F. X. Browne, Inc.

Engineers • Planners • Scientists

May 3, 2002

Mr. Chris Allyn
8 Lake Trail West
Morristown, NJ 07960

RE: Ten Towns Great Swamp Watershed
Lakes and Ponds Study – Mt. Kemble Lake
FXB File No. NJ1356-14

Dear Mr. Allyn:

Thank you for allowing us to include your lake in the Great Swamp Ten Towns Committee's study of lakes and ponds in the Great Swamp Watershed.

Enclosed is a copy of the assessment report for your lake. The report provides an overview of the entire study's findings, information about lake and pond ecology, and specific information about your lake, including watershed area and land use, water quality data, survey data, and management recommendations.

We would like to monitor your lake again this summer. A second year of data would be valuable in confirming the ecological condition of your lake. One of our staff will contact you this summer to set up a convenient time to sample your lake.

If you have any questions regarding the information contained in the report or management alternatives for your lake, please contact us at 215-362-3878 or visit our website at www.fxbrowne.com.

Sincerely,

F. X. BROWNE, INC.

By:
Frank X. Browne, Ph.D., P.E.

FXB/bab
Enc.
cc: Peter Braun, Executive Director-
Ten Towns Great Swamp Watershed

Great Swamp Lakes and Ponds Study

Mt. Kemble Lake

January 2002

Prepared By:
F. X. Browne, Inc.
P.O. Box 401
Lansdale, PA 19446

Great Swamp Lakes and Ponds Study

Mt. Kemble Lake

January 2002

Submitted to:
Ten Towns Great Swamp Watershed Management Committee
c/o Morris 2000
2 Ridgedale Avenue
Cedar Knolls, NJ 07927

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Table of Contents

List of Tables

List of Figures

List of Appendices

Executive Summary

The Ten Towns Great Swamp Watershed Management Committee commissioned F. X. Browne, Inc. to perform one-day lake surveys on 15 of the 231 lakes in the Great Swamp watershed. Each lake was monitored for total phosphorus (nutrient), chlorophyll a (a measure of algal biomass), phytoplankton (algae identification), macrophytes (aquatic plants), and dissolved oxygen. Bathymetric surveys were also performed on each lake to determine the water depth and sediment thickness.

EPA criteria and the Carlson Trophic State Index were used to classify the trophic, or ecological, condition of the lake. The following table summarizes the characteristics and trophic state of each lake.

The trophic condition of a lake depends on many characteristics including mean depth, lake size, watershed size, land use in the watershed, point sources, and upstream activities. The results of this study indicate that all 15 lakes are eutrophic with, in fact, nine of the 15 lakes classified as hyper-eutrophic.

A conceptual management plan is recommended for each lake. Implementing the recommended management plan would help restore each lake to a more desirable condition.

The results of this study indicate that Mt. Kemble Lake is eutrophic. Mt. Kemble Lake has a relatively small watershed and approximately 50 percent of the land use remains as forest. Batch or continuous alum treatment of this lake may significantly improve the water quality of the lake. Dredging of the lake does not appear to be necessary at this time since the lake is relatively deep. Nonpoint source pollution problem areas within the Mt. Kemble Lake watershed should be identified and targeted, Best Management Practices (BMPs) should be designed and installed to reduce the sediment and nutrient loading to the lake. BMPs are control measures that can be installed to reduce runoff and erosion and can significantly reduce sediment and nutrient loadings. Shoreline stabilization does not appear to be necessary at this time. Since the bottom waters of the lake do become anoxic, lake aeration should be evaluated as a potential restoration method.

Summary of Lake Characteristics								
Lake	Mean Depth (Ft.)	Lake Area (Ac)	Watershed Area (Ac)	Watershed to Lake Area Ratio	Trophic State Index			Trophic State
					TP	Chl a	SD	
Kitchell Pond	1.4	5.5	1269	23:1	94	73	65	Hyper-Eutrophic
Ledell Pond	1.6	13.0	2105	162:1	80	50	55	Eutrophic
Osborne Pond	1.7	9.0	6502	722:1	57	52	62	Eutrophic
Mt. Kemble Lake	11.6	12.4	489	39:1	63	62	49	Eutrophic
Applewood Pond	4.7	0.5	21	42:1	73	71	70	Hyper-Eutrophic
Foote's Pond	1.7	2.6	614	236:1	86	45	N/A	Hyper-Eutrophic
Dellwood Parkway Pond	5.1	0.7	6.9	10:1	73	74	55	Hyper-Eutrophic
Branta Pond	1.5	6.6	261	40:1	88	74	87	Hyper-Eutrophic
Sunset Pond	2.9	1.2	21	17:1	88	68	70	Hyper-Eutrophic
Fairmount CC #4/5 Pond	-	0.8	37	46:1	77	53	59	Eutrophic
Bayne Park Pond	3.6	0.9	193	214:1	76	70	67	Hyper-Eutrophic
Armstrong Pond	4.4	7.4	126	17:1	86	84	72	Hyper-Eutrophic
Fairmount CC #11 Pond	-	0.6	263	438:1	78	52	73	Hyper-Eutrophic
Spring Brook CC Pond	1.9	3.4	33	10:1	64	43	66	Eutrophic
Dreeson Pond	-	2.2	1772	805:1	64	47	55	Eutrophic

Carlson Trophic State Index
- > 50 indicates eutrophic condition
- > 65 indicates hyper-eutrophic

TP = Total Phosphorus
Chl a = Chlorophyll a
SD = Secchi disk

1.0 Introduction

There are 231 lakes and ponds within the 7450 acre Great Swamp watershed. Each of these impoundments are important natural resources that provide habitat for aquatic and terrestrial wildlife species. These impoundments also serve as settling basins for the Great Swamp by trapping sediment from the Great Swamp watershed. Therefore, these impoundments have served to protect the water quality of the Great Swamp over the years. Many of the lakes and ponds, however, have become filled will sediment and are experiencing severe water quality problems. Their efficiency for trapping sediments and preserving the water quality of the Great Swamp is diminishing.

In an attempt to assess this situation, the Ten Towns Great Swamp Watershed Management Committee received a Victoria Foundation Grant to evaluate 15 lakes and ponds located within the Great Swamp Watershed. This study included sampling both water and sediment in 15 lakes and ponds, evaluating contributory land use within the watershed of each waterbody, and developing preliminary recommendations for the management of the lakes and ponds.

This report includes a primer on lake and pond ecology, a section describing the methodology that was used to evaluate the 15 lakes and ponds, results of the water quality investigations for each individual lake or pond, and a summary of water quality issues for lakes and ponds within the Great Swamp watershed. A glossary of Lake and Watershed Terms is provided in Appendix A. A primer on lake dredging is provided in Appendix C.

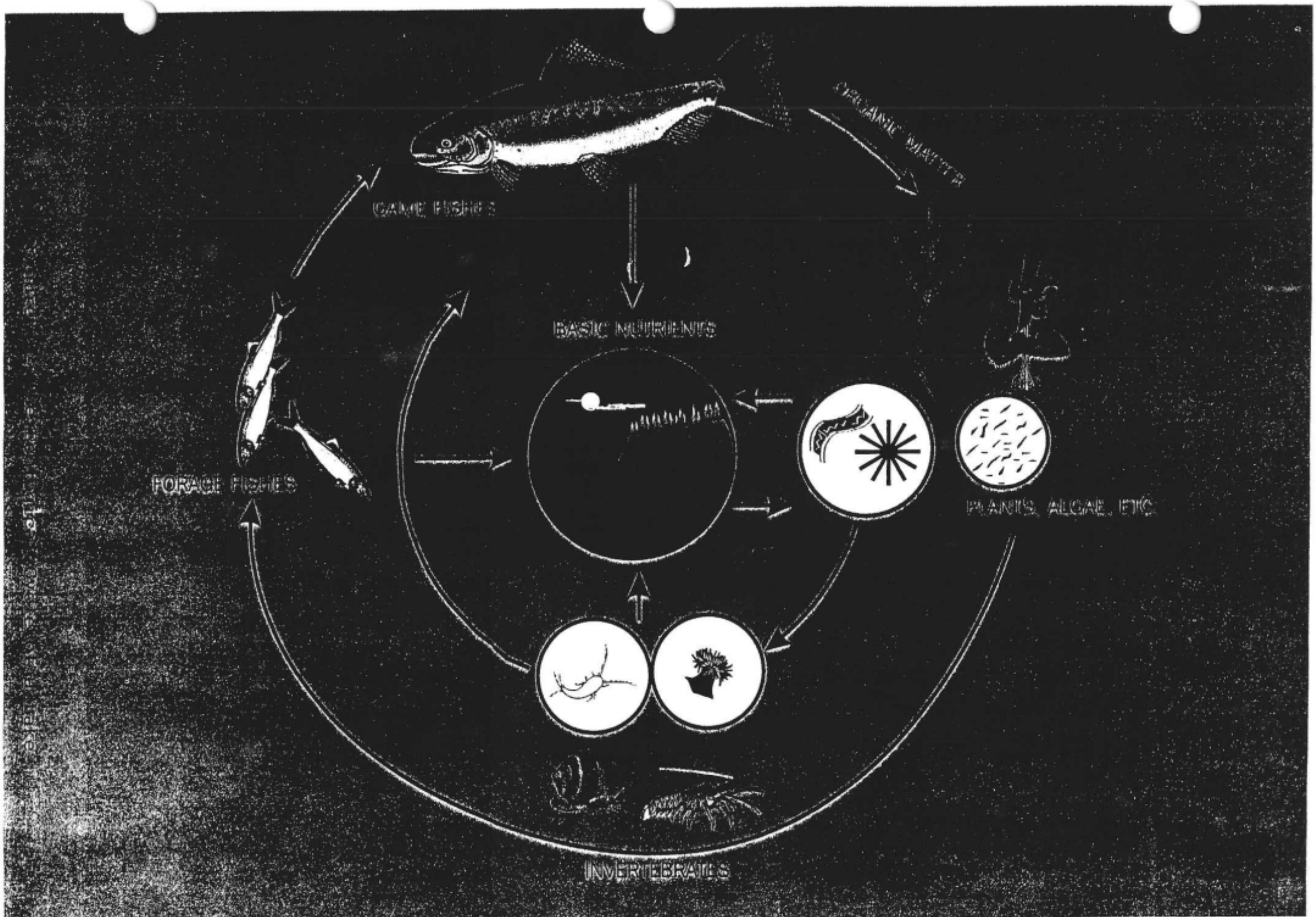
2.0 Lake and Pond Ecology Primer

Ecological Cycle

In a lake, a basic ecological cycle exists. As shown in Figure 1, nutrients such as phosphorus and nitrogen, along with sunlight, are used by the aquatic plants - algae (microscopic aquatic plants) and macrophytes (large aquatic plants) to grow. Small aquatic animals such as invertebrates (rotifers, protozoa, etc.), snails and insects eat the algae and reproduce. Small forage fish eat the small animals, and, in turn are eaten by larger game fish and other animals.

In a healthy lake, there is a balance in this ecological system. However, when too many nutrients enter a lake, the algae and/or large aquatic plants grow to a point of excess. There are too many aquatic plants in the lake.

If the small animals ate all of the algae and weeds and were in-turn eaten by the small and large fish, then the lake would have a nice, large fishery. This relationship, called the ecological pyramid, is illustrated in Figure 2. With a larger population of algae you would expect a larger population of fish. But the problem is that the excessive plant life is not transferred up the food chain. The small aquatic animals do not eat much of the excess algae (they do not like some of the algae, especially the blue-green algae). Therefore, we get a buildup of algae and other plants that destroy the


GAME FISHES
ORGANIC MATTER
BASIC NUTRIENTS
FORAGE FISHES
PLANTS, ALGAE, ETC
INVERTEBRATES

THE ECOLOGICAL PYRAMID

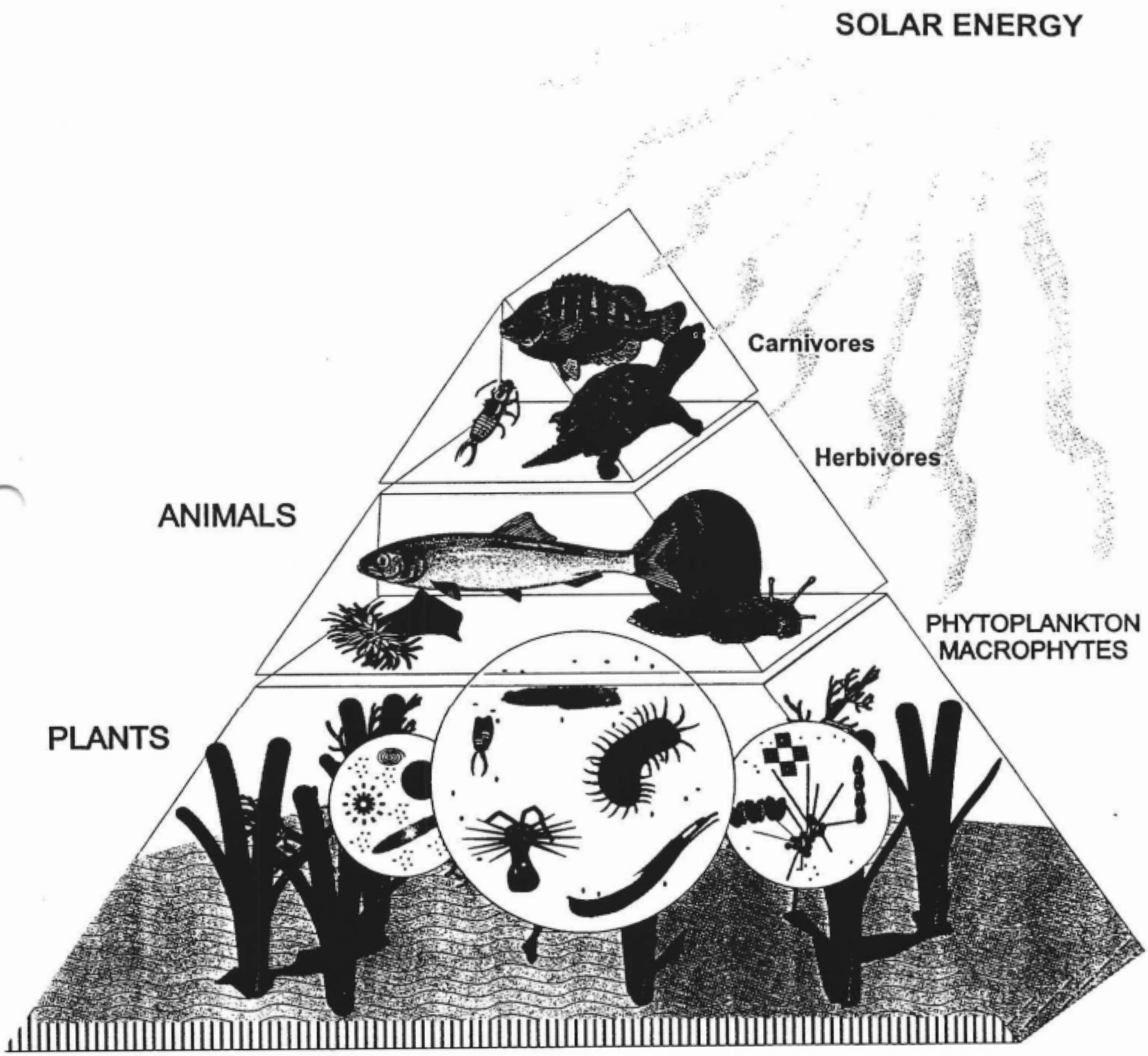


Figure 2 - The Ecological Pyramid of a Typical Lake

ecological balance of the lake ecosystem. This can result in a reduction in the fish population. It often results in a change in the type of fish found in the lake.

In order to understand the processes that occur in a lake, we must first understand the concept of lake succession or aging.

Lake Succession Over Time

All lakes go through an aging process called ecological succession. It is a natural process whereby a lake starts out as an "ecologically" young lake with little vegetation (such as algae and aquatic plants), low nutrients, clear water, and very little unconsolidated (loose) sediment on the bottom. It should be noted that ecological age is different than chronological age. It can be said, therefore, that lakes have both a chronological and ecological age. The chronological age is simply the number of years a lake has existed. The ecological age, on the other hand, is a measure of the physical, chemical, and biological conditions of a lake.

A lake may be young in actual chronological years (i.e. built only 3 years ago) but it could be ecologically old in the sense of having lots of algae and aquatic plants and bottom sediments.

Natural lake succession or aging is illustrated in Figure 3. As a lake ages, more nutrients and sediments enter the lake due to erosion and stormwater runoff from the lake's watershed. As more nutrients and sediments enter a lake, several things occur. Usually, the additional nutrients, such as phosphorus and nitrogen, cause an increase in the amount of algae and aquatic weeds. The additional sediment entering the lake settles to the bottom of the lake, increasing the amount of sediment on the lake's bottom.

Thus as a lake ages, it slowly starts to fill up with sediments, algae and aquatic weeds. Initially, the aquatic vegetation is submergent vegetation, that is, it stays beneath the water surface. As the lake further fills up with sediment, emergent vegetation appears (emergent plants "emerge" above the water surface).

Ultimately, due to sedimentation of the lake (from incoming sediment from the watershed and from dying algae, aquatic plants, and animals), the lake transforms into a pond or swamp and eventually, over hundreds or thousands of years, into a forest.

Lake Aging

Lake succession or aging is a natural process that occurs in all lakes. However, the influence of man's activities in the watershed can significantly accelerate the aging process.

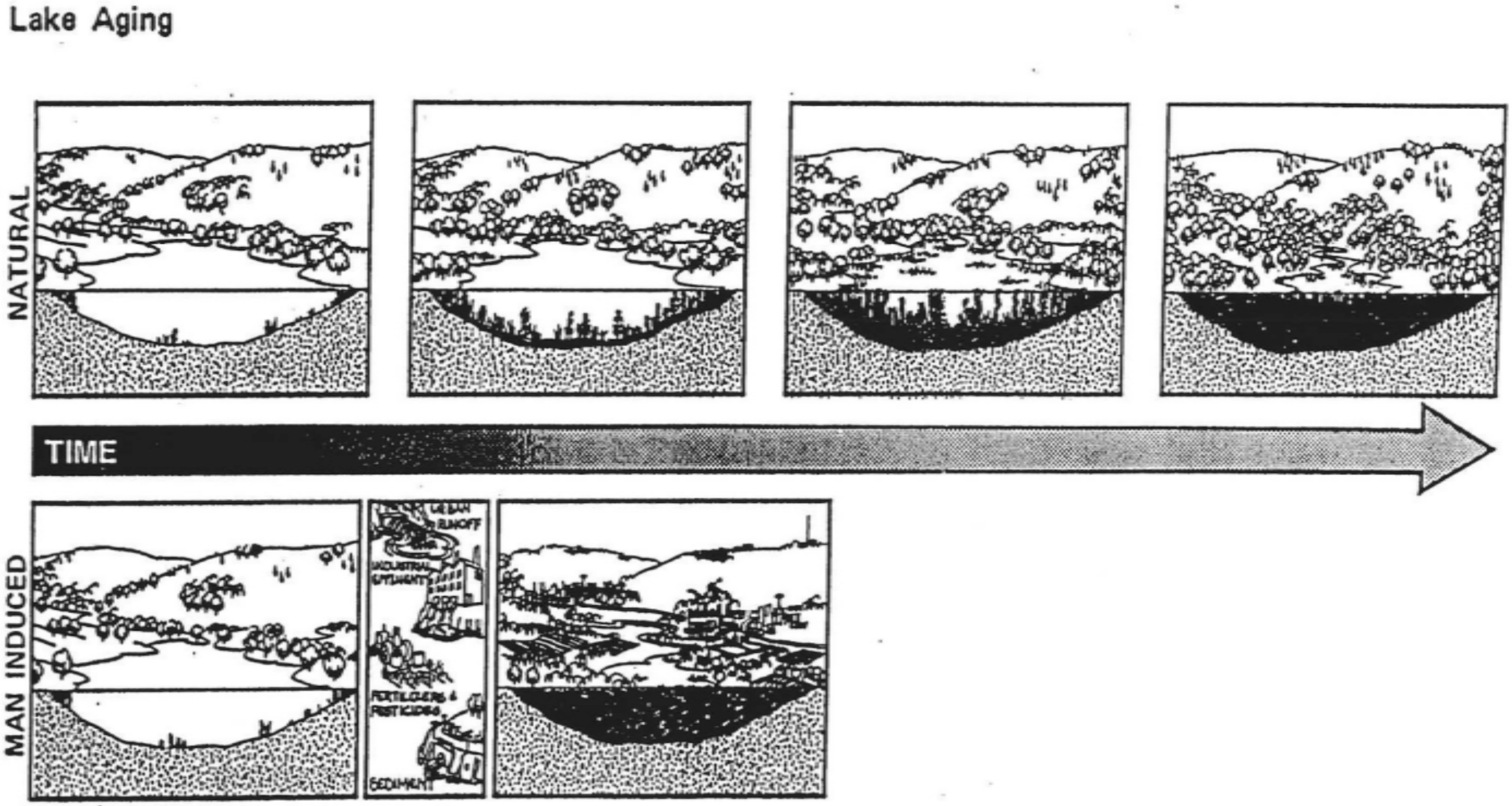


Figure 3 - Natural and Man-Induced Lake Succession

The lake aging process is accelerated by:

Wastewater Treatment Plant Discharges
Malfunctioning Septic Systems
Agricultural Activities (cropland and pastureland)
Construction Activities
Developed Land
Roadways
Streambank Erosion
Landfills

Thus, man's activities in a watershed can add sediments and nutrients (phosphorus and nitrogen) to a lake, resulting in accelerated aging or what we call "cultural eutrophication." As shown in Figure 3, man-induced influences can significantly increase the rate at which a lake ages.

Lake Classification

Lakes are classified by the amount of nutrients (or food) contained in the lake. The Greek word for food is "trophic." Therefore, we classify lakes by their "trophic" or food/nutrient state. Such as:

Oligo = little (little nutrients)
Meso = medium (medium nutrients)
Eu = too much (too much nutrients)

The trophic state refers to the "ecological" age of the lake, not its chronological age. Therefore, an oligotrophic lake is a lake that is ecologically young. For example, a eutrophic, or ecologically old lake, could be two years old.

Lakes are classified by nutrient level and the presence of aquatic plants as described below.

Oligotrophic lake
- ecologically young lake
- low level of nutrients
- low population of algae and aquatic plants

Mesotrophic lake
- ecologically middle-aged lake
- moderate level of nutrients
- moderate population of algae and aquatic plants

Eutrophic lake

- ecologically old lake
- high level of nutrients
- high population of algae and aquatic plants

Lake Problems

Excessive nutrients entering a lake from its watershed cause algae blooms, excessive aquatic plants (macrophytes), lake siltation(settling of sediments in lake, loss of lake volume and capacity), and fishery problems (low dissolved oxygen levels change the fish from game fish to trash fish such as carp). All of this results in loss of recreation.

Causes of Lake Problems

Lake problems are caused by point sources and nonpoint sources. Point sources are wastewater treatment plant discharges. Nonpoint sources come from are any activity that causes erosion and stormwater runoff or leaching from septic systems.

Nonpoint Sources

Nonpoint sources, as mentioned earlier, cause soil erosion and stormwater runoff. Nonpoint sources come from:

- Agricultural Activities
- Construction Activities
- Developed Land
- Roadways
- Landfills
- Streambank Erosion
- Wildlife

3.0 Methodology

The Great Swamp Lake and Pond Study was performed following accepted scientific methods. The following factors were used to select representative lakes and ponds for this study:

1. Location of the lake or pond (one lake or pond in each municipality was desired),
2. Access to the lake,
3. Size of the lake or pond,
4. Size of the watershed draining to the lake or pond, and
5. Land use within the contributory drainage area (varying land uses were desirable).

The fifteen lakes and ponds that were selected were located in 8 of the 10 municipalities in the watershed and ranged in size from 0.5 acres to 13 acres in size.

The watershed for each lake or pond was delineated in the Great Swamp GIS using DEM mapping. Land use was then extracted from the GIS for the watershed area.

Water Samples

During each lake or pond survey, water and sediment samples were collected for analysis. Water samples were collected with a Van Dorn water sampler, transferred to appropriate bottles, preserved as necessary, and placed in a cooler for transport back to the F. X. Browne, Inc. New Jersey-certified laboratory. Sediment samples were collected with an Eckmann sediment sampler and also placed in the cooler for storage and transport to the laboratory.

Transparency

The transparency of the water in each lake and pond was measured with a Secchi disk. Secchi disk transparency is an indirect measurement of the total amount of organic and inorganic turbidity in a lake. This measurement was obtained by lowering a 20 cm white and black patterned disk into the water until it was no longer visible. The Secchi disk was then raised slightly until the disk could just be seen. The depth in meters recorded at that point was recorded as the Secchi disk transparency. Observed Secchi disk values range from a few centimeters in very turbid lakes to over 40 meters in the clearest known lakes.

Chlorophyll a

Chlorophyll a is a green pigment contained in all green plants, where it is used to convert sunlight to chemical energy during photosynthesis. Water samples containing algae can be treated to extract chlorophyll a from algae cells for analysis. Chlorophyll a constitutes about 1 to 2 percent of the dry weight of planktonic algae, so the amount of chlorophyll a in a water sample is an indicator of phytoplankton biomass. Chlorophyll a samples were collected for all lakes and pond in this study by collecting a composited water sample from the water column to a depth of two times the Secchi disk (this is considered the photic zone where algae can live).

Phytoplankton

Phytoplankton samples were collected at each lake or pond by obtaining a composite water sample from the lake photic zone. Phytoplankton are microscopic algae that have little or no resistance to currents and live free floating and suspended in open water. Their forms may be unicellular, colonial, or filamentous. As photosynthetic organisms (primary producers), phytoplankton form the foundation of the aquatic food web and are grazed upon by zooplankton (microscopic animals) and herbivorous fish (plant-eating fish).

A healthy lake should support a diverse assemblage of phytoplankton represented by a variety of algal species. Excessive phytoplanktonic growth, which typically consists of a few dominant species, is undesirable. Excessive growth can result in severe oxygen depletion in the water at night, when the algae are respiring (using up oxygen) and not photosynthesizing (producing oxygen). Oxygen depletion can also occur after an algal bloom when bacteria grow and multiply using dead algal cells as a food source. Excessive growths of some species of algae, particularly members of the blue-green group, may cause taste and odor problems, release toxic substances to the water, or give the water an unattractive green soupy or scummy appearance.

Planktonic productivity is commonly expressed by enumeration and biomass. Enumeration of phytoplankton is expressed as cells per milliliter (cells/mL). Biomass is expressed on a mass per volume basis as micrograms per liter (μg/L). Of the two, biomass provides a better estimate of the actual standing crop of phytoplankton in lakes.

What used to be referred to as blue-green algae (Cyanophyta) is now commonly referred to in the scientific literature as Cyanobacteria. These organisms act like both algae, in that they contain chlorophyll and perform photosynthesis, and bacteria, in that their cell structure is similar to bacteria. In this report we refer to these organisms as blue-green algae from the taxa Cyanophyta since their primary role in lakes and ponds is similar to algae.

Dissolved Oxygen and Temperature

Dissolved oxygen and temperature measurements were taken at each lake or pond with a YSI 610DM dissolved oxygen and temperature meter. Measurements were collected at varying increments from the surface of the water to the bottom of the lake or pond. In most of the shallower lakes and ponds, the dissolved oxygen and temperature remained completely mixed; however, in some of the deeper lakes and ponds, thermal stratification occurred and dissolved oxygen in the bottom waters of these lakes and ponds were very low.

In late spring or the beginning of summer, deep temperate lakes develop stratified layers of water, with warmer water near the lake's surface (epilimnion) and colder water near the lake's bottom (hypolimnion). As the temperature difference becomes greater between these two water layers, the resistance to mixing increases. Under these circumstances, the epilimnion (top water) is usually oxygen-rich due to photosynthesis and direct inputs from the atmosphere, while the hypolimnion (bottom water) may become depleted of oxygen due to oxygen being consumed by organisms decomposing organic matter at the lake bottom.

Conversely, shallow temperate lakes may never develop stratified layers of water. For these shallow lake systems, wave action caused by the wind may be sufficient to keep the entire lake completely mixed for most of the year. In shallow lakes, low dissolved oxygen levels may occur above the lake sediments even though most of the water in the lake is completely mixed.

Therefore, both shallow and deep temperate lakes can have low dissolved oxygen concentrations near the surface of the lake sediments. If low dissolved oxygen levels occur near the lake bottom, sediments may release significant amounts of nutrients (primarily orthophosphorus and ammonium) back into the lake, thereby allowing for more nutrients for algae and aquatic plant growth.

Bathymetric Survey

A bathymetric survey (lake bottom contour survey) was conducted for most of the lakes and ponds that were studied. Water depth and depth of accumulated sediment were measured along pre-determined transects in the lake. This information was used to develop a bathymetric map (bottom contour map) and sediment thickness map using AutoCAD. The volume of water and sediment in each lake was calculated using AutoCAD Land Development Desktop.

Shoreline Assessment

The shoreline of each lake or pond was visually assessed to identify areas of erosion and to determine if the lake level could be raised to increase the efficiency and storage volume of the lake or pond.

Evaluation of Lake Trophic State

As explained in the lake ecology primer, the trophic state of a lake represents its ecological age. Lakes that have excessive levels of phosphorus, phytoplankton (algae) and/or macrophytes (aquatic plants) are considered eutrophic. This is not a good condition and usually means that lake restoration and/or watershed management measures are needed to restore the lake to a more desirable condition. Lakes and ponds are classified in this report based on a variety of parameters including total phosphorus (nutrient), chlorophyll a (a measure of algal biomass), phytoplankton type and biomass (actual counting and identifying of algae), water transparency (as measured by the Secchi disk), macrophytes (aquatic plants), and dissolved oxygen. These parameters were compared to EPA criteria and the Carlson Trophic State Index.

It should be noted that the lakes and ponds were classified based on data collected from one lake survey. The water quality and biota of a lake changes from month to month and from year to year. The classification of these lakes, therefore, should be considered as an indicator of their general condition. A more accurate assessment of lake condition would require additional monitoring during the warm weather months of June through September. Although based on only one lake survey, the classification of each lake is an excellent indicator of its general ecological condition.

4.0 Lake Survey

Fifteen lake and pond surveys were conducted during the period of August 2001 through October 2001. The results of the Mt. Kemble Lake survey are provided in this section.

Lake Location, Watershed Area, and Land Use Information

Mt. Kemble Lake is a 12.4 acre lake located in Harding Township, Morris County, New Jersey. The watershed of Mt. Kemble Lake, as shown in Figure 4, is approximately 489.3 acres and consists primarily of residential, forest, and open space land uses as shown in Table 1.

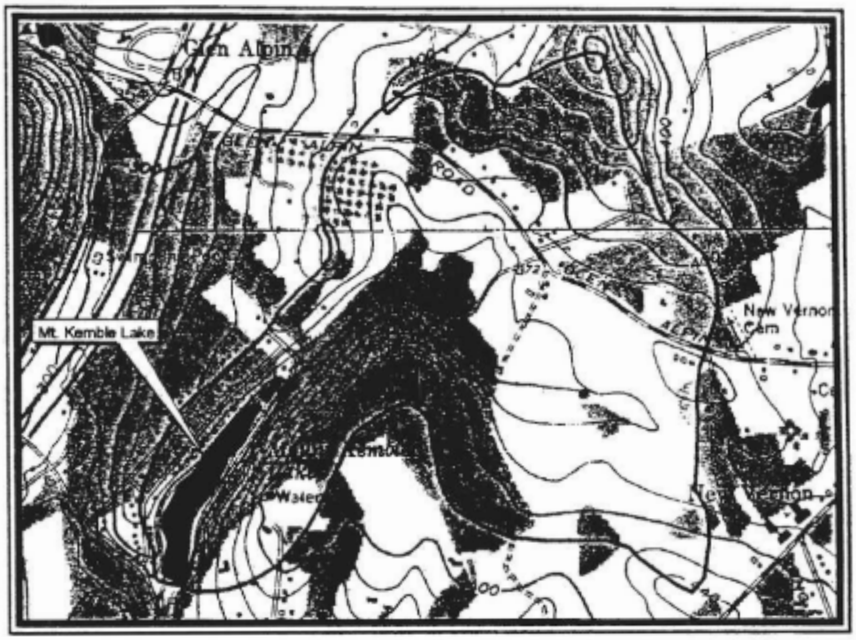


Figure 4 Mount Kemble Lake and its Watershed

Table 1 Land Use in Mt. Kemble Lake Watershed		
Land Use	**Acres**	**Percent of Watershed**
Open Space	47.6	9.73
Residential	188.6	38.54
Water	13.5	2.76
Forest	239.6	48.97
Total	**489.3**	**100.00**

Water Quality Information and Trophic State Index

Water quality information for Mt. Kemble Lake is provided in Table 2.

Table 2
Water Quality Data for Mt. Kemble Lake

Parameter	Result	Eutrophic Criteria
Total Phosphorus	60 μg/L	> 24 - 25 μg/L
Chlorophyll a	24 μg/L	> 7 - 10 μg/L
Secchi Disk Transparency	2.2 meters	> 2 meters

Total phosphorus and chlorophyll a concentrations in Mt. Kemble Lake are high and are indicative of eutrophic lake conditions based on EPA criteria. Lakes with phosphorus concentrations greater than 25 μg/L and lakes with chlorophyll a concentrations greater than 10 μg/L are considered eutrophic. Secchi disk transparency in Mt. Kemble Lake is 2.2 meters and is borderline mesotrophic to eutrophic. Lakes with Secchi disk transparency readings of less than 2 meters are considered eutrophic.

Another way to determine the trophic state of a lake is to calculate the lake's trophic state index. There are several indices that can be used; however, the Carlson Tropic State Index (TSI) is commonly used in northern lakes that are phosphorus limited, including most New Jersey lakes. TSI values are calculated based on logarithmic equations for total phosphorus, chlorophyll a, and Secchi disk transparency. Carlson TSI values for Mt. Kemble Lake are provided in Table 3. TSI values greater than 50 indicate eutrophic conditions. Therefore, based on Carlson's TSI, Mt. Kemble Lake is also classified as eutrophic.

Table 3
Carlson TSI Values for Mt. Kemble Lake

Parameter	TSI	Eutrophic Criteria
Total Phosphorus	63	> 50
Chlorophyll a	62	> 50
Secchi Disk Transparency	49	> 50

Phytoplankton and Macrophytes
Seven taxa (groups) of phytoplankton were identified in Mt. Kemble Lake on the sampling date including Bacillariophyta (diatoms), Chlorophyta (green algae), Chrysophyta (golden brown algae), Cryptophyta (cryptomonads), Cyanophyta (blue-green algae), Euglenophyta (Euglena), and Pyrrhophyta (dinoflagellates). The total phytoplanktonic biomass was 7,801 micrograms per liter (μg/L) and the total number of phytoplankton cells was 20,937 cells per milliliter. These phytoplankton numbers are relatively high compared to other lakes were have evaluated in New Jersey; however, there are no generally accepted standards for phytoplankton biomass or numbers. Phytoplankton data are presented in Appendix B. Another indication of eutrophication is the presence of blue-green algae (Cyanophyta) in lakes. The blue-green algae *Merismopedis, Oacillatoria, and Spirulina* were observed on the sampling date, but they were not the dominant type of algae in the lake based on algal biomass. The lake was treated with an algacide on June 30, 2001. Since the sampling event did not occur until August 8, 2001, the results of the phytoplankton analysis were not significantly affected by the algacide treatment. A minor amount of macrophytes (aquatic plants) were present on Mt. Kemble Lake.

Dissolved Oxygen and Temperature Information
Dissolved oxygen and temperature profiles were measured in each lake at varying intervals from the surface to the bottom of the water column. Dissolved oxygen and temperature data for Mt. Kemble Lake are provided in Table 4.

Table 4
Dissolved Oxygen and Temperature Data for Mt. Kemble Lake

Depth from Surface (meters)	Dissolved Oxygen (mg/L)	Temperature (°C)
1.003	7.85	28.25
2.002	5.14	25.31
2.998	2.24	22.70
4.007	0.53	16.07
4.626	0.32	13.39

Mt. Kemble Lake is a relatively deep lake and is thermally stratified. Dissolved oxygen is depleted in the bottom waters of the lake which is another indication of a eutrophic lake.

Bathymetric Information
A bathymetric survey was conducted for Mt. Kemble Lake. A bathymetric map and sediment thickness map for Mt. Kemble Lake are provided in Figures 1 and 2 in Appendix B. Based on the results of the bathymetric survey, Mt. Kemble Lake has an average depth of 11.6 feet and a

maximum depth of 30 feet. The lake volume is approximately 232,663 cubic yards, and the lake contains approximately 10,914 cubic yards of unconsolidated sediment. A sediment sample was collected from Mt. Kemble Lake and analyzed for total phosphorus, total volatile solids, and total solids. The sediments contained 3,580 mg/kg total phosphorus (dry weight), 28,000 mg/kg total volatile solids, and 197,000 mg/kg total solids. There is no standard for total phosphorus in sediments; however, the total phosphorus in the sediments of Mt. Kemble Lake is relatively high compared to other New Jersey lakes.

Shoreline Conditions

The shoreline of Mt. Kemble Lake is very developed; however, much of the natural vegetation along the lake shoreline, including trees have been preserved. In some areas of the lake, bulkheads have been installed to prevent erosion of the shoreline. Based on surrounding topography and land use, raising the water level of Mt. Kemble Lake would significantly impact the shoreline property owners.

Impact of Mt Kemble Lake on the Great Swamp

Based on unit area loadings for total suspended solids and total phosphorus developed from the Great Swamp water monitoring program for the Primrose Brook subwatershed and based on the methodology presented in "Performance of Detention Basins for Control of Urban Runoff Quality" by Eugene Driscoll, Mt. Kemble Lake is currently removing approximately 12 percent of the total suspended solids loading and approximately 12 percent of the total phosphorus loading. This translates to a reduction of approximately 376 lb/year of total suspended solids and 0.7 lb/year of total phosphorus.

Management Recommendations for Mt. Kemble Lake

Mt. Kemble Lake has a relatively small watershed and approximately 50 percent of the land use remains as forest. Batch or continuous alum treatment of this lake may significantly improve the water quality of the lake. Dredging of the lake dose not appear to be necessary at this time since the lake is relatively deep. Nonpoint source pollution problem areas within the Mt. Kemble Lake watershed should be identified and targeted and Best Management Practices (BMPs) should be designed and installed to reduce the sediment and nutrient loading to the lake. BMPs are control measures that can be installed to reduce runoff and erosion and can significantly reduce sediment and nutrient loadings. Shoreline stabilization does not appear to be necessary at this time. Since the bottom waters of the lake do become anoxic, lake aeration should be evaluated as a potential restoration method.

APPENDIX A

Glossary of Lake and Watershed Terms

Glossary of Lake and Watershed Terms

Acid neutralizing capacity (ANC): the equivalent capacity of a solution to neutralize strong acids. The components of ANC include weak bases (carbonate species, dissociated organic acids, alumino-hydroxides, borates, and silicates) and strong bases (primarily, OH-). In the National Surface Water Survey, as well as in most other recent studies of acid-base chemistry of surface waters, ANC was measured by the Gran titration procedure.

Acidic deposition: transfer of acids and acidifying compounds from the atmosphere to terrestrial and aquatic environments via rain, snow, sleet, hail, cloud droplets, particles, and gas exchange.

Adsorption: The adhesion of one substance to the surface of another: clays, for example, can adsorb phosphorus and organic molecules

Aerobic: Describes life or processes that require the presence of molecular oxygen.

Algae: Small aquatic plants that occur as single cells, colonies, or filaments. Planktonic algae float freely in the open water. Filamentous algae form long threads and are often seen as mats on the surface in shallow areas of the lake.

Alkalinity: (see *acid neutralizing capacity*).

Allochthonous: Materials (e.g., organic matter and sediment) that enter a lake from atmosphere or drainage basin (see *autochthonous*).

Anaerobic: Describes processes that occur in the absence of molecular oxygen.

Anoxia: A condition of no oxygen in the water. Often occurs near the bottom of fertile stratified lakes in the summer and under ice in late winter.

Anoxic: "Without oxygen." (see *anoxia*).

Autochthonous: Materials produced within a lake e.g., autochthonous organic matter from plankton versus allochthonous organic matter from terrestrial vegetation.

Bathymetric map: A map showing the bottom contours and depth of a lake; can be used to calculate lake volume.

Benthic: Macroscopic (seen without aid of a microscope) organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the substrate. Also referred to as *benthos*.

Biochemical oxygen demand (BOD): The rate of oxygen consumption by organisms during the decomposition (respiration) of organic matter, expressed as grams oxygen per cubic meter of water per hour.

Biomass: The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often measured in terms of grams per square meter of surface.

Biota: All plant and animal species occurring in a specified area.

Chemical oxygen demand (COD): Non-biological uptake of molecular oxygen by organic and inorganic compounds in water.

Chlorophyll: A green pigment in algae and other green plants that is essential for the conversion of sunlight, carbon dioxide and water to sugar (photosynthesis). Sugar is then converted to starch, proteins, fats and other organic molecules.

Chlorophyll a: A type of chlorophyll present in all types of algae, sometimes in direct proportion to the biomass of algae.

Cluster development: Placement of housing and other buildings of a development in groups to provide larger areas of open space

Consumers: Animals that cannot produce their own food through photosynthesis and must consume plants or animals for energy (see *producers*).

Decomposition: The transformation of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and non-biological processes.

Delphi: A technique that solicits potential solutions to a problem situation from a group of experts and then asks the experts to rank the full list of alternatives.

Density flows: A flow of water of one density (determined by temperature or salinity) over or under water of another density (e.g. flow of cold river water under warm reservoir surface water).

Detritus: Non-living dissolved and particulate organic material from the metabolic activities and deaths of terrestrial and aquatic organisms.

Drainage basin: Land area from which water flows into a stream or lake (see *watershed*).

Drainage lakes: Lakes having a defined surface inlet and outlet.

Ecology: Scientific study of relationships between organisms and their environment: also defined as the study of the structure and function of nature.

Ecosystem: A system of interrelated organisms and their physical-chemical environment. In limnology, the ecosystem is usually considered to include the lake and its watershed.

Effluent: Liquid wastes from sewage treatment, septic systems or industrial sources that are released to a surface water.

Environment: Collectively, the surrounding conditions, influences and living and inert matter that affect a particular organism or biological community.

Epilimnion: Uppermost, warmest, well-mixed layer of a lake during summertime thermal stratification. The epilimnion extends from the surface to the thermocline.

Erosion: Breakdown and movement of land surface which is often intensified by human disturbances.

Eutrophic: From Greek for well-nourished; describes a lake of high photosynthetic activity and low transparency.

Eutrophication: The process of physical, chemical, and biological changes associated with nutrients, organic matter, silt enrichment, and sedimentation of a lake or reservoir. If the process is accelerated by man-made influences it is termed cultural eutrophication.

Fall overturn: The autumn mixing, top to bottom, of lake water caused by cooling and wind-derived energy.

Fecal coliform test: Most common test for the presence of fecal material from warm-blooded animals. Fecal coliforms are measured because of convenience; they are not necessarily harmful but indicate the potential presence of other disease-causing organisms.

Floodplain: Land adjacent to lakes or rivers that is covered as water levels rise and overflow the normal water channels.

Flushing rate: The rate at which water enters and leaves a lake relative to lake volume, usually expressed as time needed to replace the lake volume with inflowing water.

Flux: The rate at which a measurable amount of a material flows past a designated point in a given amount of time.

Food chain: The general progression of feeding levels from primary producers, to herbivores, to planktivores, to the larger predators.

Food web: The complex of feeding interactions existing among the lake's organisms.

Forage fish: Fish, including a variety of panfish and minnows, that are prey for game fish.

Groundwater: Water found beneath the soil surface; saturates the stratum at which it is located; often connected to lakes.

Hard water: Water with relatively high levels of dissolved minerals such as calcium, iron, and magnesium.

Hydrographic map: A map showing the location of areas or objects within a lake.

Hydrologic cycle: The circular flow or cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Runoff, surface water, groundwater, and water infiltrated in soils are all part of the hydrologic cycle.

Hypolimnion: Lower, cooler layer of a lake during summertime thermal stratification.

Hypoxia: A condition of low oxygen in the water (< 2.0 mg/L). Often occurs near the bottom of fertile stratified lakes in the summer and under ice in late winter.

Influent: A tributary stream.

Internal nutrient cycling: Transformation of nutrients such as nitrogen or phosphorus from biological to inorganic forms through decomposition, occurring within the lake itself. Also refers to the release of sediment-bound nutrients into the overlying water that typically occurs within the anoxic hypolimnion of stratified, mesotrophic and eutrophic lakes.

Isothermal: The same temperature throughout the water column of a lake.

Lake: A considerable inland body of standing water, either naturally formed or manmade.

Lake district: A special purpose unit of government with authority to manage a lake(s) and with financial powers to raise funds through mill levy, user charge, special assessment, bonding, and borrowing. May or may not have police power to inspect septic systems, regulate surface water use, or zone land.

Lake management: The practice of keeping lake quality in a state such that attainable uses can be achieved and maintained.

Lake protection: The act of preventing degradation or deterioration of attainable lake uses.

Lake restoration: The act of bringing a lake back to its attainable uses.

Lentic: Relating to standing water (versus lotic, running water).

Limnologist: One who studies limnology.

Limnology: Scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes. Also termed freshwater ecology.

Littoral zone: That portion of a waterbody extending from the shoreline lakeward to the greatest depth occupied by rooted plants.

Loading: The total amount of material (sediment, nutrients, oxygen-demanding material) brought into the lake by inflowing streams, runoff, direct discharge through pipes, groundwater, the air, and other sources over a specific period of time (often annually).

Macroinvertebrates: Aquatic insects, worms, clams, snails, and other animals visible without the aid of a microscope, that may be associated with or live on substrates such as sediments and macrophytes. They supply a major portion of fish diets and consume detritus and algae.

Macrophytes: Rooted and floating aquatic plants, commonly referred to as waterweeds. These plants may flower and bear seed. Some forms, such as duckweed and coontail (*Ceratophyllum*), are free-floating forms without roots in the sediment.

Mandatory property owners association: Organization of property owners in a subdivision or development with membership and annual fee required by covenants on the property deed. The association will often enforce deed restrictions on members' property and may have common facilities such as bathhouse, clubhouse, golf course, etc.

Marginal zone: Area where land and water meet at the perimeter of a lake. Includes plant species, insects and animals that thrive in this narrow, specialized ecological system.

Mesotrophic: Describes a lake of moderate plant productivity and transparency; a trophic state between oligotrophic and eutrophic.

Metalimnion: Layer of rapid temperature and density change in a thermally stratified lake. Resistance to mixing is high in this region.

Morphometry: Relating to a lake's physical structure (e.g., depth, shoreline length).

Nekton: Large aquatic organisms whose mobility is not determined by water movement -- for example, fish and amphibians.

Nominal group process: A process of soliciting concerns/issues/ideas from members of a group and ranking the resulting list to ascertain group priorities. Designed to neutralize dominant personalities.

Nutrient: An element or chemical essential to life, such as carbon, oxygen, nitrogen, and phosphorus.

Nutrient budget: Quantitative assessment of nutrients (e.g., nitrogen or phosphorus) moving into, being retained in, and moving out of an ecosystem; commonly constructed for phosphorus because of its tendency to control lake trophic state.

Nutrient cycling: The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).

Oligotrophic: "Poorly nourished," from the Greek. Describes a lake of low plant productivity and high transparency.

Ooze: Lake bottom accumulation of inorganic sediments and the partially decomposed remains of algae, weeds, fish, and aquatic insects. Sometimes called muck (see *sediment*).

Ordinary high water mark: Physical demarcation line, indicating the highest point that water level reaches and maintains for some time. Line is visible on rocks, or shoreline, and by the location of certain types of vegetation.

Organic matter: Molecules manufactured by plants and animals and containing linked carbon atoms and elements such as hydrogen, oxygen, nitrogen, sulfur, and phosphorus.

Paleolimnology: The study of the fossil record within lake sediments.

Pathogen: A microorganism capable of producing disease. They are of great concern to human health relative to drinking water and swimming beaches.

Pelagic zone: This is the open area of a lake, from the edge of the littoral zone to the center of the lake.

Perched: A condition where the lake water is isolated from the groundwater table by impermeable material such as clay.

pH: A measure of the concentration of hydrogen ions of a substance, which ranges from very acid (pH = 1) to very alkaline (pH = 14). pH 7 is neutral and most lake waters range between 6 and 9. pH values less than 6 are considered acidic, and most life forms can not survive at pH of 4.0 or lower.

Photic zone: The lighted region of a lake where photosynthesis takes place. Extends down to a depth where plant growth and respiration are balanced by the amount of light available.

Phytoplankton: Microscopic algae and microbes that float freely in open water of lakes and oceans.

Plankton: Microscopic plants, microbes and animals floating or swimmng freely about in lakes and oceans.

Primary productivity: The rate at which algae and macrophytes fix or convert light, water and carbon dioxide to sugar in plant cells (through photosynthesis). Commonly measured as milligrams of carbon per square meter per hour.

Primary producers: Green plants that manufacture their own food through photosynthesis.

Profundal zone: Area of lake water and sediment occurring on the lake bottom below the depth of light penetration.

Reservoir: A manmade lake where water is collected and kept in quantity for a variety of uses, including flood control, water supply, recreation and hydroelectric power.

Residence time: Commonly called the hydraulic residence time -- the amount of time required to completely replace the lake's current volume of water with an equal volume of new water.

Respiration: Process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process releases energy, carbon dioxide, and water.

Secchi depth: A measure of transparency of water obtained by lowering a black and white, or all white, disk (Secchi disk, 20 cm in diameter) into water until it is no longer visible. Measured in units of meters or feet.

Sediment: Bottom material in a lake that has been deposited after the formation of a lake basin. It originates from remains of aquatic organisms, chemical precipitation of dissolved minerals, and erosion of surrounding lands (see *ooze* and *detritus*).

Seepage lakes: Lakes having either an inlet or outlet (but not both) and generally obtaining their water from groundwater and rain or snow.

Soil retention capacity: The ability of a given soil type to adsorb substances such as phosphorus, thus retarding their movement to the water.

Stratification: Layering of water caused by differences in water density. Thermal stratification is typical of most deep lakes during summer. Chemical stratification can also occur.

Swimmers itch: A rash caused by penetration into the skin of the immature stage (cercaria) of a flatworm (not easily controlled due to complex life cycle). A shower or alcohol rubdown should minimize penetration.

Thermal stratification: Lake stratification caused by temperature-created differences in water density.

Thermocline: A horizontal plane across a lake at the depth of the most rapid vertical change in temperature and density in a stratified lake (see *metalimnion.*).

Topographic map: A map showing the elevation of the landscape at specified contour intervals (typically 10 or 20 foot intervals, may be expressed in feet or meters). Can be used to delineate the watershed.

Trophic state: The degree of eutrophication of a lake. Transparency, chlorophy!! a levels, phosphorus concentrations, amount of macrophytes, and quantity of dissolved oxygen in the hypolimnion can be used to assess state.

Voluntary lake property owners association: Organization of property owners in an area around a lake that members join at their option.

Water column: Water in the lake between the interface with the atmosphere at the surface and the interface with the sediment layer at the bottom. Idea derives from vertical series of measurements (oxygen, temperature, phosphorus) used to characterize lake water.

Water table: The upper surface of groundwater; below this point, the soil is saturated with water.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Zooplankton: Microscopic animals that float or swim freely in lake water, graze on detritus particles, bacteria, and algae, and may be consumed by fish.

APPENDIX B

Mt. Kemble Lake Pond Phytoplankton and Bathymetric Data

Mt. Kemble Lake
Phytoplankton Data
August 8, 2001

TAXON	Phytoplankton Density (#/mL)	Phytoplankton Biomass (µg/L)
BACILLARIOPHYTA		
Achnanthes	0.0	0.0
Amphipleura	0.0	0.0
Amphora	0.0	0.0
Caloneis	0.0	0.0
Cocconeis	0.0	0.0
Cyclotella	0.0	0.0
Cymbella	0.0	0.0
Fragilaria	210.0	63.0
Frustulia	0.0	0.0
Gomphonema	0.0	0.0
Melosira	0.0	0.0
Navicula	0.0	0.0
Nitzschia	0.0	0.0
Rhoicosphenia	0.0	0.0
Stephanodiscus	0.0	0.0
Synedra	21.0	16.8
CHLOROPHYTA		
Actinastrum	0.0	0.0
Ankistrodesmus	0.0	0.0
Carteria	0.0	0.0
Chlamydomonas	0.0	0.0
Chlorella	0.0	0.0
Chlorogonium	0.0	0.0
Closterium	0.0	0.0
Coelastrum	0.0	0.0
Crucigenia	0.0	0.0
Dictyosphaerium	0.0	0.0
Elakatothrix	0.0	0.0
Euastrum	0.0	0.0
Eudorina	0.0	0.0
Golenkinia	0.0	0.0
Kirchneriella	0.0	0.0
Lobomonas	0.0	0.0
Micractinium	0.0	0.0
Mougeotia	0.0	0.0
Oedogonium	0.0	0.0
Oocystis	0.0	0.0
Pandorina	2142.0	970.2
Paulschultzia	0.0	0.0
Pediastrum	0.0	0.0
Scenedesmus	126.0	71.4
Schroederia	0.0	0.0
Sphaerocystis	0.0	0.0
Staurastrum	42.0	33.6
Tetraedron	231.0	138.6
Treubaria	0.0	0.0
CHRYSOPHYTA		
Chromulina	0.0	0.0
Dinobryon	0.0	0.0
Gonyostomum	0.0	0.0
Mallomonas	0.0	0.0
Ochromonas	0.0	0.0
Synura	0.0	0.0
Other Goldens #1 (Coccoid)	168.0	8.4

TAXON	Phytoplankton Density (#/mL)	Phytoplankton Biomass (µg/L)
CRYPTOPHYTA		
Cryptomonas	294.0	352.8
CYANOPHYTA		
Anabaena	0.0	0.0
Aphanizomenon	0.0	0.0
Aphanocapsa	0.0	0.0
Chroococcus	0.0	0.0
Coelosphaerium	0.0	0.0
Dactylococcopsis	0.0	0.0
Gomphosphaeria	0.0	0.0
Merismopedia	13188.0	131.9
Microcystis	0.0	0.0
Oscillatoria	3360.0	33.6
Spirulina	840.0	8.4
EUGLENOPHYTA		
Euglena	21.0	10.5
Phacus	21.0	6.3
Trachelomonas	21.0	21.0
PYRRHOPHYTA		
Ceratium	0.0	0.0
Gymnodinium	0.0	0.0
Peridinium	252.0	5934.6
RHODOPHYTA		
SUMMARY STATISTICS		
DENSITY (#/ML)		
BACILLARIOPHYTA	231.0	79.8
CHLOROPHYTA	2541.0	1213.8
CHRYSOPHYTA	168.0	8.4
CRYPTOPHYTA	294.0	352.8
CYANOPHYTA	17388.0	173.9
EUGLENOPHYTA	63.0	37.8
PYRRHOPHYTA	252.0	5934.6
RHODOPHYTA	0.0	0.0
TOTAL PHYTOPLANKTON	20937.0	7801.1
TAXONOMIC RICHNESS		
BACILLARIOPHYTA	2.0	
CHLOROPHYTA	4.0	
CHRYSOPHYTA	1.0	
CRYPTOPHYTA	1.0	
CYANOPHYTA	3.0	
EUGLENOPHYTA	3.0	
PYRRHOPHYTA	1.0	
RHODOPHYTA	0.0	
TOTAL PHYTOPLANKTON	15.0	
S-W DIVERSITY INDEX	0.5	
EVENNESS INDEX	0.5	

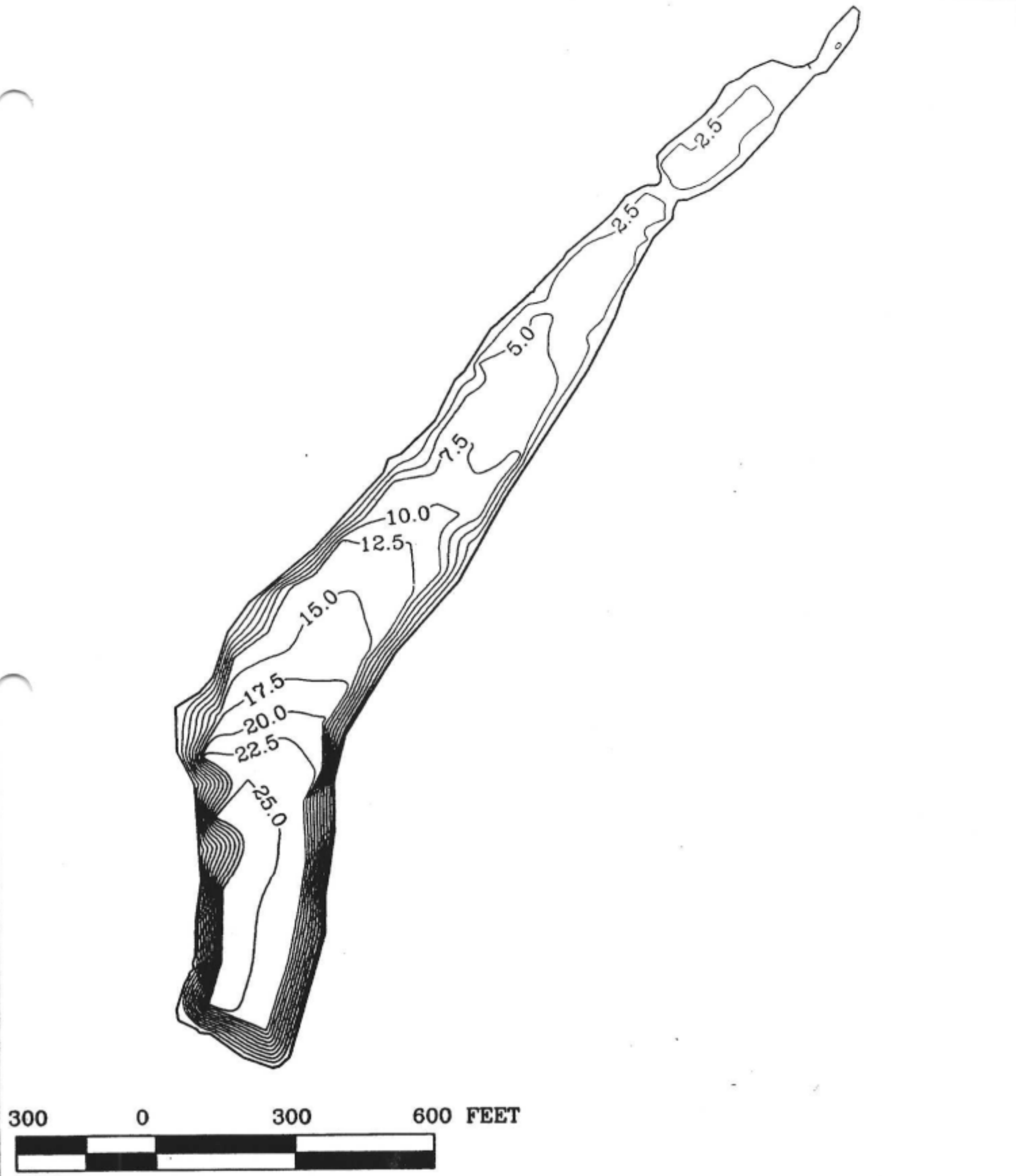


Figure 1

Water Depth Map for Mt. Kemble Lake

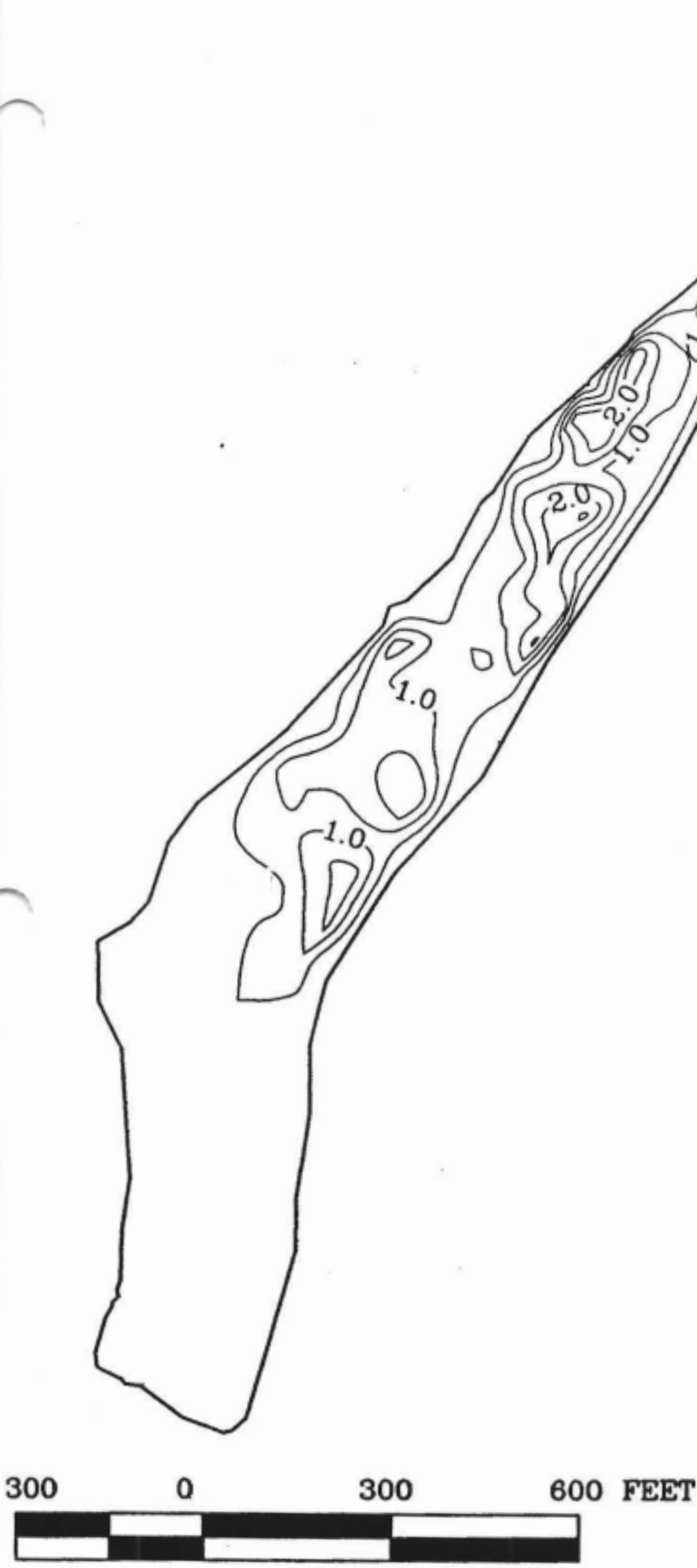


Figure 2	Sediment Thickness Map for Mt. Kemble Lake

Mt. Kemble Lake Sediment Data

A sediment sample was collected from Mt. Kemble Lake and analyzed for total phosphorus, total volatile solids, and total solids. Results of the sediment tests are provided below.

Mt. Kemble Lake Sediment Data	
Parameter	Result
Total Phosphorus (mg/kg dry weight)	3,580
Total Volatile Solids (mg/kg)	28,000
Total Solids (mg/kg)	197,000

There is no standard for total phosphorus in sediments; however, the total phosphorus in the sediments of Mt. Kemble Lake is relatively high compared to other lakes monitored in the Great Swamp watershed. The organic matter in the sediment, as measured by total volatile solids, is low (14% of the sediment). This indicates that the sediment is mainly inorganic in nature. During dredging, these sediments would probably not cause an odor problem.

APPENDIX C

Dredging Primer

Lake Dredging Primer

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The Basics of Dredging

Dredging is the removal of built-up sediments from lakes, ponds, and reservoirs. Although expensive and time-consuming, it is sometimes the only method for restoring degraded lakes.

Dredging enhances water quality by increasing water depth. Increased water depth reduces light transmission and generally reduces the area in which nuisance aquatic plants can grow. Dredging also removes nutrient-laden sediments from a waterbody. These sediments can stimulate aquatic plant and algal growth to nuisance levels, reducing water quality, aesthetic value, and recreational opportunities.

There are several dredging methods. The most common are hydraulic dredging, during which dredged material is "sucked" out of the lake using a device called a cutterhead, and mechanical dredging, during which material is manually removed with heavy equipment such as bulldozers and clam shells.

Once the material is removed from the lake, it is transported by dump truck or by pipeline to a suitable disposal site. Generally, disposal sites are open areas such as parks. Once at the disposal site, the material is left to dry, often for a period of months. Finally, the dry material is seeded and planted to restore the area to its original state. If dredged spoils are found to be contaminated, regulatory agencies may require that they be "capped" with a liner of clean fill or taken to a landfill. Occasionally, nutrient-rich dredged soils can be put to good use as fertilizer or as a soil base for restoring brownfield areas.

Prior to construction, a dredging project must be designed and permitted, a process that usually takes at least one year. The first step in the design process is to conduct a lake bathymetric survey to measure the depth of the water and unconsolidated sediment at the bottom of the lake. During the survey and initial design process, the amount of sediment to be dredged is determined, and lake and floodplain topography is mapped. Sediment testing may be required by regulatory agencies to determine suitable disposal alternatives. Usually at least one sediment sample is collected to determine the consistency and organic content of the sediment. Land use within the watershed is analyzed to identify industrial or hazardous waste sites that are potential sources of sediment contamination.

Following the initial design process, engineering plans and permit applications must be prepared by a professional engineer. Once the permit applications are submitted, the reviews may take several months to complete. The project may also require public bidding, which can add several months to the project schedule. For most lakes and reservoirs, the actual removal of material requires several months. Full restoration of the disposal areas may take several years.

Dredging Permitting Issues and Concerns

Obtaining all required permits for a dredging project requires coordination with a host of state and local agencies. In New Jersey, the New Jersey Department of Environmental Protection Land Use Regulation is the primary regulatory authority in the dredging permitting process. Prior to submitting permits to Land Use Regulation, a pre-application meeting should be scheduled with Land Use Regulation. During the pre-application meeting, issues of concern regarding dredging method, disturbance of sensitive areas, and disposal site locations are presented. Land Use Regulation will provide guidance to the applicant concerning these issues to expedite the permit review and approval process.

One of the major hurdles in the permitting process is timing. Generally, the late summer and early fall are the least restrictive times to conduct dredging. During the winter months, dredging is prohibited by the New Jersey Department of Environmental Protection – Division of Fish and Wildlife, to protect turtle populations. During the spring and early summer, dredging is generally prohibited to protect cold and warm water fisheries.

The best approach to the permitting process is to simplify it as much as possible. For example, the placement of fill in floodplain or wetland makes the permitting process more complex and should be avoided. The disturbance of wetlands should also be avoided if possible. Careful selection of access points, hauling routes, and disposal locations can significantly reduce the complexity of the permitting process.

Listed below are the various types of permits generally required for dredging projects in New Jersey. Most of these permits have associated application fees. Total fees for permitting dredging projects usually range from several hundred to several thousand dollars.

1. Federal Permit

   Much of the federal authority to regulate activities such as dredging has been delegated to the state and local regulatory agencies. If the proposed project affects a federally-endangered species or a structure or area designated on the National Register of Historic Places, federal agencies may become directly involved in the permitting process

2. State Permits

   A. Stream Encroachment Permits

      All dredging projects in New Jersey must comply with the New Jersey Flood Hazard Area Control Act Rules (N.J.A.C. 7.13-1.1 ET SEQ). These rules regulate activities in state waterways and floodplains.

Typically, both hydraulic and mechanical dredging projects require that a minor stream encroachment permit be obtained through the New Jersey Department of Environmental Protection - Land Use Regulation.

If the dredged material will be placed within the 100-year floodplain of any waterway, a major stream encroachment permit must be filed. Net fill calculations must be submitted along with the major stream encroachment permit.

Instructions on filing a minor stream encroachment permit are available from the New Jersey Department of Environmental Protection - Land Use Regulation:

New Jersey Department of Environmental Protection
Land Use Regulation
501 East State Street
2nd Floor
P.O. Box 439
Trenton, NJ 08625
Web:· www.state.nj.us/dep/landuse/index.html
Phone: Morris County (609)633-927
Somerset County (609) 633-6754

B. Freshwater Wetlands Permits

Dredging is a regulated activity in state open waters under the Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7 A).

In New Jersey, dredging projects require a General Permit #13 for Lake Dredging from the New Jersey Department of Environmental Protection - Land Use Regulation Program. Application for the General Permit #13 is typically made concurrently with the minor or major stream encroachment application.

If the dredging of wetlands exceeds one acre, or if deemed necessary by the Department (for example, where impacts to endangered species are suspected), the applicant may be required to obtain an individual freshwater wetlands permit for the dredging project.

Further, if disposal material is to be placed into a wetland or other state open water, an individual freshwater wetlands permit will be required.

C. Water Lowering and Fish Stocking Permits

If the dredging project involves the removal of water from the lake or impoundment prior to dredging, a water lowering permit and a fish stocking permit must be obtained from the New Jersey Department of Environmental Protection – Division of Fish and Wildlife.

Application materials for a water lowering permit are available by contacting the New Jersey Department of Environmental Protection – Division of Fish and Wildlife:

New Jersey Department of Environmental Protection
Division of Fish and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400
Phone: (609) 292-2965
Email: njwildlife@nac.net
Web: www.state.nj.us/dep/fgw/

D. Dam Safety Approval

If dredging is conducted within 200 feet of a dam, a dam safety approval must be obtained from the New Jersey Department of Environmental Protection – Division of Engineering & Construction – Dam Safety Section:

New Jersey Department of Environmental Protection
Division of Engineering & Construction
Dam Safety Section
501 East State Street
P.O. Box 419
Trenton, NJ 08625
Email: DamSaftey@dep.state.nj.us
Web: www.state.nj.us/dep/nhr/engineering/damsaftey

E. New Jersey Register of Historic Places

If the proposed dredging project impacts a structure or area listed on the New Jersey Register of Historic Places, then the Division of Parks and Forestry, Historic Preservation Office must be contacted. The exact nature of the permitting process varies, depending on the extent and nature of the disturbance.

3. County Permits

All dredging projects in New Jersey must have an approved erosion and sediment control plan. The plan is typically prepared by the project consultant and shows the methods that will be used to control erosion during the construction process, both at the dredging site and at the disposal area.

A Request for Authorization Form must be submitted along with the erosion and sediment control plan. This form is an application for a General National Pollution Discharge Elimination System Permit for a Stormwater Discharge Associated with a Construction Activity. Although this is a federal authorization, in New Jersey, the county conservation districts are granted the authority to issue this permit on behalf of the federal government.

The soil and sediment control plan and Request for Authorization Form are submitted to the appropriate county conservation district:

Morris County Conservation District
Court House
560 W. Hanover Township
Morris Township
P.O. Box 900
Morristown, NJ 07960
Phone: (973) 285-2953
Fax: (973) 285-8345
Email: mcscd@ibm.net

Somerset-Union County Conservation District
Somerset County 4-H Center
308 Milltown Road
Bridgewater, New Jersey 08807
Phone: (908) 526-2701
Fax: (908) 526-7017
Email: thurlow@co.somerset.nj.us

Dredging Methods

Mechanical Dredging

Lake dredging can be performed using mechanical or hydraulic methods. Mechanical dredging can be performed with or without lowering the lake water level. When the lake water level is lowered, sediment can be excavated using bulldozers and other heavy construction equipment. Cranes with clam shell buckets can operate from the shoreline or from a barge to remove sediment without lowering the lake water level. Once the sediment is excavated, it is loaded onto trucks and hauled to the disposal site. If the sediment is not sufficiently dewatered at the lake, watertight trucks must be used for transportation. Hauling sediment with high water content increases the project cost by increasing the volume of material that must be transported.

Hydraulic Dredging

Prior to hydraulic dredging, a dredging barge is unloaded from a trailer into the lake. The barge is equipped with a cutterhead, which dislodges sediment from the bottom of the lake. The sediment mixes with water and is pumped as a slurry from the barge to a disposal site via a pipeline. Disposal of hydraulically dredged sediment requires the construction of a sedimentation basin at the disposal site or requires that mechanical dewatering equipment be used to dewater the dredged material. If mechanical dewatering equipment is used, the dredging rate must be comparable to the dewatering rate or a holding basin must be constructed for the sediment slurry. In general, mechanical dewatering is more costly than constructing a disposal basin. Hydraulic dredging may be hindered by the presence of large rocks, trees, and other debris in the sediment.

Hydraulic dredging has a lower impact to shoreline areas than mechanical dredging and is usually more cost effective. Additionally, hydraulic dredging does not require a lake drawdown permit. One potential negative impact of hydraulic dredging is the resuspension of lake sediments by the cutterhead dredge, although this is only a temporary impact. Generally, however, the biggest drawback of hydraulic dredging is the necessity of a suitable, nearby (generally within 1 mile) disposal site.

Disposal Site Considerations

The disposal site should be as close to the dredging site as possible, particularly if hydraulic dredging is used. If mechanical dredging is used, the dredged material may be hauled via dump truck to a more distant disposal site. However, hauling is expensive and a distant disposal site can increase the overall project cost considerably.

If mechanical dredging is used, the best disposal site is a relatively flat, open field. The site should have adequate drainage and should be located out of wetland and floodplain areas. The disposal site should not be located within sensitive groundwater recharge areas. Finally, the disposal site should provide easy access for heavy equipment. If possible, land that is not actively used by the public should be used for a disposal site. If park land is to be used, the disposal process will interrupt use of the park for a number of years. These concerns must be addressed at the beginning of the planning process.

If hydraulic dredging is used, the disposal site must be large enough to build an adequate dewatering basin. The construction of a dewatering basin typically involves excavating down into the existing ground surface. Therefore, the depth to bedrock or groundwater must be deep enough to allow excavation to the required basin depth. The disposal site must be located to allow for the placement of inflow and outflow pipelines from the dredging site to the disposal site. The pipeline route should avoid crossing major roads and utilities. Ideally, the disposal site should be higher in elevation than the dredging site and should slope towards the dredging site. This will allow the return water to flow via gravity back to the lake.

Sediment Characteristics and Sediment Quality

Sediment characteristics and sediment quality influence the dredging method and disposal site selection. The most important sediment characteristics are particle size and organic matter content. Silt, clay, and sand are suitable for mechanical or hydraulic dredging, while gravel and cobble are more suited for mechanical removal. It may be more difficult to dispose of large material such as sand, gravel, or cobble than silt and clay because they cannot be planted. Rock material may be disposed of at a quarry, while sand material can sometimes be used for dune restoration or beach amendment efforts. Material that is high in organic matter may cause odor problems at the disposal site and may be difficult to settle in a dewatering basin. Material that is very low in organic matter may require the addition of fertilizer before seeding or planting following disposal.

The degree of sediment contamination is a key factor in determining dredging and disposal requirements. The New Jersey Department of Environmental Protection will require sediment contaminant testing for waterbodies where contamination is suspected due to the surrounding land use. The Department will determine the type and extent of testing that must be completed on a case-by-case basis. Levels of contaminants in the sediment are compared to the New Jersey Soil Cleanup Criteria. This document establishes two basic criteria, residential and nonresidential, for many common contaminants. If the sediment contamination is below the residential criteria for all measured contaminants, it can be placed almost anywhere. If levels of one or more of the measured contaminants fall between the residential and nonresidential criteria, the material must be disposed of at a non-residential facility (e.g., park, brownfield). If one or more of the measured contaminants exceed the nonresidential criteria, the Department may require that the material be taken to a landfill or covered with a layer of non-contaminated material.

Dredging Costs

Dredging costs vary according to type and amount of material, dredging method, disposal site location, sediment contamination levels, season, location within the state, and a variety of other factors. A review of previous dredging projects designed by F. X. Browne, Inc. indicates that per cubic yard costs vary from approximately $9 for large projects (>200,000 cubic yards) to approximately $150-200 for small projects (1,000-2,000 cubic yards). Costs for projects ranging from 10,000 – 250,000 cubic yards averaged approximately $16 per cubic yard.