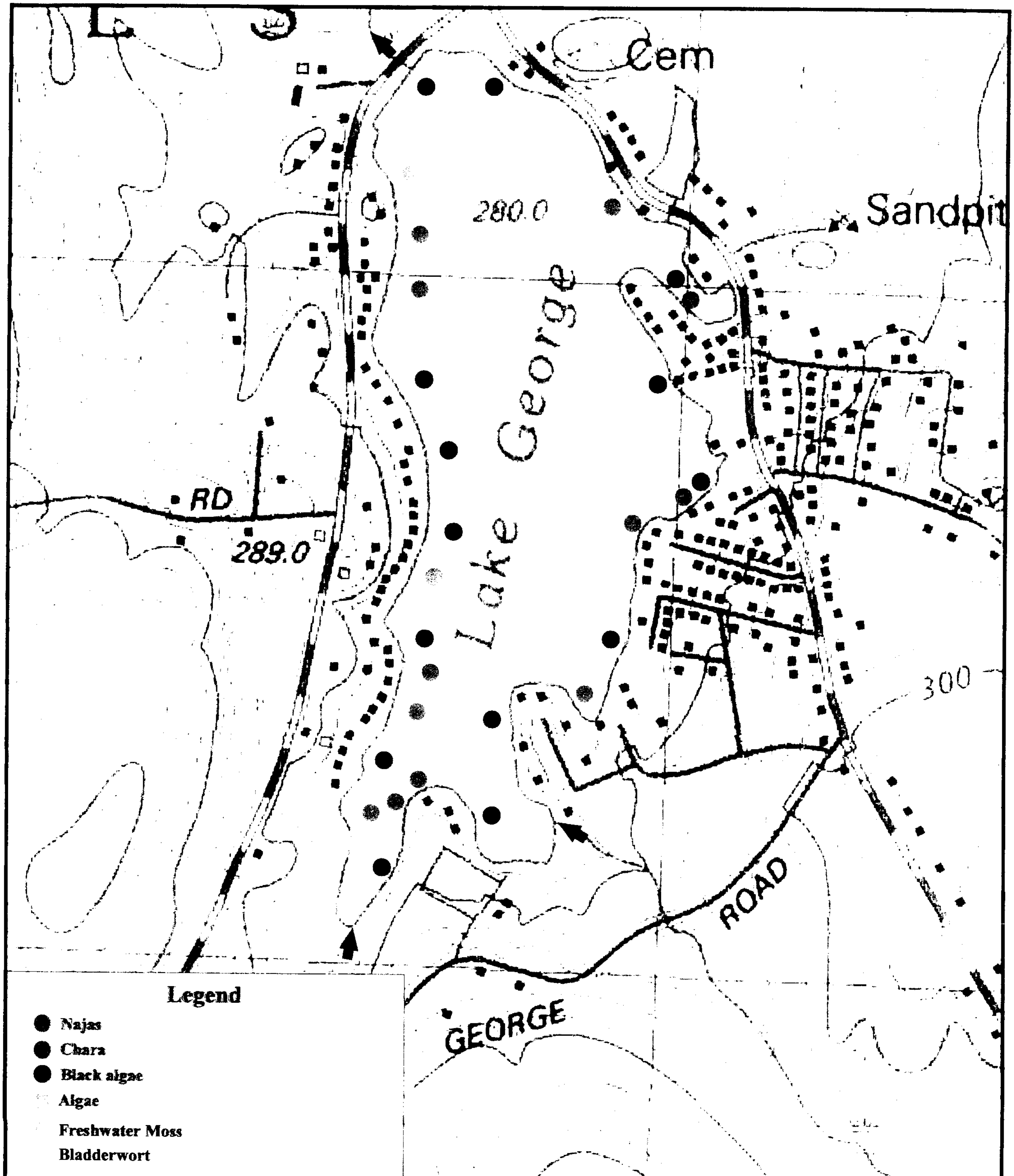

Lake George Study Committee Survey Map - July 2008

Lake George Wales, MA

Figure 2.

USGS Quadrangle
7.5-Minute Topos
MASSGIS Data

N

Lake Area: 93 Acres

Scale 1:7,680

0 — 1000 Feet

600 Charlton Street
Southbridge, MA 01550
Phone: (508) 765-0101
Fax: (508) 765-1352
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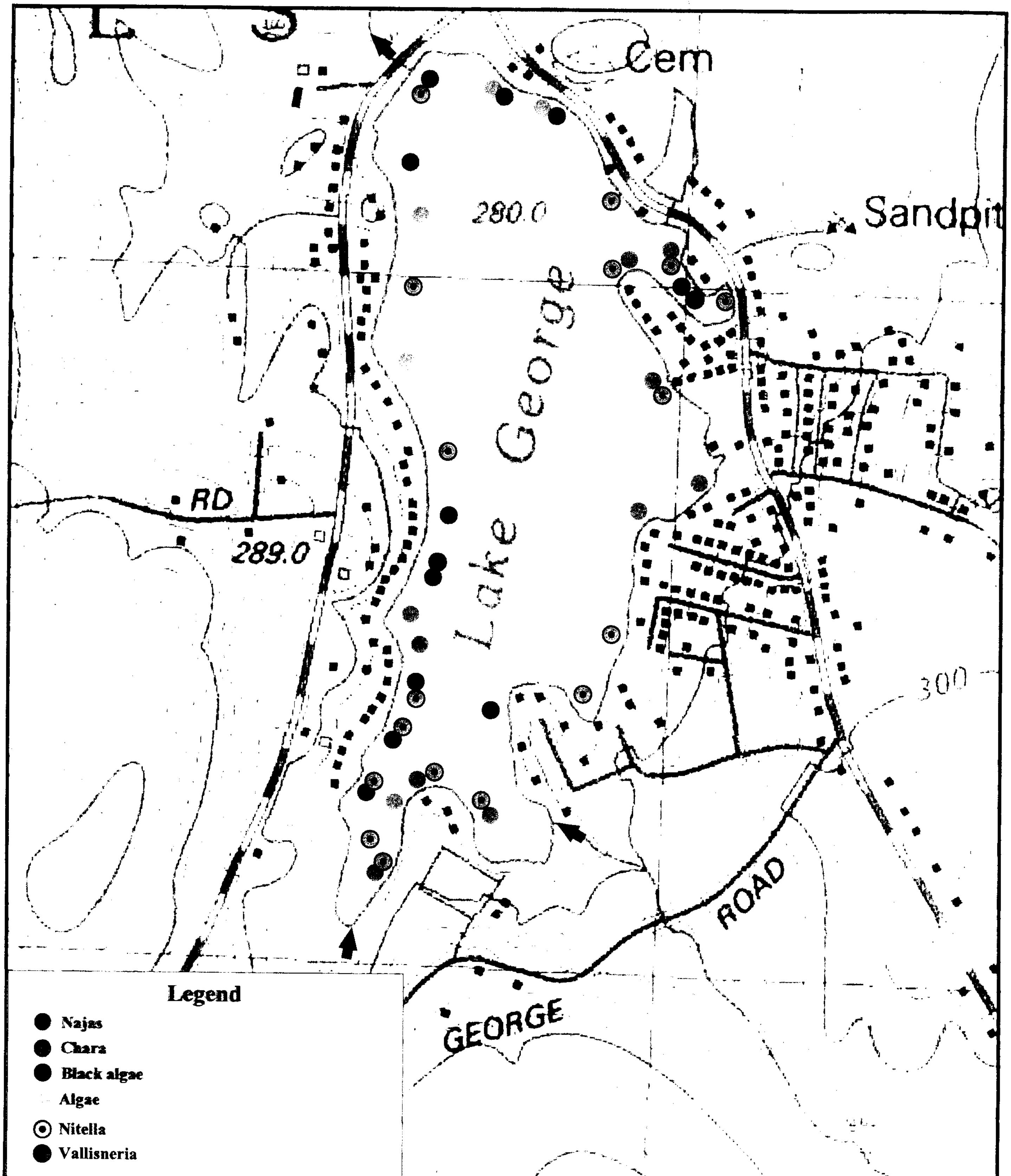

Legend

- Najas
- Chara
- Black algae
- Algae
- Nitella
- Vallisneria

Lake George Study Committee
Survey Map - August 2008

Lake George
Wales, MA

Figure 3.

USGS Quadrangle
7.5-Minute Topos
MASSGIS Data

Lake Area: 93 Acres

N

Scale 1:7,680

0 1000 Feet

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Table 1. Lake George Aquatic Vegetation Survey Table for August 2008

Location (Refer to Fig. 2,3)	**Water Depth** (Ft)	**Aquatic Type Observed** (P = Presence)					
		Algae	Black Algae	Chara	Najas	Nitella	Vallisneria
1	4			P		P	
2	4			P		P	
3	4			P		P	
4	4		P				
5	4					P	
6	4					P	
7	9			P			
8	9			P			
9	9			P		P	
10	10			P		P	
11	9			P		P	
12	4				P		P
13	3					P	
14	8					P	
15	10	P			P		
16	8	P			P		
17	11				P	P	
18	8				P		
19	8	P					
20	8					P	
21	8	P					
22	12					P	
23	12				P		
24	9				P		P
25	5			P			
26	8			P			
27	4				P	P	
28	5				P	P	
29	4				P	P	
30	3					P	
31	3					P	

Appendix B: MassGIS website: Maps of Lake George region.

The Massachusetts GIS database (http://www.mass.gov/mgis/massgis.htm) was accessed in order to obtain information related to Lake George. The Figures in Appendix B represent some of that information.

Figure B-1. Ortho Image View of Lake George
A more detailed view is used to create the maps of Appendix A. Those maps provide the detail needed to conduct aquatic vegetation surveys and treatment planning.

Figure B-2. USGS Topographic Map – Area around Lake George
This map was used to assess the watershed area surrounding Lake George and how the tributaries entering into the Southeast and southern coves of Lake George are affected by areas south and southeast of the lake.

Figure B-3. Water Supply Protection Area Map.
This map was used to confirm that Lake George is in the Quinebaug basin area but that the lake is not in a water supply protection area.

Figure B-4. DEP Priority Resource Map – Lake George Region
This map was used to confirm that Lake George is not in a Priority Resource area.

In addition, a back and white orthophoto view from MassGIS for the Lake George area was generated and all the selectable Natural Heritage Data layers were added to that view. The illustration below identifies the nearest Natural Heritage areas in relation to Lake George: BioMap Core Habitat (185 meters, avg), Priority Habitat (479 meters), and Living Waters Critical Supporting Watershed (738 meters). This confirms that Lake George is not in any of the Natural Heritage Data core habitat concern areas.

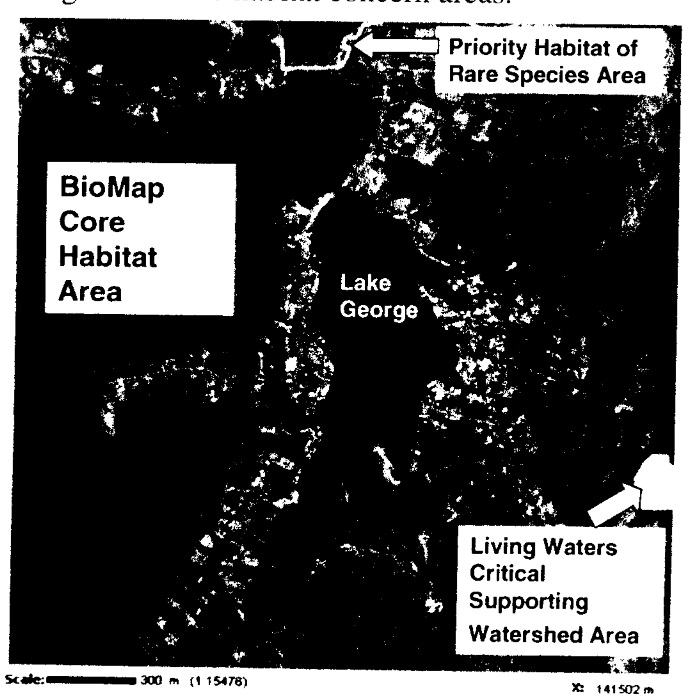


Figure B-1. Ortho Image View of Lake George.

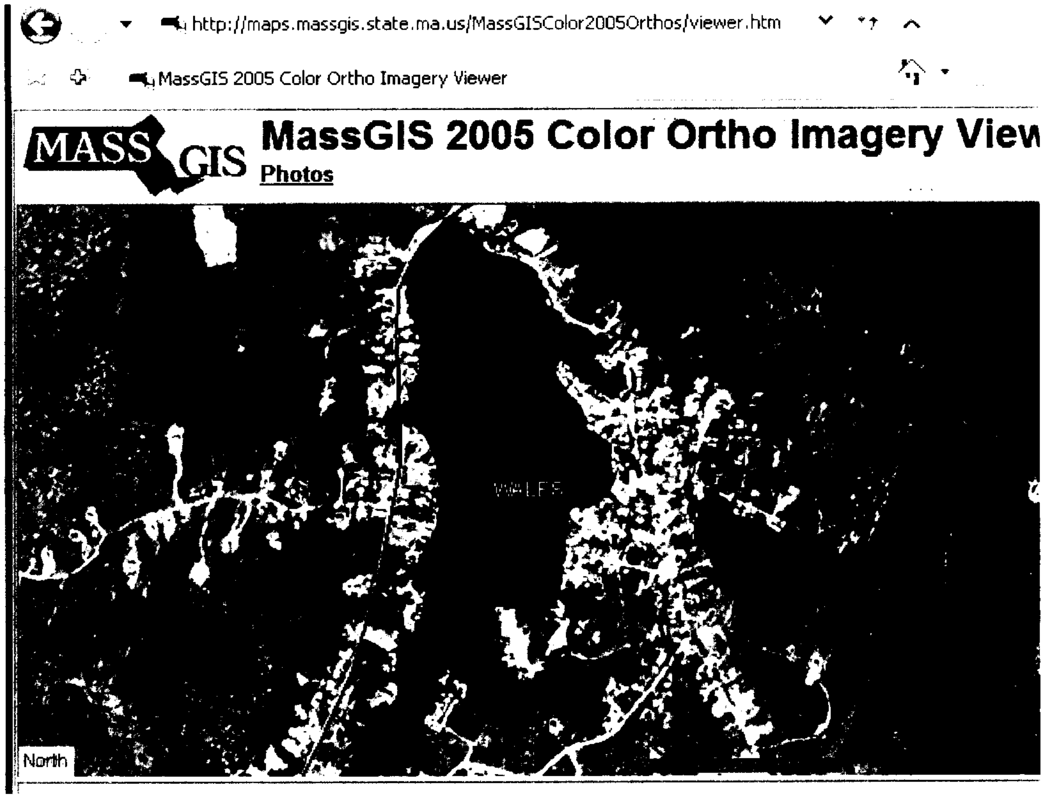


Figure B-2. USGS Topographic Map – Area around Lake George.

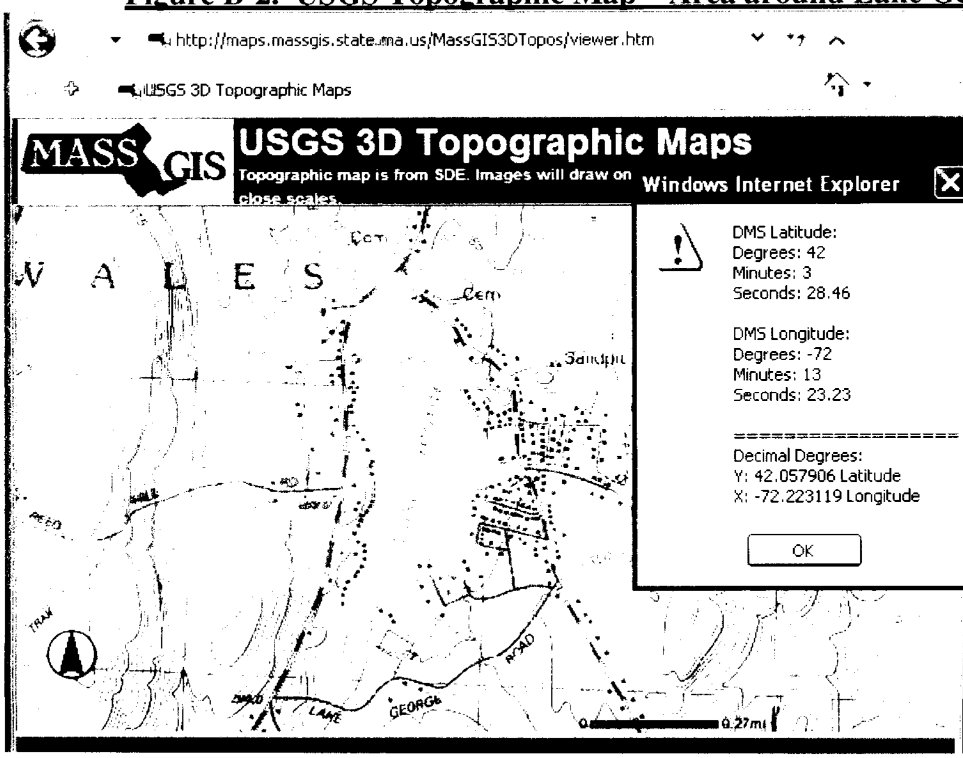
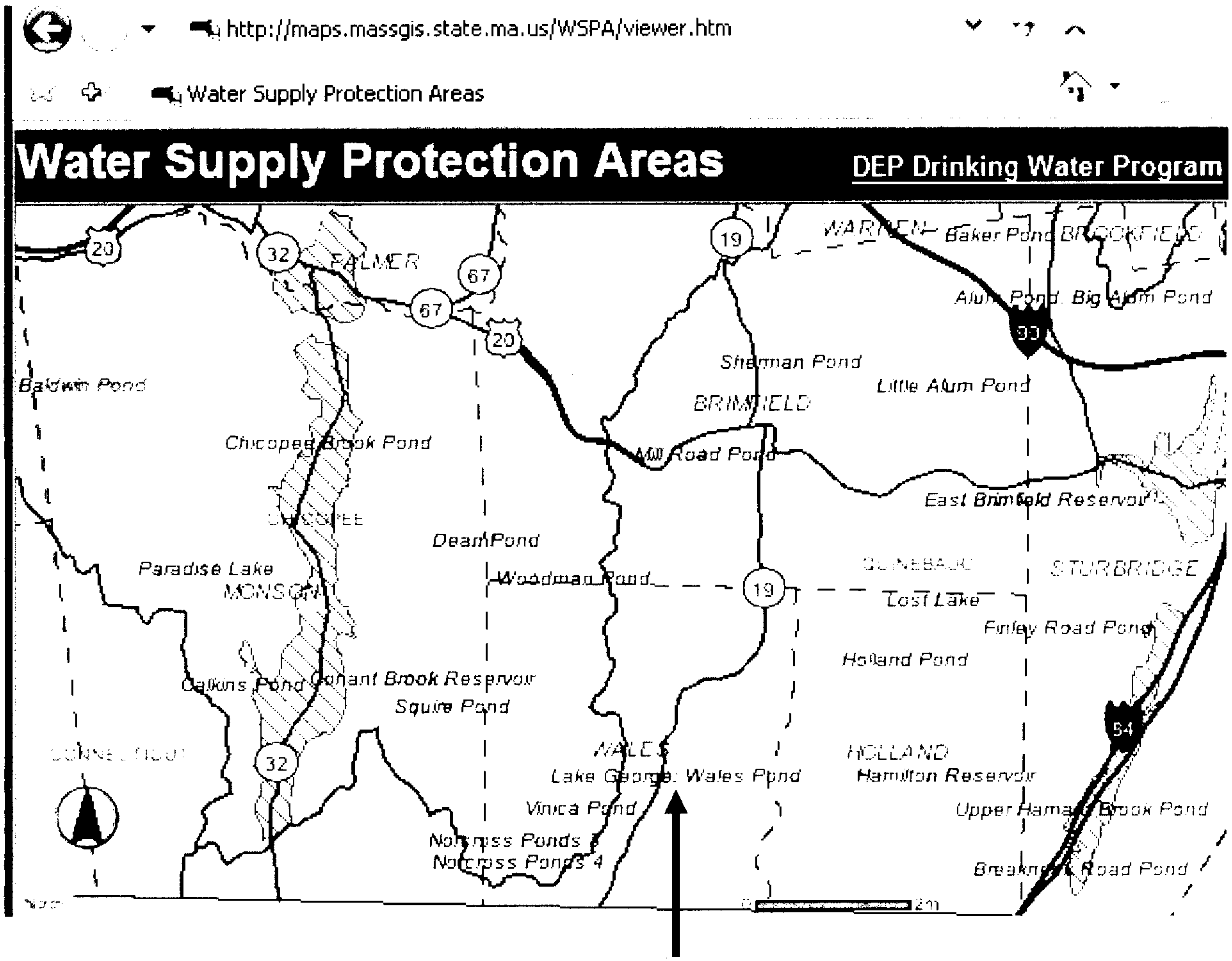


Figure B-3. Water Supply Protection Area Map.



Lake George

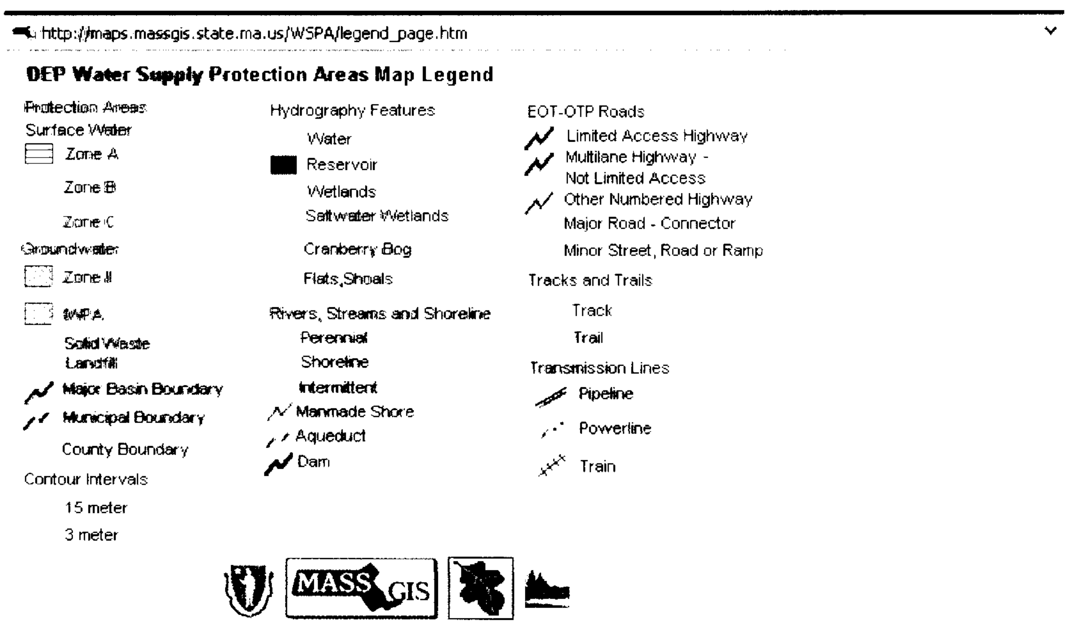
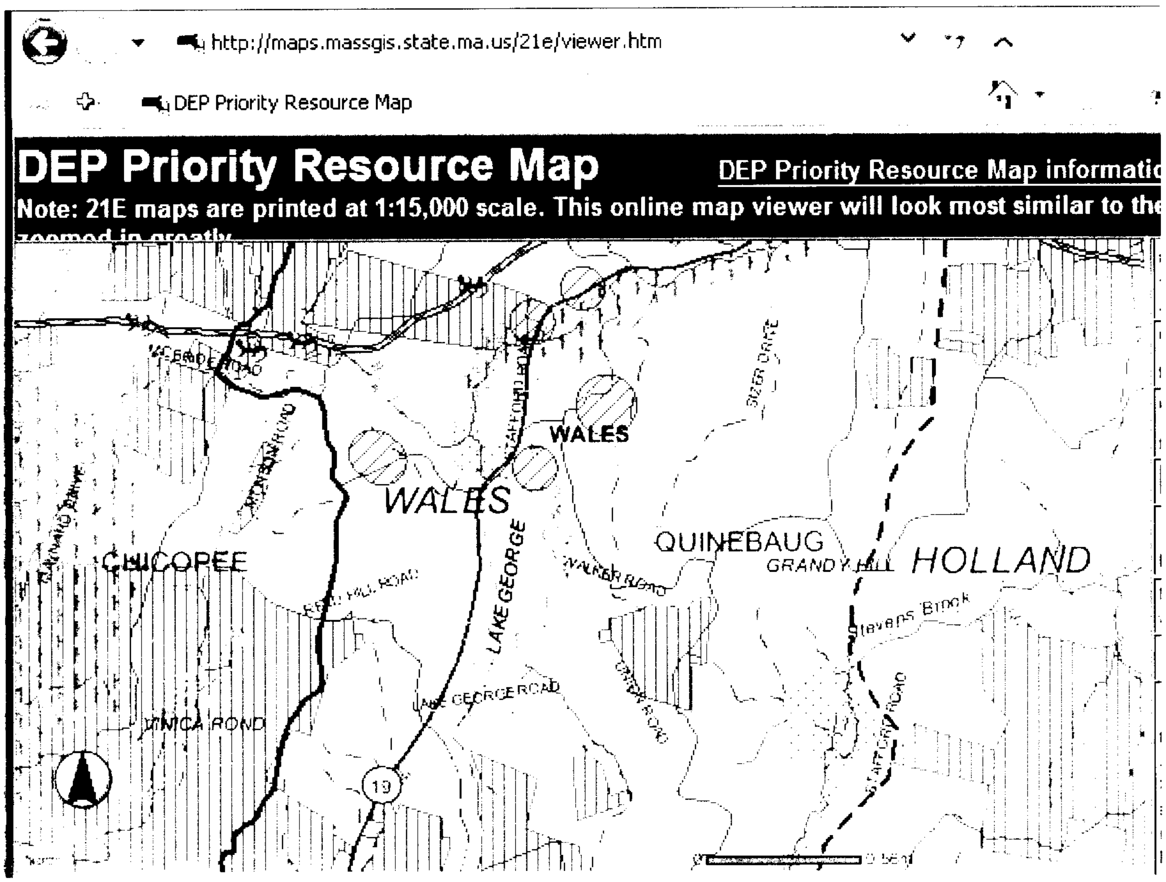
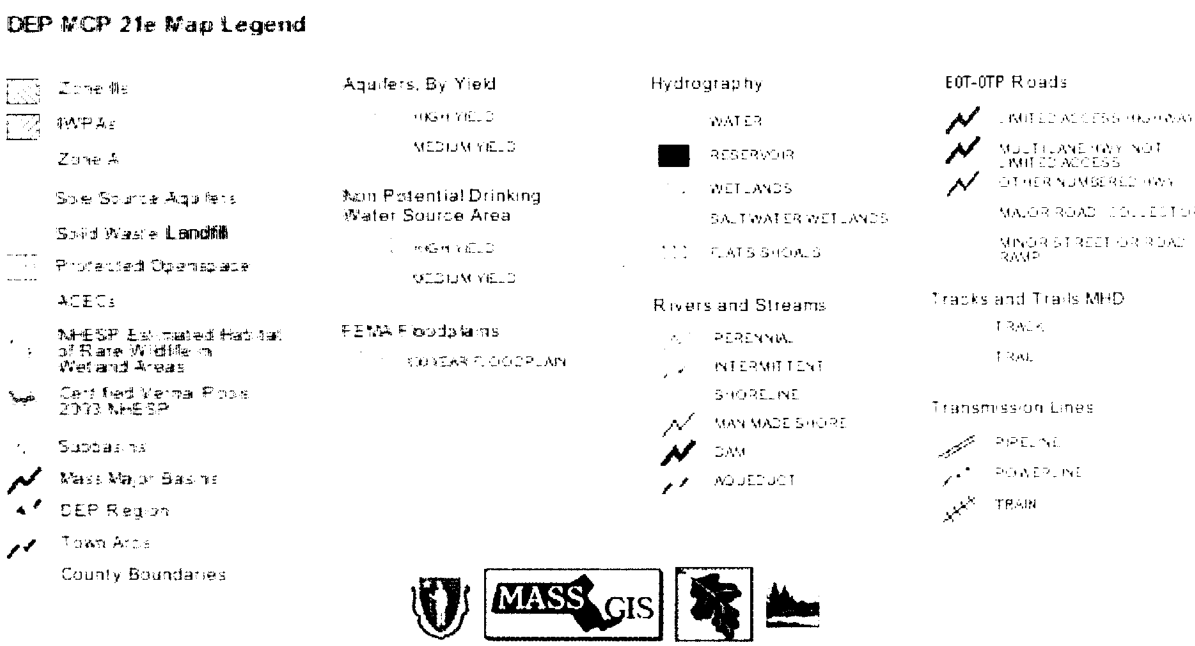


Figure B-4. DEP Priority Resource Map – Lake George Region





Appendix C: Lake George Water Quality Data

Table 2-1 on the following page (Lake George Water Quality Sampling Resuts) was taken from a report compiled in Yr 2004. The other tables in Appendix C was compiled by the Lake George Study Committee in order to identify potential sources supplemental details regarding nutrients in a lake (not just Lake George) and to help interpret the data of Table 2-1.

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Table 2-1 - Lake George Water Quality Sampling Results

Parameters	Units	Standards *	Sampling Locations			
			Causeway	Lake Shore Dr	Shore Dr	Outlet
pH		6.5-8.3	6.97	6.73	6.93	6.64
Conductivity	uS/cm	- -	158.9	154.3	144.5	149.2
Temperature	C	< 28	21.4	22.1	21.5	22.2
Alkalinity		- -	19.0	21.0	20.0	21.0
BOD		- -	ND	ND	ND	ND
Nitrate		- -	ND	ND	ND	ND
Ammonia		- -	ND	ND	ND	ND
Total Nitrogen	mg/l	0.092	1.00	1.40	0.800	2.20
Total Phosphorus	mg/l	0.025	0.026	0.015	0.016	0.016
Total Solids		- -	113	106	102	106
Color		- -	45	45	45	45
Total Coliform	Organisms/ 100 ml	1,000	3,500	4,200	800	7,000
Fecal Coliform	Organisms/ 100 ml	200	30	60	30	1,000

* Listed standards were derived from 314 CMR 4.00: Massachusetts Surface Water Quality Standards, with the exception of the standard for total coliform. This value originated in the USEPA's "Quality Criteria for Water 1976."

Lake Water Quality

Significant material taken from: "Understanding Lake Data" http://www.dnr.state.wi.us/org/water/fhp/lakes/under/index.htm#carb

Category	Measurement	Chemical Symbol	Source(s)	Additional Detail
Clarity	Total Solids	None		
	Color	None		
	Secchi Disk	None		
Algae/Plant Growth	**Nutrients:**			
	Nitrate	NO3-	Nitrogen is second only to phosphorus as an important nutrient for plant and algae growth. A lake's nitrogen sources vary widely. Nitrogen compounds often exceed 0.5 mg/l in rainfall, so that precipitation may be the main nitrogen source for seepage and some drainage lakes. In most cases, however, the amount of nitrogen in lake water corresponds to local land use. Nitrogen may come from fertilizer and animal wastes on agricultural lands, human waste from sewage treatment plants or septic systems, and lawn fertilizers used on lakeshore property. Nitrogen may enter a lake from surface runoff or groundwater sources.	Nitrogen exists in lakes in several forms. Analysis usually includes nitrate (NO3-) plus nitrite (NO2-), anunonium (NH4+), and organic plus ammonium (Kjeldahl nitrogen). Total nitrogen is calculated by adding nitrate and nitrite to Kjeldahl nitrogen. Organic nitrogen is often referred to as biomass nitrogen. Low nitrogen levels do not guarantee limited algae growth in the same way low phosphorus levels do. Nuisance blue-green algae blooms are often associated with lakes that have low nitrogen to phosphorus (N:P) ratios. Nitrogen does not occur naturally in soil minerals, but is a major component of all organic (plant and animal) matter. Decomposing organic matter releases ammonia, which is converted to nitrate if oxygen is present. This conversion occurs more rapidly at higher water temperatures. All inorganic forms of nitrogen (NO3-, NO2- and NH4+) can be used by aquatic plants and algae. If these inorganic forms of nitrogen exceed 0.3 mg/l (as N) in spring, there is sufficient nitrogen to support summer algae blooms.
	Ammonia	NH4		
	Total Nitrogen	N		
	Total Phosphorus	P	Phosphorus originates from a variety of sources, many of which are related to human activities. Major sources include human and animal wastes, soil erosion, detergents, septic systems and runoff from farmland or lawns.	Phosphorus promotes excessive aquatic plant growth. In more than 80% of Wisconsin's lakes, phosphorus is the key nutrient affecting the amount of algae and weed growth.

Category	Measurement	Chemical Symbol	Source(s)	Additional Detail
	Sodium	Na	Sodium is often associated with chloride. It finds its way into lakes from road salt, fertilizers, and human and animal waste.	Increasing sodium and potassium values over time can mean there are long-term effects caused by pollution. Although not normally toxic themselves, these compounds strongly indicate possible contamination from more damaging compounds.
	Potassium	K	Potassium is the key component of commonly-used potash fertilizer, and is abundant in animal waste.	Some studies suggest there may be a link between certain algae and potassium concentrations. Other studies indicate potassium can be used to control Cyanobacteria Microcystis
	Mapping	None		Suggested monitoring plans: - Map the distribution of plant beds - Estimate the density - Collect specimens for professional identification
Acidification	pH An index of lake water's acid level,	H+	Acid Rain	pH is an important component of the carbonate system. It is the negative logarithm of the hydrogen ion (H+) concentration and therefore inversely related to the amount of hydrogen ion in the water. The measure of the hydrogen ion (acid) concentration in water is called pH. A pH of 7 is neutral. Values above 7 are alkaline or basic. Those below 7 are acidic. A change of 1 pH unit is a tenfold change in acid level.
	Alkalinity	$2CO_3$	Minerals in the soil and watershed bedrockgroundwater from aquifers containing limestone minerals such as calcite (CaCO3) and dolomite (CaMgCO3),	provides acid buffering
Oxygen Concentration	Oxygen	O_2	The most important of the gases, since most aquatic organisms need it to survive. The solubility of oxygen and other gases depends on water temperature. The colder the water, the more gases it can hold. Boiling water removes all gases.	Dissolved oxygen: The EPD proposed standard is: a daily average of 5.0 mg/l and no less than 4.0 mg/l at all times at one meter depth.

Category	Measurement	Chemical Symbol	Source(s)	Additional Detail
Pollution	Bacterial: Total Coliform		A group of bacteria pronominally inhabiting the intestines of man or animals but occasionally found elsewhere	
	Bacterial: Fecal Coliform		Subgroup of the total coliforms and are associated with with fecal matter of warm-blooded animals. The fecal coliform count is an indicator of pollution of water by human and animal/waterfowl excrement and hence the risk of gastrointestinal illness to swimmers.	If values fluctuate dramatically or exceed the value of 200 fecal coliforms per 100ml. of water, or there is some evidence of beach contamination, samples may be taken as often as daily until the problem resolves.
	Sulfate		Sulfate in lake water is primarily related to the types of minerals found in the watershed and to acid rain. Industries and utilities that burn coal release sulfur compounds into the atmosphere that are carried into lakes by rainfall.	In water depleted of oxygen (anaerobic water), sulfate can be reduced to hydrogen sulfide (H2S). Hydrogen sulfide gas smells like rotten eggs and is toxic to aquatic organisms.
	Cyanobacteria		Cyanobacteria are aquatic and photosynthetic, that is, they live in the water, and can manufacture their own food. Because they are bacteria, they are quite small and usually unicellular, though they often grow in colonies large enough to see. Cyanobacteria are often called "blue-green algae". This name is convenient for talking about organisms in the water that make their own food, but does not reflect any relationship between the cyan bacteria and other organisms called algae. Cyanobacteria are relatives of the bacteria, not eukaryotes, and it is only the *chloroplast* in eukaryotic algae to which the cyanobacteria are related.	. Blue-green algae can form when warm surface water temperatures and calm winds limit vertical mixing of the lake water. These conditions, together with abundant phosphorus, can contribute to blue-green algae growth patterns that produce neurotoxins and prompt local human health concerns. (The chloroplast with which plants make food for themselves is actually a cyanobacterium living within the plant's cells)

Appendix D: Hydro-Raking

Hydro-Raking in Lake George is conducted in accordance with DEP permit, the most recent one being file #313-82.

The hydro-rake is designed to work along the shoreline up to a depth of 12 feet, and remove nuisance aquatic weeds and debris. The machine begins at the shoreline and works in reverse out into the depths of the water. When the rake is full, the load of debris is deposited on the shore behind a silt barrier, thus preventing its return to the water. Final removal of the raked material and the silt barrier from the shoreline is to occur within a reasonable period of time – ideally with 48 hours. An area of 50 x 50 feet cam be raked in approximately one hour, however, this is dependent on the density and type of aquatic weeds as well as bottom conditions. Annual raking is strongly encouraged in order to keep the area under control.. Reference (5)provides an example of this process that is used throughout New England and New York state.

The general timeframe for hydro-raking should be either early spring or mid-to-late summer, so as to avoid the peak fish spawning periods between late April and mid-July when the water temperature between 50 and 75 degrees F promotes this activity.

Table D-1 identifies the locations and approximate square footage areas Hydro-Raked in Lake George between Year 2004 and Year 2008. During that time, seventeen different locations have been involved in this activity, with an average of eight locations per year paying for this service. The yearly square footage figures are a function of how quickly vegetation returns to a particular region. Sq-Ft totals in Yr 2004 and 2005 were likely influenced by the lack of Hydro-raking activity in the prior 3-4 years. On average, 27,000 square feet (0.62 acres) of area, or less than 1% of the lake area, is addressed by hydro-raking. Figure D-1 illustrates the limited regions involved in hydro-raking activities.

	Location	**2004**	**2005**	**2006**	**2007**	**2008**
1	4 Birch Street	2500	2500	2500	2500	2500
2	40 Fountain Rd	7500			2500	5000
3	4 Grove Point	10000	15000			
4	6 Grove Point					
5	11 Grove Point	2500	2500			
6	15 Grove Point	2500	2500	2500		2500
7	42 Lake George Rd	7500	10-12500	10000	6250	5000
8	3 Shore Drive			2500		
9	23 Shore Drive		2500			2500
10	25 Shore Drive			2500		
11	27 Shore Drive		5000	2500		
12	35 Shore Drive	5000	2500		3750	
13	43 Shore Drive		2500			
14	47 Shore Drive			2500	2500	5000
15	49 Shore Drive	2500		2500	2500	2500
16	31 Union Rd			2500		
17	Lakeland Beach Club				2500-5000	2500
	Yearly Totals (Sq-Ft)	**40,000**	**47,500**	**30,000**	**25,000**	**27,500**

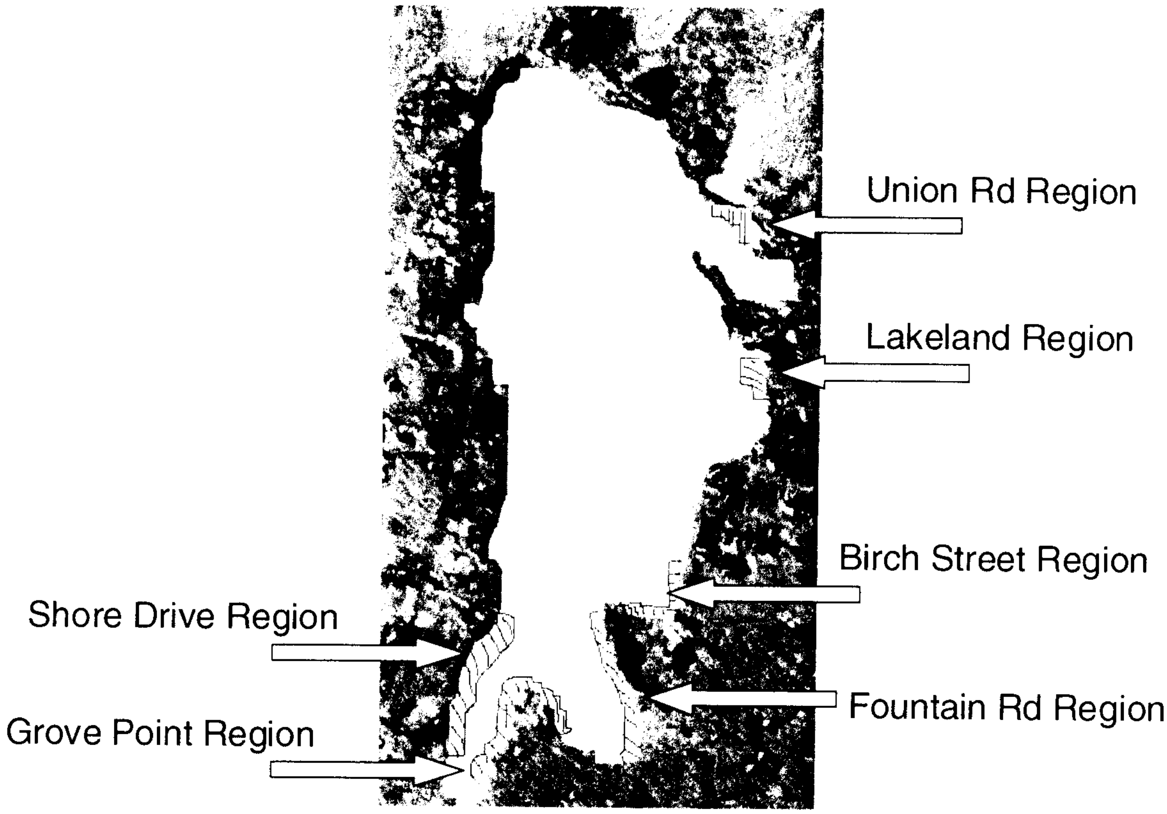

Figure D-1 - Lake George Regions involved in hydro-Raking

Appendix E: Algae: Information & Lake George Photo's

What are Algae?

Algae are primitive aquatic plants. These simple plants differ from other plants by lacking true stems, leaves or roots. Algae are a basic component of a complex aquatic food web, converting the sun's energy into a form useful to other aquatic life. Algae are also a primary source of dissolved oxygen, which is a byproduct of their energy production.
Algae occur in three basic forms: planktonic, filamentous and macrophytic.

Planktonic algae are single-celled, microscopic plants that float freely in the water. When these plants are extremely abundant or "bloom," they make the pond water turn green. Less often, they can turn the water other colors, including yellow, gray, brown or red.

Filamentous algae is sometimes referred to as "pond moss" or "pond scum." Filamentous algae occurs as fine green threads that form floating mats, which are often moved around the pond by wind. This type of algae is also commonly found attached to rocks, submerged trees, other aquatic plants and boat docks.

Macrophytic algae resemble true plants in that they appear to have stems and leaves, and are attached to the bottom. The most commonly occurring macrophytic algae in Missouri is called *Chara* or musk grass (due to its strong musky odor.) *Chara* feels coarse to the touch, because of lime (calcium carbonate) deposits on its surface, earning it another common name -- stonewort.

Algae Control

Algae problems are usually caused by an overabundance of nutrients (nitrogen and phosphorous) in the pond. From the moment a pond is built, it becomes a settling basin for nutrients washing in from the land that drains into it (the pond's watershed). The older a pond gets the more nutrients it has accumulated and the more susceptible it is to algae problems.

Runoff from fertilized fields, lawns and pastures, or from feedlots, septic tanks and leach fields accelerates nutrient loading and algae growth in the pond. If the pond is old and has become shallow due to accumulation of black muck on the bottom, it may be necessary to drain, dry and deepen the pond. Excavated material should be removed from the pond's watershed.

Factors that Affect Algal Growth

There are a number of environmental factors that influence algal growth. The major factors include:

- the amount of light that penetrates the water (determined by the intensity of sunlight, the amount of suspended material, and water color);
- the availability of nutrients for algal uptake (determined both by source and removal mechanisms);
- water temperature (regulated by climate, altitude, et cetera);
- the physical removal of algae by sinking or flushing through an outflow;
- grazing on the algal population by microscopic animals, fish, and other organisms;
- parasitism by bacteria, fungi, and other microorganisms; and
- competition pressure from other aquatic plants for nutrients and sunlight.

It is a combination of these and other environmental factors that determines the type and quantity of algae found in a lake. It is important to note, however, that these factors are always in a state of flux. This is because a multitude of events, including the change of seasons, development in the watershed, and rainstorms constantly create "new environments" in a lake.

These environmental changes may or may not present optimal habitats for growth or even survival for any particular species of algae. Consequently, there is usually a succession of different species in a lake over the course of a year and from year to year.

The Overgrowth of Algae

Excessive growth of one or more species of algae is termed a *bloom*. Algal blooms, usually occurring in response to an increased supply of nutrients, are often a disturbing symptom of cultural eutrophication.

Blooms of algae can give the water an unpleasant taste or odor, reduce clarity, and color the lake a vivid green, brown, yellow, or even red, depending on the species. Filamentous and colonial algae are especially troublesome because they can mass together to form scums or mats on the lake surface. These mats can drift and clog water intakes, foul beaches, and ruin many recreational opportunities.

Citizen programs designed to monitor the algal condition of a lake usually require to measure:

- the water clarity;
- the density of the algal population; and
- the concentration of the critical algal nutrient, phosphorus.

Algae In Lake George

The photos on the following page were taken from 4 Grove Point, looking southwest. The photos were taken in late September and clearly show the effect of excess algae in the lake. The brown-green differences in water color are due to segmentation between algae-laced water and water containing a high concentration of tannic acid (caused by decaying leaves) as the algae was being blown into the south cove from winds out of the north.

Algae Control Plan for Lake George

The Lake Study Committee is intending to conduct periodic water quality sampling in the coming year, in order to establish a nutrient baseline for the lake. We intend to use this information in the hope of reducing the suspect nutrients that may be contributing to Algae growth in Lake George.

Photos of Planktonic algae in Lake George – Refer to previous page for details.

Lake Management Plan for Lake George (09 March 2009): Summary

	Goal	Recommendation: Achieve goals by: Drawdown	Hydro-raking	Chemical Treatment	Minimize external nutrient loading
1	**Improve the natural capacity of the resource area** by controlling nuisance vegetation	• Allows beach clean up • Potential freezing of vegetation	•Directly benefits this goal…limited scope (< 1% of the lake body)	•Directly benefits this goal…limited scope (< 20% of the lake body)	• May facilitate the reduction of some forms of vegetation. However, will not, by itself, achieve the goal.
2	**Preserve & advance flood control & storm damage prevention** in the watershed area	• Directly benefits these goals	• Insignificant contributor	• Insignificant contributor	• Insignificant contributor
3	**Maintain/ improve water quality** by limiting pollution into Lake George	• Facilitates locating potential sources (aka, septic systems)	• Insignificant contributor	• Insignificant contributor to achieving goal. No negative effects identified.	• Directly benefits this goal – greatest opportunity for improvement – will require coordination between BoS, ConCom, BoH, LSC