Franklin Lake
Diagnostic-Feasibility Study

September 1989

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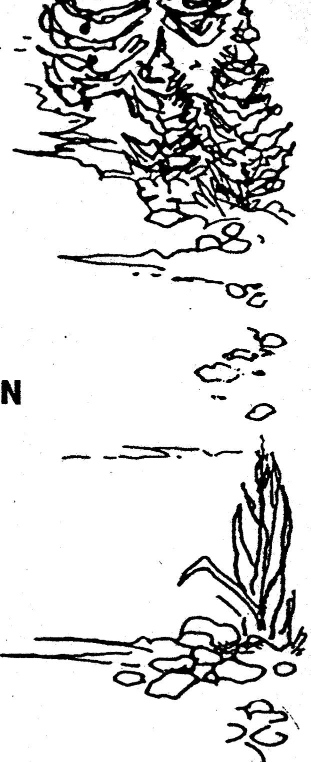

The Borough of
West Long Branch, New Jersey

And The New Jersey
Department of Environmental Protection

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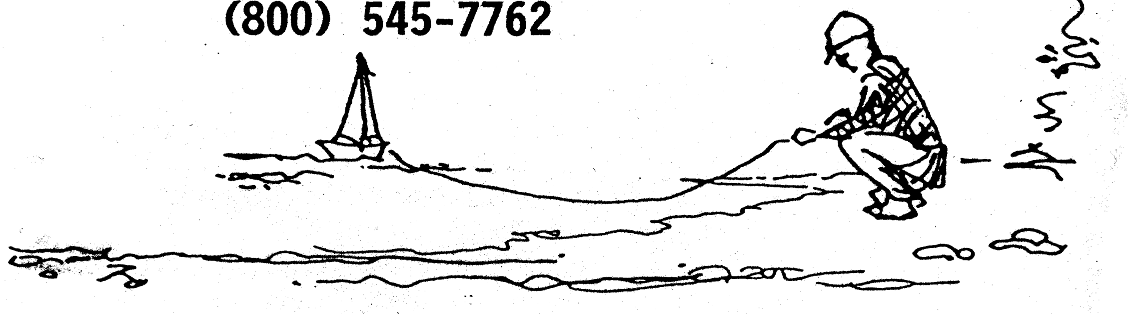

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FXB Project 1113-01

Prepared for:
Borough of West Long Branch
West Long Branch, New Jersey

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LIST OF ABBREVIATIONS

BMP's	Best Management Practices
U.S. EPA	United States Environmental Protection Agency
NJDEP	New Jersey Department of Environmental Protection
ft^2/day	Square feet per day
DRP	Dissolved Reactive Phosphorus
DOP	Dissolved Orthophosphorus
TKN	Total Kjeldahl Nitrogen
NH_3-N	Ammonia nitrogen
NO_3-N	Nitrate Nitrogen
NO_2-N	Nitrite Nitrogen
FC	Fecal Coliform Bacteria
FS	Fecal Streptococcus Bacteria
mg/L	Milligrams per liter
$CaCO_3$	Calcium Carbonate
TIN	Total Inorganic Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSI	Trophic Status Index
ug/L	Micrograms per liter
mg/kg	Milligrams per kilogram
TSS	Total suspended solids
Alk.	Alkalinity
UAL	Unit areal loading
kg/ha	Kilograms per hectare
U.S.D.A.	United States Department of Agriculture

LIST OF ABBREVIATIONS (CONTINUED)

SCS	Soil Conservation Service
cfs	cubic feet per second

1.0 Executive Summary

1.1 Conclusions

1. Franklin Lake is highly eutrophic. Severe algal blooms and excessive siltation have impaired the recreational uses of the lake and surrounding park.

2. Concentrations of the nutrients nitrogen and phosphorus are high in Franklin Lake. Algal growth appeared to be limited by phosphorus and nitrogen concentrations at different times during the growing season, but concentrations of both total nitrogen and total phosphorus were always present at levels far in excess of those required to support large phytoplankton populations. The recommended plan will concentrate on phosphorus removal because that nutrient is easier to control.

3. No significant thermal stratification or oxygen depletion was observed in Franklin Lake. The lake waters appeared to be well-mixed throughout the year.

4. Algal biomass, as indicated by chlorophyll a concentrations, is high in Franklin Lake.

5. The phytoplankton assemblage was dominated by the blue-green algae, Aphanizomenon and Coelosphaerium, and the green alga, Spirogyra.

6. Macrophyte growth in Franklin Lake was limited to a shoreline assemblage.

7. Levels of heavy metals and pesticides/PCB's in the lake sediments were low. No pesticides or PCB's were recovered by the EP Toxicity Test. Heavy metal concentrations were well below the Mean Contaminant Levels for the EP Toxicity.

8. Runoff from the watershed contributes approximately 63.1 percent of the total phosphorus, 75.3 percent of the total nitrogen, and 99.6 percent of the total suspended solids loads to Franklin Lake. Waterfowl contribute an estimated 35.5 percent of the total phosphorus and 20.8 percent of the total nitrogen loads to Franklin Lake. Precipitation on the lake surface contributes about 1.4 percent of the total phosphorus, 3.9 percent of the total nitrogen, and 0.4 percent of the total suspended solids.

9. Erosion was noted in some areas of the Franklin Lake watershed, including a parking area near the Dennis Brook inlet.

10. The mean depth of Franklin Lake has decreased to only 1.4 feet as a result of sedimentation and lowering the water level of the lake. Much of the sedimentation appears to have been caused by slumping of banks associated with the drop in water level and past management practices.

1.2 Recommendations

1. A multi-faceted management plan, incorporating both in-lake and watershed management practices, is necessary to expand the recreational usage of Franklin Lake and to control pollutant sources.

2. Dredging was evaluated as a lake management option because the mean depth of Franklin Lake is only 1.4 feet. Dredging would enhance recreational activities by deepening the lake. Either mechanical or hydraulic dredging could be implemented at Franklin Lake.

3. Steps should be taken to stabilize the eroding banks along the shore of Franklin Lake. Although the total pollutant loads from this source are not expected to be large in comparison to other sources, their impact on Franklin Lake is immediate. Cast-in-place concrete walls are recommended to stabilize a large section of the shoreline of Franklin Lake. Vegetation, such as crown vetch, is recommended to stabilize the banks near the Shore Regional High School.

4. Existing wet areas above Franklin Lake should be enhanced through the creation of artificial wetlands. These created wetlands will help trap both sediments and nutrients before they reach the lake.

5. Agricultural best management practices, such as the use of filter strips, should be implemented to minimize phosphorus and sediment loss if the existing farm in the Franklin Lake watershed is actively farmed again. The Monmouth County Conservation Service should be consulted to coordinate all conservation practices. This farm is also the only piece of land in the Borough of West Long Branch that could be developed. West Long Branch should ensure that the property is not used for industrial, commercial or high-density residential purposes if this area is re-zoned.

6. Storm sewer catch basins throughout the Franklin Lake watershed should be cleaned out on a regular basis. Sediment accumulates in these basins and should be removed to assure the continuing efficiency of these structures. If necessary, West Long Branch should allocate additional funds to their maintenance budget for this purpose.

7. The existing parking area near the Dennis Brook inlet should be modified to alleviate the existing gully erosion problem. The existing asphalt in this area should be removed and the area should be graded and seeded. New curbing should be installed to connect East Lakeview Avenue and Franklin Parkway and a storm sewer should be installed to drain this area.

8. Residents of West Long Branch should use proper erosion and sediment control measures when making improvements to their property.

9. The detention basin at Peter Cooper Village should be routinely maintained and a new outlet structure should be installed to ensure the continued efficiency of this basin.

10. The Borough of West Long Branch should install signs asking residents not to feed the ducks at Franklin Lake because of their impact on the nutrient budgets for the lake. The public should be made aware of the detrimental effects of waterfowl on the water quality of Franklin Lake. If necessary, The Borough of West Long Branch should consider the adoption of an ordinance to prohibit the feeding of ducks and geese in the park.

11. The Borough of West Long Branch should actively enforce the "pooper scooper" ordinance. A sign should be erected in the park to inform the public that the ordinance will be enforced. Increased enforcement would reduce nutrient loads and improve the aesthetics of Franklin Lake Park.

12. The Borough of West Long Branch should develop a "homeowner practices" flyer and distribute it to the residents of West Long Branch. A public workshop to discuss practices should be scheduled.

13. Additional trash cans should be provided around Franklin Lake to encourage visitors not to throw trash into Franklin Lake. This will require the cooperation of the West Long Branch Public Works Department. "Clean Up" Franklin Lake Days should be continued at least once per year to pick up trash that will inevitably accumulate in and around the lake.

14. Aeration holds some promise as an in-lake control measure; however, results from other lakes where this method has been used have been mixed. Aeration should be considered for Franklin Lake only after dredging is completed. If dredging does not reduce phytoplankton growth, aeration should be re-evaluated as a restoration method.

1.3 Phase II Restoration Costs

The recommended management plan for Franklin Lake includes a combination of in-lake restoration techniques and watershed management practices. Restoration costs, based on 1989 dollars, are summarized in Table 1.

Table 1

Phase II Restoration Costs for Franklin Lake

Restoration Activity	Cost
Dredging	$355,000
Shoreline Stabilization	$418,600
Created Wetlands	$40,000
Agricultural BMP's - Filter Strips	$1,000
Erosion and Sediment Control	$19,200
Homeowner Practices	$2,500
Water Quality Monitoring	$10,000
Documentation	$10,000
Total Estimated Phase II Costs	**$856,300**

In addition to the costs listed in Table 1, additional funds will be required from The Borough of West Long Branch. Estimated annual costs are $1,500 for road and storm sewer maintenance and $1,000 for park management practices.

Possible funding sources for the Phase II Restoration Program include the U.S. EPA Clean Lakes Program and the New Jersey Lakes Management Program. The EPA Clean Lakes Program provides 50 percent matching funds for restoration programs and the New Jersey Lakes Management Program will pay up to 40 percent of Phase II costs if the project is a also funded by the EPA. The local share of EPA funded projects is 10 percent. If EPA funding is not available, the New Jersey program will contribute 75 percent of a Phase II restoration project the local match is 25 percent.

2.0 Project Description

2.1 Objectives

This Phase I Diagnostic Feasibility Study of Franklin Lake was conducted under the New Jersey Clean Lakes Program. A diagnostic-feasibility study is typically conducted in two stages. The diagnostic portion of the study is conducted to determine the lake's water quality condition, to identify existing problems, and to determine the pollutant sources that are causing the problem. The feasibility part of the study involves the development of alternative restoration programs based on the results of the diagnostic study. These alternatives can include watershed management practices and in-lake restoration methods.

The Franklin lake Phase I Diagnostic-Feasibility Study was designed to meet all EPA and NJDEP Phase I study criteria. The primary objectives of the Franklin Lake Project were:

1. To determine the trophic (ecological) state of Franklin Lake,

2. To identify the sources of pollutants entering Franklin Lake,

3. To evaluate potentially feasible control alternatives,

4. To develop and recommend a lake and watershed management program that is cost-effective, environmentally sound, and acceptable to the public, and

5. To develop preliminary design information for the recommended management program.

6. To review existing ordinances to determine their adequacy for the protection of Franklin Lake.

2.2 Project Background

Franklin Lake is located in the Borough of West Long Branch, Monmouth County, New Jersey. The approximate coordinates of the lake are 74°01'25" west longitude and 40°17'50" north latitude.

Problems associated with Franklin Lake began to surface in the early 1970's when the Mosquito Commission drained Franklin Lake in order to control the mosquito population. Then, in 1982, reports of summertime foul odors emanating from the lake began to appear in local newspapers. In 1983, the odor problem was investigated by the Monmouth County Regional Health Commission

No. 1 and was attributed to eutrophic lake conditions, namely a high nutrient content and blooms of algae, resulting in release of hydrogen sulfide from anaerobic lake sediments. Further studies by the New Jersey Department of Environmental Protection, the Freehold Soil Conservation District, and Monmouth College substantiated the Health Commission's conclusions. All of these studies suggested that nutrient sources might include waterfowl, dogs, and street runoff. According to available historical accounts, the average depth of Franklin Lake was 6 to 7 feet in the early 1900's. The mean depth is now 1.4 feet.

In 1984, the West Long Branch Environmental Commission began a coordinated effort designed to collect pertinent information, to contact governmental agencies, and to involve local community groups and the public in reaching a consensus regarding a plan of action for the restoration of Franklin Lake. With encouragement from the Environmental Commission and the NJDEP Clean Lakes Program Division, the citizens of West Long Branch agreed to support a Phase I Diagnostic-Feasibility Study of Franklin Lake and base decisions concerning lake treatment on the conclusions and recommendations of this study.

2.3 Project Funding

The total project cost for the Phase I Franklin Lake Restoration Study was $93,600. Fifty percent of the funding was provided by the New Jersey Department of Environmental Protection, and the other fifty percent was provided the Borough of West Long Branch and Monmouth County as shown in Table 2. Freeholder Larrison went to the Monmouth County Health Lab and encouraged them to participate in the Franklin Lake Study by performing the required chemical analyses.

Table 2

Project Funding Summary

	Cash	**In-Kind**	**Total**
NJDEP	$46,800	-	$46,800
Borough of West Long Branch and Monmouth County	$28,300	$18,500	$46,800
Total	**$75,100**	**$18,500**	**$93,600**

3.0 Lake and Watershed Characteristics

3.1 Lake Morphology

Franklin Lake is a very shallow lake with a mean depth of 1.4 feet. The lake has a relatively low ratio of watershed area to lake surface area. The physical characteristics of Franklin Lake are presented in Table 3. Two tributaries enter Franklin Lake. Dennis Brook enters Franklin Lake from the south and an unnamed tributary enters Franklin Lake from the northeast.

Table 3

Physical Characteristics of Franklin Lake

Surface Area	15.5 acres
Watershed Area	523.5 acres
Watershed to Lake Surface Area Ratio	34:1
Lake Volume	918,115 ft^3
Mean Depth	1.4 ft
Maximum Depth	2.9 ft
Mean Discharge	1.2 cfs
Mean Hydraulic Residence Time	9 days

3.2 Bathymetric Survey

A detailed bathymetric survey of Franklin Lake was performed on April 8, 9, and 10, 1987. The bathymetric survey was conducted to determine the volume of the lake and the quantity of unconsolidated sediments on the lake bottom. The survey was conducted with assistance from Boy Scout Troop #45 of West Long Branch, New Jersey and from members of the West Long Branch Environmental Commission. The boy scouts were instructed on the purpose and methodology of the bathymetric survey. As a result of the bathymetric survey, the boy scouts are presently completing a merit badge for surveying.

Approximately 200 measurements of the bottom of Franklin Lake were taken. Based on the information obtained during the bathymetric survey a bathymetric, or bottom contour, map of the lake was prepared. A copy of this map is included in Appendix A. Cross sections of the lake were prepared showing the existing bottom of the lake and the depth of unconsolidated sediment in the lake. This information was used to calculate the volume of unconsolidated sediment in the lake. Approximately 21,400 cubic yards of unconsolidated sediment are in the lake.

3.3 Watershed Characteristics

The drainage basin for Franklin Lake has an area of 523.5 acres and lies entirely within the Atlantic Coastal Plain physiographic province. The boundaries of the Franklin Lake watershed and the locations of major tributaries are shown in Figure 1.

3.3.1 Topography and Soils

The topography of the Franklin Lake watershed is one of a gently undulating plain with low relief. The maximum elevation is approximately 60 feet mean sea level and ranges down to about 15 feet mean sea level at the lake surface.

The predominant soil types in the Franklin Lake watershed are Downer sandy loam, Evesboro sand, and Freehold sandy loam soils. These soils are in an Urban land complex with 0 to 10 percent slopes. Typical characteristics for all three of these soils series have been extensively modified by urban development, which has significantly increased the amount of impervious surfaces in the area. The Downer and Freehold soils are deep, well-drained soils and the Evesboro soils are deep, excessively-drained soils. All three soils are found on uplands and were formed in acid coastal plain sediments. These soils are all susceptible to wind erosion.

Fallsington loam soils are found along the stream entering the lake from the south and along the southern edge of the watershed. Kjel sandy loam-Urban land complex with 0 to 3 percent slopes, Downer loamy sand with 0 to 10 percent slopes, and Shrewsbury sandy loam are minor soil types in the area. The Fallsington soils are deep, poorly-drained soils found on upland flats and in depressions. Fallsington soils were formed from marine and alluvial sediments. Kjel soils are deep, moderately well- and somewhat poorly-drained soils found on uplands, and Shrewsbury soils are deep, poorly drained soils found in low positions. Both were formed in coastal plain sediments. Downer soils are deep, well-drained soils formed in acid, moderately coarse-textured coastal plain sediments on uplands. The Fallsington loam, Kjel sandy loam, and Shrewsbury sandy loam soils all tend to be wet, and the Fallsington soils are also easily eroded.

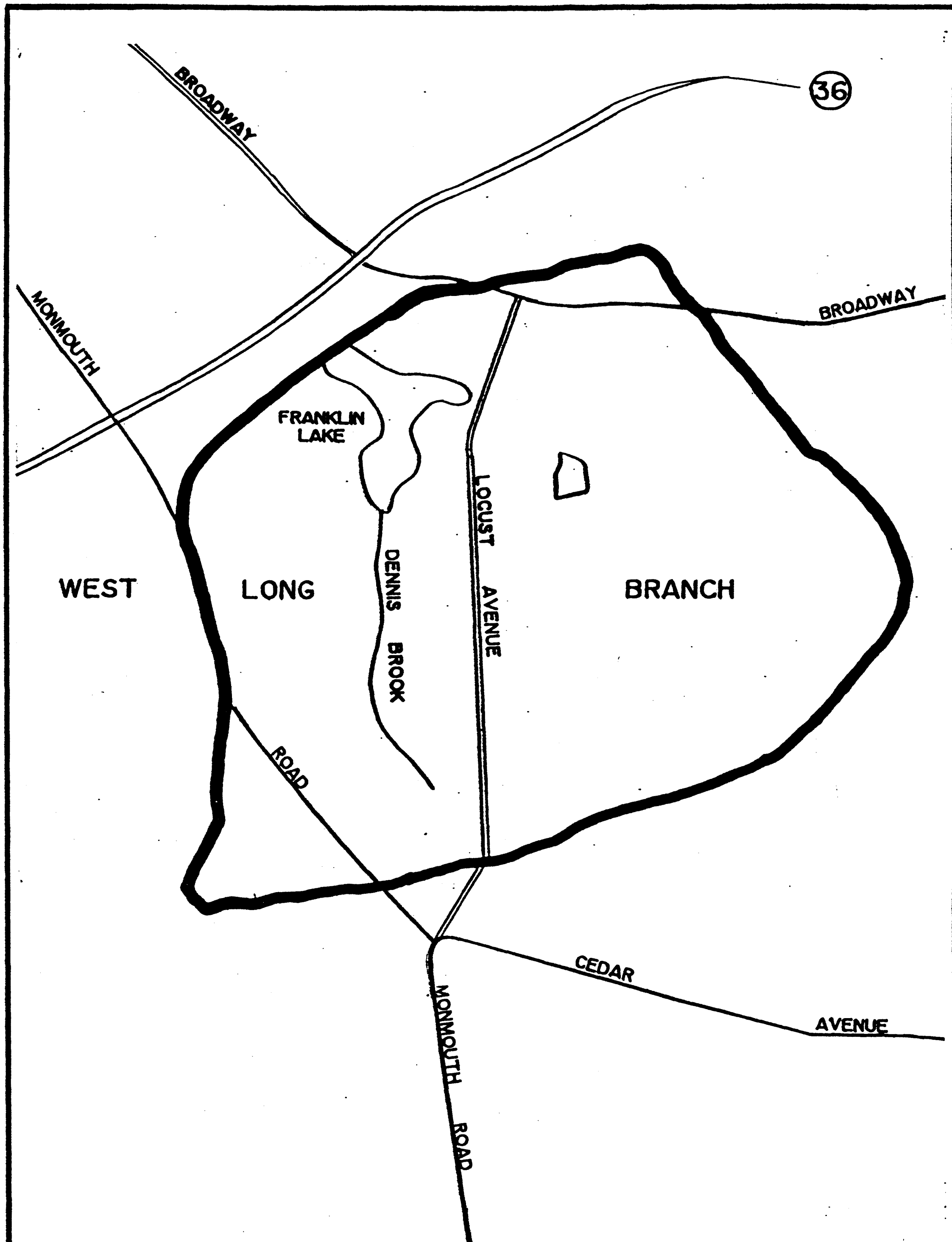


Figure 1	Franklin Lake Watershed

3.3.2 Groundwater

The Englishtown Formation, lying at a depth of almost 300 feet in the West Long Branch area, is a major source of groundwater for public supplies in both Monmouth and northern Ocean Counties. The Englishtown aquifer is approximately 120 feet thick near West Long Branch and has a transmissivity of about 1400 ft^2/day. Water levels in the aquifer declined about 40 feet between 1900 and 1959, and pumping rates increased about 80 percent between 1959 and 1970 (Nichols, 1977).

Fine-grained sediments of the Marshalltown and Wenonah Formations act as the upper confining bed for the Englishtown Formation and are about 40 feet thick near Franklin Lake. The lower confining layer is composed of the Merchantville Formation and Woodbury Clay, with a combined thickness in this area of about 140 feet. The Raritan and Magothy Formations, which lie below the Woodbury Clay and Merchantville Formation, are a source of groundwater for much of New Jersey. This aquifer would appear to have some potential for supplying groundwater to Monmouth County if depletion of the Englishtown Formation becomes a problem.

3.3.3 Geology

Monmouth County is part of the Atlantic Coastal Plain physiographic province and is underlain by Cretaceous and Tertiary age unconsolidated sediments. The coastal plain sediments, ranging in thickness from 500 feet in the northwestern part of the county to 1200 feet in southeastern Monmouth County, are of both marine and continental origin and are composed mainly of sands, silts, clays and greensands or glauconitic sands with interspaced gravel beds (Monmouth County Environmental Council, 1975). A thin layer of quaternary age sand, clay, and gravel deposits overlies the older sediments.

Most of the Franklin Lake watershed lies over Tertiary age sedimentary rocks of the Vincentown Sand formation. These deposits are comprised of glauconitic quartz sand alternating with mostly consolidated beds of lime sand. The land immediately surrounding the lake lies on Hornerstown Marl. These deposits are Tertiary age sedimentary rocks of dark green glauconitic marl with varying amounts of quartz, fine earth, and clay. A marked shell bed lies at the top of this formation (Wedmer, 1972).

3.4 Population

Franklin Lake is used primarily by residents of the Borough of West Long Branch and nearby communities in Monmouth County, New Jersey. U.S. Census population data for 1980, 1987 population estimates and future population projections for West Long Branch and Monmouth County (Monmouth County Department of Economic Development, 1988) are given in Table 4.

Table 4

Population Data for West Long Branch Borough and Monmouth County, New Jersey

Year	1980	1987	1995
West Long Branch	7,380	8,057	8,381
Monmouth County	503,173	568,148	661,252

There are 2,608 individuals per square mile (4.08 persons/acre) in West Long Branch, which is more than double that for Monmouth County as a whole (1,067 individuals/square mile or 1.67 persons/acre).

There was a 9 percent population increase in West Long Branch between 1980 and 1987 and a 4 percent increase expected between 1987 and 1995. The Monmouth County Planning Commission estimates that between 1987 and 1995, the population in West Long Branch will only increase by an additional 4 percent. This indicates that West Long Branch is reaching saturation in terms of its population.

3.5 Socio-Economic Structure

Figure 2 presents the age distribution of the inhabitants of West Long Branch and Monmouth County, New Jersey. The median age is 32 in both West Long Branch and Monmouth County.

The distribution of citizens, by race, in 1980 in West Long Branch Borough was 98.1 percent white, 0.9 percent black, and 1.0 percent other minorities. The figures for Monmouth County were 89.3 percent white, 8.5 percent black, and 2.2 percent other minorities. Per capita incomes in 1985 were $14,331 for West Long Branch and $14,364 for Monmouth County (Monmouth County Department of Economic Development, 1988).

Occupational data for Monmouth County is graphically presented in Figure 3. Data from the 1980 census indicate Monmouth County has a broad employment base with significant numbers of workers in every category except agriculture.

3.6 History

Before 1700, the Lenni-Lenape Indians often traveled through the area now occupied by Franklin Lake on a trail connecting the

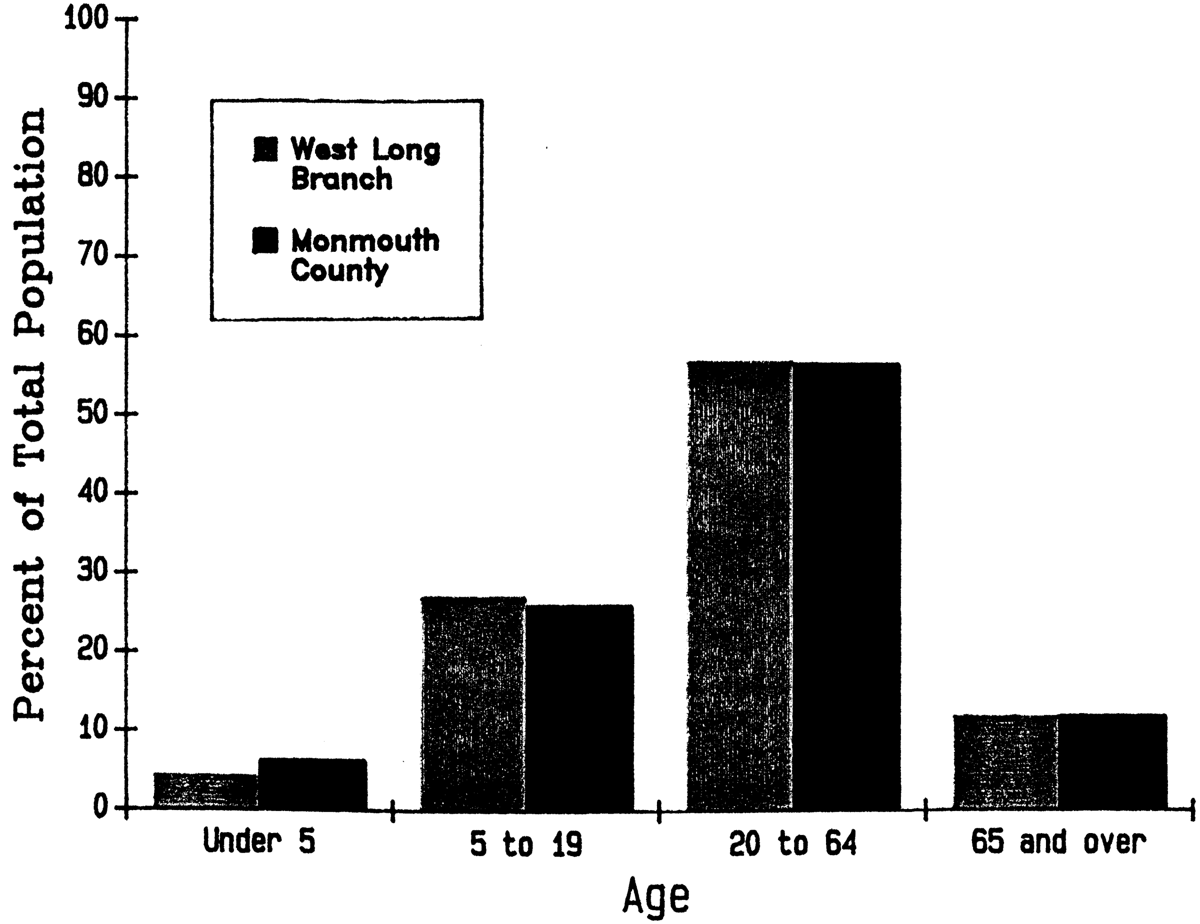


Figure 2	Age Distribution of the Residents of West Long Branch and Monmouth County in 1980

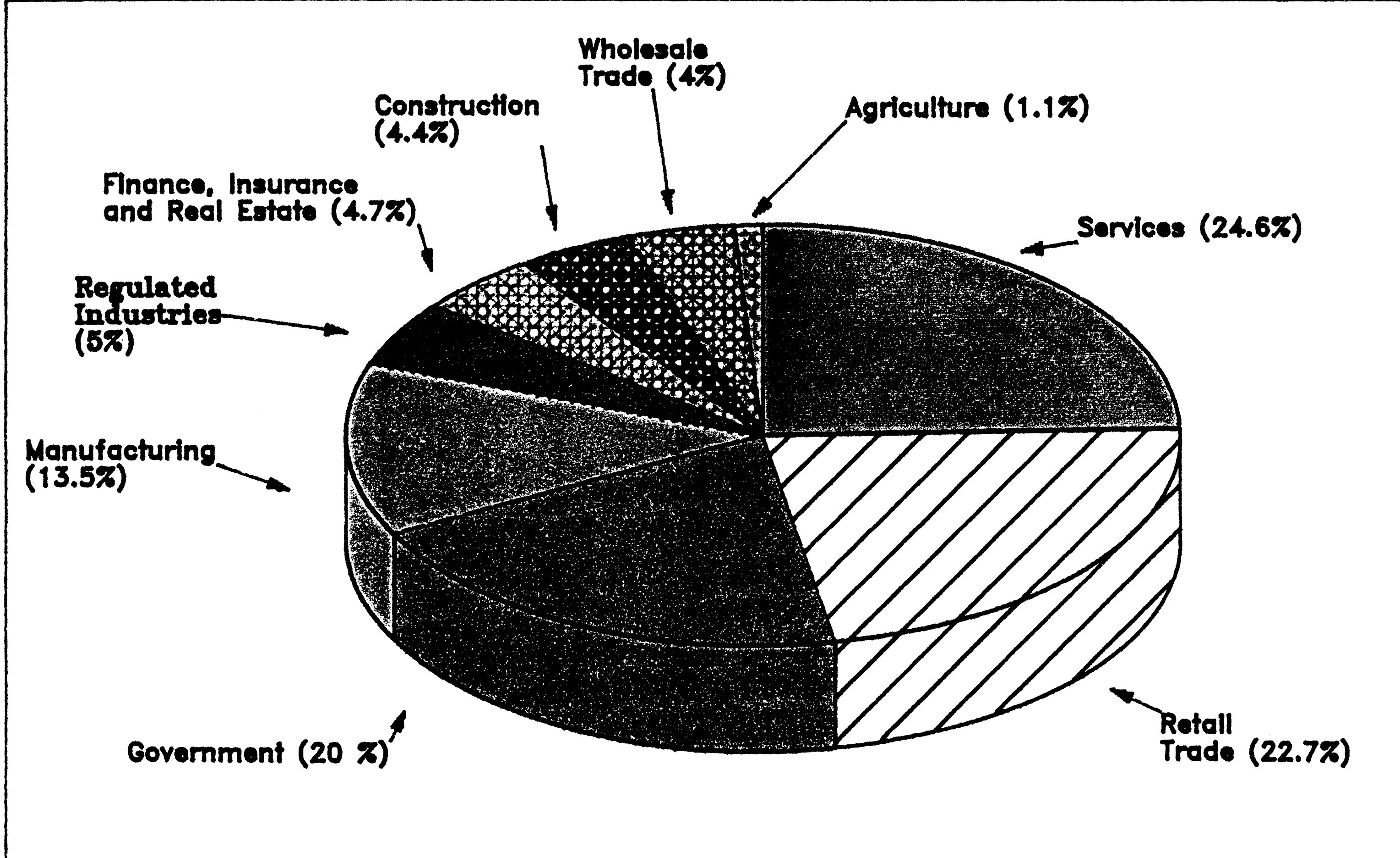


Figure 3	Employed Persons by Occupation in Monmouth County, 1980

ocean and their principal home areas in the Delaware Valley. The land was then swampland fed by springs and small streams.

During the 1700's and 1800's, much of the land in the West Long Branch area was farmed. In the mid-1800's, the Dennis family constructed a wooden dam across Mill Creek in order to create a lake which would supply clean drinking water for their farm animals. A local personage, Garret A. Hobart, was born near the site of the lake in 1844. He served as Vice President of the United States during President McKinley's Administration. In the early 1900's, a concrete dam was built to replace the wooden one and Dennis Pond became a centerpiece of the farm. Frank Dennis ran an ice supply business in the early 1900's which was the principal source of ice for Jersey Shore residents. Ice was cut from the lake and stored under sawdust in an ice house located along the lake shore. The outline of the ice house foundation can still be seen in Franklin Lake Park. Frank Dennis was also known as the watercress king for the watercress he grew at the lake.

Franklin was the first name of many Dennis family members. Dennis Pond became known as Franklin's lake, later shortened to Franklin Lake. When the Dennis farm was subdivided and sold, the Borough of West Long Branch acquired Franklin Lake and the surrounding park area.

3.7 Land Use

Land use in the Franklin Lake watershed is primarily residential. Large expanses of grass with scattered trees are found in parks, cemeteries and school athletic fields. There is a small farm in the south west section of the watershed. Scattered stores and gas stations comprise the commercial sector. Land use as a percentage of watershed land area is presented in Table 5.

3.8 Lake Uses

Franklin Lake Park is primarily used for recreational purposes including jogging, walking, and relaxing. Some fishing also occurs in the lake. Park benches and the gazebo provide citizens with comfortable resting locations. The gazebo is a popular and picturesque spot for wedding ceremonies. Many people visit Franklin Lake Park on the Fourth of July to watch fireworks displays that are presented by the Borough of West Long Branch each year. The park also receives many visitors when concerts are held in the park.

Presently, lake uses include fishing, ice skating and boating in small boats without motors. Since the average lake depth is only 1.4 feet, these recreational activities are limited. Motor boating and swimming are not permitted at Franklin Lake.

Table 5

Existing Land Use in Franklin Lake Watershed

Land Use	Watershed Land Area	
	Hectares*	Percent
Urban-Residential	157	74.0
Parks, Cemeteries, Athletic Fields	39	18.8
Agriculture	9	4.3
Water	6	2.9

* 1 hectare = 2.47 acres

4.0 Lake and Stream Water Quality

4.1 Monitoring Program

Samples for lake water quality analyses were collected from three locations in Franklin Lake as shown in Figure 4. Samples for all stations were collected from May, 1987 through May, 1988. The monitoring frequency was twice per month from May through July and once per month for the remainder of the monitoring period.

Lake samples were analyzed at each station on each sampling date. Temperature and dissolved oxygen were measured at the surface and bottom of the lake. Since Franklin Lake is very shallow, water quality samples were collected at one depth and analyzed for the following parameters:

- Total Phosphorus
- Soluble Orthophosphorus
- Total Kjeldahl Nitrogen
- Nitrate/Nitrite
- Ammonia
- Total Suspended Solids
- Alkalinity
- pH
- Chlorophyll a
- Pheophytin a
- Phytoplankton (to genera)
- Fecal Coliform
- Fecal Streptococcus

The following parameters were also measured in the field during each lake survey:

- Air Temperature
- Weather Conditions
- Transparency (Secchi Disk)
- Water Temperature
- Dissolved Oxygen

A boat was provided by Perry Neuhaus, a local West Long Branch citizen, to collect lake samples during each lake survey. Water samples were collected by F. X. Browne Associates, and delivered for laboratory analysis to the Monmouth County Department of Health in Freehold, New Jersey.

Inlet stream samples were also collected during the May 1987 through May 1988 monitoring period (Figure 4). Monthly samples were collected in the two tributaries of Franklin Lake and analyzed for total phosphorus, total Kjeldahl nitrogen, total suspended solids, pH and alkalinity. These samples were collected on the same day as the lake samples were collected. The samples also were taken to the Monmouth County Department of Health laboratory for analysis.

During the 1987-1988 sampling season, six wet weather stream samples were collected at both stream inlets and the outlet to

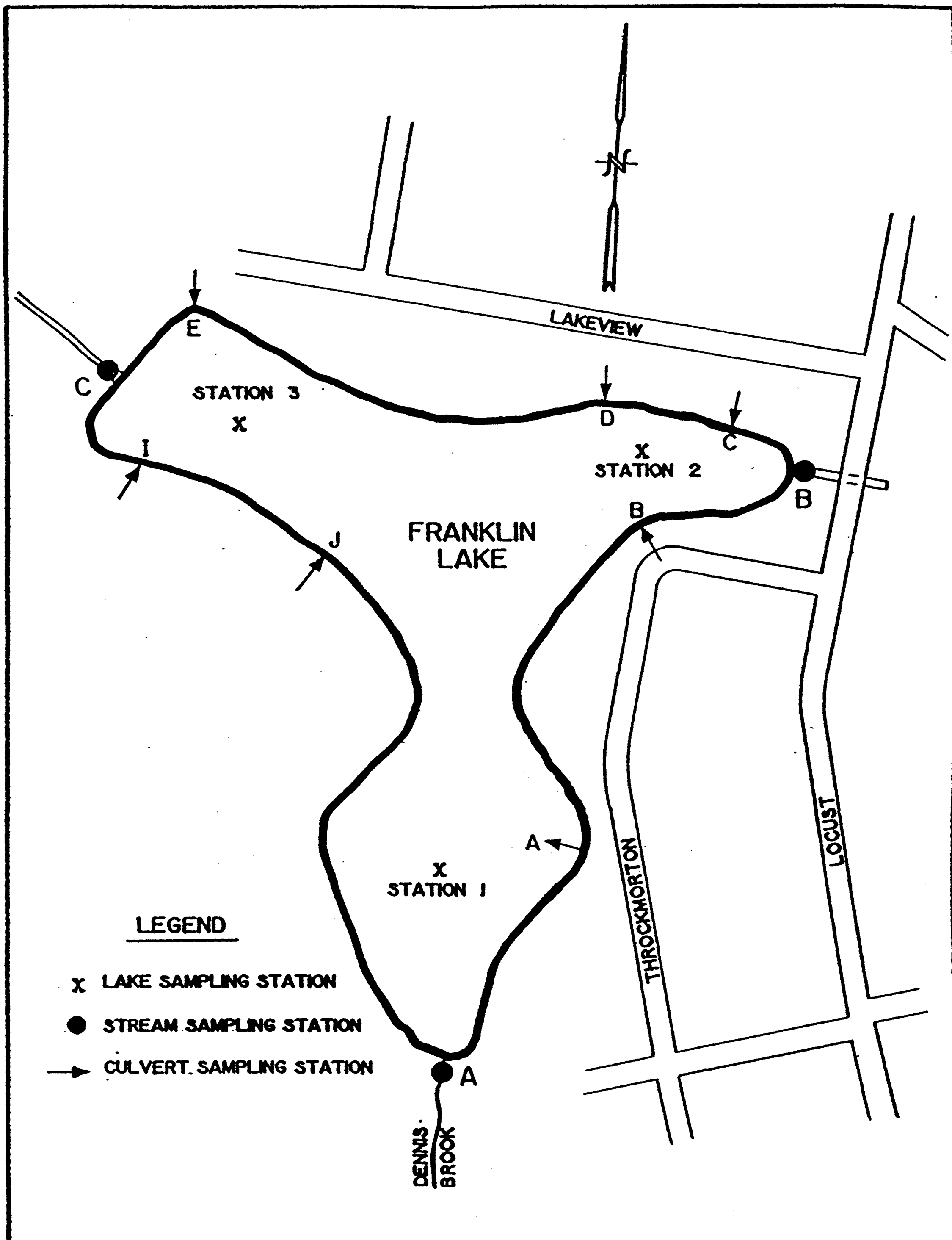


Figure 4	Lake and Stream Sampling Locations

obtain information on the pollutant loading to Franklin Lake during storm events. Samples were collected at several culverts to estimate the loading from the street runoff. Fred Martinson, a volunteer and resident of West Long Branch, collected samples during the six rain events. The samples were flow composited and taken to the Monmouth County Health Laboratory by the Monmouth County Regional Health Commission #1 for analysis. During one rain event, Fred Martinson collected rainwater samples in buckets in his backyard. These samples were analyzed for total phosphorus, total Kjeldahl nitrogen, and total suspended solids to estimate the quantities of these parameters in the rain around Franklin Lake.

4.2 Chemical and Biological Interactions

Water quality is determined by a complex system of chemical, physical and biological interactions. Lake water quality is dependent upon land use in the upstream drainage basin. Nutrients (nitrogen and phosphorus) and suspended solids enter Franklin Lake from upstream tributaries and from storm sewers that collect runoff from the urban areas adjacent to the lake. As water enters the lake its velocity decreases, resulting in sedimentation of suspended solids. A portion of the phosphorus entering the lake is bound to sediment particles (referred to as particulate phosphorus), and this portion gradually settles. Very small sediment particles, such as clays, resist sedimentation and may pass through the lake without settling.

Algae (phytoplankton) and attached plants adsorb available nutrients and convert them into plant material. The most readily-available form of phosphorus is dissolved orthophosphate, analytically determined as dissolved reactive phosphorus (DRP), which can also include hydrolyzable particulate and organic phosphorus. The inorganic forms of nitrogen, ammonia (NH_3-N) and nitrate (NO_3-N), are the forms most available to support the growth of aquatic life. Aquatic plants, or macrophytes, and algae can also affect concentrations of other chemical species in water. For example, the photosynthetic process results in increased concentrations of dissolved oxygen and pH as carbon dioxide, a weak acid, is removed from the water and oxygen is produced.

Interactions among biological communities greatly affect levels and cycling of nutrients, such as phosphorus, nitrogen and carbon in lakes. Energy from the sun is captured and converted to chemical energy via photosynthesis in aquatic plants, which forms the base of the food web as shown in Figure 5. Energy and nutrients, now tied up in organic molecules, travel through the different levels of the food web. Small aquatic animals (zooplankton and invertebrates) graze upon algae and plants. Larger invertebrates and fish then consume the grazers.

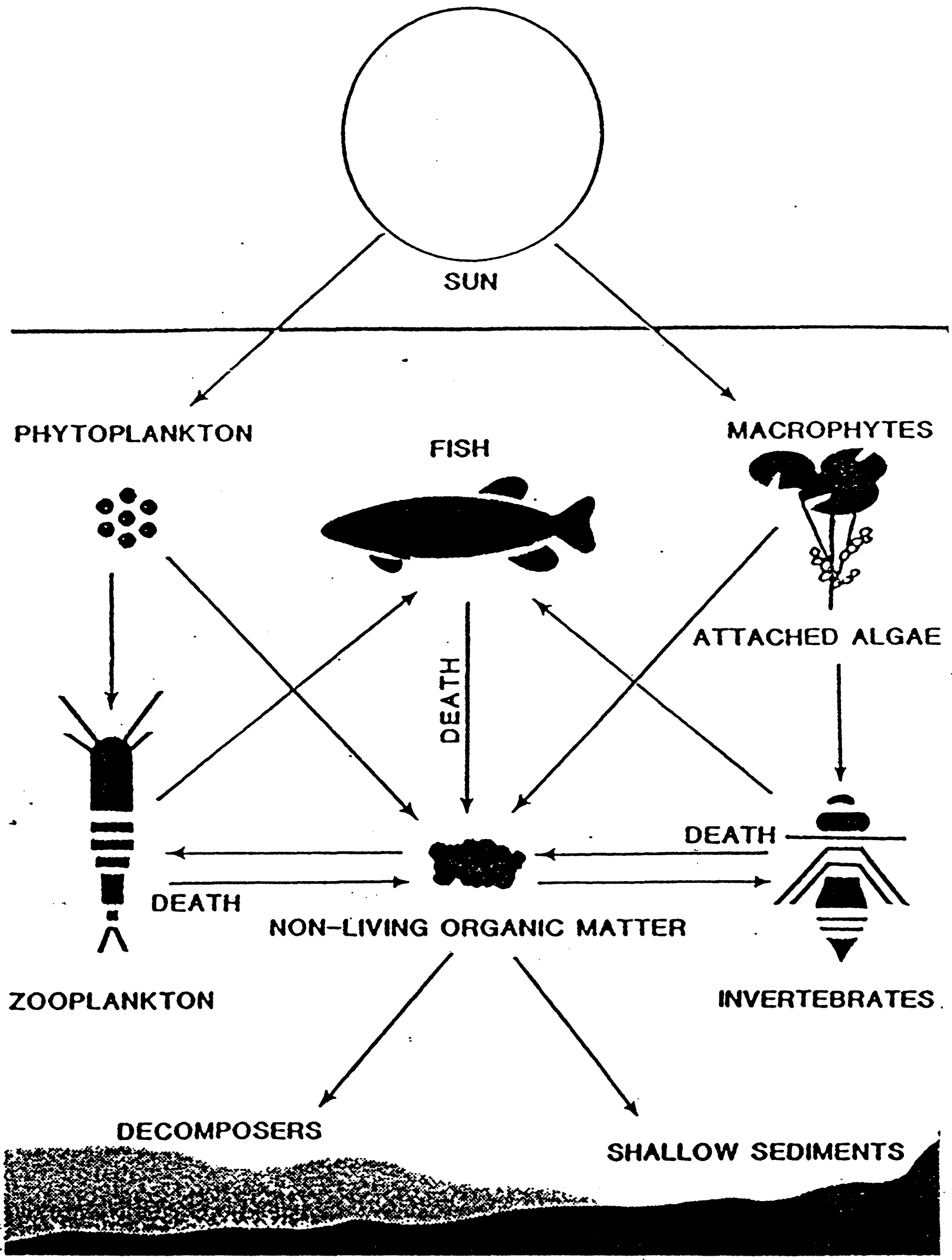


Figure 5	Food web

Energy at upper levels of the food web is derived from the breakdown of organic molecules in the process known as respiration. Respiration and decomposition processes consume oxygen in the water column and in lake sediments. The larger organic waste products of the food web organisms, together with their remains after death, comprise detritus, which settles to the bottom of the lake, becoming part of the sediment. Bacteria and fungi (decomposers) utilize the energy in this material, converting organic molecules to inorganic nutrients which are then available for use by plants and algae. Unused organic material accumulates in the sediments.

The size of algal and plant populations, and chlorophyll a concentrations in water, are primary biological indicators of lake trophic conditions. Chlorophyll a is a green pigment contained by all green plants which converts sunlight to chemical energy.

Identification of species within producer and consumer food web levels is also important in understanding dynamics causing lake conditions. Eutrophic lakes often support unbalanced communities characterized by large numbers of relatively few species. Energy can become blocked in lower levels of the food web instead of flowing smoothly through it, because many of the algae and aquatic plants found in highly eutrophic lakes are also the ones least favored by grazers.

A glossary of lake and watershed terms is provided in Appendix B.

4.3 Franklin Lake Water Quality Data

Existing water quality in a lake is determined by numerous chemical, physical, and biological factors. The amount of nutrients and sediments delivered to a lake via its tributaries is a major factor affecting water quality. Variations in ambient temperature and sunlight are also important factors. Physical, chemical, and biological characteristics of Franklin Lake are discussed in the following sections. Complete results of the lake water quality analyses are presented in Appendix C.

4.3.1 Dissolved Oxygen and Temperature

Dissolved oxygen and temperature were measured at the three lake stations during each lake survey. Because of the extreme shallowness of Franklin Lake, measurements taken at the lake surface and bottom were sufficient to establish profiles. No thermal stratification of the water column was observed during the one year monitoring period. Surface mixing and photosynthetic activity apparently keep both the dissolved oxygen and temperature values constant throughout the lake.

The average temperature of Franklin Lake during June, July and August was 24 degrees Celsius. The dissolved oxygen concentration in Franklin Lake ranged from a low of 3.5 milligrams per liter (mg/L) at Station #1 on July 30, 1987 to a high of 18.2 mg/L at Station #2 on June 17, 1987. Generally the dissolved oxygen concentrations in Franklin Lake were above saturation values (more than water would normally contain under ambient temperature and pressure) indicating that significant oxygen was being produced by photosynthetic activity in the lake. A dissolved oxygen level of 5.0 mg/L or above is desirable.

During the summer of 1988 some fish kills were reported. This could be due to thermal stress or low oxygen. Dissolved oxygen and temperature data are presented in Tables D.1, D.2, and D.3 of Appendix D.

4.3.2 pH and Alkalinity

Alkalinity and pH are interrelated. pH is a term used to express the intensity of the acids or bases in the water in terms of hydrogen ion concentration. It is important because most chemical and biological reactions are controlled or affected by pH. The alkalinity of water is a measure of the buffering capacity, or the capacity of the water to neutralize acids. Alkalinity of neutral waters is due primarily to salts of weak acids such as bicarbonates, carbonates, borates, silicates and phosphates. Although many materials contribute to the alkalinity of water, most of the alkalinity in natural waters is caused by hydroxides, carbonates and bicarbonates. The bicarbonates represent the major form of alkalinity because they are formed by the action of carbon dioxide with basic materials in soil.

In lake ecosystems, interactions between hydrogen ions and buffering ions occur when phytoplankton use carbon dioxide in their photosynthetic activity. As carbon dioxide is removed by algae, the pH of the water increased, transforming both carbonate and bicarbonate forms of alkalinity into carbon dioxide, which the algae use for further growth. Thus, carbonate acts as a food source for the algae by supplying carbon dioxide as a carbon source for algae growth.

Alkalinity values in Franklin Lake ranged from 44 to 76 mg/L as $CaCO_3$. The average alkalinity in Franklin Lake during the monitoring period was 56 mg/L. This level provides the lake with a moderate buffering capacity which protects the lake against fluctuations in pH such as those caused by algae. The relatively high alkalinity in Franklin Lake is due to underlying lime sand deposits and a shell bed. The shell bed is composed of calcium carbonate which adds to the alkalinity of the water.

The average pH in Franklin Lake was 7.9 standard units. The pH ranged from 6.81 units to 8.88 units. According to the U.S. EPA

"Red Book" (1976), a pH of less than 6.5 units may be harmful to many species of fish. All pH values measured were above the New Jersey standard of 6.5 units, indicating low pH is not a problem in Franklin Lake.

4.3.3 Total Suspended Solids

Total suspended solids is a measure of the amount of particulate matter in the water column. Suspended solids are comprised of both organic matter, such as algae, and inorganic material, including soil particles and clay minerals. The water in Franklin Lake appears to contain turbidity from both organic and inorganic sources.

The suspended solids concentration in Franklin Lake appeared to be affected by both runoff and the internal generation of particulate material. The average suspended solids concentration in Franklin Lake during the 1987-1988 monitoring period was 26 mg/L. Figure 6 graphically presents the total suspended solids concentrations at the three sampling stations.

4.3.4 Transparency

The transparency, or clarity, of water is most often reported in lakes as the Secchi depth. This measurement is taken by lowering a circular white or black-and-white disk, 20 centimeters in diameter, into the water until it is no longer visible. Observed Secchi depths range from a few centimeters in very turbid lakes to over 40 meters in the clearest known lakes (Wetzel, 1975). Therefore, greater Secchi depths represent better water transparency. Although somewhat simplistic and subjective, this testing method probably best represents the conditions which are most readily visible to the common lake user.

Since Franklin Lake is so shallow, the Secchi disk could be seen at the bottom of the lake at each lake station during most of the sampling period. Therefore, the Secchi disk readings in Franklin Lake cannot be compared to any established water quality criterion.

4.3.5 Nutrient Concentrations

<u>Phosphorus</u>

Phosphorus compounds are important for the growth of algae and other aquatic organisms in the aquatic food web. The lake monitoring program that was developed for Franklin Lake included the analysis of lake samples for both total phosphorus and soluble orthophosphorus. Total phosphorus represents the sum of all phosphorus including live algae, dead algae, other microorganisms, organic phosphorus, polyphosphates, and orthophosphates. Soluble orthophosphate is the phosphorus form

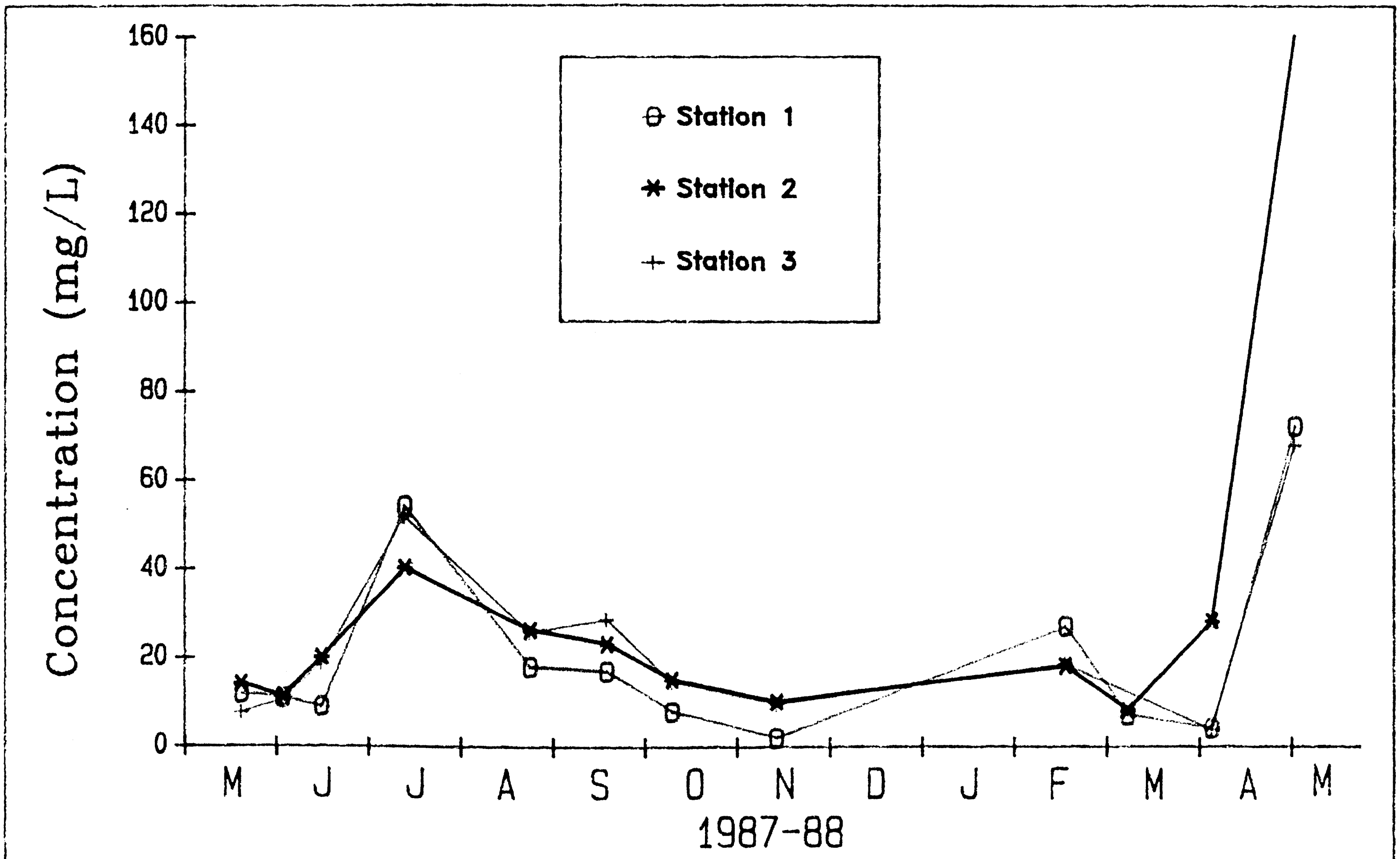


Figure 6

Total Suspended Solids Concentrations
in Franklin Lake

that is most readily available for algal uptake. While total phosphorus levels are strongly affected by the daily phosphorus loads that enter the lake, soluble orthophosphate levels are affected by algal uptake during the growing season.

The variations of total phosphorus for Franklin Lake are shown graphically in Figure 7 for the three sampling stations. The mean in-lake total phosphorus concentration in Franklin Lake was 0.12 mg/L. This mean value of total phosphorus is very high and is well above the EPA eutrophic criterion of 0.02 mg/L to 0.0.3 mg/L for total phosphorus. The soluble orthophosphorus concentrations were below the detection limit of 0.01 mg/L.

Nitrogen

Nitrate and ammonia concentrations were relatively low during the summer growing season at all three stations. During the winter months nitrate levels increased since there was less photosynthetic activity. Ammonia concentrations seemed relatively high during the summer months for a lake that does not thermally stratify. Figures 8, 9, and 10 present nitrogen series data for the three sampling stations.

Limiting Nutrient

Limited amounts of algae are desirable in lake ecosystems. Algal growth depends on a variety of nutrients, including macronutrients such as phosphorus, nitrogen, and carbon, and trace nutrients, such as iron, manganese, and other trace minerals. The Law of the Minimum states that biological growth is limited by the substance that is present in the minimum quantity with respect to the needs of the organism. Nitrogen and phosphorus are usually the nutrients that limit growth in most natural waters. If the limiting nutrient can be controlled, water quality improvements can be expected.

Depending on the species, algae require approximately 15 to 26 atoms of nitrogen for every atom of phosphorus. This ratio converts to 7 to 12 milligrams of nitrogen per 1 milligram of phosphorus on a mass basis. A ratio of total nitrogen to total phosphorus of 15:1 is generally regarded as the dividing point between nitrogen and phosphorus limitation (U.S. EPA, 1980). Identification of the limiting nutrient becomes more certain as the total nitrogen to total phosphorus ratio moves farther away from the dividing point, with ratios of 10:1 or less providing a strong indication of nitrogen limitation and ratios of 20:1 or more strongly indicating phosphorus limitation (Porcella et al., 1974).

Inorganic nutrient concentrations may provide a better indication of the limiting nutrient because the inorganic nutrients are the forms directly available for algal growth. Ratios of total

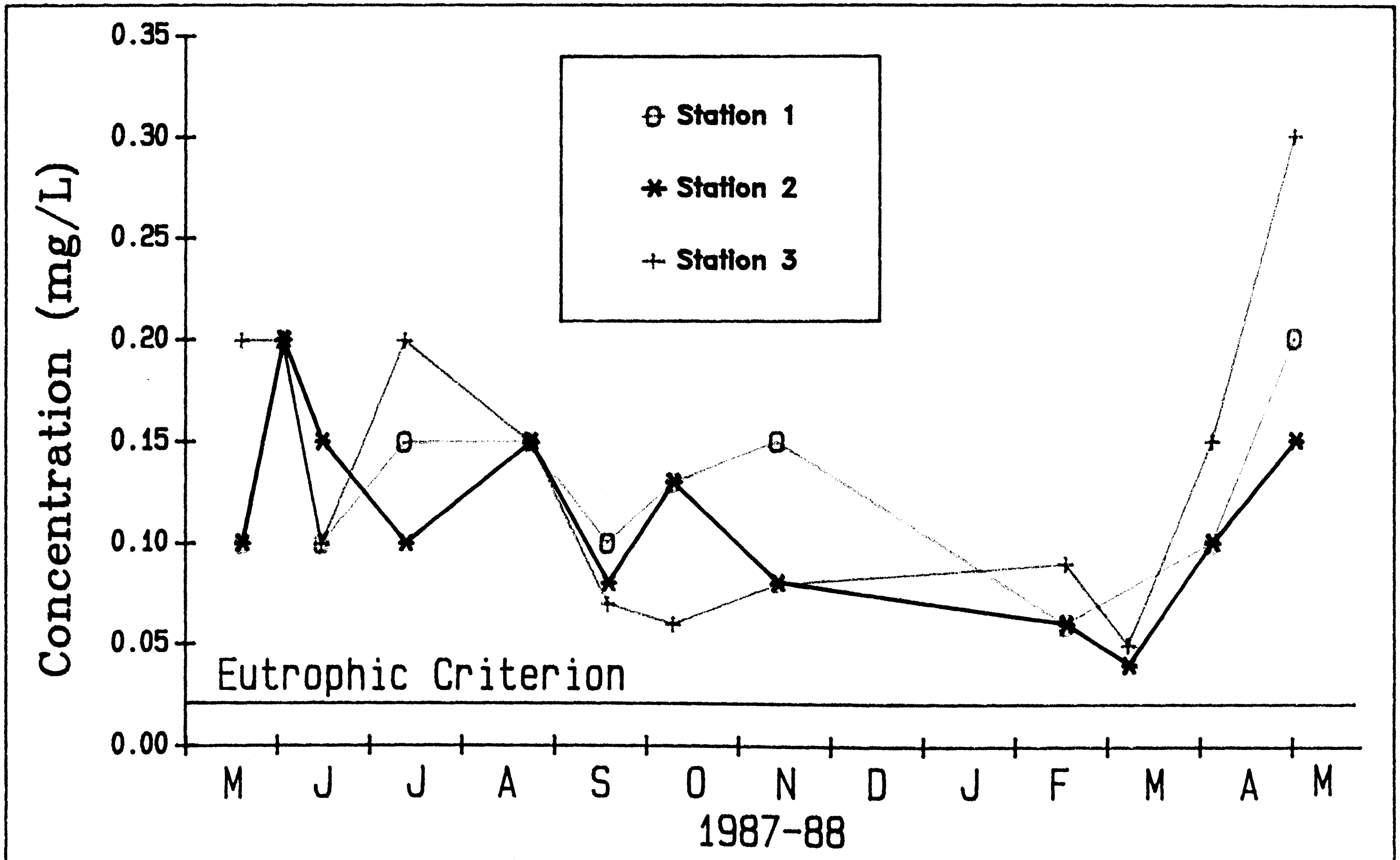


Figure 7 | Total Phosphorus Concentrations in Franklin Lake

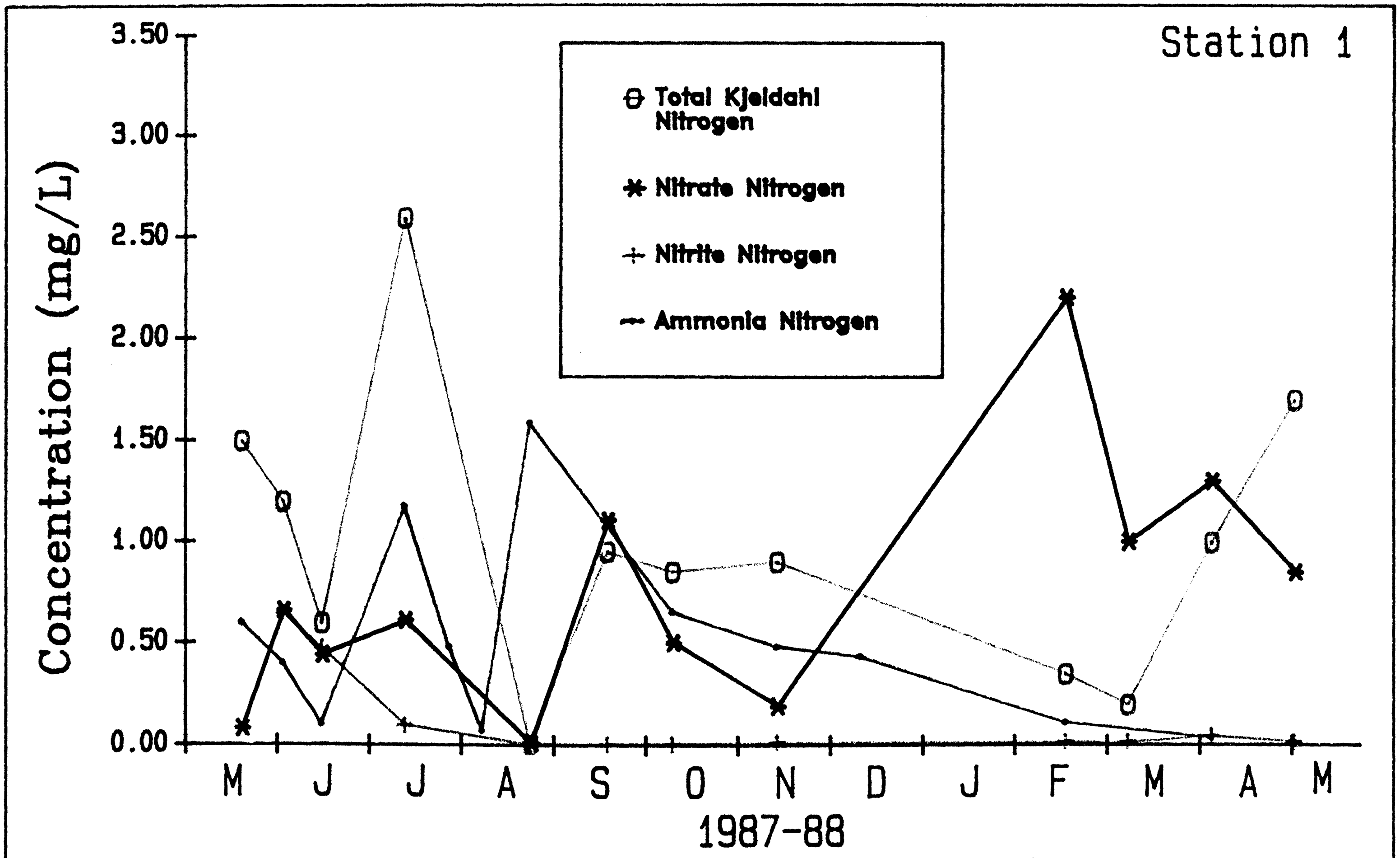


Figure 8	Concentrations of the Different Forms of Nitrogen at Station 1

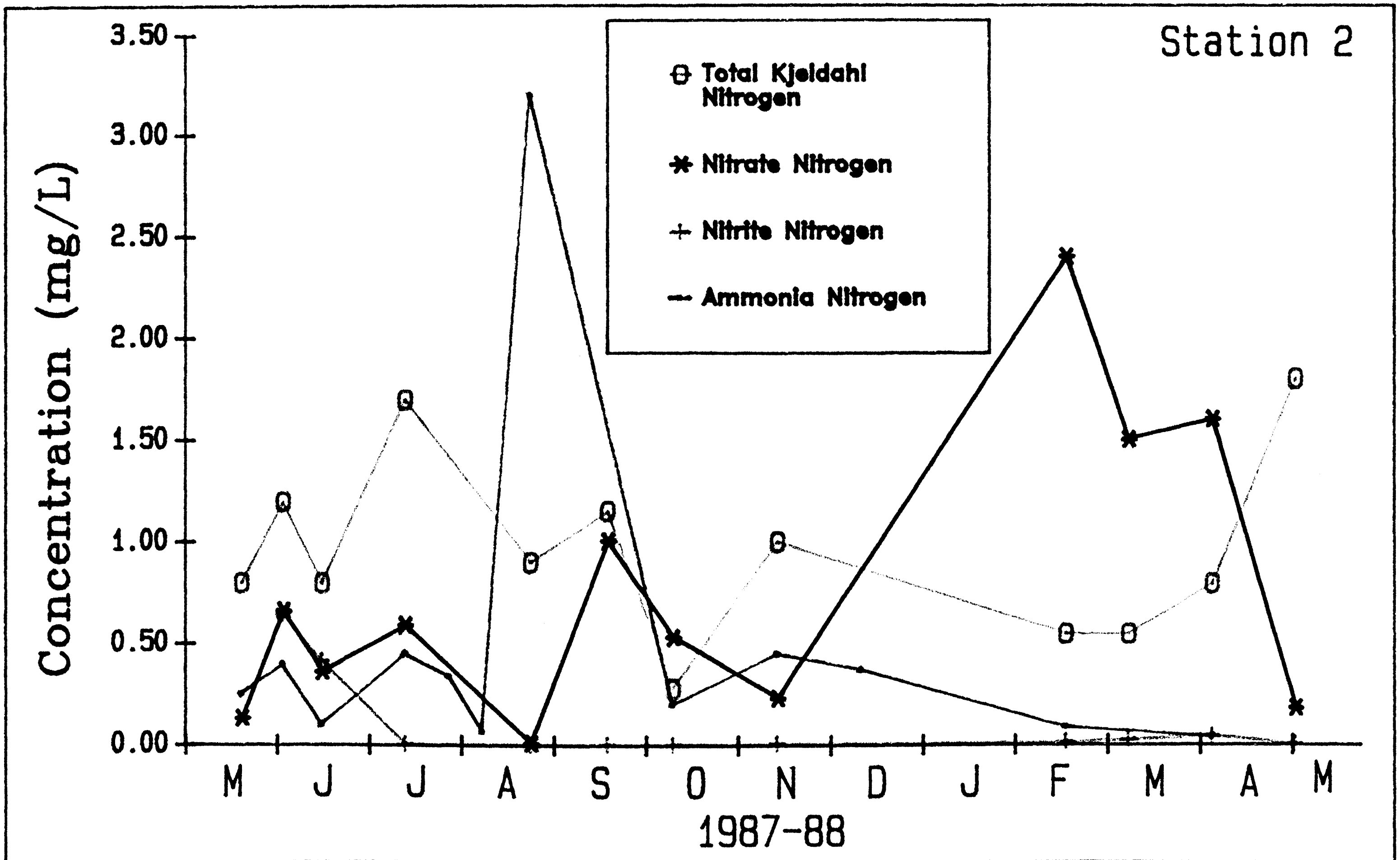


Figure 9	Concentrations of the Different Forms of NItrogen at Station 2

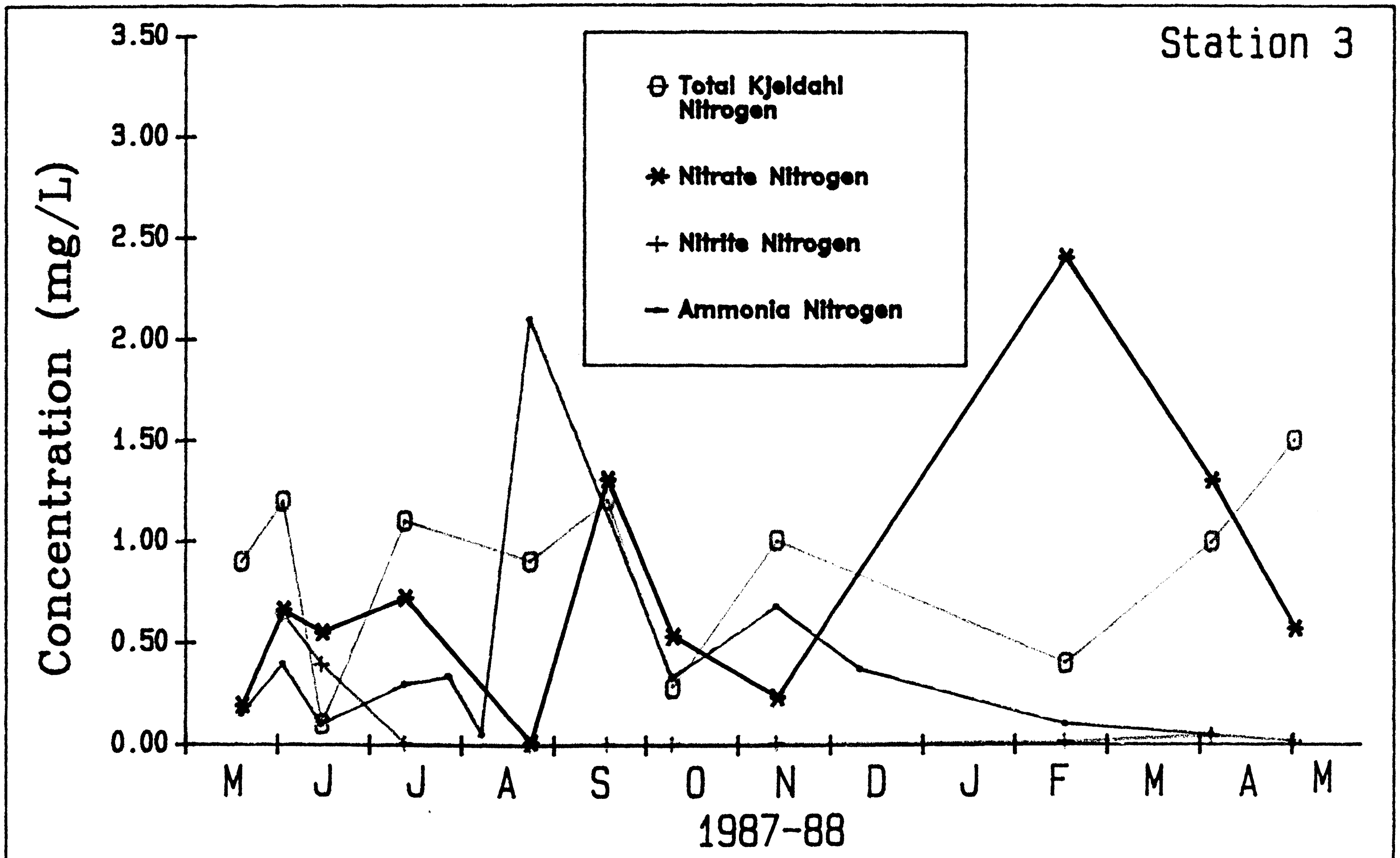


Figure 10	Concentrations of the Different Forms of Nitrogen at Station 3

inorganic nitrogen (TIN = ammonia and nitrate plus nitrite-nitrogen) to dissolved orthophosphorus (DOP) greater than 12 are indicative of phosphorus limitation, ratios of TIN:DOP less than 7 are indicative of nitrogen limitation, and TIN:DOP ratios between 7 and 12 indicate either nutrient can be limiting.

Ratios of TIN:DOP for Franklin Lake were not meaningful because dissolved orthophosphorus concentrations were lower than detection limits on nearly all sampling dates.

The low orthophosphorus concentrations may be a good indication that phosphorus concentrations limit algal growth in Franklin Lake. Because phosphorus concentrations limit algal growth in Franklin Lake, the restoration program should be aimed at reducing phosphorus loads.

Ratios of TN:TP were calculated from Franklin Lake nutrient data and are presented in Table 6. Ratios of TN:TP indicate that phosphorus is usually the limiting nutrient in Franklin Lake, but nitrogen appeared to be limiting on some sampling dates.

Table 6

Nitrogen to Phosphorus Ratios in Franklin Lake

Date	Sampling Station Station #1	 Station #2	 Station #3
	TN:TP	TN:TP	TN:TP
05/21/87	7.9	9.3	--
06/04/87	12.5	12.5	12.5
06/17/87	15.2	10.5	10.5
07/15/87	16.6	23.0	12.2
08/27/87	10.8	21.5	14.1
09/22/87	29.4	27.0	25.1
10/14/87	22.7	6.3	6.3
11/18/87	13.9	15.6	8.3
02/24/88	28.6	49.5	47.0
03/16/88	24.4	52.0	--
04/13/88	15.7	24.5	23.5
05/11/88	8.6	13.3	10.5
Average:	17.2	22.1	17.0

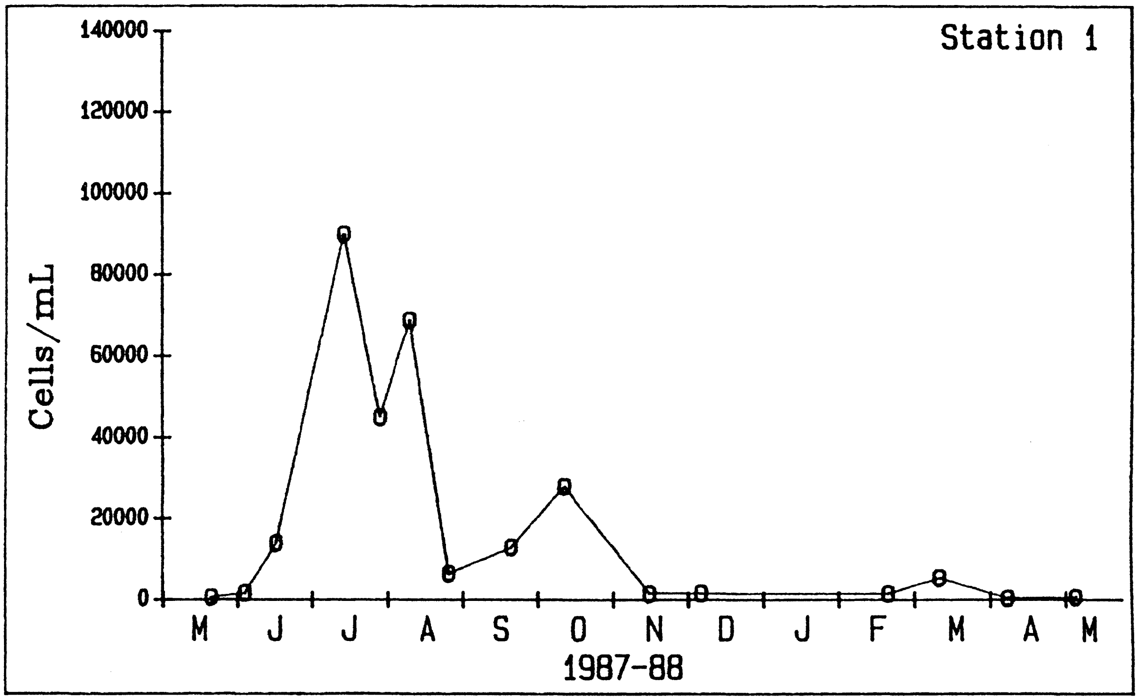
4.3.6 Phytoplankton

Microscopic algae which have little or no resistance to currents and live free-floating and suspended in open water are called phytoplankton. Forms may be unicellular, colonial or filamentous. As photosynthetic organisms (primary producers), they form the base of aquatic food chains and are grazed upon by zooplankton and herbivorous fish. A healthy lake should support a diverse assemblage of phytoplankton, in which many algal classes are represented. Excessive growth of a few species is usually undesirable. Such growths can cause oxygen depletion in the water at night, when the algae are respiring but not photosynthesizing. Oxygen depletion can also occur after an algal bloom when bacteria, using dead algal cells as a food source, grow and multiply. 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.

Fifteen phytoplankton samples were collected from three stations in Franklin Lake during 1987 and 1988. For each station, algae were identified to genus level and counted, then biomass of each genus was determined on the basis of cell size. Graphs showing algal population levels during the sampling period in number of cells per milliliter and the distribution of algal classes within the population are presented in Figures 11, 12, and 13 for Stations 1, 2, and 3, respectively. Similar charts showing biomass levels throughout the sampling period in micrograms per liter and distribution of algal classes by weight are shown in Figures 14 through 16.

In Franklin Lake the phytoplankton population levels were very high. Dominant genera were the blue-green Coelosphaerium, Anabaena and Aphanizomenon at all three stations during much of the sampling period, particularly in late June and July when blooms occurred as the water temperature rose to 27 - 28 degrees Celsius. The blue-green Oscillatoria was also a population dominant, particularly at Station 3 in late August.

Blue-green algae grow well at high pH levels (greater than 7.0) and high temperatures. The pH of Franklin Lake during the phytoplankton sampling period ranged from 7.7 to 8.9. Coelosphaerium, Anabaena and Aphanizomenon often cause taste and odor problems in lakes. Anabaena produces a toxin which has been known to kill waterfowl, livestock and wild mammals. Massive growths of blue-green algae can inhibit development of other more desirable algal species. Algal "water blooms" dominated by Anabaena, Aphanizomenon and Oscillatoria are common in eutrophic lakes of temperate regions in the summer.



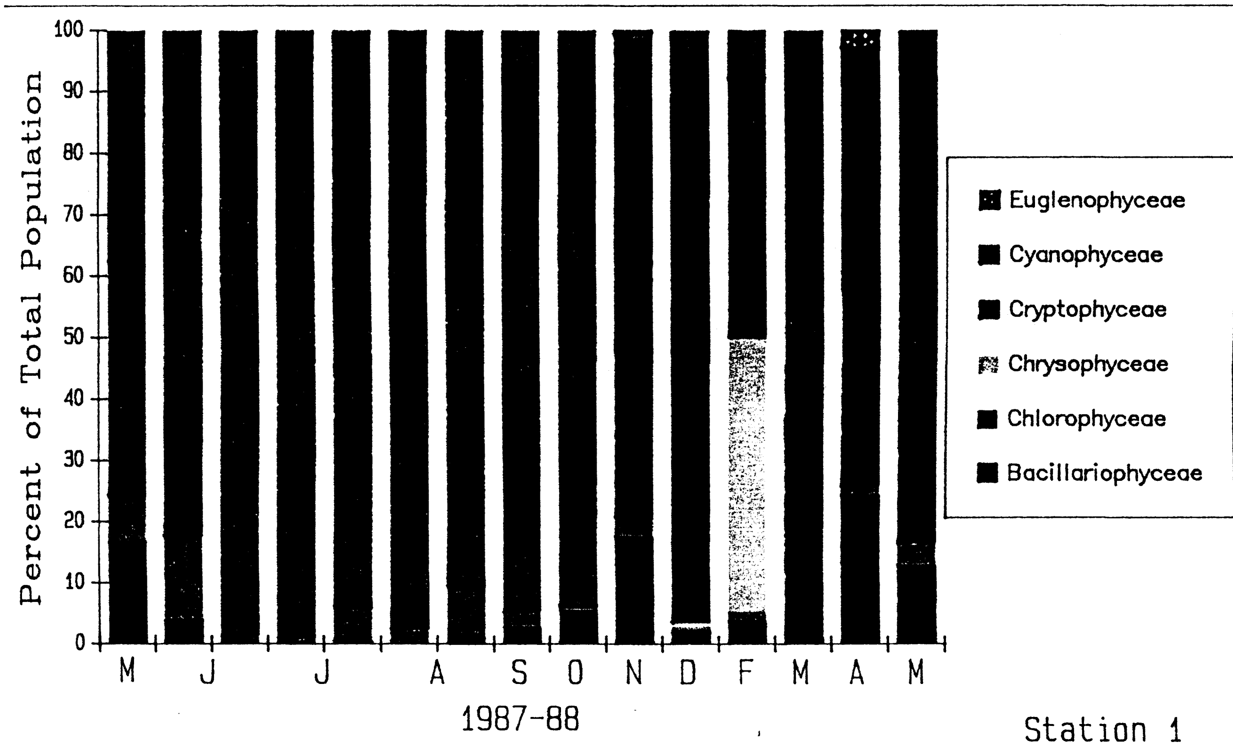
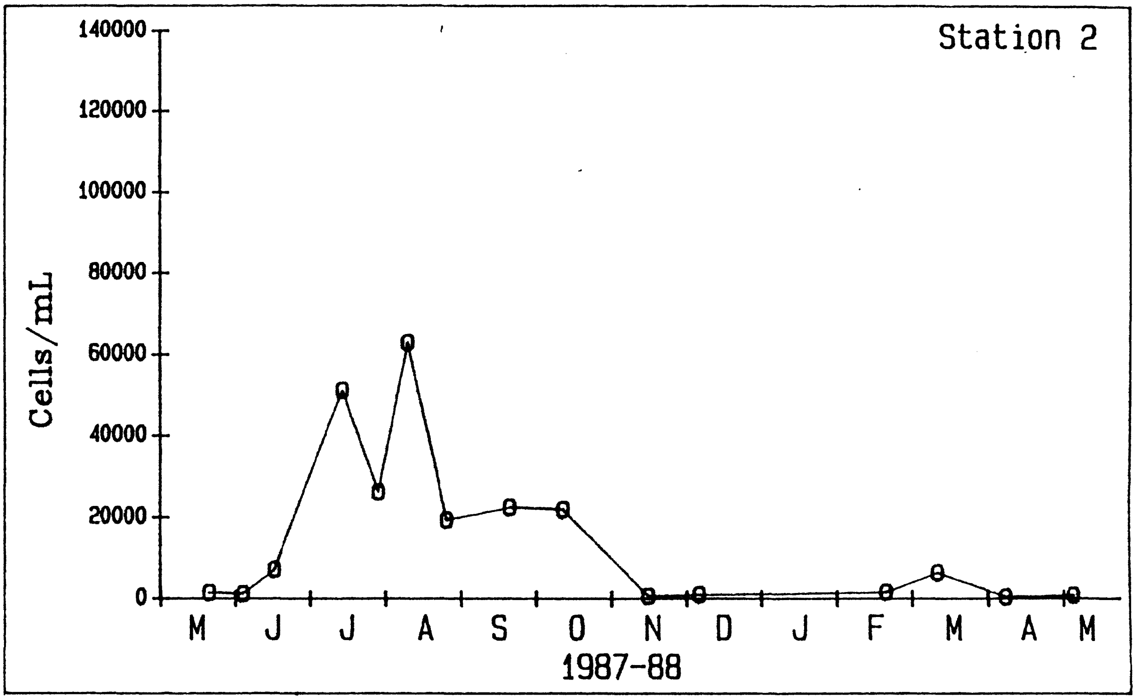


Figure 11	Algal Population Levels and Distribution of Algal Classes by Number at Station 1



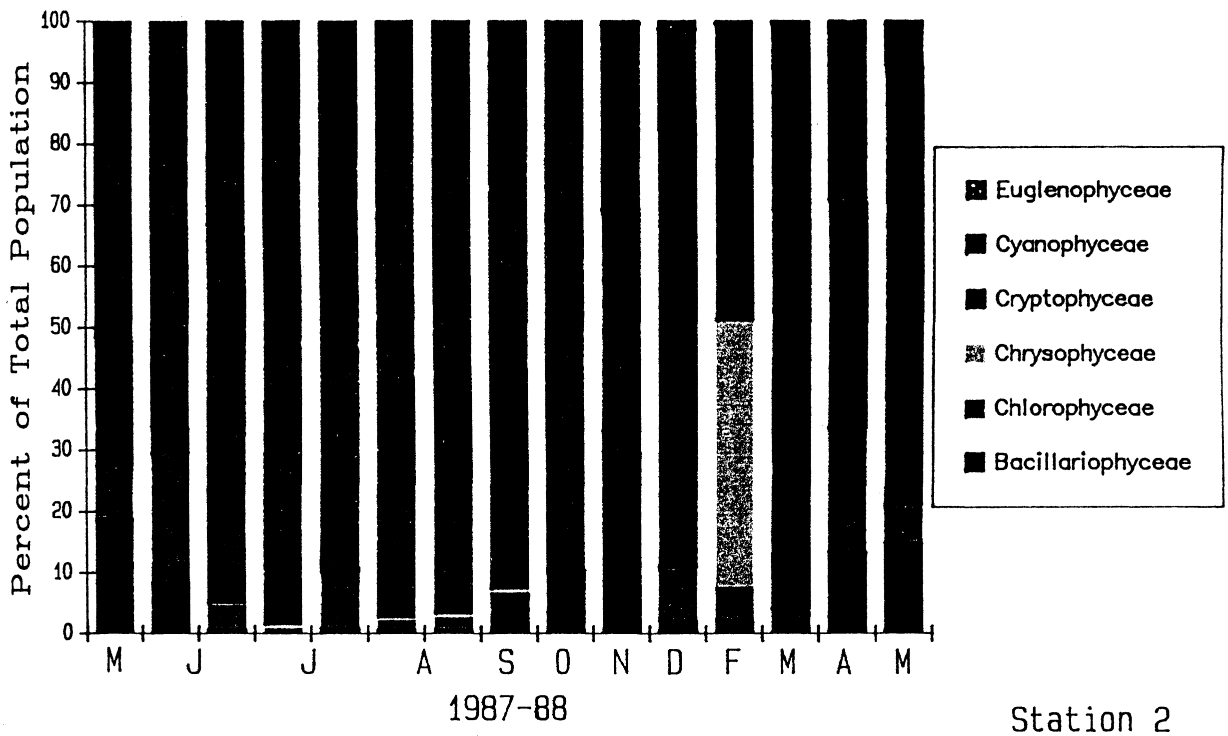
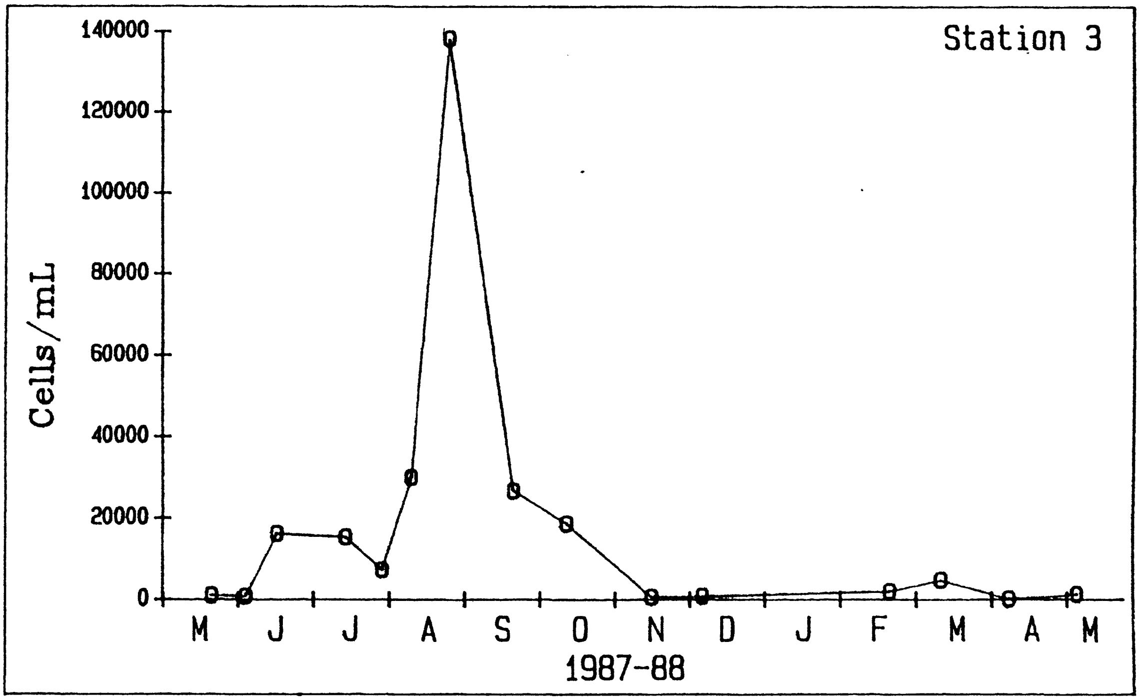


Figure 12	Algal Population Levels and Distribution of Algal Classes by Number at Station 2



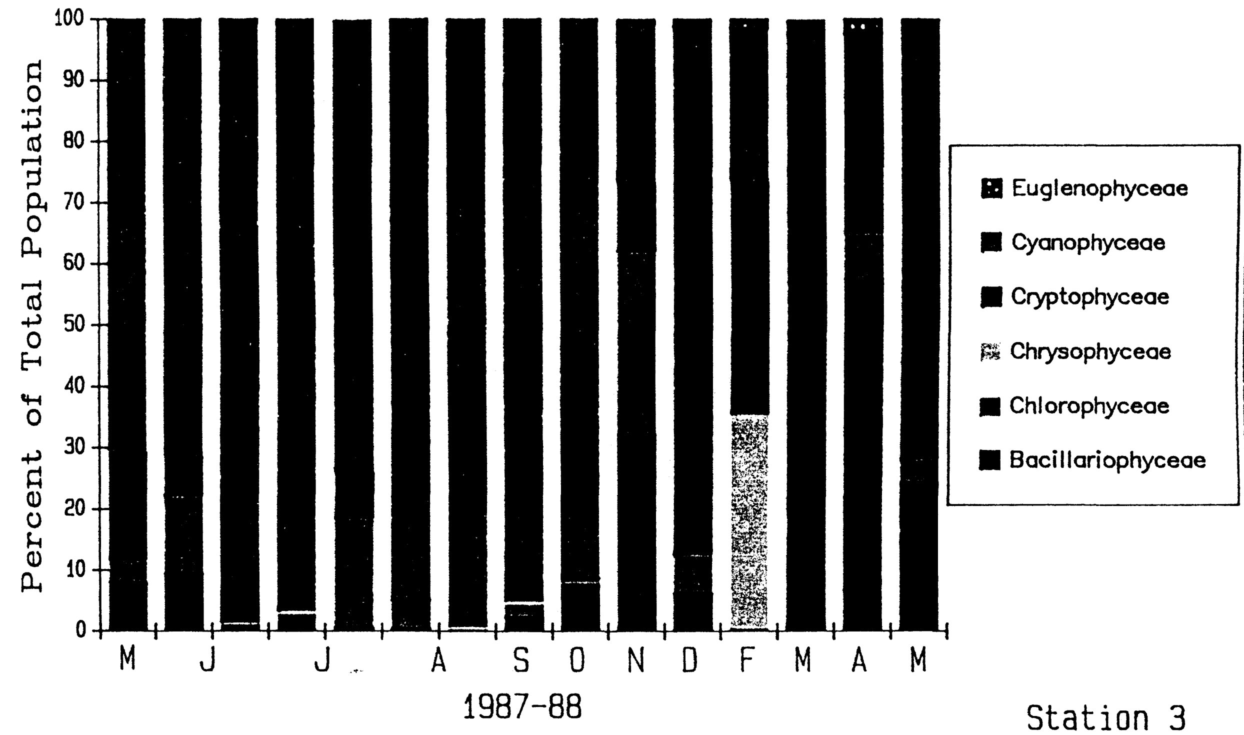
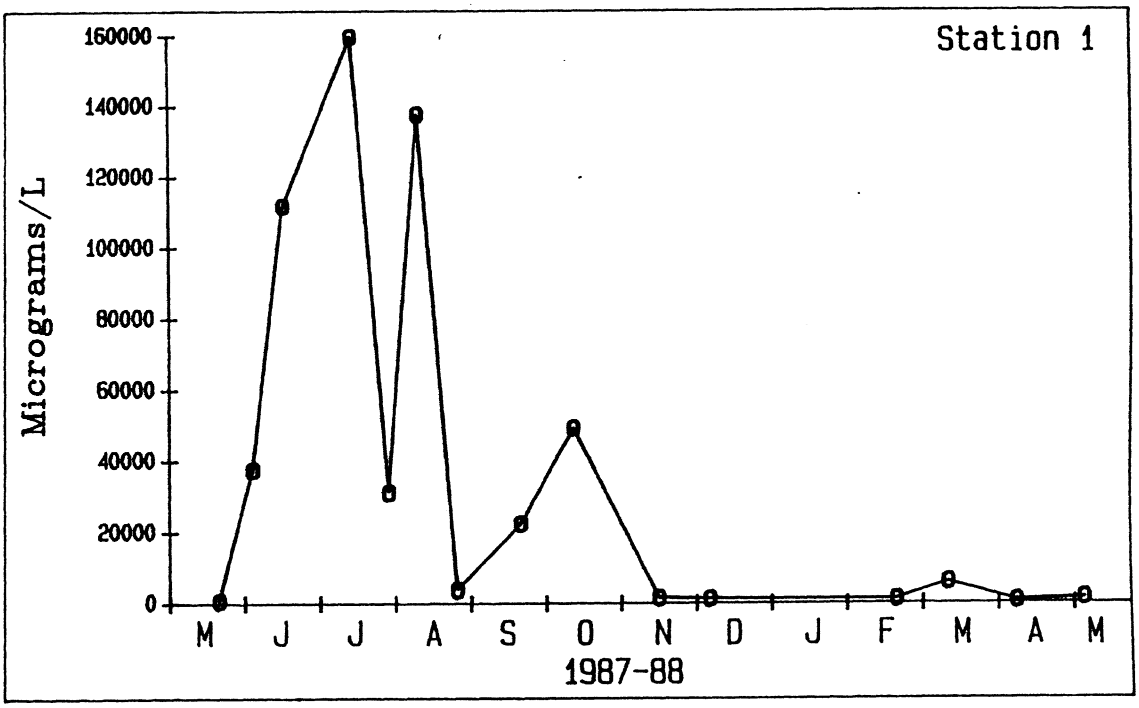


Figure 13	Algal Population Levels and Distribution of Algal Classes by Number at Station 3



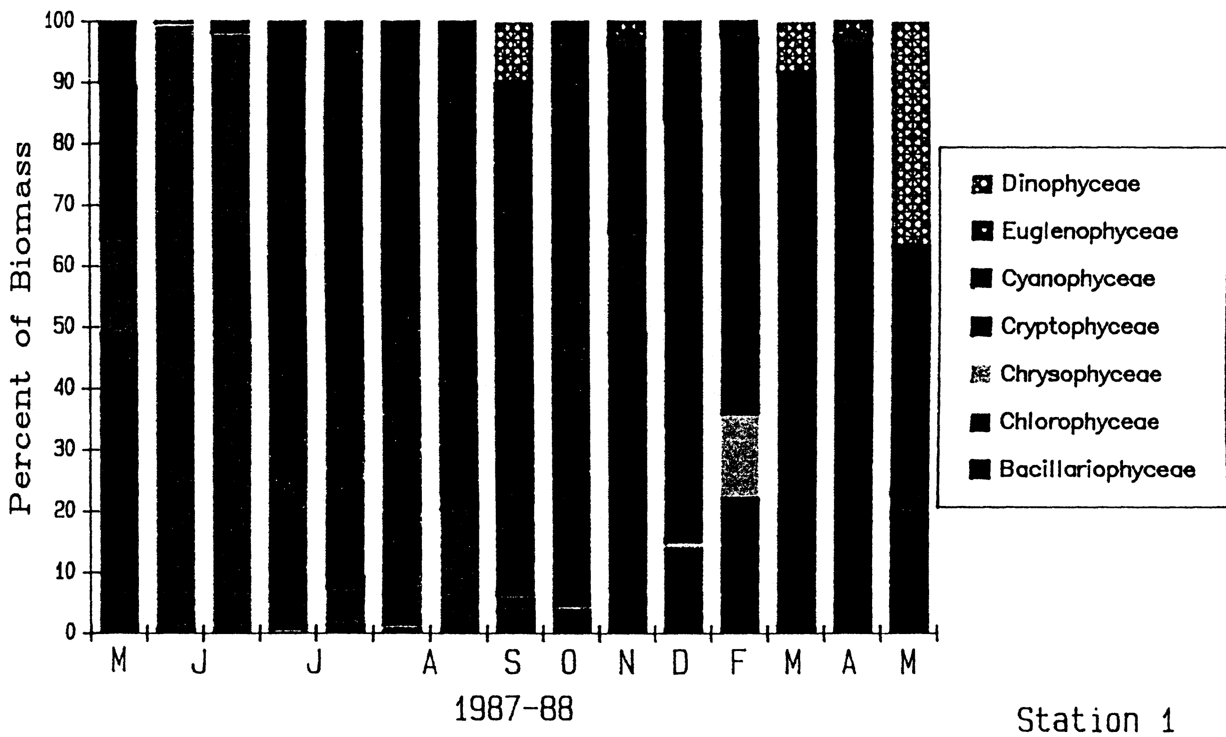
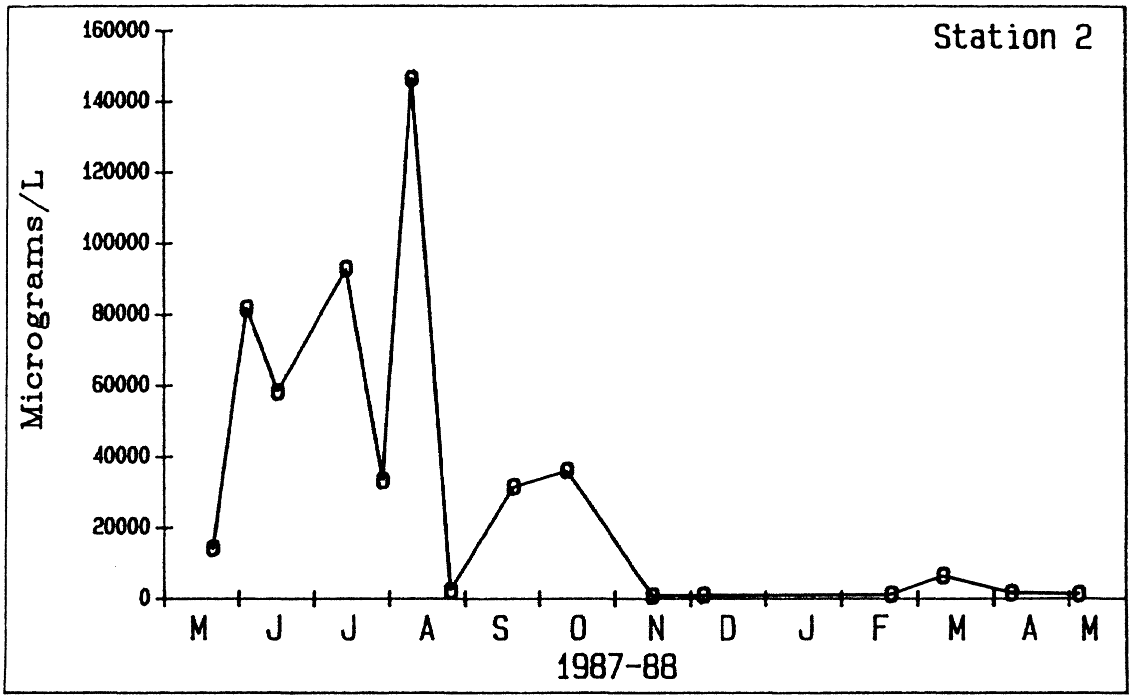


Figure 14	Algal Biomass Levels and Distribution of Algal Classes by Weight at Station 1



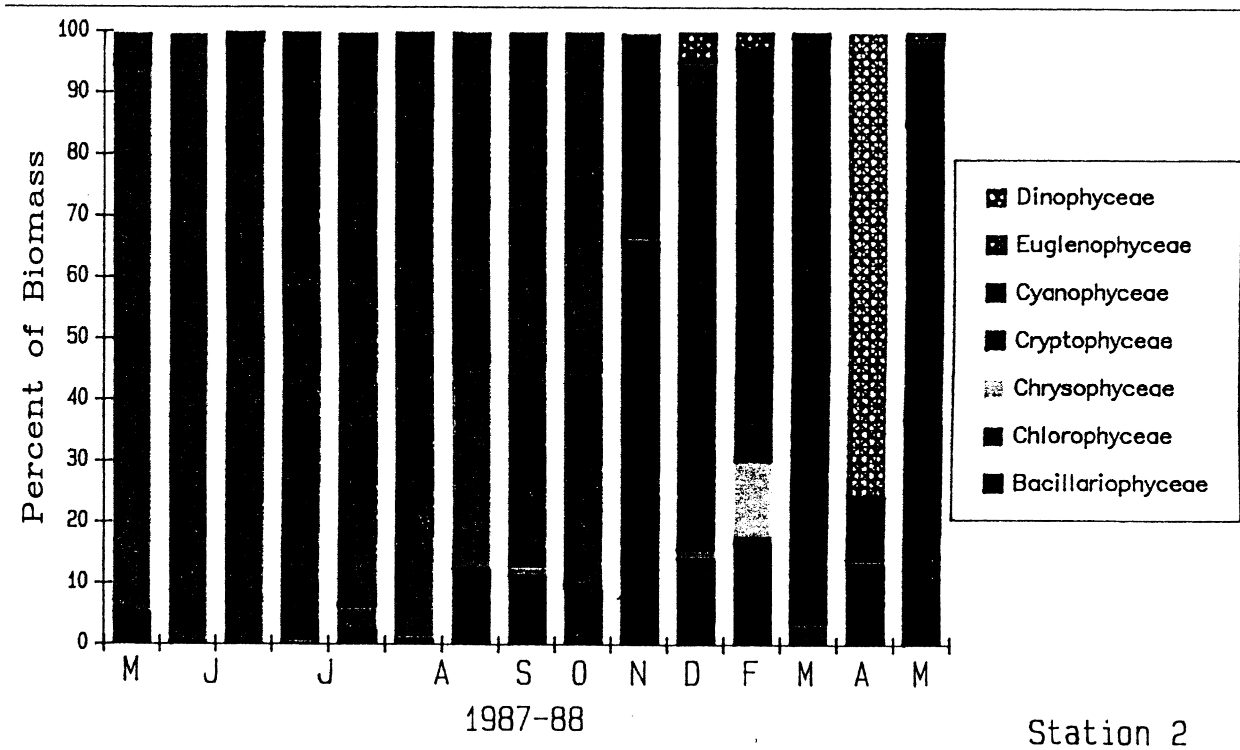
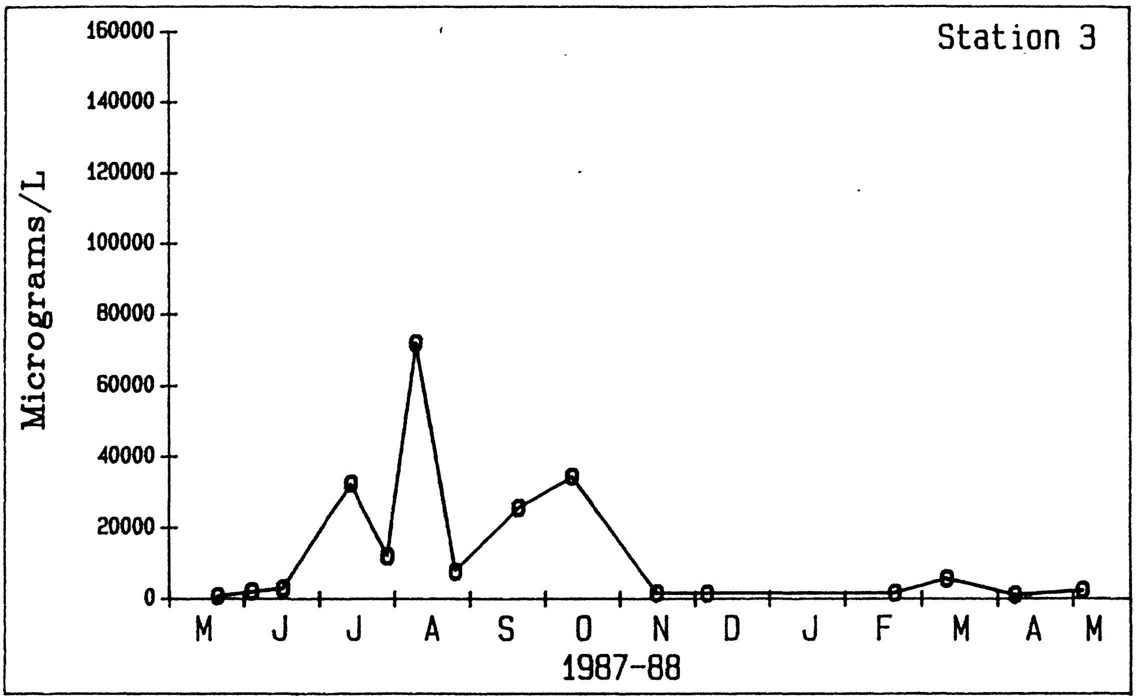


Figure 15	Algal Biomass Levels and Distribution of Algal Classes by Weight at Station 2



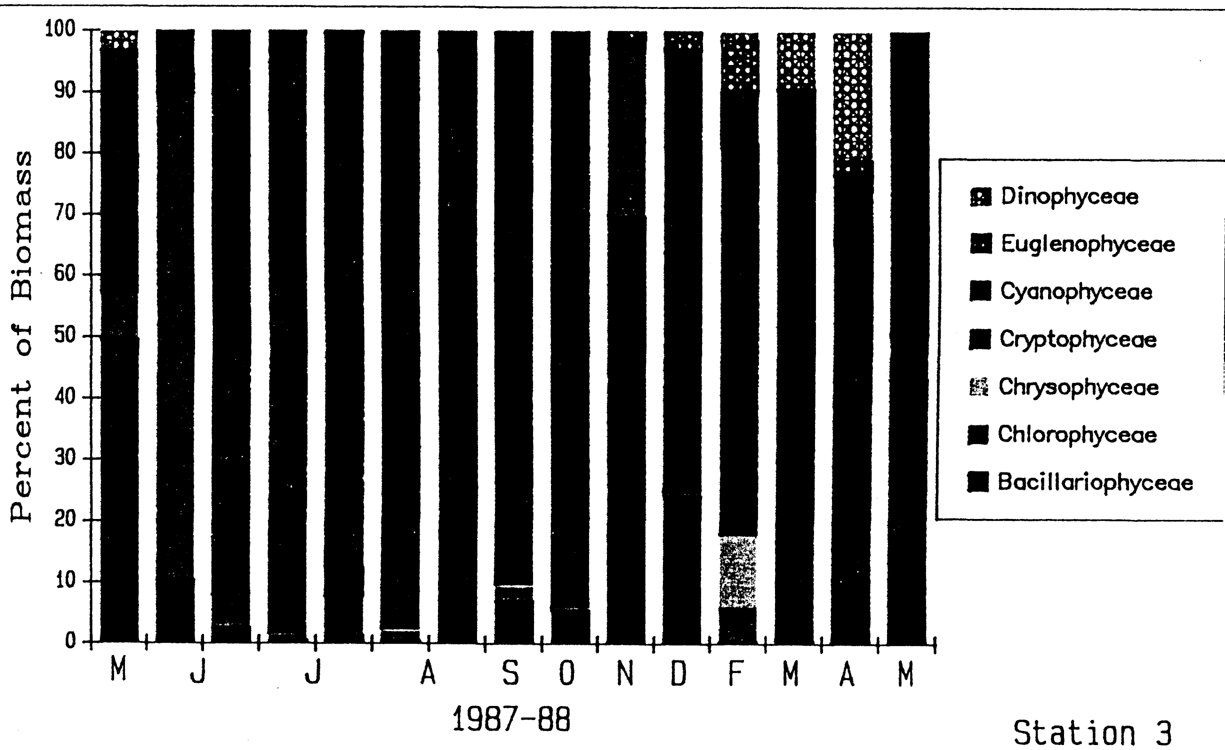


Figure 16	Algal Biomass Levels and Distribution of Algal Classes by Weight at Station 3

Although growth of blue-green algae is indicative of high nutrient concentrations, blue-greens can also grow well when nutrient concentrations in the water are low. The following reasons may explain this apparent paradox. Some species of Anabaena and Aphanizomenon can "fix" atmospheric nitrogen, converting it to a biologically usable form. Because of this ability, blue-green algae will grow well when nitrate and organic nitrogen concentrations are low. Blue-green algae are capable of using nutrients in low concentrations, and at high temperatures can grow rapidly, out-competing other algal forms. At higher temperatures, phosphate and some nitrate or ammonia can diffuse from organic mud into epilimnetic water in contact with it. Many types of blue-green algae can grow directly on the mud surface until low oxygen levels initiate pseudovacuole ("air bubbles" within the cell) formation, which float the cells to the water surface.

The type of algae which dominates the phytoplankton in terms of number of cells per milliliter may not dominate phytoplankton biomass because of differences in cell size and composition. For example, at Station 1 on July 17, the blue-green Aphanizomenon and Coelosphaerium dominated in terms of number, while the green Spirogyra dominated in terms of weight. One Spirogyra cell is about 35 times the size of a Coelosphaerium cell and 12 times the size of an Aphanizomenon cell.

Phytoplankton biomass in Franklin Lake was very high and dominated by the filamentous green Spirogyra, the green desmid Closterium, and the blue-green Anabaena and Coelosphaerium. Spirogyra filaments are large enough to be seen without the aid of a microscope and may form thread-like clumps and mats in the water. Spirogyra is often associated with polluted water. Although somewhat difficult to digest, Spirogyra is eaten by small crustaceans and some types of fish. Some species of Closterium have been associated with sewage ponds where nutrient levels are very high.

4.3.7 Chlorophyll and Pheophytin

Chlorophyll a is a pigment which gives the green color to all green plants. Its function is to convert sunlight to chemical energy in the process known as photosynthesis. Water samples containing algae can be treated to extract chlorophyll a from algal 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.

In Franklin Lake, Chlorophyll a concentrations ranged from a low of 1 microgram per liter (ug/L) in December to a high of 43 ug/L in July (Figure 17). In general, the chlorophyll a levels correspond with algal bloom events. Chlorophyll a levels

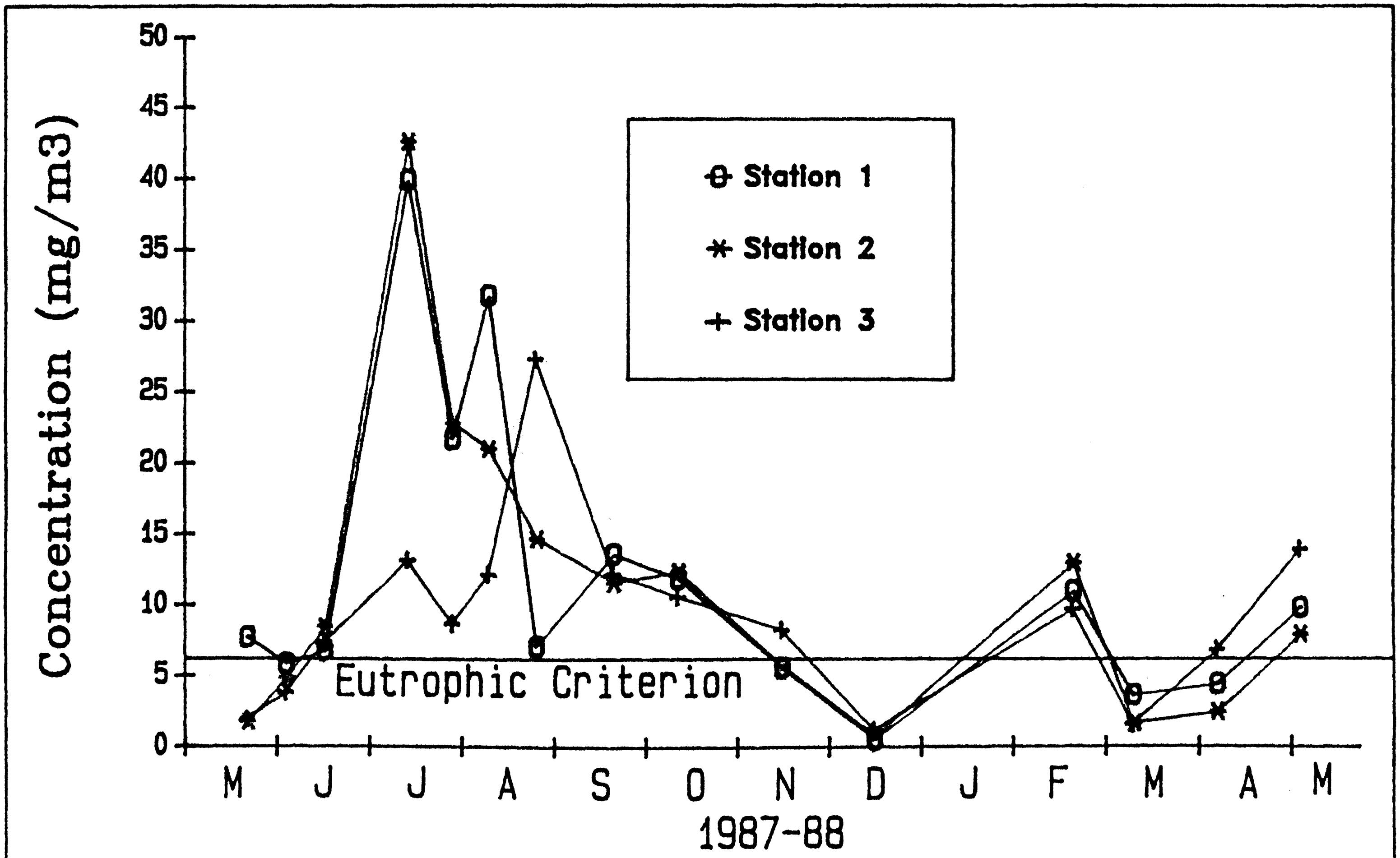


Figure I7	Chlorophyll a Concentrations in Franklin Lake

exceed the eutrophic criterion of 6-10 micrograms per liter in Franklin Lake during most of the sampling period indicating that Franklin Lake has a very high algal biomass. There are some discrepancies between the time of maximum chlorophyll a levels and the time of maximum biomass levels determined by cell size, which may be due to chlorophyll a levels within algal cells varying from the assumed 1-2 percent dry weight. However, both methods show high algal biomass levels in Franklin Lake.

When chlorophyll a loses its magnesium atom, it becomes pheophytin a, a common degradation product. As plant cells cease to function and die, chlorophyll a breaks down and pheophytin a levels increase. The ratio of chlorophyll a to pheophytin a shows whether the algae population is made up primarily of healthy photosynthesizing cells (ratio greater than 1), or if there is a significant proportion of dying cells (ratio less than or equal to 1).

Chlorophyll a to pheophytin a ratios indicate that the greater proportion of the phytoplankton population was made up of active photosynthesizing cells during the summer and during bloom events in the autumn and in February. The algae were in an environment conducive to rapid growth during these times: plenty of nutrients and optimal temperature and light conditions.

4.3.8 Macrophyte Survey

On August 30, 1988, macrophytes growing in and near Franklin Lake were collected and their locations were noted on a base map. Macrophytes in Franklin Lake are limited to a shoreline assemblage extending only a few inches into the lake itself. Considering the shallowness of the lake, one would expect more plants to grown in the lake bottom. It may be that carp and bullheads are eating all available plants in the lake, and their habit of stirring up sediments makes it difficult for plants to establish themselves. The assemblage along the shore contains the following representative plants:

Water Pennywort (*Hydrocotyle ranunculoides*)
Arrow Arum (*Peltandra virginica*)
Arrowhead (*Sagittaria*)
Bulrush (*Scirpus, Juncus*)
Sedge (*Cyperus*)
Elephant Grass (*Phragmites maximus*)
Milkweed (*Asclepias*)
Joe-Pye Weed (*Eupatroruim*)
Knotweed (*Polygonum*)

4.4 Trophic State Index

The Trophic State Index (TSI) developed by Carlson (1977) is among the most commonly used indicators of lake trophic state. This index is actually composed of three separate indices based on observations of total phosphorus concentrations, chlorophyll a concentrations, and Secchi depths from a variety of lakes. Total phosphorus was chosen for the index because phosphorus is often the nutrient limiting algal growth in lakes, chlorophyll a concentrations are used to provide an indication of the biomass of algae in a lake, and Secchi depth is a common measure of the transparency of lake water.

Mean values of total phosphorus, chlorophyll a, and Secchi depth for an individual lake are logarithmically converted to a scale of relative trophic state ranging from 1 to 100. Increasing values for the Trophic State Index are indicative of increasing trophic state, with indices of 40, 50, and 60 representing mesotrophic, meso/eutrophic, and eutrophic conditions, respectively.

Values for the TSI were calculated for each of the three sampling stations using monitoring data from the months of May through August because Carlson suggested that summer average values may give the best results. The results, presented in Table 7, indicated that Franklin Lake is eutrophic. Calculated trophic state indices were well into the eutrophic category for both total phosphorus and Secchi depth and in the mesotrophic to eutrophic range for chlorophyll a.

Table 7

Summer Trophic State Indices for Franklin Lake

	Trophic State Index		
Station	Total P	Secchi Depth	Chlorophyll a
Station #1	79.8	74.7	58.5
Station #2	75.4	71.8	58.1
Station #3	76.4	74.3	53.8

Of the three parameters, chlorophyll a may be the best indicator of the true trophic state of Franklin Lake because it is not subject to interferences found in indices based on Secchi depth and total phosphorus. The trophic state index for Secchi depth is artificially high because the shallow water depth in Franklin

Lake resulted in the Secchi disk being visible on the lake bottom on most sampling dates. The trophic state index based on total phosphorus may also be too high because most of the phosphorus in Franklin Lake is apparently present in a particulate form that would not be readily available to support algal growth.

Another method of assessing the trophic state of a lake is to compare monitoring data to eutrophic criteria established by the U. S. Environmental Protection Agency (1980). Table 8 compares EPA eutrophic classification criteria to existing water quality in Franklin Lake.

Table 8

Comparison of Franklin Lake to Eutrophic Classification Criteria*

Parameter	Eutrophic Criterion	Franklin Lake Mean Concentrations
Total Phosphorus (mg/L as P)	0.02-0.03	0.12
Chlorophyll a (ug/L)	>6-10	14.10
Secchi Depth (meters)	1.5-2.0	0.39 (bottom)

*Source: EPA, 1980

Phytoplankton populations in Franklin Lake are also indicative of eutrophic conditions. Blue-green algae are the dominant phytoplankton in the lake, and species diversity is very low.

4.5 Sediment Analysis

Sediment analyses were conducted on four sediment core samples that were collected on October 13, 1987. No heavy metals, pesticides, or PCB's were present at problem levels. No pesticides or PCB's were detected with the EP Toxicity Test, and all heavy metal concentrations were well below maximum contaminant levels. Pesticide, PCB, and heavy metal results are presented in Appendix E. Concentrations of sediment nutrients and solids are presented in Table 9.

Table 9

Sediment Nutrient and Solids Data

	Site #1	Site #2	Site #3	Site #4
% Solids	37.3	54.3	50.8	60.1
% Volatile Solids	4.89	4.02	3.84	2.49
Total Phosphorus (mg/kg)	200	260	180	120
TKN (mg/kg)	1820	1200	1114	831

4.6 Stream Water Quality Data

Water quality samples were collected from the two tributary streams and from Dennis Brook below the Franklin Lake dam and analyzed for nutrients and other water quality parameters. Samples were also collected from storm sewers during rain events. Complete results from the stream monitoring program are included in Appendix F.

4.6.1 Dry Weather Stream Monitoring

Results from the dry weather stream monitoring program are summarized in Table 10. Concentrations of total phosphorus, total Kjeldahl nitrogen, and total suspended solids were generally higher in the lake outlet (Station C) than in either of the lake inlets (Stations A and B).

The observed results could indicate either efficient scavenging of pollutants by plants growing in the inlet stream channels or internal pollutant sources in Franklin Lake. The conversion of dissolved nutrients into algal cells could explain an increase in the total suspended solids concentration. Groundwater inputs or nutrient inputs from the large resident waterfowl population are both possible internal nutrient sources.

4.6.2 Storm Water Analyses

Storm water samples were collected from two lake inlets, the lake outlet, and five culverts that contribute runoff to Franklin Lake through storm sewers. As expected, concentrations of most parameters were higher during wet weather than during dry weather. The results, summarized in Table 11, indicate that significant pollutant loads enter Franklin Lake during storm events.

Table 10

Dry Weather Stream Monitoring Data

Location	Total P (mg/L)	NH_3-N (mg/L)	TKN (mg/L)	TSS (mg/L)	pH
	Mean Concentrations				
Station A	0.07	0.28	0.8	10	7.5
Station B	0.11	0.41	0.7	7	7.6
Station C	0.34	0.33	2.0	25	7.7
In-Lake	0.12	0.47	0.95	26	7.6

Table 11

Wet Weather Monitoring Data for Franklin Lake

Location	Total P (mg/L)	DRP (mg/L)	NH_3-N (mg/L)	TSS (mg/L)	Alk. (mg/L as $CaCO_3$)	pH
	Mean Concentrations					
Station A	0.14	0.04	1.83	15	32	8.01
Station B	0.15	0.04	0.26	19	42	7.84
Station C	0.14	0.09	1.33	44	48	8.08
Culverts A-E	0.44	0.28	--	11	17	7.66

5.0 Pollutant Sources

Pollutants can enter a lake from both point and nonpoint sources. Point sources are defined as all wastewater effluent discharges within a watershed. All other pollutant sources within a watershed are classified as nonpoint sources. Nonpoint sources can contribute pollutants to a lake through inflow from tributaries, direct runoff, direct precipitation on the lake surface, or through internal loading and groundwater inputs. Both natural events, such as precipitation and runoff, and human activities, including agriculture, silviculture, and construction, can contribute pollutants from nonpoint sources. Nonpoint sources can be difficult to quantify but are important because they often constitute the major source of pollutants to a lake.

Calculations of pollutant loads require information on the water quality of influent streams, knowledge of lake and watershed interactions, and hydrology, and also require data analysis, modeling, and engineering assumptions. Many sources of error can be incorporated into the results because of the number of water quality samples which must be analyzed, the data analysis required, and the number of assumptions which must be made.

Errors resulting from the water quality analyses can be minimized through a good laboratory quality assurance/quality control program, but the other errors involved can only be reduced through the collection of large amounts of chemical and hydrologic data from the entire watershed. This approach would be technically impractical and economically infeasible. As a result, the pollutant loads presented in this report should be considered as best estimates rather than absolute values of the actual pollutant loads.

5.1 Point Source Pollutant Loads

Point sources are defined as all wastewater effluent discharges within a watershed. All point source dischargers of municipal and industrial waste are required to operate under a permit and are assigned a specific discharge number by the National Pollutant Discharge Elimination System (NPDES). There are no point source discharges in the Franklin Lake watershed.

5.2 Nonpoint Source Pollutant Loads

Nonpoint source pollutant loadings for lakes can be assessed through an extensive lake and stream monitoring program or through the use of the unit areal loading (UAL) approach (U.S. EPA, 1980). The monitoring approach requires that influent streams be analyzed for flow and pollutant concentrations during both wet and dry weather to determine average pollutant loadings. The unit areal loading approach can also be used to develop pollutant budgets and is based on the premise that different types of land use contribute different quantities of pollutants through runoff. Both methods were used to generate annual pollutant budgets for Franklin Lake.

5.2.1 Unit Areal Loadings

The unit areal loading (UAL) approach for the estimation of pollutant inputs from nonpoint sources has been widely-accepted for watersheds where extensive stream monitoring data is not available. Unit areal loadings were used in this report for the calculation of nonpoint source pollutant budgets for nutrients and total suspended solids in Franklin Lake.

The nutrient export coefficients compiled by Uttormark et al. (1974), Reckhow et al.(1980), and the U.S. EPA (1980) were evaluated and specific export coefficients were selected based on their applicability to the Franklin Lake Watershed. The export coefficients describe the mass of pollutant loss per unit area and are usually given in the metric units of kilograms/hectare (kg/ha). Nutrient export coefficients for urban areas were taken from a study of an urban lake located in Madison, WI (Kluesner and Lee, 1974). The median values for nutrient export coefficients reported by Reckhow et. al. (1980) were chosen for agricultural land.

Suspended solids loading coefficients are within ranges reported by U.S. EPA (1980) for each category. Export coefficients for suspended solids loadings from urban land were taken from values near the middle of the reported range and values from near the lower end of the reported range were used for parks, cemeteries, and athletic fields. Total suspended solids export coefficients for agricultural land from the bottom third of the range reported by the U.S. EPA (1980) were selected because of low slopes in the area surrounding Franklin Lake.

Loadings from precipitation were estimated from rain samples collected as part of this study. The average concentrations measured for total phosphorus, total Kjeldahl nitrogen and total suspended solids were 0.01 mg/L, 0.15 mg/L and 2.0 mg/L, respectively. Multiplication of these values by the average annual rainfall in West Long Branch of 45.46" (NOAA, 1988) results in loadings of 0.68 kg of total phosphorus/yr, 10.2 kg of total Kjeldahl nitrogen/yr, and 140 kg of total suspended solids/yr.

The selected runoff coefficients and resulting unit areal loadings for the Franklin Lake watershed are summarized in Table 12. Table 13 presents pollutant loadings for each land use category, based on unit areal loading data. As Table 10 clearly indicates, urban areas contribute the major portion of all pollutant loads from runoff to Franklin Lake. Urban areas were

Table 12

Unit Areal Loadings for the Franklin Lake Drainage Basin

Land Use (% of Drainage Basin)	Area	Parameter	Runoff Coeff.	Annual Load
	(ha)		(kg/ha/yr)	(kg/yr)
Urban - Residential	157	Total P	1.1	172
(74.0)	157	Total N	5	783
	157	TSS	1000	157000
Parks, Cemeteries,	40	Total P	1.1	44
Athletic Fields	40	Total N	5	199
(18.8)	40	TSS	300	12000
Agriculture	9	Total P	2.24	20
(4.3)	9	Total N	9	82
	9	TSS	1500	13500
Water (Lake Surface)	6	Total P	0.11	1
(2.9)	6	Total N	1.7	10
	6	TSS	23	140
Total Drainage Basin	212	Total P Load		237
	212	Total N Load		1074
	212	Total SS Load		182640
Parks, Cemeteries,	39	Total P	1.1	43
Athletic Fields	39	Total N	5	195
(18.8)	39	TSS	300	11700
Agriculture	9	Total P	2.24	20
(4.3)	9	Total N	9	81
	9	TSS	1500	13500
Water (Lake Surface)	6	Total P	0.11	1
(2.9)	6	Total N	1.7	10
	6	TSS	23	140
Total Drainage Basin	207	Total P Load		232
	207	Total N Load		1051
	207	Total SS Load		178340

Table 13

Nonpoint Source Pollutant Loadings to Franklin Lake by Land Use Category

Land Use (% of Total)	Phosphorus Load (%)	Nitrogen Load (%)	Total Suspended Solids Load (%)
Urban - Residential (74.0)	72.6	72.9	85.8
Parks, Cemeteries, Athletic Fields (18.8)	18.5	18.6	6.6
Agriculture (4.3)	8.6	7.6	7.5
Water (Lake Surface) (2.9)	0.3	0.9	0.1
Total (100.0)	100.0	100.0	100.0

calculated to contribute 72.6 percent of the total phosphorus load, 72.9 percent of the total nitrogen load and, most significantly, 85.8 percent of the total suspended solids load to Franklin Lake. Based on actual area, agricultural lands contribute a disproportionate share of all pollutants considered, but the total amount of land in this category is low.

5.2.2 Internal Nutrient Loading

Internal nutrient loading may be expected to have an impact on the Franklin Lake nutrient budgets because of the presence of springs in the lake. Phosphorus and nitrogen concentrations in Franklin Lake sediments were low, however, so internal nutrient loadings are not expected to be a significant factor in Franklin Lake nutrient budgets. No exact estimates of internal loading can be made because measurements of groundwater inputs to the lake were beyond the scope of the present project and no information was available on nutrient levels in groundwater in the Franklin Lake area.

5.2.3 Nutrient Loadings from Waterfowl

An average goose contributes approximately 1.4 grams of nitrogen and 0.4 grams of phosphorus per day to a lake if it remains there for the entire day (Manny et al., 1975). The estimated 24-hour nutrient load from one gull is 1.0 gram of nitrogen and .07 grams of phosphorus (Gould and Fletcher, 1978). It is reasonable to assume that ducks contribute a 25% smaller nutrient load than geese, due to their smaller size.

A survey of waterfowl conducted at Franklin Lake in 1983 noted 465 ducks, 1000 geese and 50 gulls. The population figures were rounded off and it was assumed that the birds remained on the lake throughout the entire year. Calculations based on these figures and show that waterfowl and gulls contribute an estimated 77 kg of phosphorus and 268 kg of nitrogen per year to Franklin Lake. These numbers are a significant fraction of the nutrient budgets calculated using the UAL approach, indicating waterfowl have significant effects on the nutrient budgets of Franklin Lake.

5.2.4 Calculated Franklin Lake Pollutant Budgets

Nutrient budgets for Franklin Lake were also calculated from monitoring data. This approach may produce more accurate results than the UAL approach, especially because of the impact of waterfowl on the nutrient budgets for Franklin Lake.

The typical runoff value for this area of 1.5 cubic feet per second per square mile of drainage basin area and the Franklin Lake watershed area of 523.5 acres (0.82 square miles) were used to calculate a mean annual discharge of 1.23 cubic feet per second (cfs). Dry weather flows were calculated from observed discharges at the Franklin Lake dam, and wet weather flows were calculated as the difference between annual flow and dry weather flow.

Pollutant loadings from were calculated by multiplying the calculated dry weather and wet weather discharges by average concentrations of total phosphorus and total Kjeldahl nitrogen, or ammonia nitrogen for wet weather samples, obtained during the monitoring program (Appendix F). The calculated pollutant loadings from precipitation calculated in Section 5.2.1 and calculated nutrient loadings from waterfowl calculated in Section 5.2.3 were added to the pollutant loadings from runoff to arrive at the final budgets.

The modified annual pollutant budgets for Franklin Lake are presented in Table 14. The nutrient budgets calculated from monitoring data are similar to those determined from the unit areal loading approach. The differences between the total phosphorus and total nitrogen budgets calculated by the two methods were well within the expected range of error for estimates of this type. Because of the similarity of results from the two approaches, the nutrient budgets calculated from monitoring data were used for decision-making purposes because they incorporate real data from the Franklin Lake watershed.

Table 14

Calculated Pollutant Budgets for Franklin Lake

Pollutant Source	Total P Load kg/yr	(%)	Total N Load kg/yr	(%)	TSS Load kg/yr	(%)
Runoff, Dry Weather	59	(27.4)	469	(38.1)	5536	(42.6)
Runoff, Wet Weather	78	(36.3)	488	(39.6)	7332	(56.4)
Waterfowl	77	(35.8)	264	(21.5)	--	
Precipitation on Lake Surface	1	(0.5)	10	(0.8)	140	(1.0)
Total	**215**	**(100.0)**	**1231**	**(100.0)**	**13008**	**(100.0)**

The total suspended solids budget calculated from monitoring data, with precipitation accounting for 1.0 percent of the total budget, appears to be much too low. The small number of runoff samples and the variations in expected total suspended solids concentrations during storm events could easily have underestimated the actual solids loading, therefore, the total suspended solids load calculated from the unit areal loading method was used in the assessment of restoration methods.

5.3 Phosphorus Modeling

Because phosphorus is the nutrient limiting aquatic growth in Franklin Lake for much of the year and is easier to control than nitrogen, The phosphorus budgets for Franklin Lake determined from unit areal loadings (Table 12) and monitoring data (Tables 10 and 11) were used in conjunction with the physical characteristics of Franklin Lake (Table 3) to determine the effectiveness of the Dillon and Rigler (1974) model for predicting the response of Franklin Lake to phosphorus inputs. The Dillon and Rigler model is one of the most widely-used phosphorus loading models was selected for this study because it has been shown to describe the response of a variety of lakes to changes in phosphorus inputs. The model has the form:

$$TP = L(1-R)/pz \qquad (1)$$

where TP = annual mean phosphorus concentration (g/m^3),
L = areal phosphorus loading ($g/m^2/yr$),
R = phosphorus retention coefficient,
p = flushing rate (yr^{-1}), and
z = mean depth (m).

The calculated values for L are 3.78 $g/m^2/yr$ for UAL data and 3.42 $g/m^2/yr$ for monitoring data. The values for p and z are 40.4 yr^{-1} and 0.43 m, respectively. Proper selection of the phosphorus retention term can be used to calibrate the Dillon and Rigler model for specific lakes. The phosphorus retention coefficient providing the best results for Franklin Lake was the value calculated from the equation developed by Kirchner and Dillon (1975):

$$R = (0.426)\exp(-0.271*z/Tw) + (0.574)\exp(-0.00979*z/Tw) \quad (2)$$

where z = mean depth and Tw = mean hydraulic residence time.

The mean values for the total phosphorus concentration in Franklin Lake calculated from the above equations are 0.11 mg/L from the UAL data and 0.10 mg/L from the monitoring data, which are in good agreement with the observed concentration of 0.12 mg/L. These results indicate the phosphorus budgets developed for Franklin Lake are realistic and that the above equations can be used to adequately predict the response of Franklin Lake to changes in phosphorus loading.

Equation 1 was used to calculate "acceptable" phosphorus loadings for Franklin Lake based on the eutrophic criterion of 0.02 g/m^3 for total phosphorus. The calculated "acceptable" load is 0.54 $g/m^2/yr$ for total phosphorus. These results indicate that an 81 percent reduction in the total phosphorus loading to Franklin Lake would be required to move the lake into the mesotrophic range.

A phosphorus reduction of this magnitude may be difficult to achieve; however, most of the phosphorus in Franklin Lake is apparently present in particulate forms which would be unavailable for algal growth and smaller reductions may significantly reduce algal growth. As discussed earlier, chlorophyll a concentrations may be a better predictor than total phosphorus concentrations of the trophic state of Franklin Lake, and a reduction of only 50 percent in chlorophyll a concentrations would move water quality into the mesotrophic range. The management plan will focus on the removal of phosphorus and suspended solids as a result of these findings.

6.0 Evaluation of Lake Restoration Alternatives

A list of the methods which are potentially applicable to the restoration of Franklin Lake are listed in Table 15. These methods are discussed in detail in the following sections. Table 13 includes only methods which were judged to be potentially effective for Franklin Lake and does not include methods deemed inappropriate for reasons such as lake morphology, hydraulic residence time, or attainment of desired objectives. For instance, alum treatment is widely-used to seal bottom sediments and control nutrient release, but the short flushing time for Franklin Lake would make repeated treatments necessary and limit the effectiveness of the method.

Table 15

Potential Lake Restoration Methods for Franklin Lake

In-lake methods for improving lake water quality and recreation potential

a. Water Level Control
b. Drawdown and Sediment Consolidation
c. Aeration
b. Biological Controls
c. Dredging

Methods for controlling inputs of sediments, nutrients and bacteria from the watershed

a. Shoreline Stabilization
b. Created Wetlands
c. Agricultural Best Management Practices
d. Road and Storm Sewer Maintenance
e. Erosion and Sediment Control
f. Park Management Practices
g. Homeowner Practices
h. Stormwater Diversion

6.1 In-Lake Restoration Methods

In-lake management practices can be implemented to reverse the impacts of eutrophication. In-lake management practices should be considered along with watershed management practices since it is important to eliminate or reduce the problems in the watershed so that in-lake practices are cost-effective. Dredging, water level control, drawdown and sediment consolidation, aeration, and biological controls are options that were evaluated for Franklin Lake.

6.1.1 Water Level Control

One method that could be used to deepen Franklin Lake is to raise the water surface elevation. Although this approach would serve to increase the lake volume, it does not directly address the issue of high nutrient concentrations in the lake. In general, this method has limited practical application since it would cause shoreline and habitat destruction and may increase the groundwater level in the area slightly. Some residents near the lake already experience water in their basements.

6.1.2 Winter Drawdown and Sediment Consolidation

Drawdown and sediment consolidation is another method commonly used to increase lake depth. Consolidation is the gradual decrease in water content of a saturated soil under load and usually results in a significant decrease in volume and rearrangement of the soil structure. Franklin Lake surface sediments contain from 90 to 95 percent water, and complete dewatering could decrease sediment thickness by a corresponding amount. Consolidation of sediments is largely irreversible and little re-swelling would be expected after the lake was refilled (Dunst et al., 1974).

One of the main advantages of lake drawdown is the low cost. Costs for lowering the water level in Franklin Lake would be minimal because the dam is equipped with control structures to allow drainage of the lake.

Recreation would be severely curtailed during the time that lake levels were low. Franklin Lake is used for ice skating in the winter and this use would be severely restricted since the water levels would be very low.

The major disadvantage of drawdown and consolidation is that exact results cannot be predicted. Some sediments are difficult to dewater and the desired increase in lake depth may not be achievable. The presence of springs in Franklin Lake could interfere with sediment dewatering, and therefore, results are difficult to predict.

6.1.3 Aeration

Aeration has been widely-used as a restoration measure for lakes where summer hypolimnetic oxygen depletion and/or winter-kill are of major concern. A number of recent studies have indicated that aeration may also has some potential as a method of algal control in shallower lakes where dissolved oxygen levels are not the major concern. Aeration has been reported to cause a shift in algal populations away from undesirable blue-green algae to more desirable species of green algae. The reasons for the observed improvement are still uncertain, but three possible explanations have been presented.

Mechanical disruption of the algal cells has been suggested as one reason for the removal of blue-green algae during aeration. The mixing action provided by the aerators may rupture cell walls, particularly the gas vacuoles present in blue-green algae, to provide a measure of control for algal populations.

A second possible explanation for the control of algae by aeration is chemical changes brought about by complete mixing of the water column. Aeration tends to strip free carbon dioxide from the water column, and high carbon dioxide levels are known to favor blue-green algae. In addition, mixing of surface and bottom waters generally results in a lower surface pH, and blue-green algae prefer a higher pH.

Mixing of the water column is a third explanation which has been presented for the control of algae by aeration. Individual algal cells are exposed to lower average light intensities as they are circulated throughout the water column than they would be under quiescent conditions. As a result, algal growth rates may be inhibited by complete mixing of the water column.

Little improvement would be expected from aeration at the current lake depth. Light penetrates to the bottom of the lake so algal cells would not be subjected to lower light intensity, and the proximity of the sediments would provide some buffer capacity to limit pH changes.

Aeration is gaining in popularity, in spite of the uncertainties associated with its use, because it is a relatively inexpensive lake management option. Capital costs for the purchase and installation of aerators for Franklin Lake are estimated at $40,000. An additional $3,000/yr is expected for operation and maintenance.

6.1.4 Biological Controls

The use of planktivorous fish, notably Tilapia, has gained interest as a management technique for the control of blue-green algae. These fish are relatively inexpensive and have been shown to control some types of blue-green algae, however; most of the positive results with these fish have been obtained in warmer climates. More research is necessary to document the effectiveness of these fish for eliminating blue-green algae populations before their use as a control measure can be recommended.

6.1.5 Dredging

The physical removal of sediments by dredging could accomplish several lake restoration objectives. Nutrient-rich sediments would be removed from the lake and the lake would be deepened. Since the average depth in Franklin Lake is only 1.4 feet, the main objective of dredging Franklin Lake is deepening. The most significant benefit of dredging Franklin Lake is the enhancement of recreational activities by deepening the lake. In the case of shallow lakes, such as Franklin Lake, deepening can produce conditions more desirable for fishing, boating, and general aesthetics. Also, a larger lake volume generally allows greater levels of fish production (Carline and Brynildson, 1977).

Another objective of dredging is to remove nutrients from the lake system. In most lakes, large quantities of nutrients accumulate in the sediments. These nutrients serve as fertilizer to rooted aquatic plants. The nutrients can also be returned to the water column where they are available to support the growth of floating plants and phytoplankton.

Dredging Methods

The two methods of dredging include in-lake dredging and drawdown and excavation. In-lake dredging includes methods which do not necessitate a complete drawdown of the lake, such as dragline and hydraulic dredging. Drawdown and excavation involves the actual drainage of the lake and the removal of sediment by the use of specialized earthmoving equipment. Most types of dredging are relatively expensive when compared to other methods of lake restoration. However, the costs of dredging are often offset by the long-term benefits.

Disposal Area Considerations

Another concern which must be addressed for all dredging projects is the size and location of the disposal area. A hydraulic dredging project usually requires a large disposal site due to the quantities of water which are pumped along with the sediments. Chemical treatment of the effluent from these disposal areas is sometimes necessary to ensure that a sufficient portion of the nutrients and suspended solids precipitate out of the water. Sediments which have already been dewatered in the lake bottom do not need as much disposal area.

The availability of adequate disposal areas is an important factor in determining the feasibility of a dredging project. To minimize dredging costs, disposal sites should be located as close to the lake as possible. Location of adequate disposal sites may present problems for the hydraulic dredging of Franklin Lake. One potential disposal site near the lake has been located, but it has an estimated capacity of only 11,600 cubic yards and there are over 21,000 cubic yards of sediments in Franklin Lake that could be removed by dredging.

At Franklin Lake, either hydraulic or mechanical dredging could be used. If a large enough disposal area can be found close to the lake, hydraulic dredging would be the preferred method of dredging since the lake could be dredged without lowering the water level of the lake. A preliminary evaluation of potential disposal sites revealed no areas near Franklin Lake were suitable for the disposal of hydraulic dredging spoils. Mechanical dredging would therefore appear to be the method of choice. The dredged spoils would be loaded onto watertight trucks and taken to a suitable disposal site.

Environmental Impacts

Dredging a lake can have significant environmental impacts on the lake ecosystem. Both types of dredging cause destruction of the benthic, or bottom organism, community (including fish food organisms). If the entire lake basin is dredged, two to three years may be required to re-establish the benthic community. However, if portions of the bottom are left undredged, the restoration may be almost immediate or be completed within one to two years (Peterson, 1981). In any case, the effect on the benthic community appears to be of relatively short duration compared to the long-term benefits derived from sediment removal.

Problems with in-lake dredging often occur due to the resuspension of sediments and nutrients during the dredging operation. These phenomena can result in detrimental impacts such as algae blooms, increased turbidity levels, and dissolved oxygen depletion. However, the continued improvement of hydraulic dredging equipment and dredging methods have helped to minimize these adverse impacts.

Secondary Benefits of Dredging

A secondary benefit of dredging Franklin Lake is the regained use of the lake as a source of water for fire protection at Shore Regional High School. Currently, there is a fire hydrant located on the school property which is connected to a standpipe in Franklin Lake. This water source can not be used at the present time because of siltation -- sediments entering the lines caused considerable damage to the fire department's pumps when the system was last tested about 15 years ago.

Costs

Costs were estimated for the mechanical dredging Franklin Lake are $355,000. Removal costs for total phosphorus and total suspended solids were calculated based on this estimated cost. A total of 3950 kg of phosphorus and 1.97×10^7 kg of total solids would be removed with the removal of 21,400 cy of sediment from Franklin Lake. These figures result in calculated removal costs of $89.90/kg for total phosphorus and $0.02/kg for total suspended solids removal.

6.2 Watershed Management

In order to control the quantities of nutrients and sediments entering Franklin Lake, watershed management techniques will be required. Shoreline stabilization, agricultural best management practices, road and storm sewer maintenance, erosion and sediment control, park management practices, homeowner practices, stormwater diversion -- all are watershed management practices that have been evaluated for the Franklin Lake watershed.

6.2.1 Shoreline Stabilization

Most of the Franklin Lake watershed is developed and the land is stabilized. However, several problem areas do exist in the watershed. The shoreline of the lake is severely eroded and may be a significant source of sediment loading to the lake. The shoreline has eroded three feet in some areas as of a result of slumping that apparently resulted from lowering the lake level.

Shoreline stabilization can be achieved by numerous methods. Gabion walls, concrete walls, riprap, wooden walls, and vegetation have been evaluated for shoreline stabilization at Franklin Lake.

Gabion Walls

Gabions are wire baskets filled with gravel or rock that are used for erosion control along a bank or stream. The gabions are wired together to form a stable wall or mattress and offer an efficient and reliable solution to retaining wall construction that does not require skilled labor or special equipment.

The advantages of gabions include permeability, earth retention, and flexibility. They are fairly economical where rock is available but have a tendency to collect trash and debris in the wire cages. The gabion structures require periodic maintenance and they may occasionally need replacement, which can present problems since the gabion cells are wired to each other. Removal of one cell could lead to replacement of others just to access the damaged units. Gabions can be very expensive where rock is unavailable or if they are incorrectly installed. They also give a lake an "engineered" appearance which may not be aesthetically pleasing.

Concrete Walls

Dura-Hold is a heavy duty interlocking retaining wall system produced be Dura-Corp, in Pittsburgh, Pennsylvania. Standard units consist of concrete blocks 12" x 24" x 72" which interconnect to form a protective wall. Dura-Hold wall systems give a very pleasing look to shorelines and offer low maintenance and long life for erosion control and waterfront treatments. Dura-Hold's only preparation is a levelled crushed stone base or concrete levelling pad. In addition, Dura-Hold offers the flexibility of adding to existing Dura-Hold walls. Dura-Hold is relatively expensive compared with other alternatives because the individual units must be trucked by private freight and the weight of the Dura-Hold units limits number of units that can be shipped at one time on a truck.

A cast-in-place concrete wall is an alternative to the pre-cast Dura-Hold concrete wall. This option offers more flexibility than Dura-Hold walls because any desired shape, length, and height can be achieved. Cast concrete walls can also be textured or colored to produce a more pleasing appearance. Concrete walls are also relatively expensive, with costs similar to Dura-Hold walls.

Riprap

Riprap involves the use of boulders or cobbles to prevent soil erosion due to the movement of water. Presently, there is a small portion of riprap installed at Franklin Lake along . Riprap is relatively inexpensive where stone is available on site and provides flexibility for meandering shorelines. Riprap is resistant to scour and allows percolation of water. Riprap can be visually attractive but may become expensive due to trucking costs if rock is not available nearby.

Placement of riprap requires an adequate slope and is not recommended on steep slopes. Installation of riprap at Franklin Lake would require that existing slopes be cut back to a reasonable slope. This would increase costs because the existing path along the northeast side of the lake would have to be relocated.

Wooden Walls

Timber retaining walls, similar to those placed at the east end of Franklin Lake, are widely-used for shoreline stabilization. Any additional wooden walls would be built with pressure-treated lumber to withstand weathering, unlike the present wall which is treated with creosote.

Timber walls can be varied in height; however, an adequate foundation length must be provided. Wooden retaining walls provide protection similar to concrete and Dura-hold walls, and they will prevent the deposit of trash and debris along the shore. Wooden walls require virtually no maintenance but, like concrete, are relatively expensive. In addition, most pressure-treated lumber is treated with chromated copper arsenate. Chromium, copper, and arsenic can be toxic to aquatic life, but minimal release of these metals occurs from the treated lumber.

Vegetation

The establishment of a permanent vegetative cover is another method that is often used for stabilizing banks. The primary advantage of vegetative covers is their low cost and, if properly selected, low maintenance requirements. There are no adverse environmental impacts associated with the use of vegetation for slope stabilization. Vegetation may be difficult to establish in high-traffic areas and would probably not be as effective as the other shoreline stabilization methods discussed for Franklin Lake; however, a vegetative cover could be effective on the slopes along the southwest shore of the lake near the high school.

Cost Summary

Shoreline stabilization would be beneficial for most of the lake shore. Shoreline areas along most the north and east shore, plus the west shore near the high school, are especially critical. Cost estimates for the various shoreline stabilization methods considered were developed for these areas and are summarized in Table 16. Vegetation was considered only for the southwest shore of the lake near the high school, while other stabilization methods were evaluated for most of the northern and eastern shores of Franklin Lake.

Table 16

Cost of Various Retaining Wall Options*

Stabilization Method	Total Cost
Dura-Hold Wall	$392,100
Maccaferri Gabions	$297,800
Rip-Rap	$175,100
Wood	$457,300
Concrete	$407,000
Vegetation	$1,600**

*Based on 1989 Dollars
**Southwest shore only

6.2.2 Created Wetlands

Wetlands can improve water quality by removing and retaining nitrogen and phosphorus, by processing chemical and organic wastes, and by reducing the sediment load of the water. Wetlands have recently been used as treatment areas for urban runoff because they are effective nutrient sinks. Forty to eighty percent of influent total phosphorus and eighty percent of influent nitrogen from urban runoff have been retained in wetlands (Barten, 1983).

The purpose of creating wetlands in Franklin Lake's tributaries is to slow down the flow of water so that fine particulate sediment and associated nutrients will settle out before the water reaches the lake. Wetland plants will also use some of the dissolved nutrients which will reduce the total nutrient load to Franklin Lake. There are additional advantages to creating wetlands. Plants can be chosen for their beauty, and arranged to maximize function and aesthetic appeal. Wetlands support a diverse community of invertebrates, and with cover supplied by wetland plants, young fish are provided with an ideal nursery habitat.

Sites selected for creation of wetlands should be furnished with a permanent source of water to ensure that soils remain saturated throughout the growing season. Also, soils should be relatively non-permeable, so that water will be retained. Both of these criteria are satisfied at the proposed sites. Soils are in the Fallsington and Shrewsbury series which are categorized as soils displaying consistent hydric (wet) conditions in most places (Tiner, 1985). The Fallsington and Shrewsbury series consist of deep, poorly drained soils. Both are rated as a good potential habitat for wetland plants (USDA, SCS, 1986).

Table 17 lists species of wetland plants which are recommended based on their availability, hardiness, suitability, and attractiveness (Plewa, 1987; Tiner, 1985). The plants listed are generally do not spread rapidly and are not expected to create additional problems in Franklin Lake.

The costs for the creation of artificial wetlands are limited to site preparation and the purchase of plants. The enlargement of the wetland along Dennis Brook would require the construction of a retention basin and outlet structure, while creation of an artificial wetland in the existing detention pond would require only minimal site preparation before planting could begin. The estimated costs are $37,000 for the Dennis Brook location and $3,000 for the existing retention pond.

Table 17

Recommended Wetland Plants

Water Depth	Scientific Name	Common Name	Description
Fringe	Phragmites maximus*	Elephant Grass	6-12 ft.tall silky plume
	Iris versicolor Iris prismatica Iris pseudacorus	Blue Flag Slender Blue Flag Yellow Iris	1-3 ft. tall Blooms late spring to early summer
	Hibiscus palustris	Swamp Rose Mallow	3-7 ft. tall Large showy pink or white flowers in August
	Acorus calamus	Sweet Flag	1-4 ft. tall Fragrant foliage
	Typha latifolia Typha augustifolia	Cattail Narrow-leaved Cattail	4-8 ft. tall
	Lobelia cardinalis	Cardinal Flower	2-5 ft. tall Scarlet flowers in Aug. and Sept.
0-1 ft.	Hydrocotyle ranunculoides*	Water Pennywort	Creeping or floating
	Nelumbo lutea	American Lotus	Large leaves and pale yellow flowers above the water
	Nymphaea oderata	Fragrant Water Lily	Floating leaves and white fragrant flowers
	Nasturtium officianale*	Watercress	Floating or creeping

Table 17 (Continued)

Recommended Wetland Plants

	Sagittaria latifolia*	Broadleaf Arrowhead	1-2 ft. tall White flowers
	Peltandra virginica*	Arrow Arum	3-4 ft. tall
1-3 ft.	Pontederia cordata	Pickerelweed	1-3 ft. tall Blue flowers in summer and fall
	Anacharis occidentalis	Elodea	Submersed

* Presently growing near Franklin Lake

6.2.3 Agricultural Best Management Practices (BMP's)

Nonpoint source pollution from agricultural runoff is a potential source of phosphorus, nitrogen, and sediment in the Franklin Lake watershed. A 20-acre farm at the head of Dennis Brook is not currently farmed; however, agricultural BMP's should be implemented if this farm is actively farmed in the future. Because the land in this area is relatively flat, buffer strips or other similar measures would reduce potential pollutant inputs. Buffer strips cost approximately $400/acre and could remove about 50 percent of the total phosphorus and suspended solids loads. Any control measures should be coordinated with the Monmouth County Soil Conservation Service.

6.2.4 Road and Storm Sewer Maintenance

Catch basins throughout the Franklin Lake watershed should be cleaned out on a regular basis. Sediment accumulates in the basins and should be removed to assure the continuing efficiency of these structures. If the sediment is not removed from the catch basins on a regular basis, the sediment from the streets will wash into the lake.

Street sweeping has been somewhat effective in reducing sediment loadings from streets; however, most of the sediment that accumulates on the streets in West Long Branch is very sandy and would be difficult to collect with a street sweeper. Regular cleaning of catch basins would be more effective than street sweeping at Franklin Lake, especially if the frequency of cleaning is increased. The Borough of West Long Branch should consider allocating additional funds, estimated at $1,500 per year for the additional maintenance required.

6.2.5 Erosion and Sediment Control

A watershed survey was performed to locate any potential problem areas with respect to soil erosion. The results of the survey indicate that most of the watershed is stabilized. However, gully erosion does occur near the intersection of Franklin Parkway and East Lakeview Avenue. The erosion near this area can be corrected by reconstructing the intersection at an estimated cost of $9,200. Additional pollutant loads from urban areas can be significantly reduced by implementing best management practices at construction sites and planting cover on exposed areas.

The existing detention basin at Peter Cooper Village has been effectively removing sediment. Cattails are now growing in the basin, which further increases its effectiveness. The sediment has accumulated to the point where both inlet and outlet structures are becoming blocked. Modification of the outlet structure and cleaning the areas around the inlet structures would increase the effectiveness of the basin and prevent possible drainage problems which could result if the basin is not maintained.

6.2.6 Park Management Practices

Waterfowl

Although feeding wildfowl is an enjoyable and seemingly kind and generous activity, it can adversely affect the bird population as well as create water quality problems in the lake and the quality of the grounds near the shore. Feeding birds makes them dependent upon people. Instead of continuing upon their natural migration in search of highly nutritious wetland and grassland plants and a warmer winter climate, wildfowl may be lured into remaining in an urban area where, since food is handed to them, they make no effort to find their own.

Most people offer bread, potato chips or popcorn to the birds, which fills them up but does not supply them with nutrients and fiber essential for their good health. The stresses created by crowded conditions, low nutrient food and harsh weather make the wildfowl population susceptible to avian diseases such as avian cholera, duck plague or avian botulism. Once the water becomes contaminated, diseases can be spread to migrant wildfowl populations.

Crowded conditions also make birds subject to increased predation (even from pet dogs and cats). The presence of a large waterfowl population will significantly increase phosphorus, nitrogen and fecal bacteria levels in the water. Bird droppings along the shore and on park grounds create an aesthetic problem, and also may pose a health threat due to possible bacterial contamination.

Because of the problems resulting from a large resident wildfowl population, communities may decide to use methods which would discourage birds from making urban parks into permanent homes. The easiest and most effective method to control wildfowl is to discontinue feeding. However, if people strongly support bird feeding as a recreational activity, perhaps it could be limited to supplying corn or cracked wheat during times of severe weather. The U.S. Department of Agriculture (U.S.D.A.) no longer relocates waterfowl because they have found relocation provides only temporary relief from the problem. No sooner are the old birds removed than new ones arrive to take their place. It is the features of the environment which attract and retain birds that must be changed. The U.S.D.A. recommends the following as steps to take in reducing problems caused by nuisance populations of residential waterfowl consisting of semi-wild mallard ducks and Canada geese:

1. Stop all feeding of ducks and geese, even if it means drafting an ordinance with provisions for a fine in persistent violations. It is unlikely that a ban on feeding waterfowl would be completely successful, but an educational campaign and signs asking residents not to feed these birds may have some effect.

2. Construct signs explaining the problems caused by feeding the birds.

3. Eliminate all domestic waterfowl from the area, including white Peking ducks, Muscovy ducks, and Emperor geese. These birds act as live decoys which attract wild birds. The presence of domestic birds encourages feeding for humane reasons as well as attracting well-meaning members of the public to the area with additional handouts. In either event, wild birds soon learn to join in on the handouts, becoming quite bold and very much a nuisance.

4. Create barriers such as 2 foot fences, walls or hedgerows between the water and shore areas containing grass or plants which birds would eat.

5. Use scarecrows, exploders, balloons or flags to startle and prevent birds from landing in specified areas.

Community residents may decide that they would like to keep a resident population of waterfowl at the park. If so, the population must be managed to limit the number of individuals, and their access to park land and the lake should be restricted and maintained to protect water quality, public health and the health of the birds.

<u>Litter Control</u>

Some litter was observed in the park, which is not surprising considering the lack of garbage cans. More garbage cans placed at strategic locations around the lake would improve overall park cleanliness and keep unwanted garbage out of the lake. This will require the cooperation of the West Long Branch Public Works Department.

Model Boating

The issue of whether or not battery-operated model boats were allowed on Franklin Lake was raised during the course of this investigation. The current ordinance reads in part: "No person shall...operate any motor powered boat, raft or other watercraft upon any lake... However, this prohibition shall not apply to non-powered boats, crafts, or other watercraft." This ordinance would appear to allow model boats, depending on the definition of the "operator" of the boat. The current ordinance would probably need to be amended if the Borough of West Long Branch wanted to keep model boats off the lake, especially if the ban was only intended for battery-powered model boats.

6.2.7 Homeowner Practices

Local residents can reduce nutrient and sediment loads which enter Franklin Lake via urban runoff by following several simple recommendations. The suggested measures involve minimal costs, requiring only a public education campaign. The resulting reductions in pollutant loads would also be small, but would have a beneficial effect on Franklin Lake.

The controlled use of lawn fertilizers with respect to both the time and quantity of application can reduce nutrient inputs. Proper disposal of trash and pet wastes reduces nutrient and bacterial loads, while keeping trash and litter out of stream channels reduces pollutant loads and promotes good drainage. The enforcement of the "pooper scooper" ordinance in the park would be especially effective in controlling pet wastes. A sign should be erected in the park to inform the public that the ordinance will be enforced. Other pollution control measures that can be taken include the installation of splash blocks below gutters and pipe outlets, the maintenance of a good vegetative cover to prevent exposed soil areas, washing cars over grassy areas where phosphates will be partially absorbed, proper disposal of automobile solutions, and limited use of pesticides and herbicides. Residents of West Long Branch should use proper erosion and sediment control measures when making improvements to their property.

6.2.8 Stormwater Diversion

Diversion of stormwater entering Franklin Lake would permanently eliminate a portion of the nutrient and suspended solids loadings. Existing storm sewers entering the lake from the Shore Regional High School parking lot and from Lakeview Street adjacent to the park could be connected to an interceptor sewer with minimal difficulty because only school and park land would be disturbed.

The stormwater diversion would eliminate pollutant loadings from approximately 10 percent of the Franklin Lake watershed and would remove an estimated 10 percent of the total phosphorus load and 12 percent of the total suspended solids load. The total estimated costs for stormwater diversion would be $254,000. The interceptor line for the high school parking lot would cost $139,000 and the line along the lake shore on the side of the lake near the gazebo would cost $115,000.

Annual removal costs for total phosphorus and total suspended solids would be dependent on the life of the project. If a 50-year project life is assumed, annual costs would be $21.60/kg/yr for total phosphorus and $0.03/kg/yr for total suspended solids removal.

The diverted stormwater would enter Dennis Brook below the Franklin Lake outfall and would result in higher nutrient and suspended solids loadings to this stream. There is also a possibility that higher bacterial levels will reach Dennis Brook and other downstream locations if stormwater is diverted from Franklin Lake. Because of these considerations and the current concern over pollution of the New Jersey coast, stormwater diversion is not recommended.

7.0 Recommended Management Plan

Based on the data collected during the diagnostic portion of this study and the research into the feasibility of various lake and watershed management techniques presented in Sections 5 and 6 of this report, a recommended program to address the water quality problems in Franklin Lake has been developed. The recommended management plan for Franklin Lake consists of a combination of in-lake restoration methods and watershed management techniques.

7.1 In-Lake Restoration Methods

Franklin Lake should be dredged to deepen the lake and enhance recreational activities. Approximately 21,400 cubic yards of unconsolidated sediment are located in Franklin Lake. Based on the evaluation of dredging alternatives, mechanical dredging was choosen as the best option for dredging Franklin Lake. Estimated costs for the dredging project are $355,000.

Dredging alone may not eliminate the existing problems with algal blooms. If the desired improvements in water quality do not occur after the dredging program has been completed, aeration should be considered as an additional lake management option.

7.2 Watershed Management

7.2.1 Shoreline Stabilization

A combination of concrete walls and vegetative cover are recommended for shoreline stabilization at Franklin Lake. While the concrete walls are more expensive than some of the other options, their versatility, durability, and low maintenance requirements make them the preferred option. The shoreline stabilization program was divided into five phases because of the high costs involved, with the most critical areas to be treated first. Phase 1 would stabilize the north shore of the lake, while Phases 2 and 3 would stabilize much of the east shore. Phase 4 would establish a vegetative cover on a portion of the west shore of Franklin Lake, and Phase 5 would replace the existing wooden retaining wall at the northeast corner of the lake.

The locations of the shoreline areas to be stabilized are shown in Figure 18, which shows the area to be treated during each phase. Phases 1, 2, 3, and 5 all involve the placement of concrete walls, while Phase 4 would establish a permanent vegetative cover for bank stabilization. The existing walkway on the north side of the lake, between the gazebo and the outlet structure, is crumbling and falling into the lake and will need to be relocated. Estimated costs for each phase of the shoreline stabilization project and the length of shoreline to be stabilized are shown in Table 18.

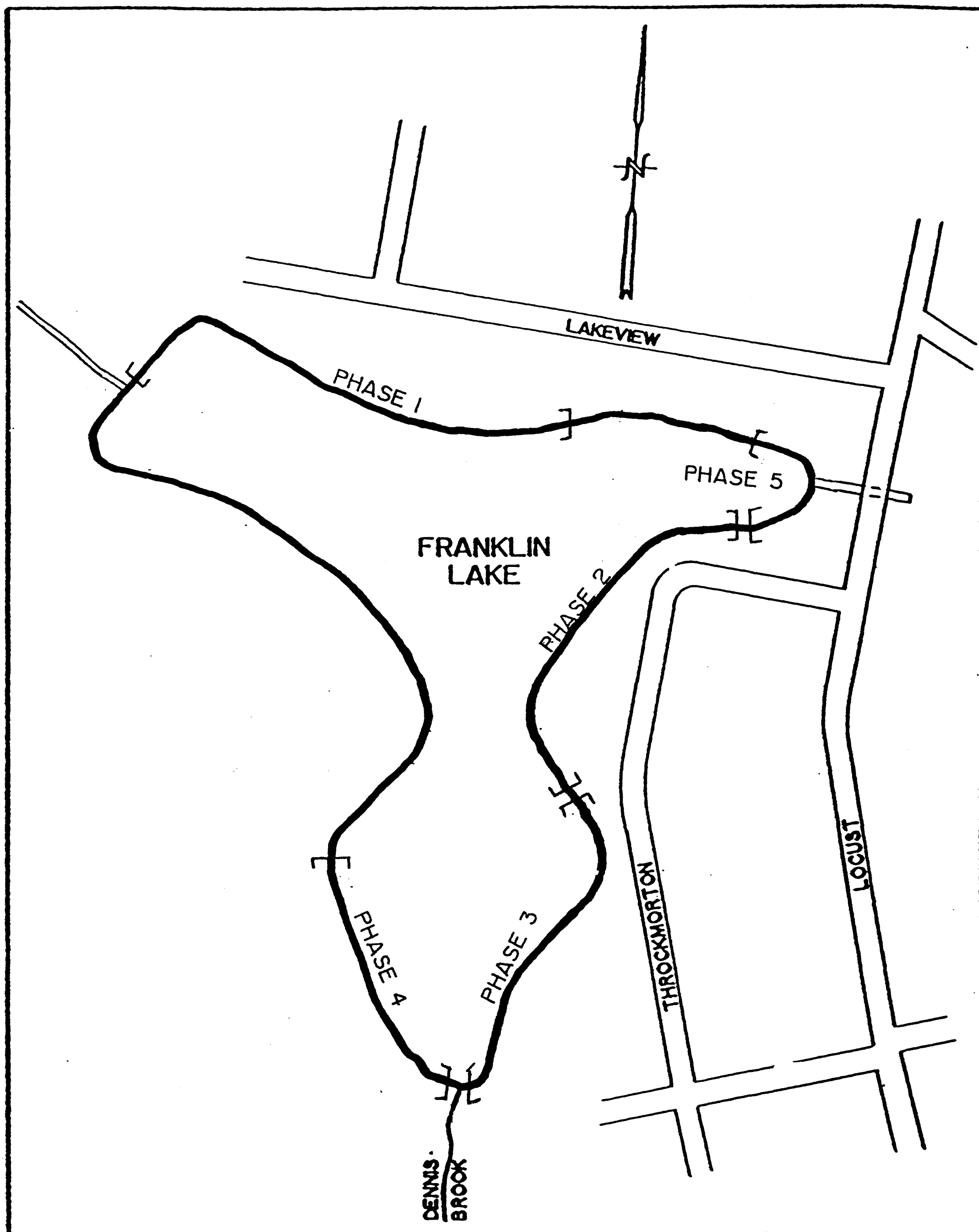


Figure 18	Locations for Shoreline Stabilization

Table 18

Estimated Costs for Shoreline Stabilization*

Phase	Linear Feet	Stabilization Method	Estimated Cost
1	1100	Concrete	$130,700
2	900	Concrete	$107,300
3	900	Concrete	$107,300
4	710	Vegetation	$1,600
5	280	Concrete	$61,700
Permitting			$10,000
Total	**3890**		**$418,600**

*Based on 1989 Dollars

7.2.2 Created Wetlands

Creating wetlands upstream of Franklin Lake will reduce nutrient and sediment loadings. Two wetlands are proposed for Franklin Lake and would enlarge existing wet areas. These areas are located along Dennis Brook near Shore Regional High School and at the existing retention pond about 1000 feet east of Franklin Lake along the Locust Avenue tributary, as shown in Figure 19.

The Dennis Brook wetland will require construction of an in-stream retention basin at an estimated cost of $37,000. Wetland plantings are all that will be required for the existing retention pond; costs for this location are $3,000.

7.2.3 Agricultural BMP's

Agricultural BMP's should be implemented if the farm at the headwaters of the lake along Dennis Brook is actively farmed. Filter strips should be installed between the stream and the fields at a total cost $1,000. The installation of agricultural BMP's should be coordinated with the Monmouth County Soil Conservation Service.

This farm is also the only piece of land in the Borough of West Long Branch that could be developed. West Long Branch should ensure that the property is not used for industrial, commercial or high-density residential purposes if this area is re-zoned.

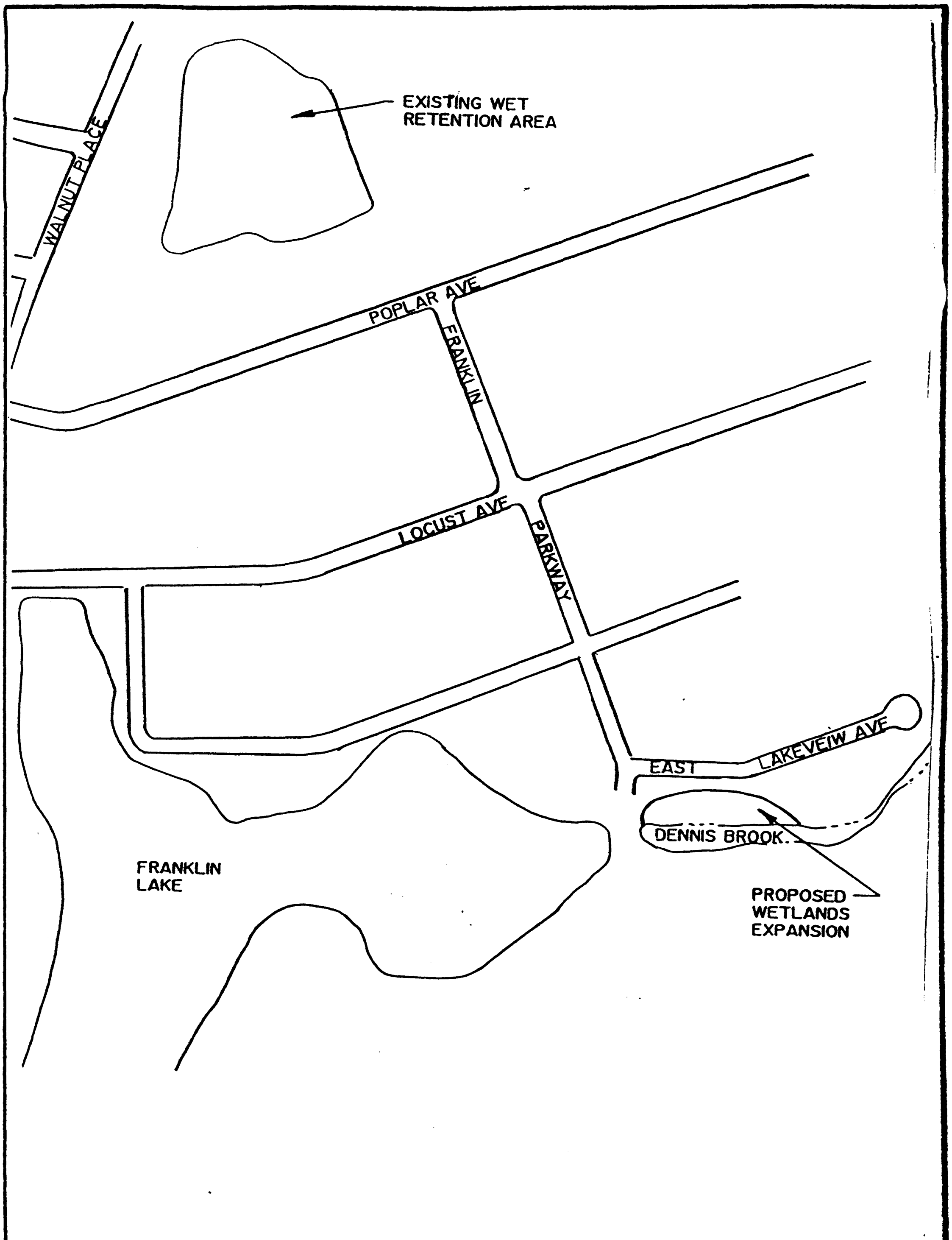


Figure 19	Location of Created Wetlands

7.2.4 Erosion and Sediment Control

An intensive survey of the Franklin Lake watershed was performed to identify areas in the watershed that are not stable. The area at the southeast end of the lake near the Dennis Brook inlet, which used to be a dirt parking area, is not stable and gulley erosion occurs during storm events. Runoff from the streets concentrates in this area and runs directly into the lake. This situation can be remedied by installing a curb and directing the runoff to a new storm sewer inlet. The installation of curbing and reconstruction of the drainage facilities for the intersection has an estimated construction cost of $9,200.

The existing retention basin at Peter Cooper Village should be cleaned and altered to increase its efficiency. Modification of the outlet structure and cleaning the areas around the inlet structures would increase the effectiveness of the basin and prevent possible drainage problems which could result if the basin is not maintained. The estimated costs for rehabilitation of the detention basin is $10,000. Since this detention basin is on private property, State or Federal funds could not be used for the suggested cleaning and modification unless a maintenance agreement is obtained by the Borough of West Long Branch.

7.2.5 Public Education Program

<u>Homeowner Practices</u>

The Borough of West Long Branch should make every effort to inform local citizens of the steps they can take to help protect Franklin Lake. A "homeowner practices" flyer should be developed and distributed to the residents of West Long Branch. A public workshop should be scheduled to discuss these practices and to inform the public of the necessity for the control of waterfowl and pet wastes.

<u>Parkland Management</u>

The Borough of West Long Branch should install signs asking residents not to feed the ducks at Franklin Lake because of their impact on the nutrient budgets for the lake. The public should be made aware of the detrimental effects of waterfowl on the water quality of Franklin Lake. If necessary, The Borough of West Long Branch should consider the adoption of an ordinance to prohibit the feeding of ducks and geese in the park.

The Borough of West Long Branch should actively enforce the "pooper scooper" ordinance. A sign should be erected in the park to inform the public that the ordinance will be enforced. Increased enforcement would reduce nutrient loads and improve the aesthetics of Franklin Lake Park.

7.3 Preliminary Engineering Design

7.3.1 Dredging

A preliminary dredging program has been designed for Franklin Lake. The detailed bathymetric survey of Franklin Lake (Appendix A) included 31 transects of the lake, which were used to calculate the volume of the lake and the volume of unconsolidated sediments. Three typical transects, showing both existing and proposed bottom contours and sediment depths, are shown in Figure 20. The locations of these three transects are indicated in Figure 21.

Three disposal areas were identified by representatives of West Long Branch, as shown in Figure 22. Disposal Site #1 is the closest to the lake and has a capacity to accept approximately 11,600 cubic yards of sediment if a 3 foot earthen berm is built around the area. Based on the underlying soils, vegetation and hydrology of the area, this area is not a wetland and would be an acceptable spoils disposal area. Because this area cannot accept the total volume of sediments recommended for removal from Franklin Lake, some dredged sediments will need to be allowed to dewater and settle at this site for later disposal at the County Landfill to allow completion of the proposed dredging project.

Disposal area #2 is relatively steep and could potentially provide additional spoils disposal area, but a sanitary sewer line cuts through this site and a manhole is located in the lower portion of the site. The third disposal area that was evaluated was a wetland and therefore was considered to be an unsuitable spoils disposal area.

Franklin Lake should be mechanically dredged with a dragline that will be attached to a shore-mounted crane. The lake will be lowered 1 to 2 feet to allow some of the sediments to dewater before dredging begins. Sediment will be deposited into trucks and hauled to the disposal site for final dewatering. Most of the unconsolidated sediments will be removed from Franklin Lake, although some sediments will also be removed to provide a smooth final bottom contour.

7.3.2 Shoreline Stabilization

The recommended method of shoreline stabilization for Franklin Lake is a combination of concrete retaining walls and natural vegetation. Figure 23 is a preliminary design drawing of the proposed concrete wall at Franklin Lake. The existing banks along Franklin Lake are steep and vary in height from 1 feet to 4 feet. The proposed concrete wall will be constructed to an elevation of 2 feet above the surface of the water; drains are included in the wall design to alleviate excess pressure buildup behind the wall. In areas where the bank is higher than 2 feet,

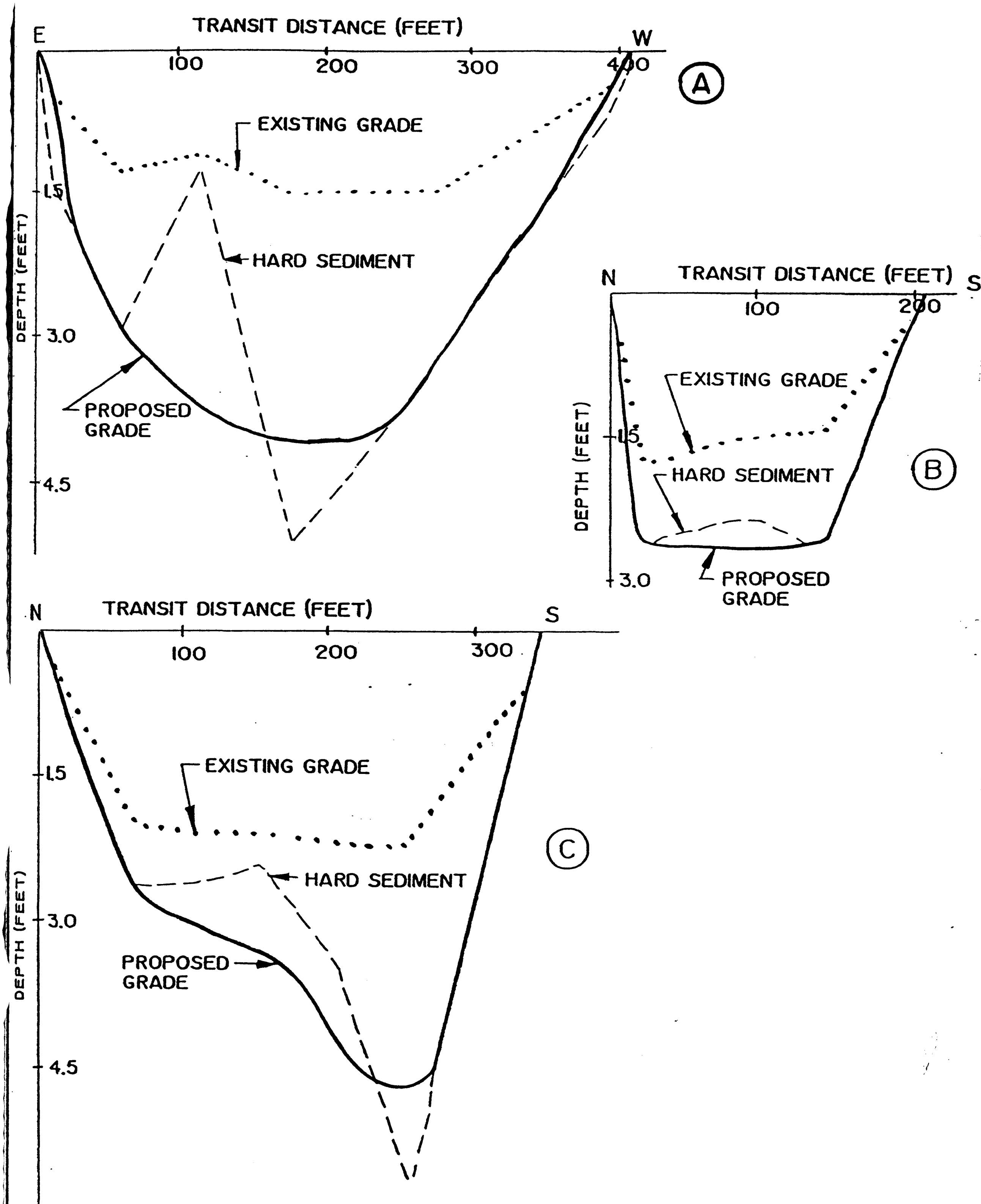


Figure 20	Typical transects of Franklin Lake

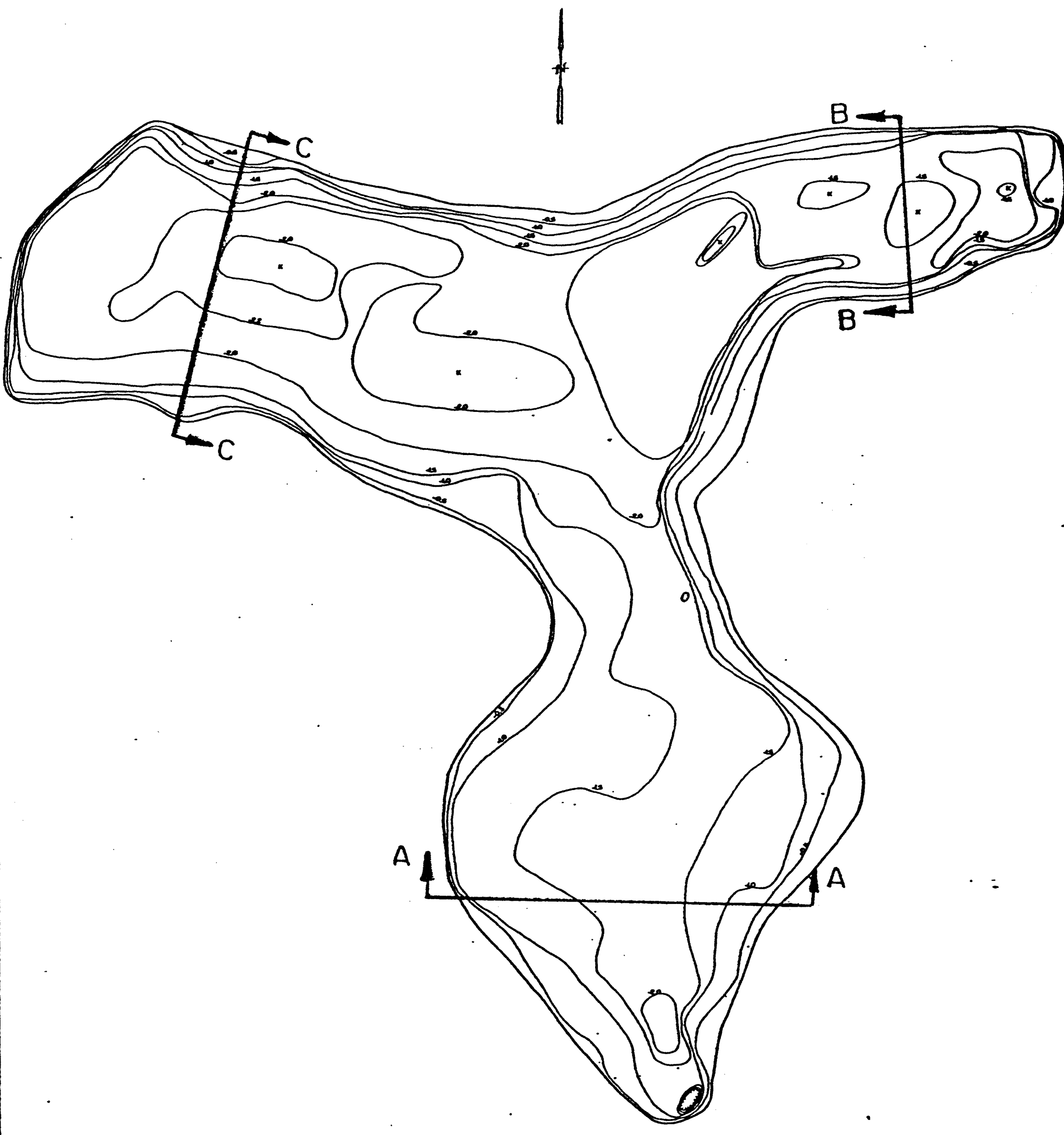


Figure 21	Locations of transects shown in Figure 20

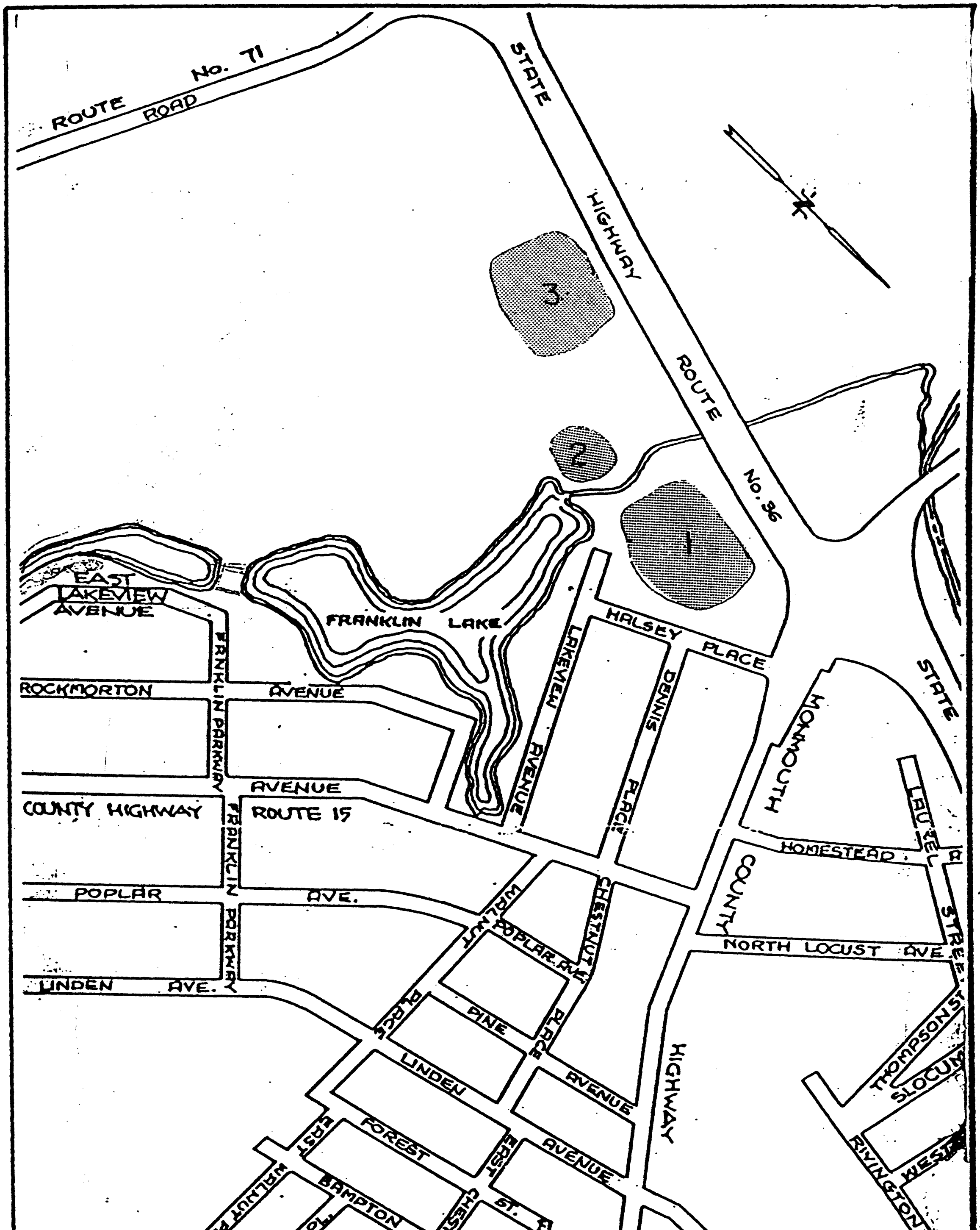


Figure 22	Potential dredge spoil disposal areas

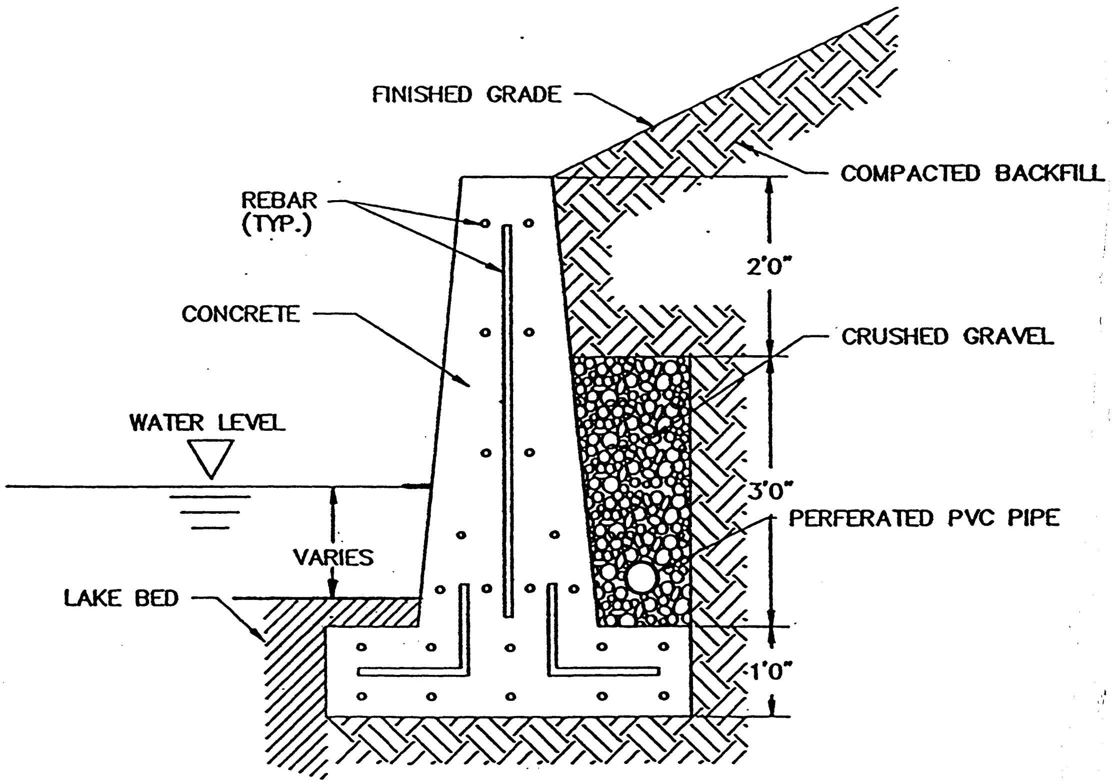


Figure 23	Proposed concrete wall for shoreline stabilization

the bank behind the retaining wall will be graded to a slope of 2:1 or 3:1, depending on site locations. These graded areas will be revegetated with grass.

7.3.3 Created Wetlands

The recommended plan calls for the installation of an instream detention basin in Dennis Brook. Wetland plants will be planted in the basin to decrease water velocity and to absorb nutrients. A three foot earthen embankment will be constructed across Dennis Brook just upstream of the inlet culvert.

The construction of a retention basin in a stream is subject to the NJDEP's Flood Hazard Rules and Regulations as they pertain to stream encroachment. The regulations require detailed hydrologic and hydraulic analysis to determine changes in water surface level, flow patterns, and erosion potential resulting from the proposed construction. Final disign of the instream retention basin will include a hydraulic analysis of backwater level conditions using the HEC-2 computer model.

Results of the hydraulic analysis will provide key information to be used in the final design of the dam and outlet structure. Included in the design will be a complete structural and foundation analysis including consideration of overturning and sliding effects of the earthen embankment. Specified soil erosion and sediment control requirements will also be incorporated into the final design.

The wet basin located above the Locust Avenue Branch will also be modified to enhance sedimentation and nutrient uptake. Wetland plants will be planted around the lake, especially near the two major inlet culverts. During the final design phase, a planting plan will be developed. A hydraulic analysis of the basin will also be performed to ensure that the wetland plants will not cause or aggravate flooding problems.

7.3.4 Erosion and Sediment Control

Existing gully erosion near the intersection of Franklin Parkway and East Lakeview Avenue can be corrected by reconstructing the intersection, as shown in Figure 24. The new storm sewer inlet would tie into an existing storm sewer which empties into Dennis Brook above Franklin Lake. Existing uncovered areas will be graded and seeded.

Final design considerations for the proposed modifications should include an evaluation of the design capacity of the existing storm sewer. A hydrologic and hydraulic analysis of the existing storm sewer will be necessary to determine if the existing sewer will have the capacity to handle the additional flow. If not, then a new sewer will need to be installed.

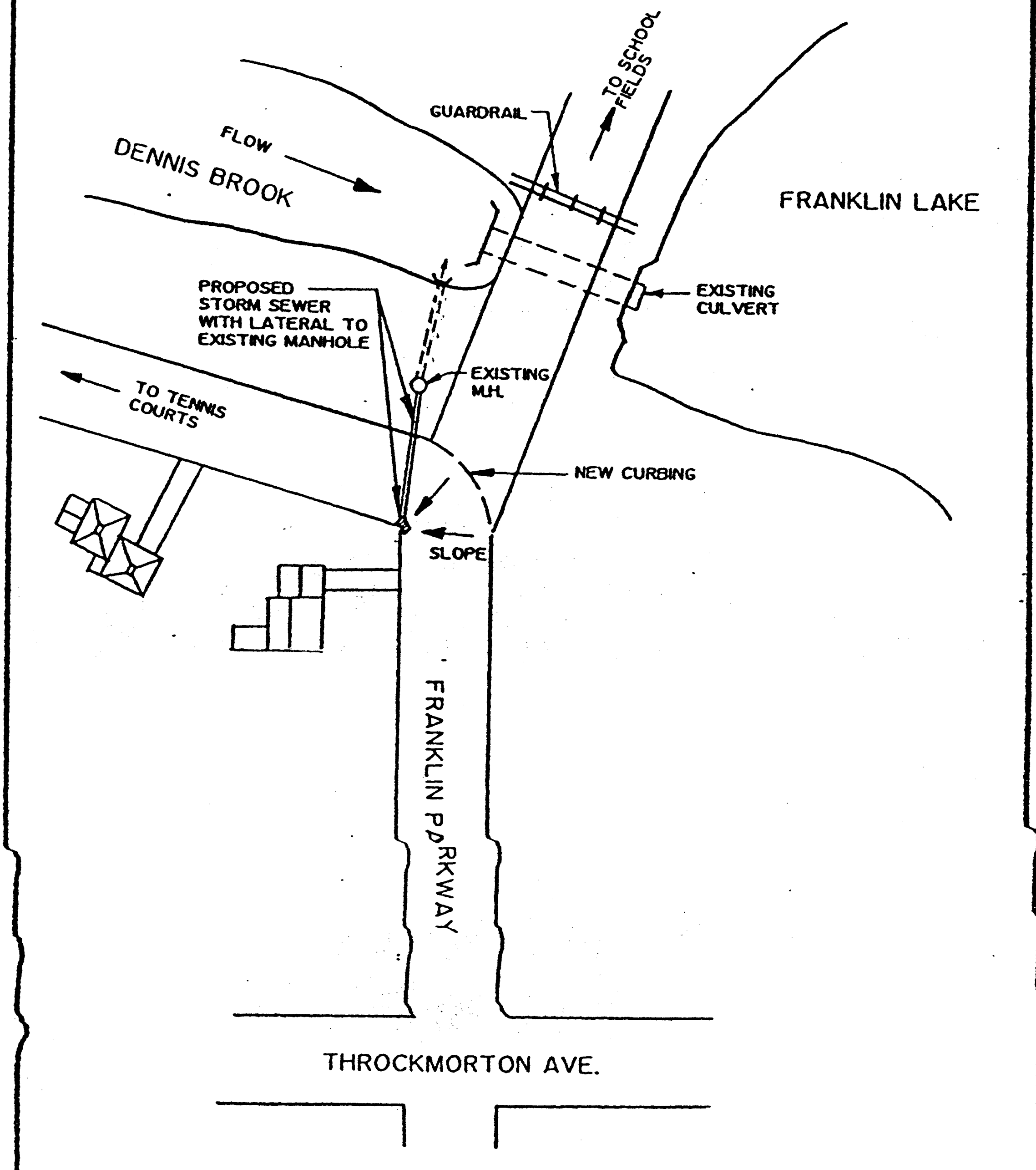


Figure 24	Proposed intersection reconstruction

7.4 Implementation Program

7.4.1 Financial Assistance

Recent trends in federal funding indicate that implementation of the recommended management plan for Franklin Lake may have to derive funds from local, regional, and State sources. The original intent of the Clean Lakes Program was to fund Phase I studies to diagnose lake problems and develop feasible restoration alternatives, and then provide Phase II grants to implement lake restoration programs.

Clean Lakes Program funding has been curtailed in recent years, but a Phase II application for the Franklin Lake will be submitted to both the New Jersey Department of Environmental Protection, and the U.S. Environmental Protection Agency. If a Phase II grant is awarded by the EPA, 50 percent of the total project costs would be funded at the federal level, and the remaining 50 percent would require a local match. The award of a Phase II grant from the New Jersey Lakes Management Program would provide 75 percent of the funding and would require a 25 percent local match. If the project is funded by both the EPA and the New Jersey Lakes Management Program, the U.S. EPA would provide 50 percent of the the total project costs, the New Jersey Lakes Management Program would provide 40 percent of the total project costs, and local funding would be required for the remaining 10 percent.

The Natural Resources Preservation and Restoration Act, currently under consideration by the New Jersey Legislature, would allocate up to $10 million per year for shore protection, conservation, flood protection, and dredging projects. If this bill is passed, portions of the Franklin Lake restoration project might also qualify for 80 percent funding under this program.

7.4.2 Future Monitoring

EPA regulations require that water quality monitoring be conducted to detect changes occurring as a result of Phase II restoration programs. A limited monitoring program should be conducted throughout the restoration project and for at least one additional year after all facets of the management program are in place.

Collection of water quality data from Station C, near the lake outlet should be sufficient to determine trends in water quality arising from restoration efforts. Since control measures are directed toward the removal of nutrients and suspended solids, regular analyses will include most of the parameters measured during the Phase I study, including dissolved reactive phosphorus, total phosphorus, nitrate + nitrite-N, ammonia-N, total Kjeldahl nitrogen, total suspended solids, chlorophyll <u>a</u>, phytoplankton, Secchi depth, dissolved oxygen and temperature profiles, pH, and alkalinity.

7.4.3 Scheduling

Providing that acceptable funding arrangements can be made, the implementation schedule presented in Table 19 is recommended for the restoration of Franklin Lake. Actual dates for the activities listed in Table 19 would depend on schedules set by the funding source and contractor's availability.

Table 19

Milestone Schedule for Franklin Lake Restoration

Activity	Date
Engineering and Permits	September, 1989 to August, 1990
Lake Drawdown and Sediment Consolidation	September, 1989 to January, 1990
Dredging and Weir Construction	January, 1990 to June, 1990
Monitoring Program	June, 1990 to May, 1991

7.4.4 Permit Requirements

A number of permits may be required for implementation of the proposed restoration project. If dredging is chosen as the lake restoration alternative, the permits and fees listed in Table 20 may be required.

7.5 Environmental Evaluation

Since socio-economic and environmental impacts are part of the cost-effectiveness analysis for the restoration of Franklin Lake, many of these impacts were addressed during the evaluation of restoration alternatives. However, the impacts and their mitigative measures are formally documented below using the environmental evaluation checklist in the Clean Lakes Program Guidance Manual (U.S. EPA, 1980).

Table 20

Permits needed for lake drawdown and dredging in New Jersey

Permit	Fee
Temporary Water Lowering Permit NJDEP Division of Fish, Game and Wildlife	$2.00
Stream Encroachment Permit NJDEP Division of Water Resources	$1500.00 for each major element (re-channelization, weir) $150.00 for each minor element
Freshwater Wetlands Permit	$1000.00 plus $100.00 per 1/10 acre affected wetland
Water Quality Certification NJDEP	
New Jersey Heritage Section 106 Review NJDEP Office of New Jersey Heritage (may not apply)	
Soil Erosion and Sedimentation Control Certification NJSSCC (may not apply)	

1. Will the project displace people?

   No.

2. Will the project deface existing residences or residential areas?

   No. Residential areas are not affected by the proposed plan.

3. Will the project be likely to lead to changes in established land use pattern or an increase in development pressure?

   No. The Franklin Lake watershed is almost completely developed and land use patterns should not change.

4. Will the project adversely affect prime agricultural land or activities?

   No. Prime agricultural lands will not be affected by the proposed restoration program.

5. Will the project adversely affect parkland, public land or scenic land?

   No. Restoration activities will greatly enhance the recreational and aesthetic uses of the lake and adjacent park land.

6. Will the project adversely affect lands or structures of historic, architectural, archeological or cultural value?

   The project as planned involves no modifications or activities which will impact existing structures. No lands which have not already been altered by agricultural or other development activities will be affected.

7. Will the project lead to a significant long-range increase in energy demands?

   The selected restoration alternatives will not cause any significant increases in energy demand over the long-term. An increase in energy demand would result if the aeration option is chosen, but the resulting energy requirements are expected to be small.

8. Will the project adversely affect short-term or long-term ambient air quality?

   Air quality may be affected over the short-term due to construction activities. All construction equipment should have proper emission controls and proper dust control practices should be used.

9. Will the project adversely affect short-term or long-term noise levels?

   Noise levels may be temporarily affected by construction activities. All construction vehicles and equipment should use noise control devices. The compressors from an aeration system may slightly increase noise levels in the immediate area, but no major effects are expected.

10. If the project involves the use of in-lake chemical treatment, will it cause any short-term or long-term effects?

    The use of chemical treatment is not proposed for this project.

11. Will the project be located in a floodplain?

    Yes. Created wetlands will be located in the floodplain.

12. Will structures be constructed in the floodplain?

    Yes. A small dam will be constructed to create an artificial wetland and the shoreline stabilization structures will be located in the floodplain.

13. If the project involves physically modifying the lake shore, its bed, or its watershed, will the project cause any short or long-term adverse effects?

    Shoreline stabilization and dredging activities may cause temporary increases in be lake turbidity. Other construction activities could result in the transportation of nutrients, sediments or other pollutants to downstream waters. This will be minimized by lowering the lake level prior to construction activities. All earthmoving activities will be conducted in a way to minimize the erosion potential and minimize in-lake turbidity.

14. Will the project have a significant adverse effect on fish and wildlife, wetlands or other wildlife habitat?

No adverse impacts on fish and wildlife, or on wetlands and other wildlife habitat is foreseen. The created wetlands would provide additional wildlife habitat, and any measure taken to control waterfowl in the lake would have long-term beneficial effects on waterfowl health.

15. Have all feasible alternative to the project been considered in terms of environmental impacts, resource commitment, public interest and cost?

All feasible alternatives for restoring Franklin Lake have been thoroughly analyzed. The recommended plan has minimal negative environmental impacts, and will improve water quality in Franklin Lake. Because of the complexity of the problems encountered in Franklin Lake and its watershed, the recommended multiple approach appears to be the most cost-effective method to improve fishing, boating, aesthetics, and other lakeside uses of Franklin Lake.

16. Are there other measures not previously discussed which are necessary to mitigate adverse impacts resulting from the project?

There are no possible mitigation measures known at the present time which not been discussed.

8.0 Public Participation

A questionnaire was prepared for the residents of the Borough of West Long Branch as part of the public participation program for the Franklin Lake Phase I Diagnostic-Feasibility Study, The purpose of the questionnaire was to establish public opinion regarding the potential uses of Franklin Lake.

The questionnaire was distributed to residents of West Long Branch by mail along with an announcement for a public meeting that was held on November 23, 1987. A total of 2,465 questionnaires were distributed, and 286 questionnaires, or 11.6 percent, were returned.

Table 21 is a sample questionnaire that has been completed showing the percentages of responses to each question. In general, 83 percent of the people that returned the questionnaire were aware of the Phase I Study, 90 percent think that it is important to protect and restore Franklin Lake, and 72 percent believe that the water quality of Franklin Lake is poor. Approximately 71 percent of the responders are aware that waterfowl contribute to the water quality problems; however, only 27 percent believe that duck feeding should be prohibited. 52 percent of the responders believe that duck feeding should be limited. Most of the people that responded to the questionnaire lived within one mile of Franklin Lake; however, 18 percent of the people live 2 miles or greater from the lake. Approximately 54 percent visit the lake at least once per week.

Numerous reasons were cited for visiting Franklin Lake including picnicking, biking, fishing, walking, socializing, skating, jogging, sledding, feeding the ducks, watching fireworks, enjoying nature and relaxing. Most people feel that the uses of Franklin Lake Park should include ice skating, fishing, model boating and possibly canoeing.

On November 23, 1987, a public meeting was held at the Borough Hall in West Long Branch to discuss the Phase I Diagnostic-Feasibility Study of Franklin Lake. Approximately 80-90 citizens attended the meeting. F. X. Browne Associates presented the audience with a brief lake ecology primer, and then proceeded to explain the tasks that were being completed as part of the study. Several questions were asked by the audience which were answered by Dr. F. X. Browne. A copy of the questionnaire and the meeting announcement that was sent to all residents of West Long Branch, and the minutes from the November 23, 1987 meeting are presented in Appendix G.

On March 16, 1989, another public meeting was held at the Borough Hall in West Long Branch to present the results of the Phase I Study of Franklin. Dr. Chris Holdren, of F. X. Browne Associates, presented the audience of approximately 100 citizens

TABLE 21
RESPONSES TO QUESTIONNAIRE

FRANKLIN LAKE QUESTIONNAIRE

e take a few minutes to complete this questionnaire on Franklin Lake. We are
g to obtain as much information on public opinion of Franklin Lake as possible and
input will be very helpful. When you have completed the questionnarie fold it
the dotted line, put a 22 cent stamp on the space provided, and drop it in the mail
If you plan to attend the public meeting on November 23, 1987, you can bring your
ionnaire with you. Thank you for your cooperation.

How often do you visit Franklin Lake?

At least once per week: 54%
Less than once per week: 46%

How far do you travel to visit Franklin Lake?

Less than 1 mile: 82%
2 miles or more: 18%

Why do you visit Franklin Lake?

Relax: 18%
Nature: 21%
Walk: 27%
Socialize: 0.6%
Jog: 4.1 %
Feed Ducks: 12%
Bike: 2.1%
Other: 15.2 %

How would you rate the water quality of Franklin Lake?

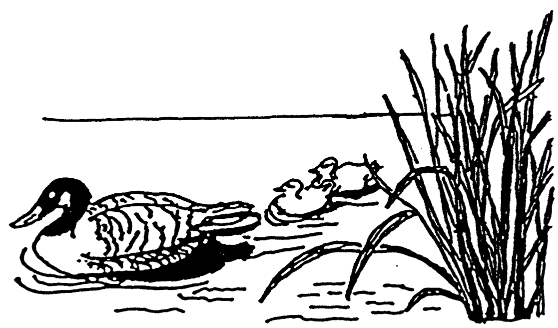
a 3% Good
b 25% Fair
c 72% Poor

Are you aware that a water quality study of Franklin Lake is currently underway?

Yes 83% No 17%

How important do you think it is to protect and restore Franklin Lake?

a 4% Not important
b 6% Slightly important
c 90% Very important



Did you realize that the waterfowl at Franklin Lake may have a negative impact on the water quality in Franklin Lake?

71% Yes 29% No

Do you think that duck feeding should be limited? 52%
Prohibited? 27% Neither 21%

Should the Borough of West Long Branch require "pooper scoopers"?

90% Yes 10% No

Different lake restorat techniques are available for differ t lake uses. How do you want to use the la and park?

Numbers in table represent number of responses.

	Definitely Not	Doubtful	Possible	Definitely Yes
Fishing	77	30	80	87
Row Boating	124	42	59	37
Paddle Boating	131	56	51	39
Model Boating	61	38	100	63
Canoeing	105	35	75	49
Ice Skating	12	7	44	206
Picnicing with B.B.Q. Facilities	121	22	60	61
Playground with swings, seesaws, climbing bars	93	27	54	77
Shuffle Board - Bocci	77	27	69	83
Jogging - Walking Path	7	3	18	242

*Swimming is not an option

PLACE STAMP HERE

POSTAL SERVICE WILL NOT DELIVER UNLESS STAMPED

F. X. Browne Associates, Inc.
220 South Broad Street
Lansdale, PA 19446

with the recommendations of the study and estimated costs to implement the recommendations of the study. A copy of the meeting announcement sent to postal patrons in The Borough of West Long Branch and minutes from the March 16, 1989 public meeting are presented in Appendix H.

9.0 References

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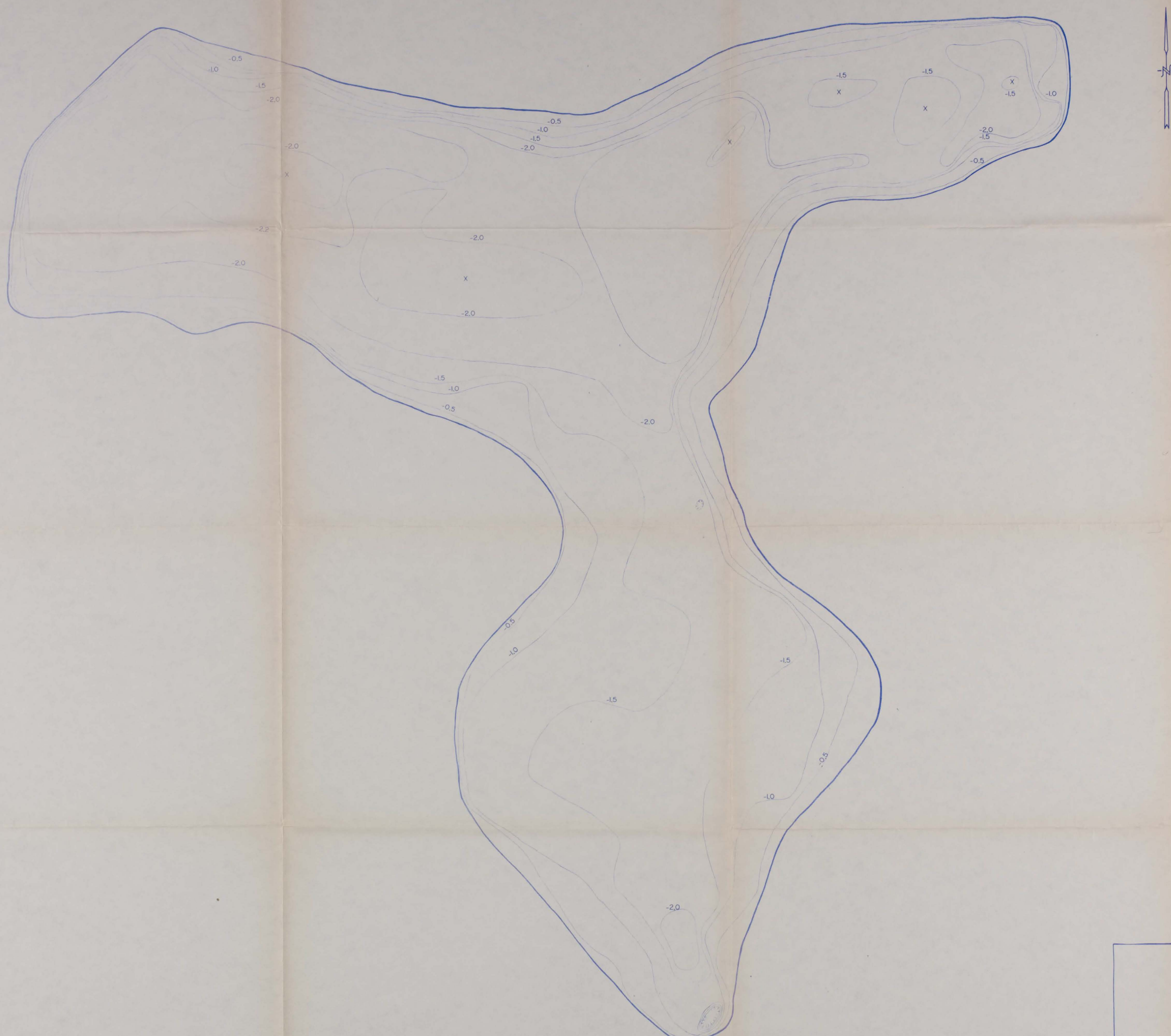
APPENDIX A

BATHYMETRIC MAP OF FRANKLIN LAKE



REV.	DESCRIPTION	DATE:	BY:

F. X. BROWNE ASSOCIATES, INC. ENGINEERS/PLANNERS/SCIENTISTS 220 S. BROAD ST., LANSDALE, PENNSYLVANIA 19446 TELEPHONE: 215-362-3878	SHEET NO.
	SCALE 1" = 60'
	PROJ. NO. 1113-01
FRANKLIN LAKE BATHYMETRIC MAP	DATE 5/11/88
	DRAWN ST
	CHECKED MRM
FRANCIS X. BROWNE, PH.D., P.E. PROFESSIONAL ENGINEER NJ LIC. NO. 28069 DATE	APPROVED
	REVISED

APPENDIX B

GLOSSARY OF LAKE AND WATERSHED TERMS

GLOSSARY OF LAKE AND WATERSHED MANAGEMENT TERMS*

Aeration: A process in which water is treated with air or other gases, usually oxygen. In lake restoration, aeration is used to prevent anaerobic condition or to provide artificial destratification.

Algal bloom: A high concentration of a specific algal species in a water body, usually caused by nutrient enrichment.

Algicide: A chemical highly toxic to algae.

Alkalinity: A quantitative measure of water's capacity to neutralize acids. Alkalinity results from the presence of bicarbonates, carbonates, hydroxides, salts, and occasionally of borates, silicates, and phosphates. Numerically, it is expressed as the concentration of calcium carbonate that has an equivalent capacity to neutralize strong acids.

Allochthonous: Describes organic matter produced outside of a specific stream or lake system.

Alluvial: Pertaining to sediments gradually deposited by moving water.

Artificial destratification: The process of inducing water currents in a lake to produce partial or total vertical circulation.

Artificial recharge: The addition of water to the groundwater reservoir by activities of man, such as irrigation or induced infiltration.

Assimilation: The absorption and conversion of nutritive elements into protoplasm.

Autochthon: Any organic matter indigenous to a specific stream or lake.

Autotrophic: The ability to synthesize organic matter from inorganic substances.

Background loading of concentration: The concentration of a chemical constituent arising from natural sources.

Base flow: Stream discharge due to groundwater flow.

Benthic oxygen demand: Oxygen demand exerted from the bottom of a stream or lake, usually by biochemical oxidation of organic material in the sediments.

Benthos: Organisms living on or in the bottom of a body of water.

Best management practices: Practices, either structural or non-structural, which are used to control nonpoint source pollution.

Bioassay: The use of living organisms to determine the biological effect of some substance, factor, or condition.

Biochemical oxidation: The process by which bacteria and other microorganisms break down organic material and remove organic matter from solution.

Biochemical oxygen demand (BOD), biological oxygen demand: The amount of oxygen used by aerobic organisms to decompose organic material. Provides an indirect measure of the concentration of biologically degradable material present in water or wastewater.

Biological control: A method of controlling pest organisms by introduced or naturally occurring predatory organisms, sterilization, inhibiting hormones, or other nonmechanical or nonchemical means.

Biological magnification, biomagnification: An increase in concentration of a substance along succeeding steps in a food chain.

*From EPA Clean Lakes Manual, 1980.

Biomass: The total mass of living organisms in a particular volume or area.

Biota: All living matter in a particular region.

Blue-green algae: The phylum Cyanophyta, characterized by the presence of blue pigment in addition to green chlorophyll.

Catch basin: A collection chamber usually built at the curb line of a street, designed to admit surface water to a sewer or subdrain and to retain matter that would block the sewer.

Catchment: Surface drainage area.

Chemical control: A method of controlling pest organisms through exposure to specific toxic chemicals.

Chlorophyll: Green pigment in plants and algae necessary for photosynthesis.

Circulation period: The interval of time in which the thermal stratification of a lake is destroyed, resulting in the mixing of the entire water body.

Coagulation: The aggregation of colloidal particles, often induced by chemicals such as lime or alum.

Coliform bacteria: Nonpathogenic organisms considered a good indicator of pathogenic bacterial pollution.

Colorimetry: The technique used to infer the concentration of a dissolved substance in solution by comparison of its color intensity with that of a solution of known concentration.

Combined sewer: A sewer receiving both stormwater runoff and sewage.

Compensation point: The depth of water at which oxygen production by photosynthesis and respiration by plants and animals are at equilibrium due to light intensity.

Cover crop: A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of permanent vegetation.

Crustacea: Aquatic animals with a rigid outer covering, jointed appendages, and gills.

Culture: A growth of microorganisms in an artificial medium.

Denitrification: Reduction of nitrates to nitrites or to elemental nitrogen by bacterial action.

Depression storage: Water retained in surface depressions when precipitation intensity is greater than infiltration capacity.

Design storm: A rainfall pattern of specified amount, intensity, duration, and frequency that is used as a basis for design.

Detention: Managing stormwater runoff or sewer flows through temporary holding and controlled release.

Detritus: Finely divided material of organic or inorganic origin.

Diatoms: Organisms belonging to the group Bacillariophyceae, characterized by the presence of silica in its cell walls.

Dilution: A lake restorative measure aimed at reducing nutrient levels within a water body by the replacement of nutrient-rich waters with nutrient-poor waters.

Discharge: A volume of fluid passing a point per unit time, commonly expressed as cubic meters per second.

Dissolved oxygen (DO): The quantity of oxygen present in water in a dissolved state, usually expressed as milligrams per liter of water, or as a percent of saturation at a specific temperature.

Dissolved solids (DS): The total amount of dissolved material, organic and inorganic, contained in water or wastes.

Diversion: A channel or berm constructed across or at the bottom of a slope for the purpose of intercepting surface runoff.

Drainage basin, watershed, drainage area: A geographical area where surface runoff from streams and other natural watercourses is carried by a single drainage system to a common outlet.

Dry weather flow: The combination of sanitary sewage and industrial and commercial wastes normally found in the sanitary sewers during the dry weather season of the year; or, flow in streams during dry seasons.

Dystrophic lakes: Brown-water lakes with a low lime content and a high humus content, often severely lacking nutrients.

Enrichment: The addition to or accumulation of plant nutrients in water.

Epilimnion: The upper, circulating layer of a thermally stratified lake.

Erosion: The process by which the soils of the earth's crust are worn away and carried from one place to another by weathering, corrosion, solution, and transportation.

Eutrophication: A natural enrichment process of a lake, which may be accelerated by man's activities. Usually manifested by one or more of the following characteristics: (a) excessive biomass accumulations of primary producers; (b) rapid organic and/or inorganic sedimentation and shallowing; or (c) seasonal and/or diurnal dissolved oxygen deficiencies.

Fecal streptococcus: A group of bacteria normally present in large numbers in the intestinal tracts of humans and other warm-blooded animals.

First flush: The first, and generally most polluted, portion of runoff generated by rainfall.

Flocculation: The process by which suspended particles collide and combine into larger particles or floccules and settle out of solution.

Gabion: A rectangular or cylindrical wire mesh cage (a chicken wire basket) filled with rock and used to protect against erosion.

Gaging station: A selected section of a stream channel equipped with a gage, recorder, and/or other facilities for determining stream discharge.

Grassed waterway: A natural or constructed waterway covered with erosion-resistant grasses, used to conduct surface water from an area at a reduced flow rate.

Green algae: Algae characterized by the presence of photosynthetic pigments similar in color to those of the higher green plants.

Heavy metals: Metals of high specific gravity, including cadmium, chromium, cobalt, copper, lead, mercury. They are toxic to many organisms even in low concentrations.

Hydrograph: A continuous graph showing the properties of stream flow with respect to time.

Hydrologic cycle: The movement of water from the oceans to the atmosphere and back to the sea. Many subcycles exist including precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Hypolimnion: The lower, non-circulating layer of a thermally stratified lake.

Intermittent stream: A stream or portion of a stream that flows only when replenished by frequent precipitation.

Irrigation return flow: Irrigation water which is not consumed in evaporation or plant growth, and which returns to a surface stream or groundwater reservoir.

Leaching: Removal of the more soluble materials from the soil by percolating waters.

Limiting nutrient: The substance that is limiting to biological growth due to its short supply with respect to other substances necessary for the growth of an organism.

Littoral: The region along the shore of a body of water.

Macrophytes: Large vascular, aquatic plants which are either rooted or floating.

Mesotrophic lake: A trophic condition between an oligotrophic and an eutrophic water body.

Metalimnion: The middle layer of a thermally stratified lake in which temperature rapidly decreases with depth.

Most probable number (MPN): A statistical indication of the number of bacteria present in a given volume (usually 100 ml).

Nannoplankton: Those organisms suspended in open water which because of their small size, cannot be collected by nets (usually smaller than approximately 25 microns).

Nitrification: The biochemical oxidation process by which ammonia is changed first to nitrates and then to nitrites by bacterial action.

Nitrogen, available: Includes ammonium, nitrate ions, ammonia, and certain simple amines readily available for plant growth.

Nitrogen cycle: The sequence of biochemical changes in which atmospheric nitrogen is "fixed," then used by a living organism, liberated upon the death and decomposition of the organism, and reduced to its original state.

Nitrogen fixation: The biological process of removing elemental nitrogen from the atmosphere and incorporating it into organic compounds.

Nitrogen, organic: Nitrogen components of biological origin such as amino acids, proteins, and peptides.

Nonpoint source: Nonpoint source pollutants are not traceable to a discrete origin, but generally result from land runoff, precipitation, drainage, or seepage.

Nutrient, available: That portion of an element or compound that can be readily absorbed and assimilated by growing plants.

Nutrient budget: An analysis of the nutrients entering a lake, discharging from the lake, and accumulating in the lake (e.g., input minus output = accumulation).

Nutrient inactivation: The process of rendering nutrients inactive by one of three methods: (1) Changing the form of a nutrient to make it unavailable to plants, (2) removing the nutrient from the photic zone, or (3) preventing the release or recycling of potentially available nutrients within a lake.

Oligotrophic lake: A lake with a small supply of nutrients, and consequently a low level of primary production. Oligotrophic lakes are often characterized by a high level of species diversification.

Orthophosphate: See phosphorus, available.

Outfall: The point where wastewater or drainage discharges from a sewer to a receiving body of water.

Overturn, turnovers: The complete mixing of a previously thermally stratified lake. This occurs in the spring and fall when water temperatures in the lake are uniform.

Oxygen deficit: The difference between observed oxygen concentrations and the amount that would be present at 100 percent saturation at a specific temperature.

Peak discharge: The maximum instantaneous flow from a given storm condition at a specific location.

Percolation test: A test used to determine the rate of percolation or seepage of water through natural soils. The percolation rate is expressed as time in minutes for a 1-inch fall of water in a test hold and is used to determine the acceptability of a site for treatment of domestic wastes by a septic system.

Perennial stream: A stream that maintains water in its channel throughout the year.

Periphyton: Microorganisms that are attached to or growing on submerged surfaces in a waterway.

Phosphorus, available: Phosphorus which is readily available for plant growth. Usually in the form of soluble orthophosphates.

Phosphorus, total (TP): All of the phosphorus present in a sample regardless of form. Usually measured by the persulfate digestion procedure.

Photic zone: The upper layer in a lake where sufficient light is available for photosynthesis.

Photosynthesis: The process occurring in green plants in which light energy is used to convert inorganic compounds to carbohydrates. In this process, carbon dioxide is consumed and oxygen is released.

Phytoplankton: Plant microorganisms, such as algae, living unattached in the water.

Plankton: Unattached aquatic microorganisms which drift passively through water.

Point source: A discreet pollutant discharge such as a pipe, ditch, channel, or concentrated animal feeding operation.

Population equivalent: An expression of the amount of a given waste load in terms of the size of human population that would contribute the same amount of biochemical oxygen demand (BOD) per day. A common base is 0.17 pounds (7.72 grams) of 5-day BOD per capita per day.

Primary production: The production of organic matter from light energy and inorganic materials, by autotrophic organisms.

Protozoa: Unicellular animals, including the ciliates and nonchlorophyllous flagellates.

Rainfall intensity: The rate at which rain falls, usually expressed in centimeters per hour.

Rational method: A means of computing peak storm drainage runoff (Q) by use of the formula Q = CIA, where C is a coefficient describing the physical drainage area, I is the average rainfall intensity, and A is the size of the drainage area.

Raw water: A water supply which is available for use but which has not yet been treated or purified.

Recurrence interval: The anticipated period in years that will elapse, based on average probability of storms in the design region, before a storm of a given intensity and/or total volume will recur; thus, a 10-year storm can be expected to occur on the average once every 10 years. Sewers are generally designed for a specific design storm frequency.

Riprap: Broken rock, cobbles, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves).

Saprophytic: Pertaining to those organisms that live on dead or decaying organic matter.

Scouring: The clearing and digging action of flowing water, especially the downward erosion caused by stream water in sweeping away mud and silt, usually during a flood.

Secchi depth: A measure of optical water clarity as determined by lowering a weighted Secchi disk into a water body to the point where it is no longer visible.

Sediment basin: A structure designed to slow the velocity of runoff water and facilitate the settling and retention of sediment and debris.

Sediment delivery ratio: The fraction of soil eroded from upland sources that reaches a continuous stream channel or storage reservoir.

Sediment discharge: The quantity of sediment, expressed as a dry weight or volume, transported through a stream cross-section in a given time. Sediment discharge consists of both suspended load and bedload.

Septic: A putrefactive condition produced by anaerobic decomposition of organic wastes, usually accompanied by production of malodorous gases.

Standing crop: The biomass present in a body of water at a particular time.

Sub-basin: A physical division of a larger basin, associated with one reach of the storm drainage system.

Substrate: The substance or base upon which an organism grows.

Suspended solids: Refers to the particulate matter in a sample, including the material that settles readily as well as the material that remains dispersed.

Swale: An elongated depression in the land surface that is at least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and provide some groundwater recharge.

Terrace: An embankment or combination of an embankment and channel built across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Thermal stratification: The layering of water bodies due to temperature-induced density differences.

Thermocline: See metalimnion.

Tile drainage: Land drainage by means of a series of tile lines laid at a specified depth and grade.

Total solids: The solids in water, sewage, or other liquids, including the dissolved, filterable, and nonfilterable solids. The residue left when a sample is evaporated and dried at a specified temperature.

Trace elements: Those elements which are needed in low concentrations for the growth of an organism.

Trophic condition: A relative description of a lake's biological productivity. The range of trophic conditions is characterized by the terms oligotrophic for the least biologically productive, to eutrophic for the most biologically productive.

Turbidity: A measure of the cloudiness of a liquid. Turbidity provides an indirect measure of the suspended solids concentration in water.

Urban runoff: Surface runoff from an urban drainage area.

Volatile solids: The quantity of solids in water, sewage, or other liquid, which is lost upon ignition at 600° C.

Waste load allocation: The assignment of target pollutant loads to point sources so as to achieve water quality standards in a stream segment in the most effective manner.

Water quality: A term used to describe the chemical, physical, and biological characteristics of water, usually with respect to its suitability for a particular purpose.

Water quality standards: State-enforced standards describing the required physical and chemical properties of water according to its designated uses.

Watershed: See drainage basin.

Weir: Device for measuring or regulating the flow of water.

Zooplankton: Protozoa and other animal microorganisms living unattached in water.

APPENDIX C

LAKE WATER QUALITY DATA

Franklin Lake Water Quality Data

Station #1

Date	TP (mg/l)	DOP (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	TSS (mg/l)	TN/TP NO3+NO2+TKN/TP
05/21/87	0.2	<0.10	0.08	--	0.60	1.5	12	7.90
06/04/87	0.2	<0.10	0.66	0.65	0.40	1.2	11	12.55
06/17/87	0.1	<0.10	0.44	0.48	<0.1	0.6	9	15.20
07/15/87	0.2	<0.10	0.61	<0.10	1.17	2.6	54	16.55
07/30/87	--	--	--	--	0.48	--	--	--
08/11/87	--	--	--	--	0.071	--	--	--
08/27/87	0.15	<0.10	<0.01	<0.01	1.58	<0.01	18	0.20
09/22/87	0.07	<0.01	1.10	<0.01	--	1.0	17	29.43
10/14/87	0.06	<0.01	0.50	<0.01	0.65	0.9	8	22.67
11/18/87	0.08	0.01	0.19	0.02	0.48	0.9	2	13.88
12/16/87	--	--	--	--	0.43	--	--	--
02/24/88	0.09	<0.01	2.20	0.02	0.11	0.4	27	28.56
03/16/88	0.05	<0.01	1.00	0.02	--	0.2	7	24.40
04/13/88	0.15	<0.01	1.30	0.05	0.036	1.0	4	15.67
05/11/88	0.3	<0.01	0.85	0.02	--	1.7	72	8.57
Average	0.14	<0.01	0.74	0.13	0.50	1.0	20	16.30

Date	pH (s.u.)	Alkal. (mg/l)	FC (#/100m	FS (#/100m	Chl. a (ug/l)	Pheo. a (ug/l)	SD (m)
05/21/87	8.5	62	--	--	7.67	3.88	0.5
06/04/87	7.7	76	--	--	5.81	5.21	0.4
06/17/87	8.3	54	--	--	6.75	3.52	0.4
07/15/87	8.9	57	--	--	39.90	16.50	0.2
07/30/87	6.8	--	--	--	21.60	14.60	0.35
08/11/87	8.7	--	--	--	31.70	20.70	0.3
08/27/87	7.1	54	60	--	7.05	7.75	0.4
09/22/87	--	50	252	40	13.50	4.40	--
10/14/87	7.0	54	3200	<100	11.80	5.36	--
11/18/87	8.3	52	--	--	--	--	--
12/16/87	7.6	--	--	--	--	--	--
02/24/88	7.7	48	--	--	--	--	--
03/16/88	--	57	130	10	--	--	--
04/13/88	8.6	59	40	60	--	--	--
05/11/88	--	57	--	--	--	--	--
Average	7.9	57	736	53	16.20	9.10	0.36

Franklin Lake Water Quality Data

Station #2

Date	TP (mg/l)	DOP (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	TSS (mg/l)	TN/TP NO3+NO2+TKN/TP
05/21/87	0.10	<0.1	0.13	--	0.25	0.80	14	9.30
06/04/87	0.20	<0.1	0.66	0.65	0.40	1.20	11	12.55
06/17/87	0.15	<0.1	0.36	0.42	<0.1	0.80	20	10.53
07/15/87	0.10	<0.1	0.59	<0.01	0.45	1.70	40	23.00
07/30/87	--	--	--	--	0.34	--	--	--
08/11/87	--	--	--	--	0.07	--	--	--
08/27/87	0.15	<0.1	<0.01	<0.01	3.20	0.90	26	6.13
09/22/87	0.08	<0.01	1.00	<0.01	--	1.15	23	27.00
10/14/87	0.13	<0.01	0.53	<0.01	0.20	0.28	15	6.31
11/18/87	0.08	<0.01	0.23	0.015	0.45	1.00	10	15.56
12/16/87	--	--	--	--	0.37	--	--	--
02/24/88	0.06	<0.01	2.4	0.02	0.09	0.55	18	49.50
03/16/88	0.04	<0.01	1.5	0.03	--	0.55	8	52.00
04/13/88	0.10	<0.01	1.6	0.05	0.04	0.80	28	24.50
05/11/88	0.15	<0.01	0.18	0.01	--	1.80	162	13.27
Average	0.11	<0.01	0.77	0.11	0.49	0.96	31	20.80

Date	pH (s.u.)	Alkal. (mg/l)	FC (#/100m	FS (#/100m	Chl. a (ug/l)	Pheo. a (ug/l)	SD (m)
05/21/87	8.1	56	--	--	1.73	5.37	0.6
06/04/87	7.7	76	--	--	4.84	3.97	0.6
06/17/87	8.6	52	--	--	8.45	5.03	0.5
07/15/87	8.79	59	--	--	42.60	19.10	0.3
07/30/87	7.3	--	--	--	22.70	21.20	0.4
08/11/87	8.72	--	--	--	20.90	12.40	0.3
08/27/87	7.31	54	48	--	14.60	17.50	0.4
09/22/87	--	44	168	34	11.50	7.60	--
10/14/87	7.03	64	<100	<100	12.30	6.76	--
11/18/87	8.13	49	--	--	--	--	--
12/16/87	7.61	--	--	--	--	--	--
02/24/88	7.81	51	--	--	--	--	--
03/16/88	--	59	20	<10	--	--	--
04/13/88	--	59	--	20	--	--	--
05/11/88	--	53	--	--	--	--	--
Average	7.26	56	84	51	15.51	10.99	0.44

Franklin Lake Water Quality Data

Station #3

Date	TP (mg/l)	DOP (mg/l)	NO3-N (mg/l)	NO2-N (mg/l)	NH3-N (mg/l)	TKN (mg/l)	TSS (mg/l)	TN/TP NO3+NO2+TKN/TP
05/21/87	<0.1	<0.1	0.19	--	0.15	0.9	8	--
06/04/87	0.2	<0.1	0.66	0.65	0.40	1.2	11	12.55
06/17/87	0.1	<0.1	0.55	0.40	0.10	0.1	19	10.50
07/15/87	0.15	<0.1	0.72	<0.01	0.30	1.1	52	12.20
07/30/87	--	--	--	--	0.34	--	--	--
08/11/87	--	--	--	--	0.06	--	--	--
08/27/87	0.15	<0.1	<0.01	<0.01	2.10	0.9	26	6.13
09/22/87	0.1	<0.01	1.30	<0.01	--	1.2	29	25.10
10/14/87	0.13	<0.01	0.53	<0.01	0.33	0.3	15	6.31
11/18/87	0.15	<0.01	0.23	0.015	0.68	1.0	10	8.30
12/16/87	--	--	--	--	0.37	--	--	--
02/24/88	0.06	<0.01	2.40	0.018	0.10	0.4	19	46.97
03/16/88	--	--	--	--	--	--	--	--
04/13/88	0.1	<0.01	1.30	0.05	0.05	1.0	4	23.50
05/11/88	0.2	<0.01	0.57	0.02	--	1.5	68	10.45
Average	0.12	<0.01	0.77	0.12	0.41	0.9	24	16.20

Date	pH (s.u.)	Alkal. (mg/l)	FC (#/100m	FS (#/100m	Chl. a (ug/l)	Pheo. a (ug/l)	SD (m)
05/21/87	8.3	58	--	--	1.98	4.60	0.4
06/04/87	7.7	76	--	--	3.88	3.25	0.4
06/17/87	8.5	52	--	--	7.44	7.09	0.4
07/15/87	8.2	54	--	--	13.20	9.71	0.4
07/30/87	7.3	--	--	--	8.70	6.73	0.3
08/11/87	7.7	--	--	--	12.20	8.67	0.35
08/27/87	7.4	54	42	--	27.30	17.00	0.35
09/22/87	--	46	190	52	12.20	10.20	--
10/14/87	7.0	64	5200	<100	10.60	6.04	--
11/18/87	8.0	49	--	--	--	--	--
12/16/87	7.5	--	--	--	--	--	--
02/24/88	7.7	51	--	--	--	--	--
03/16/88	--	--	20	10	--	--	--
04/13/88	--	60	30	50	--	--	--
05/11/88	--	57	--	--	--	--	--
Average	7.76	56	1096	53	10.83	8.14	0.37

APPENDIX D

DISSOLVED OXYGEN AND TEMPERATURE DATA

Franklin Lake Dissolved Oxygen Data

Date	Station	Depth 0.1	0.2	0.25	0.3	0.4	0.5
05/21/87	1			11.8			
	2					11.6	
	3			11.8			
06/04/87	1			9.1			
	2				7.5		
	3			7.3			
06/17/87	2						18.2
	3				15		
07/15/87	1					17.2	
	2					15.0	
	3				11.2		
07/30/87	1				3.5		
	2					4.3	
	3		5.0				
08/11/87	1			11.3			
	2			9.4			
	3		8.9				
08/27/87	1	6.1		6.0			
	2	5.2		5.2		5.2	
	3	5.9		5.8	5.9		
09/22/87	1	6.1		6.05			
	2	6.7		6.6			6.55
	3	6.05		6.0			
10/14/87	1	10.2		10.2			
	2	9.5					9.6
	3	10.0				10.0	
11/18/87	1	7.1			6.8		
	2	7.5			5.8		
	3	7.25					6.2
12/09/87	1	10.0	10.2				
	3	10.25	10.0				
03/16/88	1	13.0			12.75		
	2	13.2				13	
	3	12.4			12.45		
04/13/88	1	10.8			10.7		
	2	10.4				10.4	
	3	10.6				10.4	

Franklin Lake Temperature Data

Date	Station	Depth 0.1	0.2	0.25	0.3	0.4	0.5
05/21/87	1			13			
	2					13	
	3			13			
06/04/87	1			20			
	2				19.5		
	3			18			
06/17/87	2						27
	3				26.5		
07/15/87	1					28	
	2					27.5	
	3				27.54		
07/30/87	1				25		
	2					25	
	3		23.5				
08/11/87	1			27.2			
	2			25.2			
	3		27				
08/27/87	1	20		20			
	2	21		21		21	
	3	20.9		20.9	20.9		
09/22/87	1	17		16.9			
	2	18.1		18			18
	3	18.2		18.2			
10/14/87	1	11.5		11.5			
	2	10.5					10.5
	3	10				10	
11/18/87	1	14			14		
	2	14			14		
	3	14.5					14.5
12/09/87	1	3	3				
	3	3.5	3.5				
03/16/88	1	3.0			3.0		
	2	3.0				3.25	
	3	2.5			2.5		
04/13/88	1	8.5			9		
	2	9				9	
	3	8				8	

APPENDIX E

SEDIMENT QUALITY DATA

Pesticides and PCB's in Franklin Lake

	Detection Limit (mg/kg)	Site #1	Site #2	Site #3
Aldrin	0.1	ND	ND	ND
Chlordane	0.1	ND	ND	ND
Dieldrin	0.1	ND	ND	ND
PP' - DDT	0.25	ND	ND	ND
Endrin	0.1	ND	ND	ND
Heptachlor	0.1	ND	ND	ND
Heptachlor Epoxide	0.1	ND	ND	ND
Lindane	0.1	ND	ND	ND
Methoxychlor	0.25	ND	ND	ND
Mirex	0.25	ND	ND	ND
PCB's	0.50	ND	ND	ND
PP' - DDE	0.25	ND	ND	ND
PP' - DDD	0.25	ND	ND	ND
Toxaphene	1.00	ND	ND	ND

Heavy Metal Concentrations in Franklin Lake

	Site #1	Site #2	Site #3	Site #4
Arsenic	<0.01	<0.01	<0.01	<0.01
Barium	0.23	0.41	0.21	0.15
Cadmium	0.01	0.30	<0.01	<0.01
Chromium	<0.02	<0.02	<0.02	<0.02
Lead	<0.02	<0.02	<0.02	<0.02
Mercury	<0.01	<0.01	<0.01	<0.01
Selenium	<0.001	<0.001	<0.001	<0.001
Silver	<0.01	<0.01	<0.01	<0.01

APPENDIX F

STREAM MONITORING PROGRAM DATA

Franklin Lake Stream Water Quality Data (Dry Weather)

Station #A

Date	TP (mg/l)	NH3-N (mg/l)	TKN (mg/l)	TSS (mg/l)	pH (s.u.)
05/21/87	<0.1	--	--	4	--
06/04/87	<0.1	--	--	1	--
10/14/87	0.09	--	0.8	24	7.0
11/18/87	0.06	0.48	1.0	9	7.8
12/16/87	0.02	0.23	0.7	--	7.4
02/24/88	--	0.13	--	--	7.4
04/13/88	--	0.28	--	--	7.9
Average	0.07	0.28	0.8	10	7.5

Station #B

Date	TP (mg/l)	NH3-N (mg/l)	TKN (mg/l)	TSS (mg/l)	pH (s.u.)
05/21/87	<0.1	--	--	7	--
06/04/87	<0.1	--	--	1	--
10/14/87	0.06	--	0.55	18	7.0
11/18/87	0.11	1.12	1.25	4	7.8
12/16/87	0.18	0.31	0.3	--	7.6
02/24/88	--	0.13	--	--	7.7
04/13/88	--	0.07	--	--	7.8
Average	0.11	0.41	0.7	7	7.6

Station #C

Date	TP (mg/l)	NH3-N (mg/l)	TKN (mg/l)	TSS (mg/l)	pH (s.u.)
05/21/87	--	--	--	--	--
06/04/87	--	--	--	--	--
7/15/87	0.14	--	1.1	51	--
10/14/87	0.06	--	1.2	25	7.0
11/18/87	0.99	0.51	1.0	3	7.8
12/16/87	0.18	0.63	4.6	20	7.6
02/24/88	--	0.11	--	--	7.6
04/13/88	--	0.07	--	--	8.5
Average	0.34	0.33	2.0	25	7.7

F. X. BROWNE ASSOCIATES, INC.

Franklin Lake Wet Weather Stream Water Quality Data

Station #A

Date	TP (mg/l)	DOP (mg/l)	TSS (mg/l)	pH (s.u.)	Alkalinity (mg/l)	NH3 (mg/l)
10/01/87	0.15	<0.07	23	7.42	46	
10/28/87	0.1	0.03	11	8.43	36	
11/12/87	0.27	0.08	4		35	
11/30/87	0.13	0.02	7	8.51	24	0.16
12/16/87	0.06	0.02	10	8.44	18	0.9
05/11/88	0.15		48	7.26		4.43
05/18/88	0.09		4			
Average	0.14	0.03	15	8.01	32	1.83

Station #B

Date	TP (mg/l)	DOP (mg/l)	TSS (mg/l)	pH (s.u.)	Alkalinity (mg/l)	NH3 (mg/l)
10/01/87	0.03	<0.01	19	6.3	60	
10/28/87	0.23	<0.01	28	8.16	34	
11/12/87	0.13	<0.01	4		53	
11/30/87	0.16	0.06	4	8.24	46	0.33
12/16/87	0.08	0.01	6	8.3	18	0.23
05/11/88	0.25		62	8.18		0.21
05/18/88	0.15		8			
Average	0.15	0.01	19	7.84	42	0.26

Station #C

Date	TP (mg/l)	DOP (mg/l)	TSS (mg/l)	pH (s.u.)	Alkalinity (mg/l)	NH3 (mg/l)
10/01/87	0.15	0.04	21	6.46	52	
10/28/87	0.09	<0.01	156	7.9	32	
11/12/87	0.09	<0.01	2		54	
11/30/87	0.18	0.13	2	8.15	56	0.21
12/16/87	0.09	<0.01	24	8.24	46	1.7
05/18/88	0.25		48			
05/11/88	0.15		52	9.64		2.09
Average	0.14	0.03	44	8.08	48	1.33

Storm Sewer Water Quality**

Date	Culvert*	TP (mg/l)	DOP (mg/l)	TSS (mg/l)	Alkalinity (mg/l)	pH (s.u.)
10/28/87	F	0.43	0.15	21	44	7.66
11/12/87	F	0.19	0.13	3	2	
11/12/87	D	1.51	0.82	3	26	
11/30/87	D	0.08	0.04	6	4	
11/30/87	F	0.75	0.42	7	18	
11/30/87	H	0.47	0.38	7	16	
12/15/87	G	<0.01	<1	12	6	
05/18/88	E	0.65		8		
05/18/88	F	0.15		32		
05/18/88	H	0.15		14		

*See Figure _ for culvert locations
**Grab samples taken in middle of storm event

APPENDIX G

NOVEMBER 23, 1987 PUBLIC HEARING INFORMATION

PUBLIC MEETING NOV. 23 AT 8 P.M. - BORO HALL

All Citizens Are Encouraged to Attend.

Hear About Our Progress and Provide Input.

WEST LONG BRANCH, NJ FRANKLIN LAKE PROJECT DESCRIPTION

On the recommendation of the Association of New Jersey Environmental Commissions (ANJEC), the Environmental Commission of West Long Branch, Monmouth County, NJ began an Environmental Resource Inventory. Finding a major problem was not very difficult. It became immediately clear that our 12-acre Franklin Lake, the environmental centerpiece of our small community of some 2,400 homes, was in serious trouble. On a number of occasions good intentioned people had implemented programs to try to correct some of the problems. None of these programs really worked and some even hastened the decline.

The Commission set aside its Environmental Inventory Project to concentrate on the development of alternatives for saving the lake. It became quickly apparent that specialized help was needed. The quest led to the office of the New Jersey Department of Environmental Protection, Lakes Management Coordinator. A conference report of that meeting (Exhibit 1), dated Jan. 24, 1986, laid out the parameters of an effort that was finally resolved 18 months later on July 29, 1987 (Exhibits 2 & 3).

The intervening period was one of careful planning, public participation, thoughtful communication with the "right" people, the development of public awareness of the problem, and support for a special appropriation of $28,300. The latter became a real sticking point because the Borough Council did not want to appropriate these dollars unless there was a clear consensus among local citizens.

Four different votes were taken as plans and resolutions were moved forward and as public reaction developed following a series of public meetings. The first vote was four in favor and two against. The second vote was five yes and one abstained; the next two votes were unanimously in favor of the proposed study and West Long Branch's share of the cost. With this approval in hand, the environmental commission hired F. X. Browne Associates, Inc., an environmental consultant, to develop a detailed work-plan that would serve as an application for matching funds from the NJDEP when the Monmouth County Health Department agreed to provide laboratory analysis of water and bottom samples, taken monthly for a year, we were able to put together an "In-Kind" package amounting to $18,400. This, together with West Long Branch's $28,300, amounted to a Borough/County contribution of $46,800. It was this figure that we asked the Department of Environmental Protection to match.

On July 29, 1987, the Department of Environmental Protection approved our request. We were funded to conduct a $93,600 Phase I Diagnostic/Feasibility Study of Franklin Lake. The 12-month study has been designed to meet all State and Federal requirements to qualify for Phase II construction funding.

The study, now underway, has already been recognized as a "showcase" that could help guide other communities having possible lake problems.

The work-plan includes several unusual and special features:

- Strong public participation,
- An evaluation of all current ordinances,
- A public opinion survey about future uses of the lake, and
- A special report on the conditions found in the watershed area that might be of interest to the Planning and Zoning Boards.

A final report is expected in the early Spring.

Prepared by: John Harvey, Chairman, West long Branch Environmental Commission
456 Monmouth Road, West Long Branch, NJ 07764
(201) 229-1336

SAVING FRANKLIN PARK LAKE

A PUBLIC MEETING FOR THOUGHTFUL CITIZENS

November 23, 1987

8:00 P.M.

Boro Hall

Your Environmental Commission has asked Dr. Frank X. Browne to provide his preliminary thoughts on Franklin Lake at a public meeting to be held on November 23, 1987 at 8:00 p.m. at the Boro Hall.

Come prepared to ask questions and provide input.

FRANKLIN LAKE QUESTIONNAIRE

Please take a few minutes to complete this questionnaire on Franklin Lake. We are trying to obtain as much information on public opinion of Franklin Lake as possible and your input will be very helpful. When you have completed the questionnarie fold it along the dotted line, put a 22 cent stamp on the space provided, and drop it in the mail box. If you plan to attend the public meeting on November 23, 1987, you can bring your Questionnaire with you. Thank you for your cooperation.

1. How often do you visit Franklin Lake?

2. How far do you travel to visit Franklin Lake?

3. Why do you visit Franklin Lake?

4. How would you rate the water quality of Franklin Lake?

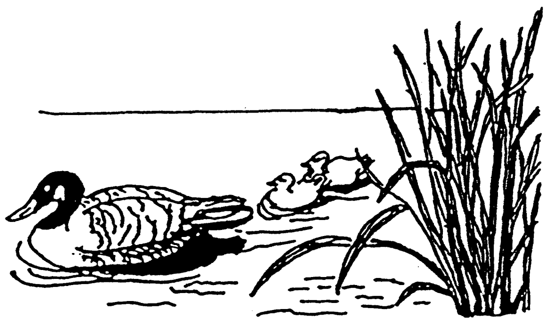
   a ______________ Good
   b ______________ Fair
   c ______________ Poor

4. Are you aware that a water quality study of Franklin Lake is currently underway?

   Yes ______________ No ______________

6. How important do you think it is to protect and restore Franklin Lake?

   a ______________ Not important
   b ______________ Slightly important
   c ______________ Very important



7. Did you realize that the waterfowl at Franklin Lake may have a negative impact on the water quality in Franklin Lake?

   ______________ Yes ______________ No

8. Do you think that duck feeding should be limited? ______________
   Prohibited? ______________

9. Should the Borough of West Long Branch require "pooper scoopers"?

   ______________ Yes ______________ No

10. **Different lake restoration techniques are available for different lake uses. How do you want to use the lake and park?**

	Definitely Not	Doubtful	Possible	Definitely Yes
Fishing				
Row Boating				
Paddle Boating				
Model Boating				
Canoeing				
Ice Skating				
Picnicing with B.B.Q. Facilities				
Playground with swings, seesaws, climbing bars				
Shuffle Board - Bocci				
Jogging - Walking Path				

*Swimming is not an option

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F. X. Browne Associates, Inc.
220 South Broad Street
Lansdale, PA 19446

West Long Branch Environmental Commission

MINUTES

A special Public Forum to discuss the Franklin Lake Project was sponsored by the WLB Environmental Commission on Monday, November 23 at 8 p.m. at Boro Hall.

John Harvey, chairman of Commission, introduced and identified the members (all members, except Robert Welch, were present). Mr. Harvey commented on the fullhouse turnout and the better-than-expected response of 150 questionnaires in just two (2,000 questionnaires have been sent).

Chairman Harvey reported that 17 companies have been invited to submit proposals or make presentations for feasibility studies of Franklin Lake. The company of F. X. Browne Associates, Inc. has a history of 100% in acquiring funding and Dr. Browne also wrote the Clean Lake Manual for the U. S. Environmental Protection Agency; it was for these reasons that this company was selected to conduct the Franklin Lake Project.

John Harvey then introduced Dr. Browne and his associate, Marlene Miller (who handled the slide presentation). Dr. Browne outlined the Franklin Lake Project.

The Lake Management topics that were considered in the presentation:

1. Lake Ecology
2. Water cycle
3. Causes of algae blooms
4. Excessive phosphates and runoff
5. Watershed concepts
6. Siltation (aging of the Lake)
7. Eutrophication (too many nutrients causing overgrowth)
8. Ecosystem of the Lake
9. Ecological pyramid
10. Types of algae

The purpose of the Franklin Lake Project: the Evaluation, Protection and Restoration of the Lake.

The specific problems of Franklin Lake:

1. Excessive nutrients (too many phosphates)
2. Excessive algae (too many of the undesirable type)
3. Weeds
4. Siltation
5. Depletion of Fishery (the algae and weeds take too much of the oxygen so that there is an insufficient supply for the fish)
6. Lost recreational potential (the choice of activities becomes more limited).
7. Toxins (algae are toxic and give people allergies)

More specifically, the biggest problems of Franklin Lake are the algae, the weeds and the siltation.

The problems that will be diagnosed will be:

1. How bad is the problem?
2. What types of algae are there in Franklin Lake?
3. What kind of sediment is there?
4. What's coming into the Lake from the Watershed?
5. How much siltation is there?

The 15 tasks of the study were enumerated:

1. Collect and analyze data
1. Lake surveys
3. Dry weather stream monitoring
4. Wet weather stream monitoring
5. Detailed bathymetric survey (how deep is the water and mud depth in the Lake)
6. Macrophyte survey - an analysis of the weeds
7. Lake and watershed analysis (for a one year period)
8. Evaluate Lake and Watershed management alternatives
9, Review of existing ordinances
10. Environmental impact assessment
11. Analysis of costs
12. Development of comprehensive management plan
13. Preliminary engineering solutions
14. Public participation
15. Project documentation

Project Director Browne explained that the State and Federal Government may fund between 75% and 90% of the total cost of the Phase II Restoration Project.

A member of the audience recalled when 11 natural springs fed into Franklin Lake, and how deep and crystal-clear it was years ago.

Franklin Lake, which is shaped like a high-button shoe, is approximately 12 acres; it has two inlets and one outlet.

Dr. Browne reported that 12 different substances are measured in the Lake's monthly samples and data analyses.

The management alternatives should meet certain criteria (the solutions that will be selected will be judged by the following factors):

1. Effectiveness
2. Longevity
3. Confidence
4. Applicability
5. Environmental impact
6 Capital costs
7. Operating and maintenance costs

The range of potential management alternatives (the various solutions that are possible) include:

1. Watershed management
2. Ordinances
3. Detention basins
4. Nutrient inactivation
5. Biological controls
6. Aeration

The actual management plan that will be presented to WLB will consist of:

1. The alternatives that have been selected (which of the possible solutions are chosen to resolve Franklin Lake's problems)
2. Preliminary Engineering Design
3. Analysis of costs
4. Funding options (ways the restoration work can be paid for)
5. Implementation schedule (a time schedule of the work process)

Dr. Browne explained that the public will participate through public meetings and questionnaires.

After Dr. Browne completed his presentation, John Harvey called for questions from the audience. He requested everyone to announce his name and the street where he lives. The questions were answered by Dr. Browne.

Question by jack Wooley: How can the Boy Scouts help?

Answer: By bathymetrics and communication

Question by Ira White, ex-chief of police, from Chestnut Place: Is there a possibility of changing the water table so that residents will get water in their basements?

Answer: After the Lake is dredged, the water level will drop, not increase, and this will only be 1/2 to 1 inch. The change in the water level will do more to protect the surrounding homes than it will to endanger them.

Question: What kind of visitors will the lake attract after it is improved?

Answer: this will depend upon the kind of activities for which the Lake will be used.

Question by Gene Denton from Wall Street: What is the approximate cost of the improvement project? Mr. Denton felt that the Lake problems are being overdramatized. He suggested that, in view of the new school costs, the Lake project might be postponed.

Answer: Madelyn Fedak, a member of the Board of Education, mentioned that the new school costs would not increase taxes. John Harvey stated that the Franklin Lake Study Project is funded 70% by the Federal Government and 30% by WLB; and additional funding would be sought for the restoration work.

Question: Has anything been done so far, based on the tests already taken, to resolve any of the Lake's problems? Why can't they remove the dam and flush it, as has been done in other places?

Answer: This has been an effective solution in some places, but may not be for Franklin Lake. The appropriate solutions will be decided at the completion of the study.

Question by Frank Meade of Throckmorton Avenue: Why are things so complex and complicated nowadays, he said, recalling when he used to skate around the cattails in the middle of the Lake - the Lake was simply dredged, stocked and refilled.

Answer by John Harvey: When it was simply dredged in this manner, it was being improperly dredged on the sides only and not in the middle.

Answer by Dr. Browne: If it is properly done, it does not have to be redone at frequent intervals. If Franklin Lake is dredged again, it will be bigger and deeper and will cost only 10% to 25% of the total cost since the Federal Government will subsidize 75% to 90%. If the lake is not properly dredged, the government does not pay anything.

Question by a young Boy Scout: Then why don't you just dredge down the middle and get rid of the weeds?

Answer: The weeds are around the shoreline.

Question by Ralph Johnson of Oceanport Avenue: Since the banks of the Lake are erroding rapidly, what is being done to stabilize the banks. Why not plant willow trees to keep the shoreline from erroding?

Answer: Willow trees have been used effectively in other places and my be effective for Franklin Lake, but they will not resolve all the problems of Franklin Lake.

Comment from Rich Cole of Oakhurst, who has used the Lake for his model sailboat. Spring Lake has problems similar to Franklin Lake; many of the problems came from the storm sewers emptying into the Lake.

Answer: The storm sewers will be studied.

Question: When will the study be completed?

Answer by John Harvey: The middle of 1988.

John Harvey adjourned the Public Forum after thanking Dr. Browne for his presentation and the audience for their attendance and participation.

Respectfully submitted,

Lee Gray
Secretary

APPENDIX H

MARCH 16, 1989 PUBLIC HEARING INFORMATION

To All Who Are Interested In The Future Of Franklin Lake...

Our Phase I study of Franklin Lake is ready for your review and comment.

Please come to Borough Hall
Thursday
March 16, 1989
7:30 P.M.

The environmental specialists who conducted the year-long study will be here to share with you the results and their recommendations.

Your Environmental Commission will welcome your thoughts and suggestions.

John Harvey, Chairman
WLB Environmental Commission

RESTORATION OF FRANKLIN LAKE

Public Hearing on March 16, 1989, 7:30 p.m.
at Borough Hall, West Long Branch, New Jersey

Where is Franklin Lake?

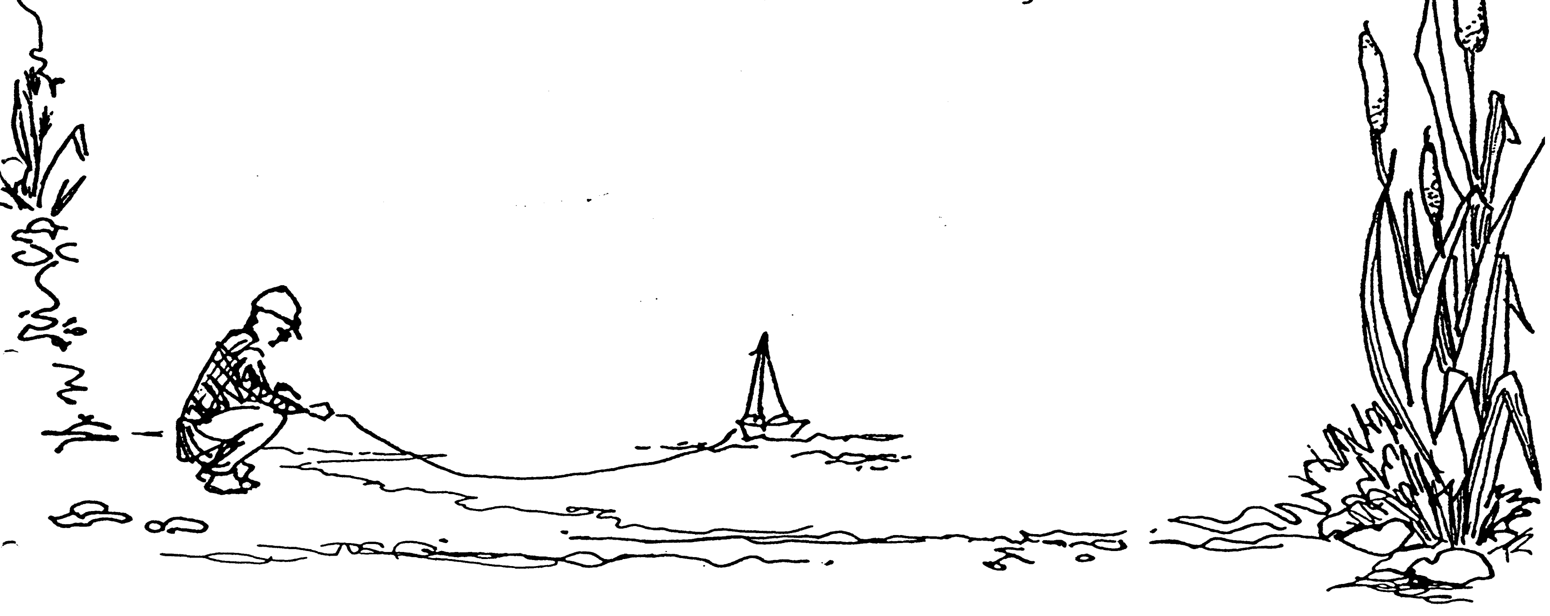
Franklin Lake is the focal point of an urban park in The Borough of West Long Branch, Monmouth County, New Jersey. It is a very shallow lake with a mean depth of 1.4 feet and a maximum depth of 2.9 feet. The surface area of the lake is 15.5 acres.

Why is Franklin Lake important?

Franklin Lake Park is highly valued by residents of West Long Branch who enjoy jogging or walking on park trails, fishing, boating, skating, or just relaxing and appreciating the beauty of nature. The park is an integral part of community life, providing a picturesque backdrop for wedding ceremonies and drawing visitors from nearby towns for Fourth of July fireworks displays and concerts.

What problems exist at Franklin Lake?

Severe algal blooms and excessive siltation have impaired the recreational uses of Franklin Lake and the surrounding park. There are complaints about foul odors emanating from the lake in the summertime and the water has a green soupy or scummy appearance. The extreme shallowness limits recreational usage of the lake.



How can these problems be addressed?

With encouragement from the West Long Branch Environmental Commission and the New Jersey Department of Environmental Protection Clean Lakes Program Division, the citizens of West Long Branch agreed to help support a Phase I Diagnostic-Feasibility Study of Franklin Lake and base decisions concerning lake treatment on the conclusions and recommendations of this study. Fifty percent of the funding for this study was provided by the NJDEP and the other fifty percent was provided by the Borough of West Long Branch and Monmouth County. The primary objectives of the Phase I Study were:

1. To determine the trophic (ecological) state of Franklin Lake,

2. To identify the sources of pollutants entering Franklin Lake,

3. To evaluate potentially feasible control alternatives,

4. To develop and recommend a lake and watershed management program that is cost-effective, environmentally sound, and acceptable to the public,

5. To develop preliminary design information for the recommended management program, and

6. To review existing ordinances to determine their adequacy for the protection of Franklin Lake.

According to this study, what is causing the problems in Franklin Lake?

Sediment from urban runoff and shoreline erosion have filled in Franklin Lake. There are high concentrations of the nutrients phosphorus and nitrogen in the lake which support a large population of algae. Runoff from the watershed contributes approximately 63.1% of the total phosphorus, 75.3% of the total nitrogen, and 99.6% of the total suspended solids loads to Franklin Lake. Waterfowl contribute an estimated 35.5% of the total phosphorus and 20.8% of the total nitrogen loads to Franklin Lake. Precipitation on the lake surface contributes about 1.4% of the total phosphorus, 3.9% of the total nitrogen, and 0.4% of the total suspended solids.

How can we correct these problems and restore Franklin Lake?

A multi-faceted management plan, incorporating both in-lake and watershed management practices, is necessary to expand the recreational usage of Franklin Lake and to control pollutant sources. The following methods are recommended:

1. Dredging was evaluated as a lake management option because the mean depth of Franklin Lake is only 1.4 feet. Dredging would enhance recreational activities by deepening the lake. Either mechanical or hydraulic dredging could be implemented at Franklin Lake.

2. Steps should be taken to stabilize the eroding banks along the shore of Franklin Lake. Although the total pollutant loads from this source are not expected to be large in comparison to other sources, their impact on Franklin Lake is immediate. Cast-in-place concrete walls are recommended to stabilize a large section of the shoreline of Franklin Lake. Vegetation, such as crown vetch, is recommended to stabilize the banks near the Shore Regional High School.

3. Existing wet areas above Franklin Lake should be enhanced through the creation of artificial wetlands. These created wetlands will help trap both sediments and nutrients before they reach the lake.

4. Agricultural best management practices, such as the use of filter strips, should be implemented to minimize phosphorus and sediment loss if the existing farm in the Franklin Lake watershed is actively farmed again. The Monmouth County Conservation Service should be consulted to coordinate all conservation practices.

5. Storm sewer catch basins throughout the Franklin Lake watershed should be cleaned out on a regular basis. Sediment accumulates in these basins and should be removed to assure the continuing efficiency of these structures. If necessary, West Long Branch should allocate additional funds to their maintenance budget for this purpose.

6. The existing parking area near the Dennis Brook inlet should be modified to alleviate the existing gully erosion problem. The existing asphalt in this area should be removed and the area should be graded and seeded. New curbing should be installed to connect East Lakeview Avenue and Franklin Parkway and a storm sewer should be installed to drain this area.

7. The Borough of West Long Branch should install signs asking residents not to feed the ducks at Franklin Lake because of their impact on the nutrient budgets for the lake. The public should be made aware of the detrimental effects of waterfowl on the water quality of Franklin Lake. If necessary, The Borough of West Long Branch should consider the adoption of an ordinance to prohibit the feeding of ducks and geese in the park.

8. The Borough of West Long Branch should actively enforce the "pooper scooper" ordinance. A sign should be erected in the park to inform the public that the ordinance will be enforced. Increased enforcement would reduce nutrient loads and improve the aesthetics of Franklin Lake Park.

9. The Borough of West Long Branch should develop a "homeowner practices" flyer and distribute it to the residents of West Long Branch. A public workshop to discuss practices should be scheduled.

10. Diversion of stormwater entering Franklin Lake from Lakeview Avenue should be diverted via a storm sewer interceptor to Dennis Brook below the dam.

11. Additional trash cans should be provided around Franklin Lake to encourage visitors not to throw trash into Franklin Lake. This will require the cooperation of the West Long Branch Public Works Department. "Clean Up" Franklin Lake Days should be continued at least once per year to pick up trash that will inevitably accumulate in and around the lake.

12. Aeration holds some promise as an in-lake control measure; however, results from other lakes where this method has been used have been mixed. Aeration should be considered for Franklin Lake only after dredging is completed. If dredging does not reduce phytoplankton growth, aeration should be re-evaluated as a restoration method.

How much will the restoration cost and what funding sources are available?

The estimated costs for the recommended in-lake restoration techniques and watershed management practices are summarized in Table 1.

Table 1

Phase II Restoration Costs for Franklin Lake

Restoration Activity	Cost
Dredging	$345,000
Shoreline Stabilization	$408,600
Created Wetlands	$36,000
Agricultural BMP's - Filter Strips	$1,000
Erosion and Sediment Control	$9,200
Homeowner Practices	$2,500
Stormwater Diversion	$115,000
Water Quality Monitoring	$10,000
Documentation	$10,000
Total Estimated Phase II Costs	**$937,300**

In addition to the costs listed in Table 1, additional funds will be required from The Borough of West Long Branch. Estimated annual costs are $1,500 for road and storm sewer maintenance and $1,000 for park management practices.

Possible funding sources for the Phase II Restoration Program include the U.S. EPA Clean Lakes Program and the New Jersey Lakes Management Program. The EPA Clean Lakes Program provides 50% matching funds for restoration programs and the New Jersey Lakes Management Program will pay up to 75% of Phase II costs. The New Jersey program will contribute 75% of the local match if the project receives EPA funding.

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Franklin Lake Public Meeting
March 16, 1989

Meeting Minutes

John Harvey welcomed everyone to the meeting and introduced Dr. Chris Holdren, Marlene Miller, and Teena Reichgott of F. X. Browne Associates to the audience. Mr. Harvey explained that F. X. Browne Associates have been engaged in a one and one-half year Phase I study of Franklin Lake and are ready to present the results of the study and their recommendations for the restoration of Franklin Lake. Mr. Harvey then turned the presentation over to Dr. Holdren who presented the results of the study.

Dr. Holdren's presentation indicated that Franklin Lake is highly eutrophic. He also indicated that most of the pollutants that enter the lake come from nonpoint sources and that the waterfowl at Franklin Lake contribute a significant amount of undesirable phosphorus to the lake. Specific recommendations for the restoration of Franklin Lake were presented and can be found in the Franklin Lake Fact Sheet distributed to the many citizens who attended the meeting.

John Harvey: Last year, the question was "Why is such an expensive study needed for Franklin Lake?" Now we know the answer. The government wanted to make sure we did it right. I am proud to say that our study has met all the criteria recommended by the DEP and the EPA, the two principal agencies from which we will be seeking funding for Phase II. Our project has taken top honors by winning the national "Take Pride in America" award. We sent a delegation to Washington D.C. to see the President and to receive the award. As a result of the "Take Pride in America" award, we have received recognition from New Jersey Governor Kean, the Commissioner of the DEP, State Senators and Assemblymen; the State Senate passed a resolution of congratulations. I assure you that we did not seek this recognition; however, it was very welcome!

They have told us we were doing necessary and important work. When we go to these same people and ask for funding for the Franklin Lake restoration, I ask you: how can they refuse? They are well aware of the success of the Franklin Lake Project. An additional good fortune is that legislation currently in the Senate will provide 50 million dollars to help fund dredging projects, cleanup and related activities. Your Environmental Commission has written to the president of the Senate endorsing this legislation as has the Mayor and his Council. All of us are encouraging Senator Russo to bring this Bill out for vote on the full Senate floor. We look forward with great anticipation to it becoming law and providing much needed funding. This is the story of where we are at the moment. Now it is your turn. We are eager for your input. That will put the finishing touches on what is now our almost complete copy of the final report on the Lake. The report is detailed; it's very well done; I'm proud to be associated with it. But we want to make sure that you people have an opportunity to have input; after all, it's your lake. Now I invite your questions, and I look forward to questions from the young people in particular. I hope you will share with us your thoughts about what you've heard this evening and what you think of the Lake.

Mr. Harvey: I'll take the first question.
Question: All this sounds very well and good, but I'm concerned about the cost. How much is this going to cost us? Of this $937,000 how much of this is our share?
Mr. Harvey: We don't know yet.
Comment: Well I was given to understand by Mrs. Tucci at the Council not so long ago that it wouldn't cost the Borough anything.
Mr. Harvey: We don't know that yet.
Question: Well why did she make a statement like that?
Mr. Harvey: Oh, I don't think she made a hard and fast statement like that. Next question, please.

Question: How much will you deepen the lake?
Mr. Harvey: The final lake depth will be 3 to 4 feet.
Question: Why not deeper? It used to be very deep.
Mr. Harvey: We have problems if we go too deep as well.
Comment: It used to be 12 feet of more.
Dr. Holdren: If you want to increase the cost by a factor of five or ten, then you might get the 12 feet. The other problem that you have is as the lake gets deeper, it undergoes a process called stratification in the summer months. If the lake is deep enough and small, with this size and shape, the lake will separate into two layers. You will have a warmer layer on the top and a colder layer on the bottom which doesn't mix. When this happens, and you experience algal problems, there may also be a problem of a lack of oxygen in the bottom of the lake, and the increased depth might create more problems that it solves. We picked the 3 to 4 feet in coordination with the Environmental Commission for a number of reasons. First of all, it is not the maximum depth. Three to four feet is the average depth. Right now you can see that the maximum depth is 3.0 feet while the mean depth was 1.4 feet. So the deepest part now may become 5 or 6 feet. It keeps the cost down and it also makes it safe for ice skating, so small children can't fall in and disappear.

Comment: We used to fish and everything in there and it (low oxygen levels) never bothered them (the fish) at the 12 or 14 feet depth.
Dr. Holdren: My guess is that at that depth you didn't have the algal blooms and the rest of the problems that are now apparent at Franklin Lake. It all works together. When you get the algal blooms, that's when you run into problems with low dissolved oxygen. The primary reason for making the mean depth of the lake 3 to 4 feet is cost. That's the number one consideration. Another consideration in determining the depth is that you want to limit the macrophyte growth, and a 3 to 4 foot depth will limit macrophyte growth.

Question: Have you found out whether any of that material is toxic?
Dr. Holdren: We did extensive studies of the sediment and we found no problem at all with toxicity. We did a pesticide/PCB scan where we looked at the common pesticides; we looked at heavy metals; and we also did something called an EP toxicity test which the EPA requires of all solid wastes. Happily, there was nothing in any of these tests that indicated a problem.

Question: Has any thought been given to where you are going to put this dirt?
Dr. Holdren: There are two possible locations; however, it depends on the type of dredging we go with. If we went with the mechanical dredging, it would be hauled to the County landfill. If we go with hydraulic dredging, we need to find a site very close to the lake. Now, there is a flat piece of property below the dam which would make a good disposal site. We don't know at this point if we really have enough capacity at this site. Most likely, if we went that route, the lake would have to be dredged in stages. We simply could not stack all the sediment at that site at one time. We would have to put some of it there and let it dewater and then put the rest of the material there at a later date.
Mr. Harvey: The method of dredging and disposal will be a subject of negotiations down the road.
Dr. Holdren: Actually, the negotiation would be altered by what the Contractor might use in terms of the bid. As we indicated, the costs of the two dredging methods were fairly close. So, if the contractors go one way, we might select one method over the other. At this point, it is too close really to push hard for one method over the other.

Mr. Harvey: We have a question from the young man back in the corner.
Question: When the lake was originally built, what was the general topography? How deep was it, or how big was the lake?
Mrs. Reichgott: The history of Franklin Lake is very interesting. The site was originally part of the Dennis farm. The dam was originally built in the early years of this centruy to provide a source of water for the farm animals. Some very early maps show the lake area as marshy wetlands.
Dr. Holdren: Another thing I'd like to point out is that one of the reasons that the lake isn't at least four feet deeper now is that the lake level was lowered. If you look at the dam, you will see a pipe that goes through the dam a couple of feet below the crest. As I understand, that pipe was put in because there was water in some of the basements around the lake. If we would simply plug up that pipe and allow the lake level to rise, we could get you 3 or 4 feet very easily.
Comment: Then we would get water in our basement. If you raise the surface, you get water in the basements.
Dr. Holdren: Right, that's why we didn't suggest raising the lake level. It would be a lot cheaper than the dredging, but then again it's not something that we recommended.

Comment: That culvert saved a lot. I think they should have put two in.
Dr. Holdren: I think that's why the lake used to be twelve feet in the past since it was lowered by 4 feet and has silted in by at least 2 to 3 feet.
Comment: But they dammed that up to make ice. They used to have a big ice house and they sold the ice. You could eat that; it was spring water. But you see, they let the water out every Spring.

Question: If you used mechanical dredging, would you drain the lake first?
Dr. Holdren: There are a couple of options for mechanical dredging. One would be to drain the lake, that's the easiest one. Now, with the springs that you have in Franklin Lake that may present some difficulties. There is something else called dragline dredging, which can be used as a form of mechanical dredging. My guess is that this is the method that would work best here.

Question: If you elected to drain the lake, is it possible that you could get permission to put a trench around the dam so that you could actually drain the lake? I don't see any other way that you could actually drain the lake. You can't just drain it by raising the gate in the dam.
Dr. Holdren: In some of the lakes that we've worked on in the past, we've used a combination of a lot of things. In some cases, we have just pumped the water out of the lake. We have a lake that we just finished where we put in a couple of large pumps to encourage the water to get on downstream. There are ways to do that which may be cheaper in the long run.

Question: When you talk about fertilizer on the lawns, how localized a problem is that? In other words, is it fertilizer throughout the drainage basin or is it just from areas that are close to the lake?
Dr. Holdren: It is a problem throughout the watershed to some degree; however, areas that are close to the lake or the streams are more likely to add more pollutants to the lake.

Mr. Harvey: One of the nice things about working on this project was the nice people that we got to work with. And one of the fine young men in this town that I would like to call on to tell us about the involvement of the Boy Scouts in this project is Adam Bogner. Adam, how did the boys react to this project?
Mr. Bogner: Very positively. Tonight I have Boy Scouts here who are finishing up the final requirements of their surveying merit badge. They worked with Marlene and Vince (F. X. Browne Associates, Inc.) on surveying the lake depth, I forget the term....
Mr. Harvey: Bathymetric Survey
Mr. Bogner: Yes, Bathymetric Survey. We spent one day studying the watershed, and three days measuring the depth. This involved the entire troop, they had a good time. They learned a lot, and we had a lot of involvement. We had the troop out on two occasions helping K. C. Kelly and the rest of the committee cleaning up

around the lake, picking up the cans and the litter. The troop is also involved in a community award sponsored by the Boy Scouts of America in which one requirement is to be involved in a project in their community that has some environmental impact to the town such as the lake. Do you guys (scouts) have any comments, or any thing to say.... This is a quiet troop.

Mr. Harvey: I recognize some of the boys' faces. One of the fellows was sitting in the front of the boat with the walkie-talkie and the other fellow in the back working the surveying staff. We had a windy day to do this survey. As a matter of fact, it was so windy that I went home and got a piece of railroad track that I use in my shop as an anvil. I tied a big line to it, and we took it over to the lake to use as an anchor to help us stay on our stations as we did our calculations. The anchor is right over there and there is a sign on it that says "Marlene is an engineer extraordinaire. Marlene was pulling that anchor in and out of the boat and I'd like you to know that she slept well that night.
Mr. Bogner: One scouts bike was retrieved from out of the lake during the survey.
Mr. Harvey: Yes, and we retrieved a bike out of the lake during the course of the study. I would also like to thank Perry Newhaus. I don't know if Perry's here, I've not met Perry, but I can tell you he volunteered and made available to us his boat. It was used for a full year to go out monthly on the lake to retrieve those water samples. We thank Perry for his involvement.

Question: Just an observation, overlooking the big bucks that it would take to improve the lake and the park. It seems like the most wonderful project, but I must say that in the past thirty years or so that we have been living here making use of the walk around the park, you have to be a ballet dancer to avoid the excrement. To get to the walk, the excrement of dogs is pretty heavy. I'm sure it is a paradise for people that have dogs in the area, and bring them there every morning. If I had a dog, I'd probably bring him there too. But it's a little rough, in fact to walk around the area, and regardless of what you do in terms of signs of "don't feed the ducks", you get parents with three and four year old youngsters who throw in loads and loads of bread. Signs will not mean a thing. Certainly, I'm not going to assign patrolmen to hand out a summons or warnings or such. So I think that's a topic that really has to be considered, regardless of what you do with the lake.
Mr. Harvey: I think you are absolutely right. We have in existence a "Pooper Scooper" law. It is not being enforced. Now we have to take this under consideration and this report will comment on that and come forth with a recommendation.

Question: Is there any way to get rid of the ducks?
Mr. Harvey: One way is to stop feeding the ducks; then they would leave. They would go about their regular migrations, but I'll tell you, when grandparents and grandchildren go over to the lake for a little outing, it's natural that they want to feed the ducks. I can really appreciate that, but it's also contributing to the

problem. We are going to have to put on an educational program as part of our Phase II effort. There will be a whole series of things that citizens can do, or not do, to make a contribution to the future health and vitality of Franklin Lake.

Question: I have a small child. He is only this high and the geese are also this high. I have to hold both his arms because he's terrified of the geese. He doesn't bring any bread or anything. He doesn't want to go to the lake anymore because those things are ferocious. They honk at you; they attack small children.
Mr. Harvey: I think that is a very valid comment.
Dr. Holdren: I think the one thing I could offer is that the public education program can help. Other lakes have the same problem. You're not alone in this and there has been considerable success. Granted, you are not going to solve the problem completely. If I took my son out there, I know he would want a loaf of bread to feed the ducks. It's a matter of getting enough people to know that feeding the ducks is bad, not only for the lake but for the ducks and geese. But, you are not going to get 100 percent compliance: I don't think anybody expects that. If you can get one-half of the people to quit feeding the ducks, you are going to cause a few of those ducks and geese to move on. If the food isn't there, they will leave: that's been very well documented in a number of cases. Maybe there should be some kind of sign in the park that explains the bad things that are happening to the ducks--that would help out.
Mr. Harvey: The government has taken the attitude that they won't move the ducks anymore.
Fred Martinson: The big geese that he's talking about are the farm geese. There are 23 of them. Now people raise farm geese for financial purposes. Why can't we catch those 23 geese and sell them. They don't fly there. People drop them off, and so let's sell them.

Comment: If you have a body of water, I don't care what you do, whether you feed the ducks or you don't feed them, you are going to have Canadian geese.
Dr. Holdren: You will have them because of normal migration patterns, but they will not stay all year long if they are not fed. That's what we have at Franklin Lake.

Comment: Up in North Jersey, we have them all year round, and we've done everything under the sun to get rid of them. We swim in that water and the water is part of the watershed. We've been doing this for more than thirty years, and we have not been able to get rid of the geese. How you are going to get rid of the geese by not feeding them...I don't know.
Mr. Martinson: Those domestic farm geese, what are they going to do? They come over in my yard. If no one comes over to feed them during rainy times they come over into my yard. They cross the street. If you chase them away, they come back.

Mr. Harvey: Is Lenny Remick here? There was a special problem at the lake where there is a stand pipe that goes down into the water. It was built there many years ago when they built the high school. The problem was that it was too expensive to tie into the Borough Water System for fire protection. So they built this standpipe, and the fire trucks used to come and pump the water out of the lake to test their equipment. About ten or fifteen years ago, they connected the pump to the stand pipe and caused $1,200 dollars worth of damage to their pump because it drew up so much silt and sediment that had accumulated in the lake. They have declared that the stand pipe is no longer operational. There is no emergency standby system on that side of the high school. One of the added benefits of the Phase II project could be the reconstruction of the stand pipe system so that it could be used again for fire protection. The lake is also a source of water for watering the ball fields.

Question: All the stuff you're talking about, are we still going to get water in our basements? That's what I want to find out.
Mr. Harvey: If you do now you probably still will. We are not going to change the surface of the lake. The lake surface will stay the same, it will not be increased. Yes, young man.

Question: Is it a problem that the ducks go to the bathroom in the lake?
Dr. Holdren: That's a very definite problem.

(Note: The recorder malfunctioned briefly at this point and some questions and answers were not audible.)

Comments: A lake in Holmdale found placing artificial swans in take-off position on the lake was effective in keeping wildfowl from landing.
Dr. Holdren: We will look into that and see if it is a possible solution.

Question: What is the next step in the lake restoration procedure?
Mr. Harvey: To put together a package for a Phase II application.

Comment: Congratulations are extended to the West Long Branch Environmental Commission and the Consultant for the highly professional quality of the job. It sounds as if there is help available to defray costs of Phase II implementation. There are portions of the restoration plan calling for attention to ordinances. Are any enforcement problems foreseen?
Mr. Harvey: Our role is to recommend implementation and enforcement. For some of the ordinances (littering and "pooper scooper") the fine may be too stiff for effective enforcement. Perhaps lowering the fine would increase the number of citations.
Dr. Holdren: Although those living nearest the lake may be impacted most by the ordinances, they will also be the ones to benefit most by them.

Question: Will drainage in other sections of the watershed be affected?
Dr. Holdren: Yes. The drainage patterns will be changed by wetlands and stormwater diversion.

Question: What will be the impact of enlarged wetlands on homeowners adjacent to Dennis Brook?
Dr. Holdren: The water level in the stream will rise, but the impact will be low. The water level in the stream will be raised to where it was before the water level in Franklin Lake was lowered.

Question: Should the culverts near Peter Cooper Village and other stormwater culverts be cleaned?
Dr. Holdren: Yes, that would be done as part of the road maintenance program. The largest cost is the initial one.

Comment: The timing of an additional cost burden to local taxpayers with other expensive programs coming up may be a problem.
Dr. Holdren: Local in-kind services can help defray local costs in the implementation of the Phase II Program.

Question: What is the timetable for the implementation of Phase II?
Dr. Holdren: If we had the money in hand, we could begin in the fall of 1989. With the time involved in obtaining Phase II funding, it will take longer. At best, it would take about 2 years.

Question: If dredging doesn't improve water quality, should aeration be considered?
Dr. Holdren: Aeration is a possibility, but it can create algal bloom problems in some cases. Aeration may have a better chance for effectiveness after dredging because of the increased depth.

Question: What funding sources are available and what is the time frame for obtaining money?
Dr. Holdren: Possible funding sources include the U.S. EPA Clean Lakes Program and the New Jersey Lakes Management Program. The application process is fairly short. We can be ready to apply for federal funds in February, 1990, and to the state before that. Perhaps the funding can be approved in phases which will provide enough to get started.

Question: How can sediment from lake dredging be used? As backfill?
Dr. Holdren: It can be used for a variety of things. The chemical analysis shows that no toxic chemicals are present in the sediment. Because there is a site for placement of dredged sediment near the lake, it is not necessary to pay someone to remove it from the area.

Question: What about chemical treatment to control the algae problem?

Dr. Holdren: That is a possibility, but it is a band-aid approach which would have to be repeated again and again. Copper sulfate is most commonly used because it is safe for humans and can be used in water supply reservoirs. However copper can build up in the lake system and become toxic to aquatic life, including fish-food organisms. Therefore, it is not a recommended management alternative for Franklin Lake.

Question: Is there any money left from the Phase I Study?
Mr. Harvey: No, the contract came out on the penny.

Question: Will the dredging project remove silt or hard sediment?
Dr. Holdren: Silt and unconsolidated material will be removed by dredging. Disturbing the hard sediments could affect the aquifer below the lake and must be avoided.

Question: How soon would the lake refill with sediment after dredging?
Dr. Holdren: That is a difficult question to answer, but our calculations indicate that it could take fifty to 100 years to refill at current loading rates.

Question: What is the local approval procedure?
Mr. Harvey: Council approval. No referendum is necessary.

Question: Will the dredging operation create an odor problem?
Dr. Holdren: Yes, a temporary one as sediments dewater.

Mr. Harvey: Are there any more questions or comments? With that, I would like to thank everyone for attending our meeting tonight to provide comments and concerns which will be included in our final report.

The meeting was adjourned at 9:00 p.m.