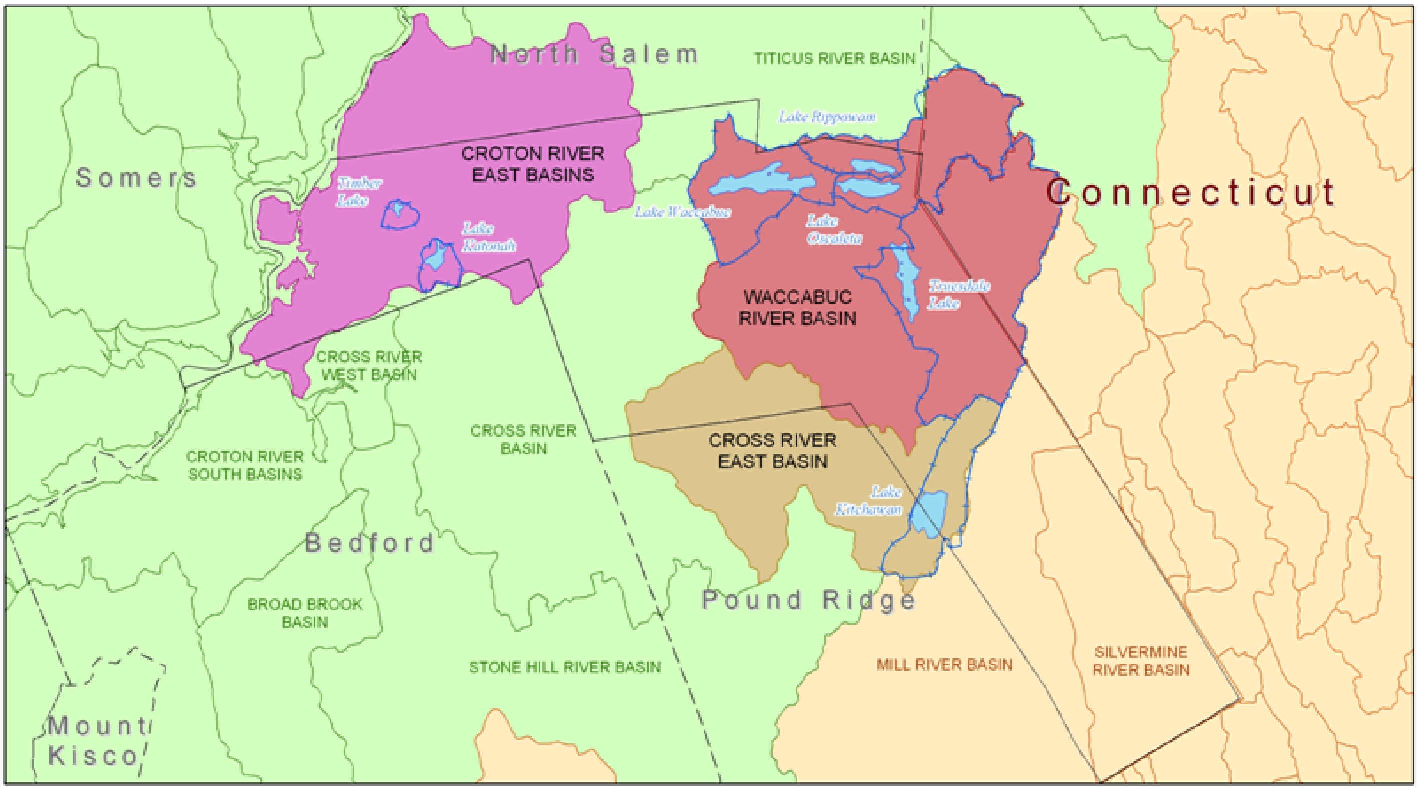
REPORT



Town-wide Comprehensive Lakes Management Plan

Town of Lewisboro, New York

Edward Brancati, Town Supervisor

Final Report

FEBRUARY 6, 2009

EcoLogic

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1. Introduction

1.1. Objectives

In August 2007, EcoLogic entered into an agreement with the Town of Lewisboro to develop a planning document outlining management of the lakes and watershed areas within the Town. Four specific objectives were cited:

- Create a central repository of natural resource data, statistics, and testing data for each of the lakes in the Town;
- Summarize each lake's water quality and environmental concerns;
- Recommend the most logical, environmentally sound, and cost-effective sequence of projects to improve and maintain water quality throughout the Town;
- Synthesize and collate all the studies on each of the lakes.

Additional data gathering and evaluation tasks were included to meet the overall objectives. This document – *Town-Wide Comprehensive Lakes Management Plan* - summarizes the water quality and aquatic habitat conditions of seven lakes in the Town of Lewisboro, and recommends measures for their protection and restoration.

1.2. Report Organization

The Town-wide Lakes Management Plan is organized into ten sections. Sections 1, 2 and 3 are composed of this introduction, a summary of the environmental settings of the lakes, followed by "Fact Sheets" for each lake. These fact sheets may be used as reference material for the lake associations. Sections 4 and 5 discuss the water quality issues on a Town-wide basis, identify the pollutant(s) of concern and their source(s), and identify reductions needed to meet restoration goals. Sections 6, 7, 8 and 9 synthesize management options, set forth recommendations and potential sources for funding, and identify priority actions for the Town of Lewisboro. Section 10 details the references used to create this report.

1.3. The importance of phosphorus in the lake ecosystem

1.3.1. Eutrophication

Eutrophication is the term that describes both the process and the effects of enrichment of surface water systems (including lakes, estuaries, and reservoirs), and it is a major water quality issue. Aquatic systems become increasingly enriched with plant nutrients, organic matter, and silt, resulting in increased biomass of algae and plants, reduced water clarity, and ultimately, a reduction in volume. Aesthetic quality and habitat conditions are degraded, and surface waters may lose suitability for recreational uses and water supply as eutrophication proceeds. The composition and abundance of the aquatic biota may be altered.

While eutrophication is a natural process, it can be greatly accelerated by human activities. There are numerous lakes included in state compendia of impaired waters; most are listed due to excessive nutrient inputs from nonpoint sources such as agricultural runoff and (less frequently) point sources such as outfalls of wastewater treatment facilities.

Water resources managers focus on identifying and controlling the sources of nutrients, organic material, and silt to aquatic ecosystems in an effort to slow down the eutrophication process.

Phosphorus is most often the limiting nutrient for primary productivity and algal biomass in inland lakes of the Northeast. A limiting nutrient is one that is essential for algal growth, but can be present in amounts smaller than required. Once the limiting nutrient (phosphorus) is exhausted, the algal community stops growing. If more phosphorus is added, algal growth will continue until growth is again limited by lack of phosphorus or by other limiting environmental factors (example, decreased sunlight and/or temperature). This finding has focused lake restoration and management techniques on controlling the concentration of phosphorus and has led to significant improvements in many systems. However, Cooke et al. (1993) point out that many lakes are shallow, with extensive wetlands, littoral zones, and macrophyte communities. The complexity of nutrient flux and food web interactions at the sediment-water interface in highly productive shallow regions of lakes cannot be ignored. Nutrient cycling and biological interactions in shallow weedy sections of the Lewisboro Lakes may contribute to maintaining elevated nutrient levels and undesirable plant growth long after external loading is reduced.

1.3.2. Trophic States

Eutrophication, defined as enrichment of lakes with nutrients and the effects of this enrichment, occurs along a continuum. Lakes progress from a nutrient-poor, clear water state (*oligotrophic*) through an intermediate state of higher biological productivity (*mesotrophic*) and eventually to a nutrient rich condition of very high biological productivity (*eutrophic*). *Hypereutrophic* lakes are turbid lakes, closest to the wetland status. However, lakes may exist in a trophic equilibrium for decades or centuries. When human activities accelerate the eutrophication process, it is termed *cultural eutrophication*.

Limnologists and lake managers have developed guidelines to define the transition between trophic states based on phosphorus, water clarity, chlorophyll-a, and deep water dissolved oxygen concentrations (Table 1-1). Assigning a lake to one category requires professional judgment that considers the cumulative evidence of water quality conditions and the level of productivity.

Table 1-1. Trophic states and indicator parameters

	Oligotrophic	**Mesotrophic**	**Eutrophic**	**Hypereutrophic**
Average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75
Average Secchi disk transparency (meters)	>6	6-3	3-1.5	<1.5
Minimum Secchi disk transparency (meters)	>3	3-1.5	1.5-0.7	<0.7
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero

Source: Janus and Vollenweider 1981

2. Environmental Setting

Seven lakes are included in this evaluation and report: Truesdale Lake, Lake Kitchawan, Lake Katonah, the Three Lakes (Rippowam, Oscaleta and Waccabuc), and Timber Lake. Collectively referred to as the Lewisboro Lakes, the lakes range in size from 2.9 to 57 ha (7.2– 141 acres) (Table 2-1). Location of the lakes within the Town of Lewisboro is displayed in Figure 2-1. Water levels in three of the seven lakes – Truesdale, Katonah and Timber – are controlled by dam structures, whereas the remaining four lakes –Rippowam, Oscaleta, Waccabuc and Kitchawan – are not dammed.

Table 2-1. Summary of physical characteristics: Lewisboro Lakes.

Lake	Average Depth (m)	Max. Depth (m)	Surface Area (ha)	Number of Structures[a]
Waccabuc	7.1	13.4	57	235
Kitchawan	1.7	4.3	43	127
Truesdale	1.1	3.4	34	303[b]
Oscaleta	5.9	10.8	27	68[c]
Rippowam	4.1	6.1	15	46
Katonah	1.6	3.1	10	44
Timber	2.1	3.1	2.9	20

[a] Number of structures within 100 m of surface water in watershed; excludes areas of Truesdale and Oscaleta watersheds in Connecticut. Number of structures was obtained from digitized map created by Westchester County from aerial photographs taken in 2000 and 2004.
[b] Of total area within 100m of surface water in Truesdale watershed, approximately 27% is within Connecticut and no structures data were available.
[c] Of total area within 100m of surface water in Oscaleta watershed, approximately 57% is within Connecticut and no structures data were available.

The Lewisboro Lakes are distributed among three drainage sub-basins, which are part of the New York City water supply watershed (Figure 2-2):

Major Basin	**Lower Hudson River**		
Regional Basin	***Croton River***		
Sub-Basin	*Waccabuc River*	*Cross River East*	*Croton River East*
Lake Basins	Rippowam Oscaleta Waccabuc Truesdale	Kitchawan	Timber Katonah

2.1. Vegetative cover and land use

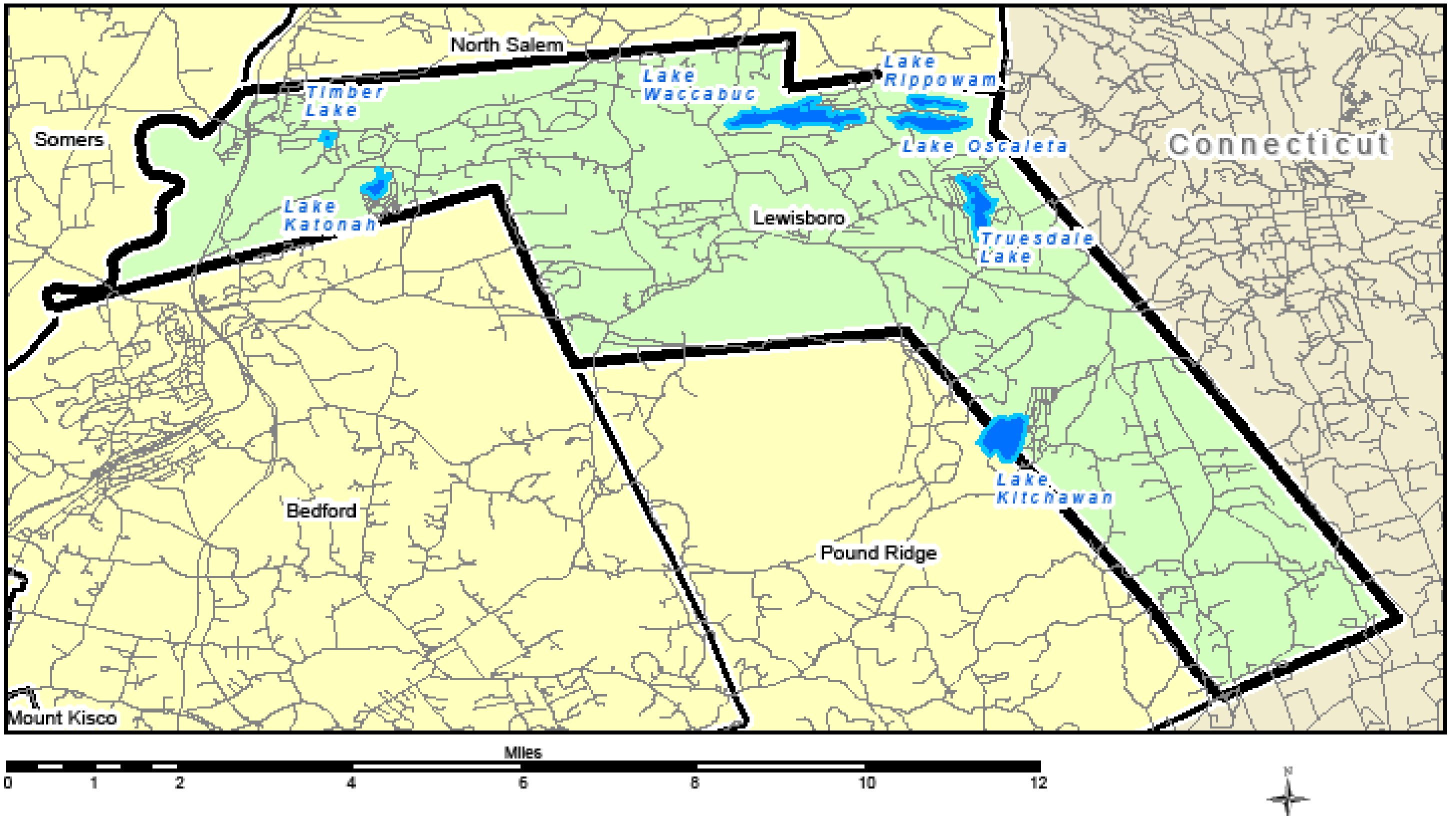
Nearly all the Lewisboro Lake watersheds had more than half of their area covered by Forest/Shrub class (Table 2-2). The exception was Lake Katonah, where the Developed class was dominant (48%). The Developed class was the second most common land cover class for four of the seven watersheds – Waccabuc, Truesdale, Kitchawan and Timber. The Forest/Shrub class was the second most common in the Lake Katonah watershed; and the Open Water class was the second most common in the Rippowam and Oscaleta watersheds.

Table 2-2. Watershed land cover class distribution, Lewisboro Lakes.

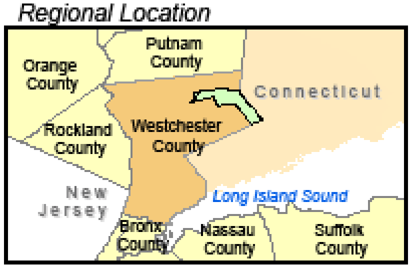
	Land Cover by Watershed (percent)						
Land Cover Classes	**Rippowam**	**Oscaleta**	**Waccabuc**	**Truesdale**	**Kitchawan**	**Katonah**	**Timber**
Open water	11	9.0	15	3.5	12	16	9.0
Developed*	6.8	5.4	26	15	20	48	43
Forest/Shrub**	73	78	53	67	51	36	46
Grassland/Pasture/Crops	0.86	1.9	3.4	4.3	1.2	--	--
Wetlands (woody/emergent)	7.9	5.4	2.7	10	16	--	2.1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: National Land Cover Dataset 2001
Shaded cells indicate the highest percentage for land cover class in each watershed.
*Developed – sum of three Developed classes: open space, low intensity and medium intensity.
*Forest/Shrub – sum of four classes: Forest Deciduous, Forest Evergreen, Forest Mixed, and Shrub/scrub.

Figure 2-1
Town Of Lewisboro Lakes



Regional Location

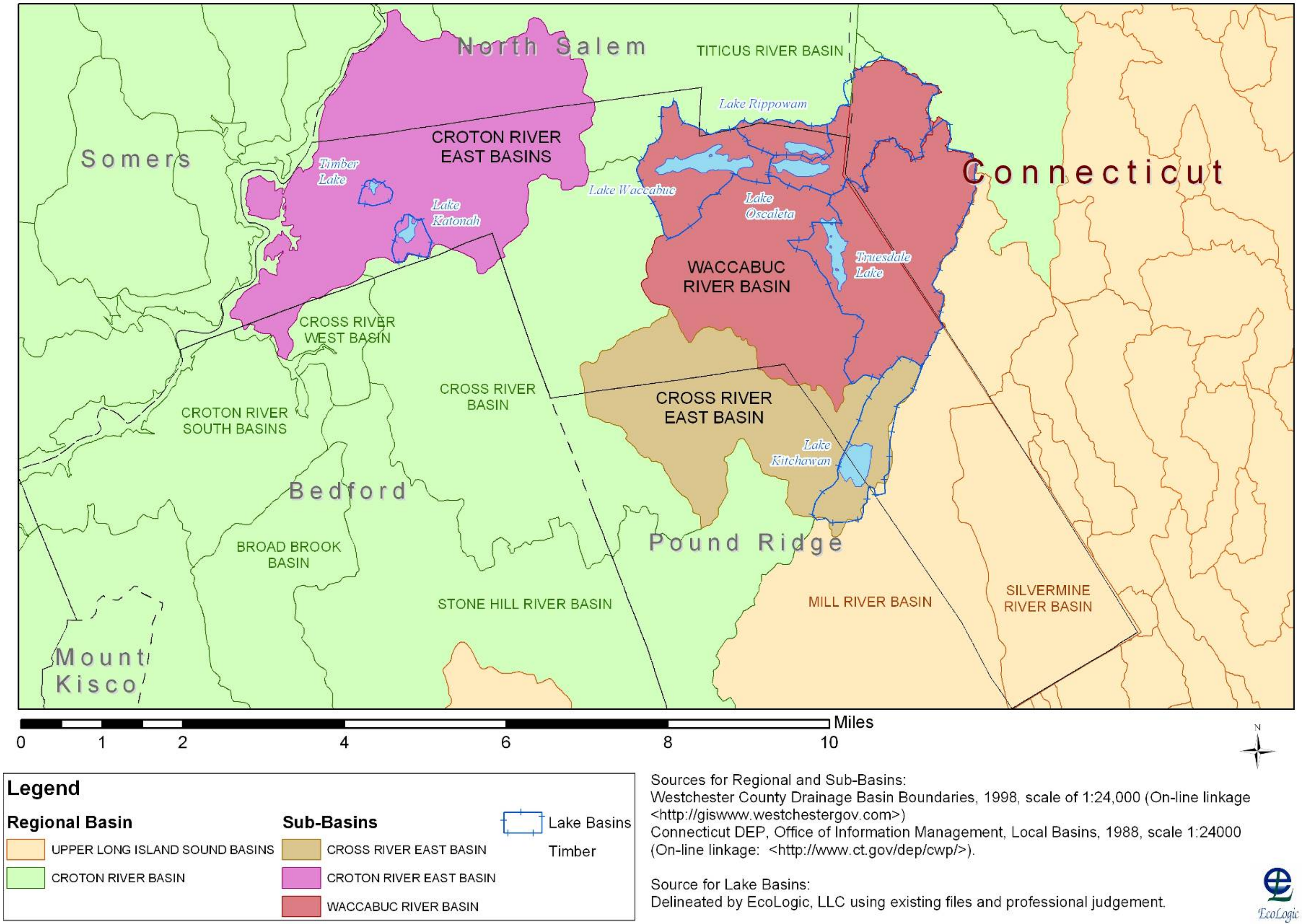


Legend

- Roads
- New York Town Boundaries
- Lewisboro Boundary
- Connecticut

Sources:
Borders: U.S. Department of Commerce U.S. Census Bureau Geography Division. Census Minor Civil Divisions, New York State (Shapefile : 2001).
CUGIR, the Cornell University Geospatial Information Repository, using US Department of Commerce, Bureau of the Census data, developed the GIS data set versions of 2000 Census TIGER/Line files for 12 coverages for each of the 62 counties in New York State.
Roads and lakes: Obtained from the Westchester County web site http://giswww.westchestergov.com/
Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

Figure 2-2
Town Of Lewisboro Drainage Basins



Sources for Regional and Sub-Basins:
Westchester County Drainage Basin Boundaries, 1998, scale of 1:24,000 (On-line linkage <http://giswww.westchestergov.com>)
Connecticut DEP, Office of Information Management, Local Basins, 1988, scale 1:24000 (On-line linkage: <http://www.ct.gov/dep/cwp/>).

Source for Lake Basins:
Delineated by EcoLogic, LLC using existing files and professional judgement.

2.2. Soils

Lewisboro is underlain by bedrock of the Manhattan Prong, which includes metamorphic gneiss, schist and carbonate rock (Leggette, Brashears & Graham, Inc.). The bedrock is generally covered by shallow surficial soils at higher elevations and thicker surficial soils in the valleys. This material predominantly consists of glacial till, composed of a very poorly-sorted mixture of sand, gravel, silt, clay and stones deposited directly by the glacial ice (Leggette, Brashears & Graham, Inc.).

The combination of shallow till soils and fairly steep slopes exacerbate rainfall runoff, increasing the potential for erosion and transport of sediment, nutrients and contaminants from upland areas into the lakes.

2.3. Fish and wildlife

The Town of Lewisboro has a significant amount of green space interspersed with residential development. This green space supports a diverse wildlife population including a number of State listed rare plant and animal species (see Fact Sheets for listing of species for each lake's watershed).

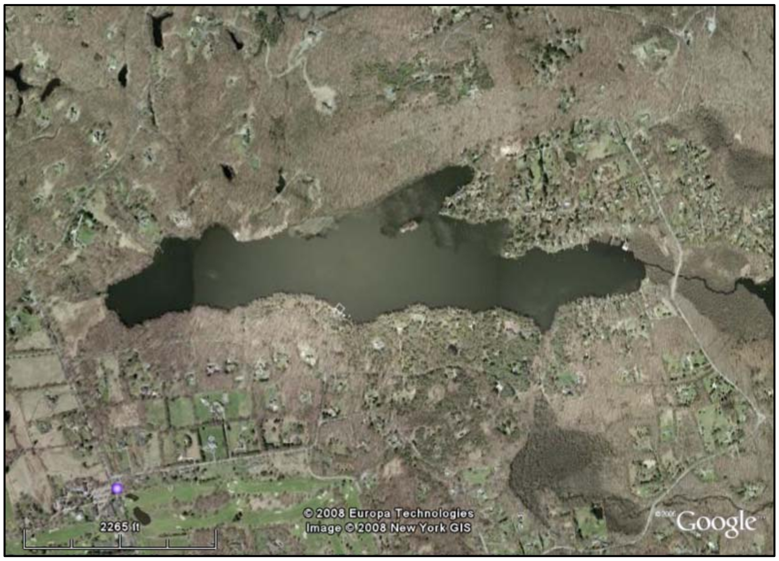
The lakes in Lewisboro support productive fish communities. Warmwater species, such as bass and sunfish, tend to be most abundant because of the shallowness of many of the lakes. The deeper lakes (Waccabuc, Oscaleta, and Rippowam) have historically supported both a warm and cold water (trout) fishery. Although some of the deeper lakes, such as Oscaleta, have been stocked with trout in recent years, the seasonal low dissolved oxygen concentrations in the deeper colder areas of the lakes has apparently led to significant declines in the coldwater fishery. This trend is likely to continue as the lakes continue to become increasingly eutrophic.

3. Lake Fact Sheets

A large amount of information has been collected by individual lake associations. This information has been summarized into fact sheets for each lake. This section presents a summary of lake and watershed characteristics for each lake. The page numbering system in this section is intended to allow each fact sheet to act as a standalone document that can be used by each lakes association. The fact sheets are ordered by surface area (largest to smallest).

3.1. Lake Waccabuc

Lake Waccabuc



Surface water quality classification: Class A

Morphology Summary:

Characteristic	Units	Value	Source
Surface area	hectares	56	Cedar Eden 2004
Watershed area	hectares	298	EcoLogic 2008 (excl lake)
Volume	mgal	3,696	Cedar Eden 2004
Elevation	m	144	NYSDEC 2007
Maximum depth	m	14.2	CSLAP Sampling
Average Depth	m	7.1	Cedar Eden 2004

Lake Inlet: at the eastern end via channel from Lake Oscaleta and two streams which drain the extreme northwest and southwest portions of the watershed. There are also more than ninety storm drains that flow into the lake. (Cedar Eden 2002).

Lake Outlet: Waccabuc River along the southeastern shore.

Recreational impacts: The limited recreational use impacts were associated with poor clarity and high algae levels. (NYSDEC 2007).

Lakeshore Development: High density residential development along the northeastern shore, in addition to a small cluster of homes along the southeastern end of the lake. For the most part, the northwest and southwestern shores are undeveloped, and include some conservancy land along the southwest shore. A steeply sloping ridge runs next to the lake along the central north shore (Cedar Eden 2002)

Figure 1
Lake Waccabuc
Bathymetry

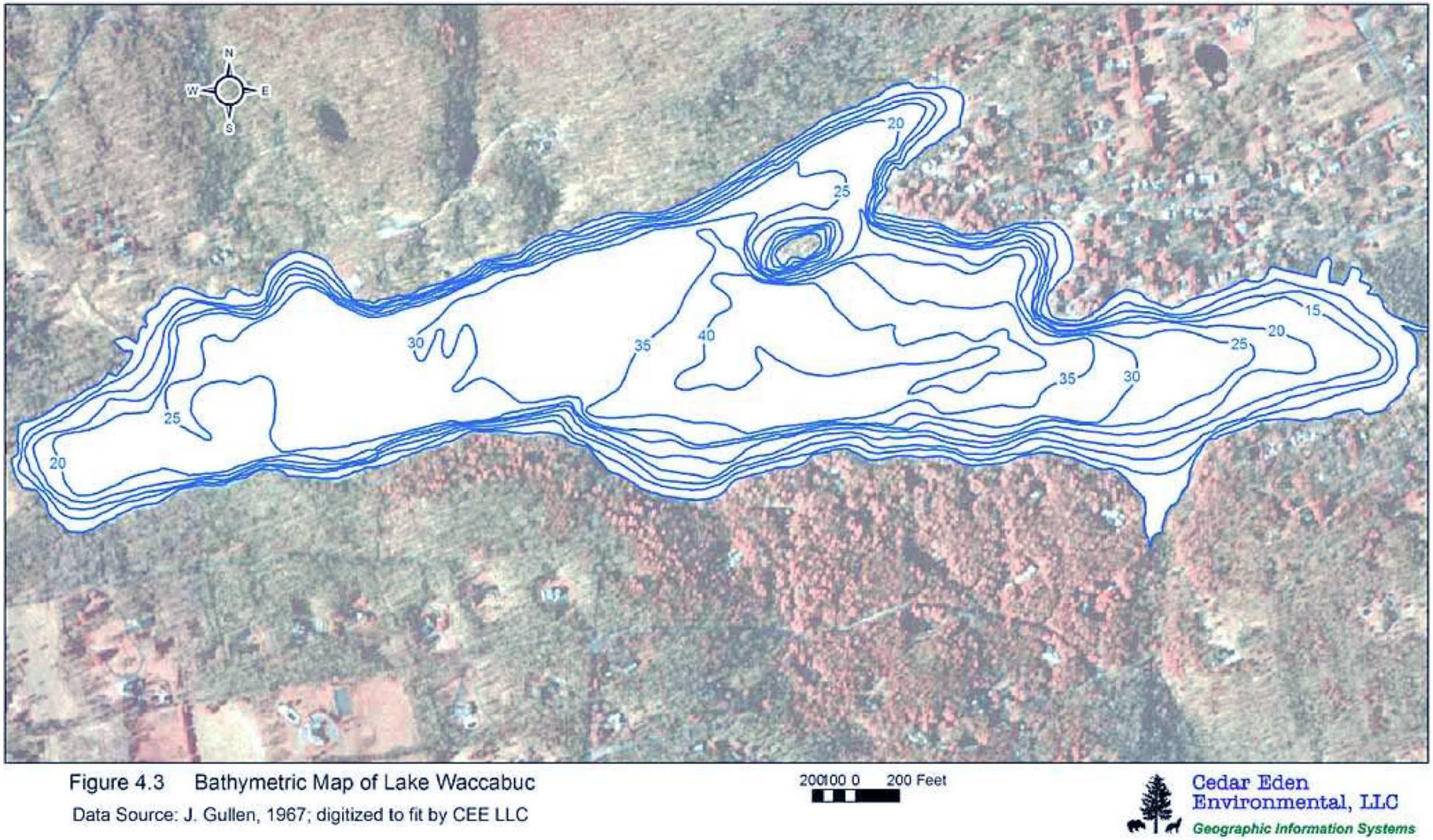
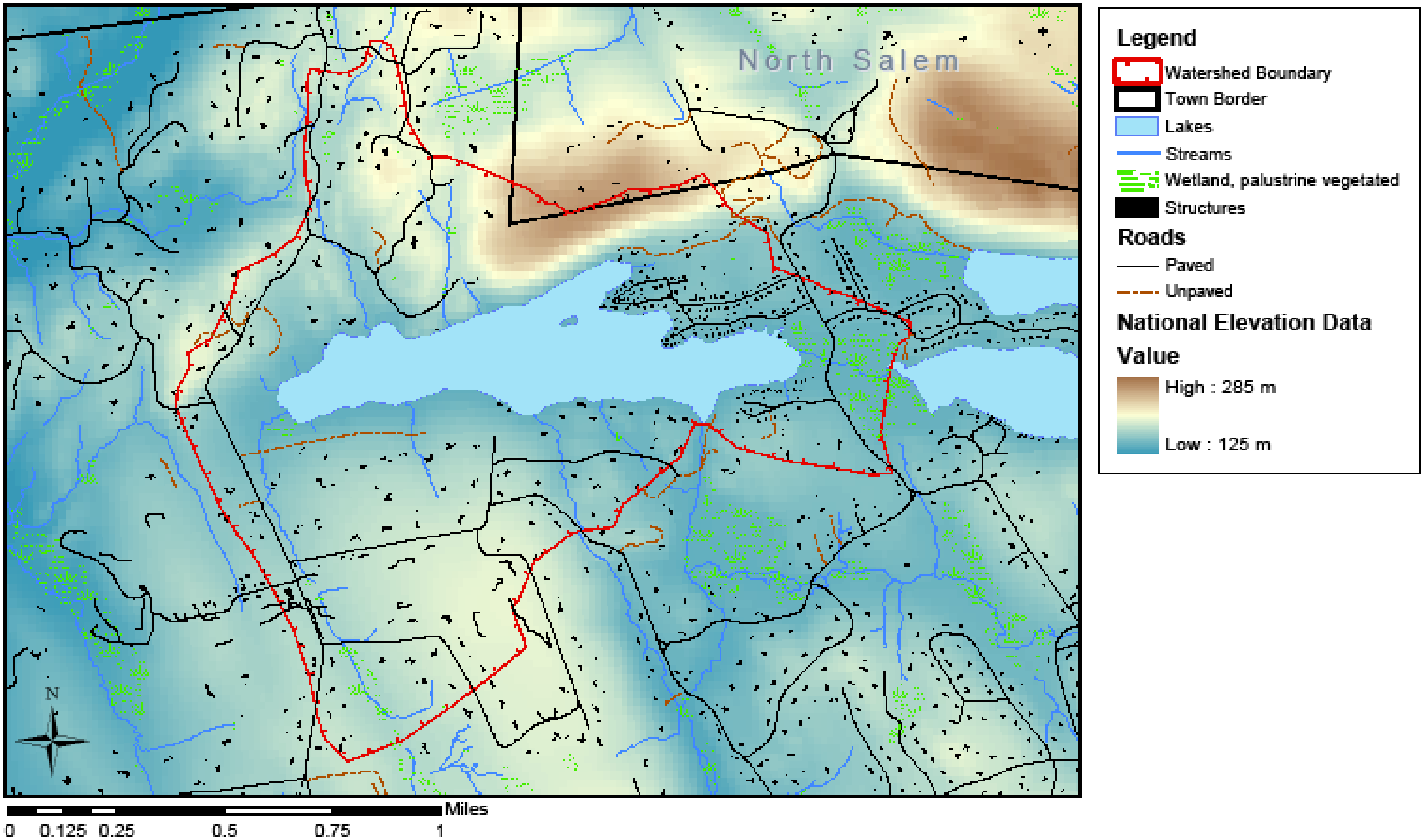


Figure 4.3 Bathymetric Map of Lake Waccabuc

Data Source: J. Gullen, 1967; digitized to fit by CEE LLC

Figure 2
Lake Waccabuc
Topographic and Human Features



Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/. Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary:

Data were collected under the Citizen Statewide Lake Assessment Program (CSLAP), as well as by the Three Lakes Council and other entities over time. Depths ranging from 0 to 15 meters (both upper and lower waters), including some half-meter increment profiles. Table A below summarizes samples collected between January and December of each year; the statistics represent averages of sample results for the time period for all depths, unless otherwise noted. Table B below summarizes samples collected during the summer, defined as the period between June 15 and September 15 each year.

A. Representing samples collected between January and December each year.

Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Alkalinity (mg/l)	1936	6	15	34	21
	1972-1976	52	19	55	33
	2002-2007	8	28	46	43
Calcium (mg/l)	2006-2007	4	13.78	14.87	14.45
Chlorophyll-α (mg/m^3)	1976-1979	20	0.81	21.65	7.28
	1980-1989	67	0.17	24.4	6.69
	1990-1996	34	2.01	26.2	9.62
	2002-2007	42	0.90	39.8	10.69
Color (platinum color units)	1986-1989	46	3	23	11
	1990-1996	34	3	20	9
	2006-2007	16	9	29	15
Conductivity	1972-1976	52	86	144	115
	1986-1989	47	123	156	134
	1990-1996	32	136	190	165
	2002-2007	41	142	218	182
Fe++ (mg/l)	1975	10	0.025	0.40	0.14
Mn++ (mg/l)	1975	10	0.02	1.15	0.42
pH (std units)	1936	6	6.4	8.0	7.45
	1972-1976	56	6.2	7.36	6.81
	1986-1989	48	6.11	9.02	7.76
	1990-1996	33	5.85	8.79	7.77
	2002-2007	29	6.0	9.92	8.0
Phaeophytin-α (mg/m^3)	2002-2006	21	0.005	3.1	0.41
Secchi depth (m)	1972-1979	103	0.90	6.0	2.99
	1980-1989	114	1.2	4.68	2.58
	1990-1996	38	2	5	3.34
	2002-2007	86	1.1	4.7	2.32
Temperature:					
Surface (°C) (min depth sampled)	1936	1 (0 m)	27.8	27.8	27.8
	1974-1979	33 (0-1 m)	12	28.2	22.2
	1981-1989	85 (0-1.5 m)	7	29	22
	1990-1996	40 (0-1.5 m)	13	30	23
	2002-2007	80 (0-1 m)	4.2	29.3	19.7
Depth >8 m (°C)	1936	1 (14 m)	7.8	7.8	7.8
	1974-1979	27 (8-15 m)	7	11.8	8.9
	1981-1983	39 (12-14 m)	5.5	11	7.8
	1991-1992	5 (12-15 m)	5.0	9.0	7.8
	2002-2007	78 (12-14 m)	4.2	10.6	6.8

A. Representing samples collected between January and December each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Dissolved Oxygen:					
Surface (mg/l) (min depth sampled)	1936	1 (0 m)	7.9	7.9	7.9
	1972-1979	34 (0-1m)	7.4	14	9.18
	1980-1983	44 (0-1m)	4.6	13.5	8.91
	1991-1992	5 (0-0.3m)	7.0	8.8	8.2
	2002-2007	80 (0-1m)	5.83	14.68	10.3
Depth >8 m (mg/l)	1936	1 (14m)	0	0	0
	1972-1979	29 (8-15m)	0	6.2	3.01
	1980-1983	44 (8-14m)	0.05	9.8	2.36
	1991-1992	5 (12-15m)	0.90	2.2	1.32
	2002-2007	76 (12-14m)	0	10.83	1.60
Nutrients *Total Phosphorus:*					
Surface (mg/l) (min depth sampled)	1986-1989	47 (1.5 m)	0.003	0.037	0.018
	1990-1996	34 (1.5 m)	0.010	0.030	0.016
	2003-2007	10 (1.5 m)	0.024	0.062	0.038
Depth >8 m (mg/l)	1975	14 (12 m)	0.029	0.345	0.164
	1986	1 (13.5 m)	0.12	0.12	0.12
	2003-2007	12 (11-12.5 m)	0.046	0.49	0.242
Soluble Reactive P (mg/l)	1975	14	0.01	0.364	0.132
Nitrate Nitrogen (mg/l)	1973-1975	60	0.0005	0.294	0.078
	1986-1989	35	0.01	0.72	0.049
	1990-1996	8	0.01	0.06	0.01
	2003-2007	21	0.0025	0.13	0.024
Total Kjeldahl Nitrogen (mg/l)	1975	13	0.45	1.93	1.08
	2002-2007	12	0.44	1.1	0.76
Ammonia Nitrogen (mg/l)	1973-1975	60	0.04	1.84	0.88
	2006-2007	16	0.006	0.10	0.03

B. Representing samples collected between June 15 and September 15 each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Chlorophyll-α (mg/m^3)	1979	10	0.81	21.65	7.28
	1980-1989	41	0.17	24.4	6.46
	1990-1996	27	2.01	14	8.35
	2002-2007	27	1.58	39.8	11.9
Phaeophytin-α (mg/m^3)	2002-2006	14	0.005	1.4	0.32
Secchi depth (m)	1972-1979	45	0.9	5.6	2.66
	1980-1989	74	1.4	4.68	2.73
	1990-1996	29	2	5	3.34
	2002-2007	32	1.1	3.85	2.39

B. Representing samples collected between June 15 and September 15 each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Dissolved Oxygen:					
Surface (mg/l)	1936	1 (0 m)	7.9	7.9	7.9
(min depth sampled)	1972-1979	22 (0-1 m)	7.4	11.2	9.11
	1980-1983	27 (0-1 m)	4.6	12.6	8.33
	1991-1992	3 (0 m)	8	8.8	8.4
	2002-2007	29 (0 m)	8.22	12.37	9.58
Depth >8 m (mg/l)	1936	1 (14 m)	0	0	0
	1972-1979	19 (8-14 m)	0	6.2	3.17
	1980-1983	27 (8-14 m)	0.05	5.7	2.25
	1991-1992	3 (12-14 m)	0.9	2.2	1.37
	2002-2007	26 (12-14 m)	0	1.9	0.34
Nutrients					
Total Phosphorus:					
Surface (mg/l)	1986-1989	38 (1.5 m)	0.003	0.037	0.017
(min depth sampled)	1990-1996	27 (1.5 m)	0.01	0.03	0.015
	2002-2007	24 (1.5 m)	0.011	0.047	0.027
Depth >8 m (mg/l)	1975	5 (12 m)	0.128	0.345	0.227
	1986	1 (13.5 m)	0.12	0.12	0.12
	2002-2007	26 (11-12.5 m)	0.079	0.45	0.258
Soluble Reactive P (mg/l)	1975	5	0.158	0.364	0.230
Nitrate Nitrogen (mg/l)	1973-1975	23	0.0005	0.136	0.066
	1986-1989	28	0.01	0.72	0.054
	1990-1996	7	0.01	0.01	0.01
	2003-2007	14	0.0025	0.135	0.022
Total Kjeldahl Nitrogen (mg/l)	1975	4	1.22	1.46	1.30
	2002-2007	9	0.607	1.1	0.793
Ammonia Nitrogen (mg/l)	1973-1975	23	0.56	1.54	0.10
	2006-2007	11	0.006	0.1	0.029

Note: A system of hypolimnetic aerators was installed in 1973 and were generally in operation from late spring until early fall. The aerators were updated in 2001 with the installation of new diffusers (Cedar Eden 2002). The aerators were not working properly in 2004, due either to design or sizing (Cedar Eden 2004). Use of the aerators was discontinued in 2005 (Cedar Eden 2006).

Sediment data summary: Composite samples collected May 29, 2008 (EcoLogic, 2008):

Parameter	**Analytical Method**	**Result (mg/kg dry wt)**
Pesticides/PCBs	EPA 8081/8082	ND
TCL Volatiles	EPA 8260B	ND
TCL PAHs	EPA 8270	ND
RCRA Total Metals	EPA 6010	
Arsenic		ND
Barium		ND
Cadmium		ND

Parameter	Analytical Method	Result (mg/kg dry wt)
Chromium		ND
Copper		1.5
Lead		4.2
Selenium		ND
Silver		ND
RCRA Mercury	EPA 7471	ND
Total Organic Carbon	EPA 9060	366,000
Total Solids	SM 18-20 2540B	6.9%
ND – non-detect. Analytes reported as less than the method detection limit.		

Sediment Contaminant Analysis: Interest has been expressed in exploring the feasibility of dredging. A composite sediment sample was collected on August 13, 2008 (EcoLogic, 2008) to estimate the quality of the sediments with respect to disposal options. Results are summarized in Table C, in the context of NYSDEC Screening levels. A complete set of results is attached to the end of this report. (Attachment 2 - 2008 Water Quality and Sediment Sampling Locations and Laboratory Analysis Reports)**.** The NYSDEC screening levels are separated into three Classes: A, B, and C:

- **Class A - No Appreciable Contamination (No Toxicity to aquatic life).**
  If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and in-water or riparian placement at approved locations can generally proceed.

- **Class B - Moderate Contamination (Chronic Toxicity to aquatic life).**
  Dredging and riparian placement may be conducted with several restrictions. These restrictions may be applied based upon site-specific concerns and knowledge coupled with sediment evaluation.

- **Class C - High Contamination (Acute Toxicity to aquatic life).**
  Class C dredged material is expected to be acutely toxic to aquatic biota and therefore, dredging and disposal requirements may be stringent. When the contaminant levels exceed Class C, it is the responsibility of the applicant to ensure that the dredged material is not a regulated hazardous material as defined in 6NYCRR Part 371. This TOGS does not apply to dredged materials determined to be hazardous.

Table C. Lake Waccabuc sediment analytical results, with NYSDEC Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement. Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem.

Compound	Required Method Detection Limit	Threshold Values			Waccabuc Results	Threshold Class
		Class A	Class B	Class C		
Metals (mg/kg dry wt) – EPA Method 6010B						
Arsenic	1.0	< 14	14 – 53	> 53	ND	A
Cadmium	0.5	< 1.2	1.2 - 9.5	> 9.5	ND	A
Copper*	2.5	< 33	33 – 207	> 207	1.5	A
Lead	5.0	< 33	33 – 166	> 166	4.2	A
Mercury+	0.2	< 0.17	0.17 - 1.6	> 1.6	ND	A
PAHs and Petroleum-Related Compounds (mg/kg dry wt) – EPA Methods 8020, 8021, 8260 and 8270						
Benzene	0.002	< 0.59	0.59 - 2.16	> 2.16	<0.030	A
Total BTEX*	0.002	< 0.96	0.96 - 5.9	> 5.9	<0.030	A
Total PAH[1]	0.33	< 4	4 - 35	> 35	<0.7	A
Pesticides (mg/kg dry wt) – EPA Methods 8081						
Sum of DDT+DDD+DDE+	0.029	< 0.003	0.003 - 0.03	> 0.03	ND	A
Mirex*+	0.189	< 0.0014	0.0014 - 0.014	> 0.014	na	--
Chlordane*+	0.031	< 0.003	0.003 - 0.036	> 0.036	ND	A
Dieldrin	0.019	< 0.11	0.11 -0. 48	> 0.48	ND	A
Chlorinated Hydrocarbons (mg/kg dry wt) – EPA Methods 8082 and 1613B						
PCBs (sum of aroclors)[2]	0.025	< 0.1	0.1 - 1	> 1	ND	A
2,3,7,8-TCDD*[3] (sum of toxic equivalency)	0.000002	< 0.0000045	0.0000045 - 0.00005	> 0.00005	na	--

na – not analyzed. ND – not detected

+Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit.

* Indicates case-specific parameter. The analysis and evaluation of these case specific analytes is recommended for those waters known or suspected to have sediment contamination caused by those chemicals. These determinations are made at the discretion of Division staff.

[1] For Sum of PAH, see Appendix E of TOGS 5.1.9. For Lake Kitchawan, each of the 18 PAH compounds were reported as non-detect (<0.7 mg/kg).

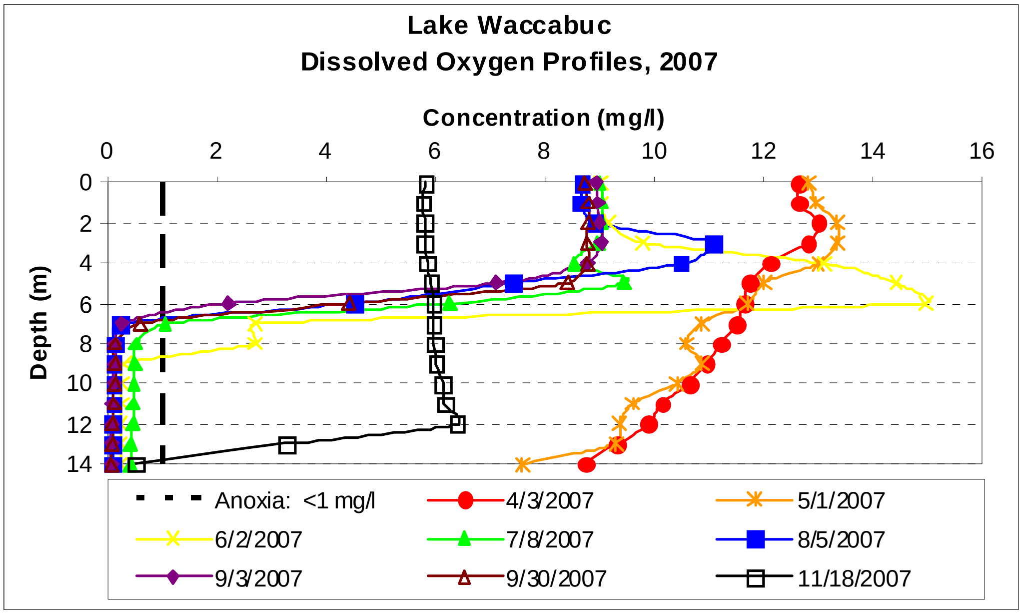
[2] For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. For Lake Kitchawan, seven Aroclors were each reported as <0.2 mg/kg; this value is reported above.

[3] TEQ calculation as per the NATO - 1988 method (see Appendix D of TOGS 5.1.9).

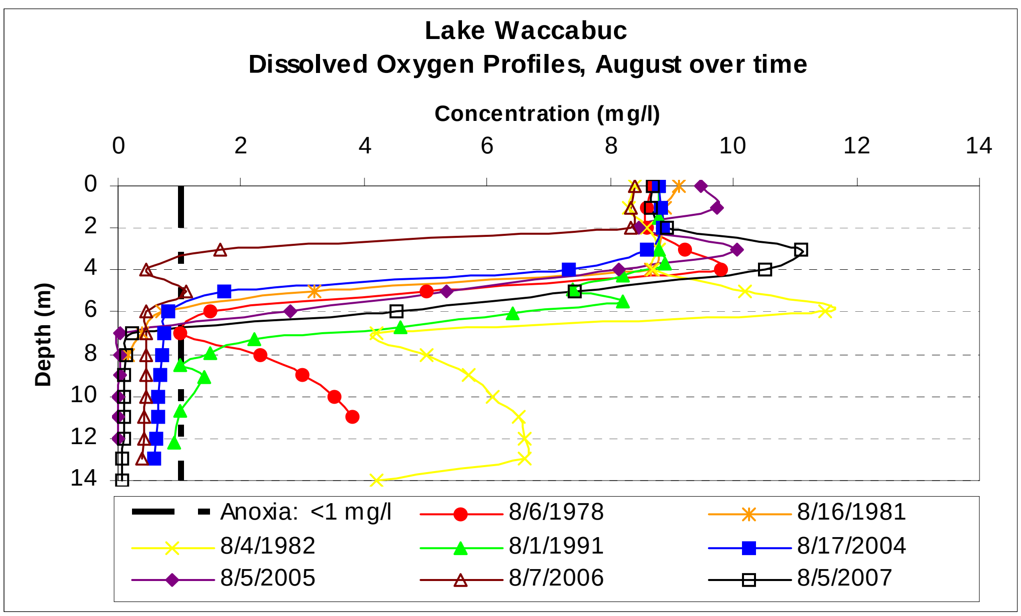
Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

Source:
Table 2, NYSDEC Division of Water, Technical & Operational Guidance Series (TOGS) 5.1.9, In-Water and Riparian Management of Sediment and Dredged Material, November, 2004

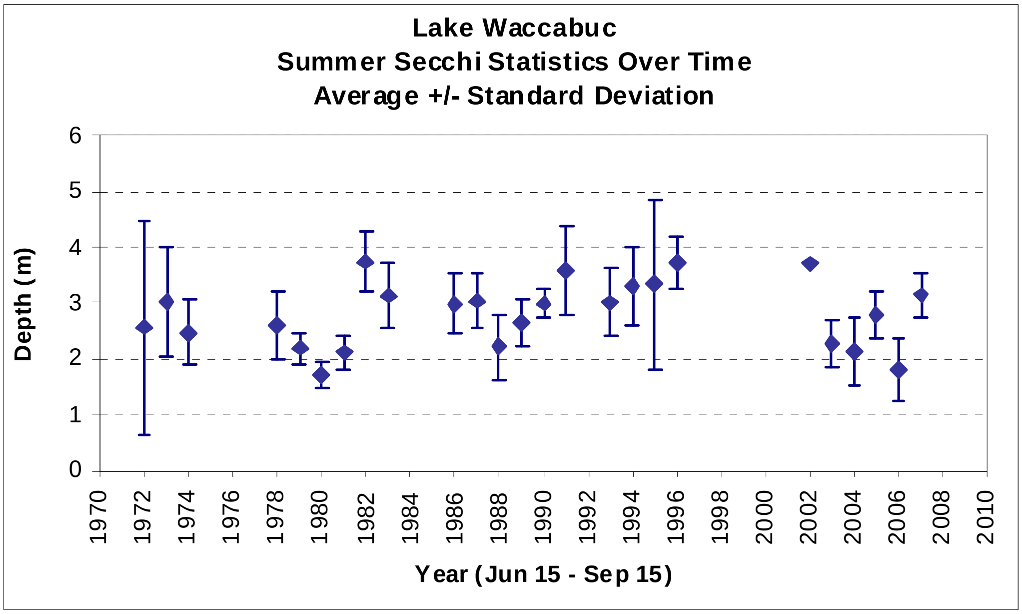
Anoxia: Dissolved oxygen decreases in lower waters, resulting in anoxic conditions from June through September at depths greater than 6 meters. By November, turnover has occurred, resulting in higher DO concentrations at depth and lower DO concentrations at surface.



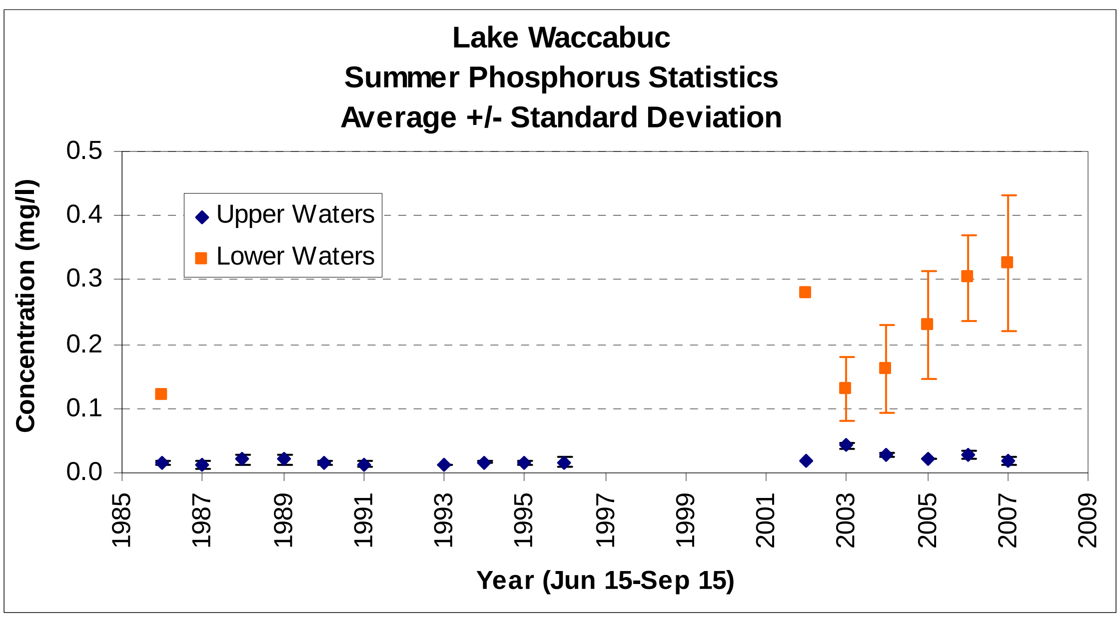
Anoxic conditions are evident in dissolved oxygen profiles collect in the month of August dating back to 1978.



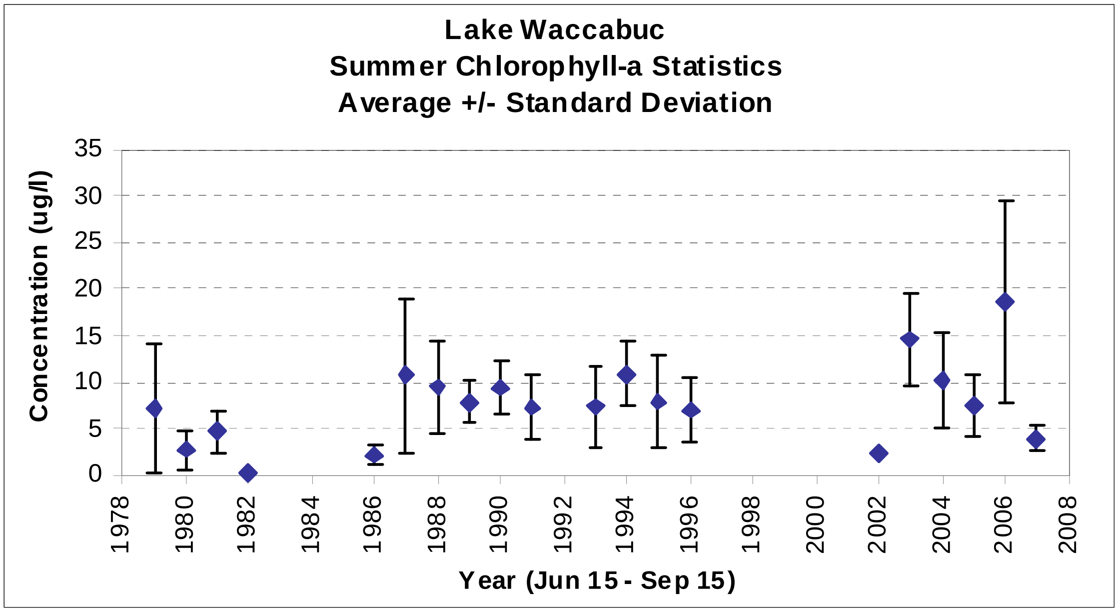
Water Clarity: Averages over time are generally between 2.0 to 4.0 meters. The historical variability around the mean is similar to recent years.



Phosphorus Concentrations: Summer phosphorus concentrations in upper waters have been fairly stable since 1985, with low variability. Phosphorus concentrations in lower waters are consistently higher than for samples collected in the upper waters. Averages in lower waters appear to be increasing in recent years.



Chlorophyll-α: Chlorophyll-α concentrations are, on average, slightly higher in recent years as compared with the previous two decades. The standard deviations show considerable variability over time.



Trophic Status:

Parameter	Trophic State (shading indicates match to Lake)				Lake Waccabuc*
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	27
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	12
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	39.8
Average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	2.4
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	1.1
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	2.52

*Summer (June 15 to September 15) averages for the period 2002 to 2007. DO percent saturation in lower waters calculated using data collected June 15 to September 15, at depths >= 12 m.

Aquatic Habitat:

- Phytoplankton in 2003 was dominated by Bluegreen group from June through September (#cells/ml ranged from 21,178-51,903). (Cedar Eden 2004)
- Zooplankton in 2003 were dominated by Rotifers in June and July, accounting for 70% and 59% of the zooplankton community, respectively. In September, Cladocerans (*Bosmina*) dominated (68%). (Cedar Eden 2004)
- Aquatic plants in July 2003 were most abundant in the shallow east end and coves, while steep shores limited vegetation establishment elsewhere. Plants at the east end inlet were characterized by Eurasian water milfoil (*Myriophyllum spicatum*), bassweed, coontail, and Robin's pondweed. Eurasian water milfoil was well-established along most of the shoreline, interspersed with white and yellow water lilies. (Cedar Eden 2004).

List of Aquatic Plants identified in 2003:

Scientific Name	Common Name
Brasena schreberi	Watershield
Ceratophyllum spp.	Coontail
Decodon spp.	Three-way sedge
Eleochaaris quadrangulata	Four-edge sedge
Eleocharis spp.	Spike-rush
Elodea canadensis	Canadian waterweed
Iris spp.	Iris
Lemna spp.	Duckweed
Lythrum salicaria	Purple loosestrife

Scientific Name	Common Name
Myriophyllum spicatum.	Eurasian watermilfoil
Nuphar spp.	Yellow water lily
Nympheae spp.	White water lily
Pontederia cordata	Pickerelweed
Potamogeton amplifolius	Bassweed
Potamogeton robensii	Robin's Pondweed
Sagittaria spp.	Arrowhead
Scirpus spp.	Bulrush

Note: A 2008 macrophyte survey conducted by Allied Biological has identified the exotic invasive plant Brazilian elodea (*Egeria densa*) in the north bay of Lake Waccabuc. Management alternatives are being considered.

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	Common Name
Heracleum mantegazzianum	Giant Hogweed
Wisteria floribunda	Japanese Wisteria, Wisteria
Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg's Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
Haliaeefus leucocephalus	Bald Eagle	Threatened, entire state
Mammals		
Myotis sodalist	Indiana Bat	Endangered, entire state
Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
Isotria medeoloides	Small Whorled Pogonia	Threatened, entire state
Platanthera leucophea	Eastern Prairie Orchid	Threatened, not relocated in NY
Scirpus ancistrochaetus	Northeastern Bulrush	Endangered, not relocated in NY

- New York Natural Heritage Program

Scientific Name	Common Name	NY Legal Status
Reptiles		
Glyptemys muhlenbergii (formerly Clemmys muhlenbergii)	Bog Turtle	Endangered
Birds		
Oporornis formosus	Kentucky Warbler	Protected
Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	562
Evaporation (ET)	22	258
Runoff (R)	26	1,597

Water Budget:	
Inflow to Lake [R+(P-ET)]	1,528 mgal/year
Lake Volume	3,696 mgal
Flushing Rate	0.4 times/year
Residence Time	2.4 years

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed (acres)	Cover (%)	Phosphorus Export Coeff.	Estim. P Export kg/year	Percent
Open water (all)	135	15	0.30	16	28
Developed, open space	234	26	0.20	19	32
Developed, low intensity	4.0	0.43	0.30	0.48	0.82
Developed, moderate intensity	1.0	0.11	0.50	0.20	0.34
Deciduous forest	400	44	0.07	11	19
Evergreen forest	70	7.7	0.20	5.7	10
Mixed forest	3.6	0.39	0.09	0.13	0.22
Shrub/scrub	10	1.1	0.28	1.2	2.0
Grassland/herbaceous	15	1.6	0.28	1.7	2.9
Pasture/hay	16	1.8	0.30	2.0	3.4
Woody wetlands	22	2.4	0.09	0.80	1.4
Emergent herbaceous wetlands	2.4	0.27	0.10	0.10	0.17
Total Acres	**913**	**100**		**58**	**100**

(B) Septic: Septic systems serve the communities along the shoreline (Cedar Eden 2002).

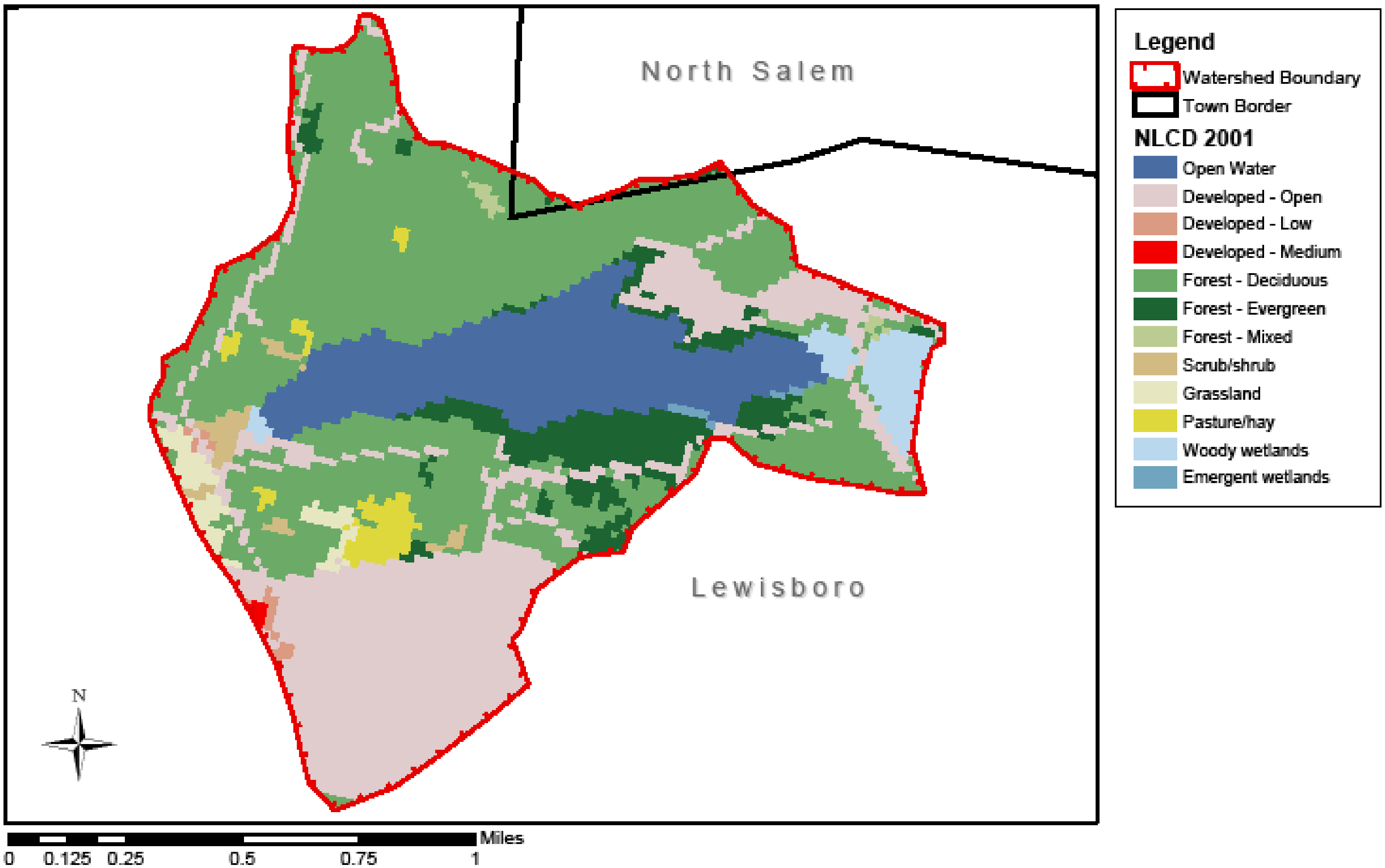
Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

Class	N Structures	Average Household	Estimated Population
Not limited	21	2.5	53
Somewhat limited	142	2.5	355
Very limited	72	2.5	180
Total	**235**		**588**

Estimated Phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%.

Class	Population	P per cap	Transport	kg/year
Not limited	50	0.6	10%	3.0
Somewhat limited	337	0.6	30%	61
Very limited	171	0.6	60%	62
Failed systems (5%)	30	0.6	100%	18
Total	**588**			**144**

Figure 3
Lake Waccabuc
National Land Cover Dataset 2001

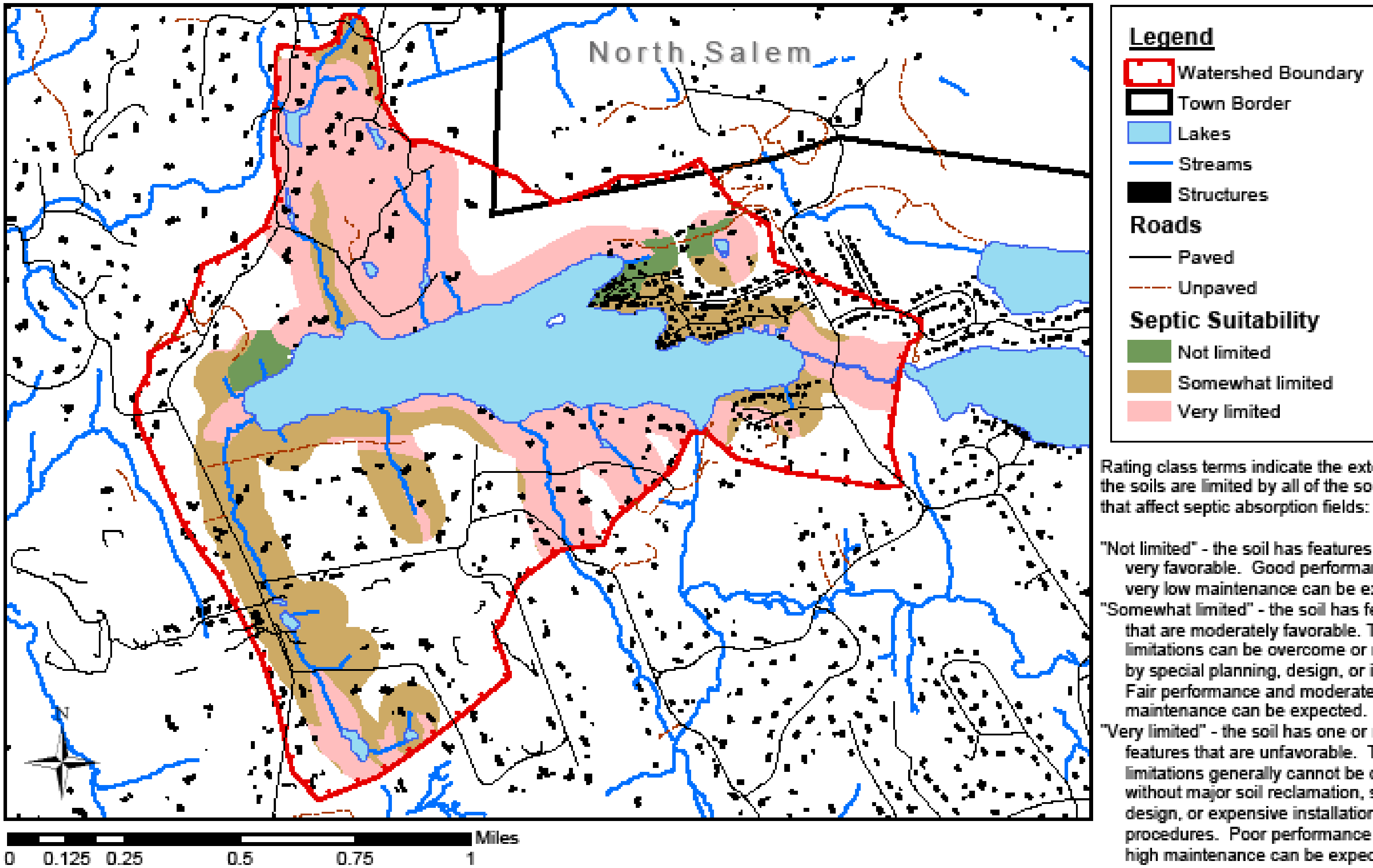


Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4

Lake Waccabuc

Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.

"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:

Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

(C) Point Sources: The outlet of Lake Oscaleta flows to Lake Waccabuc.

Estimated point source load of phosphorus

Source	**Estim. Volume input (m^3/year)**	**Surface Average P 2002-2007 (ug/l)**	**Estimated P load (kg/year)**
Lake Oscaleta	3,438,272	24	83

(D) Summary of Phosphorus Input to the Lake:

Source	**Input (kg/year)**
Watershed Land Cover	59
Point Sources	83
Septic within 100m of surface water	143
Internal loading (sediment)	260
Total	**544**

<u>Phosphorus Mass Balance:</u> Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10+H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = flushes per year

Parameter	**Units**	**Result**
W′	g/m^2/year	957
H	m	7.1
ρ	flushes per year	2.4
p	**ug/l**	**35**
Summer average TP 2002-2007, upper waters:		**27 ug/l**

REFERENCES

Cedar Eden Environmental, LLC. 2006 State of the Lakes: 2004/2005 Water Quality of Lake Rippowam, Lake Oscaleta and Lake Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. April 2006.

Cedar Eden Environmental, LLC. 2004 Diagnostic-Feasibility Study and Lake & Watershed Management Plan for Lake Rippowam, Lake Oscaleta, and Lake Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. May 2004.

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Invasive Species Council of New York State. Early Detection Invasive Plants by Region. Web site: http://www.ipcnys.org/. Obtained on-line 11/29/07.

New York Natural Heritage Program. Letter dated December 21, 2007 received by EcoLogic, LLC. New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources.

New York State Department of Environmental Conservation. 2007. 2006 Interpretive Summay, New York Citizens Statewide Lake Assessment Program (CSLAP) 2006 Annual Report - Lake Waccabuc. September 2007. With New York Federation of Lake Associations. Scott A. Kishbaugh, PE.

US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

3.2. Lake Kitchawan

Lake Kitchawan

Surface water quality classification: Class B

Morphology Summary:

Characteristic	**Units**	**Value**	**Source**
Surface area	hectares	43	ENSR 2008
Watershed area	hectares	225 184.6 (lake) 141.9 (lagoon) 326.4 (both)	EcoLogic 2008 (excl lake) ENSR 2008
Volume	mgal	174 (lake) 3 (lagoon) 177 (both)	ENSR 2008
Elevation	m	158	
Maximum depth	m	4.3	ENSR 2008
Average Depth	m	1.7	ENSR 2008

Lake Inlet: Primary inlet drains a large area to the north and enters at north end. Secondary inlets drain areas west and south of the lake. Numerous storm drains enter along east shore.

Lake Outlet: The Lake discharges to the west.

Recreational impacts: Occasional poor water quality. High density of macrophytes.

Lakeshore Development: Development is predominantly residential; the highest density is to the east of the lake.

Figure 1
Lake Kitchawan
Bathymetry

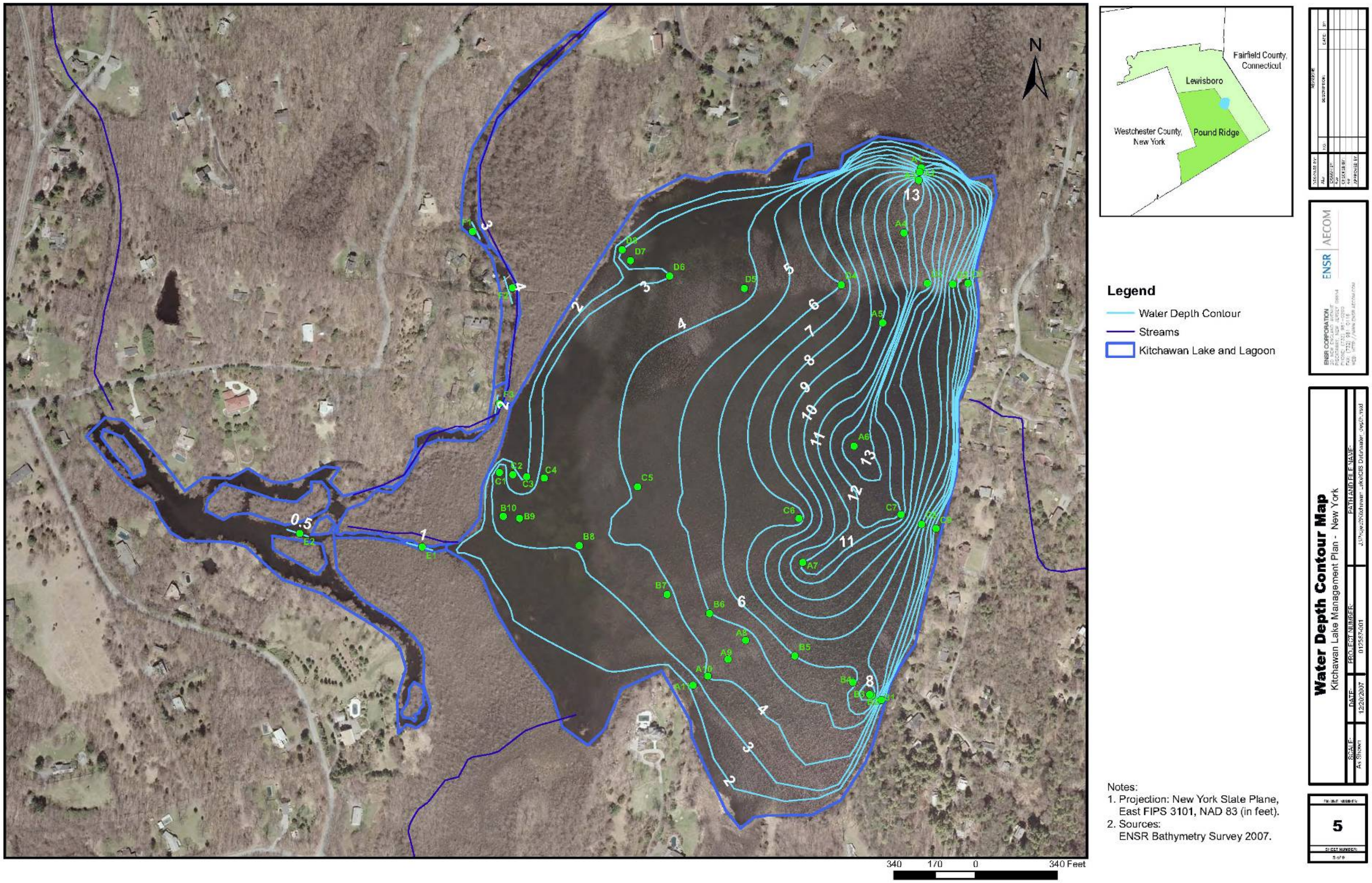
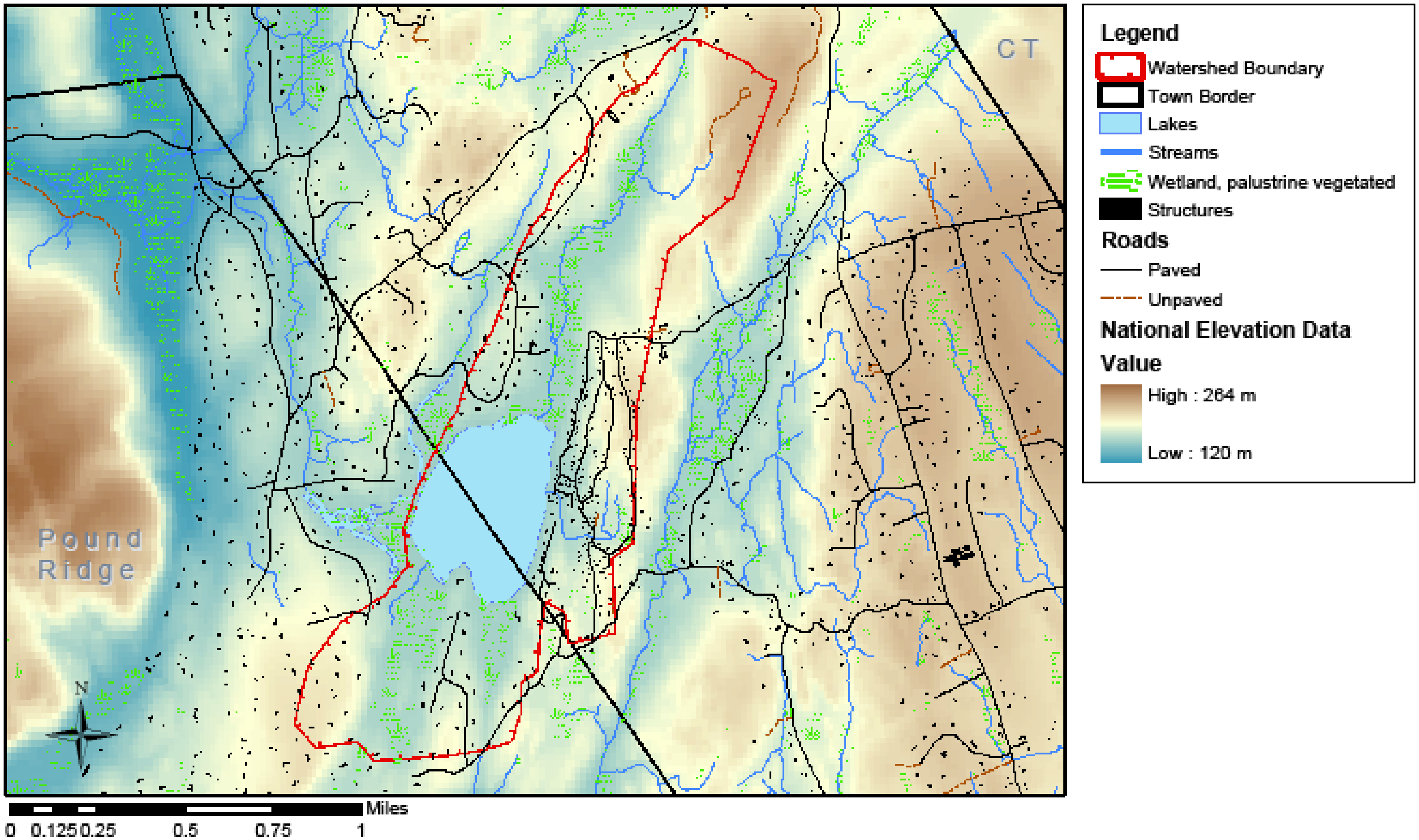


Figure 2
Lake Kitchawan
Topographic and Human Features



Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/. Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary: ENSR(2007) reported two sample events, May and July; Samples were collected from five sites: three in the lake; one at the outlet; and one in the wetland. Only one of the five sites – Site 2 – was sampled both at the surface and at depth.

A. Representing in-lake samples collected in May and July2007.

Parameter (units)	Time Period	Location	Number of Samples	Minimum	Maximum	Average
Alkalinity (mg/l)	2007	Upper waters	6	58.9	160	77.5
		Lower waters	2	64.9	85.9	75.4
Chlorophyll-α (ug/l)	2007	Upper waters	2	0.65	5.8	3.2
		Lower waters	0	--	--	--
Conductivity (uS/cm)	2007	Upper waters	9	248	282	263
		Lower waters	5	257	321	275
Dissolved oxygen (mg/l)	2007	Upper waters	9	5.66	11.7	8.95
		Lower waters	5	0.26	16.4	9.94
Dissolved oxygen (%)	2007	Upper waters	9	68	138	106
		Lower waters	5	3.1	183	108
Fecal Coliform (col/100ml)	2007	Upper waters	6	4	46	16.7
		Lower waters	0	--	--	--
pH (std units)	2007	Upper waters	9	7.82	9.06	8.48
		Lower waters	5	6.98	8.84	8.17
Temperature (°C)	2007	Upper waters	9	22.8	25.3	23.8
		Lower waters	5	17.9	21.8	19.9
Total suspended solids (mg/l)	2007	Upper waters	5	<3.9	5.0	4.2
		Lower waters	2	<3.9	6.0	5.0
Nutrients:						
Total Phosphorus (mg/l)	2007	Upper waters	6	0.015	0.085	0.037
		Lower waters	2	0.011	0.023	0.017
Soluble Reactive P (mg/l)	2007	Upper waters	6	<0.005	0.03	0.017
		Lower waters	2	0.009	0.02	0.015
Ammonia Nitrogen (mg/l)	2007	Upper waters	6	<0.032	0.1	0.058
		Lower waters	2	<0.032	0.13	0.081
Nitrate plus Nitrite (mg/l)	2007	Upper waters	6	<0.007	0.062	0.023
		Lower waters	2	<0.007	0.008	0.0075
Total Kjeldahl Nitrogen (mg/l)	2007	Upper waters	6	0.38	0.72	0.58
		Lower waters	2	0.27	0.81	0.54

Note: Site 2 surface duplicate averaged with parent sample prior to calculating upper waters average.
Upper waters statistics represent samples collected at depths of less than 2m from three sites in the lake. Lower waters statistics represent samples collected at depths greater than 2m from Site 2 in the lake.

B. Representing in-lake samples collected in July2007.

Parameter (units)	Time Period	Location	Number of Samples	Minimum	Maximum	Average
Chlorophyll-α (ug/l)	2007	Upper waters	1	5.75	5.75	5.75
		Lower waters	0	--	--	--

B. Representing in-lake samples collected in July2007.

Parameter (units)	Time Period	Location	Number of Samples	Minimum	Maximum	Average
Dissolved oxygen (mg/l)	2007	Upper waters	4	6.95	8.48	7.44
		Lower waters	3	14.89	16.36	15.46
Dissolved oxygen (%)	2007	Upper waters	4	81	100.4	87.95
		Lower waters	2	3.1	35.2	19.2
Nutrients:						
Total Phosphorus (mg/l)	2007	Upper waters	3	0.015	0.031	0.025
		Lower waters	1	0.023	0.023	0.023
Soluble Reactive P (mg/l)	2007	Upper waters	3	<0.005	0.03	0.015
		Lower waters	1	0.021	0.021	0.021
Ammonia Nitrogen (mg/l)	2007	Upper waters	3	0.066	0.1	0.084
		Lower waters	1	0.13	0.13	0.13
Nitrate plus Nitrite (mg/l)	2007	Upper waters	3	0.026	0.062	0.039
		Lower waters	1	0.008	0.008	0.008
Total Kjeldahl Nitrogen (mg/l)	2007	Upper waters	3	0.66	0.72	0.69
		Lower waters	1	0.81	0.81	0.81

Note: Site 2 surface duplicate averaged with parent sample prior to calculating upper waters average.
Upper waters statistics represent samples collected at depths of less than 2m from three sites in the lake. Lower waters statistics represent samples collected at depths greater than 2m from Site 2 in the lake.

August 2008 water quality data summary:

A. Analytical Results

Parameter (units)	Surface (0 m)	Depth (4.6 m)
Secchi Transparency (m)	1.50	na
Chlorophyll-a (mg/l)	0.014	na
Alkalinity (mg/l)	54	na
Phosphorus:		
Total Phosphorus (mg/l)	0.013	0.035
Soluble Reactive Phosphorus (mg/l)	0.0087[a]	0.014[a]
Nitrogen:		
Total Nitrogen	1	1.5
Nitrate + Nitrite N (mg/l)	0.049[a]	0.17[a]
Total Kjeldahl Nitrogen (mg/l)	0.98[a]	1.3[a]

na – not analyzed
[a] The result of the laboratory control sample was greater than the established limit.

B. Field Profiles

Depth ft (m)	Temperature (°C)	pH	Conductivity (us)	DO (mg/l)	DO (% sat)
1 (0.305)	23.4	6.8	319	5.0	59.5
2 (0.610)	23.8		321	5.0	59.5
3 (0.915)	23.8		321	5.0	59.5
4 (1.22)	23.8		321	5.0	59.8
5 (1.53)	23.8		319	5.0	59.8
6 (1.83)	23.8		321	5.0	59.8
7 (2.14)	23.8		320	5.0	58.9
8 (2.44)	23.8		319	5.1	60.6
9 (2.75)	23.8		319	5.2	61.4
10 (3.05)	23.7		312	5.5	62.6
11 (3.36)	23.2		312	5.5	62.8
12 (3.66)	22.9		295	4.6	54.3
13 (3.97)	22.8		297	4.7	55.4
14 (4.27)	22.4		287	4.6	53.1
14.5 (4.42)	22.4		287	4.6	53.1

Sediment data summary:

- Composite samples collected August 12, 2008 (EcoLogic, 2008):

Parameter	Analytical Method	Result (mg/kg dry wt)
Pesticides/PCBs	EPA 8081/8082	ND
TCL Volatiles	EPA 8260B	ND
TCL Semi-Volatiles	EPA 8270	ND
RCRA Total Metals	EPA 6010	
Arsenic		ND
Barium		16
Cadmium		0.24
Chromium		3.1
Copper		8.5
Lead		11
Selenium		0.054
Silver		ND
RCRA Mercury	EPA 7471	ND
Total Organic Carbon	EPA 9060	94000
Total Solids	SM 18-20 2540B	12%
ND – non-detect. Analytes reported as less than the method detection limit.		

<u>Sediment Contaminant Analysis:</u> Interest has been expressed in exploring the feasibility of dredging. A composite sediment sample was collected on August 13, 2008 (EcoLogic, 2008) to determine if any threshold screening values that might preclude dredging were exceeded. Results are summarized in Table C, in the context of NYSDEC Screening levels. A complete set of results is attached to the end of this report. (Attachment 2 - 2008 Water Quality and Sediment Sampling Locations and Laboratory Analysis Reports). The NYSDEC screening levels are separated into three Classes: A, B, and C:

- **<u>Class A - No Appreciable Contamination (No Toxicity to aquatic life).</u>**
  If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and in-water or riparian placement, at approved locations, can generally proceed.

- **<u>Class B - Moderate Contamination (Chronic Toxicity to aquatic life).</u>**
  Dredging and riparian placement may be conducted with several restrictions. These restrictions may be applied based upon site-specific concerns and knowledge coupled with sediment evaluation.

- **<u>Class C - High Contamination (Acute Toxicity to aquatic life).</u>**
  Class C dredged material is expected to be acutely toxic to aquatic biota and therefore, dredging and disposal requirements may be stringent. When the contaminant levels exceed Class C, it is the responsibility of the applicant to ensure that the dredged material is not a regulated hazardous material as defined in 6NYCRR Part 371. This TOGS does not apply to dredged materials determined to be hazardous.

Table C. Lake Kitchawan sediment analytical results, with NYSDEC Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement. Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem. Results that fall into Class C (high contamination) are highlighted. ND= Not detected.

Compound	Required Method Detection Limit	Threshold Values			Kitchawan Results	Threshold Class
		Class A	Class B	Class C		
Metals (mg/kg dry wt) – EPA Method 6010B						
Arsenic	1.0	< 14	14 – 53	> 53	ND	A
Cadmium	0.5	< 1.2	1.2 - 9.5	> 9.5	0.24	A
Copper*	2.5	< 33	33 – 207	> 207	8.5	A
Lead	5.0	< 33	33 – 166	> 166	11	A
Mercury+	0.2	< 0.17	0.17 - 1.6	> 1.6	ND	A
PAHs and Petroleum-Related Compounds (mg/kg dry wt) – EPA Methods 8020, 8021, 8260 and 8270						
Benzene	0.002	< 0.59	0.59 - 2.16	> 2.16	ND	A
Total BTEX*	0.002	< 0.96	0.96 - 5.9	> 5.9	ND	A
Total PAH[1]	0.33	< 4	4 - 35	> 35	ND	A
Pesticides (mg/kg dry wt) – EPA Methods 8081						
Sum of DDT+DDD+DDE+	0.029	< 0.003	0.003 - 0.03	> 0.03	ND	A
Mirex*+	0.189	< 0.0014	0.0014 - 0.014	> 0.014	na	--
Chlordane*+	0.031	< 0.003	0.003 - 0.036	> 0.036	ND	A
Dieldrin	0.019	< 0.11	0.11 -0. 48	> 0.48	ND	A
Chlorinated Hydrocarbons (mg/kg dry wt) – EPA Methods 8082 and 1613B						
PCBs (sum of aroclors)[2]	0.025	< 0.1	0.1 - 1	> 1	ND	A
2,3,7,8-TCDD*[3](sum of toxic equivalency)	0.000002	< 0.0000045	0.0000045 - 0.00005	> 0.00005	na	--

na – not analyzed. ND – not detected

+Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit.

* Indicates case-specific parameter. The analysis and evaluation of these case specific analytes is recommended for those waters known or suspected to have sediment contamination caused by those chemicals. These determinations are made at the discretion of Division staff.

[1]For Sum of PAH, see Appendix E of TOGS 5.1.9. For Lake Kitchawan, each of the 18 PAH compounds were reported as non-detect (<0.7 mg/kg).

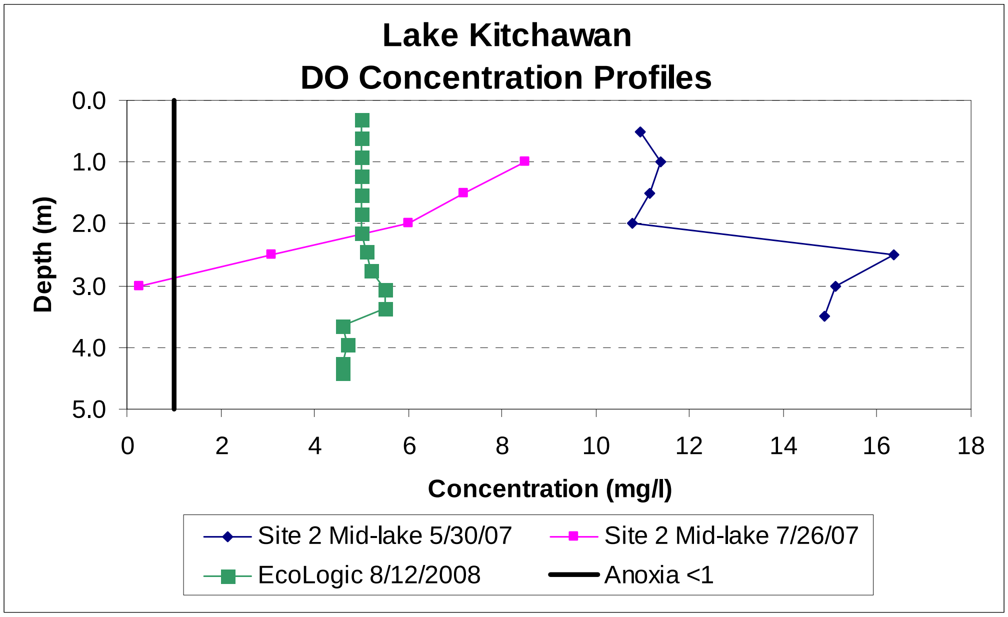
[2]For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. For Lake Kitchawan, seven Aroclors were each reported as <0.2 mg/kg; this value is reported above.

[3]TEQ calculation as per the NATO - 1988 method (see Appendix D of TOGS 5.1.9).

Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

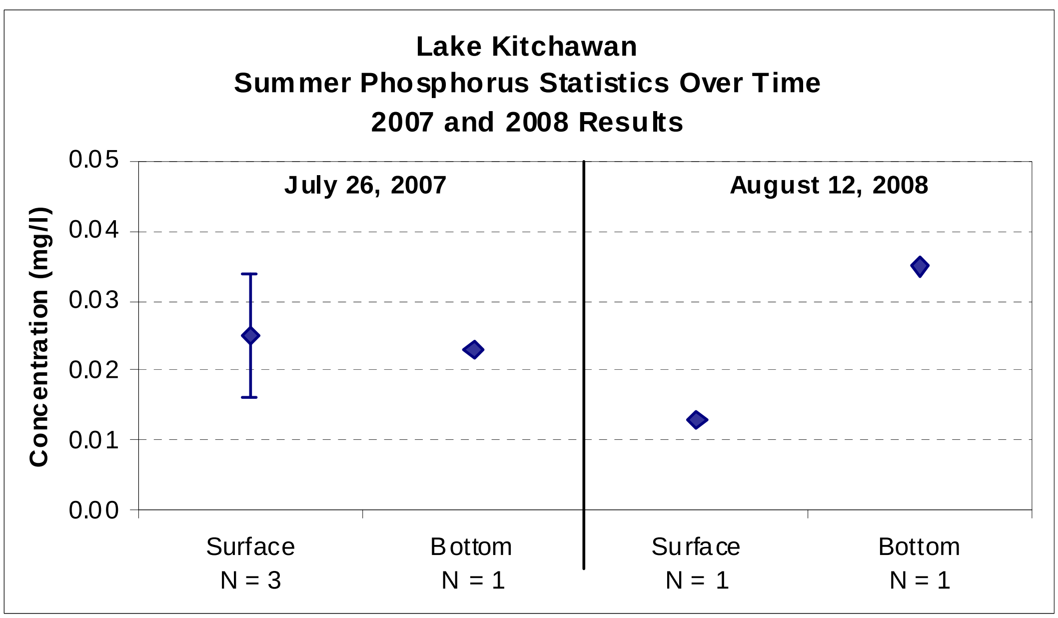
Source: Table 2, NYSDEC Division of Water, Technical & Operational Guidance Series (TOGS) 5.1.9, "In-Water and Riparian Management of Sediment and Dredged Material", Nov. 2004

Anoxia: Evidence of anoxic conditions at depth in July 2007; no stratification in May 2007 or in August 2008.

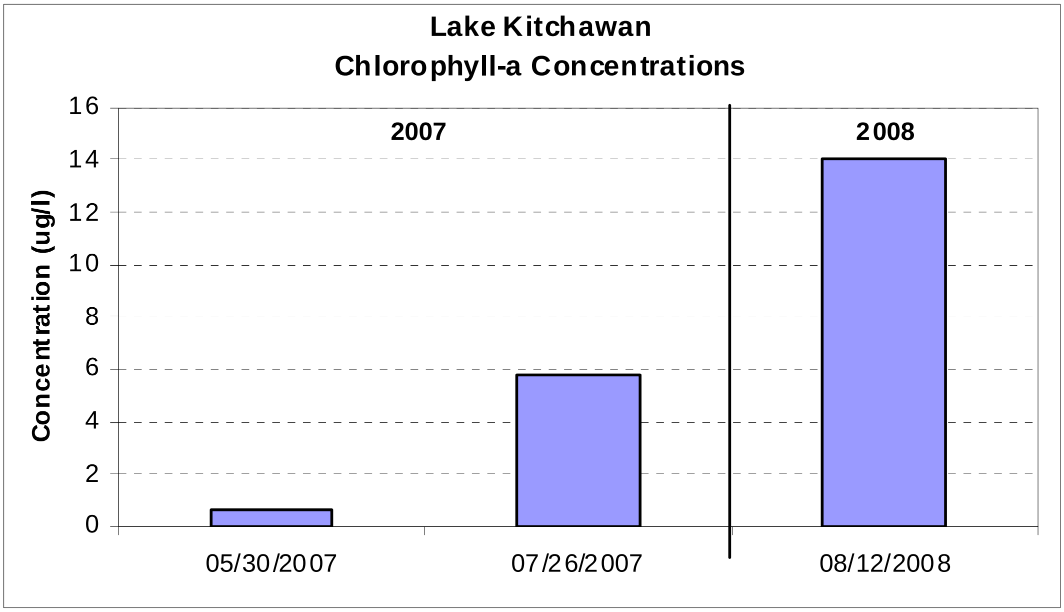


Water Clarity: Secchi depth was measured at 1.5 meters by EcoLogic on August 12, 2008. This is the only known Secchi measurement.

Phosphorus Concentrations: Samples were collected in-lake in May and July 2007, and August 2008.



Chlorophyll-α: Two samples collected in 2007 from the mid-lake sample location, and one sample in 2008.



Trophic Status:

Parameter	Trophic State (shading indicates match to Lake)				Lake Kitchawan*
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	23
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	5.6
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	5.8
Average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	1.5
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	1.5
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	19%

ENSR data collected May and July 2007; summer represented by July samples except Secchi depth which represents one reading collected by EcoLogic on 8/12/2008.
Sample results from 2007 include three lake stations, and do not include outlet and wetland samples collected during the same field event.

Aquatic Habitat:

- Supports a warm-water fish community (largemouth bass, sunfish, other recreational species)
- Invasives observed: Eurasian watermilfoil

- Aquatic plants identified in July 2007

Scientific Name	Common Name
Ceratophyllum demersum	Coontail
Elodea canadensis	Common Water Weed
Lemna sp.	Duckweed
Lythrum salicaria	Purple Loosestrife
Myriophyllum spicatum.	Eurasion Milfoil
Nuphar polysepala	Spatterdock
Nuphar sp.	Yellow Water Lily

Scientific Name	Common Name
Nympheae sp.	White Water Lily
Pontederia cordata	Pickerel Weed
Potamogeton crispus	Curly Pondweed
Potamogeton illinoensis	Illinois Pondweed
Potamogeton robensii	Fern Pondweed
Ranunculus longirostris	White Water Crowfoot
Vallisneria americana	Wild Celery

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	Common Name
Heracleum mantegazzianum	Giant Hogweed
Wisteria floribunda	Japanese Wisteria, Wisteria
Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg's Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
Haliaeefus leucocephalus	Bald Eagle	Threatened, entire state
Mammals		
Myotis sodalist	Indiana Bat	Endangered, entire state
Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
Isotria medeoloides	Small Whorled Pogonia	Threatened, entire state
Platanthera leucophea	Eastern Prairie Orchid	Threatened, not relocated in NY
Scirpus ancistrochaetus	Northeastern Bulrush	Endangered, not relocated in NY

- New York Natural Heritage Program – Town of Lewisboro

Scientific Name	Common Name	NY Legal Status
Reptiles		
Glyptemys muhlenbergii (formerly Clemmys muhlenbergii)	Bog Turtle	Endangered
Birds		
Oporornis formosus	Kentucky Warbler	Protected
Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted*
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered

* indicates species of particular concern for this lake and watershed.

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	427
Evaporation (ET)	22	196
Runoff (R)	26	1,204

Water Budget:	
Inflow to Lake [R+(P-ET)]	468 mgal/yr
Lake Volume	174 mgal
Flushing Rate	2.7 times/year
Residence Time	0.37 years

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed (acres)	Cover (%)	Phosphorus Export Coeff	Estim P Export kg/year	Estim P Export Percent
Open water (all)	78	12	0.30	9.5	26
Developed, open space	130	19	0.20	10.5	28
Developed, low intensity	3.6	0.53	0.30	0.432	1.2
Deciduous forest	305	45	0.07	8.63	23
Evergreen forest	35	5.2	0.20	2.82	7.6
Mixed forest	7.1	1.0	0.09	0.257	0.69
Shrub/scrub	0.16	0.02	0.28	0.018	0.05
Pasture/hay	8.3	1.2	0.30	1.01	2.7
Woody wetlands	97	14	2.10	3.55	10
Emergent herbaceous wetlands	12	1.7	0.09	0.467	1.3
Total Acres*	**676**	**100**		**37.2**	**100**

(B) Septic: Assumes that communities around the lake are on septic systems.

Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

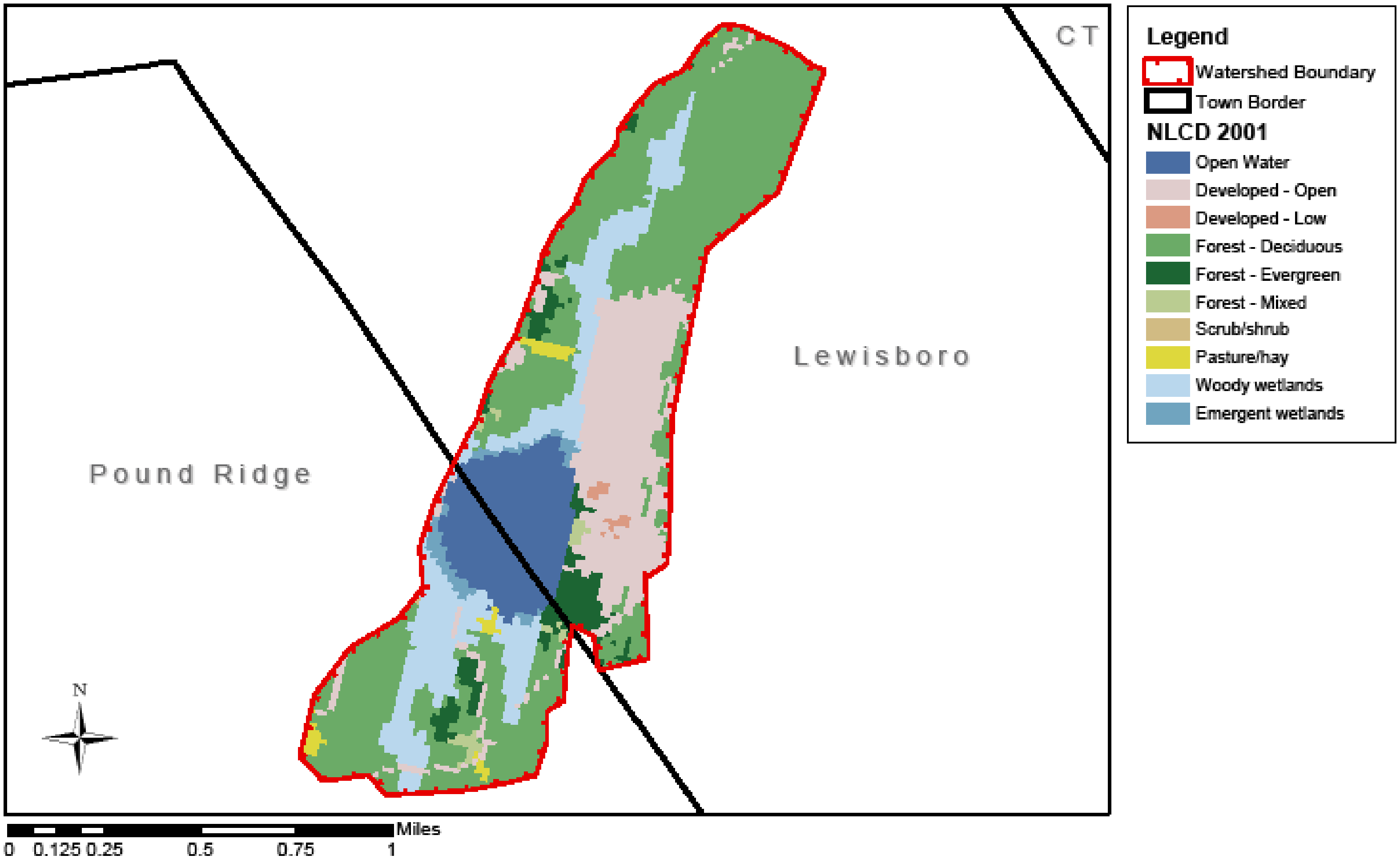
Class	N Structures	Average Household	Estimated Population*
Not limited	0	2.5	0
Somewhat limited	57	2.5	143
Very limited	71	2.5	175
Total	**127**		**318**

Estimated Phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%.

Class	Population*	P per cap	Transport	kg/year
Not limited	0	0.6	10%	0
Somewhat limited	135	0.6	30%	24
Very limited	166	0.6	60%	60
Failed systems (5%)	17	0.6	100%	10
Total	**318**			**94**

Figure 3

Lake Kitchawan
National Land Cover Dataset 2001

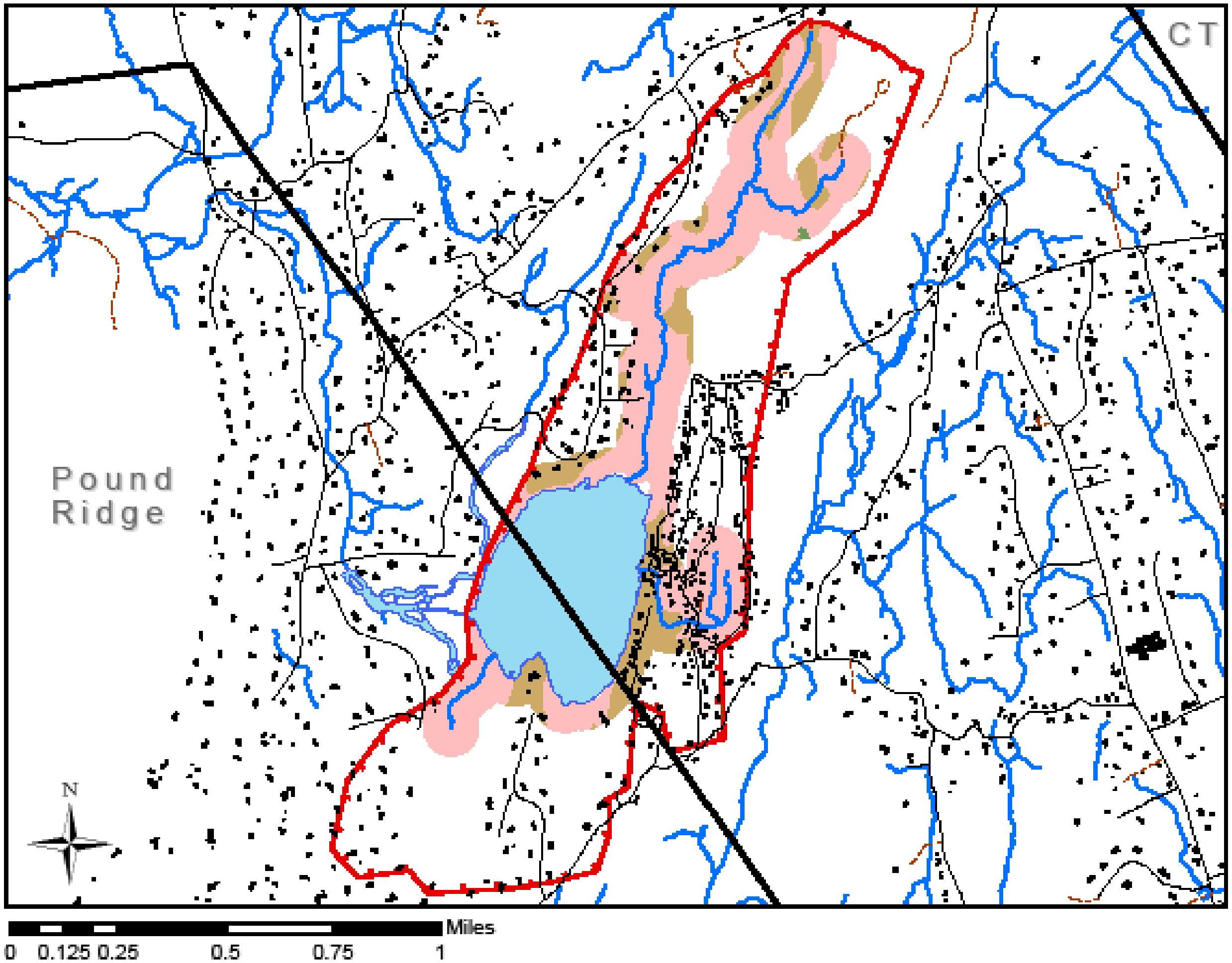


Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4

Lake Kitchawan

Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Legend

- Watershed Boundary
- Town Border
- Lakes
- Streams
- Structures

Roads

- Paved
- Unpaved

Septic Suitability

- Not limited
- Somewhat limited
- Very limited

Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.
"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

EcoLogic

(C) Point Sources: There are no known point sources of phosphorus to Lake Kitchawan

(D) Summary of Phosphorus Input to the Lake:

Source	Input (kg/year)
Watershed Land Cover	37
Point Sources	0
Septic within 100m of surface water	94
Internal loading (sediment)	0
Total	**131**

<u>Phosphorus Mass Balance:</u> Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10+H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = residence time (year)

Parameter	Units	Result
W′	g/m^2/year	303
H	m	1.7
ρ	flushes per year	0.37
p	**ug/l**	**28**
Summer average TP 2007 and 2008, upper waters:		**22 ug/l**

REFERENCES

ENSR Corporation. 2008. Final Report - Lake/Lagoon and Watershed Management Plan for Lake Kitchawan –Pound Ridge, NY. Prepared for Lake Kitchawan Conservation Committee, Pound Ridge, New York. March 2008. Document number 12567-002-100.

Invasive Species Council of New York State. Early Detection Invasive Plants by Region. Web site: http://www.ipcnys.org/. Obtained on-line 11/29/07.

New York Natural Heritage Program. Letter dated December 21, 2007 received by EcoLogic, LLC. New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources.

US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

3.3. Truesdale Lake

Truesdale Lake

Surface water quality classification: Class B

Morphology Summary:

Characteristic	Units	Value	Source
Surface area	hectares	34	Land-Tech 2001
Watershed area	hectares	972*	EcoLogic 2008 (excl lake)
Volume	mgal	99.2	Land-Tech 2001
Elevation	m	153	NYSDEC 2007
Maximum depth	m	3.4	Land-Tech 2001
Average Depth	m	1.1**	EcoLogic 2008

* Approximately 49% of the lake's watershed area lies within the State of Connecticut.
**EcoLogic calculated from Land-Tech data: mean depth = volume divided by area.

Lake Inlet: A perennial watercourse discharges into the northeastern portion of the lake from Pumping Station Swamp, a drinking water wellfield located on the border of New York and Connecticut (Land-Tech 2001). A smaller intermittent water course discharges to a cove in the northeast portion of the lake. The lake level is lowered seasonally to minimize damage from ice and to minimize encroachment of aquatic plants.

Recreational impacts: Recreational assessments degrade through mid summer (coincident with increasing lake productivity and despite decreasing weed densities) and improve slightly during late summer as weed densities drop. (NYSDEC 2007).

Lakeshore Development: Mix of forest and maintained lawns (Land-Tech 2001)

Lake Outlet: The lake discharges at the northern end of the lake through a concrete dam. The dam contains an 18-foot spillway with removable springboards allowing the lake levels to be seasonally managed. A spillway height of 14 inches is maintained during the summer months.

Additional Notes:

- Truesdale Lake is a man-made lake created in 1927 by damming a stream and flooding a small pond and surrounding swamp (Truesdale Lake web site[1])
- Sediments accumulate in the lake at a rate of approximately 0.1-0.3 inches per year (Land-Tech 2001).
- Volunteer monitoring Truesdale Inlet from May to August 31 2007 measured Orthophosphate at average concentration of 63.2 ug/l.

[1] Truesdale Lake web site <http://www.truesdalelake.com/>

Figure 1
Truesdale Lake Aquatic Vegetation Survey
Bathymetry Map
July 7, 2005

0 260 520 1,040 1,560 2,080 Feet

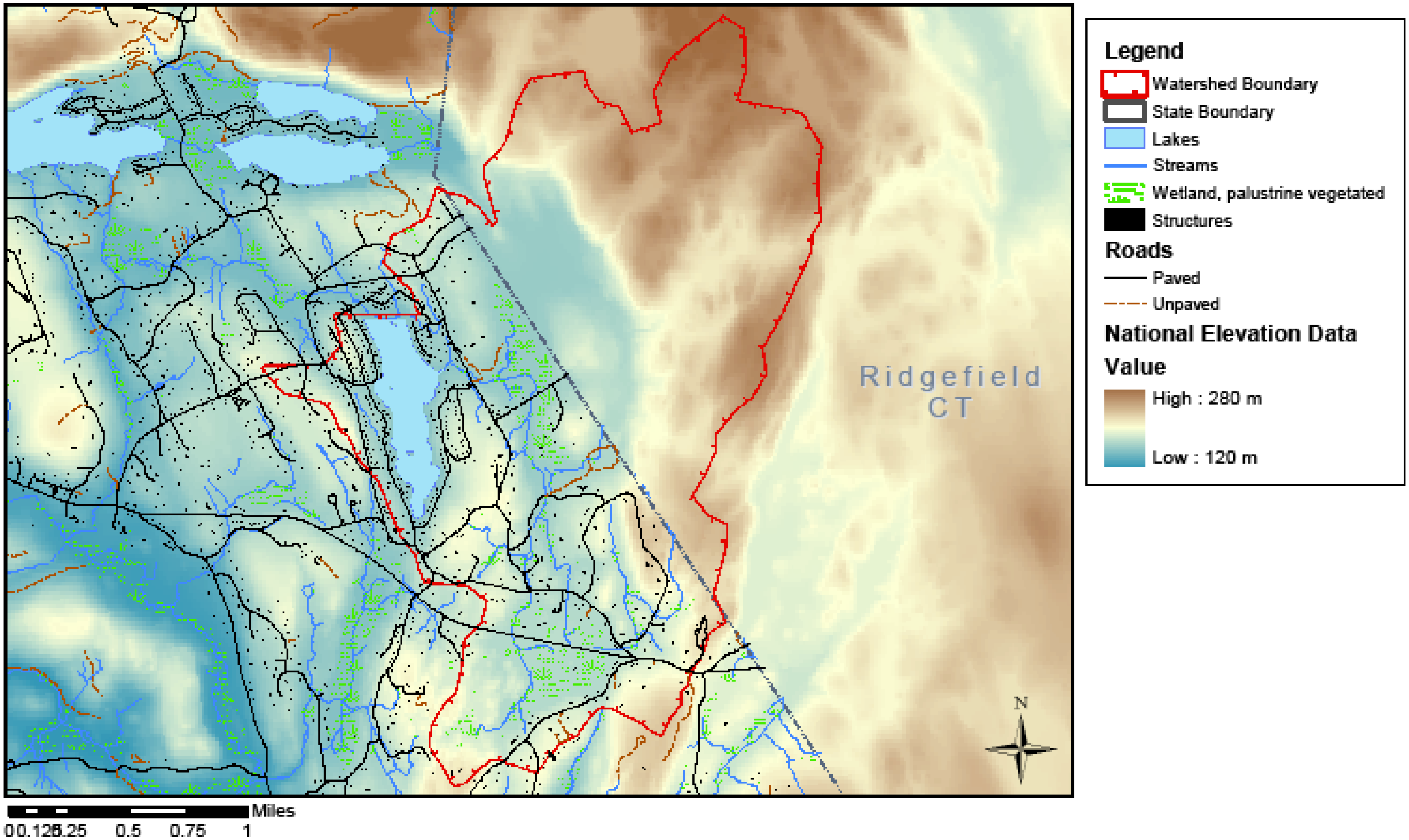
Legend

- Water Depth in feet

N

Allied Biological

Figure 2
Truesdale Lake
Topographic and Human Features



Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/. Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary: Data were collected under the Citizens Statewide Lake Assessment Program (CSLAP), at depths ranging from 1.0 to 1.5 meters (upper waters only). Table A below summarizes samples collected between January and December of each year. Table B below summarizes samples collected during the summer, defined as the period between June 15 and September 15 each year.

A. Representing samples collected between January and December each year.

Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Calcium (mg/l)	2003-2007	7	21.4	30	25.4
Chlorophyll-α (ug/l)	1999-2007	69	0.24	116	27.3
Color (platinum color units)	1999-2007	69	11	88	31.5
Conductivity (umhos/cm; 25°C)	1999-2007	70	110	322	263
Dissolved Nitrogen (mg/l)	2002-2007	45	0.005	1.52	0.66
Nitrate Nitrogen (mg/l)	1999-2007	71	0.0015	0.14	0.023
Ammonia Nitrogen (mg/l)	2002-2007	47	0.005	0.20	0.038
Phosphorus (mg/l)	1999-2007	78	0.018	0.125	0.057
Nitrogen:Phosphorus Ratio	2002-2007	44	0.20	61	13.6
pH (std units)	1999-2007	68	7.02	9.17	8.02
Secchi depth (m)	1999-2007	72	0.53	2.7	1.23
Temperature (°C)	1999-2007	72	17	31	24

B. Representing samples collected between June 15 and September 15 each year.

Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Chlorophyll-α (ug/l)	1999-2007	69	1.9	116	30.21
Dissolved Nitrogen (mg/l)	2002-2007	35	0.147	1.52	0.70
Nitrate N (mg/l)	1999-2007	55	0.0015	0.14	0.023
Ammonia N (mg/l)	2002-2007	36	0.005	0.155	0.035
Phosphorus (mg/l)	1999-2007	62	0.018	0.125	0.059
Nitrogen:Phosphorus Ratio	2002-2007	35	1.86	61	13.26
Secchi depth (m)	1999-2007	56	0.53	2.48	1.09

EcoLogic August 2008 water quality data summary:

A. Analytical Results 08/12/2008

Parameter (units)	Surface (0 m)	Depth (3.3 m)
Secchi Transparency (m)	0.75	na
Chlorophyll-a (mg/l)	0.12	na
Alkalinity (mg/l)	80	na
Phosphorus:		
Total Phosphorus (mg/l)	0.092	0.096
Soluble Reactive Phosphorus (mg/l)	0.0070[a]	0.021[a]
Nitrogen:		
Nitrate + Nitrite as N (mg/l)	0.065[a]	0.092[a]
Total Kjeldahl Nitrogen (mg/l)	1.3[a]	1.6[a]
Total Nitrogen (mg/l)	1.4	1.7

na – not analyzed
[a]The result of the laboratory control sample was greater than the established limit.

B. Field Profiles

Depth ft (m)	Temperature (°C)	pH	Conductivity (us)	DO (mg/l)	DO (% sat)
1 (0.305)	23.8	7.7	308	7.1	83.9
2 (0.61)	23.9		308	7.0	81.9
3 (0.915)	23.8		308	6.9	81.6
4 (1.22)	23.8		308	6.8	81.1
5 (1.525)	23.7		309	6.6	78.5
6 (1.83)	23.7		309	6.7	79.1
7 (2.135)	23.6		309	6.4	74.0
8 (2.44)	23.3		308	6.3	74.4
9 (2.745)	23.1		305	5.6	67.0
10 (3.05)	21.8		275	4.2	48.3

Sediment data summary:

- Composite samples collected May 2001 (Land-Tech, 2001):

Parameter (units)	Result
Phosphorus (mg/kg)	410
Copper (mg/kg)	34

- Composite samples collected August 12, 2008 (EcoLogic, 2008):

Parameter	Analytical Method	Result-1 (mg/kg dry wt)	Result-2 (mg/kg dry wt)
Pesticides/PCBs	EPA 8081/8082	ND	ND
TCL Volatiles	EPA 8260B	ND	ND
TCL Semi-Volatiles	EPA 8270	ND	ND
RCRA Total Metals	EPA 6010		
Arsenic		ND	ND
Barium		19	26
Cadmium		0.23	0.32
Chromium		3.3	4.7

Parameter	Analytical Method	Result-1 (mg/kg dry wt)	Result-2 (mg/kg dry wt)
Copper		240	210
Lead		7.8	8.2
Selenium		ND	ND
Silver		ND	ND
RCRA Mercury	EPA 7471	ND	ND
Total Organic Carbon	EPA 9060	132000	39300
Total Solids	SM 18-20 2540B	9.2%	26%
ND – non-detect. Analytes reported as less than the method detection limit.			

Sediment Contaminant Analysis: Interest has been expressed in exploring the feasibility of dredging. A composite sediment sample was collected on August 13, 2008 (EcoLogic, 2008) to determine if any threshold screening values that might preclude dredging were exceeded. Results are summarized in Table C, in the context of NYSDEC Screening levels. A complete set of results is attached to the end of this report. (Attachment 2 - 2008 Water Quality and Sediment Sampling Locations and Laboratory Analysis Reports). The NYSDEC screening levels are separated into three Classes: A, B, and C:

- **Class A - No Appreciable Contamination (No Toxicity to aquatic life).**
  If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and in-water or riparian placement, at approved locations, can generally proceed.

- **Class B - Moderate Contamination (Chronic Toxicity to aquatic life).**
  Dredging and riparian placement may be conducted with several restrictions. These restrictions may be applied based upon site-specific concerns and knowledge coupled with sediment evaluation.

- **Class C - High Contamination (Acute Toxicity to aquatic life).**
  Class C dredged material is expected to be acutely toxic to aquatic biota and therefore, dredging and disposal requirements may be stringent. When the contaminant levels exceed Class C, it is the responsibility of the applicant to ensure that the dredged material is not a regulated hazardous material as defined in 6NYCRR Part 371. This TOGS does not apply to dredged materials determined to be hazardous.

Table C. Truesdale Lake sediment analytical results for two samples, with NYSDEC Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement. Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem. Results that fall into Class C (high contamination) are highlighted.

Compound	Required Method Detection Limit	Threshold Values			Truesdale Results	Threshold Class
		Class A	Class B	Class C		
Metals (mg/kg dry wt) – EPA Method 6010B						
Arsenic	1.0	< 14	14 – 53	> 53	ND; ND	A
Cadmium	0.5	< 1.2	1.2 - 9.5	> 9.5	0.23; 0.32	A
Copper*	2.5	< 33	33 – 207	> 207	240; 210	C
Lead	5.0	< 33	33 – 166	> 166	7.8; 8.2	A
Mercury+	0.2	< 0.17	0.17 - 1.6	> 1.6	ND; ND	A
PAHs and Petroleum-Related Compounds (mg/kg dry wt) – EPA Methods 8020, 8021, 8260 and 8270						
Benzene	0.002	< 0.59	0.59 - 2.16	> 2.16	ND; ND	A
Total BTEX*	0.002	< 0.96	0.96 - 5.9	> 5.9	ND; ND	A
Total PAH[1]	0.33	< 4	4 - 35	> 35	ND; ND	A
Pesticides (mg/kg dry wt) – EPA Methods 8081						
Sum of DDT+DDD+DDE+	0.029	< 0.003	0.003 - 0.03	> 0.03	ND; ND	A
Mirex*+	0.189	< 0.0014	0.0014 - 0.014	> 0.014	na	--
Chlordane*+	0.031	< 0.003	0.003 - 0.036	> 0.036	ND; ND	A
Dieldrin	0.019	< 0.11	0.11 -0. 48	> 0.48	ND; ND	A
Chlorinated Hydrocarbons (mg/kg dry wt) – EPA Methods 8082 and 1613B						
PCBs (sum of aroclors)[2]	0.025	< 0.1	0.1 - 1	> 1	ND; ND	A
2,3,7,8-TCDD*[3](sum of toxic equivalency)	0.000002	< 0.0000045	0.0000045 - 0.00005	> 0.00005	na	--

na – not analyzed; "<" – indicates result was not detected above the level reported.

+Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit.

* Indicates case-specific parameter. The analysis and evaluation of these case specific analytes is recommended for those waters known or suspected to have sediment contamination caused by those chemicals. These determinations are made at the discretion of Division staff.

[1]For Sum of PAH, see Appendix E of TOGS 5.1.9. For Truesdale Lake, each of the 18 PAH compounds in two samples were reported as non-detect (<0.8 and <1 mg/kg).

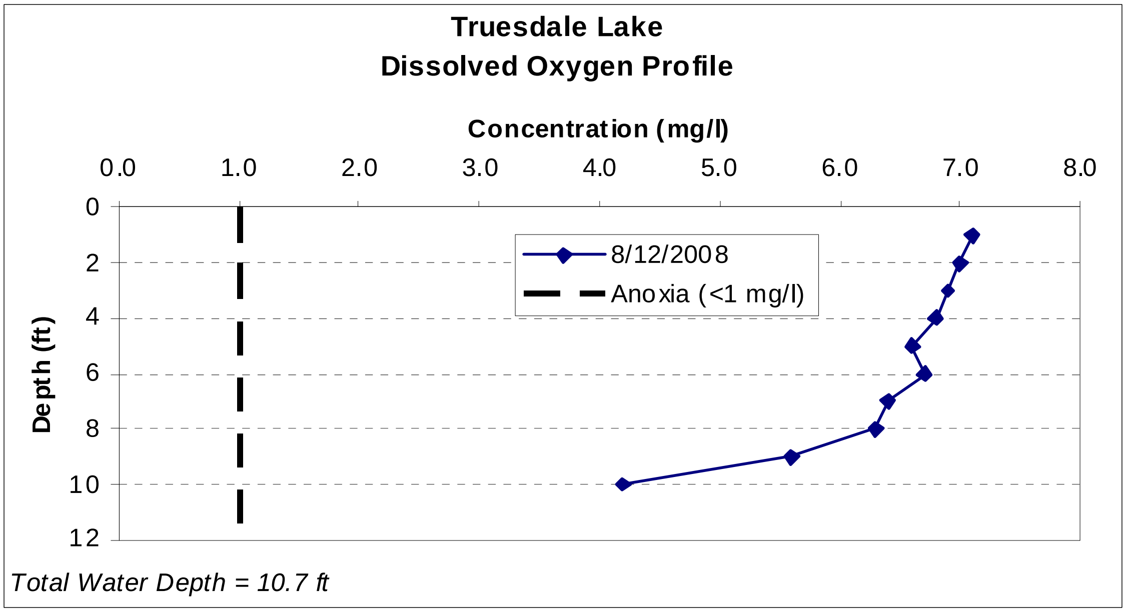
[2]For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. For Truesdale Lake, seven Aroclors were each reported as <0.2 mg/kg; this value is reported above.

[3]TEQ calculation as per the NATO - 1988 method (see Appendix D of TOGS 5.1.9).

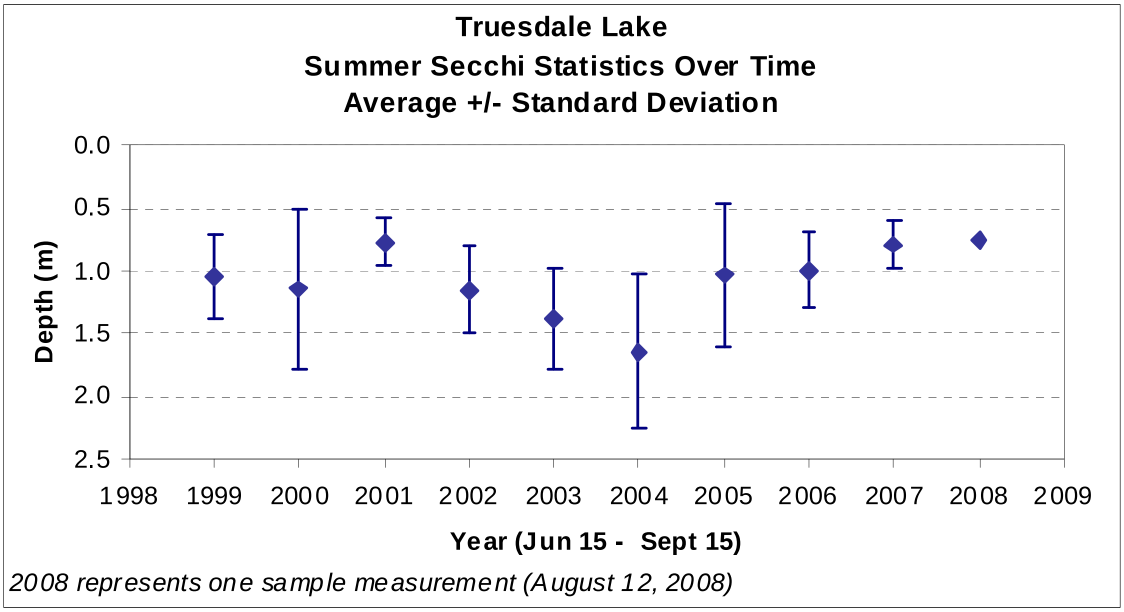
Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

Source: Table 2, NYSDEC Division of Water, Technical & Operational Guidance Series (TOGS) 5.1.9, "In-Water and Riparian Management of Sediment and Dredged Material", Nov. 2004

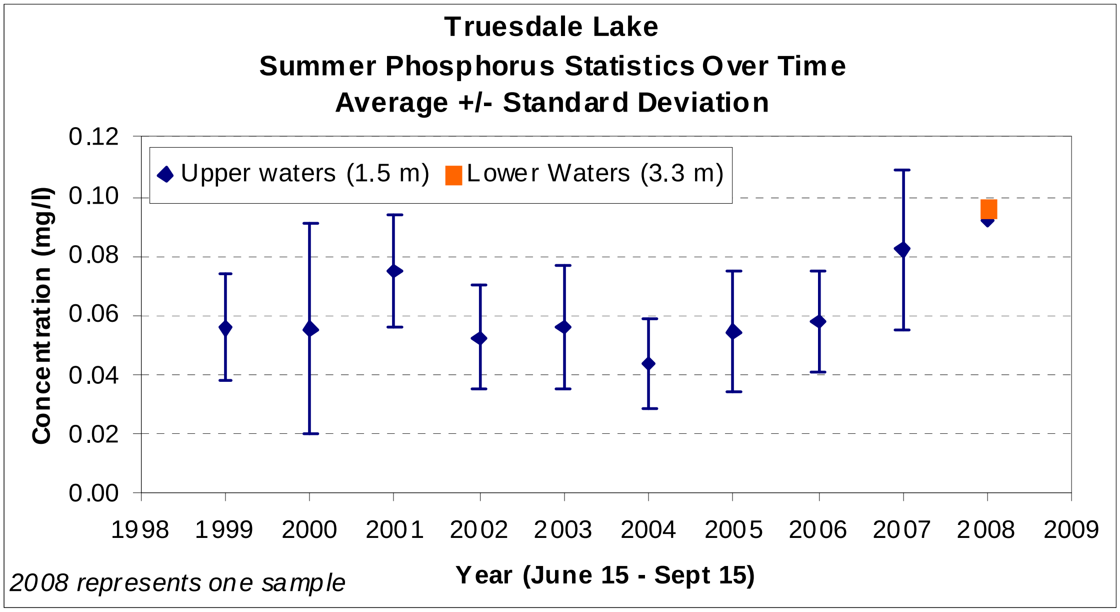
Anoxia: Based on the dissolved oxygen profile collected on August 12, 2008, oxygen levels were depleted in the lower waters, but anoxic conditions (concentrations less than 1 mg/l) were not observed in the lake.



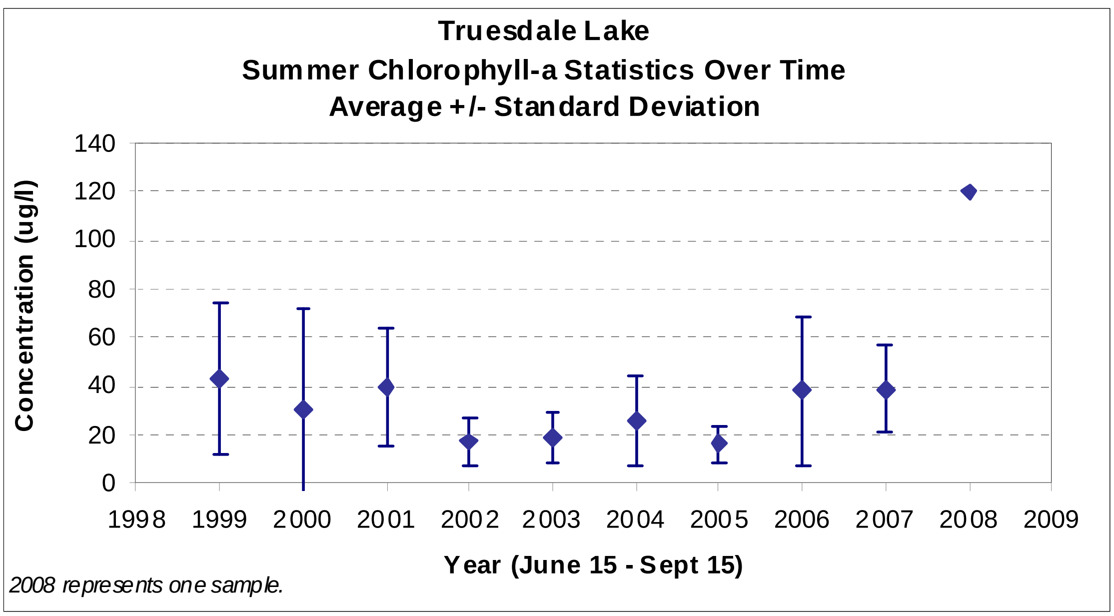
Water Clarity: Averages over time are generally less than 2 meters. The historical variability around the mean is about half a meter.



Phosphorus Concentrations: Phosphorus concentrations in upper waters have been fairly stable since 1999. There are no phosphorus data for lower waters prior to 2008. In 2008, lower and upper waters phosphorus concentrations are similar.



Chlorophyll-α: Chlorophyll-α concentrations are generally lower for the 2002 through 2005 time period than for the 1999 through 2001 period. The concentrations in 2006 and 2007 are comparable to the 1999 through 2001 period. The standard deviations show considerable variability over time.



Trophic Status:

Parameter	Trophic State (shading indicates match to Lake)				Truesdale Lake*
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	59
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	30
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	116
Average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	1.09
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	0.53
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	48.3

*Data shown represent the period 1999-2007, except for dissolved oxygen, which was collected at a depth of 10 feet by EcoLogic on 08/12/2008.

Aquatic Habitat:

- The lake lacks habitat diversity; it is shallow with gentle slopes offering little variation in depth for fish habitat. (Land-Tech 2001)

- Aquatic vascular plants and algae are a major problem in Lake Truesdale. The physical removal of weeds goes back to 1950 using weed cutters and harvesting. Chemical treatment was initiated in 1957 under the direction of Cornell University's State School of Agriculture, Conservation Department. (Land-Tech 2001).

- Vegetation survey was conducted on July 7, 2005 (Allied Biological):

  - Truesdale Lake was treated with an aquatic herbicide ten days before the vegetation survey (June 27, 2005). The target macrophytes were Curly-leaf pondweed (*P. crispus*) and Leafy pondweed (*P. foliosus*). Since neither of these pondweeds were observed during the July 7th survey, that treatment can be considered a success.
  - Benthic filamentous algae was scattered throughout the lake, as was stonewort. Southern Naiad was observed mostly in the northern half of the lake but almost exclusively in trace amounts. As Southern Naiad is a late season annual, the July 7th survey is probably not an accurate representation of its true distribution later in the season. Common Waterweed was only observed at three sample locations in Lake Truesdale.
  - List of Aquatic Plants identified in 2005:

Scientific Name	Common Name
Miscellaneous	Benthic filamentous algae
Nitella spp.	Stonewort, Nitella
Najas guadalupensis	Southern naiad, southern water nymph, bushy pondweed
Elodea canadensis.	Elodea, common water weed

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	Common Name
Heracleum mantegazzianum	Giant Hogweed
Wisteria floribunda	Japanese Wisteria, Wisteria
Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg's Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
Haliaeefus leucocephalus	Bald Eagle	Threatened, entire state
Mammals		
Myotis sodalist	Indiana Bat	Endangered, entire state
Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
Isotria medeoloides	Small Whorled Pogonia	Threatened, entire state
Platanthera leucophea	Eastern Prairie Orchid	Threatened, not relocated in NY
Scirpus ancistrochaetus	Northeastern Bulrush	Endangered, not relocated in NY

- New York Natural Heritage Program – Town of Lewisboro

Scientific Name	Common Name	NY Legal Status
Reptiles		
Glyptemys muhlenbergii (formerly Clemmys muhlenbergii)	Bog Turtle	Endangered
Birds		
Oporornis formosus	Kentucky Warbler	Protected
Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	336
Evaporation (ET)	22	154
Runoff (R)	26	5,206

Water Budget:	
Inflow to Lake [R+(P-ET)]	1,756 mgal/year
Lake Volume	180 mgal
Flushing Rate	10 times/year
Residence Time	0.10 years

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed (acres)	Cover (%)	Phosphorus Export Coeff	Estim P Export kg/year	Estim P Export Percent
Open water (all)	90	3.5	0.30	11	9.0
Developed, open space	380	15	0.20	31	25
Developed, low intensity	6.3	0.25	0.30	0.77	0.63
Developed, moderate intensity	2.5	0.10	0.50	0.52	0.42
Deciduous forest	1,569	61	0.07	44	36
Evergreen forest	105	4.1	0.20	8.5	6.9
Mixed forest	36	1.4	0.09	1.3	1.1
Shrub/scrub	3.8	0.15	0.28	0.43	0.35
Grassland/herbaceous	2.2	0.09	0.28	0.25	0.21
Pasture/hay	106	4.1	0.30	13	11
Cultivated crops	2.0	0.08	2.10	1.7	1.4
Woody wetlands	264	10	0.09	9.6	7.9
Total Acres*	**2,567**	**100**		**122**	**100**

*Watershed area includes the area located in the State of Connecticut.

(B) Septic: Assumes that communities around the lake are on septic systems.

Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

Class	N Structures	Average Household	Estimated Population*
Not limited	9	3	27
Somewhat limited	198	3	594
Very limited	96	3	288
Total	**303**		**909**

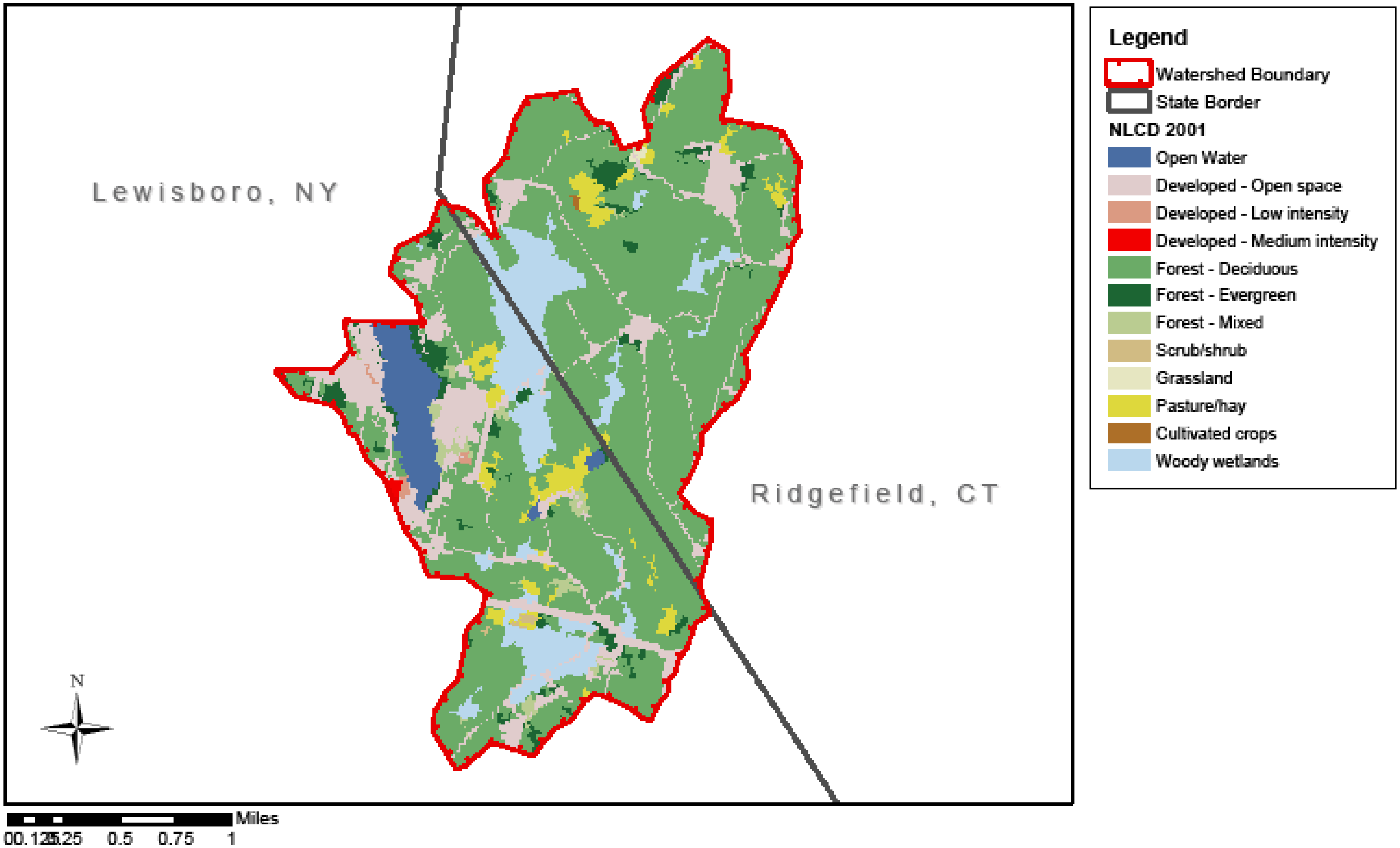
*Population estimate does not include the area of the watershed located in the State of Connecticut; a Structures file was not available to conduct the analysis.

Estimated Phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%.

Class	Population*	P per cap	Transport	kg/year
Not limited	26	0.6	10%	1.5
Somewhat limited	564	0.6	30%	102
Very limited	274	0.6	60%	98
Failed systems (5%)	45	0.6	100%	27
Total	**909**			**229**

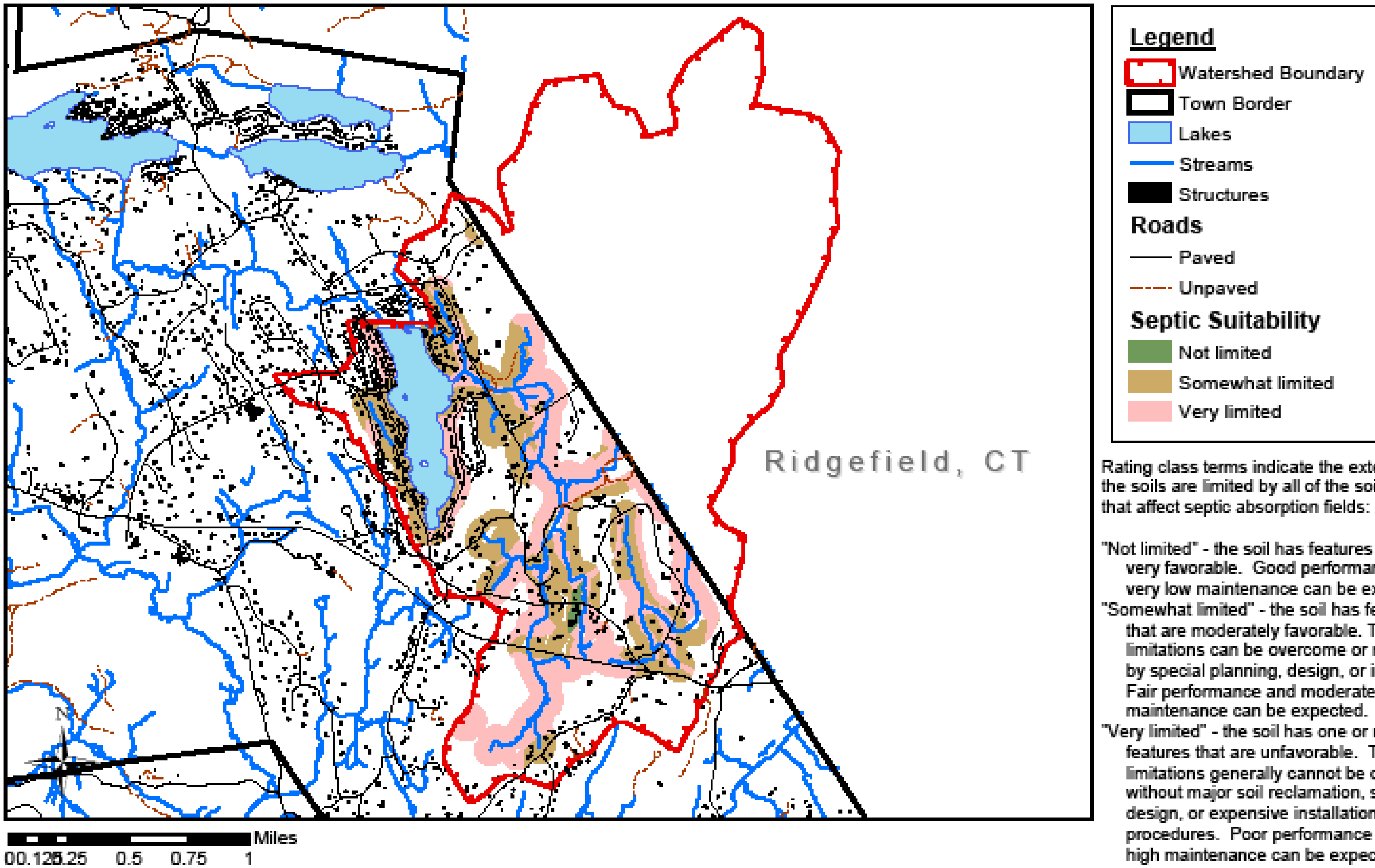
*Population estimate does not include the area located in the State of Connecticut; a Structures file was not available for this area.

Figure 3
Truesdale Lake
National Land Cover Dataset 2001



Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4
Truesdale Lake
Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.
"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

EcoLogic

(C) Point Sources: There are no known point sources of phosphorus to Truesdale Lake.

(D) Summary of Phosphorus Input to the Lake:

Source	Input (kg/year)
Watershed Land Cover	122
Point Sources	0
Septic within 100m of surface water	229
Internal loading (sediments)	0
Total	**351**

<u>Phosphorus Mass Balance:</u> Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10 + H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = flushes per year

Parameter	Units	Result
W′	g/m^2/year	1,032
H	m	2.0
ρ	flushes per year	0.10
p	**ug/l**	**101**
Summer (Jun 15 – Sept 15) average TP 1999-2007, upper waters:		**54 ug/l**

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New York State Department of Environmental Conservation. 2007. 2006 Interpretive Summay, New York Citizens Statewide Lake Assessment Program (CSLAP) 2006 Annual Report - Lake Truesdale. October 2007. With New York Federation of Lake Associations. Scott A. Kishbaugh, PE.

Truesdale Lake web site http://www.truesdalelake.com/

US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

3.4. Lake Oscaleta

Lake Oscaleta

Surface water quality classification: Class B

Morphology Summary:

Characteristic	Units	Value	Source
Surface area	hectares	26	Cedar Eden 2004
Watershed area*	hectares	384	EcoLogic 2008 (excl lake)
Volume	mgal	412	Cedar Eden 2004
Elevation	m	144	CSLAP 2006
Maximum depth	m	10.8	Cedar Eden 2004
Average Depth	m	5.9	Cedar Eden 2004
*Approximately 73% of the watershed area is within the State of Connecticut; approximately 6% is located in the Town of North Salem.			

Lake Inlet: at the northeast end via channel from Lake Rippowam (Cedar Eden 2002), and via Rippowam Creek on the east shore.

Lake Outlet: at the western end of the lake, discharging via channel to Lake Waccabuc.

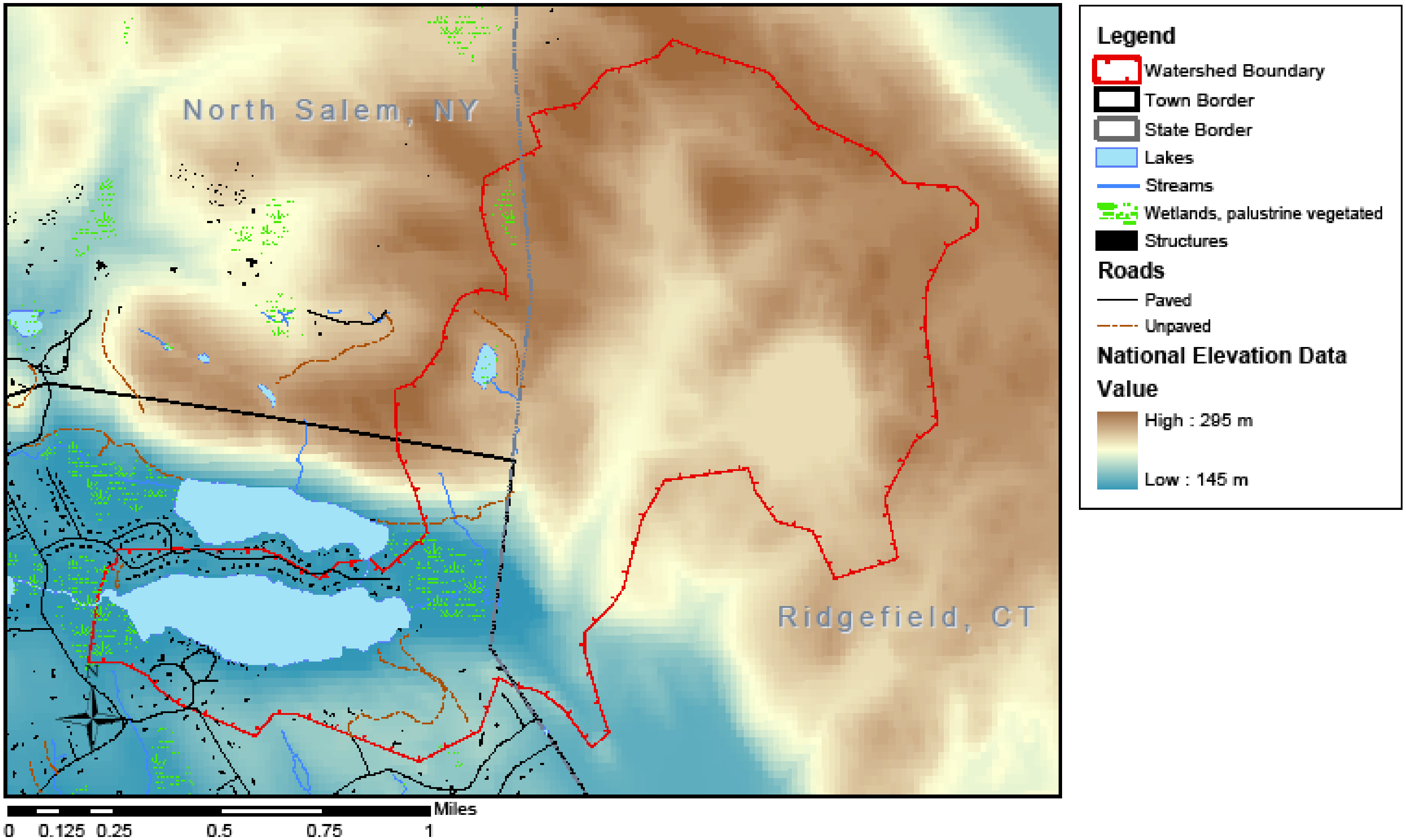
Recreational impacts: Water quality and aquatic plants were both cited as impacting recreational assessments, although the most significant impacts were associated with poor clarity and high algae levels. (CSLAP 2006)

Lakeshore Development: Northern shore (Twin Lakes Community built in the 1950's). Southern shore there is a cluster of camps (built in early 1900's) that are now mostly year-round homes. Community beach at the northwest end. Otherwise, the shoreline is forested. Forested wetlands at eastern and western ends of the lake (Cedar Eden 2002).

Figure 1
Lake Oscaleta
Bathymetry

Figure 4.2 Bathymetric map of Lake Oscaleta
Data Source: Field Points by P.Lewis, 5 foot contours by CEE LLC

Figure 2
Lake Oscaleta
Topographic and Human Features



Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/. Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary: Data have been collected as part of the New York Citizens Statewide Lake Assessment Program (CSLAP), as well as by the Three Lakes Council and other entities over time. Depths ranging from 0 to 11 meters (both upper and lower waters), including some half-meter increment profiles. Table A below summarizes samples collected between January and December of each year; the statistics represent averages of sample results for the time period for all depths, unless otherwise noted. Table B below summarizes samples collected during the summer, defined as the period between June 15 and September 15 each year.

A. Representing samples collected between January and December each year.

Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Alkalinity (mg/l)	1972-1974	52	15	45	29
	2002-2007	8	16	38	31
Calcium (mg/l)	2006-2007	4	11.7	15.6	12.77
Chlorophyll-α (mg/m^3) – Jun-Sept	1979	19	0.81	19.8	6.13
	1980-1982	23	0.75	56	7.13
	2002-2007	41	0.16	53.6	8.90
Color (platinum color units)	2006-2007	16	8	35	16.75
Conductivity	1972-1974	49	94	132	109
	2002-2007	39	108	177	146
Fe++ (mg/l)	1975	10	0.025	0.45	0.15
Mn++ (mg/l)	1975	10	0.01	1.01	0.40
pH (std units)	1972-1974	52	6.3	7.36	6.80
	2002-2007	28	6.85	10.03	7.87
Phaeophytin-α (mg/m^3)	2003-2006	19	0.005	2.1	0.38
Secchi depth (m)	1972-1979	97	1.0	5.3	3.34
	1980-1983	69	1.5	4.25	2.92
	2002-2007	88	0.5	4.42	2.73
Temperature:					
Surface (°C) (depth <2m)	1974-1979	32 (0-1 m)	17	27.5	22.98
	1981-1983	78 (0-1 m)	6.8	28.3	20.4
	1991	2 (0-1.5m)	25	26	25.5
	2002-2007	170 (0-1.5 m)	3.3	31	19.57
Depth >8m (°C)	1978-1979	22 (9-10 m)	8.5	11	9.5
	1981-1982	29 (9 m)	6.5	10.5	8.13
	1991	1 (9.1 m)	8.5	8.5	8.5
	2002-2007	204 (9-11 m)	3.8	10.2	7.06
Dissolved Oxygen:					
Surface (mg/l) (<2 m)	1972-1979	30 (0-1 m)	7.8	10	8.79
	1981-1983	78 (0-1 m)	4.4	12.3	8.22
	1991	2 (0-1.5 m)	7.9	8.0	7.95
	2002-2007	152 (0-1 m)	7.13	16	10.0
Depth >8m (mg/l)	1978-1979	19 (9-10 m)	0	0.5	0.12
	1981-1982	29 (9 m)	0	7.8	1.04
	1991	1 (9.1 m)	1.1	1.1	1.1
	2002-2007	198 (9-11 m)	-0.77	12.28	2.43

A. Representing samples collected between January and December each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Nutrients					
Phosphorus:					
Surface (mg/l) (<2 m)	2002-2007	43 (1.5 m)	0.012	0.055	0.024
Depth >8m (mg/l)	1975 2004-2007	13 (9 m) 35 (9-10 m)	0.015 0.013	0.225 0.240	0.072 0.069
Soluble Reactive P (mg/l)	1975	14	0.001	0.131	0.043
Nitrate-N (mg/l)	1973-1975 2003-2007	34 21	0 0.003	0.19 0.045	0.052 0.011
Total Kjeldahl Nitrogen (mg/l)	1975 2002-2007	14 13	0.24 0.37	1.7 1.0	0.99 0.62
Ammonia Nitrogen (mg/l)	1973-1975 2006-2007	37 16	0.04 0.006	1.7 0.12	0.67 0.028

B. Representing samples collected between June 15 and September 15 each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Chlorophyll-α (mg/m^3)	1979 1980-1982 2002-2007	10 5 26	0.81 0.75 0.16	9.8 4.4 53.6	3.21 2.59 8.84
Phaeophytin-α (mg/m^3)	2003-2006	12	0.005	1.2	0.23
Secchi depth (m)	1972-1979 1980-1983 2002-2007	43 37 33	1 1.8 0.5	5 4.2 4.42	3.37 3.17 3.15
Dissolved Oxygen:					
Surface (mg/l) (< 2m)	1972-1979 1981-1983 1991 2002-2007	24 (0-1 m) 46 (0-1 m) 2 (0-1.5 m) 50 (0-1 m)	7.8 4.4 7.9 7.59	10 10.2 8 14.3	8.69 7.6 7.95 9.04
Depth >8 m (mg/l)	1978-1979 1981-1982 1991 2002-2007	16 (9-10 m) 15 (9 m) 1 (9.1 m) 64 (9-10.5 m)	0 0 1.1 -0.01	0.3 1.4 1.1 1.03	0.088 0.49 1.1 0.33
Nutrients					
Phosphorus:					
Surface (mg/l) (<2 m)	2002-2007	26 (1.5 m)	0.012	0.055	0.024
Depth >8 m (mg/l)	1975 2004-2007	4 (9 m) 21 (9-10 m)	0.053 0.013	0.225 0.133	0.129 0.065
Soluble Reactive P (mg/l)	1975	5	0.001	0.131	0.073
Nitrate-N (mg/l)	1973-1975 2003-2007	14 14	0.0005 0.0025	0.108 0.02	0.06 0.009

B. Representing samples collected between June 15 and September 15 each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Total Kjeldahl Nitrogen	1975	5	0.656	1.7	1.30
(mg/l)	2002-2007	9	0.374	1	0.640
Ammonia Nitrogen	1973-1975	14	0.53	1.55	0.96
(mg/l)	2006-2007	11	0.006	0.12	0.028

Sediment data summary: Composite samples collected May 29, 2008 (EcoLogic, 2008):

Parameter	**Analytical Method**	**Result (mg/kg dry wt)**
Pesticides/PCBs	EPA 8081/8082	ND
TCL Volatiles	EPA 8260B	ND
TCL PAHs	EPA 8270	ND
RCRA Total Metals	EPA 6010	
Arsenic		ND
Barium		ND
Cadmium		ND
Chromium		ND
Copper		1.1
Lead		2.0
Selenium		ND
Silver		ND
RCRA Mercury	EPA 7471	ND
Total Organic Carbon	EPA 9060	110,000
Total Solids	SM 18-20 2540B	6.1%
ND – non-detect. Analytes reported as less than the method detection limit.		

Sediment Contaminant Analysis: Interest has been expressed in exploring the feasibility of dredging. A composite sediment sample was collected on May 29, 2008 (EcoLogic, 2008). Results are summarized in Table C, in the context of NYSDEC Screening levels. A complete set of results is appended. The NYSDEC screening levels are separated into three Classes: A, B, and C:

- **Class A - No Appreciable Contamination (No Toxicity to aquatic life).**
  If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and in-water or riparian placement, at approved locations, can generally proceed.

- **Class B - Moderate Contamination (Chronic Toxicity to aquatic life).**
  Dredging and riparian placement may be conducted with several restrictions. These restrictions may be applied based upon site-specific concerns and knowledge coupled with sediment evaluation.

- **Class C - High Contamination (Acute Toxicity to aquatic life).**
  Class C dredged material is expected to be acutely toxic to aquatic biota and therefore, dredging and disposal requirements may be stringent. When the contaminant levels exceed Class C, it is the responsibility of the applicant to ensure that the dredged material is not a regulated hazardous material as defined in 6NYCRR Part 371. This TOGS does not apply to dredged materials determined to be hazardous.

Table C. Lake Oscaleta sediment analytical results with NYSDEC Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement. Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem. Results that fall into Class C (high contamination) are highlighted.

Compound	Required Method Detection Limit	Threshold Values Class A	Threshold Values Class B	Threshold Values Class C	Oscaleta Results	Threshold Class
Metals (mg/kg dry wt) – EPA Method 6010B						
Arsenic	1.0	< 14	14 – 53	> 53	ND	A
Cadmium	0.5	< 1.2	1.2 - 9.5	> 9.5	ND	A
Copper*	2.5	< 33	33 – 207	> 207	1.1	A
Lead	5.0	< 33	33 – 166	> 166	2.0	A
Mercury[+]	0.2	< 0.17	0.17 - 1.6	> 1.6	ND	A
PAHs and Petroleum-Related Compounds (mg/kg dry wt) – EPA Methods 8020, 8021, 8260 and 8270						
Benzene	0.002	< 0.59	0.59 - 2.16	> 2.16	ND	A
Total BTEX*	0.002	< 0.96	0.96 - 5.9	> 5.9	ND	A
Total PAH[1]	0.33	< 4	4 - 35	> 35	ND	A
Pesticides (mg/kg dry wt) – EPA Methods 8081						
Sum of DDT+DDD+DDE[+]	0.029	< 0.003	0.003 - 0.03	> 0.03	ND	A
Mirex*[+]	0.189	< 0.0014	0.0014 - 0.014	> 0.014	na	--
Chlordane*[+]	0.031	< 0.003	0.003 - 0.036	> 0.036	ND	A
Dieldrin	0.019	< 0.11	0.11 -0. 48	> 0.48	ND	A
Chlorinated Hydrocarbons (mg/kg dry wt) – EPA Methods 8082 and 1613B						
PCBs (sum of aroclors)[2]	0.025	< 0.1	0.1 - 1	> 1	ND	A
2,3,7,8-TCDD*[3](sum of toxic equivalency)	0.000002	< 0.0000045	0.0000045 - 0.00005	> 0.00005	na	--

na – not analyzed; ND – not detected

[+]Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit.

* Indicates case-specific parameter. The analysis and evaluation of these case specific analytes is recommended for those waters known or suspected to have sediment contamination caused by those chemicals. These determinations are made at the discretion of Division staff.

[1]For Sum of PAH, see Appendix E of TOGS 5.1.9. For Lake Oscaleta, each of the 16 PAH compounds were reported as non-detect (<0.5 mg/kg).

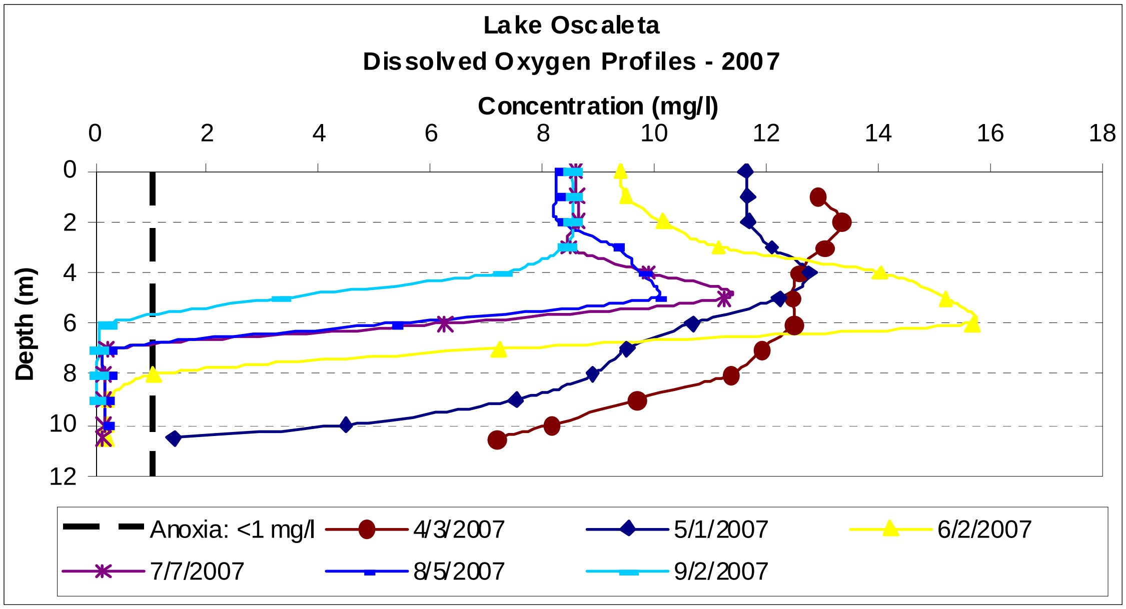
[2]For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. On Lake Oscaleta, seven Aroclors were each reported as <0.2 mg/kg; this value is reported above.

[3]TEQ calculation as per the NATO - 1988 method (see Appendix D of TOGS 5.1.9).

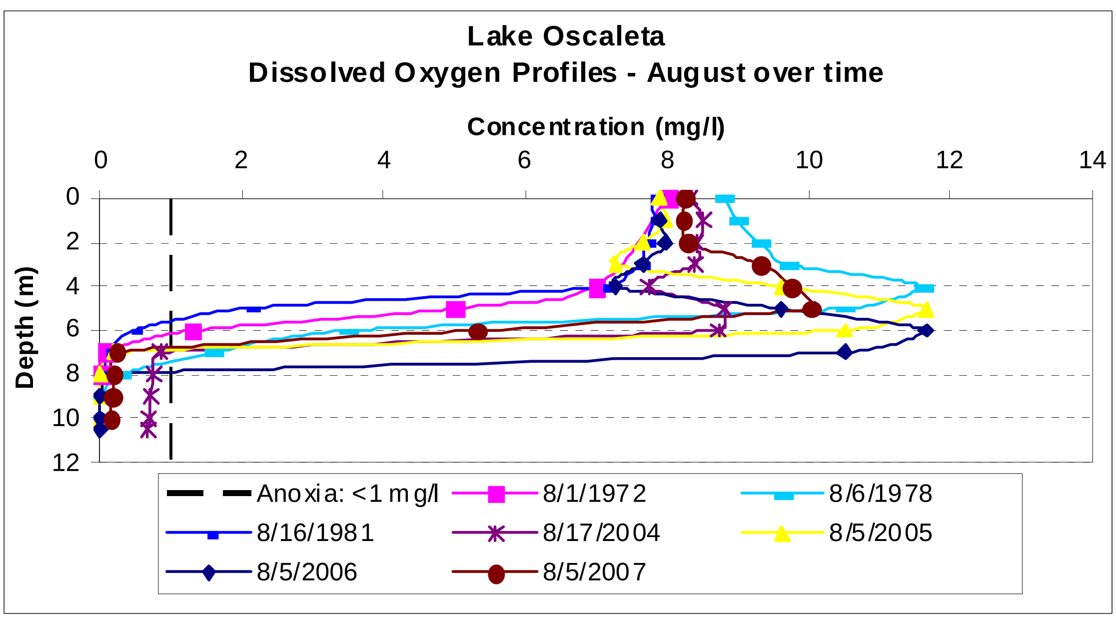
Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

Source: Table 2, NYSDEC Division of Water, Technical & Operational Guidance Series (TOGS) 5.1.9, "In-Water and Riparian Management of Sediment and Dredged Material", Nov 2004.

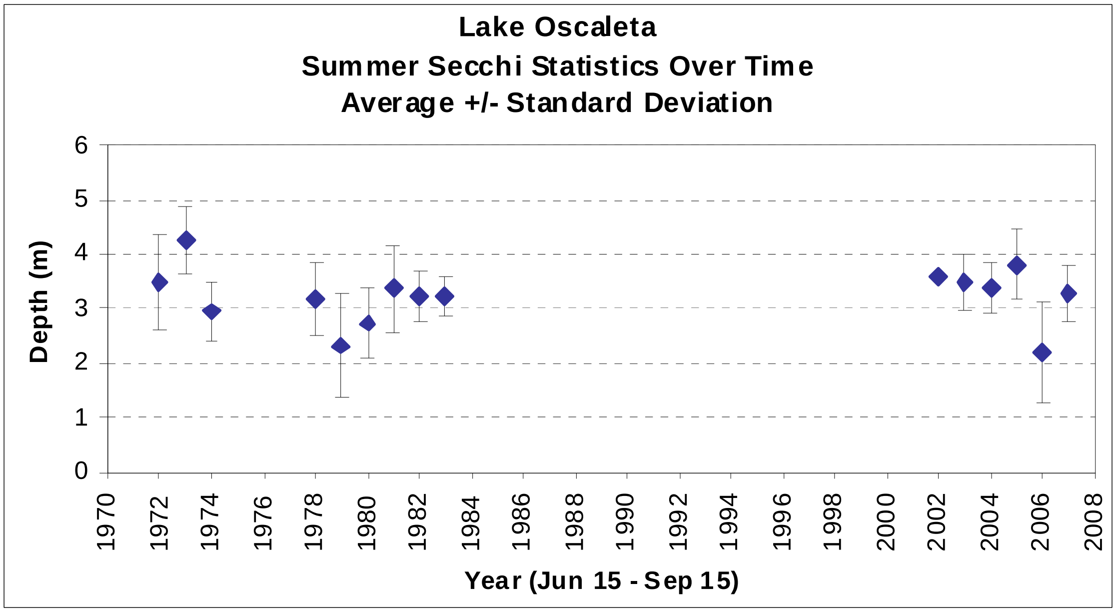
<u>Anoxia:</u> During 2007, the lake shows evidence of stratification as dissolved oxygen concentrations in lower waters become anoxic by June, and remain anoxic into September.



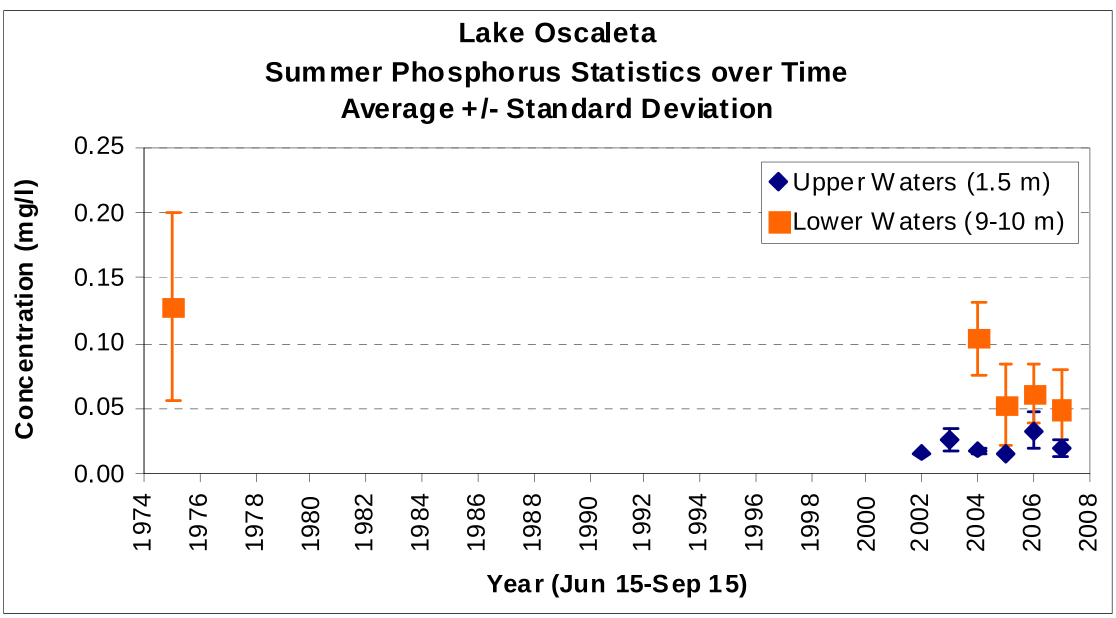
Dissolved oxygen decreases in lower waters, resulting in anoxic conditions in August at depths greater than 6 meters. These conditions were evident from the 1970's to the present.



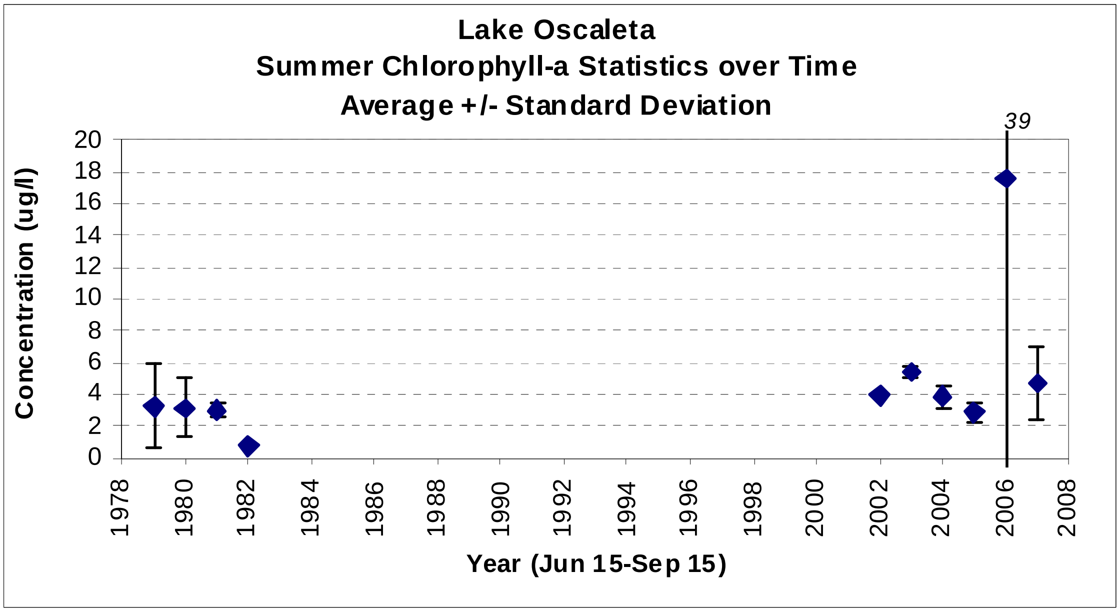
Water Clarity: Summer (June 15 to September 15) Secchi transparency averages over time are generally more than 3 meters, and historical variability around the mean is similar to recent years.



Phosphorus Concentrations: Phosphorus concentrations in upper waters have been fairly stable since 2002. During the summer months when anoxia occurs in the lower waters, phosphorus concentrations are higher in lower water samples than in upper water samples.



Chlorophyll-α: Chlorophyll-α concentrations are, on average, slightly higher in recent years compared with the late 1970's and early 1980's. The standard deviations show low variability of the data except for 2006.



Trophic Status:

Parameter	Trophic State (shading indicates match to Lake)				Lake Oscaleta*
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	24
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	8.8
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	54
Average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	3.15
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	0.5
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	2.79

*Phosphorus, chlorophyll and Secchi data for the period 2002-2007. Summer June 15 to September 15. Dissolved oxygen percent saturation calculated using data from June 15 to September 15 at depths greater than 10 m.

Aquatic Habitat:

- Phytoplankton in 2003 included Golden, Green and Bluegreen groups. June through July the Bluegreen groups dominated (#cells/ml ranged from 15,270-21,452); in August and September the Green and Golden groups were dominant (#cells/ml ranged from 10,225 to 3,298). (Cedar Eden 2004)

- Zooplankton in 2003 were dominated by Rotifers in June, accounting for 90% of the zooplankton community. In July, Cladocerans (*Bosmina/Ceriodaphnia*) dominated (50%). The Rotifers returned in September (52%) with Cladocerans and Copepods making up the rest of the population (24% and 25%, respectively. (Cedar Eden 2004)

- Aquatic Plants in July 2003 were present in large beds at the east and west ends, in a narrow band along the northern shore, and in some parts of the southern shore. Residents of the area have noted that bassweed may actually be out-competing the Eurasian water milfoil at the west end of the lake. (Cedar Eden 2004).

List of Aquatic Plants identified in 2003:

Scientific Name	**Common Name**
Brasena schreberi	Watershield
Ceratophyllum spp.	Coontail
Decodon spp.	Three-way sedge
Eleochaaris quadrangulata	Four-edge sedge
Eleocharis spp.	Spike-rush
Elodea canadensis	Canadian waterweed
Iris spp.	Iris
Lythrum salicaria	Purple loosestrife

Scientific Name	**Common Name**
Myriophyllum spicatum	Eurasian watermilfoil
Nuphar spp.	Yellow water lily
Nympheae spp.	White water lily
Pontederia cordata	Pickerelweed
Potamogeton amplifolius	Bassweed
Potamogeton robensii	Robin’s Pondweed
Sagittaria spp	Arrowhead
Scirpus spp.	Bulrush

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	**Common Name**
Heracleum mantegazzianum	Giant Hogweed
Wisteria floribunda	Japanese Wisteria, Wisteria
Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg’s Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
Haliaeefus leucocephalus	Bald Eagle	Threatened, entire state
Mammals		
Myotis sodalist	Indiana Bat	Endangered, entire state
Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
Isotria medeoloides	Small Whorled Pogonia	Threatened, entire state
Platanthera leucophea	Eastern Prairie Orchid	Threatened, not relocated in NY
Scirpus ancistrochaetus	Northeastern Bulrush	Endangered, not relocated in NY

- New York Natural Heritage Program – Town of Lewisboro.

Scientific Name	Common Name	NY Legal Status
Reptiles		
Glyptemys muhlenbergii (formerly *Clemmys muhlenbergii*)	Bog Turtle	Endangered
Birds		
Oporornis formosus	Kentucky Warbler	Protected
Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted*
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered*

* indicates particular concern for this lake and watershed.

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	265
Evaporation (ET)	22	122
Runoff (R)	26	2,058

Water Budget:	
Inflow to Lake [R+(P-ET)]	908 mgal/year
Lake Volume	412 mgal
Flushing Rate	2.2 times/year
Residence Time	0.45 year

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed* (acres)	Cover (%)	Phosphorus Export Coeff	Estim P Export kg/year	Estim P Export Percent
Open water (all)	97	9.0	0.30	12	22
Developed, open space	56	5.2	0.20	4.5	8.5
Developed, low intensity	1.8	0.17	0.30	0.22	0.41
Deciduous forest	683	63	0.07	19	37
Evergreen forest	147	14	0.20	12	22
Mixed forest	13	1.2	0.09	0.48	0.91
Shrub/scrub	1.3	0.12	0.28	0.15	0.29
Pasture/hay	21	1.9	0.30	2.5	4.7
Woody wetlands	54	5.1	0.09	2.0	3.7
Emergent herbaceous wetlands	2.9	0.27	0.10	0.12	0.22
Total Acres	**1078**	**100**		**53**	**100**

*Includes land area in Connecticut and North Salem.

(B) Septic: Septic systems serve the communities along the shoreline (Cedar Eden 2002).

Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

Class	N Structures*	Average Household	Estimated Population
Not limited	12	2.5	30
Somewhat limited	47	2.5	118
Very limited	9	2.5	23
Total	**68**		**171**

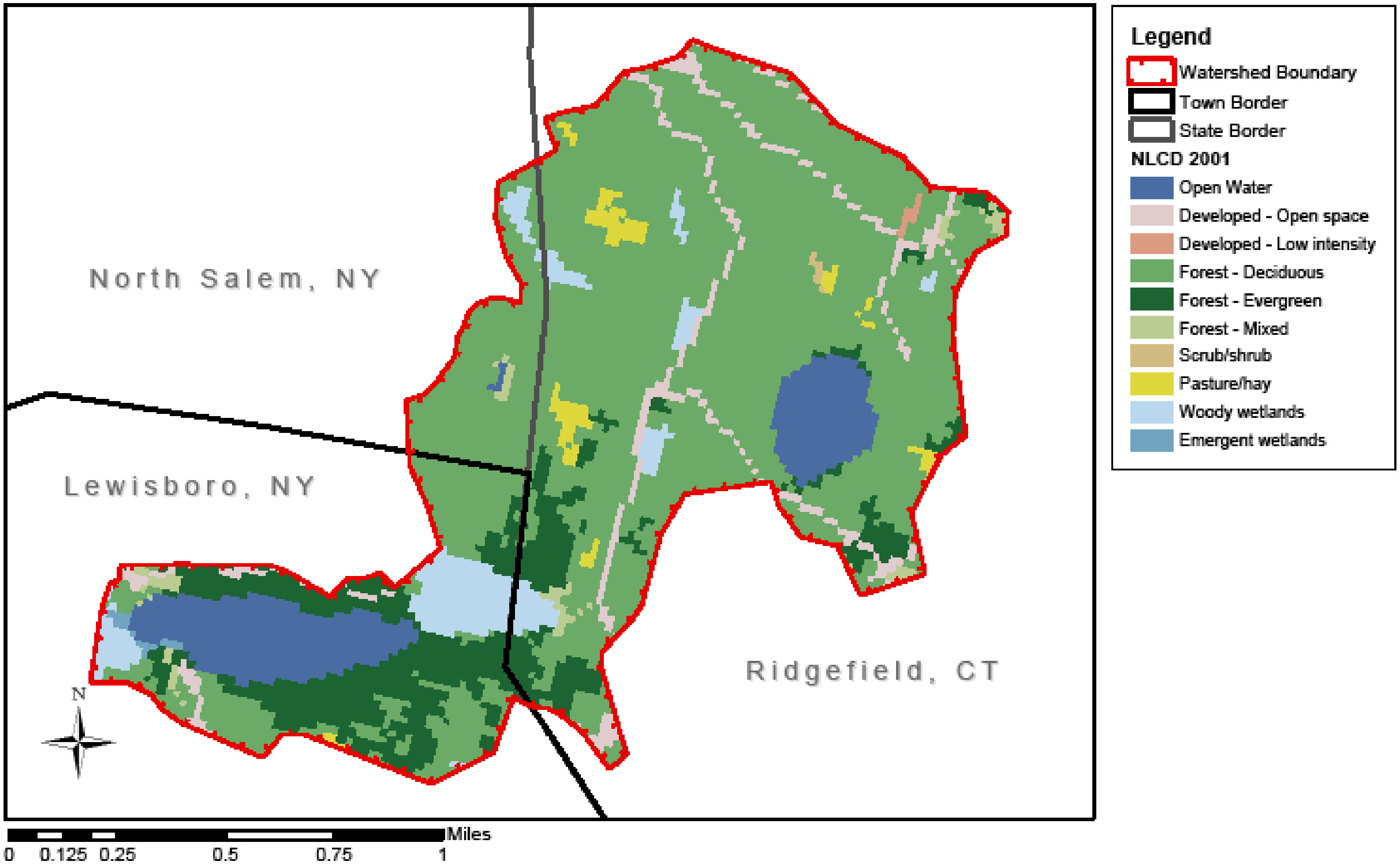
*Structures data not available for Connecticut portion of watershed.

Estimated Phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%. (Excludes Connecticut).

Class	Population	P per cap	Transport	kg/year
Not limited	29	0.6	10%	1.7
Somewhat limited	112	0.6	30%	20
Very limited	21	0.6	60%	7.7
Failed systems (5%)	9	0.6	100%	5.1
Total	**171**			**35**

Figure 3

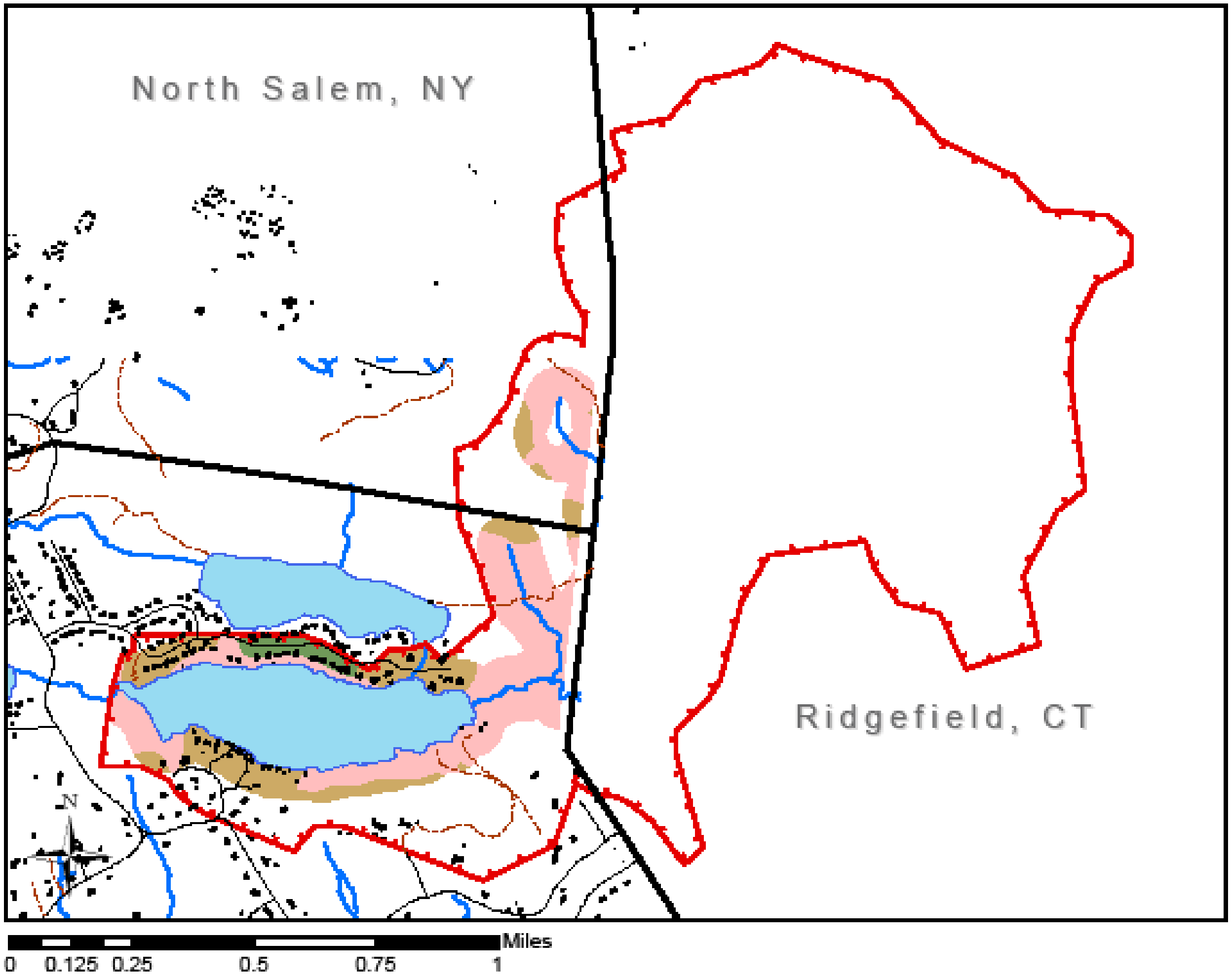
Lake Oscaleta
National Land Cover Dataset 2001



Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4

Lake Oscaleta
Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.

"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:

Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

(C) Point Sources: The outlet of Lake Rippowam flows to Lake Oscaleta.

Estimated point source load of Phosphorus

Source	**Estim. Volume input (m^3/year)**	**Surface Average P 2002-2007 (ug/l)**	**Estimated P load (kg/year)**
Lake Rippowam	721,943	24	17

(D) Summary of Phosphorus Input to the Lake:

Source	**Input (kg/year)**
Watershed Land Cover	53
Point Sources	17
Septic within 100m of surface water	35
Internal load (sediment)	12
Total	**117**

<u>Phosphorus Mass Balance:</u> Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10+H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = flushes per year

Parameter	**Units**	**Result**
W′	g/m^2/year	437
H	m	5.9
ρ	flushes per year	0.45
p	**ug/l**	**34**
Summer(Jun 15-Sep 15) average TP 2002-2007, upper waters:		**24**

REFERENCES

Cedar Eden Environmental, LLC. 2006 State of the Lakes: 2004/2005 Water Quality of Lake Rippowam, Lake Oscaleta and Lake Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. April 2006.

Cedar Eden Environmental, LLC. 2004 Diagnostic-Feasibility Study and Lake & Watershed Management Plan for Lake Rippowam, Lake Oscaleta, and Lake Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. May 2004.

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Invasive Species Council of New York State. Early Detection Invasive Plants by Region. Web site: http://www.ipcnys.org/. Obtained on-line 11/29/07.

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US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

3.5. Lake Rippowam

Lake Rippowam

Surface water quality classification: Class B

Morphology Summary:

Characteristic	Units	Value	Source
Surface area	hectares	14	Cedar Eden 2004
Watershed area	hectares	95	EcoLogic 2008 (excl lake)
Volume	mgal	150	Cedar Eden 2004
Elevation	m	144	NYSDEC 2007
Maximum depth	m	6.1	Cedar Eden 2004
Average Depth	m	4.1	Cedar Eden 2004

Lake Inlet: Primary inlet drains wetlands to the west and enters on west shore. Smaller rivulets drain area to the north of the lake.

Lake Outlet: Located at the southeastern end of the lake; outlet flows to Lake Oscaleta.

Recreational impacts: Water quality and aquatic plants were both cited as impacting recreational assessments, although the most significant impacts were associated with poor water clarity and excessive algae growth (NYSDEC 2007). The duration, intensity and composition of periodic algal blooms have not been characterized (Cedar Eden 2002)

Lakeshore Development: Limited to southern shore (Twin Lakes Community built in the 1950's). Northern shore is steeply sloped, forested and undeveloped. Forested wetlands located at eastern and western ends of the lake. (Cedar Eden 2002)

Figure 1
Lake Rippowam
Bathymetry

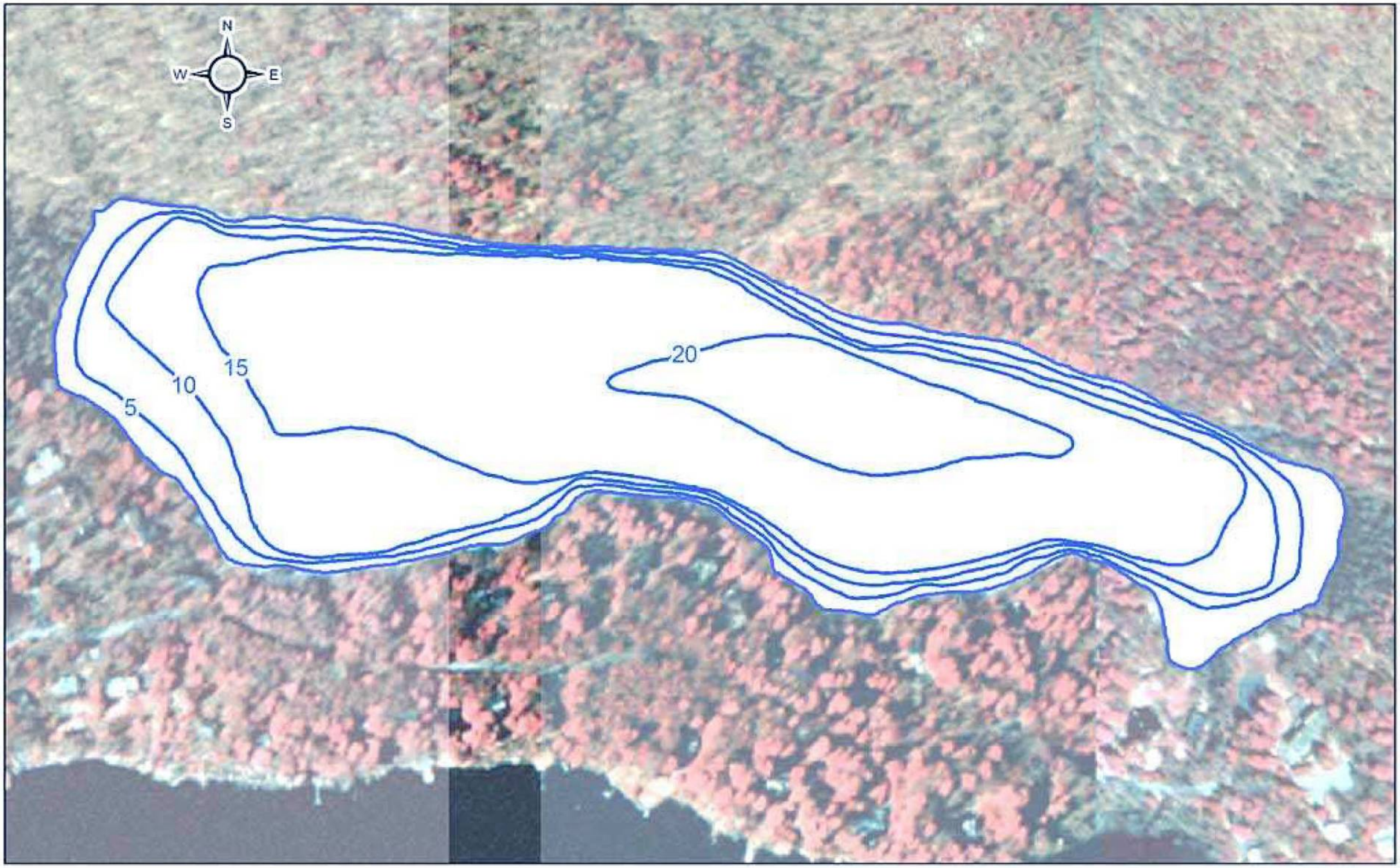


Figure 4.1 Bathymetric map of Lake Rippowam

Data Source: Field Points by P.Lewis, 5 foot contours by CEE LLC

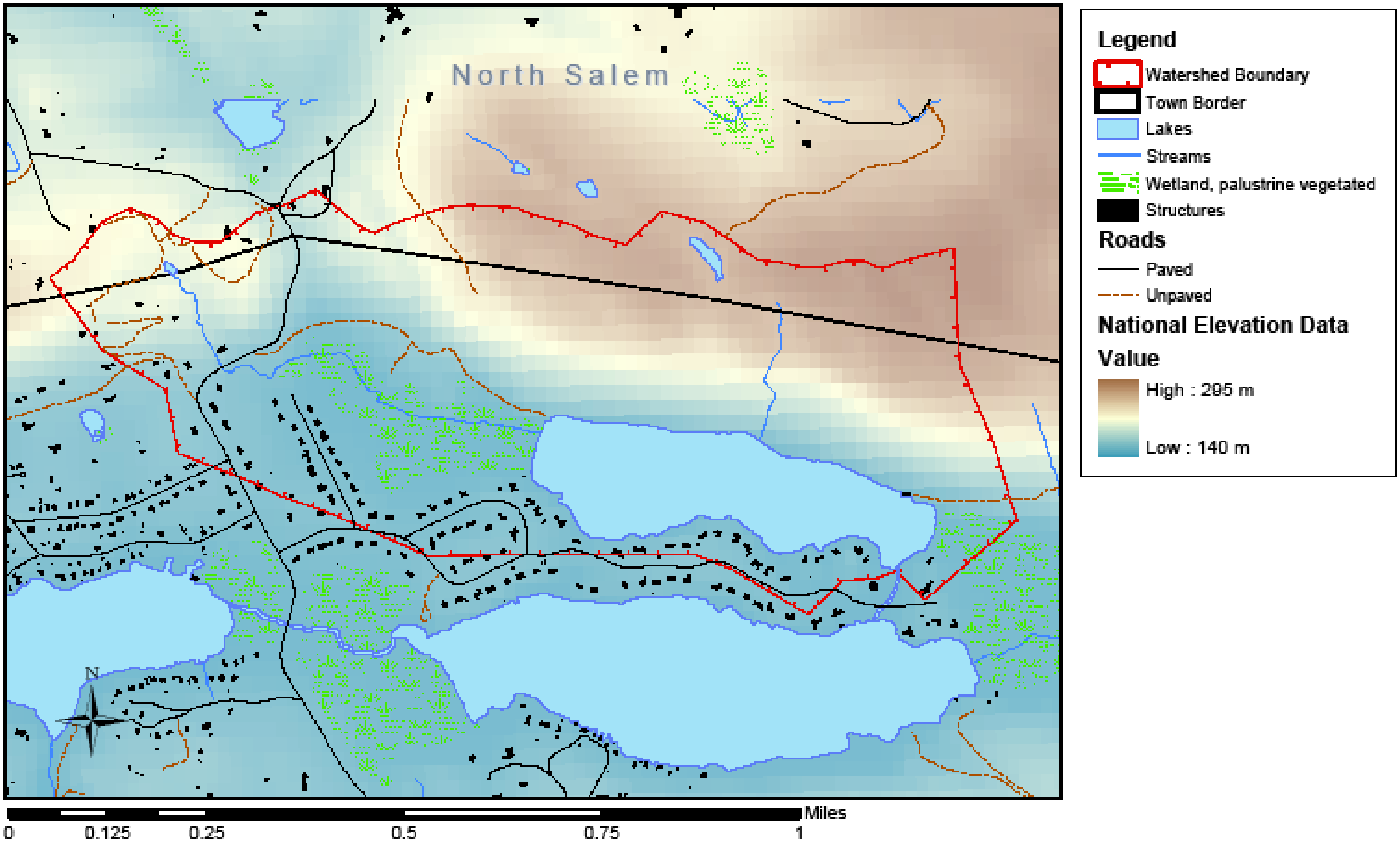
200 100 0 200 Feet

Cedar Eden Environmental, LLC
Geographic Information Systems

Figure 2

Lake Rippowam

Topographic and Human Features



Sources:

Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/. Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary:

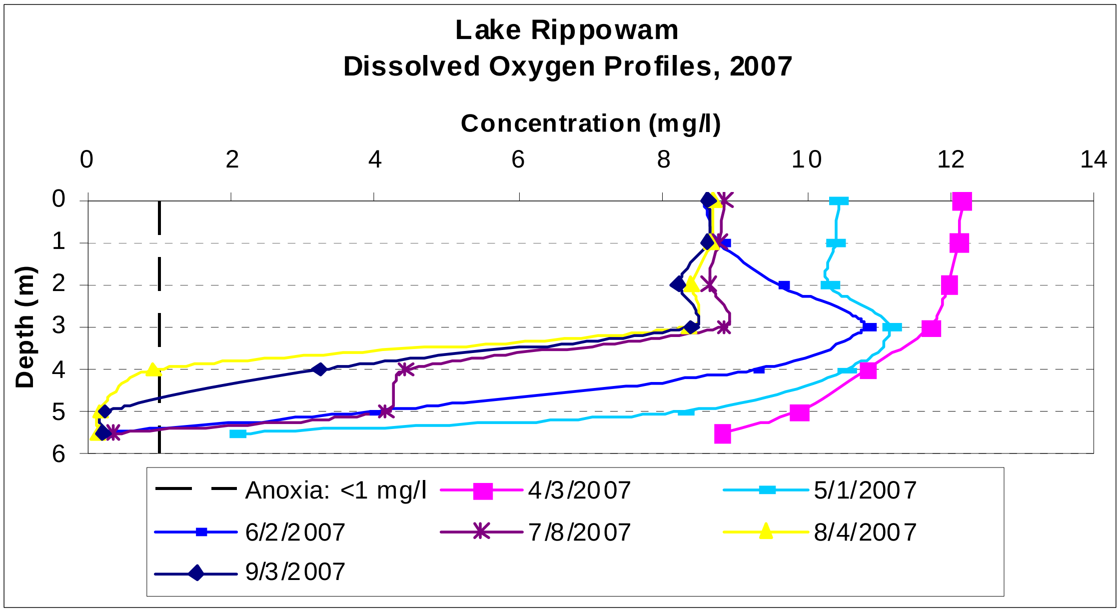
Data were collected under the Citizen Statewide Lake Assessment Program (CSLAP), as well as by the Three Lakes Council and other entities over time. Depths ranging from 0 to 5 meters (both upper and lower waters), including some half-meter increment profiles. Table A below summarizes samples collected between January and December of each year; the statistics represent averages of sample results for the time period for all depths, unless otherwise noted. Table B below summarizes samples collected during the summer, defined as the period between June 15 and September 15 each year.

A. Representing samples collected between January and December each year.

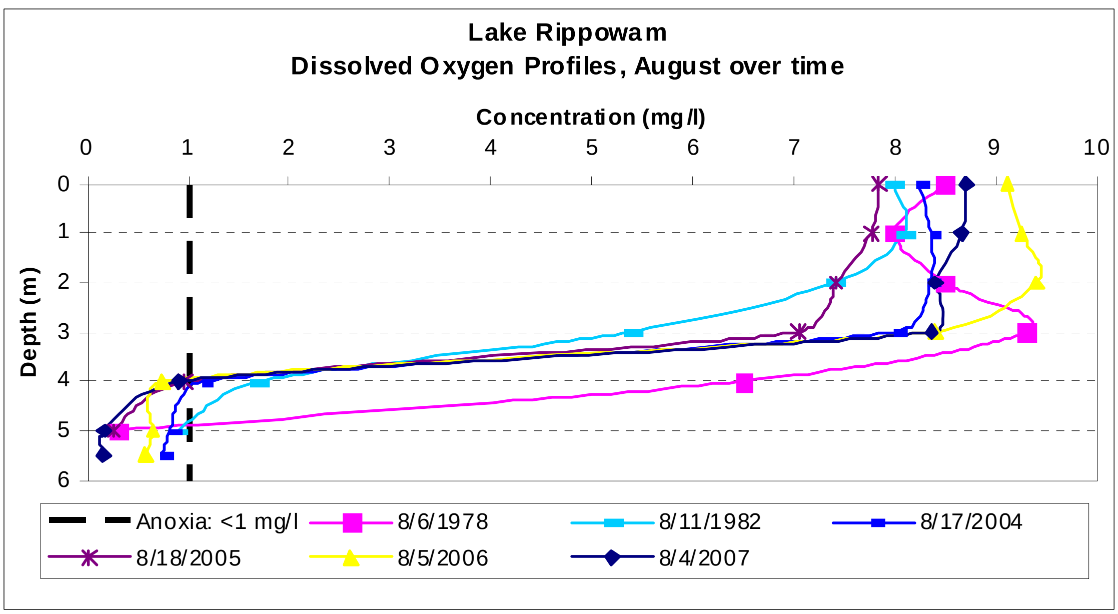
Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Alkalinity (mg/l)	2002-2007	7	42	54	45
Color (platinum color units)	2006-2007	16	13	41	22.4
Conductivity	2002-2007	37	134.6	287.5	196
pH (std units)	2002-2007	24	7.14	9.4	7.83
Chlorophyll-α (mg/m^3)	1982	3	0.952	4.571	2.752
	2002-2007	40	2.4	38.6	10.15
Phaeophytin-α (mg/m^3)	2003-2006	19	0.005	1.4	0.324
Secchi depth (m)	1978	12	1.83	3.35	2.58
	1980-1983	40	1.80	3.28	2.348
	2002-2007	59	0.50	3.40	2.18
Temperature					
Surface (°C)	1978	26 (0-1 m)	8.6	27	22
	1981-1983	53 (0-1m)	11.2	28.4	22
	2002-2007	112 (0-1.5 m)	6.2	30	21
Depth >5m (°C)	1978	11 (6-7 m)	13.5	17	14.4
	1981-1982	5 (6 m)	10.9	20	14.6
	2002-2007	35 (5.5-6 m)	5.2	19.7	12.3
Dissolved Oxygen					
Surface (mg/l)	1978	26 (0-1 m)	7.2	17	8.9
	1981-1983	53 (0-1 m)	4.5	10.8	7.5
	2002-2007	96 (0-1 m)	6.76	14.39	9.6
Depth >5m (mg/l)	1978	11 (6-7 m)	0	0.6	0.32
	1981-1983	5 (6 m)	0.6	10.2	2.93
	2002-2007	35 (5.5-6 m)	0.01	10.1	2.41
Nutrients:					
Phosphorus					
Upper waters (mg/l)	2002-2007	42 (1.5 m)	0.010	0.058	0.024
Lower waters (mg/l)	2002-2007	26 (4-5 m)	0.020	0.166	0.050
Nitrate N (mg/l)	2003-2007	21	0.0025	0.040	0.0125
Total Kjeldahl Nitrogen (mg/l)	2002-2007	13	0.41	0.98	0.70
Ammonia Nitrogen (mg/l)	2006-2007	16	0.006	0.23	0.047

B. Representing samples collected between June 15 and September 15 each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Chlorophyll-α (mg/m^3)	1982 2002-2007	1 26	0.952 2.4	0.952 38.6	0.952 8.37
Phaeophytin-α (mg/m^3)	2003-2006	12	0.005	1.2	0.16
Secchi depth (m)	1978 1980-1983 2002-2007	9 26 27	2.13 1.9 0.5	3.35 3.28 3.35	2.80 2.41 2.24
Dissolved Oxygen:					
Surface (mg/l) (min depth sampled)	1978 1981-1983 2002-2007	20 (0-1 m) 36 (0-1 m) 40 (0-1 m)	7.8 4.5 7.21	9 9.4 13.96	8.34 7.05 8.86
Depth >=4 m (mg/l)	1978 1981 2002-2007	11 (6-7 m) 1 (6 m) 15 (5.5 m)	0 2.4 0.06	0.6 2.4 2.6	0.318 2.4 0.642
Nutrients *Phosphorus:*					
Surface (mg/l) (min depth sampled)	2002-2007	27 (1.5 m)	0.01	0.058	0.021
Depth >=4 m (mg/l)	2002-2007	15 (4-5 m)	0.02	0.166	0.052
Nitrate N (mg/l)	2003-2007	15	0.0025	0.03	0.011
Total Kjeldahl Nitrogen (mg/l)	2002-2007	10	0.5159	0.98	0.708
Ammonia Nitrogen (mg/l)	2006-2007	12	0.006	0.15	0.032

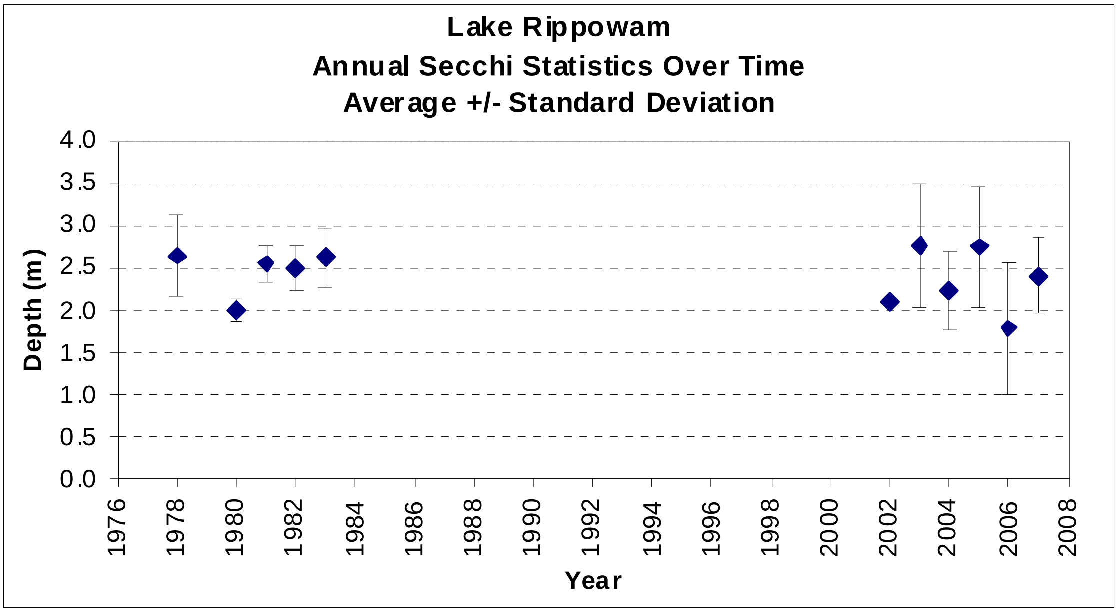
Anoxia: Dissolved oxygen decreases in lower waters, resulting in anoxic conditions from June through September.



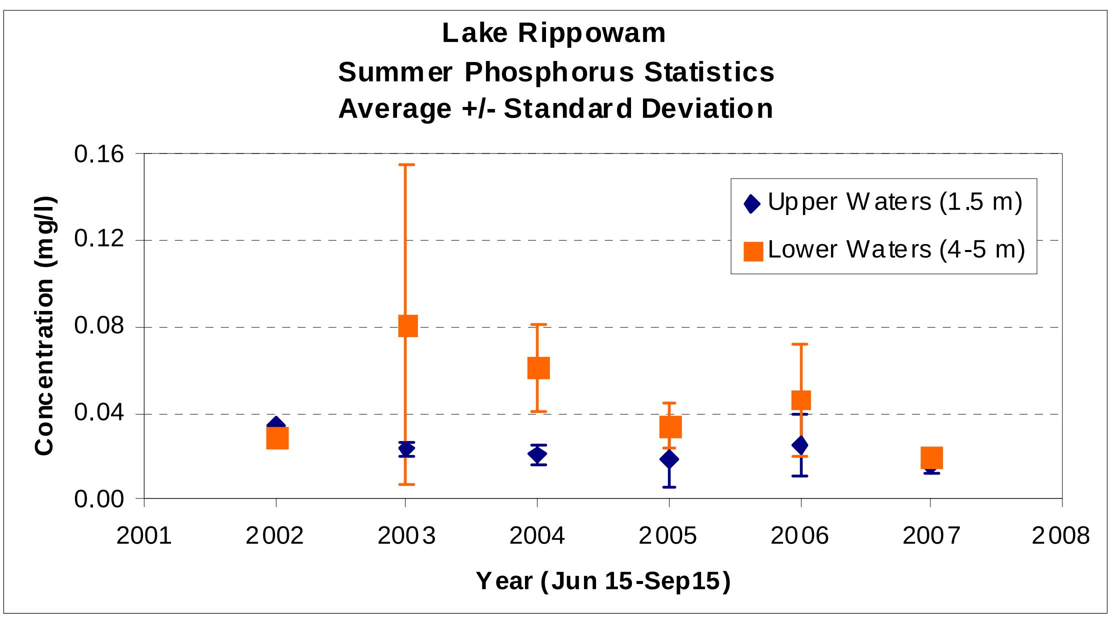
Anoxic conditions in lower waters have been observed in the lake in August from the 1970's to the present.



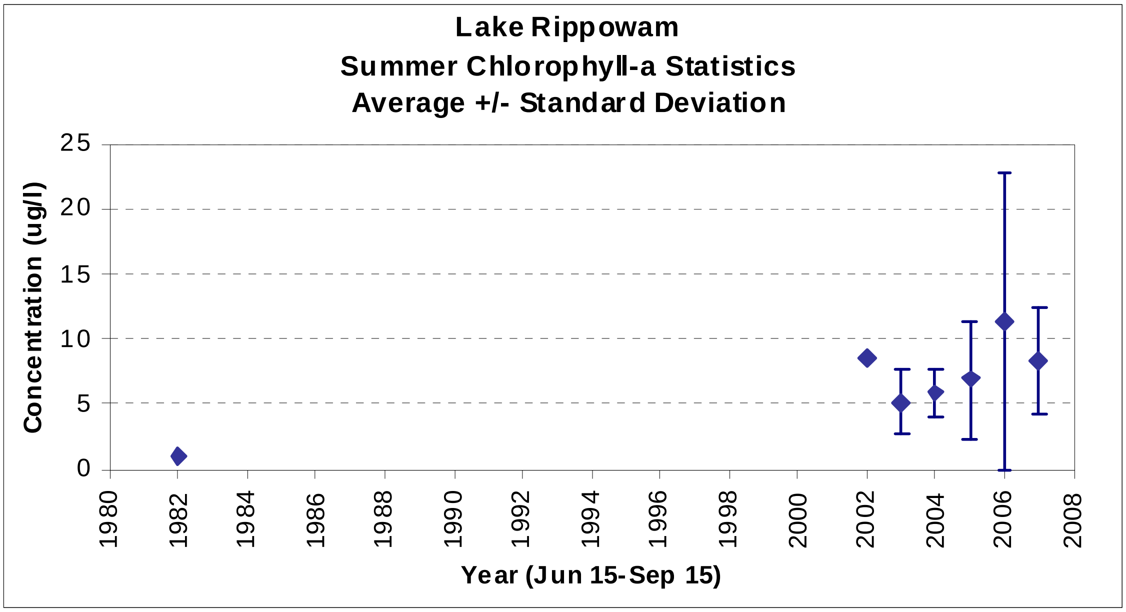
Water Clarity: Averages over time are relatively constant; there is more variability between the annual maximum and minimum in the 2000-2007 period than in the 1980s.



Phosphorus Concentrations: Phosphorus concentrations in the upper waters have been fairly stable since 2003. During the summer months when anoxia occurs in the lower waters (5 meters depth), phosphorus concentrations are elevated, reflecting sediment phosphorus release.



Chlorophyll-α: Chlorophyll-α concentrations are, on average, higher from 2002-2007 than in 1983. The standard deviations show greater variability of the 2006 data from other years.



Trophic Status:

Parameter	Trophic State Indicators (shading indicates match to Lake)				Lake Rippowam*
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	21
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	8.37
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	38.6
Average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	2.24
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	0.50
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	8.45

*Data shown are for the period 2002-2007. Summer represents June 15 to September 15. Dissolved oxygen percent saturation calculated using summer data at depths >= 5 m.

Aquatic Habitat:

- Phytoplankton in 2003 included Golden, Green and Bluegreen groups. June through August the Golden and Green groups dominated (#cells/ml ranged from 7,730-16,296); in September the Bluegreen group was dominant (#cells/ml = 59,870). (Cedar Eden 2004)

- Zooplankton in 2003 were dominated by Cladocerans (*Ceriodaphnia*), accounting for 60% and 76% of the zooplankton communities in June and July, respectively. In September, Cladocerans and Rotifers dominated (45% and 48% of the zooplankton population, respectively). Copepods generally accounted for 12% or less of the population in each sampling event. (Cedar Eden 2004)

- Aquatic Plants in July 2003 were most abundant in the shallow east and west ends, while steep shores prevented vegetation establishment along the north shore. White water lilies (*Nympheae* spp) were common in the lake. Eurasian water milfoil (*Myriophyllum spicatum*) was also present in the lake. (Cedar Eden 2004)

List of Aquatic Plants identified in 2003:

Scientific Name	Common Name
Decodon sp.	Three-way sedge
Eleocharis sp.	Spike-rush
Iris spp	Iris
Myriophyllum spicatum	Eurasian watermilfoil
Nuphar sp.	Yellow water lily

Scientific Name	Common Name
Nympheae sp.	White water lily
Pontederia cordata	Pickerelweed
Sagittaria sp.	Arrowhead
Scirpus sp.	Bulrush

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Data obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	Common Name
Heracleum mantegazzianum	Giant Hogweed
Wisteria floribunda	Japanese Wisteria, Wisteria
Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg's Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
Haliaeefus leucocephalus	Bald Eagle	Threatened, entire state
Mammals		
Myotis sodalist	Indiana Bat	Endangered, entire state
Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
Isotria medeoloides	Small Whorled Pogonia	Threatened, entire state
Platanthera leucophea	Eastern Prairie Orchid	Threatened, not relocated in NY
Scirpus ancistrochaetus	Northeastern Bulrush	Endangered, not relocated in NY

- New York Natural Heritage Program – Town of Lewisboro

Scientific Name	Common Name	NY Legal Status
Reptiles		
Glyptemys muhlenbergii (formerly Clemmys muhlenbergii)	Bog Turtle	Endangered
Birds		
Oporornis formosus	Kentucky Warbler	Protected
Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	143
Evaporation (ET)	22	66
Runoff (R)	26	507

Water Budget:	
Inflow to Lake [R+(P-ET)]	191 mgal/year
Lake Volume	150 mgal
Flushing Rate	1.3 times/year
Residence Time	0.79 year

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed (acres)	Cover (%)	Phosphorus Export Coeff	Estim P Export kg/year	Estim P Export Percent
Open water (all)	32	11	0.30	3.8	29
Developed, open space	19	6.8	0.20	1.5	12
Deciduous forest	182	65	0.07	5.1	38
Evergreen forest	22	7.9	0.20	1.8	13
Mixed forest	0.04	0.01	0.09	0.001	0.01
Pasture/hay	2.4	0.86	0.30	0.29	2.1
Woody wetlands	22	7.9	0.09	0.81	6.1
Total Acres	**279**	**100**		**13**	**100**

(B) Septic: Septic systems serve the communities along the shoreline (Cedar Eden 2002).

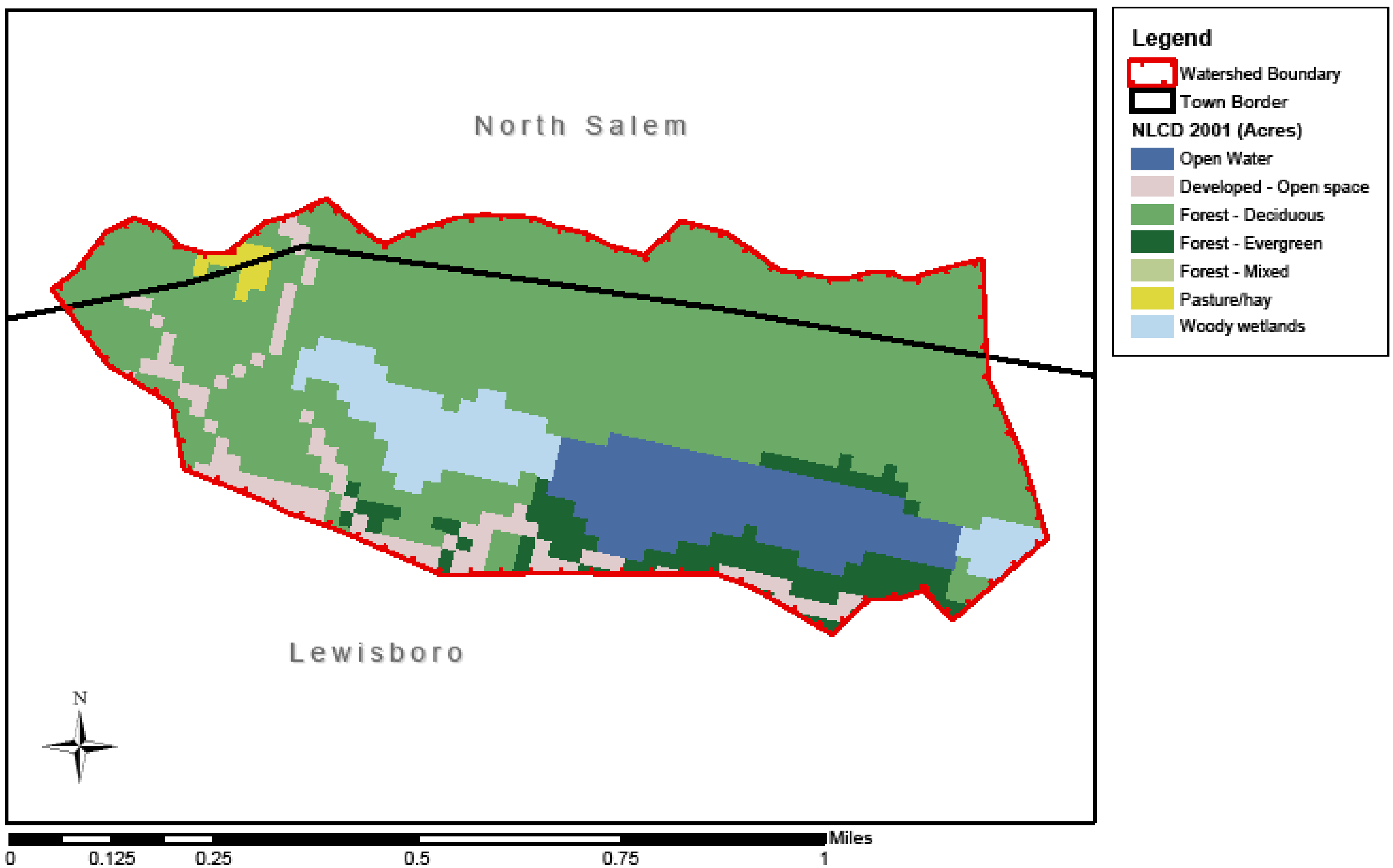
Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

Class	N Structures	Average Household	Estim Population
Not limited	7	2.5	17
Somewhat limited	21	2.5	53
Very limited	18	2.5	45
Total	**46**		**115**

Estimated Phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%.

Class	Population	P per cap	Transport	kg/year
Not limited	16	0.6	10%	1.0
Somewhat limited	50	0.6	30%	9.1
Very limited	43	0.6	60%	15
Failed systems (5%)	5.8	0.6	100%	3.5
Total	**115**			**29**

Figure 3
Lake Rippowam
National Land Cover Dataset 2001

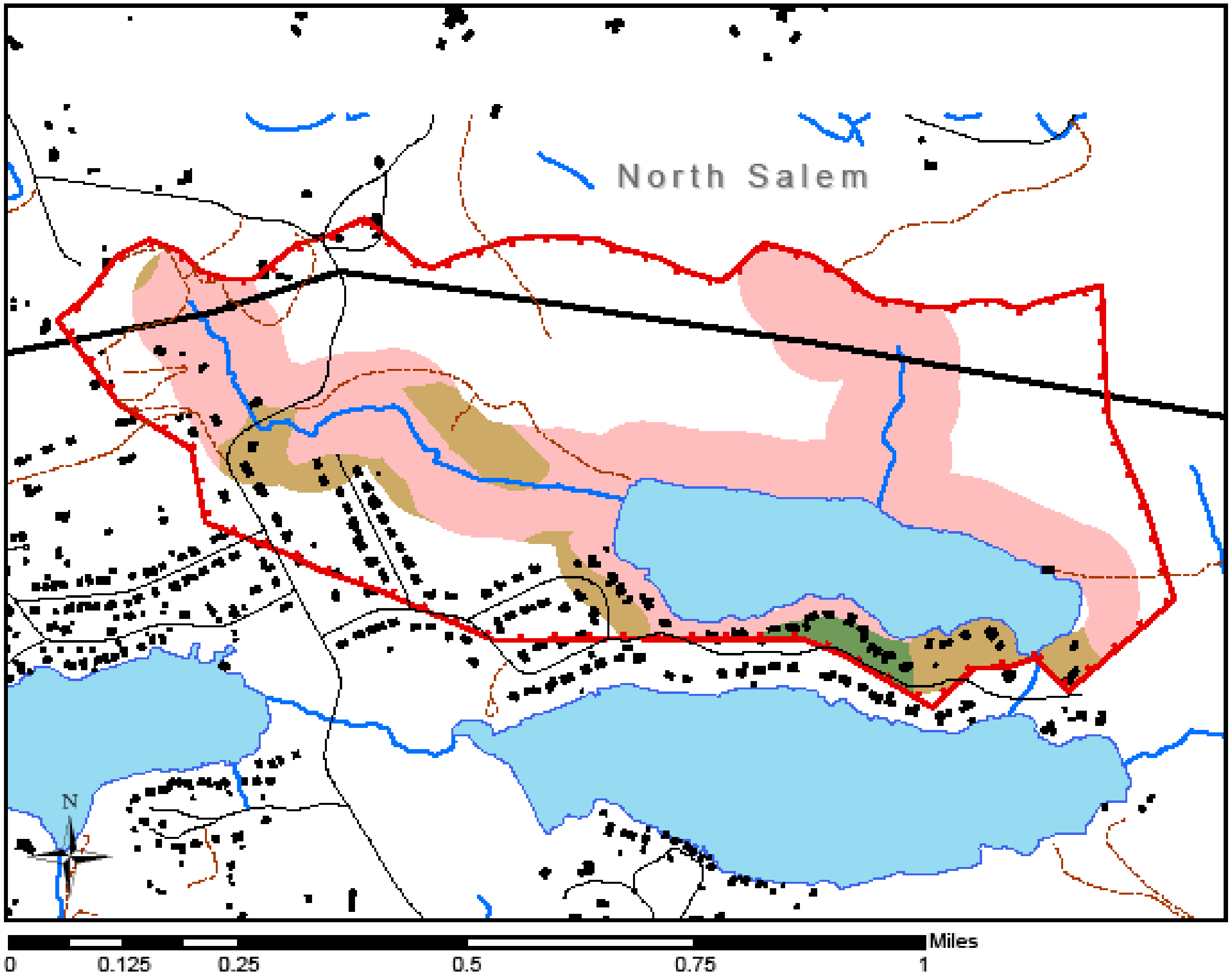


Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4

Lake Rippowam

Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.

"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.

"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:

Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

EcoLogic

(C) Point Sources: There are no known point sources of phosphorus to the lake.

(D) Summary of Phosphorus Input to the Lake:

Source	**Input (kg/year)**
Watershed Land Cover	13
Point Sources	--
Septic within 100m of surface water	29
Internal sediment loading	0.0049
Total	**42**

<u>Phosphorus Mass Balance:</u> Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10+H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = flushes per year

Parameter	**Units**	**Result**
W′	g/m^2/year	291
H	m	4.1
ρ	flushes per year	0.79
p	**ug/l**	**22**
Summer (Jun 15 – Sep 15) average TP 2002-2007, upper waters:		**21**

REFERENCES

Cedar Eden Environmental, LLC. 2006 State of the Lakes: 2004/2005 Water Quality of Lake Rippowam, Lake Oscaleta and Lake Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. April 2006.

Cedar Eden Environmental, LLC. 2004 Diagnostic-Feasibility Study and Lake & Watershed Management Plan for Lake Rippowam, Lake Oscaleta, and Lake Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. May 2004.

Cedar Eden Environmental, LLC. 2002 Lake & Watershed Management Recommendations for Lakes Oscaleta, Rippowam and Waccabuc. Prepared for The Three Lakes Council, South Salem, NY. December 2002.

Invasive Species Council of New York State. Early Detection Invasive Plants by Region. Web site: http://www.ipcnys.org/. Obtained on-line 11/29/07.

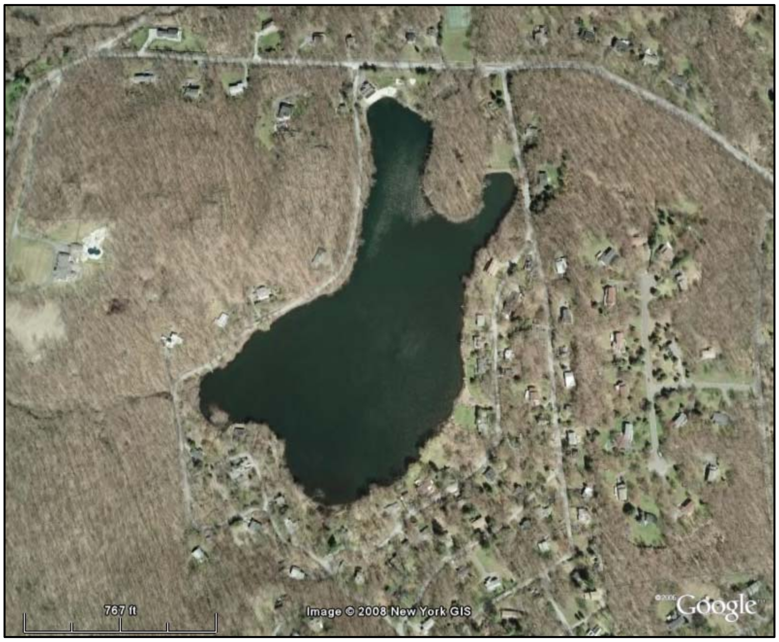
New York Natural Heritage Program. Letter dated December 21, 2007 received by EcoLogic, LLC. New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources.

New York State Department of Environmental Conservation. 2007. 2006 Interpretive Summay, New York Citizens Statewide Lake Assessment Program (CSLAP) 2006 Annual Report - Lake Rippowam. September 2007. With New York Federation of Lake Associations. Scott A. Kishbaugh, PE.

US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

3.6. Lake Katonah

Lake Katonah



Surface water quality classification: Class B

Morphology Summary:

Characteristic	Units	Value	Source
Surface area	hectares	7.8 10	NYSDEC 2007 Shapefile
Watershed area	hectares	41	EcoLogic 2008 (excl lake)
Volume	mgal	40.8	EcoLogic 2008
Elevation	m	100	EcoLogic 2008
Maximum depth	m	3.1	EcoLogic 2008
Average Depth	m	1.6	EcoLogic 2008

Lake Inlet: There were no significant inlet streams identified. Numerous natural intermittent channels and stormwater discharges are present.

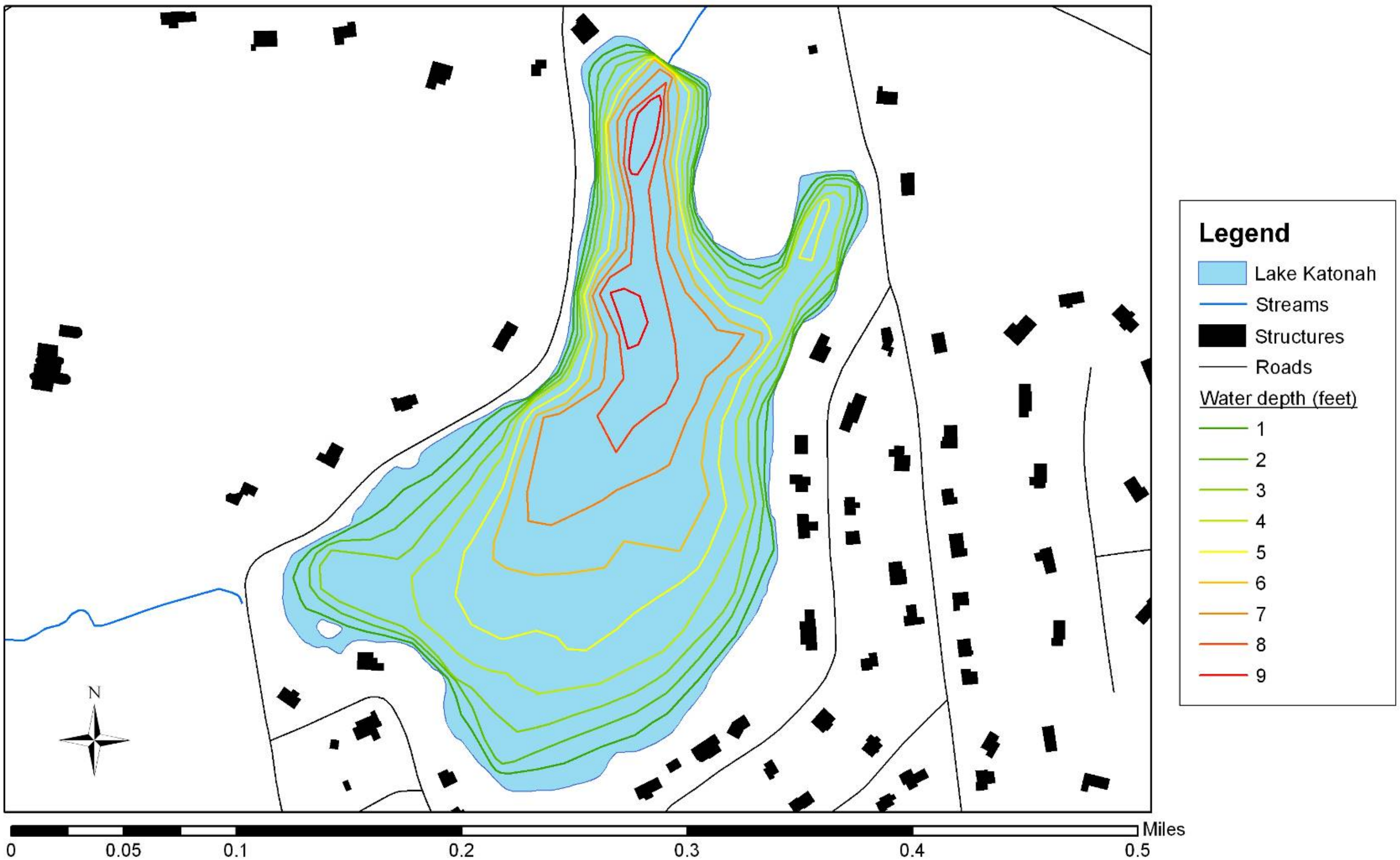
Lake Outlet: Lake level is controlled by a dam at the northwest shore.

Recreational impacts: Water quality perception improves during the summer, consistent with seasonally decreasing aquatic plant coverage despite seasonally increasing lake productivity (NYSDEC 2008).

Lake Katonah has been described by the CSLAP sampling volunteers as "slightly" impaired during 38% of the CSLAP sampling sessions, and "substantially" impaired 13% of the time. Slightly impaired conditions were associated with excessive weeds during 13% of the sampling sessions and with excessive algae 38% of the time. Substantially impaired conditions were due to excessive weeds and algae at a frequency of 13% each. (NYSDEC 2008)

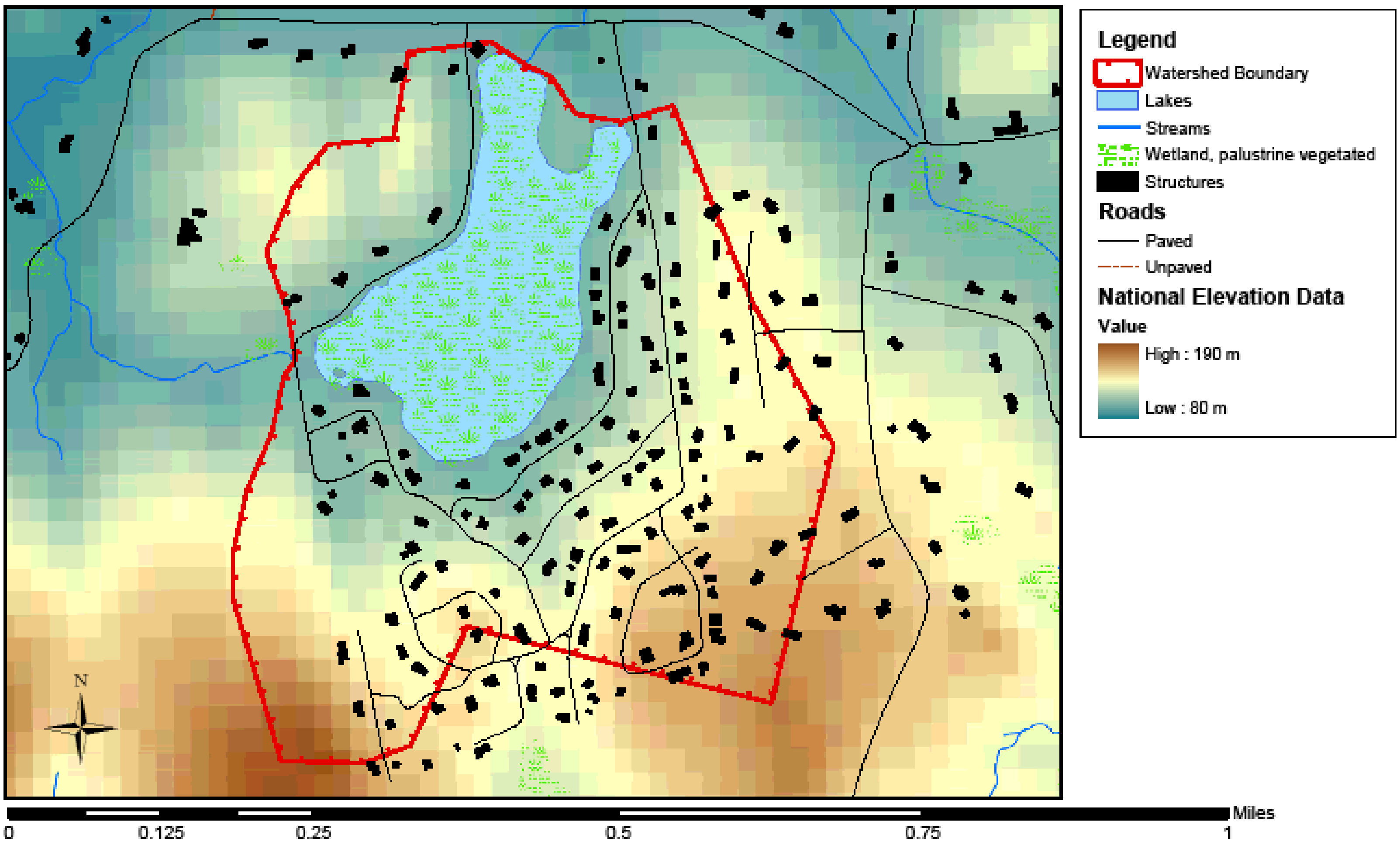
<u>Lakeshore Development</u>: Development is predominantly residential, and is most dense to the south and east of the lake.

Figure 1
Lake Katonah
Bathymetry August 12, 2008



Sources:
Lakes, Streams, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

Figure 2
Lake Katonah
Topographic and Human Features



Sources:
Lakes, Streams, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/. Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary: Data were collected under the Citizen Statewide Lake Assessment Program (CSLAP), at depths ranging from 1.0 to 1.5 meters (upper waters only). Table A below summarizes samples collected between January and December of each year. Table B below summarizes samples collected during the summer, defined as the period between June 15 and September 15 each year.

A. Representing samples collected between January and December each year.

Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Calcium (mg/l)	2006-2007	4	26.28	32.5	28.88
Chlorophyll-α (ug/l)	2006-2007	16	6.29	79.08	34.61
Color (platinum color units)	2006-2007	16	16	45	30.7
Conductivity (umhos/cm; 25°C)	2006-2007	16	335	583.8	469.5
Dissolved Nitrogen (mg/l)	2007	8	0.61	1.24	0.87
NO_3 Nitrates (mg/l)	2006-2007	14	0.0025	0.14	0.028
NH3 Nitrogen (mg/l)	2006-2007	15	0.006	0.558	0.084
Phosphorus (mg/l)	2006-2007	16	0.044	0.158	0.089
Nitrogen:Phosphorus Ratio	2007	8	7.92	20	13.47
pH (std units)	2006-2007	15	7.25	8.5	7.93
Secchi depth (m)	2006-2007	16	0.33	1.6	0.95
Temperature (°C)	2006-2007	16	17.0	28	23.7

B. Representing samples collected between June 15 and September 15 each year.

Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Chlorophyll-α (ug/l)	2006-2007	11	6.29	79.08	38.18
Dissolved Nitrogen (mg/l)	2007	5	0.71	1.24	0.95
NO_3 Nitrates (mg/l)	2006-2007	9	0.0025	0.14	0.031
NH3 Nitrogen (mg/l)	2006-2007	10	0.006	0.16	0.061
Phosphorus (mg/l)	2006-2007	11	0.046	0.159	0.094
Nitrogen:Phosphorus Ratio	2007	5	9.89	20	14.04
Secchi depth (m)	2006-2007	11	0.5	1.6	0.95

EcoLogic August 2008 water quality data summary:

A. Analytical Results 08/12/2008

Parameter (units)	Surface (0 m)	Depth (2.4 m)
Secchi Transparency (m)	0.6	na
Chlorophyll-a (mg/l)	0.17	na
Alkalinity (mg/l)	60	na
Phosphorus:		
Total Phosphorus (mg/l)	0.092	0.084
Soluble Reactive Phosphorus (mg/l)	0.010[a]	0.0098[a,b]
Nitrogen:		
Nitrate/Nitrite as N (mg/l)	0.037[a]	0.036[a,c]
Total Kjeldahl Nitrogen as N (mg/l)	2.9[a]	2.1[a,b]
Total Nitrogen (mg/l)	2.9	2.1

na – not analyzed
[a]The result of the laboratory control sample was greater than the established limit.
[b]A trace amount of this analyte was found in the laboratory preparation blank.
[c]This analysis was performed beyond the holding time limit by EPA Method 353.1.

B. Field Profiles

Depth ft (m)	Temperature (°C)	pH	Conductivity (us)	DO (mg/L)	DO (% sat)
1 (0.305)	24.7	8.2	651	8.4	108
2 (0.61)	24.2		652	7.9	94.6
3 (0.915)	24.0		653	6.0	71
4 (1.22)	23.9		653	5.6	66
5 (1.525)	23.8		654	5.2	61
6 (1.83)	23.8		654	4.9	57
7 (2.135)	23.7		655	4.6	53
8 (2.44)	23.7		658	4.2	50

Sediment data summary: Composite sample collected August 12, 2008 by EcoLogic.

Parameter	Analytical Method	Result (mg/kg dry wt)
Pesticides/PCBs	EPA 8081/8082	ND
TCL Volatiles	EPA 8260B	
Acetone		0.064
Other VOCs		ND
TCL PAHs	EPA 8270	ND
RCRA Total Metals	EPA 6010	
Arsenic		5.8
Barium		26
Cadmium		0.14
Chromium		2.2*
Copper		110
Lead		8.9
Selenium		0.13
Silver		ND

Parameter	**Analytical Method**	**Result (mg/kg dry wt)**
RCRA Mercury	EPA 7471	ND
Total Organic Carbon	EPA 9060	221,000
Total Solids	SM 18-20 2540B	9.9%

ND – non-detect. Analytes reported as less than the method detection limit.
*The result of the laboratory control sample for this analyte was less than the established limit.

Sediment Contaminant Analysis: Interest has been expressed in exploring the feasibility of dredging. A composite sediment sample was collected on August 12, 2008 (EcoLogic, 2008). Results are summarized in Table C, in the context of NYSDEC Screening levels. A complete set of results is attached to the end of this report. (Attachment 2 - 2008 Water Quality and Sediment Sampling Locations and Laboratory Analysis Reports). The NYSDEC screening levels are separated into three Classes: A, B, and C:

- **Class A - No Appreciable Contamination (No Toxicity to aquatic life).**
  If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and in-water or riparian placement, at approved locations, can generally proceed.

- **Class B - Moderate Contamination (Chronic Toxicity to aquatic life).**
  Dredging and riparian placement may be conducted with several restrictions. These restrictions may be applied based upon site-specific concerns and knowledge coupled with sediment evaluation.

- **Class C - High Contamination (Acute Toxicity to aquatic life).**
  Class C dredged material is expected to be acutely toxic to aquatic biota and therefore, dredging and disposal requirements may be stringent. When the contaminant levels exceed Class C, it is the responsibility of the applicant to ensure that the dredged material is not a regulated hazardous material as defined in 6NYCRR Part 371. This TOGS does not apply to dredged materials determined to be hazardous.

Table C. Lake Katonah sediment analytical results with NYSDEC Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement. Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem. Results that fall into Class C (high contamination) are highlighted.

Compound	Required Method Detection Limit	Threshold Values			Katonah Results	Threshold Class
		Class A	Class B	Class C		
Metals (mg/kg dry wt) – EPA Method 6010B						
Arsenic	1.0	< 14	14 – 53	> 53	5.8	A
Cadmium	0.5	< 1.2	1.2 - 9.5	> 9.5	0.14	A
Copper*	2.5	< 33	33 – 207	> 207	110	B
Lead	5.0	< 33	33 – 166	> 166	8.9	A
Mercury[+]	0.2	< 0.17	0.17 - 1.6	> 1.6	ND	A
PAHs and Petroleum-Related Compounds (mg/kg dry wt) – EPA Methods 8020, 8021, 8260 and 8270						
Benzene	0.002	< 0.59	0.59 - 2.16	> 2.16	ND	A
Total BTEX*	0.002	< 0.96	0.96 - 5.9	> 5.9	ND	A
Total PAH[1]	0.33	< 4	4 - 35	> 35	ND	A
Pesticides (mg/kg dry wt) – EPA Methods 8081						
Sum of DDT+DDD+DDE[+]	0.029	< 0.003	0.003 - 0.03	> 0.03	ND	A
Mirex*[+]	0.189	< 0.0014	0.0014 - 0.014	> 0.014	na	--
Chlordane*[+]	0.031	< 0.003	0.003 - 0.036	> 0.036	ND	A
Dieldrin	0.019	< 0.11	0.11 -0. 48	> 0.48	ND	A
Chlorinated Hydrocarbons (mg/kg dry wt) – EPA Methods 8082 and 1613B						
PCBs (sum of aroclors)[2]	0.025	< 0.1	0.1 - 1	> 1	ND	A
2,3,7,8-TCDD*[3](sum of toxic equivalency)	0.000002	< 0.0000045	0.0000045 - 0.00005	> 0.00005	na	--

na – not analyzed; ND – not detected

[+]Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit.

* Indicates case-specific parameter. The analysis and evaluation of these case specific analytes is recommended for those waters known or suspected to have sediment contamination caused by those chemicals. These determinations are made at the discretion of Division staff.

[1]For Sum of PAH, see Appendix E of TOGS 5.1.9. For Lake Katonah, each of the 18 PAH compounds were reported as non-detect (<0.8 mg/kg).

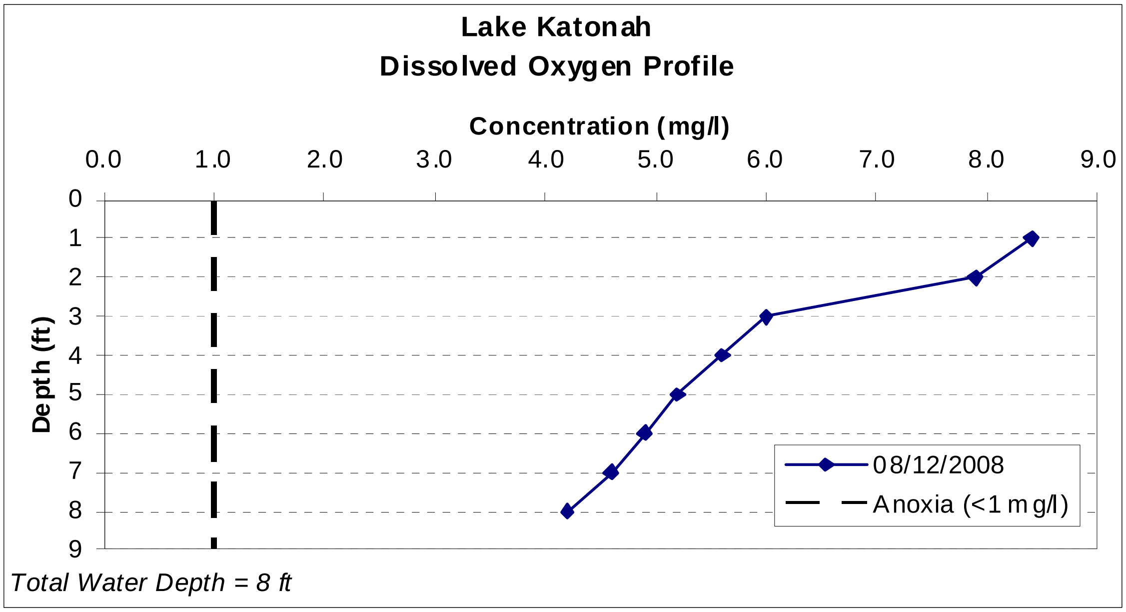
[2]For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. On Lake Katonah, seven Aroclors were each reported as <0.2 mg/kg; this value is reported above.

[3]TEQ calculation as per the NATO - 1988 method (see Appendix D of TOGS 5.1.9).

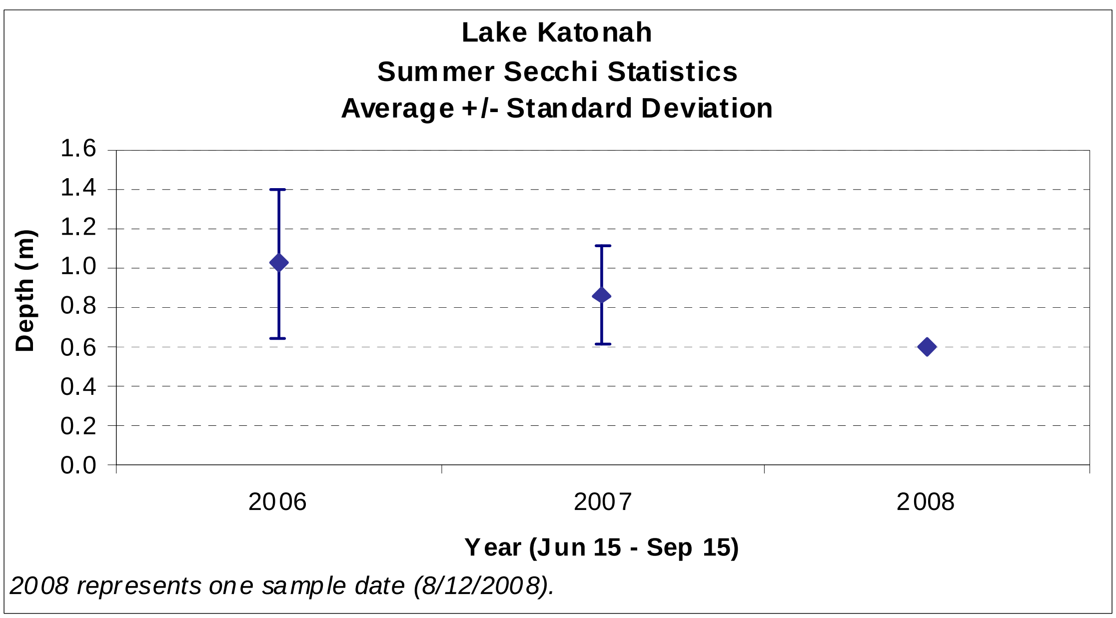
Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

<u>**Source:**</u> Table 2, NYSDEC Division of Water, Technical & Operational Guidance Series (TOGS) 5.1.9, “In-Water and Riparian Management of Sediment and Dredged Material”, Nov 2004.

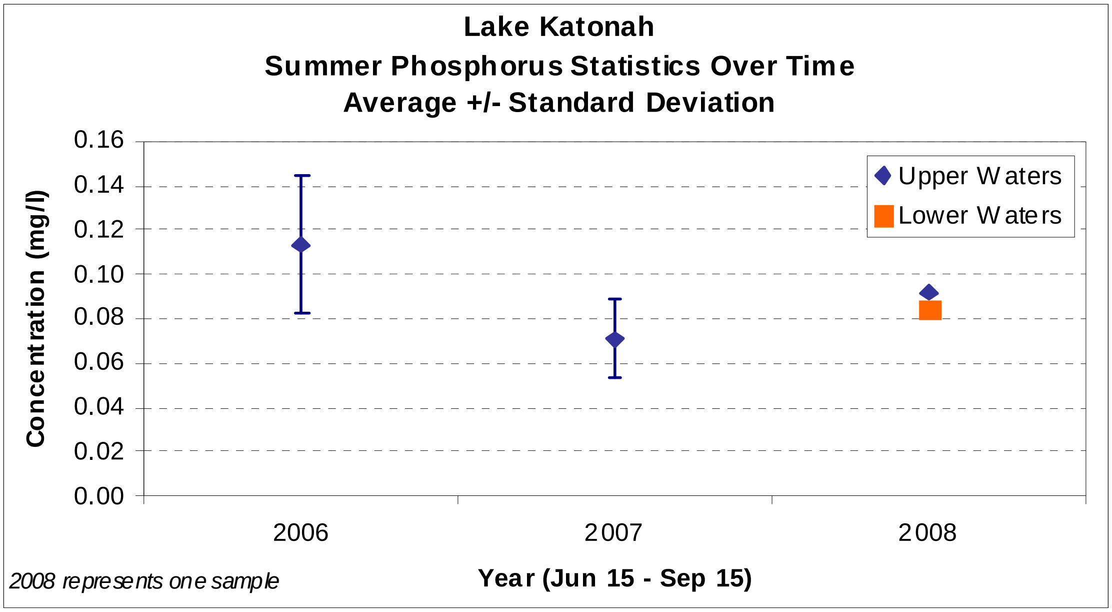
Anoxia: Based on the dissolved oxygen profile collected on August 12, 2008, oxygen levels were depleted in the lower waters, but anoxic conditions (concentrations less than 1 mg/l) were not observed in the lake.



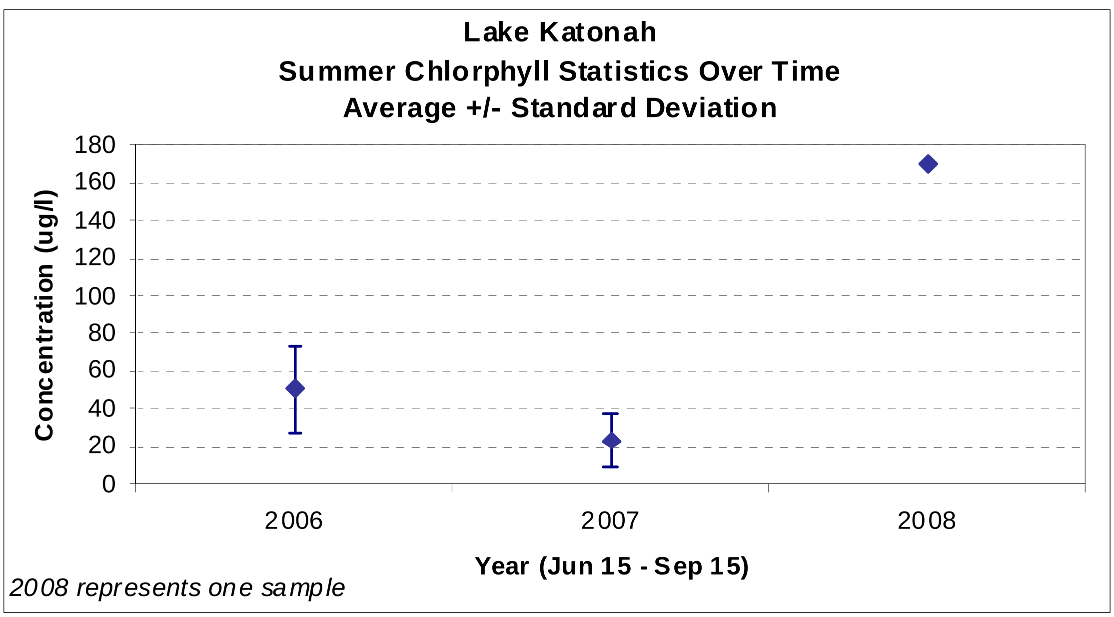
Water Clarity: There are three years of data for Secchi depth measurements.



Phosphorus Concentrations: There are three years of data for phosphorus concentrations during the summer.



Chlorophyll-α: There are three years of Chlorophyll-α data.



Trophic Status:

Parameter	Trophic State (shading indicates match to Lake)				Lake Katonah*
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	94
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	38
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	79
Summer average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	0.95
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	0.5
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	50

*Data for the period 2006-2007, except for dissolved oxygen which EcoLogic collected at a depth of 8 feet on 08/12/2008. Summer defined as period June 15 to September 15.

Aquatic Habitat:

- An aquatic macrophyte survey was conducted by Ecologic in August 2008 and found only sporadic sparse macrophyte growth around the lake. Large beds of curly pondweed are apparently present in spring but these are treated annually and were not present during the survey. Habitat for the lakes fish community appears largely limited to woody debris near the shoreline after treatment.

List of Aquatic Plants identified in 2008:

Scientific Name	Common Name
Chara sp.	Muskgrass
Lemna minor	Common duckweed
Najas flexilis	Slender naiad

Scientific Name	Common Name
Potamogeton crispus	Curly pondweed
Zannichellia palustris	Horned pondweed

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	Common Name
Heracleum mantegazzianum	Giant Hogweed
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Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg's Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine

Scientific Name	Common Name
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
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Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
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- New York Natural Heritage Program – Town of Lewisboro

Scientific Name	Common Name	NY Legal Status
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Birds		
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Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	99
Evaporation (ET)	22	45
Runoff (R)	26	221

Water Budget:	
Inflow to Lake [R+(P-ET)]	90 mgal/year
Lake Volume	41 mgal
Flushing Rate	2.2 times/year
Residence Time	0.46 year

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed (acres)	Cover (%)	Phosphorus Export Coeff	Estim P Export kg/year	Estim P Export Percent
Open water (all)	20	16	0.30	2.5	27
Developed, open space	61	48	0.20	4.9	55
Deciduous forest	39	31	0.07	1.1	12
Evergreen forest	6.9	5.4	0.20	0.56	6.2
Total Acres	**127**	**100**		**9.1**	**100**

(B) Septic: Assumed that communities around the lake are on septic systems.

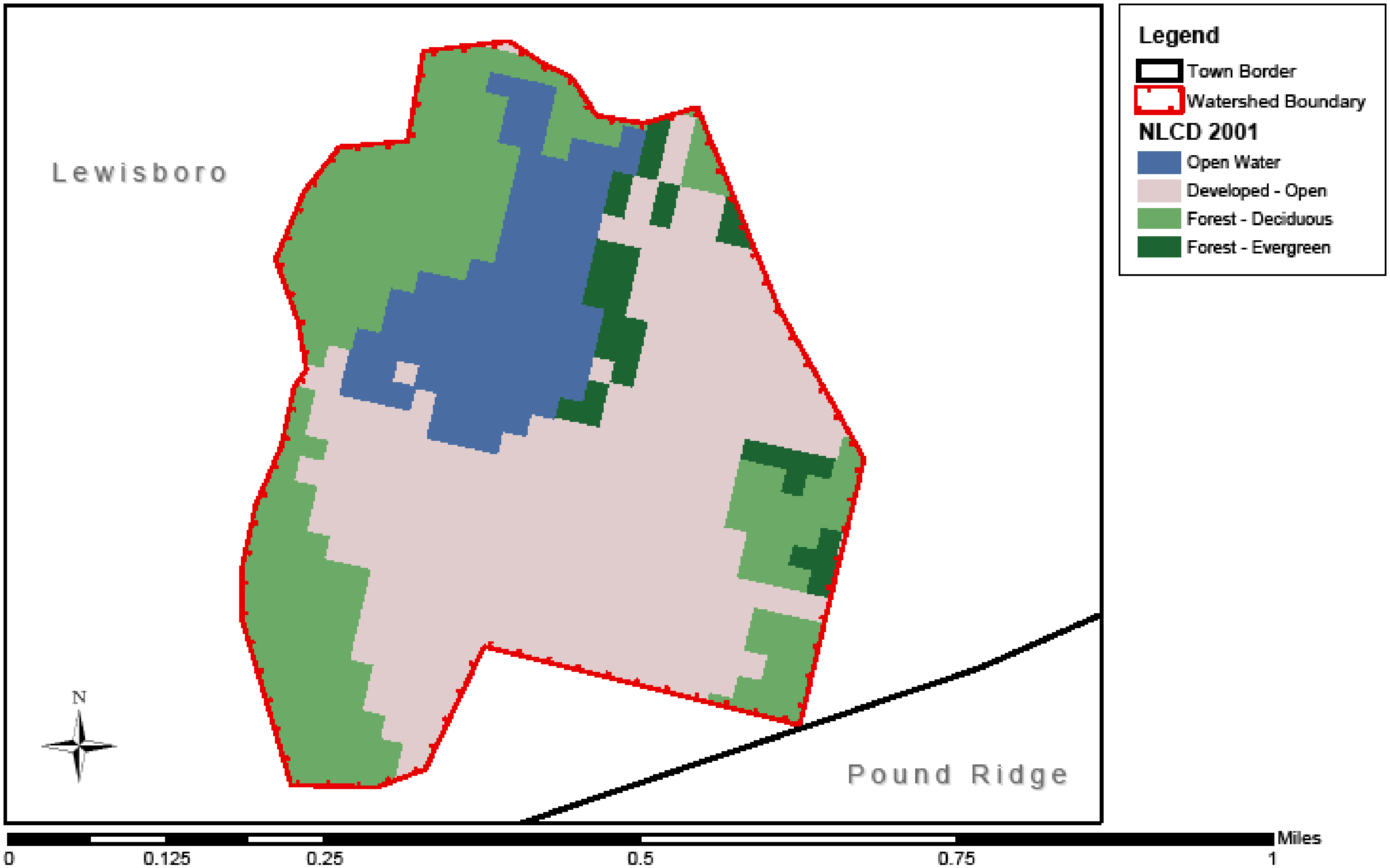
Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

Class	N Structures	Average Household	Estimated Population
Not limited	0	3	0
Somewhat limited	6	3	18
Very limited	38	3	114
Total	**44**		**132**

Estimated phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%.

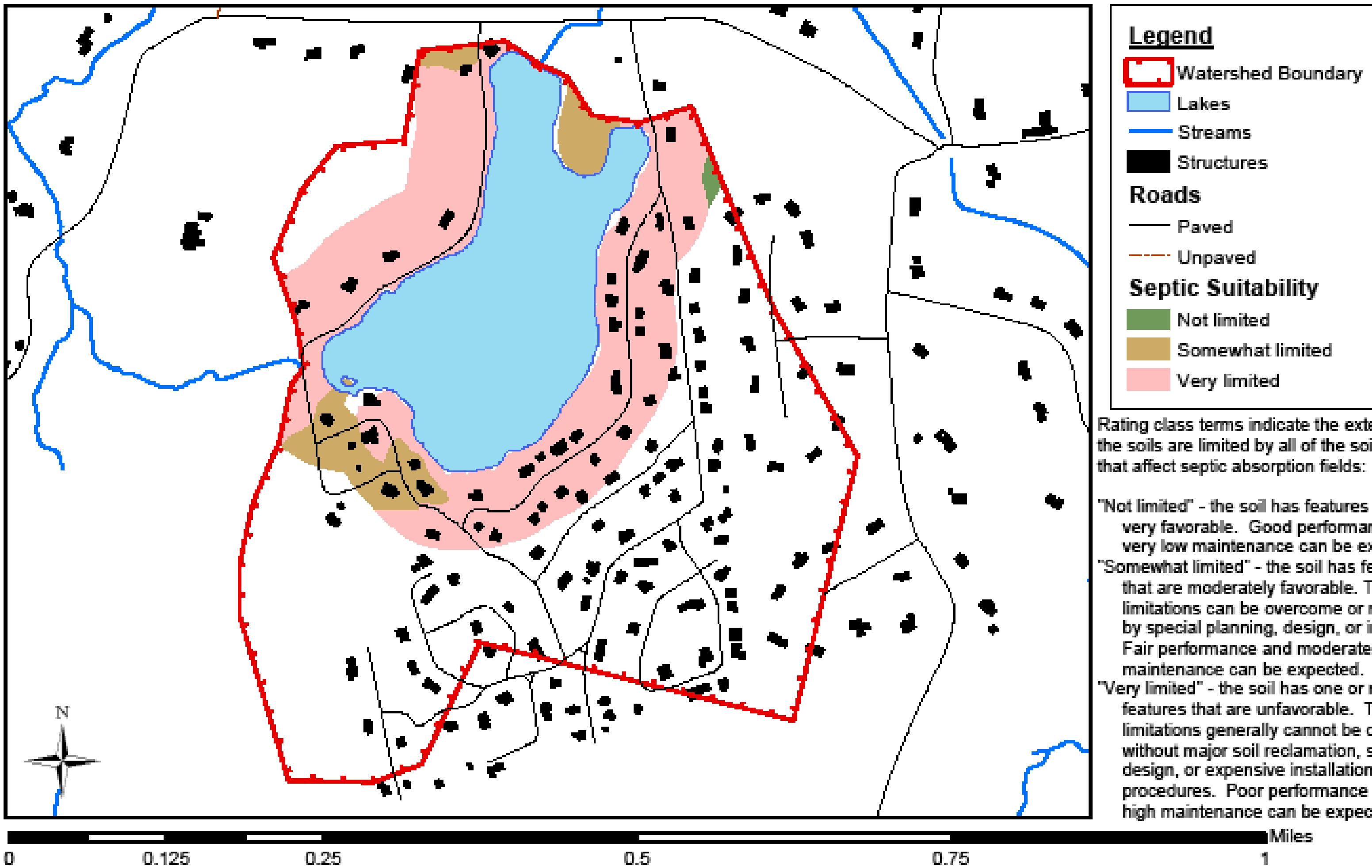
Class	Population	P per cap	Transport	kg/year
Not limited	0	0.6	10%	0
Somewhat limited	17	0.6	30%	3.1
Very limited	108	0.6	60%	39
Failed systems (5%)	7	0.6	100%	4.0
Total	**132**			**46**

Figure 3
Lake Katonah
National Land Cover Dataset 2001



Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4
Lake Katonah
Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.
"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

(C) Point Sources: There are no known point sources of phosphorus to Lake Katonah.

(D) Summary of Phosphorus Input to the Lake:

Source	**Input (kg/year)**
Watershed Land Cover	9.1
Point Sources	0
Septic within 100m of surface water	46
Internal loading (sediment)	0
Total	**55**

Phosphorus Mass Balance: Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10+H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = flushes per year

Parameter	**Units**	**Result**
W′	g/m^2/year	549
H	m	1.6
ρ	flushes per year	0.46
p	**ug/l**	**51**
Summer (Jun 15-Sep 15) average TP, 2006-2008, upper waters:		**94 ug/l**

REFERENCES

Invasive Species Council of New York State. Early Detection Invasive Plants by Region. Web site: http://www.ipcnys.org/. Obtained on-line 11/29/07.

New York Natural Heritage Program. Letter dated December 21, 2007 received by EcoLogic, LLC. New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources.

New York State Department of Environmental Conservation. 2007. 2006 Interpretive Summay, New York Citizens Statewide Lake Assessment Program (CSLAP) 2006 Annual Report - Lake Katonah. February 2007. With New York Federation of Lake Associations. Scott A. Kishbaugh, PE.

New York State Department of Environmental Conservation. 2008. 2007 Interpretive Summay, New York Citizens Statewide Lake Assessment Program (CSLAP) 2007 Abridged Annual Report - Lake Katonah. April 2008. With New York Federation of Lake Associations. Scott A. Kishbaugh, PE.

US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

3.7. Timber Lake

Timber Lake

Surface water quality classification: Class B

Morphology Summary:

Characteristic	Units	Value	Source
Surface area	hectares	2.9	NYSDEC 2008
Watershed area	hectares	22	EcoLogic 2008 (excl lake)
Volume	mgal	15.61	EcoLogic 2008
Elevation	m	80	NYSDEC 2008
Maximum depth	m	3.1	EcoLogic 2008
Average Depth	m	2.1	EcoLogic 2008

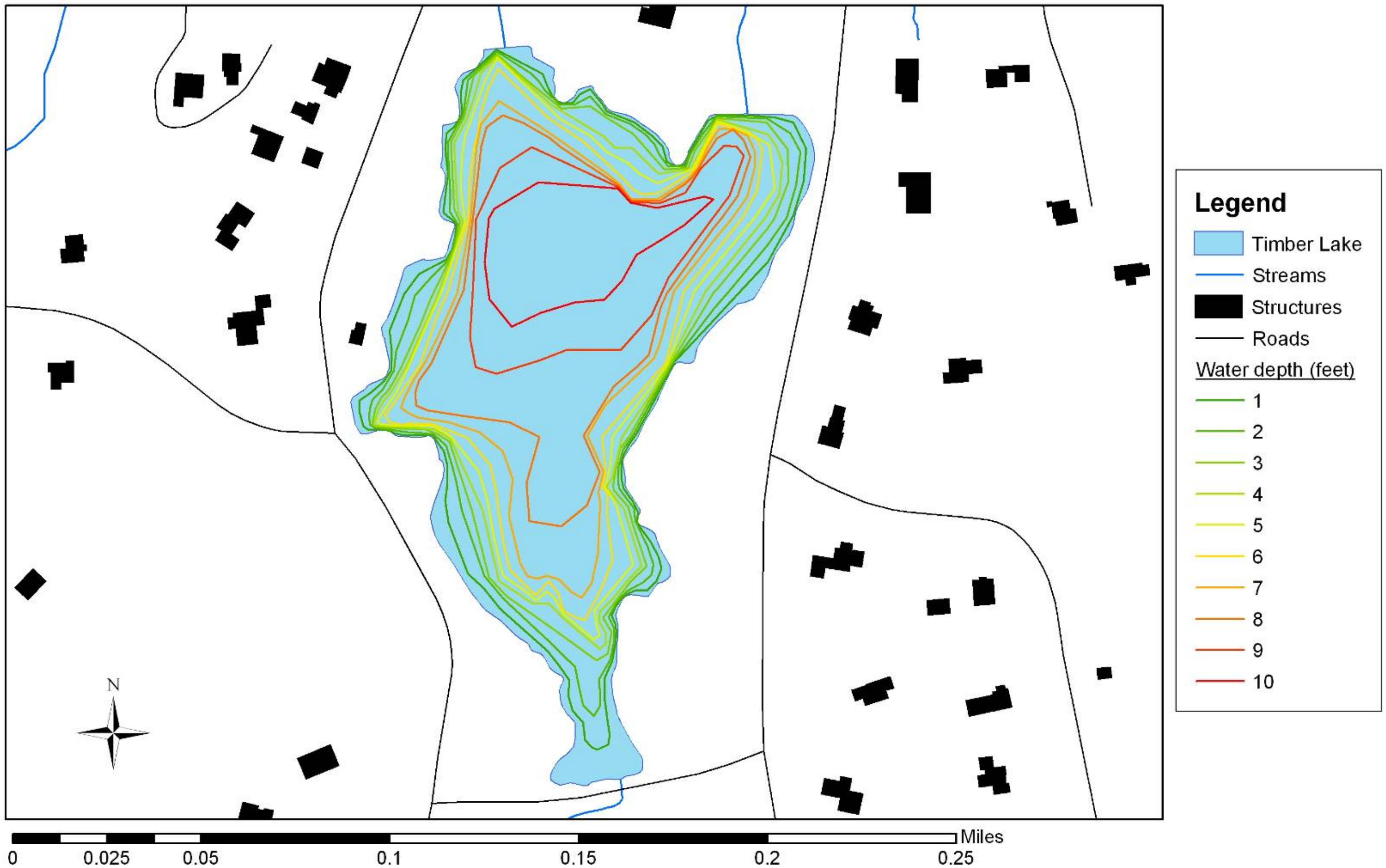
Lake Inlet: There is a small inlet entering on the south shore that drains a wetland area.

Lake Outlet: The lake level is controlled by a dam located on the northwest shore.

Recreational impacts: Recreational suitability was mostly unfavorable in 2005; the lake was described as "slightly" to "substantially" impaired for recreational uses. This was associated with a drop in water clarity and elevated algae levels. (NYSDEC 2006). The lake was described as "excellent" to "slightly" impaired for recreational uses in 2007, slightly better than in recent years, but slightly more favorable than expected given the water quality conditions. (NYSDEC 2008)

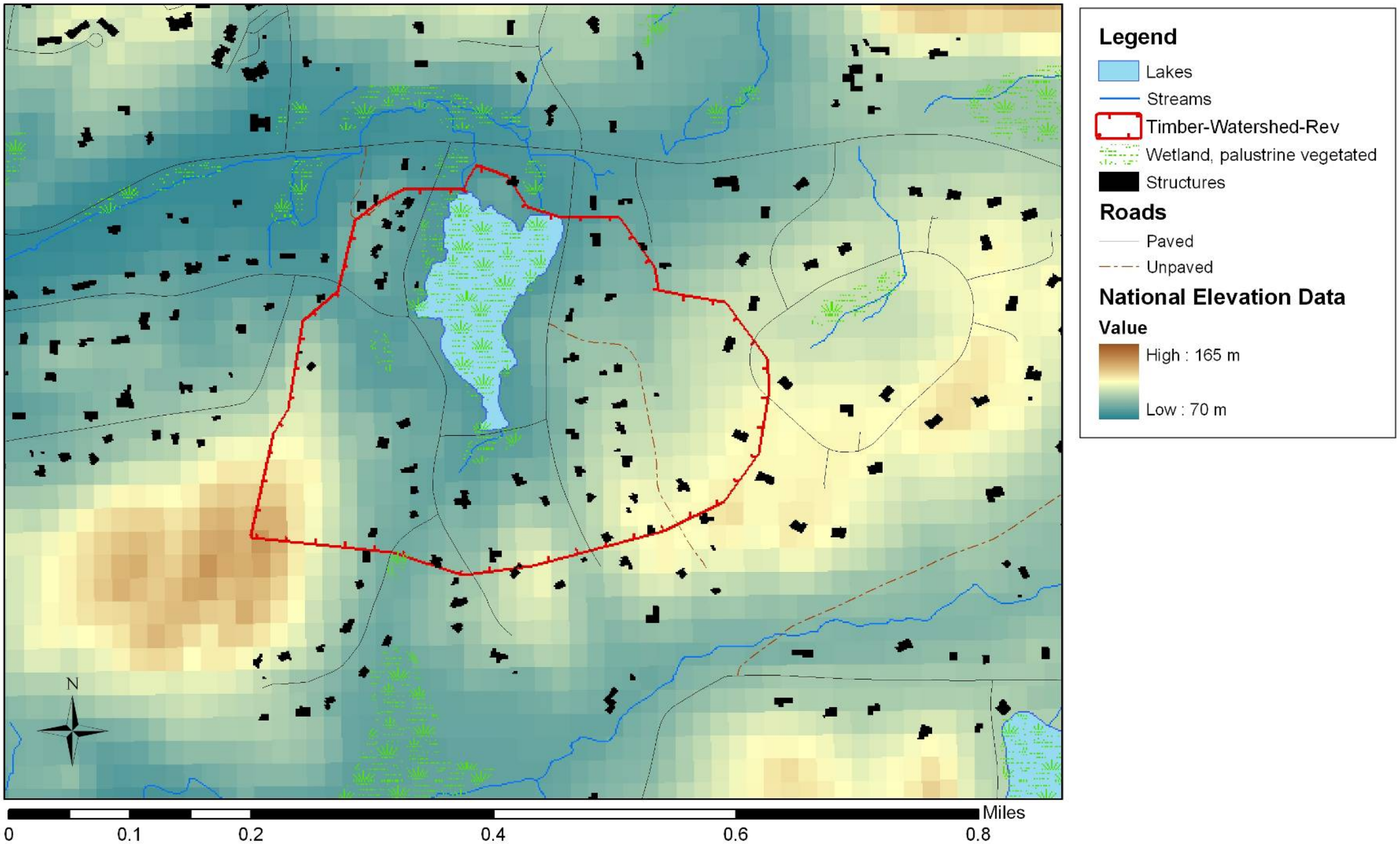
Lakeshore Development: Development is predominantly residential, and is most dense to the south and east of the lake.

Figure 1
Timber Lake
Bathymetry August 13, 2008



Sources:
Lakes, Streams, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.

Figure 2
Timber Lake
Topographic and Human Features



Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
National Elevation Dataset - U.S. Geological Survey (USGS), EROS Data Center, 1999. On-line at http://gisdata.usgs.net/ned/.
Geographic coordinate system. Horizontal datum of NAD83. Vertical datum of NAVD88.

Historical water quality data summary:

Data were collected under the Citizen Statewide Lake Assessment Program (CSLAP), at depths ranging from 1.0 to 1.5 meters (upper waters only). Table A below summarizes samples collected between January and December of each year. Table B below summarizes samples collected during the summer, defined as the period between June 15 and September 15 each year.

A. Representing samples collected between January and December each year.

Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Calcium	1994-1995	0	--	--	--
(mg/l)	2005-2007	6	18.37	25.31	22.43
Chlorophyll-α	1994-1995	0	--	--	--
(ug/l)	2005-2007	23	1.1	27.98	13.77
Color (platinum	1994-1995	0	--	--	--
color units)	2005-2007	23	3	48	16.78
Conductivity	1994-1995	0	--	--	--
(umhos/cm; 25°C)	2005-2007	24	323.9	565.1	458.7
Dissolved Nitrogen	1994-1995	0	--	--	--
(mg/l)	2005-2007	24	0.125	0.929	0.486
NO_3 Nitrates (mg/l)	1994-1995	0	--	--	--
	2005-2007	23	0.0025	0.153	0.034
NH3 Nitrogen (mg/l)	1994-1995	0	--	--	--
	2005-2007	23	0.005	0.208	0.048
Phosphorus (mg/l)	1994-1995	0	--	--	--
	2005-2007	23	0.0155	0.0588	0.0348
Nitrogen:Phosphorus	1994-1995	0	--	--	--
Ratio	2005-2007	23	2.99	37.90	16.15
pH (std units)	1994-1995	0	--	--	--
	2005-2007	24	7.29	8.38	7.78
Secchi depth (m)	1994-1995	18	0.49	2.75	1.39
	2005-2007	24	0.70	3.0	1.53
Temperature (°C)	1994-1995	0	--	--	--
	2005-2007	24	21.5	29	25.73

B. Representing samples collected between June 15 and September 15 each year.

Parameter (units)	Time Period	Number of Samples	Minimum	Maximum	Average
Chlorophyll-α	1994-1995	0	--	--	--
(ug/l)	2005-2007	20	1.1	27.98	14.17
Dissolved Nitrogen	1994-1995	0	--	--	--
(mg/l)	2005-2007	21	0.125	0.929	0.467
NO_3 Nitrates (mg/l)	1994-1995	0	--	--	--
	2005-2007	20	0.0025	0.15	0.036
NH3 Nitrogen (mg/l)	1994-1995	0	--	--	--
	2005-2007	20	0.005	0.171	0.040

B. Representing samples collected between June 15 and September 15 each year.					
Parameter (units)	**Time Period**	**Number of Samples**	**Minimum**	**Maximum**	**Average**
Phosphorus (mg/l)	1994-1995 2005-2007	0 20	-- 0.016	-- 0.059	-- 0.034
Nitrogen:Phosphorus Ratio	1994-1995 2005-2007	0 20	-- 2.99	-- 37.90	-- 16.38
Secchi depth (m)	1994-1995 2005-2007	10 21	0.51 0.70	2.52 3.0	1.39 1.49

EcoLogic August 2008 water quality data summary:

A. Analytical Results

Parameter (units)	**Surface (0 m)**	**Depth (3.1 m)**
Secchi Transparency (m)	1.0	--
Chlorophyll-a (mg/l)	0.026	na
Alkalinity (mg/l)	68	na
Phosphorus:		
Total Phosphorus (mg/l)	0.012	0.017
Soluble Orthophosphate as P (mg/l)	<0.003	0.0056[a]
Nitrogen:		
Total Kjeldahl Nitrogen (mg/l)	0.60	0.68
Nitrate/Nitrite as N (mg/l)	0.055	0.054
Total Nitrogen (mg/l)	0.66	0.73

na – not analyzed
[a]A trace amount of this analyte was found in the laboratory preparation blank.

B. Field Profiles

Depth ft (m)	**Temperature (°C)**	**pH**	**Conductivity (us)**	**DO (mg/l)**	**DO (% sat)**
1 (0.305)	24.5	7.2	636	5.2	61
2 (0.61)	24.2	--	635	5.1	61
3 (0.915)	24.2	--	634	4.9	58
4 (1.22)	24.1	--	625	4.8	57
5 (1.525)	24.1	--	635	4.8	58
6 (1.83)	24.1	--	634	4.8	57
7 (2.135)	24.1	--	634	4.7	56
8 (2.44)	24.1	--	634	4.7	56
9 (2.745)	24.1	--	634	4.7	56
10 (3.05)	24.0	--	634	4.6	54

Sediment data summary:

- Composite samples collected August 13, 2008 (EcoLogic, 2008):

Parameter	**Analytical Method**	**Result (mg/kg dry wt)**
Pesticides/PCBs	EPA 8081/8082	ND
TCL Volatiles	EPA 8260B	ND
TCL Semi-Volatiles	EPA 8270	ND

Parameter	**Analytical Method**	**Result (mg/kg dry wt)**
RCRA Total Metals	EPA 6010	
Arsenic		ND
Barium		19
Cadmium		0.26
Chromium		3.8*
Copper		18
Lead		13
Selenium		ND
Silver		ND
RCRA Mercury	EPA 7471	ND
Total Organic Carbon	EPA 9060	103,000
Total Solids	SM 18-20 2540B	18%

ND – non-detect. Analytes reported as less than the method detection limit.
*The result of the laboratory control sample for this analyte was less than the established limit.

Sediment Contaminant Analysis: Interest has been expressed in exploring the feasibility of dredging. A composite sediment sample was collected on August 13, 2008 (EcoLogic, 2008). Results are summarized in Table C, in the context of NYSDEC Screening levels. A complete set of results is attached to the end of this report. (Attachment 2 - 2008 Water Quality and Sediment Sampling Locations and Laboratory Analysis Reports). The NYSDEC screening levels are separated into three Classes: A, B, and C:

- **Class A - No Appreciable Contamination (No Toxicity to aquatic life).**
  If sediment chemistry is found to be at or below the chemical concentrations which define this class, dredging and in-water or riparian placement, at approved locations, can generally proceed.

- **Class B - Moderate Contamination (Chronic Toxicity to aquatic life).**
  Dredging and riparian placement may be conducted with several restrictions. These restrictions may be applied based upon site-specific concerns and knowledge coupled with sediment evaluation.

- **Class C - High Contamination (Acute Toxicity to aquatic life).**
  Class C dredged material is expected to be acutely toxic to aquatic biota and therefore, dredging and disposal requirements may be stringent. When the contaminant levels exceed Class C, it is the responsibility of the applicant to ensure that the dredged material is not a regulated hazardous material as defined in 6NYCRR Part 371. This TOGS does not apply to dredged materials determined to be hazardous.

Table C. Timber Lake sediment analytical results with NYSDEC Sediment Quality Threshold Values for Dredging, Riparian or In-water Placement. Threshold values are based on known and presumed impacts on aquatic organisms/ecosystem. Results that fall into Class C (high contamination) are highlighted.

Compound	Required Method Detection Limit	Threshold Values			Timber Results	Threshold Class
		Class A	Class B	Class C		
Metals (mg/kg dry wt) – EPA Method 6010B						
Arsenic	1.0	< 14	14 – 53	> 53	ND	A
Cadmium	0.5	< 1.2	1.2 - 9.5	> 9.5	0.26	A
Copper*	2.5	< 33	33 – 207	> 207	18	A
Lead	5.0	< 33	33 – 166	> 166	13	A
Mercury[+]	0.2	< 0.17	0.17 - 1.6	> 1.6	ND	A
PAHs and Petroleum-Related Compounds (mg/kg dry wt) – EPA Methods 8020, 8021, 8260 and 8270						
Benzene	0.002	< 0.59	0.59 - 2.16	> 2.16	ND	A
Total BTEX*	0.002	< 0.96	0.96 - 5.9	> 5.9	ND	A
Total PAH[1]	0.33	< 4	4 - 35	> 35	ND	A
Pesticides (mg/kg dry wt) – EPA Methods 8081						
Sum of DDT+DDD+DDE[+]	0.029	< 0.003	0.003 - 0.03	> 0.03	ND	A
Mirex*[+]	0.189	< 0.0014	0.0014 - 0.014	> 0.014	na	--
Chlordane*[+]	0.031	< 0.003	0.003 - 0.036	> 0.036	ND	A
Dieldrin	0.019	< 0.11	0.11 -0. 48	> 0.48	ND	A
Chlorinated Hydrocarbons (mg/kg dry wt) – EPA Methods 8082 and 1613B						
PCBs (sum of aroclors)[2]	0.025	< 0.1	0.1 - 1	> 1	ND	A
2,3,7,8-TCDD*[3](sum of toxic equivalency)	0.000002	< 0.0000045	0.0000045 - 0.00005	> 0.00005	na	--

na – not analyzed; “<” – indicates result was not detected above the level reported.

[+]Threshold values lower than the Method Detection Limit are superseded by the Method Detection Limit.

* Indicates case-specific parameter. The analysis and evaluation of these case specific analytes is recommended for those waters known or suspected to have sediment contamination caused by those chemicals. These determinations are made at the discretion of Division staff.

[1]For Sum of PAH, see Appendix E of TOGS 5.1.9. For Timber Lake, each of the 18 PAH compounds were reported as non-detect (<0.9 mg/kg).

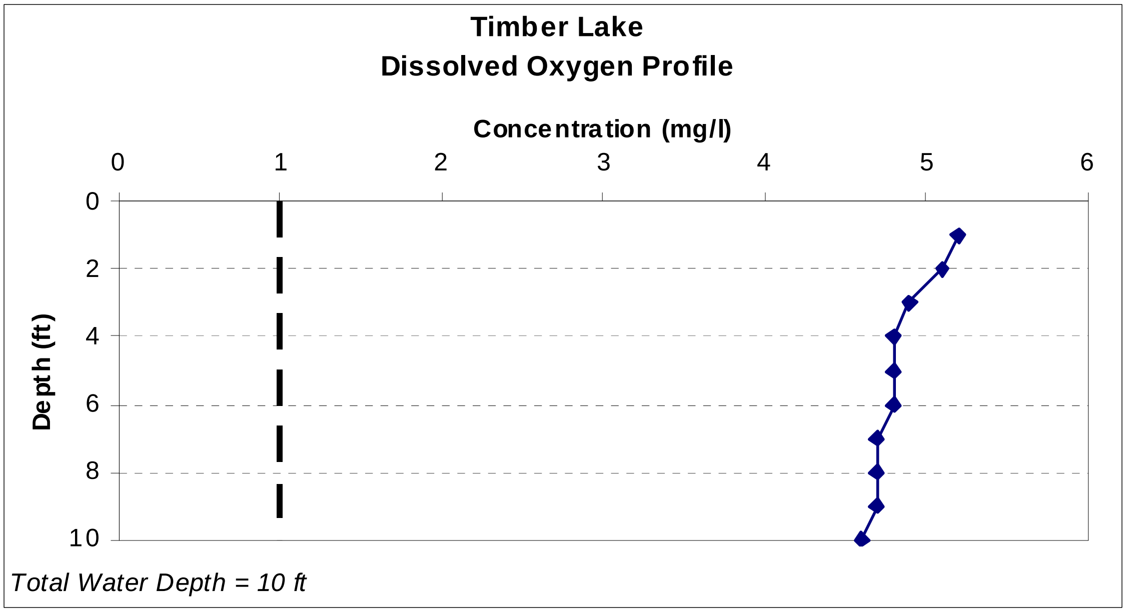
[2]For the sum of the 22 PCB congeners required by the USACE NYD or EPA Region 2, the sum must be multiplied by two to determine the total PCB concentration. On Timber Lake, seven Aroclors were each reported as <0.2 mg/kg; this value is reported above.

[3]TEQ calculation as per the NATO - 1988 method (see Appendix D of TOGS 5.1.9).

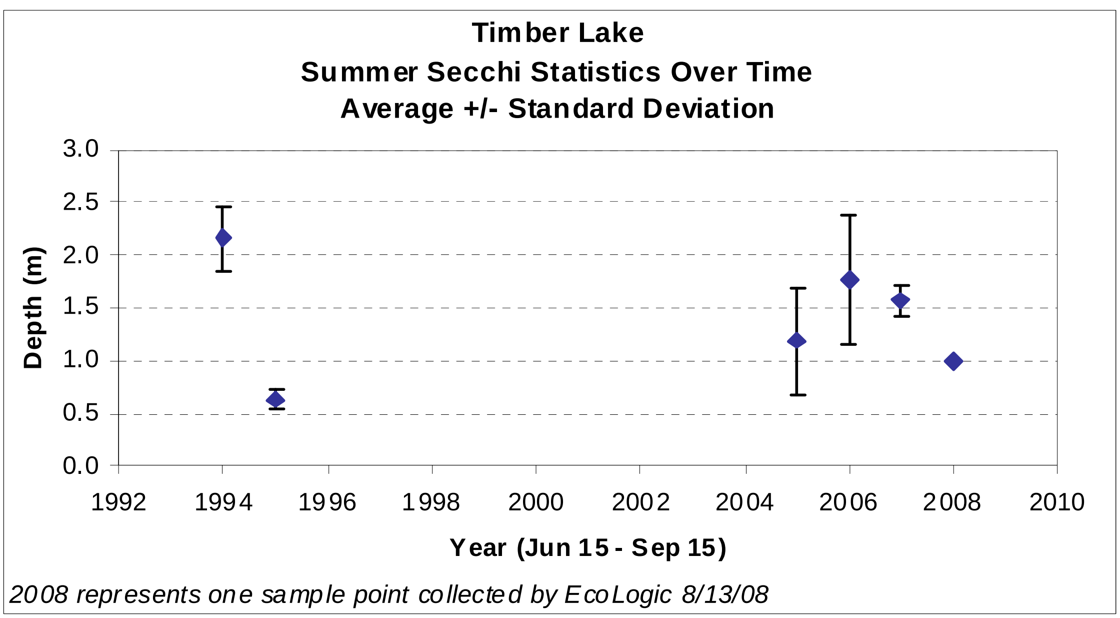
Note: The proposed list of analytes can be augmented with additional site specific parameters of concern. Any additional analytes suggested will require Division approved sediment quality threshold values for the A, B and C classifications.

Source: Table 2, NYSDEC Division of Water, Technical & Operational Guidance Series (TOGS) 5.1.9, “In-Water and Riparian Management of Sediment and Dredged Material”, Nov. 2004.

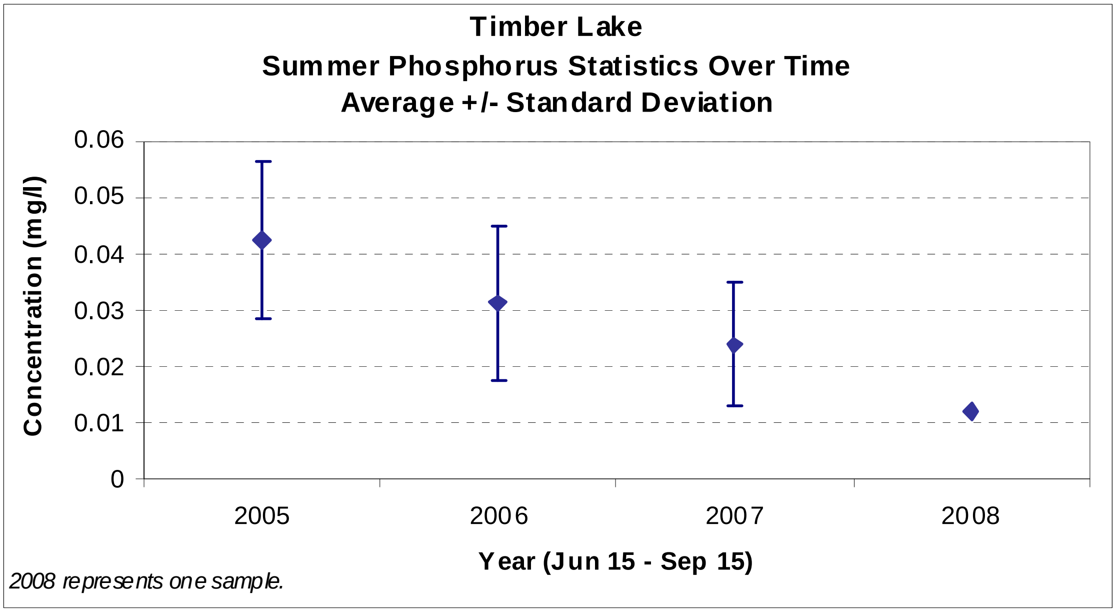
Anoxia: Based on the dissolved oxygen profile collected on August 13, 2008, oxygen levels were depleted in the lower waters, but anoxic conditions (concentrations less than 1 mg/l) were not observed in the lake.



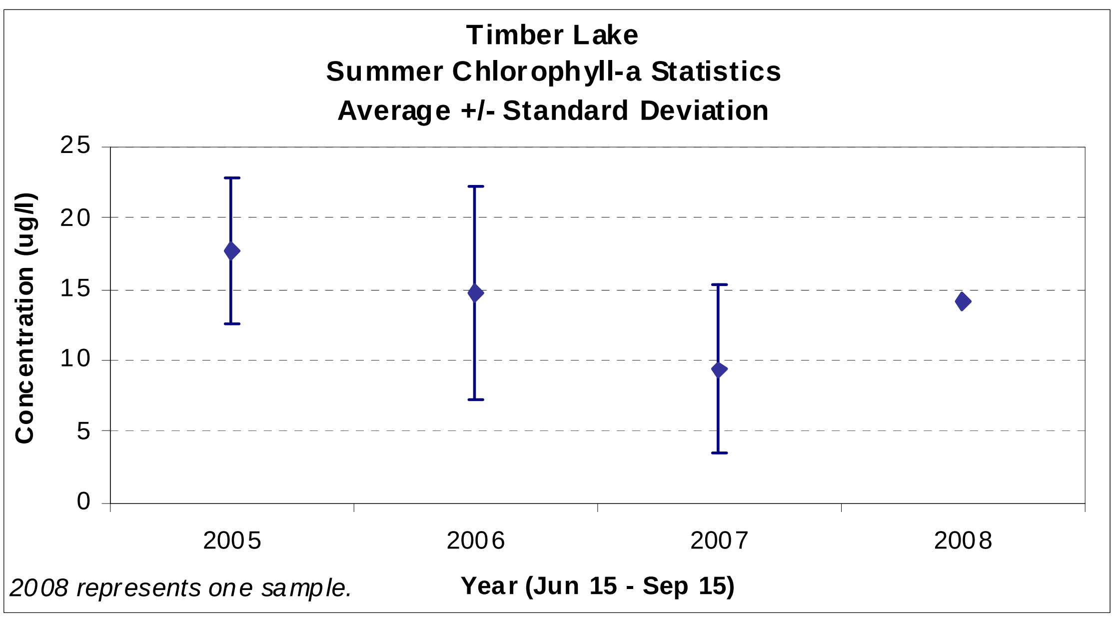
Water Clarity: While clarity in 1994 was about 2 meters, clarity was significantly reduced in 1995 at just over half a meter. The summer averages for 2005 through 2007 were generally around 1.5 meters; one measurement in 2008 was 1.0 meter.



Phosphorus Concentrations: Summer average phosphorus concentrations are decreasing over time.



Chlorophyll-α: Chlorophyll-α concentrations generally decreased from 2005 to 2007.



Trophic Status:

Parameter	Trophic State (shading indicates match to Lake)				Timber Lake*
	Oligotrophic	**Mesotrophic**	**Eutrophic**	**Hypereutrophic**	
Summer average Total Phosphorus, upper waters (µg/l)	<10	10-35	35 -100	>100	34
Summer chlorophyll-a, upper waters (µg/l)	<2.5	2.5 - 8	8 - 25	>25	14
Peak chlorophyll-a (µg/l)	<8	8-25	25-75	>75	28
Summer average Secchi disk transparency, m	>6	6-3	3-1.5	<1.5	1.5
Minimum Secchi disk transparency, meters	>3	3-1.5	1.5-0.7	<0.7	0.70
Dissolved oxygen in lower waters (% saturation)	80 - 100	10-80	Less than 10	Zero	54

*Data for the period 2005-2007, except for dissolved oxygen collected at 10-ft depth by EcoLogic on 08/13/2008. Summer defined as the period June 15 – Sept 15.

Aquatic Habitat:

- Aquatic plants have not been visible from the lake surface in recent years, probably due to the stocking of grass carp. Highest vegetation coverage reported in 1994 and 1995; lowest vegetation coverage reported in 2006 and 2007. Aquatic plant surveys have not been conducted through CSLAP at Timber Lake. (NYSDEC 2008)

List of Aquatic Plants identified in 2008:

- No aquatic plants were found during the August 2008 survey.

Invasive Species: Early Detection List for eight regions in New York State, published by the Invasive Species Plant Council of New York State. Obtained on-line (11/29/07). Lower Hudson region list:

Scientific Name	Common Name
Heracleum mantegazzianum	Giant Hogweed
Wisteria floribunda	Japanese Wisteria, Wisteria
Digitalis grandiflora (D. pupurea)	Yellow Foxglove, Foxglove
Geranium thunbergii	Thunberg's Geranium
Miscanthus sinensis	Chinese Silver Grass, Eulalia
Myriophyllum aquaticum	Parrot-feather, Waterfeather, Brazilian Watermilfoil.
Pinus thunbergiana (P. thunbergii)	Japanese Black Pine
Prunus padus	European Bird Cherry
Veronica beccabunga	European Speedwell

Endangered Species:

- US Fish and Wildlife Service

Scientific Name	Common Name	Federal Status
Reptiles		
Clemmys muhlenbergii	Bog Turtle	Threatened, Westchester Co.
Birds		
Haliaeefus leucocephalus	Bald Eagle	Threatened, entire state
Mammals		
Myotis sodalist	Indiana Bat	Endangered, entire state
Felix concolor couguar	Eastern Cougar	Endangered, entire state (probably extinct)
Plants		
Isotria medeoloides	Small Whorled Pogonia	Threatened, entire state
Platanthera leucophea	Eastern Prairie Orchid	Threatened, not relocated in NY
Scirpus ancistrochaetus	Northeastern Bulrush	Endangered, not relocated in NY

- New York Natural Heritage Program

Scientific Name	Common Name	NY Legal Status
Reptiles		
Glyptemys muhlenbergii (formerly *Clemmys muhlenbergii*)	Bog Turtle	Endangered
Birds		
Oporornis formosus	Kentucky Warbler	Protected
Butterflies and Skippers		
Satyrium favonius ontario	Northern Oak Hairstreak	Unlisted
Dragonflies and Damselflies		
Enallagma laterale	New England Bluet	Unlisted
Plants		
Asclepias purpurascens	Purple Milkweed	Unlisted
Eleocharis quadrangulata	Angled Spikerush	Endangered

Water Balance:

USGS Mean Annual (inches/year)		Volume (acre-ft/year)
Precipitation (P)	48	29
Evaporation (ET)	22	13
Runoff (R)	26	119

Water Budget:	
Inflow to Lake [R+(P-ET)]	44 mgal/year
Lake Volume	16 mgal
Flushing Rate	2.8 times/year
Residence Time	0.36 year

Phosphorus Budget:

(A) Watershed Land Cover: 2001 National Land Cover Data Set (MRLC). Includes phosphorus export coefficient (kg/ha/year) and estimated phosphorus export.

Description	Watershed (acres)	Cover (%)	Phosphorus Export Coeff	Estim P Export kg/year	Estim P Export Percent
Open water (all)	5.8	9.0	0.30	0.70	17.9
Developed, open space	28	43	0.20	2.2	57
Deciduous forest	28	44	0.07	0.8	20
Shrub/scrub	0.9	1.5	0.28	0.11	2.7
Emergent herbaceous wetlands	1.3	2.1	0.09	0.05	1.38
Total Acres*	**64**	**100**		**3.9**	**100**

(B) Septic: Assumed that communities around the lake are on septic systems.

Estimated population on septic by soil suitability class with US 2000 Census household size for 100-meter buffer of surface water.

Class	N Structures	Average Household	Estimated Population*
Not limited	0	3.0	0
Somewhat limited	11	3.0	33
Very limited	9	3.0	27
Total	**20**		**60**

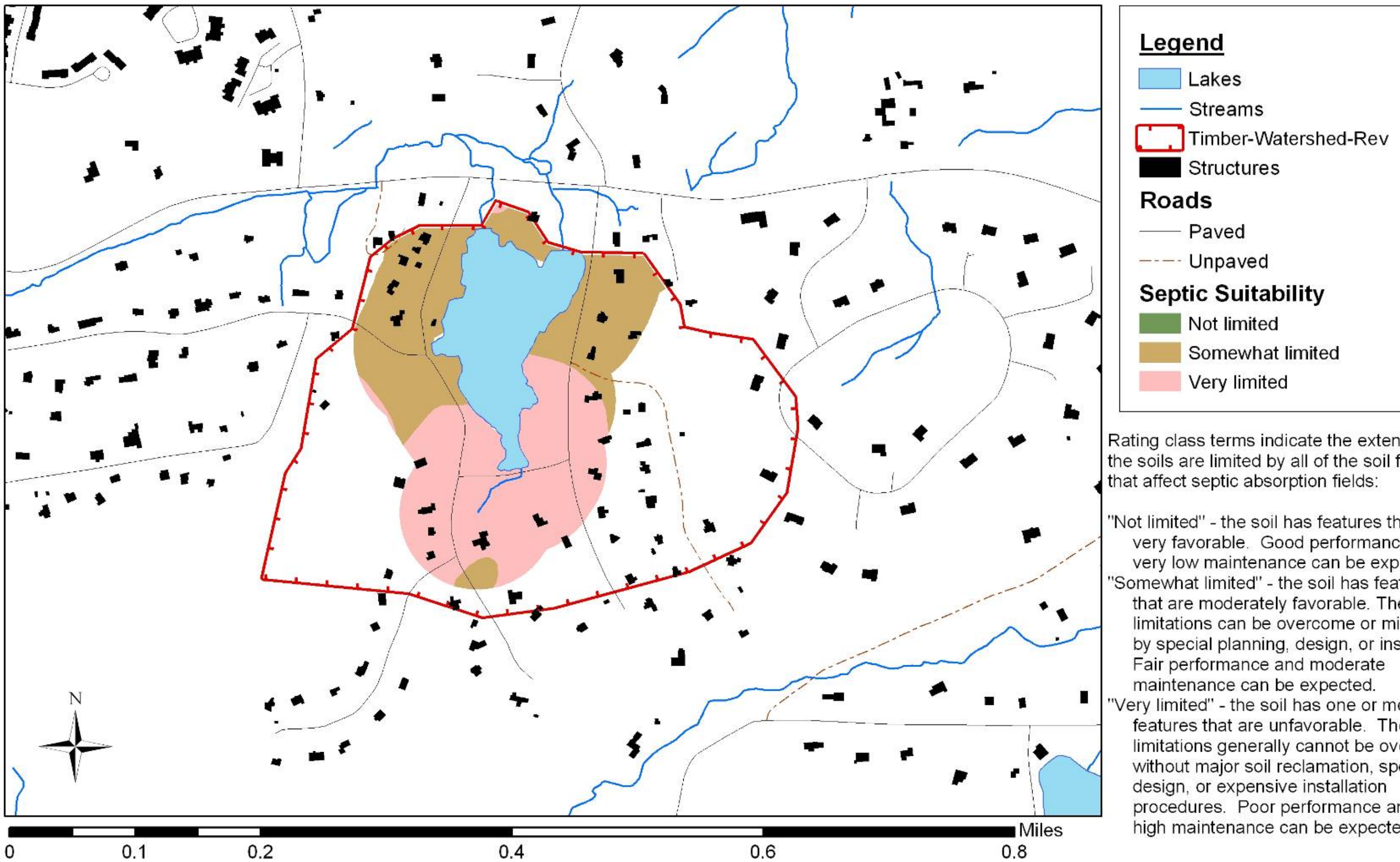
Estimated Phosphorus export by Soil Suitability class for 100-meter buffer of surface water, with failure rate of 5%.

Class	Population*	P per cap	Transport	kg/year
Not limited	0	0.6	10%	0
Somewhat limited	31	0.6	30%	6
Very limited	26	0.6	60%	9.2
Failed systems (5%)	3	0.6	100%	1.8
Total	**60**			**17**

Figure 3
Timber Lake
National Land Cover Dataset 2001

Source:
National Land Cover Database zone 65 Land Cover Layer. On-line at http://www.mrlc.gov
The National Land Cover Database 2001 land cover layer for mapping zone 65 was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium. Minimum mapping unit = 1 acre. Geo-referenced to Albers Conical Equal Area, with a spheroid of GRS 1980, and Datum of NAD83.

Figure 4
Timber Lake
Soil Septic Suitability, 100-Meter Stream Buffer Within the Watershed



Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect septic absorption fields:

"Not limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.
"Somewhat limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
"Very limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Sources:
Lakes, Streams, Wetlands, Roads and Structures - On-line at Westchester County web site http://giswww.westchestergov.com/. Municipal planimetric datasets were photogrammetrically derived from the county's 2004 base map project and meet National Map Accuracy Standards at 1"=100'.
Soil Survey of Westchester County - Compiled by Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. On-line at http://soildatamart.nrcs.usda.gov/. Accessed November 28, 2007. *"Septic tank absorption fields" are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health.*

EcoLogic

(C) Point Sources: There are no known point sources of phosphorus to Timber Lake.

(D) Summary of Phosphorus Input to the Lake:

Source	Input (kg/year)
Watershed Land Cover	3.9
Point Sources	0
Septic within 100m of surface water	17
Internal loading (sediment)	0
Total	**21**

Phosphorus Mass Balance: Empirical estimates of net loss from system based on mean depth and water residence time.

$$p = W'/10+H\rho$$

where:

p = summer average in-lake TP concentration, ug/l
W′ = areal loading rate, g/m^2/year
H = mean depth, m
ρ = flushes per year

Parameter	Units	Result
W′	g/m^2/year	714
H	m	2.1
ρ	flushes per year	0.36
p	**ug/l**	**66**
Summer (Jun 15 – Sep 15) average TP 2005-2007, upper waters:		**34 ug/l**

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Invasive Species Council of New York State. Early Detection Invasive Plants by Region. Web site: http://www.ipcnys.org/. Obtained on-line 11/29/07.

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New York State Department of Environmental Conservation. 2006. 2005 Interpretive Summay, New York Citizens Statewide Lake Assessment Program (CSLAP) 2005 Annual Report – Timber Lake. March 2006. With New York Federation of Lake Associations. Scott A. Kishbaugh, PE.

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US Fish and Wildlife Service. 2007. US Fish and Wildlife Service State Listing. List filtered to species with possible presence in the Town of Lewisboro. Obtained from web site on 11/28/07. Web site: http://www.fws.gov/northeast/Endangered/.

4. Water Quality – Current Conditions

The fact sheets in Section 3 summarize the current conditions and temporal trends in water quality for each lake. This section assesses the current state of the Lewisboro Lakes as a whole.

4.1. Sources of data and information

The extent of water quality and habitat data available for the Lewisboro Lakes varied from lake to lake. The Three Lakes – Rippowam, Oscaleta and Waccabuc – had the most long-term water quality data; measurements extended from the 1970s to the present. In contrast, Lake Kitchawan was characterized only with two sampling events in 2007. The 2008 field collection program was designed to help fill data gaps.

Data utilized used for this analysis are summarized in Table 4-1.

Table 4-1. Data sources utilized.

Lake	CSLAP* Program	Three Lakes Council	Other Lake Reports	Aquatic Macrophyte Surveys
Rippowam	2007	1978-2007	Cedar Eden 2004	Cedar Eden 2004
Oscaleta	2007	1972-2007	Cedar Eden 2004	Cedar Eden 2004
Waccabuc	1986-2007	1936-2007	Cedar Eden 2004	Cedar Eden 2004
Truesdale	1999-2007	--	Land-Tech 2001	Allied Biological 2005
Kitchawan	--	--	ENSR 2008	ENSR 2008
Katonah	2007	--	--	--
Timber	1994-2007	--	--	--

** CSLAP=Citizens State- wide Lake Assessment Program*

4.2. Classification and use attainment

Classification

All waters in New York State are classified according to their best uses. Six of the Lewisboro Lakes hold a Surface Water Quality Classification of "B", which indicates that the best usages are primary and secondary contact recreation and fishing, and that these waters shall be suitable for fish propagation and survival. Lake Waccabuc is designated Class A, which indicates that the best usages are a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing, and the waters shall be suitable for fish propagation and survival. Class A is designated for waters that may, if properly treated, meet New York State Department of Health drinking water standards and may be considered satisfactory for drinking water purposes.

Use Attainment

Six of the lakes (Kitchawan excepted) participate in the Citizens Statewide Lake Assessment Program (CSLAP). This volunteer lake monitoring program is jointly managed by the NYS Department of Environmental Conservation and the state's Federation of Lake Associations (FOLA). CSLAP includes water quality monitoring and an evaluation of perceived suitability of the lake for recreational uses. Water quality assessment and perception survey results for some recent CSLAP annual reports are summarized in Table 4-2.

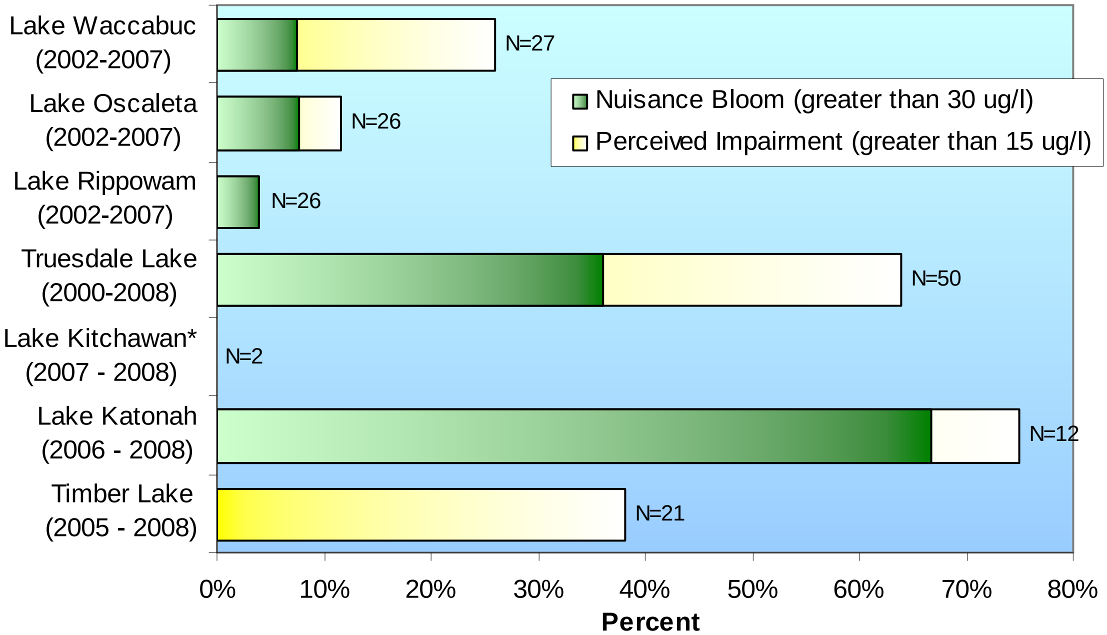
Table 4-2. Summary of 2005-2007 CSLAP perception surveys and water quality assessments.

Lake	Water Quality Assessment	Volunteer Perceptions of Water Quality	
		Lake Conditions	Problems
Rippowam	may not be adequate to support some recreational uses during the summer	Excellent conditions Not quite crystal clear	Poor water clarity Excessive algae growth
Oscaleta	may not be adequate to support some recreational uses during the summer	Slightly impaired Definite algal greenness	Poor water clarity Weed density Excessive algae growth
Waccabuc	adequate to support most recreational uses during the summer	Excellent to slightly Impaired	Poor water clarity Excessive algae growth
Truesdale	sometimes adequate to support most recreational uses during the summer	Slightly to substantially impaired	Weed density Excessive algae growth
Kitchawan	No CLSAP data	No CLSAP data	No CLSAP data
Katonah	very minor aesthetic problems but excellent for overall use	Not quite crystal clear definite algal greeness	Weed density Excessive algae growth
Timber	may not be adequate to support recreational uses during at least part of the summer	Slightly to substantially impaired	Poor water clarity High algae levels

Overall, the Lewisboro Lakes exhibit some level of perceived impairment based on the CSLAP program results. The causes of this impairment are generally listed as poor water clarity, excessive algal growth and/or weed density in the Lewisboro Lakes. Conditions in lakes Rippowam, Oscaleta and Waccabuc are considered better (excellent to slightly impaired) than conditions in Truesdale, Timber, and Katonah (slightly to substantially impaired). These perceptions of recreational suitability are consistent with measured concentrations of phosphorus and chlorophyll-a.

Chlorophyll-a concentrations above 15 µg/l are associated with a perception of algal greenness; concentrations over 30 µg/l are considered nuisance blooms. The percent of chlorophyll-a measurements exceeding these thresholds during the summer recreational period (June 15 to September 15) for each of the Lewisboro Lakes is displayed in Figure 4-1.

Figure 4-1
Percent of Chlorophyll-a Measurements Exceeding Thresholds
1.5 m depth, June 15 to September 15 Summer Period



**Lake Kitchawan represents two samples, one collected July 2007 and one collected August 2008. Both results were less than 15 ug/l. N indicates number of samples evaluated for period shown.*

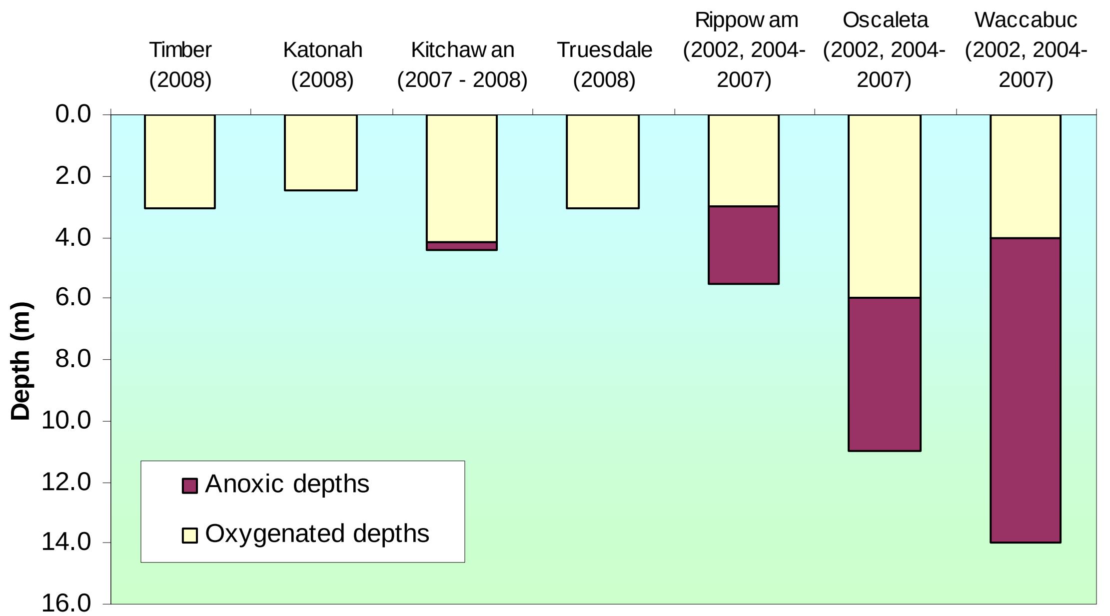
The perceived impairment and nuisance bloom percentages shown in Figure 4-1 coincide with the public perception survey results of CSLAP – lakes with greater percentage of chlorophyll-a measurements above thresholds are those identified as slightly to substantially impaired for desired uses (Truesdale, Timber and Katonah). As expected, higher phosphorus concentrations are associated with elevated chlorophyll-a concentrations and a higher risk of algal blooms.

The lakes support recreational fisheries. Fishery quality is directly dependant on both water and habitat quality. When lakes are deep enough to develop stable thermal stratification, the colder bottom waters become isolated from the atmosphere during the summer. As a result, bottom waters can become depleted of oxygen as the microbial community decomposes organic material. Under these conditions, coldwater fish species that would typically seek refuge from warm surface waters in these deeper areas cannot tolerate dissolved oxygen concentrations below about 5 mg/L for prolonged periods of time.

Lakes deeper than about 5 meters typically exhibit some degree of thermal stratification during the summer. Of the seven Lewisboro Lakes, three are deeper than 5 meters – Rippowam, Oscaleta and Waccabuc. These lakes develop stable thermal stratification with maximum temperature difference between surface and deep waters ranging from 17.8°C to 23.4°C. Dissolved oxygen concentrations in the deeper waters of these three lakes fall to very low levels during the summer,

The depth to which low oxygen conditions extend has a profound impact on the nature of he aquatic community. The maximum extent of anoxia (tracked as dissolved oxygen levels below 1 mg/l) for the Lewisboro Lakes is displayed in Figure 4-2. The bars illustrate the shallowest depth at which dissolved oxygen less than 1 mg/l has been measured. For example, in Lake Waccabuc, only the top 4 meters of the lake water column have dissolved oxygen concentrations that would support aquatic life during the summer.

Figure 4-2
Maximum Depth Sampled and Maximum Extent of Anoxia
June 1 to September 30 Summer Period



Based on this analysis, the Lewisboro Lakes may be grouped into categories describing current water quality and habitat conditions and use attainment. This grouping is presented in Table 4-3.

Table 4-3. Summary of current water quality conditions and use attainment

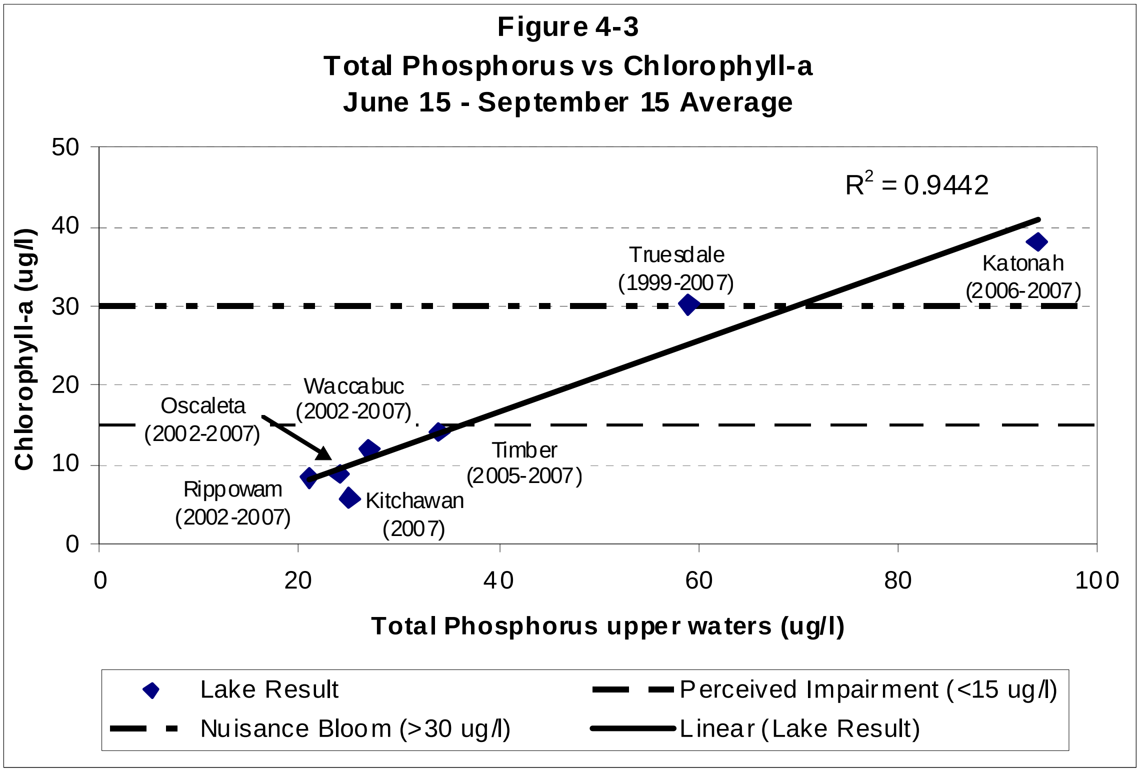
Depth Categories	Water Quality and Aquatic Habitat Status: *Meets Desired Uses*	*Meets Desired Uses, with Evidence of Degradation*	*Do Not Meet Desired Uses*
Shallow (less than 3 m maximum depth)			Timber Katonah
Medium (3 – 8 m maximum depth)		Kitchawan Rippowam	Truesdale
Deep (greater than 8 m maximum depth)		Oscaleta Waccabuc	

4.3. Phosphorus and Algae Correlation

Total phosphorus in the upper waters is one measure of nutrients in the water column available for algae and plant growth. In general, higher concentrations of phosphorus in lakes results in increased amounts of algal growth, which in turn reduce water clarity.

Average chlorophyll-a concentrations, which are an indicator of algae in the water, are highly correlated with total phosphorus in the Lewisboro Lakes (Figure 4-3). This relationship is important when considering priorities for lake protection and restoration. Certain lakes will require reductions in the supply of phosphorus to reduce the frequency of nuisance algae blooms; other lakes need protective measures to keep nuisance blooms from developing.

On average, total phosphorus and chlorophyll-a concentrations are lowest in Lakes Rippowam, Oscaleta, Kitchawan, and Waccabuc, highest in Lake Katonah, and intermediate in Timber and Truesdale Lakes.



4.4. Trophic State

The available water quality and aquatic habitat data collected in recent years indicate that the Lewisboro Lakes are in various stages of eutrophication. While the data for some lakes are somewhat limited, representing few sampling points, they do provide a basis for making an assessment of trophic state using the standard indicators described in Table 1-1. The final row in Table 4-4 represents a professional judgment of trophic state.

Table 4-4. Summary of Trophic State Parameters, Lewisboro Lakes

	Surface Water Data						
	Rippowam (2002-2007)	**Oscaleta (2002-2007)**	**Waccabuc (2002-2007)**	**Truesdale (1999-2007)**	**Kitchawan (2007-2008)**	**Katonah (2006-2007)**	**Timber (2005-2007)**
Average Total Phosphorus, upper waters (µg/l)	21	24	27	59	23	94	34
Summer chlorophyll-a, upper waters (µg/l)	8.4	8.8	12	30	5.6[a]	38	14
Peak chlorophyll-a (µg/l)	39	54	40	116	5.8[a]	79	28
Average Secchi disk transparency, m	2.2	3.2	2.4	1.1	1.5[b]	0.95	1.5
Minimum Secchi disk transparency, meters	0.50	0.50	1.1	0.53	1.5[b]	0.50	0.70
Dissolved oxygen in lower waters (% saturation)	8.5%[d]	2.8% [d]	2.5% [d]	--	--	--	--
Trophic State[c]	**M**	**E**	**E**	**E**	**M**	**H**	**E**

Notes:
Statistics represent summer period (June 15-September 15).
[a] Kitchawan chlorophyll-a data from one in-lake sample on July 26, 2007.
[b] Secchi disk transparency for Lake Kitchawan measured by EcoLogic in August 2008.
[c] Trophic State: E - eutrophic; M - mesotrophic, H - Hypereutrophic
[d] Percent saturation of DO calculated from DO concentration and temperature for Rippowam, Oscaleta and Waccabuc, using June-September data 2002-2007 as available. Since Truesdale, Timber, Katonah and Kitchawan do not stratify, the lower waters DO percent saturation is not presented.

4.5. Sources of phosphorus

Two important processes have been quantified for many aquatic systems:

(1) the relationship between watershed activities and loading (quantity of material that enters a lake over a defined period; for example kilograms of phosphorous per year), and

(2) the relationship between loading and resultant water quality conditions.

For the first relationship, scientists, engineers, and planners have quantified nutrient runoff from various conditions of land use and population density. For the second, limnologists and oceanographers have determined the physical and hydrologic features such as depth and water residence time that contribute to a lake's assimilative capacity. These relationships form the basis for defining an acceptable loading to aquatic systems to meet water quality objectives.

Standard limnological methods have been developed to quantify the relationship between external loading and in-lake concentration as a function of mean depth and water residence time. These standard methods were developed based on empirical observations of a large number of lakes, with defined inlets and outlets.

The phosphorus budget for the Lewisboro Lakes is based on existing data describing water quality conditions in the Lewisboro Lakes, and land use and vegetative cover data throughout the watershed. Several measures were taken into account:

- Water balance (volume in and volume out)
- Land cover types in the watersheds
- Septic contributions
- Point sources
- Internal loading from sediments

Watershed boundaries were delineated for the Lewisboro Lakes, using existing watershed boundaries from Westchester County[2] and Connecticut Department of Environmental Protection[3], with topographic information from the National Elevation Dataset[4] and professional judgment. The watershed boundaries provide the spatial basis for the phosphorus budget.

4.6. Water Balance

The first step in developing a phosphorus budget is to quantify the water balance. A water balance essentially estimates the total amount of water that enters and leaves a lake each year. The water balance is important because runoff from the watershed delivers phosphorus and other materials to the lake. In addition, the period of time that water stays in the lake affects the amount of phosphorus available. All else being equal, lakes with faster flushing rates will tend to grow less algae than lakes with slower flushing rates. For calculating the water balances of each of the Lewisboro Lakes, USGS mean annual values for the area were used as estimates of precipitation (48 inches/year), evaporation (22 inches/year) and runoff (26 inches/year)[5].

The water balance for each lake is displayed in Table 4-5. Flushing rate is the approximate number of times per year that all the water in the lake would be replaced in a typical year. Residence time is the opposite of this (how many years water stays in the lake, on average). The flushing rates vary from 0.4 times per year in Waccabuc to 18 times per year in Truesdale.

[2] Westchester County GIS, July 1998. Westchester County Drainage Basin Boundaries. On-line at http://giswww.westchestergov.com/westchester/emap/wc1.htm.
[3] Connecticut DEP, Office of Information Management 1988. Local Basins. On-line at http://www.ct.gov/dep/cwp/view.asp?a=2698&q=322898&depNav_GID=1707.
[4] U.S. Geological Survey (USGS), EROS Data Center, 1999. National Elevation Dataset. On-line at http://gisdata.usgs.net/ned/.
[5] USGS Mean annual runoff, precipitation and evapotranspiration in the glaciated Northeastern US 1951-1980. Plates 1 and 2.

Table 4-5. Flushing rate and residence times for the Lewisboro Lakes.

Lake	Inflow to Lake (mgal/year)	Lake Volume (mgal)	Flushing Rate (times/year)	Residence Time (years)
Rippowam	191	150[a]	1.3	0.8
Oscaleta	908	412[a]	2.2	0.5
Waccabuc	1,528	3,696[a]	0.4	2.4
Truesdale	1,756	180[b]	10	0.1
Kitchawan	468	174[c]	2.7	0.4
Katonah	90	41	2.2	0.5
Timber	44	16	2.8	0.4

Sources:
[a]Cedar Eden 2004
[b]Land-Tech, 2001
[c]ENSR 2008

4.7. Phosphorus Loading and Sources

The next step in developing a phosphorus budget is to estimate phosphorus loading. Phosphorus loading to the Lewisboro Lakes occurs through several mechanisms:

- Phosphorus carried in runoff from surrounding watershed; the amount of phosphorus runoff varies by land cover type;
- Phosphorus from septic systems that have failed, or septic systems located in poor soils that allow phosphorus to migrate to surface water
- Phosphorus from point sources; outlets of other lakes are considered point sources for the purpose of this analysis.

4.7.1. Land Cover Contributions

Nonpoint source phosphorus export from watersheds may be estimated by applying regionally-appropriate phosphorus export coefficients as a function of land use and vegetative cover using an Export Coefficient model. This estimate does not include loading from on-site wastewater disposal systems; contributions from these sources are calculated separately.

Topography can also play a role in the quantity of phosphorus exported to the lakes. More steeply-sloped watersheds pose a greater risk of soil erosion, although this relationship can be mitigated by soil type and land cover. Topography is not factored into the land use calculations, but is considered in the interpretation of the results.

For the Lewisboro Lakes, phosphorus transport from surrounding land uses was estimated using land cover GIS files; phosphorus export coefficients were derived from established literature values. The export coefficients (units of kg/ha/year) were multiplied by the area of land cover class in each watershed to get an estimate of annual phosphorus loading from each cover class (Table 4-6). The total amount of phosphorus from a given land cover is a function of both the size of the area and the loading coefficient. Overall, developed lands contribute more phosphorus per unit area than natural lands.

Table 4-6. Watershed phosphorus loading by land cover class.

Land Cover Type	Phosphorus Loading by Land Cover Class (kg/yr)						
	Rippowam	**Oscaleta**	**Waccabuc**	**Truesdale**	**Kitchawan**	**Katonah**	**Timber**
Open water	3.8	12	16	11	9.5	2.5	0.70
Developed*	1.5	4.7	20	32	11	4.9	2.2
Forest/Shrub**	6.9	32	18	54	12	1.7	0.8
Grassland/Pasture/Crops	0.29	2.5	3.7	15	1.0	--	0.11
Wetlands (woody/emergent)	0.81	2.1	0.90	9.6	4.0	--	0.05
Total	**13**	**53**	**58**	**122**	**37**	**9.1**	**3.9**

Totals are approximate due to rounding errors.
Shaded cells indicate the highest contribution for land cover class in each watershed.
*Developed – sum of three Developed classes: open space, low intensity and medium intensity.
*Forest/Shrub – sum of four classes: Forest Deciduous, Forest Evergreen, Forest Mixed, and Shrub/scrub.

Of the significant contributors by land cover class, Forest/Shrub and Open Water contributions are natural; in contrast, Developed contributions are directly influenced by human activity. Most of the phosphorus from land cover classes in the Lewisboro Lakes watersheds is contributed by natural sources; only Timber, Katonah and Waccabuc land cover contributions were mainly from areas affected by human activity (Table 4-6). Residential development increases phosphorus export.

4.7.2. On-site Wastewater Disposal System Contributions

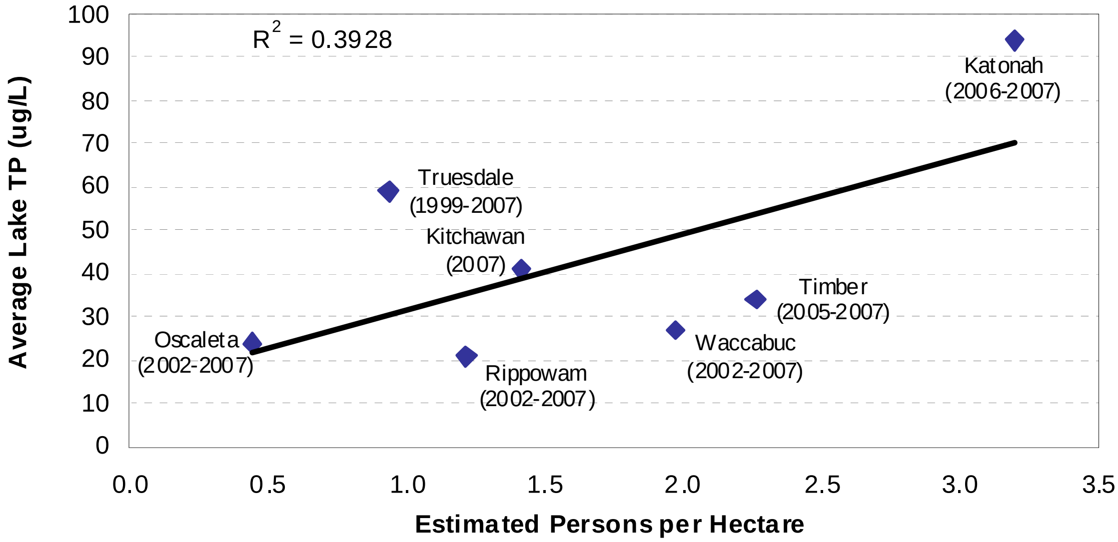
The Lewisboro Lakes' watersheds are not served by sanitary sewers. Residents dispose of wastewater using individual on-site wastewater treatment systems, primarily septic tanks with leach fields. Several sources of data were compiled to estimate the potential contribution of these onsite wastewater disposal systems to the phosphorus budget of the Lewisboro Lakes.

Environmental factors influence the total potential phosphorus migration from on-site systems to the lakes. Important factors include soil texture (particle size), mineralogy, depth to groundwater/seasonal saturation, and permeability/infiltration rate. Other factors include slope, oxygen, pH, and temperature conditions. Finally, how systems are loaded and maintained affects the potential for phosphorus migration.

For this analysis, the estimated phosphorus loading from on-site systems was assumed to be a factor of soil suitability, population density, and proximity to surface waters. There is a substantial body of research demonstrating that on-site systems in close proximity to surface waters have the potential to be a source of phosphorus, and that systems distant from surface waters have a low probability of phosphorus migration into surface waters. There is a general correlation between the number of persons living within 100m of water and the total phosphorus concentration in the Lewisboro Lakes (Figure 4-4). Therefore, only systems located within 100 m of surface waters were included in the septic phosphorus budget. In addition an overall on-site system failure rate of 5% was used for each watershed. EPA indicates that on average New York septic failure rates are about 4%. The 5% used in this analysis is a conservative estimate (i.e. we did not want to overestimate septic contribution). A cost/feasibility study done in the nearby Peach Lake watershed conducted by Stearns & Wheler found a 28% failure rate for dye tests and a 71% failure rate for percolation tests. If the failure rates in the Lewisboro lakes are anything like those in the Peach Lake watershed then we can assume septics are an even greater contributor to the Lakes problems than are estimated here. This would only make the need to eliminate this source more urgent.

An algorithm was applied to estimate the contribution of phosphorus from on-site systems (South Nation Conservation, Ontario Ministry of Environment, 2003):

Figure 4-4
Total Phosphorus June 15 - September 15 Average vs Estimated Persons per Hectare On Septic Within 100 m of Water



Phosphorus contribution = 0.6 kg/cap/yr * (population) * 1-A

"A" represents an attenuation factor such that phosphorus loading is scaled by soil suitability classes of:

- Not limited- 10% of phosphorus is transported to the lake.
- Somewhat limited- 30% of phosphorus is transported to the lake.
- Very limited- 60% of phosphorus is transported to the lake.
- Somewhat limited- 30% of phosphorus is transported to the lake.
- Failed systems- 100% of phosphorus is transported to the lake (it was assumed that 5% of systems are failing for each watershed.

The results of this analysis are presented in Table 4-7. It is important to keep in mind that a large number of assumptions were built into this estimate of phosphorus contribution from on-site wastewater disposal systems. A range of +/- 50% around the estimated total is reasonable.

Table 4-7. Estimated phosphorus loading from septics by soil types.

Soil Suitability (percent P transport to surface water)	Phosphorus Loading from Septic by Soil Type (kg/yr)						
	Rippowam	**Oscaleta**	**Waccabuc**	**Truesdale**	**Kitchawan**	**Katonah**	**Timber**
Not Limited (10%)	1.0	1.7	3.0	1.5	0	0	0
Somewhat Limited (30%)	9.1	20	61	102	24	3.1	6
Very Limited (60%)	15	7.7	62	98	60	39	9.2
Failed Systems (100%)	3.5	5.1	18	27	10	4.0	1.8
Total	**29**	**35**	**144**	**229**	**94**	**46**	**17**

Totals are approximate due to rounding errors.
Shaded cells indicate the highest percentage in each watershed.
Soil Suitability:
"Not Limited" - the soil has features that are very favorable. Good performance and very low maintenance can be expected.
"Somewhat Limited" - the soil has features that are moderately favorable. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected.
"Very Limited" - the soil has one or more features that are unfavorable. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

As shown in the soil suitability maps in each lake's Fact Sheet (Section 3.0), the soils in Lewisboro are mostly either "Somewhat" or "Very" limited with respect to their ability to prevent phosphorus from on-site systems from reaching the lakes. This results in very high phosphorus loads from on-site systems to the Town's lakes. The contribution from this source alone is usually greater than the combined total of the other sources. On average, on-site systems contribute about 75% of the anthropogenic phosphors to the lakes on an annual basis, with a range of 29% to 94%.

4.7.3. Point Sources

Based on the available information, there are no significant point sources of phosphorus in the watersheds of the Lewisboro Lakes, such as wastewater treatment plant discharges. However, there are three inter-connected lakes: Rippowam, Oscaleta and Waccabuc. The upstream lakes may be considered point sources of phosphorus loading to the downstream lakes – Rippowam discharges to Oscaleta, and Oscaleta discharges to Waccabuc. The estimated loading from the upstream to the downstream lakes are shown in Table 4-8. Overall, the phosphorus contribution from upstream lakes is small compared with other sources.

Table 4-8. Contribution of upstream lakes

Drainage Basin	Discharges to:	Water Volume Input (m^3/year)	Water Volume Output (m^3/year)	Surface Average TP Concentration (ug/l)	Surface Average TP N samples	Estimated Export to Downstream
Rippowam	Oscaleta	721,943	721,943	24	42	17 kg/yr
Oscaleta	Waccabuc	3,438,272	3,438,272	24	43	83 kg/yr

Surface average total phosphorus (TP) concentrations represent summer average (June 15 – September 15) upper waters (<=1.0 m depth) for the period 2002-2007.

4.7.4. Internal Phosphorus Loading

The three lakes that exhibit thermal stratification during the summer – Rippowam, Oscaleta and Waccabuc – develop anoxic conditions in their lower waters that allow phosphorus in sediments to be released into the water column. This is a consequence of chemical reactions at the sediment surface. As iron and manganese compounds are reduced, phosphorus held in mineral complexes is released from the sediments. Much of this phosphorus remains in the deeper waters during the stratified period and is not available to algae growing in the sunlit layers above. This can change during certain conditions such as high winds or low barometric pressure when water from deep in the lake mixes with the shallow layers. In the fall, when the lake waters cool and mix, phosphorus from sediments can be distributed throughout the water column.

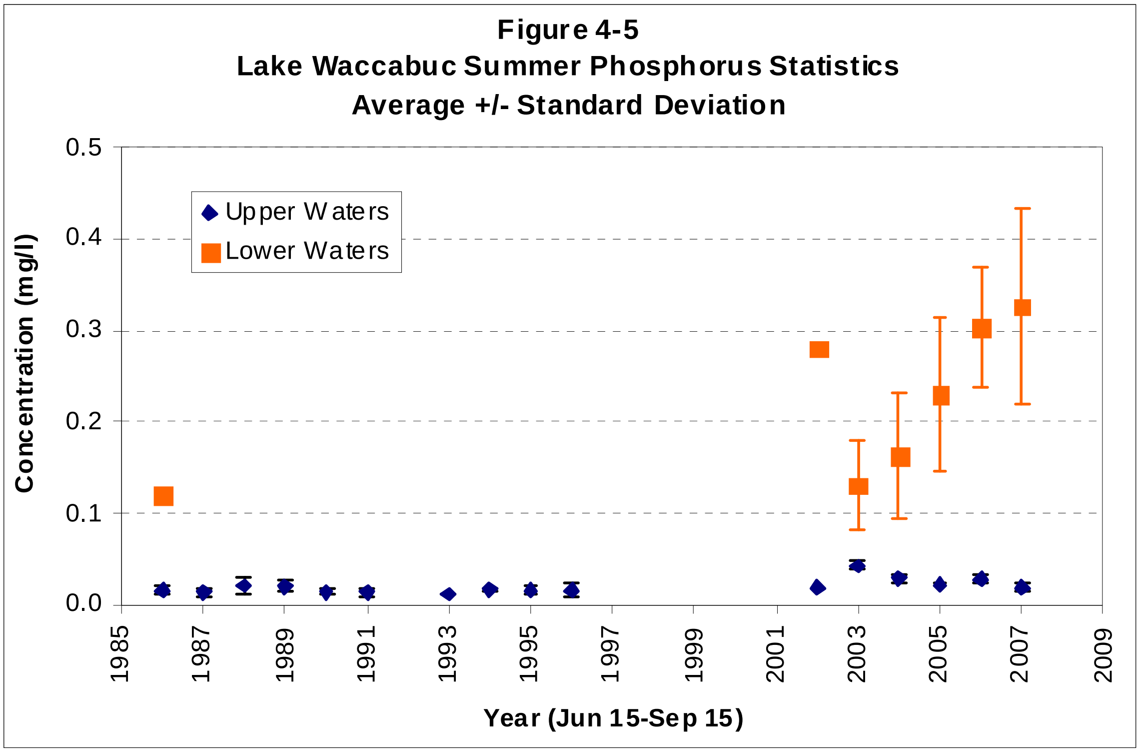
To estimate the potential for sediment phosphorus to contribute to the lakes' phosphorus budgets, the difference in lower water phosphorus concentration between spring and late summer was calculated. This difference in concentrations was multiplied by the volume of water in the lower waters to estimate the mass of phosphorus released from the sediments (Table 4-9).

Table 4-9. Estimated sediment phosphorus load

Drainage basin	Phosphorus in Lower Waters (ug/l) Spring	Late Summer	Difference	Lower Waters Volume (m^3)	Estimated internal Loading (kg)
Rippowam	42	53	11	456	<1
Oscaleta	46	99	53	230,898	12.2
Waccabuc	114	300	190	1,398,107	260

Notes:
Spring concentration represents the average of May averages over time in lowest 2 meters sampled. Includes these years: Rippowam (2003, 2006, 2007); Oscaleta (1975, 2003, 2006, 2007); Waccabuc (1975, 2003, 2006, 2007).
Late summer concentration represents the average of September averages over time in lowest 2 meters sampled. Includes these years: Rippowam (2002-2006), Oscaleta (2002-2007), Waccabuc (1975, 2002-2007)
Hypolimnetic (lower water) volumes from Cedar Eden (2004).

The estimated internal load in Lakes Rippowam and Oscaleta represents a small percentage of the external annual loading. However, as the lakes become increasingly eutrophic, the extent and duration of oxygen depletion is likely to increase, leading to increased sediment phosphorus release. The estimated internal loading in Lake Waccabuc is a more significant source of phosphorus to the lake's annual phosphorus budget; moreover, the deep water phosphorus concentrations appear to be increasing (Figure 4-5). It is notable that the total phosphorus levels in the upper waters appear to be stable.



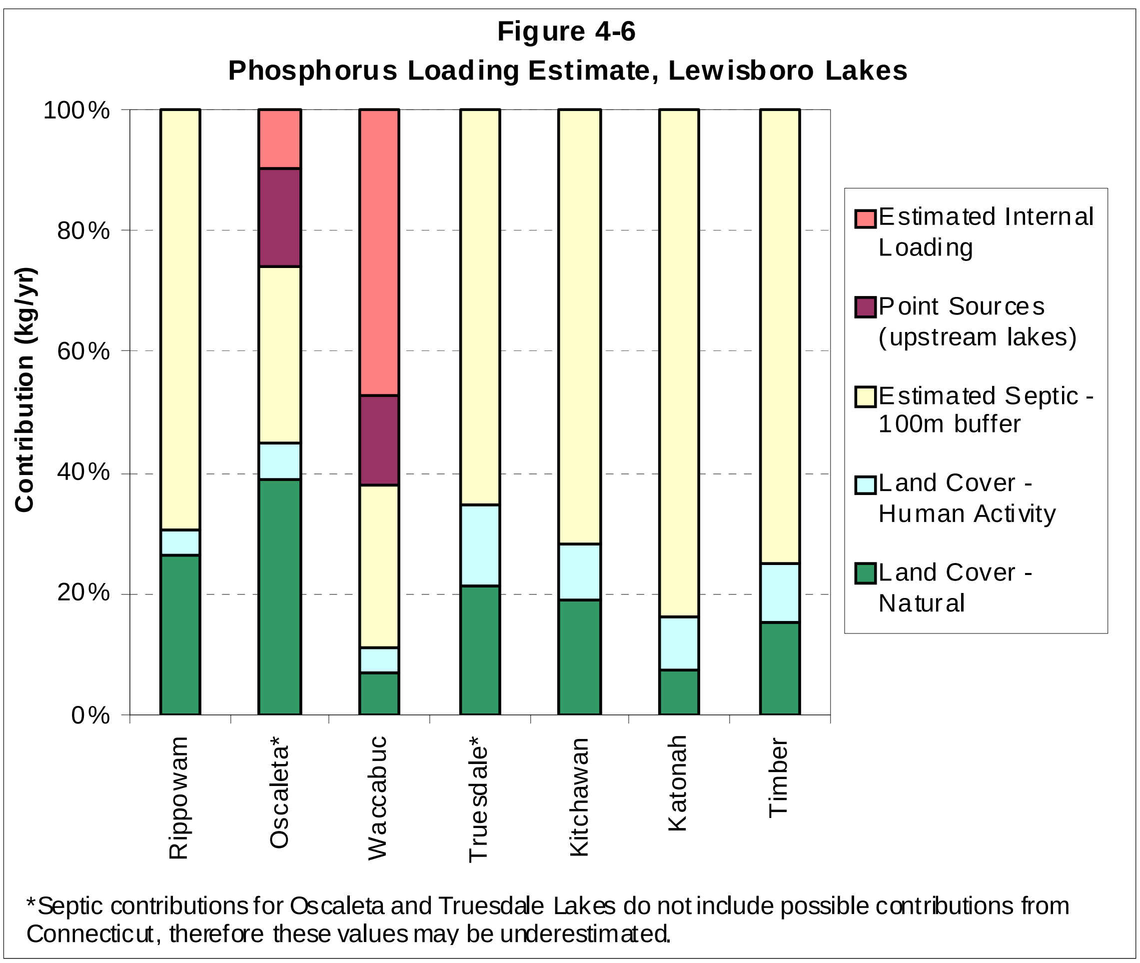
4.8. Phosphorus Loading Summary

The summary of phosphorus loading for each of the Lewisboro Lakes is summarized in Table 4-10 and Figure 4-6. The shaded values represent the highest annual loading estimated for that watershed. It is clear that contributions from on-site wastewater disposal systems represent the primary source of phosphorus, with the exceptions of Lakes Oscaleta and Waccabuc. In Lake Oscaleta the generally undeveloped nature of the watershed resulted in natural land uses being the primary source. However, of the anthropogenic source of phosphorus, on-site wastewater disposal systems were the primary source. In Lake Waccabuc, internal loading appears to be the largest source of phosphorus to the annual budget. This pool of phosphorus does not appear to affect concentrations of phosphorus in the upper waters during the summer growing season. However, this lake has the longest water residence time (over 2 years), and at least a fraction of the phosphorus released during the summer will be present in the upper waters next spring. Phosphorus from on-site wastewater disposal systems in this watershed will be available to support algal growth during the summer recreational season, thus underscoring their significance.

Table 4-10. Phosphorus loading contribution summary.

Watershed	Land Cover Contribution Natural (kg/year)	Land Cover Contribution Human Activity (kg/year)	Estimated 100m Septic (kg/year)	Point Sources (upstream lakes) (kg/year)	Internal Loading (kg/year)	Total Loading (kg/year)
Rippowam	11	1.8	29	0	0.0049	42
Oscaleta	46	7.2	35*	17	12.2	117
Waccabuc	37	22	143	83	260	544
Truesdale	75	47	229*	0	0	351
Kitchawan	25	12	94	0	0	131
Katonah	4.1	4.9	46	0	0	55
Timber	6.4	4.0	17	0	0	21

* Estimated septic input from New York portion of the watershed only; Connecticut portion not calculated due to lack of data.



5. Reductions in Phosphorus Needed to Meet State Guidance Targets

The Lewisboro Lakes are in various stages of eutrophication. A small decrease in the phosphorus concentrations in some lakes may have noticeable effects on water quality while in others only a substantial reduction in phosphorus is likely to result in perceptible improvement. In order to quantify reductions in loading, an in-lake target concentration is needed.

New York State has a narrative standard for phosphorus: "*None in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages*." The narrative standard is interpreted for lakes using a guidance value for phosphorus to protect recreational quality. A target concentration of 20 ug/l was adopted; this is measured as a summer average mid-lake sample at 1 m depth. This concentration was selected based on a statistical analysis relating perceived water quality impairment for recreational use to total phosphorus concentration.

Reduction targets for the Lewisboro Lakes were estimated using 20 ug/l total phosphorus concentration as a target concentration. For lakes with phosphorus levels near this concentration (Oscaleta, Rippowam, and Waccabuc) 20 ug/l appears to be achievable with a focused effort to reduce the phosphorus loading. For lakes currently exhibiting higher concentrations (Kitchawan, Timber, Truesdale, and Katonah) major reductions in loading would be necessary.

The estimated percent reduction needed in each lake to approach the NYS phosphorus guidance values is summarized in Table 5-1. The table also presents the reductions in external phosphorus loading based upon two management scenarios: reducing watershed load from developed lands by 50% (through best management practices), and removing the phosphorus contribution from on-site wastewater disposal systems (through installing sanitary sewers). Clearly, approaching the guidance concentration for phosphorus in most lakes is unlikely unless the contribution from on-site systems is addressed.

Table 5-1. Estimated percent reduction needed to approach state guidance targets in relation to estimated load reductions from BMPs in watershed and elimination of on-site wastewater disposal systems.

Lake	Estimated Percent Reduction in Phosphorus load needed to meet 20 ug/l target concentration	Estimated percent reduction achieved with 50% decrease in phosphorus load in runoff from developed areas	Estimated Percent Reduction achieved with installation of sanitary sewers
Oscaleta	9%	6%	29%
Rippowam	27%	4%	68%
Waccabuc	28%	4%	27%
Kitchawan	46%	9%	72%
Timber	52%	10%	75%
Truesdale	63%	13%	65%
Katonah	82%	9%	84%

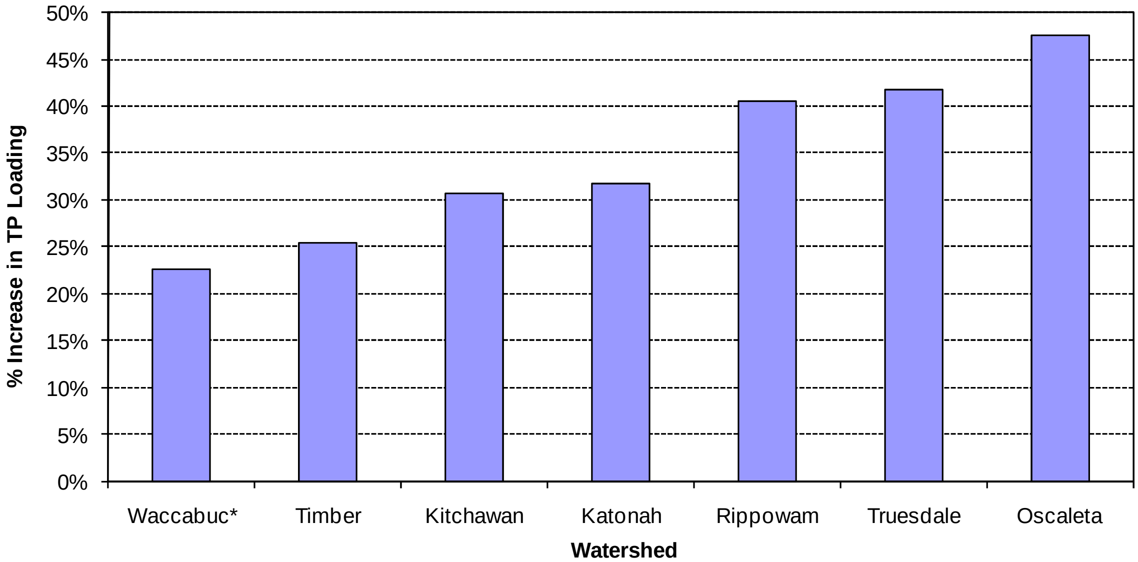
5.1. Factors Affecting Progress – Build-Out Analysis

There are currently numerous efforts, either underway or planned, within the watersheds of the Lewisboro Lakes intend to reduce phosphorus loading. The goal of improving water quality in the lakes cannot focus only on current phosphorus sources; the potential impact of continued development must be considered. Improved best management practices on new development can mitigate, but not eliminate, increased nutrient losses. The aging on-site wastewater disposal systems represent a continued source. The majority of soils types in the town have limited assimilative capacity for septic waste. Many areas are likely approaching saturation levels for phosphorus binding capacity. In addition, the failure rate of currently functioning septic systems will likely increase as the septics age.

All potential future sources of phosphorus must be considered when planning remedial measures. It is not difficult to imagine scenarios where extensive investments are made to reduce current sources of phosphorus only to have progress towards improvement offset by increased development in the watershed or other factors. The restoration of the Lewisboro Lakes is not simply a phosphorus reduction effort; it needs to be viewed as a combined reduction/prevention effort.

Because of the potential effects of increased development, a generic build-out analysis was performed to gauge the magnitude of increased phosphorus load to the lakes. The analysis was not meant to be a projection tool for planning purpose, but rather a technique to understand how increased development could potentially affect the lakes. It was assumed that 75% of the land area currently classified as forested is developed. The land use and septic contributions were adjusted accordingly and a revised loading estimate was calculated for each lake. The estimated percent increase in loading to each lake (Figure 5-1) demonstrates a range of impacts. The effect on smaller and more developed watershed is less dramatic. Overall, it is clear that future development needs to be managed in a pro-active manner to mitigate the potential for increased nutrient inputs to the lakes.

Figure 5-1
75% Buildout Analysis - Estimated Percent Change in Phosphorus Loading From Septic and Land Cover as a Result of Future Development



*Waccabuc increase does not take into account current estimated internal load.
Assumptions:
1. Forest land cover reduced by 75%; acres converted to Developed-Medium Intensity cover type, and the loading coefficient for Developed-Medium Intensity was used to estimate phosphorus loading.

2. Estimated increased septic loading using GIS-based analysis of parcels, structures, wetlands, 100m buffer around water bodies, US Census data, and soils, as follows:
- Identify parcels that do not contain structures. Assumes that the parcel is vacant without septic.
- Of those parcels, identify those that are not crossed by wetland boundaries. Assumes that parcels in wetlands will not be developed.
- Of those parcels, identify those that are within 100 ft of streams and lakes.
- For the selected parcels, apply the average household size of the watershed to estimate the added population.
- Proportionally distribute the added population among the soil types for septic suitability based on initial proportional distribution.
- Estimate phosphorus loading using revised population numbers, 0.6 kg/year/person loading, and transport coefficients for soil types.

5.2. Data Gaps

This report would not have been possible without the extensive work conducted to date by the various lake associations. The primary cause and sources of water quality degradation have been identified. The information available is sufficient to make broad recommendations aimed at restoring lake water quality. There are, however, still areas where data gaps exist. It is not necessary to have a complete understanding of each of these prior to initiation of restoration activities as the primary causes of water quality degradation is clear. If, however, the Town wishes to have a greater understanding of the issues facing the lakes we would recommend the following focus areas:

1) Determine septic failure rates and priority areas throughout the watersheds. The testing can be modeled after those done in the Peach Lake watershed and should include both dye and percolations testing.

2) Conduct a comprehensive groundwater study to determine the spatial and temporal variation of the physical and chemical properties of groundwater entering each of the lakes. This will also help determine the travel time of groundwater to the lakes; this affects the expected delay in recovery if septics are eliminated.

3) Identify priority stormwater discharge points in each watershed, and estimate sediment and phosphorus loadings from each.

4) Determine the relative importance of phosphorus loading from lake sediments in Lakes Oscaleta, Waccabuc, and Rippowam.

6. Town-wide management options

Existing data show that phosphorus is the primary nutrient supporting algae and weed growth in the Lewisboro Lakes, and that phosphorus enrichment is adversely affecting recreational quality. The estimates of phosphorus loading indicate that on-site wastewater disposal systems represent the most significant cultural source of phosphorus; nonpoint runoff from residential development is a secondary source. In addition, some of the deeper lakes exhibit anoxic conditions that allow phosphorus stored in sediments to enter the water column. Because of the high proportion of phosphorus originating from wastewater, strategies for mitigating loading should focus primarily on this source, with secondary efforts directed at storm water runoff from developed areas. The importance of phosphorus released from sediment in deeper lakes needs to be explored further.

The town has three general management options to consider:

- Do nothing

  Under this option, the town would not implement watershed management actions to address water quality issues in the lakes. It is assumed that development in the town would continue, that septic system issues would not be addressed, and that enforcement of existing town codes regarding erosion control would remain as-is. It is predicted that if no actions are taken, water quality conditions in the seven lakes will gradually deteriorate over time. It is assumed that the Town of Lewisboro would not choose this approach; therefore our recommendations will focus on the following options.

- Actions to maintain/slightly improve current water quality conditions

  Under this option, the objective is to maintain or slightly improve water quality conditions in the lakes. If there are changes in the watershed resulting in increased nutrient loading to the lakes, remedial measures would be implemented to compensate for added nutrient loading in order to maintain net loading of nutrients. This option is most warranted in those lakes experiencing only minor levels of eutrophication: Lakes Waccabuc, Rippowam, Oscaleta, and Kitchawan.

- Actions to substantially improve water quality conditions

  Under this option, the objective is to improve water quality conditions in the lakes from their present levels to the extent that it is noticeable to lake residents. This will require stronger measures to reduce, rather than maintain, nutrient loading and erosion. This option is most warranted in those lakes that are currently either in a stable eutrophic state: Lakes Truesdale, and Timber, or a stable hypereutrophic state: Katonah.

Greater levels of phosphorus reduction are associated with greater levels of effort, cost, and control over development in the watersheds. Examples of measures that could be used to address these objectives are presented in Table 6-1**,** specific recommendations to restore/protect the Lewisboro lakes are presented in Section 7.

The Town Codes provide the primary means by which the Town of Lewisboro can begin to address the water quality issues of the seven lakes. The existing Town Codes were reviewed to identify whether codes are already in place to address watershed management issues, and to identify gaps where issues are not addressed. This code review is detailed in Attachment 1.

Table 6-1. Examples of measures for implementing phosphorus loading reductions.

Objective	Measures
Small reductions to slow the eutrophication process	• Storm water runoff controls o Catch basins o Street sweeping o Erosion controls • Restrict use of fertilizers containing phosphorus • On-site wastewater disposal system controls o Test for and fix failed systems o Require that older systems are upgraded when properties are transferred • Implement goose controls on lakes with large populations. • Public education and outreach
Moderate reductions to maintain current conditions	• Storm water controls – list above plus: o Require homeowners to establish and maintain vegetative buffers on properties adjacent to surface water • On-site wastewater disposal system controls– list above plus: o Require routine (e.g annual, biennial) inspection of all septic systems located within 100 m of water bodies o Require periodic inspection of all septic systems not located near water bodies o Require maintenance/repair of tested systems that are not performing properly o Prohibit construction of new septic systems near water bodies or in soils of very limited septic suitability o Conversion to composting toilets or similar technology • Development controls o Restrict new construction near water bodies o Require storm runoff plans for new developments o Mandate utilization of Low Impact Development (LID) strategies for new development and re-devlopmnet • Public education and outreach
Significant reductions to improve conditions	• On-site wastewater disposal system controls - listed above plus: o Eliminate septic systems in populated areas by installing sewers and treatment plants • Development controls – listed above plus o Prohibit new construction near water bodies o Restrict all new development • Public education and outreach

6.1. Feasibility of Dredging – Sediment Screening Results

The potential benefit of sediment removal by dredging was brought up by members of several local Lake Associations. A detailed dredging feasibility study is beyond the scope of this assignment. However, sediment samples were collected in six of the lakes during the 2008 field effort and tested for analytes used to screen dredged material for disposal options. Results are included in the Fact Sheets of the individual lakes. The detailed lab results of all 85 analytes are included as Attachment 2.

Sediments collected at the connections between Lakes Oscaleta and Waccabuc were composited and analyzed. This sample was classified as "uncontaminated" based on the NYS guidance for disposal of dredged material. Only trace concentrations of lead and copper were detected; all analytes were well below criteria for unrestricted disposal.

One composite sediment sample was collected in Lake Kitchawan near the bathing beach. Again, the analytes present were below thresholds for contamination. The sample exhibited detectable concentrations of the metals barium, cadmium, chromium, copper, lead, and selenium.

Two composite sediment samples were collected in Truesdale Lake (refer to Attachment 2 for map of locations). The sediments exhibited detectable concentrations of the metals: barium, cadmium, chromium, copper and lead. All except copper were below thresholds for unrestricted disposal as fill. However, copper was well above these thresholds; this is likely a result of previous algaecide applications.

Lake Katonah had a single composite sediment sample collected from its south end. Detectable levels of arsenic, barium, cadmium, chromium, copper, lead, and selenium were reported. All analytes, with the exception of copper, were below thresholds for unrestricted disposal.

A composite of Timber Lake sediments were collected along the mid-axis of the lake. They had detectable levels of barium, cadmium, chromium, copper, and lead. All were below State thresholds for being considered contaminated sediments.

These results indicate that sediments near the connection between Oscaleta and Waccabuc, near the bathing beach in Kitchawan, and along the mid-axis of Timber are likely suitable for recreational dredging. Truesdale Lake and Lake Katonah would need additional testing to draw a conclusion regarding the potential for additional restrictions associated with sediment handling and disposal, due to the copper levels.

6.2. Progress Towards Improvement

Each individual lake association is striving to improve and protect their lake. The result of these efforts is an extensive set of recommendations by the associations and, in many cases, their consultants. In some cases, recommended actions have been or are being implemented; other lakes are not yet to that stage. A summary of the recommendations provided in other studies is presented in Table 6-2.

The current state of efforts in each lake is summarized below:

<u>Rippowam, Oscaleta and Waccabuc</u>: The Three Lakes Council, which coordinates the environmental efforts for the Waccabuc - Oscaleta - Rippowam watershed, monitors the water

quality of the lakes. As of 2007, the Council obtained some funding for storm water runoff controls on Twin Lakes Road by the Rippowam-Oscaleta channel[6].

Truesdale: Truesdale Lake appears to be farthest along with mitigation activities. Engineering designs were available for controlling storm runoff at six sites. In 2007, two homeowner associations proposed establishing a tax district to raise the money for repairing the dam and implementing projects in the watershed to reduce sediment and nutrient loading[7].

Kitchawan: In November 2006, the Town of Pound Ridge was awarded a Water Quality Planning and Implementation Grant for New York City Watershed Communities to perform a Comprehensive Watershed Study of Lake Kitchawan. The outcome of this study was the ENSR report (March 2008), which recommended a management plan for the lake.

Katonah and Timber: Based on the available data, Katonah and Timber Lakes are presently in the Problem Definition stage, and are part of the CSLAP monitoring program.

[6] Three Lakes Council website, minutes of October 2007 meeting.
[7] Truesdale Lake Website

Table 6-2. Summary of management recommendations already made to individual lake associations.

	Rippowam	Oscaleta	Waccabuc	Truesdale	Kitchawan	Katonah	Timber
Watershed Management							
Nutrient Controls							
Homeowner BMPs: • Increase use of buffers; use non-phosphorus fertilizers; manage pet waste	X	X	X	X			X
Golf course management	X	X	X				
Replace orthophosphorus with an alternate corrosion inhibitor in drinking water supply	X	X					
Replace old on-site wastewater disposal systems with non-polluting alternatives	X	X	X				
Wastewater management • ongoing maintenance and inspections • septic inventory/wastewater study					X		
Maintaining septic systems							X
Stormwater management • Buffer strips and swales; created pocket wetlands • Rain garden • Street sweeping/catch basin cleaning					X		X
Erosion Controls							
Utilize effective erosion and sediment control measures during construction	X	X	X		X		
Minimize land disturbances near surface waters							X
Stabilize eroding gullies and streambanks	X	X	X		X		
Maintain roads and culvert	X	X	X				
Maintain riparian corridors	X	X	X				
Control inlet stream sediment sources; install forebays				X			
Address sedimentation problems in six identified areas				X			
Zoning and Land Use Planning					X		
Invasive species							
Control purple loosestrife	X	X	X				
Establish invasive species task force	X	X	X				
Public Education	X	X	X	X	X		

	Rippowam	Oscaleta	Waccabuc	Truesdale	Kitchawan	Katonah	Timber
In-Lake Management							
Phosphorus and algae							
Alum treatment program	X	X	X				
Lake aeration		X	X				
Introduce rooted emergents along shores to take up nutrients, improve aesthetics & habitat				X			
Discourage waterfowl				X			
Plant controls							
Mechanical controls	X	X	X				
Herbicides	X	X	X		X		
Allow bassweed to out-compete Eurasian water milfoil		X	X				
Dredge coves to increase habitat diversity				X			
Dredging to control plants					X		
Benthic barriers					X		
Hand pulling (with manual removal)					X		
Harvesting with collection					X		
Hydroraking					X		
Invasive species control plan					X		
Minimize introductions of additional exotic plants and animals from public and private launch areas into lake							X
Selective planting					X		
Channel Management							
Between Rippowam and Oscaleta	X	X					
Between Oscaleta and Waccabuc		X	X				

Sources: Rippowam, Oscaleta and Waccabuc – Cedar Eden 2004; Truesdale – Land-Tech 2001; Kitchawan – ENSR draft 2008; Timber – CSLAP 2006

7. Recommended Strategies

The lakes in Lewisboro can be placed into three groups; those that are in the beginning stages of eutrophication (Waccabuc, Rippowam, Oscaleta, and Kitchawan), those that are in a stable eutrophic state (Truesdale and Timber), and those that are hypereutrophic (Katonah). Those in the beginning stages of eutrophication would likely see some improvements with only relatively moderate reductions in phosphorus loading. The eutrophic lakes will require more intensive efforts before improvements are realized. Lake Katonah's phosphorus concentrations are extreme and will require a large reduction in phosphorus before significant improvements are realized. Although there are many options available to decrease phosphorus loading, effective solutions must be tailored to reflect the most significant sources and consider the nature of the watersheds.

7.1. Reduction in phosphorus migration from on-site wastewater disposal systems

Because on-site wastewater disposal systems are by far the most significant source of anthropogenic phosphorus to the surface waters of all the Town's lakes, effective strategies to minimize this source should be the primary focus. Unless this is source is mitigated, it is unlikely that other efforts will results in noticeable long term improvements to water quality.

7.1.1. Sewers

It is estimated that between 27% and 85% of the phosphorus entering the lakes originates in septic systems. The single best way to reduce/eliminate this load would be to install a wastewater treatment system (sewers) in each watershed. All lakes would be expected to show water quality improvements after the elimination of this load. The benefits would likely not be realized immediately however. Phosphorus laden groundwater from septics takes a varying amount of time to reach the lakes. In some cases it could be decades before the full benefit of sewers is realized.

An example of a watershed community facing similar challenge is nearby Peach Lake (see text box). The municipalities in this watershed are constructing a wastewater collection and treatment system to mitigate water quality degradation associated with wastewater disposal. This recommendation is offered:

✓ The Town of Lewisboro should work with an engineering firm to conduct a feasibility/cost/benefit analysis associated with installing sewers in the watersheds of each lake. Priority watersheds should be those with the highest phosphorus levels: Katonah, Truesdale, and Timber.

The Peach Lake Example

In 2003 Putnam and Westchester Counties retained Stearns & Wheler, LLC to perform a wastewater study of Peach Lake. It was concluded that septic systems around the lakeshore were failing and discharging effluent into the lake. Due to the limiting conditions for enhanced on-site septic systems along the lake shore properties, it was decided that the construction of a sewer system and new treatment plant was the only option to eliminate the health risks and stop the lake degradation. The proposed service area for the low pressure, sanitary sewer system includes approximately 470 properties located in four associations around the Lake and a cluster of nearby businesses.

The treatment plant will discharge into the outlet or Peach Lake Brook (extensive wetlands permitting will be required). The plant will be designed with a permitted capacity (maximum month) of 170,000 gallons per day and an expected average annual flow of 120,000 gallons per day.

Any new surface discharging plant within the drinking water supply watershed requires a variance under New York City Watershed Rules and Regulations. The location of the plant places it under the jurisdiction of both the NYSDEC and NYCDEP. As such, it requires an advanced level of treatment including ammonia removal, sand and membrane filtration, and ultraviolet disinfection.

Estimated project costs:
Treatment plant: $10 million
Collection system: $14 million.
Average cost per resident $1200 per year for 30 years

Funding:
Putnam County: $2.5 million
Westchester County: $10 million
NYCDEP: TBD (they will reimburse for the tertiary level of treatment which is currently estimated to be $2.4 million

7.1.2. Mitigation of Existing On-site Wastewater Disposal Systems

Until a decision is made regarding the financial and technical feasibility of installing sanitary sewers, stringent requirements for maintenance and inspection of the on-site systems is recommended. Financial incentives for installation of technologies separating gray water and using non-discharge alternatives (such as composting toilets) for toilet waste should be considered, as should alternative on-site wastewater technologies. Many alternative septic technologies exist such as Fixed-Media Filter and Peat-Based Filter systems, as well as Aerobic Treatment Units. These technologies are primarily designed to reduce bacteria, not phosphorus. Total phosphorus reductions of less than 50% can be expected (primarily due to filtration of solids), however the reduction in soluble reactive phosphorus (the bioavailable portion that results in algal growth) will be much less (Patterson 1999). The oldest and/or failing systems would be a priority for replacement with these technologies. Discussion with the County Health Department will need to take place to outline the permitting process for these technologies.

Public education aimed at reducing disposal of household materials containing phosphorus is also warranted. Use of garbage disposals should be discouraged as should use of phosphate-containing dishwasher detergents. The Town may wish to consider restricting the sale and use of phosphate-containing dishwasher detergents within the watersheds.

This option, as a whole, is likely to be significantly less effective than installations of sewers and will require a substantial initial investment by homeowners and constant monitoring and maintenance. It may be a feasible alternative in the less eutrophic lakes (Waccabuc, Rippowam, Oscaleta, and possibly Kitchawan) where the recommended phosphorus reductions are less than the other lakes.

The overall effectiveness of this option is not predictable because the failure rate and current conditions of the septic systems are not known. The effectiveness of this option may also be limited because of the poor soil suitability of the watersheds. Properly functioning on-site wastewater disposal systems located on soils with limited assimilative capacity will still result in phosphorus transport to surface waters. Unfortunately much of the Lewisboro watershed in proximity to the lakes is limited with regards to its phosphorus assimilative capacity, meaning that inspection and maintenance will do little to reduce phosphorus loads in these areas. These recommendations are offered:

- ✓ In areas of lake watersheds where sewers are not installed the Town of Lewisboro should institute a septic inspection and maintenance program whereas septic are inspected every five years and pumped biennially.
- ✓ The Town should initiate a Public education campaign aimed at informing residents of the importance of proper septic maintenance and upkeep.
- ✓ The Town should consider a ban on sale and use of phosphate-containing dishwasher detergents within the watershed.
- ✓ The Town of Lewisboro should offer financial incentives to homeowners who convert to new technologies designed to reduce impact from septic systems. Some examples of these types of technologies are composting toilets, gray water recycling systems, Fixed-Media Filter systems, Peat-Based Filter systems, and Aerobic Treatment Units.

7.2. Management of Stormwater Runoff

Stormwater has been identified as a major conduit for phosphorus traveling from developed areas of the watersheds to the lakes. The Town of Lewisboro recognizes this and has already taken a number of steps to reduce stormwater impacts, including forming a Stormwater Management Committee in September 2007, and passing two stormwater ordinances in December 2007 to address illicit discharges, stormwater management, and sediment and erosion control measures. In addition a number of stormwater management projects have been completed, or are underway, in several watersheds. These projects include activities such as construction of catch basins and identifying storm drains and discharge points.

The current stormwater management efforts by the Town should continue and expand, as reflected in the following recommended actions:

- ✓ The Town of Lewisboro should continue to identify stormwater discharge points and drains.
- ✓ The Town of Lewisboro should expand its funding of stormwater management BMPs such as catch basins. The recommendations provided by each lakes association should be used as guidance.

- ✓ The Town should reinstitute the practice of picking up and disposing of leaves and yard waste as these areas a potential source of organic matter carried to the lakes via stormwater runoff.
- ✓ Storm drain structure sumps and catch basins should be routinely cleaned of accumulated sediment.
- ✓ The Town of Lewisboro should form watershed tax districts in order to provide a dedicated funding source to upgrade the Towns stormwater management program.

7.3. Development / Land Acquisition

New development will result in increases in phosphorus loading to the lakes. Unless controlled, new development will reduce the effectiveness of efforts to decrease phosphorus elsewhere in the watershed. Three recommendations are offered to address this issue:

- ✓ Consider adopting a moratorium on new construction of homes in affected watersheds until a sewer feasibility study is completed.
- ✓ The Town of Lewisboro should pass an ordinance that prohibits new septic constructed in areas of lake watersheds that are within 100 meters of a waterbody that is hydrologically connected to one of the Towns lakes.
- ✓ The Town of Lewisboro should identify and acquire key parcels of open space. Place high priority for acquisition of properties in riparian areas.

7.4. Fertilizer Restrictions

There are a large number of homes on or near most of the Lewisboro Lakes; many with cultivated lawns. Fertilizers applied to lawns are potentially a significant source of nutrients to nearby lakes. This recommendation is offered:

- ✓ The Town of Lewisboro should introduce a local law restricting application of phosphorus as a fertilizer. The local law should consider the following provisions:

  1. Fertilizers containing phosphorus cannot be used on lawns and turf in the <u>watersheds</u> of the Lewisboro Lakes unless one of the following situations exists:
     - A soil test or plant tissue test shows a need for phosphorus.
     - A new lawn is being established by seeding or laying sod.
     - Phosphorus fertilizer is being applied on a golf course by trained staff.
     - Phosphorus fertilizer is being applied on farm cropland.

  2. Fertilizers containing phosphorus should not be used on lawns and turf <u>within 100m</u> of a lake or waterbody hydrologically connected to one of the lakes.

7.5. Canadian Geese Controls

The number of geese on the lakes and phosphorus contribution from their waste is not quantified for the Lewisboro Lakes. An estimate as to the benefits, if any, of instituting/continuing controls cannot be made without further quantitative study. However, control efforts can be implemented rather easily and at low cost. Some reduction in overall phosphorus load would likely occur, although it is highly unlikely that this reduction would result in any notable changes in water quality. Benefits beyond phosphorus reduction are also likely to result. We recommend that:

- ✓ The Town of Lewisboro continues with their egg oiling program on the Three Lakes and Truesdale Lake, and considers implementing a similar program on the other Town lakes.
- ✓ On lakes where goose populations become large the Town should implement a volunteer goose harassment program designed to deter geese from staying on the lakes for long periods.

7.6. Education/Involvement

Educating and involving the public in the decision making process will be essential for successful implementation of a protection/restoration plan. The following recommendations are offered:

- ✓ The Town of Lewisboro, in collaboration with the Lake Associations, should convene a public forum to discuss lake ecology, the range of current water quality conditions in the seven lakes, and potential mitigating measures.
- ✓ The Town, in collaboration with the Lake Associations, should prepare an annual Lewisboro Lakes Report Card to enhance public understanding of water quality conditions and contributing factors.

7.7. Summary of Findings and Recommendations for Each Lake

Specific observations and recommendations summaries for the seven Lewisboro Lakes are summarized in Table 7-1.

Table 7-1. Summary of major findings and specific recommendations for Lewisboro Lakes, ordered by lake surface area.

Lake	Major Findings	Recommended Actions
Lake Waccabuc	Borderline eutrophic, generally good clarity, periodic algal blooms, elevated lower water phosphorus, Brazilian elodea in '08, on-site wastewater disposal systems primary P source	Education, protection, small/moderate reductions in phosphorus, additional study needed on impact of lower water phosphorus, immediate management of Brazilian elodea, consider dredging channels between other lakes, routine bacteria testing, stormwater management, consider sewers
Lake Kitchawan	Borderline eutrophic, algal blooms less than expected given phosphorus, macrophytes probably tying up phosphorus in biomass, stormwater, on-site wastewater disposal systems primary phosphorus source,	Education, moderate reductions in phosphorus, benthic barriers in swimming area, do not try to reduce macrophyte growth, routine bacteria testing, stormwater management, consider sewers
Truesdale Lake	Eutrophic, algal bloom prevalent, poor clarity, copper contaminated sediments, stormwater very problematic, on-site wastewater disposal systems primary phosphorus source	Education, significant reductions in phosphorus, routine bacteria testing at beaches, stormwater management, sewers needed
Lake Oscaleta	Borderline eutrophic, generally good clarity, periodic algal blooms, somewhat elevated lower water phosphorus, on-site wastewater disposal systems primary phosphorus source	Education, protection, small/moderate reductions in phosphorus, additional study needed on impact of sediment phosphorus release, consider dredging channels, routine bacteria testing, consider sewers
Lake Rippowam	Borderline eutrophic, generally good clarity, periodic algal blooms, elevated phosphorus in the lower waters, on-site wastewater disposal systems primary phosphorus source	Education, protection, small/moderate reductions in phosphorus, more information needed on impact of sediment phosphorus release, consider dredging channels, routine bacteria testing, consider sewers
Lake Katonah	Hypereutrophic, poor clarity, nuisance algal blooms, sediment has elevated concentration of some metals, especially copper, watershed unsuitable for on-site wastewater disposal systems, stormwater issues significant, on-site wastewater disposal systems primary phosphorus source	Education, large reduction in phosphorus load needed, routine bacteria testing, stormwater management and sewers critical
Timber Lake	Eutrophic, algal blooms, moderate clarity, elevated levels of some metals, especially copper in sediments, stormwater problematic, on-site wastewater disposal systems primary phosphorus source	Education, significant reductions in phosphorus, routine bacteria testing, stormwater management, sewers likely needed

8. Potential Funding Sources

Clearly, the costs of implementing these recommendations are high and will be difficult for the local community to finance, particularly given the current economic climate. Creativity and persistence will be needed to identify sufficient resources from potential partners at the local, city, county, state, and federal levels.

8.1. Existing Programs

New York State has a well-developed program of water resources protection and nonpoint source pollution controls, and the Lewisboro Lakes are also part of the New York City watershed; therefore, an important first step is to identify existing programs and funding opportunities. Program leaders should be contacted and made aware of the need to target restoration funds to the Lewisboro Lakes watersheds. Sources of matching funds need to be identified and leveraged to maximize state and federal contributions.

The New York City Department of Environmental Protection (NYCDEP) should be a priority contact. They have numerous programs designed to protect the drinking water supply for the city including the Septic System Rehabilitation and Replacement Program (MOA Section 124), which seems particularly applicable to the Town of Lewisboro. The NYCDEP has in the past provided assistance to the upstate communities within the City's watershed, such as nearby Peach Lake where they agreed to reimburse the community for the entire cost of upgrading a wastewater treatment facility to tertiary treatment.

The New York State Department of Environmental Conservation (NYSDEC) provides funding for nonpoint source pollution control through Nonpoint Source Management Program grants (Section 319); funding decisions are reviewed by the statewide Nonpoint Source Coordinating Committee which includes representatives of NYSDEC, the state Soil and Water Conservation Committee, and the Department of State. Awards are distributed and administered through County Water Quality Coordinating Committees. Effective cooperation and coordination with these agencies will be essential to effectively target funds to the Lewisboro Lakes restoration effort.

The United States Environmental Protection Agency (USEPA) has previously allocated funds for lake protection and restoration projects through the Clean Lakes Program (Section 314). However, the USEPA has not requested funds for the Clean Lakes Program in recent years, but rather has encouraged states to use Section 319 to fund eligible activities that might have been funded in previous years under Section 314. USEPA suggests that each state use at least 5 percent of its Section 319 funds for Clean Lakes activities to address the restoration and protection needs of priority lakes, ponds and reservoirs. They also suggest that states give priority to funding the following Clean Lakes activities: Lake Water Quality Assessment (LWQA) projects; Phase 1 Diagnostic/Feasibility Studies; Phase 2 Restoration/Implementation Projects; and Phase 3 Post-Restoration Monitoring Studies. Clearly, funding is highly competitive. Detailed proposals are required.

The Town of Lewisboro has been successful in obtaining relatively small grants through New York State and New York City. A well-developed proposal for a member item might support certain phases of the restoration efforts.

8.2. General List of Resources

The following are included as a resource for identifying the major programs that include environmental restoration among their funding priorities. Many of these resources can be best explored on the Internet; web sites are included whenever possible.

The New York State Environmental Facilities Corporation (NYSEFC) provides low-cost financing and technical assistance to municipalities, businesses and State agencies for environmental projects. The Clean Water State Revolving Fund (CWSRF) provides low-interest rate financing to construct water quality protection projects. The NYSEFC web site (www.nysefc.org) provides potential applicants with the information needed to apply for CWSRF financing, with NYSEFC staff assistance as needed. In recent news, the US House of Representatives released its first draft of an $825 billion economic recovery bill (January 15, 2009), which included $6 billion for the CWSRF, of which New York State would receive approximately $640 million. Although the bill is likely to change as it moves through Congress, it appears that some level of funding will be available through this economic recover bill for projects eligible for CWSRF financing.

The Environmental Financing Information Network (EFIN) maintains a Web page of Environmental Financial Tools (http://www.epa.gov/efinpage/efinfin.htm). This page includes tools produced by the Center for Environmental Finance, the Environmental Financial Advisory Board (EFAB), the Environmental Finance Center Network (EFCs), EFIN, EPA Offices and Programs and Other (outside EPA) sources. A key work among the financing mechanisms on this page is the *Guidebook of Financial Tools*. The *Guidebook* is produced by the Environmental Finance Center Network and the Environmental Financial Advisory Board. The 2008 revision of the *Guidebook* is a reference document for officials with environmental responsibilities, designed to assist all interested with finding the means of financing environmental protection initiatives that are appropriate for them. The *Guidebook* contains over 300 financial tools that can be used to pay for environmental systems, with ten sections covering topics ranging from raising capital and enhancing credit to financing pollution prevention activities, community-based environmental protection, and brownfields redevelopment. A new section “Tools for Accessing State and Local Financing,” includes many state grant programs. The information is intended to help governments and other parties expand their thinking about the financial options and resources available to help meet important environmental mandates and create sustainable systems.

The Catalog of Federal Funding Sources for Watershed Protection (http://cfpub.epa.gov/fedfund/) is a searchable on-line database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of watershed protection projects. Below is a list of examples of these funding sources, organized according to topic.

Economic Development

U.S. Department of Agriculture

Water and Waste Disposal Systems for Rural Communities (Rural Utilities Service - RUS)

Rural Economic Development Loan and Grant Program

U.S. Department of Commerce

Public Works and Development Facilities Program (EDA)

U.S. Department of Housing and Urban Development

Community Development Block Grant Program (CPD)

Education and Research

Corporation for National Service

Learn and Serve America Program

U.S. Environmental Protection Agency

Science to Achieve Results (ORD)

Forestry

U.S. Department of Agriculture

Cooperative Forestry Assistance Programs (FS)
Forestry Incentives Program (NRCS)

Monitoring

U.S. Environmental Protection Agency

Environmental Monitoring for Public Access and Community Tracking (OEI)

Pollution Control

Small Business Administration

Pollution Control Loans

U.S. Environmental Protection Agency

Chemical Emergency Preparedness and Prevention Technical Assistance Grants (CEPPO)
Pesticide Environmental Stewardship Grants (OPPTS)
Pollution Prevention Incentives for States (OPPTS)

Watershed and Drinking Water Source Protection

U.S. Department of Agriculture

Watershed Protection and Flood Prevention Program (NRCS)

U.S. Department of Transportation

Transportation Equity Act for the 21st Century Funding Programs (FHWA)

U.S. Department of the Interior

Land and Water Conservation Fund Grants to States (NPS)

U.S. Environmental Protection Agency

Capitalization Grants for Clean Water State Revolving Fund (OWM)
Capitalization Grants for Drinking Water State Revolving Fund (OGWDW)
Great Lakes Program (GLNPO)
Nonpoint Source Implementation Grants (319 Program) (OWOW)
Water Quality Cooperative Agreements (OWM)
Watershed Assistance Grants (OWOW)

Wetlands

U.S. Department of Agriculture

Wetlands Reserve Program (NRCS)

U.S. Department of the Interior

Coastal Wetlands Planning, Protection, and Restoration Act Program (FWS)
National Coastal Wetlands Conservation Grant Program (FWS)
North American Wetlands Conservation Act Grants Program (FWS)

U.S. Environmental Protection Agency
Five-Star Restoration Program (OWOW)
Wetlands Program Development Grants (OWOW)

Wildlife
National Fish and Wildlife Foundation
Bring Back the Natives Grant Program
U.S. Department of Agriculture
Wildlife Habitat Incentives Program (NRCS)
U.S. Department of Commerce
Community-Based Restoration Program (NOAA)
Fisheries Development and Utilization Research and Development Grants and Cooperative Agreements Program (NOAA)
U.S. Department of the Interior
Partners for Fish and Wildlife Program (FWS)
Wildlife Conservation and Appreciation Program (FWS)

8.3. Private, Nonprofit Sources

- **Chronicle of Philanthrop**y. The Chronicle Web site (http://www.philanthropy.com) includes articles and grant announcements. Users may search the Chronicle database to find what funders have provided money for projects like theirs in the past. There is currently a $50 annual fee. The Chronicle's Internet site also provides links to information on fund raising, volunteerism, technology, academic centers on philanthropy, and publications for nonprofit professionals.

- **Community of Science (COS**). The COS Funding Opportunities Internet site (http://www.cos.com) is updated daily and includes information on more than 15,000 grants from around the world. Annual subscription fees range from $500 to $1500 for most institutions and $500 for individuals.

- **Conservation Technology Support Program (CTSP**) annually awards grants of equipment plus software to tax-exempt conservation organizations to build their geographic information system (GIS) capacity. CTSP is supported by donations of equipment by Hewlett Packard Company and software by Environmental Systems Research Institute. (http://www.conservationgis.org/aagisgrant.html)

- **Council on Foundations.** The Council supports an Internet site (http://www.cof.org) that provides information on foundation grant monies.

- **Environmental Support Center (ESC**). The goal of ESC's (http://www.envsc.org) is to improve the U.S. environment by enhancing the health and well-being of local, state, and regional organizations working on environmental issues. ESC offers a Training and Organizational Assistance Program, a Technology Resources Program, a Workplace Solicitation Program, and a new Environmental Loan Fund to help environmental groups become better managed, funded, and equipped. The Environmental Loan Fund is a revolving loan fund intended to stabilize, increase, and diversify an organization's long-term funding base. ESC's Internet site also offers information on funding resources in its *Fundraising*

Resources for Grassroots Environmental Groups—An Annotated Bibliography, Parts I and II.

- **Foundation Center (FC**). The FC (http://foundationcenter.org/) publishes directories of funding opportunities, including the *Foundation Directory,* which features the nation's largest foundation funders; the *National Guide to Funding for the Environment and Animal Welfar*e, which lists 2,000 foundations, corporate direct giving programs, and grant-making public charities with an interest in the field; the *National Directory of Corporate Givin*g, which profiles more than 2,300 corporate philanthropic programs; and *FC Search: The Foundation Center's Database on CD-ROM*, a fully searchable database that includes the FC's exclusive database of foundation and corporate grant makers, as well as their associated grants.

- **Foundations and Grantmakers Directory**. Offered by the Northern California Community Foundation, this Internet site provides links to corporate, private, and community foundations (http://www.foundations.org/grantmakers.html).

- **Fundsnet Online Service**s. This web site (http://www.fundsnetservices.com) offers information on funding opportunities, listed alphabetically by geographical location and topic. Fundsnet also provides information about fund-raising and grant writing.

- **National Fish and Wildlife Foundation (NFWF**). NFWF (http://www.nfwf.org), a nonprofit organization established by Congress in 1984, awards challenge grants for natural resource conservation projects. NFWF uses its federally appropriated funds to match private sector funds. NFWF's six priority program areas include wetland conservation, conservation education, fisheries, neo-tropical migratory bird conservation, conservation policy, and wildlife and habitat. Pre-proposals are due July 1 and November 15, annually. NFWF forges partnerships between the public and private sectors to join resources in order to meet its conservation goals and to fund eligible projects.

- **Non-profit Resource Center (NRC**). The NRC (http://www.not-for-profit.org) serves as a one-stop directory for Internet resources of interest and value to nonprofit organizations. NRC provides valuable information, including a comprehensive list of fund-raising publications, fund-raising software and consultants, fund-raising programs, and information on grants and grantsmanship.

- **Sustainable Community Network (SCN**). SCN (http://www.sustainable.org/) focuses on using innovative strategies to produce communities that are environmentally sound, economically prosperous, and socially equitable. The SCN Internet site offers a variety of information, including funding sources and a comprehensive list of sustainable development resources.

8.4. Federal Sources

- ***Catalog of Federal Domestic Assistance (CFDA)*** **(Source: U.S. General Services Administration).** The CFDA is a comprehensive catalog that lists all sources of federal assistance (financial and technical). The CFDA can be accessed on the

Internet (http://www.gsa.gov/fdac/) and (http://aspe.os.dhhs.gov/cfda/). CFDA program information is also available on machine-readable magnetic tape, high-density floppy diskettes, and CD-ROM.

- **Center for Environmental Finance (CEF)**. The U.S. Environmental Protection Agency has developed the CEF to assist communities in their search for creative approaches to funding environmental projects (http://www.epa.gov/efinpage/). Drawing on the financing expertise of staff, the Environmental Financial Advisory Board (EFAB), and university-based Environmental Finance Centers (EFC), the CEF seeks to lower costs, increase investment, and build capacity by creating partnerships with state and local governments and the private sector to fund environmental needs. The CEF operates a number of funding resource services, including the following:

  (1) **Environmental Finance Center (EFC) Network**, a university-based program providing financial outreach services to regulated communities. The Network consists of eight EFCs that share information and expertise on finance issues and engage jointly in projects. The Network includes the University of New Mexico, the University of Maryland, Syracuse University, California State University at Hayward, Cleveland State University, Boise State University, the University of Louisville and the University of North Carolina at Chapel Hill. A central goal of the EFCs is to help create sustainable environmental systems in the public and private sectors. Many EFCs offer funding publications online:
  (http://www.epa.gov/efinpage/efcn.htm)

  (2) **Environmental Financing Information Network (EFIN)** is an outreach service offering electronic access (http://www.epa.gov/efinpage/efin.htm) to many types of environmental financing information for state and local environmental programs and projects . EFIN maintains an Internet web site of environmental financial tools. Of particular note among the financing mechanisms on this page is the *Guidebook of Financial Tool*s. The guidebook, produced by the EFC Network and the EFAB, is intended as a basic financial reference document for public and private officials with environmental responsibilities.

- **EPA's State Revolving Fund (SRF) Program (Office of Wastewater Management, Office of Ground Water and Drinking Water**). SRFs are available to fund a wide variety of water quality projects, including all types of nonpoint source, source water protection, and estuary management projects, as well as more traditional municipal wastewater and drinking water treatment projects.

  (1) **Clean Water State Revolving Fund (CWSRF)**. Clean Water State Revolving Fund (CWSRF) programs provided more than $5 billion annually in recent years to fund water quality protection projects for wastewater treatment, nonpoint source pollution control, and watershed and estuary management.)

  (2) **Drinking Water State Revolving Fund (DWSRF)** The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund to make funds available to drinking water systems to finance

infrastructure improvements. The program also emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water

- ***A Guide to Grants, Fellowships, and Scholarships in International Forestry and Natural Resources*** **(Source: U.S. Department of Agriculture's U.S. Forest Service, International Forestry Division, Document No. FS-584, December 1995).** This guide, available on the Internet (http://www.fs.fed.us/people/gf/gf00.htm), contains a detailed description of grants, fellowships, and scholarships available to university students, scholars, and professionals seeking funding to undertake studies or research in forestry or natural resources. Information about the awards includes the title of each program; a description; the purpose; eligibility requirements; the number, duration, and amount of awards; and application requirements, deadlines, instructions, and contacts.

- **Notices of Funding Availability (NOFA**). The NOFA Internet site (http://www.eda.gov/InvestmentsGrants/Nofa.xml) allows users to generate a customized listing of announcements that appear in the *Federal Registe*r. The *Federal Registe*r, printed each business day by the U.S. government, invites applications for federal grant programs.

- **United States Geological Survey (USGS**). The USGS provides funding for research, water resources data collection, data management, and information transfer activities. USGS program information is available on-line (http://www.usgs.gov/) and (http://www.gsa.gov/fdac/)

9. Priority Actions for the Town of Lewisboro

Actions recommended for 2009

Convene a public educational forum to discuss current water quality and habitat conditions of the lakes of Lewisboro. Solicit public input on the desired future for the lakes (overall and for individual lakes). Major topics include:

- The eutrophication process
- How have conditions changed in recent decades
- What can be done
- Why each lake may require slightly different strategies (protection, active intervention) based on physical characteristics, current conditions, and desired use
- How will a wastewater facilities affect the lakes
- What are the costs and benefits associated with alternatives

Continue and expand the annual lakes monitoring program to improve baseline data and gather data needed to apply for permits and funding for implementation of control measures. The recommended monitoring plan would collect water the standard CSLAP variables monthly from May to October in all lakes. Stratified lakes would include a near bottom water sample analyzed for phosphorus.

Prepare an annual Lewisboro Lakes Report Card to enhance public understanding of water quality conditions and contributing factors.

Convene technical committee (or select consultant) to initiate detailed planning, cost estimating, and identify funding sources for construction regional wastewater treatment facilities to serve the Town of Lewisboro Lakes watersheds.

Approach state and federal agencies to initiate discussions for funding, recognizing that the earlier the process starts, the sooner the appropriate applications can be submitted, and the more likely that funds will be available to implement lake improvement initiatives.

Propose creation of watershed tax districts to help fund stormwater management.

Propose an initiative program to encourage the use of “green” technologies as they relate to onsite waste water treatment.

Propose a moratorium on septic system construction in lake watersheds until decision is made on wastewater treatment facilities.

Introduce a local law prohibiting septic system construction within 100 meters of a waterbody hydrologically connected to one of the Towns lakes.

Actions recommended for 2010 - 2011

Propose a local law requiring periodic inspection, maintenance, and pumping of individual on-site wastewater treatment systems if wastewater facility option not initiated. The frequency can be linked to distance to lakes and hydrologically connected waterbodies, with more stringent requirements within a defined buffer zone.

If wastewater facilities are not approved, propose an ordinance that prohibits any septic system construction within 100 meters of a waterbody that is hydrologically connected to one of the Towns lakes.

Continue to convene periodic public educational forums that focus on current conditions and what needs to be done.

Continue the expanded annual lakes monitoring program and Lewisboro Lakes Report Card

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