	Plot A	Plot B	Plot C	Plot A	Plot B	Plot C
Swamp Milkweed	*Asclepias incarnata*											5%	
Water Calla	*Calla palustris*			3%									
Sedge	*Carex sp.*			50%									
Leatherleaf	*Chamaedaphne calyculata*			10%									
Filamentous Green Algae	Chlorophyta					Trace							
Spike rush	*Eleocharis sp.*				3%	35%			50%			50%	
Golden Hedge Hyssop	*Gratiola aurea*					3%			3%			15%	
Marsh St. Johns Wort	*Hypericum virginicum*				Trace	10%			10%			10%	
Bog Laurel	*Kalmia polifolia*			1%									
Purple Loosestrife	*Lythrum salicaria*	40%			10%		3%	10%	3%	3%	5%	5%	
Mint	*Menthis sp.*					3%			3%				
Moss	*Musci sp.*												80%
Nodding Waternymph	*Najas flexilis*				3%								
Spatterdock	*Nuphar variegatum*		3%										
White Water Lily	*Nymphaea odorata*				10%	40%		10%	10%		10%	10%	
Arrow Arum	*Peltandra virginica*				Trace	3%	Trace		3%	Trace			5%
Pickerelweed	*Pontedaria cordata*						3%						
Ribbonleaf Pondweed	*Potamogetan epihydrus*					10%				5%			
Oakes Pondweed	*Potamogetan natans*												Trace
Woolgrass	*Scripus cyperinus*				3%								
Bur-reed	*Sparganium americana*	5%	3%										
Sphagnum	*Sphagnum sp.*			10%						5%			
Broad Leaved Cattail	*Typha latifolia*		20%		3%			80%			80%		
Bladderwort	*Utricularia vulgaris*					3%			3%	3%			
Highbush Blueberry	*Vaccinium corymbosum*			10%						3%			10%
Wild Rice	*Zizania aquatica*				80%		90%	2%		80%	5%	5%	5%

* Percent cover based on surface area occupied, due to variations in plant heights and rounding estimates the total coverage can exceed 100%.

Photograph No. 1:
View of Shipley Swamp near vegetation plot A.

Photograph No. 2:
View of vegetation plot B.

Photograph No. 3:
View of vegetation plot C.



Photograph No. 4:
Use of underwater camera to view aquatic vegetation.