

A SUMMARY OF
LAKE RESTORATION/MANAGEMENT
PROBLEMS AND ALTERNATIVES
FOR THE FOUR LAKES OF THE
TOWNSHIP OF LACEY:
BAMBER LAKE, LAKE BARNEGAT,
DEER HEAD LAKE, AND LOWER LAKE
A PRELIMINARY REPORT

Prepared For:

Township of Lacey
Lake Restoration Sub-Committee
818 West Lacey Road
Forked River, NJ 08731

Prepared By:

Normandeau Associates, Inc.
170 Oberlin Avenue North
Lakewood, NJ 08701

NAI-NJ Project No. 10181

JULY, 1991

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EXECUTIVE SUMMARY

The purpose of this project was to conduct a comprehensive study to more fully understand lake problems identified by Lacey Township (i.e., beach closings, aquatic vegetation, siltation). The study included obtaining and evaluating site specific limnological, morphological and watershed data of each of the four lakes: Lower Lake, Lake Barnegat, Deer Head Lake, and Bamber Lake.

Basically, the Township's residents have expressed concern about a decrease in resource value of the lakes over time. There are two problems common to each lake: bacterial contamination and excessive aquatic vegetation. In addition to these problems, Lower Lake appears to exhibit excessive nutrient concentrations. Beach closings in 1990 due to elevated fecal coliform bacteria levels were substantially higher in Lower Lake (where they occurred 66% of the time), while the remainder of the lakes were closed much less frequently, ranging from 15% to 18% of the time based on the dates sampled.

The primary causes of these problems also appear to vary among the lakes. The data evaluated tend to suggest a correlation between rainfall and non-point source (NPS) pollution as a primary cause for beach closings at Lake Barnegat and Deer Head Lake. Waterfowl also likely contribute to NPS pollution, but more sporadically; it may depend on where the birds congregate in relation to the beach locations. Rough calculations indicate that the number of waterfowl observed on the lakes at times could in themselves produce sufficient bacteria loadings to cause health criteria exceedences. The data evaluated also appears to suggest that there is a correlation of rainfall events and beach closings at the Bamber lake beaches. However, dissimilar from Lake Barnegat and Deer Head Lake, the increased intensity of rainfall did not seem to result in either higher bacteria counts nor additional beach closings in 1991, on a percentage basis. It is possible that flocking waterfowl cause the spatial variation in bacteria counts.

Other than the problems associated with the lakes as stated, the data evaluated also suggests that the lakes are otherwise relatively "healthy" and that the opportunities for implementing successful remedial actions are encourag-

ing, particularly for Lake Barnegat, Deer Head Lake, and Bamber Lake. It is possible to implement techniques for Lower Lake to show significant improvements, but the relative cost and ability to sustain prolonged use of the beaches appears limited; such improvements may not be logistically and financially practicable in light of priorities at the other more heavily used lakes. Evidence suggests an undocumented source of nutrient and bacteria loading to Lower Lake; this problem should be resolved before considering other long-term restoration actions.

All of the lakes, with the exception of the lower basin of Lower Lake, retain a portion of the phosphorus that is loaded to them on an annual basis. The net effect of this is a gradual nutrient enrichment of the sediments and a gradual filling of the lake with sediments from degraded plant material. The lower basin of Lower Lake exhibits a net export of phosphorus on an annual basis. This suggests that there is either 1) a substantial internal loading of phosphorus to the water column from the sediments as a result of relatively high historical nutrient loads or that 2) there is an undocumented point source of nutrients to Lower lake that is causing enrichment beyond what would be estimated through the nutrient budget exercise.

Other than Lower Lake, the majority of nutrients which support aquatic vegetation are associated with sediments. Accordingly, sediment dredging is a viable alternative for reducing the cause of excessive aquatic vegetation. The estimated maximum amount of sediments which could be dredged from all of the lakes is 320,000 cubic yards (CY) at a cost of \$3.2 million. However, if the Township were most interested in just dredging areas adjacent to beaches, volumes could vary but appear to range from 30,000 to 50,000 cubic yards with a resulting range from \$300,000 to \$500,000. Additional open water areas for boating and fishing could be recovered by either additional dredging or alternate means such as annual maintenance via weed harvesting or herbicide application. The relative long-term versus annual costs for maintenance must be evaluated in light of the Township's objectives and budget.

Management of the likely causes of bacteria inputs involve implementation of Best Management Practices (BMP) to control stormwater runoff within the watershed as well as discouraging waterfowl use of the lake's beach areas. Both structural and non-structural BMP's are important in minimizing non-point source (NPS) pollution. Non-structural components include promoting sound water quality practices at all levels of government as well as citizen education and involvement. While this report tends to focus more on the various structural BMP alternatives it is important to realize that non-structural alternatives are an important first step. Through a public education program well known "house keeping" practices by citizens living within the watershed can contribute to reducing water quality problems. Of the structural options, infiltration trenches appear to be the most appropriate for the lake community associated with Lower, Barnegat and Deer Head Lakes for controlling bacteria due to the developed nature of that portion of the watershed. Other structural BMP techniques may be substituted for select areas as appropriate. For moderate and high priority areas within the Forked River watershed (which comprise less than 10% of the watershed area), the cost associated with constructing infiltration trenches (to provide a storage capacity of 27,000 cubic yards) is estimated to be \$2.2 million. Before committing any funds toward engineering design of treatment alternatives, data should be collected and evaluated to confirm the importance of each priority area and their resulting storm drain input; funds appear to be available from the State's Sewage Infrastructure Improvement Act. Non-structural options should be closely examined first, also. This would help focus the final treatment volumes and design requirements for each sub-watershed area.

The alternatives for waterfowl management should be field tested and successful techniques should be implemented. The relative cost for waterfowl management will vary with the techniques utilized but are relatively inexpensive.

Developing a lake management plan is a dynamic process whereby feedback is required by the Township pertaining to the alternatives presented, costs and statement of objectives. This preliminary report provides an understanding of the lake and watershed conditions and allows the township to focus on specific alternatives and relative costs that collected data and initial

analysis indicate should be successful. It is up to the Township to decide what objectives are targeted in light of relative costs; from this point a final management plan could be developed.

The findings of this study have reinforced the importance of the Township's having invested the necessary time and money to more fully understand the problems so that appropriate solutions and associated costs can be evaluated for the long-term management of the lakes.

1.0 INTRODUCTION

1.1 STATEMENT OF PROBLEM AND PURPOSE OF STUDY/REPORT

Lacey Township Lakes are comprised of manmade impoundments of two watersheds. There appears to be distinct problems associated with each lake. Prior to the onset of this study, the Township had identified several symptoms of problems such as an increased frequency of beach closings due to fecal coliform bacteria, excessive aquatic vegetation growth, and siltation.

Simply stated, the Township of Lacey's residents want to know why the beaches are being closed (i.e., what are the sources of bacteria entering the lake) and what can be done to correct the problems. The townspeople also wanted to know what could be done to reduce the amount of aquatic weed growth in order to improve the overall resource value of the lakes. In addition, the Township was interested in evaluating dredging as one remedial method to remove accumulated sediment and improve the recreation component of the lakes.

The purpose of this project was to conduct a comprehensive study and prepare this preliminary report as part of the process of the development of a lakes restoration and management plan. The need for the study was driven by the desire of the Township to only spend money on restoration techniques that would be useful and hopefully long lasting. The Townships' management wanted to make an initial (and smaller) investment to fully understand the problems and determine reasonable solutions prior to simply spending significant dollars on undirected treatment techniques. The objectives of the study were developed with the Township's Lake Management Subcommittee as part of a project scoping phase. The project objectives included obtaining and evaluating site specific limnological, morphological and watershed data on the four lakes. These data could then be used to evaluate alternative remedial techniques, which could be assessed in light of technical feasibility, to successfully improve the lakes. Accordingly, this preliminary report presents appropriate alternatives and cost information for the Township to evaluate and utilize to develop achievable objectives for the long term management of Lacey's Lakes.

GENERAL SETTING

The four lakes, located in Lacey Township, are known as Mill Pond (here after referred to as Lower Lake), Bamber Lake, Deer Head Lake, and Barnegat Lake. The lakes are located in eastern, central Ocean County, (Figure 1-1). Deer Head, Barnegat, and Lower Lakes are located east of the Garden State Parkway, in the community of Barnegat Pines. Bamber Lake is located northwest of the other three lakes and the Garden State Parkway, south of the community known historically as Cedar Crest. The four lakes comprise a total of approximately 196 acres; lake acreage and associated watersheds are listed below.

	<u>Name</u>	<u>Acreage</u>	<u>Watershed</u>
1.	Lower Lake	27	Forked River
2.	Deer Head Lake	48	Forked River
3.	Lake Barnegat	64	Forked River
4.	Bamber Lake	57	Cedar Creek

Generally, the area has a marine continental climate and an annual temperature regime characteristic of the northeast coastal zone. The mean normal annual temperature is 52.8° F with an annual average high of 64.2 °F and a low of 41.4 °F recorded in Indian Mills, New Jersey. Precipitation totals approximately 47.68 inches annually (SCS, 1981). The average normal monthly precipitation varies from a low of 3.41 inches in June to a high of 4.98 inches in August (NOAA, Sept. 1989). The topography of the area ranges from about 10 feet above sea level (at Lower Lake) to 184 feet (Forked River Mountain) for the Forked River watershed, and from about 80 feet (Bamber Lake) to 215 feet for the Cedar Creek watershed according to USGS topography data.

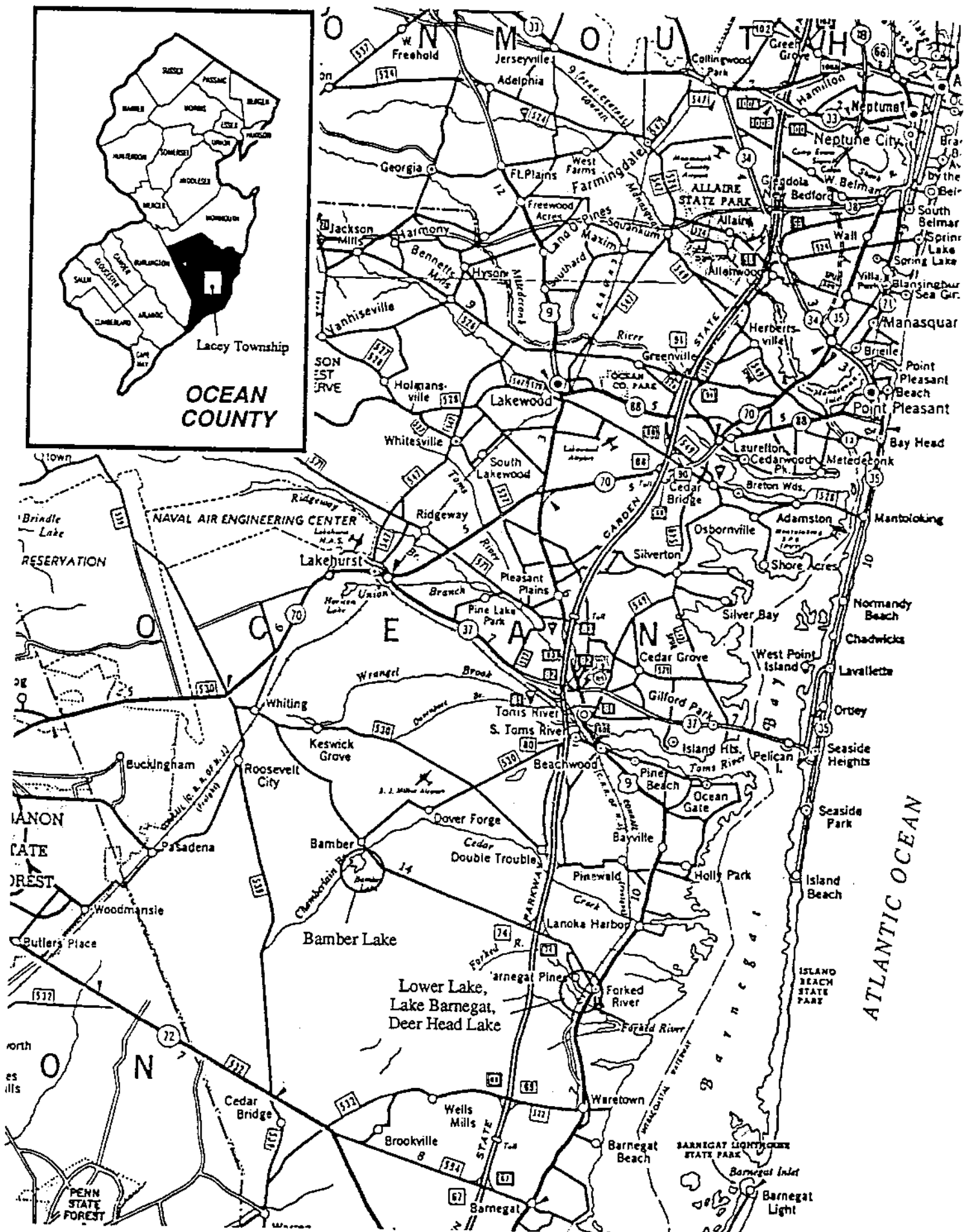


Figure 1-1. Lacey Township Lakes, Ocean County, New Jersey.

Deer Head, Lower, and Barnegat Lakes were previously Atlantic White Cedar swamp areas and logged for cedar in the 1800's. A fire in 1930 destroyed the sawmills and logging ceased. The middle lake area (Barnegat Lake) was converted to a cranberry agricultural area in the early 1900's. In 1935 the dam for Barnegat lake was constructed. The next dam built was the north dam creating Deer head lake. Mill Pond (Lower Lake) was created by the construction of Mill Dam in 1952. In an attempt to increase water circulation in the bathing area, an additional dam was constructed in 1972, referred to as the south dam on Deer Head lake.

Historical information regarding Bamber lake dates back to 1809 when General Lacey built a dam and forge on the lake to operate a bog iron ore business. Prior to this construction, the lake was home to the Lenni Lenape Indians. Until 1975, Bamber lake was the site of Camp Columbus where over 100 boys utilized the recreational resources each summer. General Lacey's dam was destroyed in a storm and consequently, the existing dam was built (1976). In an attempt to protect the undeveloped nature of Bamber lake, the New Jersey Department of Environmental Protection purchased 4,300 acres around the lake in January of 1983.

Currently, the land around the four lakes is home to residents of Lacey Township. The major recreational use of the lakes is swimming and beach areas have been developed to facilitate this use. The colored water, shallow depths, pH and historical drawdown practices do not promote an optimal habitat for many species of fish; however residents do fish for certain species, such as pickerel, hornpout and sunfish. No documentation exists regarding fish stocking of any of the lakes. Boating on the lakes is restricted to row and sail boating.

A subsample of the Township's population was surveyed to determine lake usage trends (Exhibit 1). Briefly, the survey indicated that swimming is the dominant recreational activity (79.4%) while fishing and boating had some popularity (27% and 25.4%, respectively). The majority of people visit either Barnegat Lake (55%) or Deer Head Lake (40%). Only 3% of those surveyed visit

Bamber Lake and 2% visit Lower Lake. However, 92.6% of the people surveyed feel that the quality of the lakes has declined and that the level of enjoyment of the lakes and desire to swim has been substantially reduced. Nearly 70% of those surveyed are concerned about excessive weed growth.

In the past, the Township of Lacey has utilized chemical (Sonar & Diaquat) and mechanical methods to help control nuisance weed populations. The township had indicated that mechanical harvesting has proven ineffective. Principal weed species of concern included spatterdock (Nuphar advena) and water milfoil (Myriophyllum spicatum). Although no data exists to determine the effectiveness of the weed management program, the majority of lake residents agree that the quality of the lakes has declined over the past years.

3.0 LAND USE

The lake and watershed areas of Lacey Township have experienced limited development since the creation of the lakes. Each lake is used for recreational purposes and has housing and beach areas along its shoreline. The exact breakdown of the land use for each lake is as follows:

LOWER LAKE

Lower lake is approximately 27 acres in area and is used primarily for recreation. The shoreline areas adjacent to this lake are sparsely developed with residential housing and beach areas on approximately 29% of the shoreline with the remainder of the shoreline existing as undeveloped forested land. The watershed area is approximately 9,627 acres. All homes and commercial structures within 400 feet of Lower lake are serviced by municipal sewers. The south side of Lower Lake has less impervious coverage from structures and paving due to expansive wetlands adjacent to the lake relative to the north side of the lake.

BARNEGAT LAKE

Barnegat Lake is approximately 64 acres in area and is also used for recreation. Approximately 64% of this lake's shoreline is developed with medium density housing and beach areas. The remaining 36% of the shoreline remains undeveloped. The watershed area is approximately 9,455 acres in area; the majority of the watershed area is within the Pinelands Commissions jurisdiction and undeveloped. Single family homes exist within the Barnegat Lake Watershed east of the Garden State Parkway and are served by municipal sewers.

DEER HEAD LAKE

Deer Head Lake is approximately 48 acres in area and approximately 51% of its shoreline is developed with residential housing and beach areas. This lake is used primarily for recreational swimming and non-power boating. The 8,963 acre watershed of this lake is essentially undeveloped, with approximately 7% of the watershed area

having medium density development. The development within this lake's watershed consists primarily of single family homes located within approximately 3000 feet of the lake's shoreline.

BAMBER LAKE

Approximately 12% of the 57 acre Bamber Lake shoreline has been developed through residential housing and recreational facilities. The watershed of Bamber lake is approximately 13,026 acres, about 4% of the area has been developed by the construction of low density housing. The entire watershed area of Bamber Lake is within the Pinelands.

Localized geology consists of stratified layers of sand, gravel and sandy loam of the highly permeable Cohansey Sand geologic formation. The Cohansey Aquifer is an unconfined water-bearing unit of consolidated sand and gravel in connection with the Coastal Plain Aquifer System. The aquifer system underlies most of south-central New Jersey and all of Ocean County, with the exception of minor areas of Quaternary and younger deposits of mixed gravels and sands which are found on some of the higher elevation drainage divides.

The following is a table listing the soils associated with the drainage basin of the lakes.

<u>Soil</u>	<u>% Slope</u>	Depth of <u>SHWT</u>	<u>Capability Class*</u>
Berryland Sand (BF)	level	0-0.5	Vw
Downer loamy sand (DoA)	0 - 5	>6.0	IIs
Downer sandy loam (DpB)	2 - 5	>6.0	Iie
Evesboro sand (EvB)	0 - 5	>6.0	VIIIs
Evesboro sand (EvC)	5 - 10	>6.0	VIIIs
Klej loamy sand (KlA)	0 - 3	1.5-2.0	IIIw
Lakehurst sand (LmA)	0 - 3	1.5-2.5	Ivw
Lakewood sand (LwB)	0 - 5	>6.0	VIIIs
Manahawkin muck (Ma)	level	+1-0	VIIw
Psammments (PO)	level	--	--

* Capability classes reflect the suitability of soils for field crops. VIIIs - unsuitable for cultivation, soils severely limited by moisture capacity and/or fertility; Ivw - severely limited for cultivation by low moisture capacity and low fertility; Vw - impractical to use for regular crops because of excess water and infertility.

The majority of soils are not erosion-prone, as shown in the capability class listing. Downer sandy loam, however, has a capability class of Iie which indicates a tendency towards erosion; it is located between Deer Head Lake and Lacey Road. Since the land use is residential for this area, the erosive potential of the soil is limited. Additionally, because no further development in that area is anticipated, erosion is not anticipated to pose a problem in the future.

5.0 LAKE MORPHOMETRIC/BATHYMETRY DATA

A bathymetric survey was conducted by NAI to determine the existing contours of each of the Lacey lakes. From this information, morphometric data were derived and analyzed. The following lists key morphometric data collected for the lakes:

MORPHOMETRIC DATA OF DEER HEAD LAKE

OFFICIAL NAME	Deer Head Lake
LOCATION	Lacey, New Jersey
LAKE AREA	48 acres
LAKE MAXIMUM DEPTH	5 feet
LAKE MEAN DEPTH	2.5 feet
LAKE VOLUME	100.2×10^5 cu.ft.
WATERSHED AREA	8,963 acres

MORPHOMETRIC DATA OF BARNEGAT LAKE

OFFICIAL NAME	Barnegat Lake
LOCATION	Lacey, New Jersey
LAKE AREA	64 acres
LAKE MAXIMUM DEPTH	9 feet
LAKE MEAN DEPTH	4 feet
LAKE VOLUME	179.5×10^5 cu.ft.
WATERSHED AREA	9,455 acres

MORPHOMETRIC/BATHYMETRY DATA CONTINUED

MORPHOMETRIC DATA OF LOWER LAKE

OFFICIAL NAME	Lower Lake
LOCATION	Lacey, New Jersey
LAKE AREA	27 acres
LAKE MAXIMUM DEPTH	6 feet
LAKE MEAN DEPTH	3 feet
LAKE VOLUME	601.1×10^4 cu.ft.
WATERSHED AREA	9,627 acres

MORPHOMETRIC DATA OF BAMBER LAKE

OFFICIAL NAME	Bamber Lake
LOCATION	Lacey, New Jersey
LAKE AREA	57 acres
LAKE MAXIMUM DEPTH	6 feet
LAKE MEAN DEPTH	3 feet
LAKE VOLUME	104.5×10^5 cu.ft.
WATERSHED AREA	13,026 acres

6.0 LIMNOLOGICAL SURVEY

6.1 WATER QUALITY

6.1.1 Sampling Program

The diagnostic/feasibility study of the four lakes in Lacey Township was initiated in August of 1989. This program included the collection of 12 consecutive months of water quality data from the lakes; this section details the results of that sampling. Water quality results are discussed for all lakes on a parameter by parameter basis to avoid redundancy in the discussion due to the close relationship between the lakes, both chemically and hydraulically. Where one lake shows differences from the other lakes in any one parameter, results are explained. Results presented by sampling station are presented in Exhibit 2.

6.1.2 Results of Sampling Program

pH and Alkalinity

pH is a measure of the acidity of water. pH of natural waters is typically around 7 or neutral. However, lakes with watersheds that encompass large areas of wetland and conifers may exhibit pH values that range towards the acidic end of the scale. Such appears to be the case with the lakes in Lacey Township. Most of the watersheds of the lakes are part of the pine barrens which are characterized by having sandy, poorly buffered, acidic soils. In addition, the watersheds contain large areas of wetlands which can at times contribute organic and humic acids to the lakes. Acidity in Lacey's Lakes is thought to be largely a natural phenomenon. pH in the Lakes ranged from values in the 3.5 - 4.0 range in October of 1989 to values in the 4.0 - 4.5 range on most other sampling dates at all lake stations. This indicates that the lakes of Lacey are very acidic. The detention pond, while only sampled since February of 1990, exhibited pH values between 5.3 and 6.1. These values were consistently higher than lake values. Because the primary source of water to the detention basin is

from residential areas as opposed to the pinelands drainage feeding the lakes, this disparity in pH is not surprising. The pH of the lakes in Lacey Township is at the low end of the range reported for typical natural lakes. The low pH of the Lakes in Lacey Township while probably largely natural in origin is low enough to negatively impact populations of some species of aquatic biota and fish.

Alkalinity is a measure of the ability of a waterbody to neutralize acid that is added to it. As mentioned above in the pH discussion, the watershed of each of the lakes is such that the lakes are expected to be acidic. pH values measured during the course of this study support that contention. Alkalinity values observed in the lake were nearly always at the detection limit of the laboratory equipment or essentially zero. The acidity of the inflow waters has virtually exhausted the buffering capacity of the lakes. This makes the lakes at Lacey particularly susceptible to increases in acidity or decreases in pH. Acid rain may further contribute to a decline in the pH of the lakes however the current pH of the lakes is already close to the pH associated with most acid rain.

Temperature

Temperature is important not only because at times it can cause a lake to stratify or strongly resist mixing but also because it can structure the biologic community. The maximum summer temperature of a lake often dictates the type of fish community that can exist. Because the lakes of Lacey are so shallow and light penetrates to the bottom, thermal stratification was never evident. The entire water column of each lake was nearly 25 degrees Celsius during the August sampling period. The lack of cold water habitat at present probably limits the fish community to warm water species.

Dissolved Oxygen

The importance of dissolved oxygen in lakes is twofold. First, dissolved oxygen is critical to aquatic organisms for respiration and secondly,

dissolved oxygen is critical to the balance of many other chemical constituents of lakes. Very productive lakes have the potential to exhibit dissolved oxygen depletion at times during the year. This depletion can result in limitation of fish habitat and nutrient export from the sediments. While the potential for such depletion is possible at Lacey due to the biomass of macrophytes and the highly organic sediments in the lake, substantial dissolved oxygen depletion was not observed during the sampling program on most sampling dates. Bamber Lake never exhibited substantial dissolved oxygen depletion during any of the sampling events at any of the sampling locations. Dissolved oxygen concentrations were near saturation with a few exceptions throughout most of the year on both Deerhead Lake and Lake Barnegat. However, some dissolved oxygen depletion was observed at several stations in Lower Lake during June, July and August. Although observed concentrations were generally not low enough to cause nutrient export from the sediments, nocturnal dissolved oxygen depletion could result in the mobilization of nutrients into the water column from the sediments. Light penetration to the bottom of the water column throughout each of the lakes allows photosynthetic oxygen production throughout the water column during daylight hours. It is possible that the lakes, particularly Lower Lake exhibit some nocturnal dissolved oxygen depletion when macrophytes and organic matter in the sediments are using oxygen for respiration and photosynthesis is not occurring. This possibility is discussed further in the nutrient budget section of this report.

Total Suspended Solids

Total suspended solids were measured in samples taken at all water quality stations on all sampling dates. Suspended solids can be an indication of the rate and source of sedimentation in lakes. Relatively high concentrations of suspended solids can lead one to the conclusion that the lake has the potential to become rapidly filled with sediments, particularly if high concentrations of suspended solids are observed in the inflow tributaries and not observed in the outlet of the lake. This indicates that solids are dropping out of suspension in the lake. Concentrations of suspended solids were low during all of the sampling dates with the exception of the December sample taken from

near the inlet of Lake Barnegat. From the data observed, it does not appear that suspended solids are contributing greatly to the sedimentation observed in the lakes nor that bottom sediments are being resuspended to any great extent. These data indicate that accumulation of organic matter from decaying macrophytes is the major source of sediments to the lakes.

Total Dissolved Solids

Total dissolved solids, like conductivity are a rough indicator of water quality. High concentrations of dissolved solids are generally associated with very productive lakes. While total dissolved solids concentrations do not of themselves define specific problems with the water chemistry of a lake, they may be used as indicators of high concentrations of other dissolved substances. The total dissolved solids concentrations observed in the Lacey lakes ranged from 21 to 80 mg/l. These concentration are similar to those that would be expected in moderately productive lakes. A large portion of the total dissolved solids in the lakes at Lacey may be attributable to dissolved organic substances originating in the watersheds of the lakes.

Specific Conductance

Specific conductance is a rough measure of the ionic strength of water. In most waterbodies, specific conductance does not vary seasonally to any great extent. Specific conductance was measured at all water quality stations in November 1989. Average values measured were: Lower Lake, 56 umhos/cm; Lake Barnegat 56 umhos/cm; Deer Head Lake, 54 umhos/cm; and Bamber Lake 34 umhos/cm. Values from that sampling date indicate that the specific conductance of the lakes in Lacey Township is low relative to most lakes in North America. This can be interpreted as the Lakes of Lacey having few dissolved ions. This contention is further supported by the concentration of other parameters measured during the course of this study.

Turbidity

Turbidity is a measure of the relative clarity of the water or the ability of particles in the water column to scatter light. These particles can be either inorganic in nature (suspended soil particles) or organic in nature (suspended algal cells). This is especially important in lakes where there is potential for plant growth to be limited by available light at depth. In the lakes at Lacey, high turbidity could result in reduced macrophyte growth but poor water clarity may be equally as objectionable. On the other hand, a substantial reduction in macrophyte biomass could result in an increase in algal turbidity as nutrients formerly utilized by macrophytes are used by algae. Turbidity values in the lakes were almost always below 10 NTU which is generally considered to constitute the upper limit of turbidity for discharges and the value above which recreational activity begins to become impaired. Occasionally higher turbidity readings were encountered near the outlet of Deer Head Lake and one value greater than 10 NTU was reported in the lower basin of Lower Lake in November. The reason for the higher values is unknown.

Chloride

Chloride in natural fresh waterbodies has several potential sources. First, chloride (the negatively charged ion of salt) can enter a fresh waterbody through aerosols caused by spray from the ocean. A second common source of chloride in fresh waterbodies is from roadsalt runoff from roadways. A third less common source of chloride in fresh water is from underground salt springs.

The distribution of chloride concentration among the lakes (Exhibit 1) suggests that especially for Lower Lake and Lake Barnegat, the ocean may be an important source of chloride. Concentrations in the upper lakes while lower than those observed in Lower Lake and Lake Barnegat still indicate a minor source. This source is likely roadsalt. Overall concentrations of chloride are low when compared to concentrations reported for other North American lakes indicating that none of the sources are particularly large. The current

concentrations of chloride in the lakes is well below drinking water standards and standards established for the protection of aquatic biota.

Nitrogen

Nitrogen is present in several forms in freshwater lakes. The most common forms are ammonia, nitrate and organic nitrogen. Throughout the monitoring program at Lacey Lakes, ammonia, nitrate and total Kjeldahl nitrogen were measured in samples taken from all water quality stations. TKN measures the combination of ammonia and organic nitrogen such that the concentration of organic nitrogen can be determined by subtracting ammonia concentrations from TKN. In some lakes, particularly those with very high phosphorus loads, nitrogen is the limiting nutrient to plant growth. In order to establish whether or not this was the case in the Lacey Lakes the ratio of total nitrogen defined as the sum of TKN and nitrate to total phosphorus was determined. It appears that phosphorus concentrations in the lakes are low enough relative to nitrogen concentrations to avoid nitrogen limitation on nearly all of the sampling dates. Concentrations of TKN, nitrate and ammonia were all below 1 mg/l at all lake stations on all sampling dates indicating that the lakes are all relatively unproductive, a contention further supported by chlorophyll a and phosphorus data.

Total Phosphorus

Total phosphorus is most often the nutrient of concern in lakes. Because it is in relatively short supply in the lakes of Lacey, it sets the maximum amount of plant growth possible in the lakes. This was discussed further in the discussion of N:P ratios above. Total phosphorus concentrations in the lakes were almost always at the level that would be expected from unproductive to moderately productive lakes. An exception was noted in January when concentrations were an order of magnitude greater than those observed before or after that sampling date. Elevated TSS, TDS, conductivity and turbidity values would be expected on this sampling date if the phosphorus concentrations were elevated to the level observed. However, none of these parameters exhibited elevated concentrations when compared to prior or following months. Because no

other parameters showed elevated concentrations on this date, it is believed that these values may be due to sample contamination or analytical error; therefore, the phosphorus data from January were not included in the nutrient budget analyses. Further detail on the nutrient budget is presented in later sections of this report.

Chlorophyll a

Chlorophyll a is a pigment found in all species of freshwater algae. Because it is common to all species, it is a good indicator of the concentration of algae in a waterbody at a given point in time. Because algae concentrations in lakes are rarely uniform, that is they are patchy, individual chlorophyll a values are limited in their ability to indicate specific water quality. However, the dynamics of chlorophyll a concentration over a growing season at a water quality station can indicate a good deal about the relative productivity of the waterbody. Chlorophyll a was only measured at in-lake stations during the course of the monitoring program. Concentrations observed in all the lakes suggest that there is a relatively low productivity level associated with the lake's water quality; this factor is mostly independent of the productivity associated with the lake's sediments, which is high. Competition for nutrients from the large amounts of macrophytes in the lakes probably limits the growth of phytoplankton in the lakes to some extent; however, low concentrations of nutrients in the inflow water also contributes to the low phytoplankton biomass (chlorophyll a concentrations).

Bacteria

Bacteria are frequently tested in waterbodies as an indicator of the possible presence of pathogens. Total coliform, fecal coliform and fecal streptococci were counted in samples taken at all water quality stations on all sampling dates. Total coliforms encompass both coliforms present in fecal matter as well as coliforms present in soils. Total coliform counts are still occasionally used as water quality standards.

The current bathing standard in the Township of Lacey is based on fecal coliform bacteria. The presence of fecal coliforms is associated with the fecal matter of warm blooded animals. While fecal coliforms themselves are not harmful, their presence in waterbodies is used as an indicator of the presence of pathogens. Concentrations of fecal coliform bacteria from the in-lake monitoring samples were generally below the 200 colonies per 100 ml bathing standard at all sampling stations on all sampling dates. Apparent violations of the standard were observed on Lower Lake in May and September and in Lake Barnegat and Deer Head Lake in September. Despite the absence of wide-spread water quality violations at the in-lake and tributary stations, there have been beach closings in 1989 and 1990 due to high concentrations of fecal coliform bacteria near the beach areas (see Section 8.4).

Fecal streptococci counts were also made at all water quality monitoring stations. The ratio between fecal coliform and fecal streptococci counts can be used to distinguish between fecal coliforms discharged by humans and fecal coliforms discharged by other warm blooded animals and birds if the source is clearly from one group or another and the counts are high enough. Counts of both fecal coliforms and fecal streptococci were generally not high enough to make a conclusive source differentiation at the in-lake stations. Source differentiation at the beaches using data collected by the Ocean County Health Department was not possible due to the absence of fecal streptococci analyses.

6.2 LAKE MODELING

In order to objectively evaluate alternatives for restoration of the lakes in Lacey, in terms of potential to improve water quality, a water and phosphorus budget was developed for each of the lakes. The budget was initially constructed using field data from the sampling program where possible. The constructed nutrient budget can be used to evaluate the impact of a potential restoration activity or group of activities on the nutrient regime of the lake. Activities with the greatest potential to cause improvements in water quality should be given a higher priority for implementation.

6.2.1 Hydrologic Budget

The hydrologic budget was constructed utilizing published runoff estimates for the pinelands (Pinelands Commission 1980). These estimates were applied on an areal basis to the watershed of each of the lakes and used to determine annual water loading from each major subwatershed area (see Figures 11-1 and 11-2 for subwatershed designations). The runoff estimate used for the undeveloped portion of the watersheds in the pinelands was 22.5 inches per year as reported by the Pinelands Commission (1980). The runoff estimates for the developed portion of the watershed were adjusted upward to account for the impervious areas. It was assumed that all of the rainfall that fell on the impervious areas became runoff. Using a 30% percent impervious coverage estimate (as reported by the Pinelands Commission (1980)), a runoff value for the developed portion of the watersheds was estimated at 28.9 inches per year. The results of this analysis are presented with the nutrient budget for each lake in Tables 6-1 through 6-6. The watersheds for each of the lower lakes are very similar in size because of the relatively large area of pinelands upstream of Deerhead Lake that is common watersheds to all three lakes.

6.2.2 Nutrient Budget

The nutrient budget for the lower lakes could not be constructed using a traditional per unit watershed area export coefficient approach because the lakes are in a series and act functionally as detention basins for the lake(s) below them. Therefore the following approach was used to estimate the nutrient loads from each of the major tributaries. In-lake annual phosphorus concentrations observed during the monitoring program on each of the lakes were used as a starting point. From those concentrations and an estimate of the water retention time of the lake calculated through the hydrologic budget presented above, the average annual phosphorus load required to obtain a steady state in-lake concentration of the magnitude observed was calculated according to the expression:

$$[P] = \frac{P}{1 + T^{0.5}}$$

where;

[P] - steady state in-lake phosphorus concentration in ug/l,

P - average inflow phosphorus concentration in ug/l and,

T - mean hydraulic residence time in years.

Once the concentration of the inflow water needed to produce observed in-lake concentrations was calculated, the phosphorus load from each of the subwatersheds of each lake was estimated. The load attributable to the inlet tributaries of each of the lakes was estimated through actual monitoring data. The remaining portion of the load was then apportioned to the rest of the watershed on a per unit watershed area basis. Most of these drainage subbasins convey runoff to the lakes via storm drains or discharge runoff directly to the lakes. Results of this exercise are presented in Tables 6-1 through 6-5.

Interpretation of the results of this analysis must be done with caution for several reasons. First, the lake model used is a general lake model, and as such cannot be expected to yield precise lake-specific results. Second, by apportioning all of the residual load to the small developed subbasins, the actual phosphorus loads to the lakes from these subbasins was probably overestimated. The portion of the total load coming from the tributaries during major storm events was probably underestimated and the fraction of the load entering the lakes from direct groundwater discharge was not represented. This analysis is then best used as a worst case assessment of the impact of the urbanized subwatersheds. While the actual loads calculated may be somewhat uncertain, the relative difference in loads among watersheds can be used to guide restoration efforts. Additionally, the overall impact of the urbanized areas on the lake nutrient budgets can be established. This analysis could be further refined by estimating the inputs of specific urban subwatersheds through further stormwater monitoring.

In most cases, the areas not drained by tributary streams were the developed portions of the watersheds and estimated phosphorus loads from those

subwatersheds were substantially higher than from the pinelands. However, when loads from these sources are presented as a percent of total annual load to the lakes, the contribution from any one developed subwatershed was very small. The implication of this analysis is that the majority of the nutrient load to these lakes originates in the pinelands and is essentially natural in origin.

All of the lakes with the exception of the lower basin of Lower Lake retain a portion of the phosphorus that is loaded to them on an annual basis. The net effect of this is a gradual nutrient enrichment of the sediments and a gradual filling of the lake with sediments. The lower basin of Lower Lake exhibits a net export of phosphorus on an annual basis. This suggests that there is either 1) a substantial internal loading of phosphorus to the water column from the sediments as a result of relatively high historical nutrient loads or that 2) there is an undocumented point source of nutrients to the lake that is causing enrichment beyond what would be estimated through the nutrient budget exercise.

TABLE 6-1
WATER AND TOTAL PHOSPHORUS BUDGET FOR BAMBER LAKE

	SUBWATER- SHED AREAS	AREA (acres)	MEANFLOW ac.ft/yr	INFLOW PERCENT	P-INFLOW (lbs/yr)	P-INFLOW PERCENT
	A	10,435	19,983	82.95	380	66.78
	B	1,944	3,723	15.45	71	12.48
	C	77	147	0.62	3	0.53
	D	52	109	0.45	66	11.60
	E	63	128	0.53	49	8.61
TOTAL INFLOW		12,571	24,090	100	569	100
EVAPORATION			102			
OUTFLOW			23,988			

TABLE 6-2
WATER AND TOTAL PHOSPHORUS BUDGET FOR DEER HEAD LAKE

	SUBWATER- SHED AREAS	AREA (acres)	MEANFLOW ac.ft/yr	INFLOW PERCENT	P-INFLOW (lbs/yr)	P-INFLOW PERCENT
	A	8,877	16,644	94.73	317	75.66
	B	106	255	1.45	28	6.68
	C	95	229	1.30	25	5.97
	D	27	65	0.37	7	1.67
	E	6	14	0.08	2	0.48
	F	19	46	0.26	5	1.19
	G	42	101	0.57	11	2.63
	H	57	137	0.78	15	3.58
	I	33	79	0.46	9	2.14
TOTAL INFLOW		9,262	17,570	100	419	100
EVAPORATION			83			
OUTFLOW			17,487			

TABLE 6-3
WATER AND TOTAL PHOSPHORUS BUDGET FOR LAKE BARNEGAT

	SUBWATER-SHED AREAS	AREA (acres)	MEANFLOW ac.ft/yr	INFLOW PERCENT	P-INFLOW (lbs/yr)	P-INFLOW PERCENT
	FROM DEER HEAD	9,262	17,487	94.51	380	67.5
	J	150	361	1.95	65	11.55
	K	67	161	0.87	29	5.15
	L	44	106	0.57	19	3.37
	M	4	10	0.05	2	0.36
	N	61	147	0.79	26	4.62
	O	10	24	0.13	4	0.71
	P	59	142	0.77	26	4.62
	Q	27	65	0.36	12	2.12
TOTAL INFLOW		9,684	18,503	100	563	100
EVAPORATION			111			
OUTFLOW			18,392			

TABLE 6-4
WATER AND TOTAL PHOSPHORUS BUDGET FOR LOWER LAKE - UPPER BASIN

	SUBWATER-SHED AREAS	AREA (acres)	MEANFLOW ac.ft/yr	INFLOW PERCENT	P-INFLOW (lbs/yr)	P-INFLOW PERCENT
	FROM BARNEGAT	9,684	18,392	99.12	540	99.08
	R ₁	42	101	0.54	3	0.55
	S	26	63	0.34	2	0.37
TOTAL INFLOW		9,752	18,556	100	545	100
EVAPORATION			21			
OUTFLOW			18,535			

TABLE 6-5
WATER AND TOTAL PHOSPHORUS BUDGET FOR LOWER LAKE - LOWER BASIN

	SUBWATER- SHED AREAS	AREA (acres)	MEANFLOW ac.ft/yr	INFLOW PERCENT	P-INFLOW (lbs/yr)	P-INFLOW PERCENT
	FROM UPPER BASIN	9,752	18,535	99.67	528	95.14
	R ₂	20	48	0.26	21	3.78
	T	6	14	0.07	6	1.08
TOTAL INFLOW		9,778	18,597	100	555	100
EVAPORATION			26			
OUTFLOW			18,571			

Due to the shallow depth and high nutrient content of the sediments in each of the lakes of Lacey Township, the proliferation of macrophytic plant species within these lakes is widespread. Moreover, as the sedimentation of these lakes continues, the variety of species found in the lakes has also increased. In the past, herbicide application, weed harvesting and lake drawdown have been implemented to aid in the control of this problem and to keep swimming areas weed-free. Clearly, the annual expenditure these methods incur warrants the evaluation of alternative methods to eradicate this problem.

The dominant macrophyte species present in the lakes was determined from sampling in the summer of 1990. Pond lily (nuphar luteus) and water milfoil (myriophyllum humile) were the most common of the eight dominant species reported (Table 7-1). The coverage of each lake by aquatic vegetation, as measured by lake study volunteers, Exhibit 3, are summarized in Figures 7-1 through 7-4. These figures easily demonstrate the high degree to which the lakes are encroached by aquatic weeds by mid-summer.

TABLE 7-1

DOMINANT MACROPHYTE SPECIES, LACEY LAKES AUGUST, 1990

LOWER LAKE

Upper

Nuphar luteum (pond lily)
Myriophyllum humile (water milfoil)

Lower

Orontium aquaticum (golden club)
Nuphar luteum (pond lily)
Myriophyllum humile (water milfoil)
Utricularia purpurea (bladderwort)
Nymphaea odorata (white water lily)

DEER HEAD LAKE

Nuphar luteum (pond lily)
Myriophyllum humile (water milfoil)

LAKE BARNEGAT

Nuphar luteum (pond lily)
Utricularia vulgaris (bladderwort)
Nuphar luteum (pond lily)
Myriophyllum humile (water milfoil)

BAMBER LAKE

Myriophyllum humile (water milfoil)
Nuphar luteum (pond lily)
Potamogeton confervoides (pondweed)
Scirpus subterminalis (swaying rush)
Sphagnum sp. (sphagnum moss)
Aquatic moss

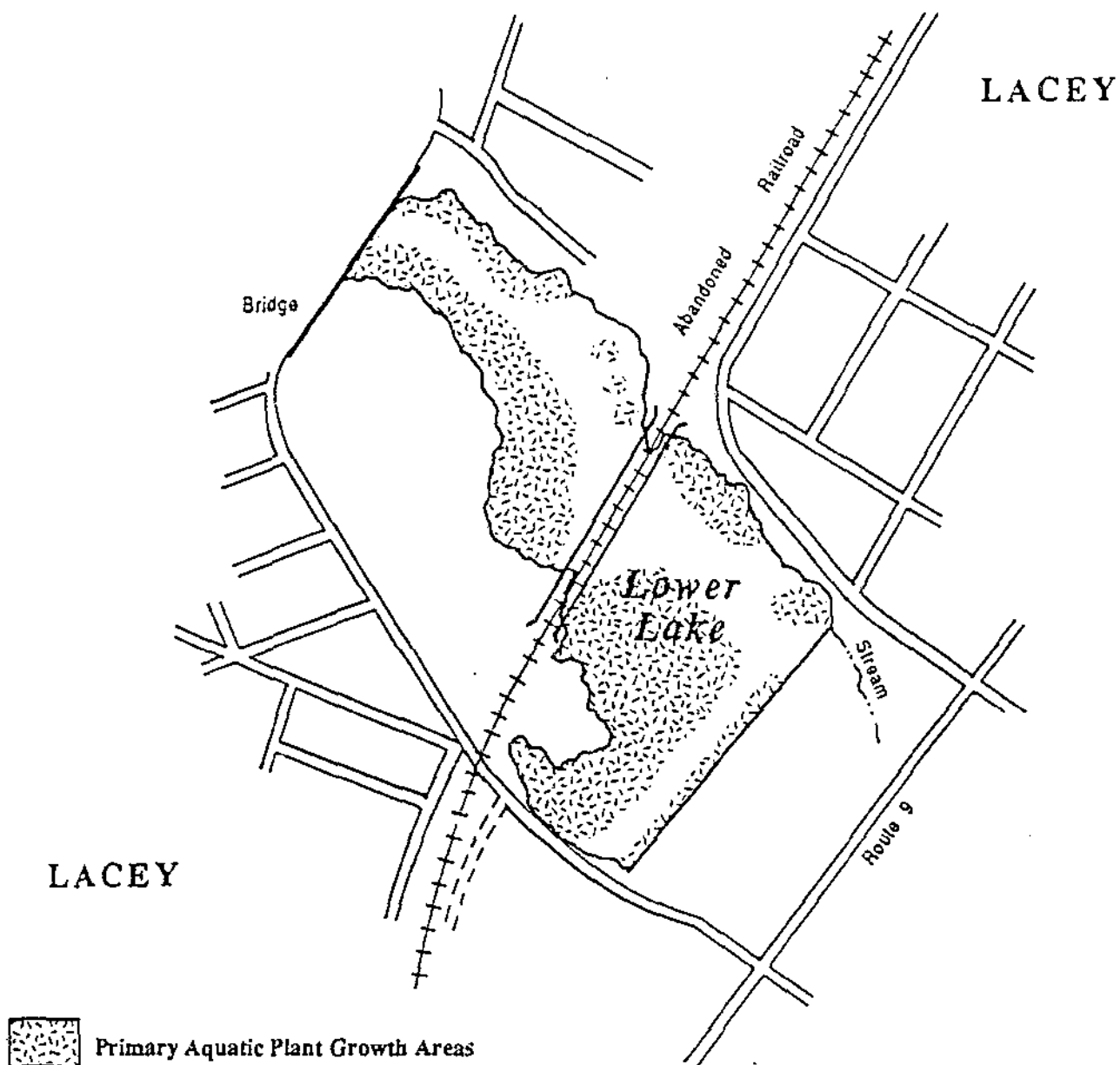
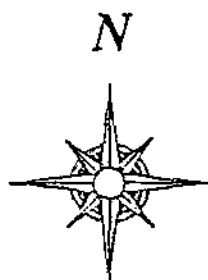


Figure 7-1. Lower Lake aquatic vegetation map provided by Lacey Township residents.



NORMANDEAU ASSOCIATES INC. A Subsidiary of Thermo Environmental Corporation and Thermo Electron Corporation Environmental Consultants						
Client: Township of Lacey				Title: LOWER LAKE Aquatic Vegetation July, 1990		
Drawn:	Date:	Checked:	Date:	Project Name: Lacey Township Lakes		
Rechecked:	Date:	Approved:	Date:	Scale: NTS	Project No. 10181	Dwg. No.

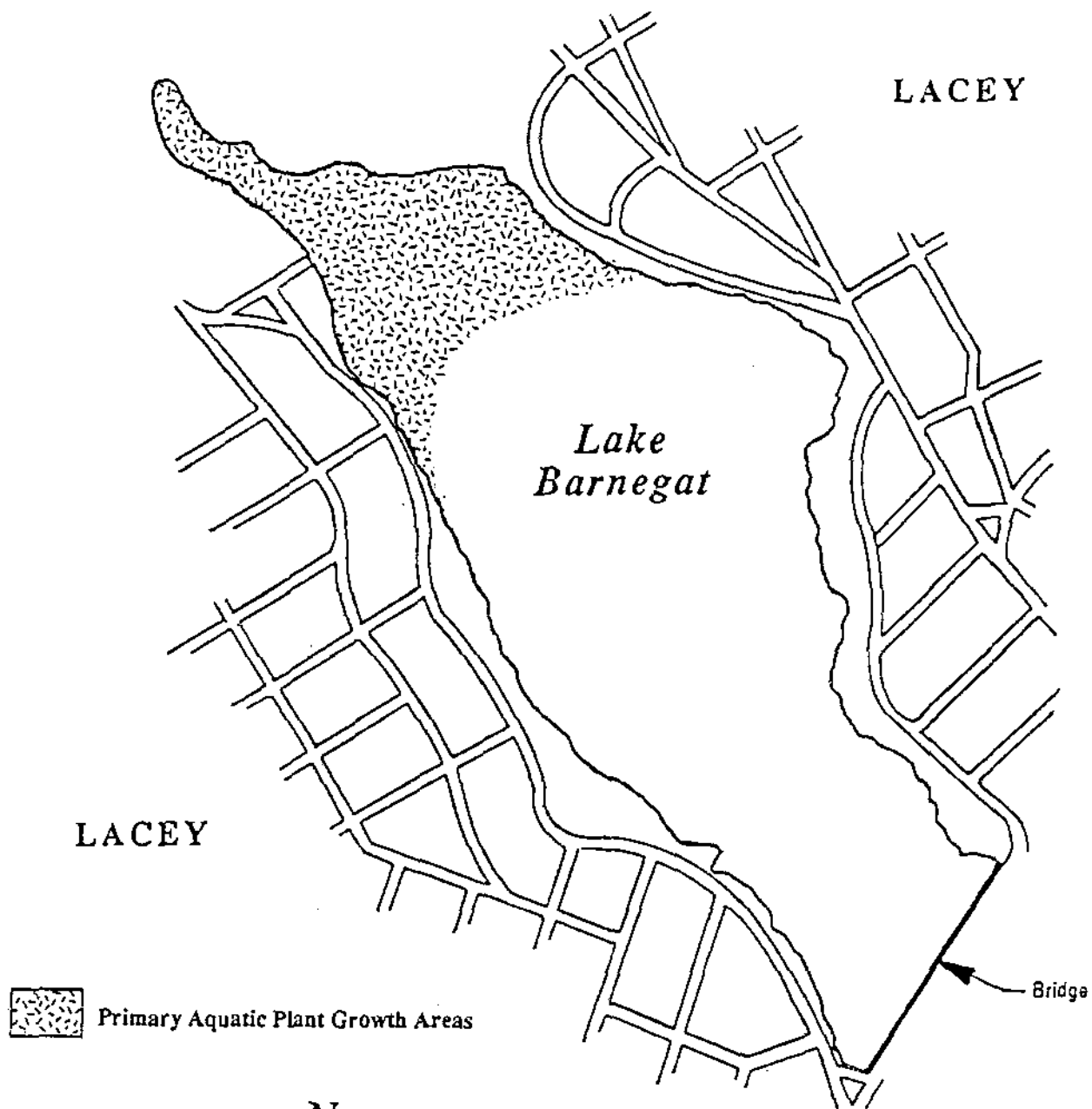


Figure 7-2. Lake Barnegat aquatic vegetation map provided by Lacey Township residents.

NORMANDEAU ASSOCIATES INC. A Subsidiary of Thermo Environmental Corporation and Thermo Electron Corporation Environmental Consultants							
Client: Township of Lacey				Title: LAKE BARNEGAT Aquatic Vegetation July, 1990			
Drawn:	Date:	Checked:	Date:	Project Name: Lacey Township Lakes			
Rechecked:	Date:	Approved:	Date:	Scale: NTS	Project No. 10181	Dwg. No.	

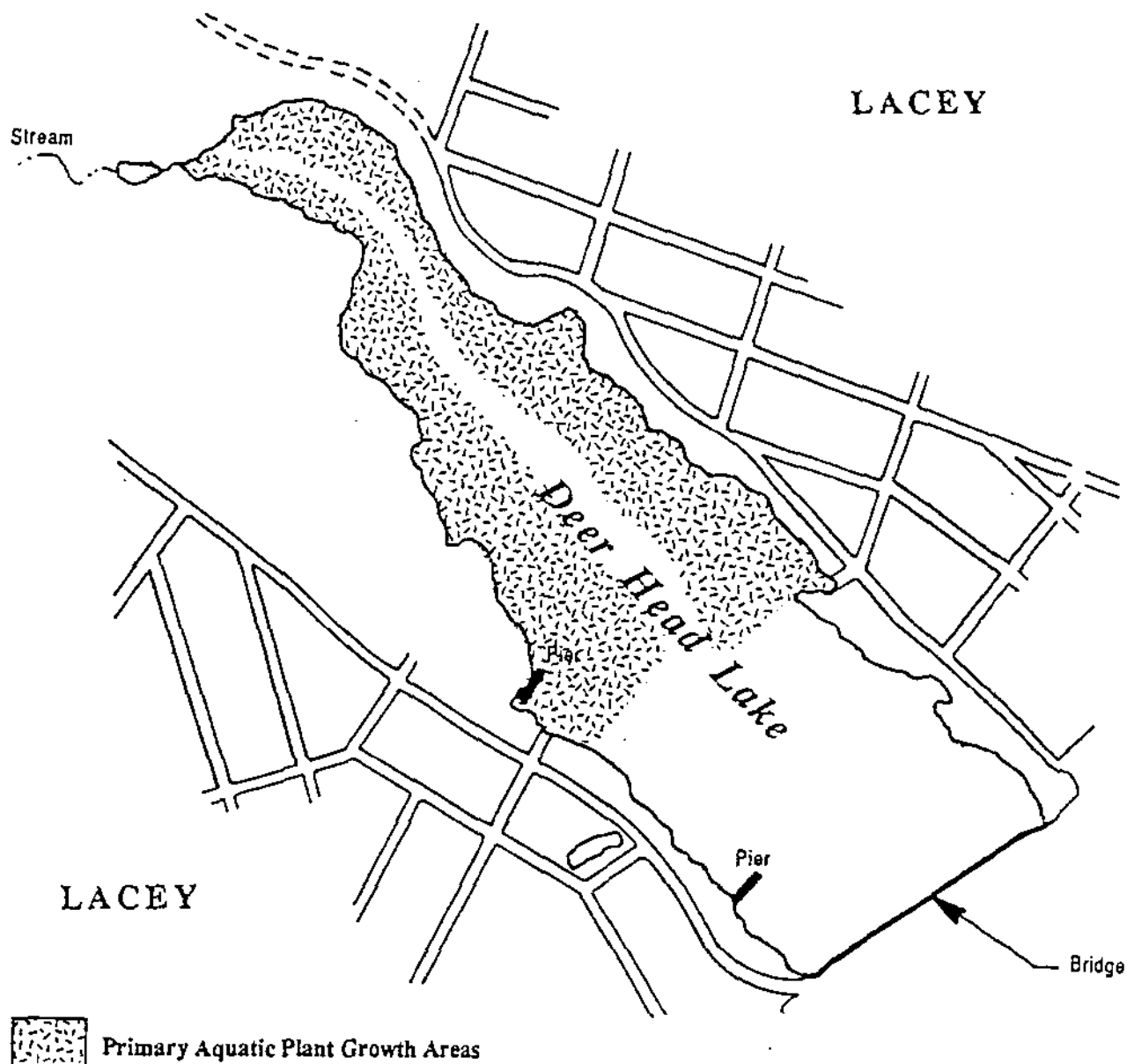


Figure 7-3. Deer Head Lake aquatic vegetation map provided by Lacey Township residents.

NORMANDEAU ASSOCIATES INC. A Subsidiary of Thermo Environmental Corporation and Thermo Electron Corporation Environmental Consultants							
Client: Township of Lacey				Title: DEER HEAD LAKE Aquatic Vegetation July, 1990			
Drawn:	Date:	Checked:	Date:	Project Name: Lacey Township Lakes			
Rechecked:	Date:	Approved:	Date:	Scale: NTS	Project No. 10141	Dwg. No.	

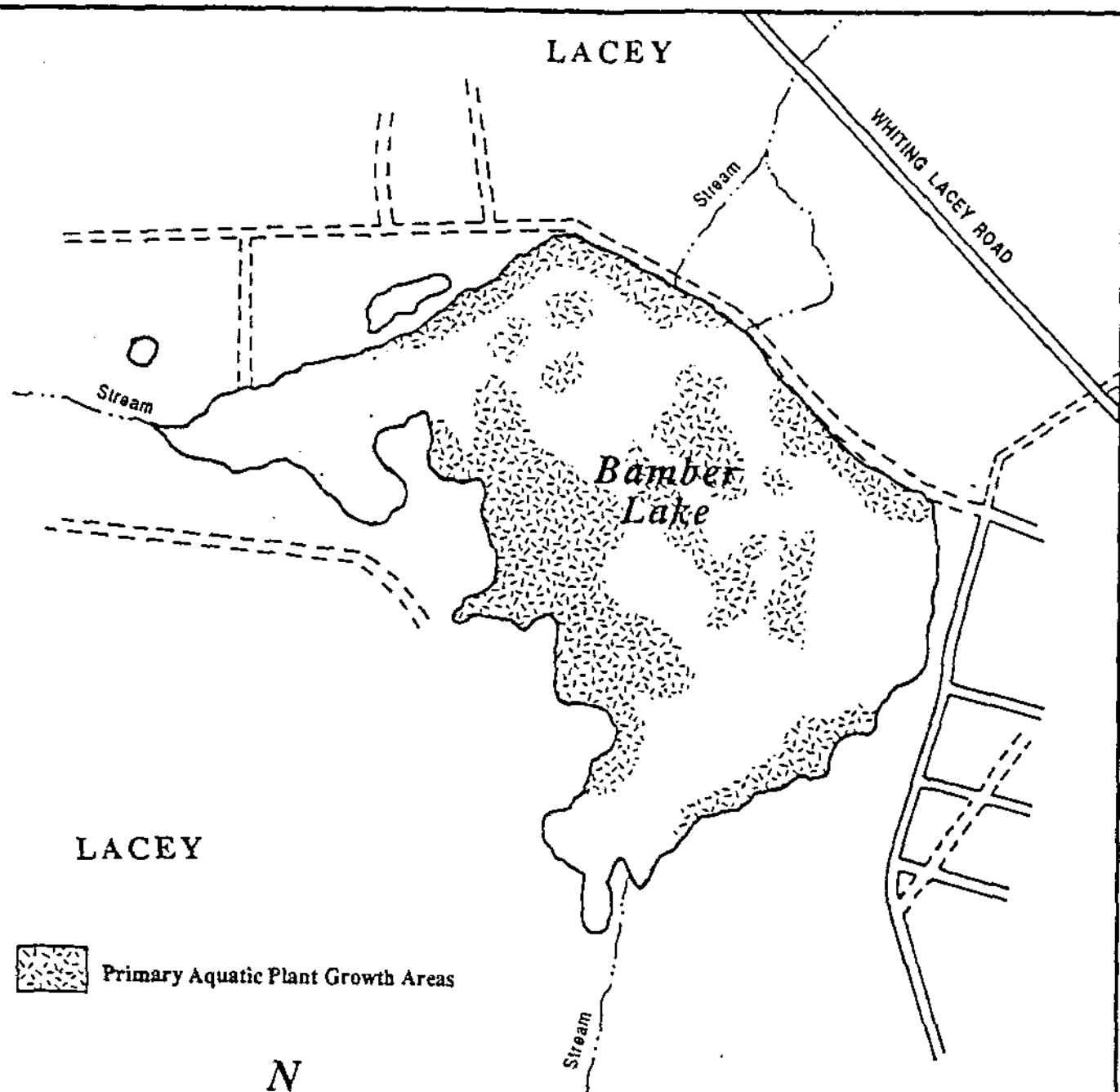


Figure 7-4. Bamber Lake aquatic vegetation map provided by Lacey Township residents.

NORMANDEAU ASSOCIATES INC.						
A Subsidiary of Thermo Environmental Corporation and Thermo Electron Corporation						
Environmental Consultants						
Client:				Title:		
Township of Lacey				BAMBER LAKE		
				Aquatic Vegetation July, 1990		
Drawn:	Date:	Checked:	Date:	Project Name: Lacey Township Lakes		
Rechecked:	Date:	Approved:	Date:	Scale: NTS	Project No. 10111	Dwg. No.

8.0 STORMWATER SURVEY

8.1 OVERVIEW OF NON-POINT SOURCE POLLUTION

Nonpoint Source Pollution (NPS) is defined in New Jersey as "a contributing factor to water pollution that cannot be traced to a specific discernible confined and discrete conveyance" (N.J.A.C. 7:14A-1.9, N.J.A.C. 7:15-1.5). NPS includes any pollution which comes from a variety of diffuse sources, rather than from a specific source such as an outfall pipe from an industrial or sewage treatment plant. Direct overland runoff into streams is an example of NPS. Urban stormwater runoff, and certain other pollution sources are often discussed with NPS even though the pollutants are frequently discharged through specific conveyances that constitute "point sources" under the Federal Clean Water Act (CWA) and State law. The distinction between "point" and "nonpoint" sources is not significant for the purposes of managing the Lacey Township Lakes. The fundamental issue is not how to make the distinction but rather, how to control the pollution.

The effects of NPS as contributors to water quality degradation in New Jersey are recognized as being significant by the NJDEP. In the New Jersey 1988 State Water Quality Inventory Report 69 percent of the monitored freshwater rivers and streams do not meet both the swimmable and fish propagation/maintenance clean water goals. The report also states that lake quality throughout the State has generally deteriorated or is threatened and that NPS pollution is the primary cause of the degradation. NPS pollution is the major reason for bathing beach closures. The results of a cooperative 1986 monitoring program carried out by the State, County, and local governments suggested a positive correlation of rainfall events and increased fecal coliform concentrations in the ocean and bays, (NJDEP 1989). Recent research has shown that contaminated stormwater from developed areas severely degrades the natural aquatic system by destroying indigenous plant and animal communities particularly in environmentally sensitive waterways, such as those of the Pinelands (Vedagiri, 1989).

The most common pollutant categories encountered are typically sediments, nutrients and bacteria. The severity of the pollutant problem is generally proportional to the watershed population density and/or the intensity. Regions where NPS pollution is minimal or water quality effects are not apparent are limited to the State-owned forests of the Pinelands region.

Nonpoint pollution sources in urban/suburban regions are diverse. In general, the most significant is runoff from paved surfaces such as roads, highways, parking lots and various commercial and industrial sites. Another significant source is lawns. Most of this runoff ends up as storm drain effluent. Urban/suburban runoff often contains lawn fertilizers, sediment, heavy metals, fecal bacteria, animal wastes, organic and inorganic debris, and household chemicals as well as oils and grease from motor vehicles. However, another possible pollution source, difficult to track, is leakage and overflow from sanitary sewer systems.

Not all NPS pollution is necessarily due to man's activities. Natural sources are also reported to be important contributors to bacteria and nutrient loading. For example, waterfowl populations which inhabit the lakes can have a significant effect upon water quality.

8.2 STORMWATER OUTFALL INVENTORY

A stormwater infrastructure inventory of the four lakes was conducted during this study. In general, Deer Head Lake, Lake Barnegat and Lower Lake have relatively extensive stormwater infrastructure systems. Conversely, Bamber Lake is comprised of less dense development and consequently, stormwater runoff is predominantly overland flow and virtually no supporting infrastructure exists. Accordingly, the inventory and focus of the stormwater quality assessment is on the lakes associated with Forked River watershed. As part of the stormwater inventory, the physical NPS area boundaries, were established and methods of NPS conveyance, discharge points and existing stormwater control structures were identified.

The inventory initially involved defining the physical boundaries of the study area (i.e., watershed). Land use characteristics were defined, as noted earlier, and the stormwater conveyance structures associated with urban land use was visually inspected and mapped for the lakes associated with the Forked River watershed. In addition, the observed catch basins, piping network and outfall structures are depicted. The inventory of stormwater outfalls discharging to each of the three lakes identified is summarized below.

LAKE STORMWATER OUTFALL INVENTORY, LAKES OF LACEY TOWNSHIP

<u>Lake</u>	<u>Open or Partially submerged</u>	<u>Submerged</u>
Deer Head	9	1
Lake Barnegat	5	5 ¹
Lower Lake	1	1

NOTES: ¹ Three of the submerged outfalls discharge directly to the Lakeside Drive Beach of Lake Barnegat.

GENERAL: There are several additional outfalls that discharge into wetland areas prior to open water. Such outfalls were not included in this assessment as being of low priority based on field inspection and best professional judgement.

For the purposes of identifying stormwater control structures, the facility must have the ability to detain runoff from entering into the lakes. In most cases it appears that the intended design of the stormwater conveyance structures is to expedite the flow of stormwater to the discharge points. This was, unfortunately, common practice during the era of the development in these communities. Conversely, the current regulatory framework dictates that prolonged detention or retention be utilized with biofiltration mechanisms to manage for water quality. There were no observed stormwater detention/retention facilities that appear to meet current regulatory design standards. There is one

facility that appeared to provide limited detention located at the corner of Lakeside and Ravine Drives.

The Township has applied for and received the necessary approvals for maintenance and dredging of accumulated sediments including a Freshwater Wetlands Permit and Soil Erosion permit for improvements to the existing "wet pond" at the above mentioned intersection. Arrangements have been made for the Ocean County Engineering Department to implement the maintenance dredging at no cost to the Township.

8.3 STORMWATER SAMPLING RESULTS

Two rounds of stormwater sampling were conducted (9-27-92 and 10-13-90) in addition to data collected during the monthly in-lake monitoring program; some of the monitoring sampling followed or occurred during rain fall events (i.e. August 30, 1989 for example). The storm sampling for bacteria conducted on September 27, 1990 included eight locations. Six sample locations were associated with sampling performed on October 13, 1990. Both storm events were less severe than forecasted by the National Weather Service so only first-flush data was collected. However, the data provided some noteworthy results.

Of the first flush samples taken on September 27, 1990 at the eight locations, few samples yielded significant fecal bacteria counts in units of most probable number (MPN)/100 ml. The outfall identified as A-1 (located near the intersection of Briggs Avenue and Lakeside Drive, upstream of the Lakeside Drive beach) had approximately 1,000 MPN/100 ml of fecal coliform and 7,000 MPN/100 ml of fecal strep. The levels in close proximity to the bathing area may explain some beach closings. A second sample at this location identified as A-1A, contained levels of 150 MPN/100 ml of fecal strep and less than 10 MPN/100 ml fecal coliform.

The lab data associated with the storm sampling conducted on October 13, 1990, consisted of six locations all having elevated bacteria concentrations (Table 8-1).

TABLE 8-1
FIRST FLUSH RESULTS FROM LAKE'S STORMWATER SAMPLING
SEPTEMBER, 1990

<u>Location</u>	<u>Fecal Coliform (MPN/100 ml)</u>	<u>Fecal Strep (MPN/100 ml)</u>
Lake Barnegat		
B-1 - outfall near Park on Lakeside Dr. So.	170	350
B-2 - outfall aprox. 1,600 west of B-1	2,160	920
B-R - street ponding sample at intersection of Norwood St. and Lakeside Dr. So.	*TNTC	830
Deer Head Lake		
C-1 - detention pond	1,600	270
D-2 - outfall between Baldwin St. and Harrison Ave.	2,060	120
D-3 - outfall near intersection of Weehawkin and Lakeside Dr. North	4,800	1,700

* To numerous to count

All of the above samples were at locations within "reasonable" proximity to the bathing areas of the respective lakes.

The stormwater sampling results indicate that stormwater runoff contributes to the elevated bacteria levels within the Lakes. To further investigate, the beach closings in 1990 were examined with rainfall data to look at causal relationships. However, runoff constitutes only one of the possible

sources of bacteria. In order to clarify, or prioritize, the possible sources of bacteria contribution to the lake, we also evaluated potential bacteria contributions from waterfowl.

8.4 COMPARISON OF RAINFALL DATA AND BEACH CLOSINGS

There are several potential sources that cause elevated bacteria levels associated with beach closings: stormwater runoff, waterfowl, human contact from swimming, sewage leaks or illegal hook ups, etc.

In addition to bacteria data from the in-lake monitoring program collected during this study, bacteria counts collected by the Ocean County Health Department in conjunction with Lacey Township was evaluated for the 1989 and 1990 swimming seasons. A beach is closed if fecal coliform counts exceed 200 colonies per 100 ml of water. Bacteria counts were compared to rainfall data from the Toms River Weather Station (supplied by Rutgers University) to examine the degree to which beach closings were associated with rainfall events. Bacteria were sampled on a regular basis only weekly (usually Tuesdays) in 1989; in 1990 a much more intensive program was conducted; typically sampling Monday through Thursday. Therefore, 1990 provided a much better opportunity for diagnosing bacteria problems.

1989

No beach closings were experienced during May in 1989. There were three rainfall events corresponding to that portion of May when beach samples were collected, each with less than 0.5 inches of precipitation. During the month of June there was one beach closing in Lower lake based on a sample collected on June 13, 1989 with a count of 380 colonies/100 ml. According to the Toms River weather data, there was no precipitation on June 11 and 12 and only 0.02 inches on June 13. There was also one beach closing on June 20, 1989 in Lower lake, based on a count of 220 colonies/100 ml; this was also a dry weather event since there was no precipitation on June 19 or 20.

Samples collected on July 6 and 7 had bacteria counts of 3160/100 ml and 725/100 ml, respectively; there was 1.93 inches of rainfall on July 6. On July 14, 1989 there was 1.16 inches of rainfall but no bacteria samples were collected that day or until July 18, 1989. On July 17, 2.11 inches of precipitation was recorded. The July 18 sampling resulted in a closing for Deer Head Lake, Lake Barnegat and West Bamber with counts of 520/100 ml, 330/100 ml and 400/100 ml respectively. Rainfall of 1.51 inches occurred July 21, but no bacteria samples were collected on or close to that date.

On August 2, a Lower Lake sample revealed a count of 2160/100 ml with little or no rainfall preceding that date; there were no abnormally high counts from samples taken at each of the other beach locations. Water samples collected on August 15, 1989 resulted in beach closings at Lower Lake and Lake Barnegat with fecal bacteria counts of 2010/100 ml and 450/100 ml respectively. Deer Head Lake was not closed with counts of 140/100 ml. The closings were preceded by significant rainfall events on August 13 and 14 with 2.03 and 1.23 inches of rainfall, respectively. Resampling efforts at Lake Barnegat from August 16 to August 18 showed elevated bacteria counts and beach closings but counts decreased over that time. Additional abnormally high bacteria counts occurred in Lower Lake from samples taken on August 23, (750/100 ml), August 24, (1200/100 ml), August 29, (760/100 ml), August 30, (3460/100 ml), and August 31, (300/100 ml).

The 1989 data demonstrates some direct relationship of increased bacteria levels and significant rainfall events (i.e., greater than 1 inch). The data also indicate bacteria input occurred from sources other than rainfall associated runoff, particularly in Lower Lake.

1990

In 1990, there was an increased sampling effort by the County Health Department. Rather than weekly (Tuesday) sampling as in 1989 (15 sampling events) samples were collected three to four times per week (53 sampling events). Beach closing events caused by elevated bacteria were categorized by relative amounts of rainfall. In general this information appears to be relatively consistent with other facets of this lakes study. Lower lake experienced beach closings 66 percent of the dates sampled. Each of the remaining lakes were closed less than

20% of the time based on sampling dates; 18% for Lake Barnegat, Deer Head Lake 15%, West Bamber Lake 15%, and East Bamber 15%.

Each of the lake's data appears to show a correlation between rainfall intensity and an increased percentage of beach closings. The data was analyzed on a daily basis (i.e., bacteria count on sampling date compared with rainfall quantity). While there appeared to be select rainfall events resulting in increased bacteria counts, there were also several instances of trace amounts of rain (i.e., <0.1 inch of rain) which resulted in very high bacteria counts. Therefore, there appears to be other sources, in addition to runoff, which contributed to elevated bacteria counts.

Lower Lake appears to be affected the greatest by sources other than runoff: having a relatively large number of closings with trace rain events or no rainfall at all. Bacteria loading from some external source is suspected. Similar conclusions were reached for nutrient input as a result of the nutrient balance calculations for Lower Lake. Consequently, it appears that equivalent improvement to each lake may result in less success (i.e., continued beach closings) for Lower Lake.

The east and west beaches of Bamber Lake were also sampled for bacteria. Bamber lake experience closings 15% of the time in 1990, based on the sampling dates. There were select samples with abnormally high bacteria counts which did not appear to have a correlation with rainfall events, when considering larger storm events. For example, on June 20, 1990 with a rainfall event of 0.43 inches the data indicated "to numerous to count" and 230 MPN/100 ml for stations LAC 5 and 6 respectively. On July 2, 1990 with 0.71 inches of rain the data indicates 40 MPN/100 ml and 280 MPN/100 ml for stations LAC 5 and 6 respectively (however precipitation may have occurred during or after sampling). On July 10, with 0.46 inches of rain the data indicates 1110 MPN/100 ml and 70 MPN/100 ml for LAC 5 and 6 respectively. August 7, 1990 with 1.37 inches of rain the data states 50 MPN/100 ml and 48 for LAC 5 and 6 respectively due to this high degree of spatial variability. One may hypothesize that sources other than runoff (i.e., waterfowl) maybe contributing to counts during rainfall events. Waterfowl have been congregating in beach areas during mild rainfall events.

T. E 8-2
1990 BEACH CLOSING DATA COMPARED WITH RAINFALL EVENTS, LACEY TOWNSHIP LAKES

LAKE	BEACH STATUS ¹		# OF SAMPLE EVENTS	NUMBER OF RAIN EVENTS EVALUATED	RAINFALL (INCHES)				
					<0.1	>0.1<0.5	>0.5<1.0	>1.0	TOTAL
Lower Lake			53	20					
	# Closings				18	11	4	2	35
	# Open				15	3	0	0	18
	% Closings				55	79	100	100	66%
Lake Barnegat			53	21					
	# Closings				1	7	0	2	10
	# Open				34	6	3	0	43
	% Closings				3	54	0	100	18%
Deer Head Lake			53	22					
	# Closings				5	0	1	2	8
	# Open				29	13	3	0	45
	% Closings				15	0	25	100	15%
W. Bamber Lake			52	22					
	# Closings				1	6	0	1	8
	# Open				32	8	3	1	44
	% Closings				3	43	0	50	15%
E. Bamber Lake			53	22					
	# Closings				1	3	2	1	8
	# Open				32	10	1	1	45
	# Closings				3	23	67	50	15%

¹ Number of sampling events which resulted in beach closings or beach remaining open.

Some limited observations of waterfowl were made by the citizens monitoring the aquatic weeds coverage in the lakes. In order to understand the magnitude of the problem due to waterfowl, a bird count was taken on the afternoon of September 27, 1990, at the Lake Barnegat beach. The bird count results at the beach are as follows:

<u>Type</u>	<u>Count</u>
Ducks	42
Sea Gulls	235
Black Birds	22
Geese	68
White Swans	9

These waterfowl can contribute to localized bacteria loadings when they congregate on the shoreline at the beaches.

The potential for these waterfowl to contribute to beach closings was evaluated by combining the average per capita daily estimates of fecal coliform by each of the above species of waterfowl with a temperature specific bacteria removal rate in the lake and the volume of water available for dilution. Given that the entire lake volume was used in the calculation, this estimate could be viewed as conservative, i.e., it would underestimate the potentially loading. Preliminary estimates utilizing the count of September 27 indicate that the resident waterfowl population on that day could, among themselves, load enough coliforms to the lake to exceed the beach closure level. It is possible that many of the beach closures not associated with rainfall events could be attributed to the presence of waterfowl in the beach areas. It would be advisable to obtain more frequent, quantitative counts of waterfowl at the beaches to fully project the usefulness of management plan alternatives. It would seem advisable for the restoration plan for the lake to include a program designed to keep waterfowl from congregating in the beach areas.

The Township's Municipal Utility Authority's (MUA) sewer line maps were reviewed to determine the availability of public sewer lines. Records for specific block and lots adjacent to the lakes were researched to confirm the presence or absence of sewer service to homes. For lake communities with the Forked River watershed east of the Garden State Parkway, MUA records indicated that residential homes located adjacent to or within 400 feet of the lakes are serviced by sanitary sewers.

The Deer Head Lake bathhouse is apparently not serviced by the MUA township sewer lines. The MUA indicated that they intend to extend sewer lines to this bathhouse "in the near future." The continued use of facilities on septic systems located near the lake may warrant an investigation unless the sewer line connection is in the MUA's active infrastructure plans.

Additionally, there are some findings from the stormwater sampling results that suggest possible presence of human as well as animal fecal waste based on fecal coliform/fecal streptococci. Such data may conflict with the findings that all homes are tied into municipal sewer lines. There is no documentation to confirm any cross connection between storm sewers and either septic or sewer lines; it is also difficult to track leakage or overflow from sanitary sewer systems. Phase II of the New Jersey Sewage Infrastructure Improvement Act Grants does allow for monetary grants to municipalities to identify the location of any unpermitted interconnections or cross-connections.

For the Bamber Lake area, nine residential homes were identified within 400 feet of the shoreline. All of these homes are presently serviced by septic systems and there are no immediate plans to convert these areas to sewer lines. Construction details and operating efficiency of these septic systems are unknown. Because of the relative age of these homes, there may have been less stringent technical standards for septic systems at the time of their construction. Thus, it is possible that there could be some adverse contribution of nutrient and other substances to Bamber Lake from these systems. However, the homes are greater than 200 feet from Bamber Lake and such a distance does provide

a buffer. In addition, the primary problem associated with Bamber Lake appears to be excessive aquatic vegetation ("weeds") creating a nuisance; bacterial and nutrient problems appear less severe.

The residents of Lacey township showed significant interest and support of this effort. This was demonstrated in lake activities such as "Earth Day (20)" where residents collected refuse in and adjacent to the lakes, attendance at public meetings to raise issues and ask questions, and attendance by the High School environmental club at a lake presentation conducted by NAI. Residents participated in distributing and responding to a questionnaire to aide in establishing priorities to recreational and aesthetic values. Certain residents (see acknowledgements) also participated in mapping aquatic vegetation on a regular basis in 1989 to help define the most persistent problem areas.

The Lacey Lakes' Subcommittee was originally established to begin the process of identifying the causes of problems associated with the lakes. The subcommittee is now included within the Lacey Environmental Commission. These members volunteered countless hours associated with this process; key players are listed in the acknowledgement section.

11.0 RESTORATION/MANAGEMENT ALTERNATIVES AND FEASIBILITY ASSESSMENT.

11.1 IN-LAKE ALTERNATIVES ASSESSMENT

11.1.1 General

The purpose of implementing in-lake restoration and management alternatives is to improve the resource by either: 1) accelerating the recovery process once inputs have been reduced, or 2) treating symptoms, or 3) removing problems that have been ongoing (although this will not be successful unless sources are eliminated). The primary users of Lacey's Lakes are recreational (passive and active) and aquatic life. Therefore, the objective is to manage the resource for an optimal balance of use by recreational users (i.e., swimming, boating, fishing, etc.) and aquatic life (i.e., waterfowl, fish, vegetation, etc.).

The lakes' recreational capacities are limited by water problems associated with excessive bacteria counts at the beaches and plant growth throughout the lakes. Restoration methods associated with water quality problems are addressed elsewhere in this report. This section will address methods to improve the lakes' resource value.

Lake use planning can be used to minimize resource conflicts while offering strategies to efficiently implement restoration methods. For example, vegetation cover provides habitat protection for fish and therefore to some degree is preferred by fishermen. However, occasionally the cover within the lakes is extensive, (as depicted in the vegetation mapping) to the point where it interferes with open-water boating and can even restrict access to fishermen themselves. Additionally, excessive plant cover can interfere with swimming activities and aesthetics. In the end, the township must decide the degree to which each conflict should be resolved. The evidence compiled in these studies indicate that certain restoration techniques should be successful; it comes down to an issue of cost and priority within the Township. For example, specific areas for use by swimmers as well as boating and fishing opportunities should be specifically designated. Areas used by waterfowl offer both enjoyment to

wildlife enthusiasts and should be designated to help minimize water quality problems for swimmers.

11.1.2 Aquatic Plant Control

Based on the water quality data provided herein, there is no strong evidence of major nutrient inputs from external sources into the Township's Lakes, with the exception of Lower Lake. This means that the majority of nutrients that support the extensive aquatic plant growth within the lakes are contained in the sediment and are being recycled annually through the plants. Given minimal external nutrient input the removal of sediments should minimize regrowth opportunities for the plants.

The Township has several methodologies available for trying to control aquatic plant growth. Some of these methods have been tried in the past and included:

- * lake draw-down
- * herbicide treatment
- * weed harvesting
- * dredging

Each of these has specific cost/benefit tradeoffs and various levels of effectiveness.

Lake draw-down

The Township has utilized this method in the past. The idea is to allow the cold/freezing weather to kill back the aquatic plants to help reduce growth. It has also shown merit as a method to consolidate loose sediments. This is a relatively inexpensive method to employ, but unfortunately its usefulness is limited. Many of the plants with vegetative rhizomes can survive within the sediments and regrow the following year. Also, one of the common plants within the lakes, water milfoil, spreads via plant fragments; once the lakes are refilled each year, plant fragments from the middle of the lake can

revegetate the draw-down areas. In addition, repeated draw-downs generally encourage draw-down resistant plant species so, while some nuisance species may be controlled, others may replace them. The real problem with this technique, however, is that it doesn't remove the source of the nutrients which support vegetation: the sediments. Additionally, the dehydration and freezing that occurs as a result of this technique can be harmful to aquatic animals that utilize the shallow littoral zone. Faunal diversity and abundance, which is important to any fishery, may be reduced. The likelihood of a winter fish kill is increased with extensive water drawdown.

Herbicide Treatment

Chemical treatment can be a cost effective method to reduce coverage by aquatic plants in that it is not that labor intensive. It can be used to control site-specific areas, which is also an advantage. However, the chemicals used can be harmful to other aquatic life. This could be of particular concern to fishermen. Obviously, the timing and extent of treatment as it relates to use by humans is an important factor. Nutrients bound up in plant tissue are released as aquatic plants decay. These nutrients are often in a form readily used by algae and can contribute to increased incidence of nuisance algal blooms. This problem could be significant in that algal blooms may be much more objectionable than the current macrophyte problem. This method also has the same disadvantage as lake draw-down: the source of plant growth nutrients, sediments, is not removed; this makes the technique somewhat futile.

Weed Harvesting

This technique instantly treats the symptoms of the Lakes' problems: it removes the weeds and some nutrients. Harvesting can be used to treat site specific areas. Damaging to aquatic biota includes impacts on biota directly associated with (on or entangled in) the vegetation and a reduction in habitat or refuge for young fishes. Besides the fact that the method is more labor intensive, it is generally considered temporary and cosmetic. That is, plants with rhizomes, which are abundant in the lake, are generally left within the sediment to propagate the following year. As mentioned above, water milfoil

propagates from plant fragments, so harvesting can leave fragments to regrow. Given site-specific needs, however, this method can help alleviate certain problems even though annual application may be necessary. As with the other techniques, the sediments are left intact and these are the source of the nutrients which support plant growth.

Dredging

Dredging is a remediation alternative that is costly but may be effective as applied to the lake's in Lacey Township. It can be applied to resolve site specific problems and is effective because it removes both the plants as well as the sediments which are a nutrient source. To be effective however, other sources of nutrient and sediment loading should not be significant. Since this condition appears to exist at these lakes, with perhaps the exception of Lower Lake, dredging could be a viable alternative. The fact that the organic sediments are underlain by inorganic, nutrient-poor sands furthers the likelihood of a dredging program in discouraging regrowth of plants.

The goals and benefits of dredging must be weighed in light of cost. The maximum probable amount of material that could be dredged from all of the four lakes totals about 320,000 cubic yards at a cost of \$3.2 million. Conversely, dredging limited to areas adjacent to each beach could total from 30,000 to 50,000 cubic yards at a cost ranging from \$300,000 to \$500,000. The cost associated with additional dredging to increase open water area for increased boating/fishing will depend on the area to be dredged. In general the cost of dredging appears to have a linear correlation with the area to be dredged for about 30 percent of the lake. Above 30 percent the cost increases due to increased depth of sediment and quantity of dredge material per area.

The Township, presumably through the lakes committee, would need to decide which lakes and for what purpose dredging should be accomplished. Through meetings and/or workshops designated areas could be identified and final costs identified. The above calculations give a frame of reference for relative costs.

The Lake Sub-Committee was conscious of the lengthy regulatory review process associated with several permits that were necessary to implement certain restoration alternatives. Accordingly, the consultant proceeded with the identification and preparation of permit submissions concurrent with the data collection phase. There was an inherent risk in that the ultimate restoration plans formulated after data collection could have been different from the restoration plans described in the permit application. However, it was judged that this risk was reasonably low and enough flexibility was built into the permit application strategy.

Conceptual dredging plans were developed for the four lakes. These plans were developed for the purpose of obtaining "jurisdictional letters" from several agencies. The plans were specifically designed to minimize regulatory jurisdiction while providing as much flexibility as possible to later modify the plans for permit applications without changing jurisdictional decisions. Exhibit 4 contains correspondence from several agencies regarding these plans.

The Township Lake Sub-Committee and the consultant set out to find solutions for the "disposal" or "re-use" of dredge spoil. Communications with Parker Associates began in December 1989. Parker Associates agreed to accept the dredged material associated with the lakes and detention basin at no charge to the Township. A formal agreement is on file at the Township extending for a period of five (5) years.

11.1.3 Bacteria

When investigating in-lake alternatives for controlling bacteria levels, one must keep in perspective the degree of the problem that can be controlled by these methods. The following 1990 beach closing statistics demonstrate this perspective.

<u>Beach</u>	# closings associated with <u><0.1" rain</u>	# closing associated with <u>>0.1" rain</u>	Total Present <u>Closings</u>
Lower Lake	18	17	66%
Lake Barnegat	1	9	18%
Deer Head Lake	5	3	15%
W. Bamber Lake	1	7	15%
E. Bamber Lake	1	6	15%

First, the percent of closings, with the exception of Lower Lake, range from only 15-18% of the total times sampled in 1990. Although frequent enough to be bothersome to townspeople, these closures do not happen a large percentage of the time. Second, at Barnegat and Bamber lakes, the majority of closures are associated with some (>0.1") rainfall, implicating some non-point source problems. At Lower lake and Deer Head more closings occurred unassociated with rain, but the problem was much greater at Lower lake. This would imply that in-lake methods may be more useful at Lower lake and Deer Head than the other lakes. Given the magnitude of the problem at Lower lake, it may be more difficult to resolve there.

Also important to keep in mind is the level of exceedence. That is, almost half (~45%) of the closures (on average, excluding Lower lake) are due to counts less than twice the closure level (200 colonies/100 ml) and 57% are less than 2.5 the closure level. This means that controlling sources that could result in reduction of bacteria counts of only a few hundred could theoretically result in cutting the beach closure problem in half; assuming the 1990 bacteria count data are typical.

Alternatives for controlling in-lake sources of bacteria are limited to those warm-blooded bacteria carrying organisms that have direct contact with the water: humans and waterfowl. Fecal coliform bacteria can only come from warm blooded animals. All other sources that may cause bacterial input from land-based activities are considered non-point sources (NPS) inputs; alternatives for controlling these sources are given below. It should be remembered however, that some of these NPS inputs could be due to adjacent shoreline activities, i.e., dog

walk areas, waterfowl feeding areas etc. Fecal bacteria from these sources can quickly be washed into the lakes during rainfall events and cause health level exceedences. There is also the issue of the Deer Head lake bath house septic systems. Again, if this is a potential source it should be part of the watershed control alternatives; however, given it's proximity to the beaches, it borders an in-lake control needs.

The alternative of controlling bacteria counts at the beaches has more operational and political implications than cost implications. The question becomes, should swimmers be required to shower prior to entering the water at the heavily used beaches? As any pool user knows, this is the best technique for controlling bacteria, even in a chlorinated pool. The beaches are shallow, the water warm and water exchange slight; obviously there is no chlorine. Having a pre-use showering rule is a regular feature of public pools; instituting a similar rule at certain beaches within the lakes would not be costly but might help reduce some closings. Some lakes do receive heavy use; for instance an average of 167 beach-goers entered the lake Barnegat beaches (total) during afternoons in July, 1990. This does not count those that entered during the morning, or in the evening after attendants left. Again, however, it must be evaluated whether these steps are important to the Township, given the small number of closings likely due to this factor. Other years data could also be evaluated to review this problem.

The alternative of controlling waterfowl can be difficult to implement with assurity; however, given the observed abundance (from various sources) of waterfowl near the beaches, this could be an important factor. Controlling waterfowl can be important to both in-lake as well as the non-point sources of bacteria. During rainfall events bacteria from feces can be washed directly into the lakes from near shore use areas. Thus they may be contributing to both the dry-weather and the wet-weather related beach closures. One recommendation would be to obtain bird counts at the beaches coincident with the bacteria counts. Then the location of the greatest problem areas and the degree of the problem could be better understood. Since wildlife are an important component of the aesthetics of the lakes, their exclusion would seem

inappropriate, and very likely not possible. The goal would be to dislocate them from the swimming areas. Alternatives to accomplish this could include:

- Not allow any feeding by humans in the beach or adjacent areas.
- Set up preferential habitat (and possible food sources) in other areas.
- Use noise generators to deter bird congregation.
- Place predator decoys in areas where birds congregate.
- Evaluate physical barriers that could be deployed during off-hours.

Some experimentation would be necessary to evaluate and invoke the appropriate alternatives; costs could range from appropriate signage for a few hundred dollars to physical or noise deterrents which might be a few thousand dollars at most; however, they may prove to be effective for a relatively small investment.

11.2 WATERSHED ALTERNATIVES ASSESSMENT

11.2.1 General

In-lake restoration techniques tend to treat the symptoms of accelerated eutrophication whereas watershed management techniques strive to correct the causes. A sound lake plan should involve an appropriate level of watershed management to prevent or at least minimize the introduction of pollutants, to the maximum extent practicable.

When trying to solve lake management problems it is important to properly target the primary factors associated with each problem. Typically, literature on managing lake water quality has focused on nutrients (i.e., phosphorous and nitrogen). There is an abundance of information on modeling systems for nutrients and abatement methods to control nutrients. Despite being

a primary cause for closure of beaches, bacteria associated with NPS inputs has received less attention pertaining to abatement solutions.

Based on the data collected as part of this study, the most significant water quality issue appears to be bacterial contamination. While in-lake control methods should resolve some of the problem, watershed control methods also make up part of the solution. Therefore, the goal of this section is to identify alternatives and assess the feasibility of these alternatives (i.e., regulatory feasibility, cost feasibility, and implementation feasibility) so that appropriate decisions can be made by the Township.

11.2.2 Designation of Watershed Priorities Areas

Based on the information from the literature, assessment of land use and existing stormwater infrastructure, and water quality sampling results, it would be difficult to dispute that stormwater runoff contributes levels of bacteria that may contribute to Lacey Lakes beach closings. Considering the factors addressed above, the sub-watershed areas can be ranked as high, medium or low with the respect to the need and subsequently the priority for watershed input control.

The NJDEP (1989) has stated that there are a few remaining land areas that are undeveloped and water quality remains pristine. One such area is the Pinelands. While the entire watershed of the Forked River is within the Pinelands National Reserve, only the portion of watershed area west of the Garden State Parkway is within the Pineland Commission's jurisdiction and is virtually undeveloped. Consequently, the runoff contributed from the watershed west of the parkway is relatively free of human introduced contaminants. This was verified by this study's monthly sampling results. Therefore, we feel that the watershed area west of the Parkway should be a low priority for trying to identify and/or improve any suspected land areas contributing NPS pollution.

The land areas east of the parkway are either currently developed or have an increased chance of being developed, other than state regulated wetland

areas. Consequently, these areas are ranked as either medium or high priority for receiving attention for potential watershed input. The remaining undevelopable land are wetlands which are important for stormwater storage and biofiltration of contaminants. Accordingly, the location of wetlands was an important factor in distinguishing between medium and high priority areas.

The primary reason to identify medium and high priority areas is to ultimately implement management practices that provide the greatest remediation for the dollars spent. With this in mind, it is important to recognize that costs associated with management and control practices should be greater (on a per unit area basis) in high priority areas while less intensive management practices are likely to be appropriate for medium priority areas.

The following procedure/rationale was used to identify medium and high priority areas:

1. Subwatershed areas were established to distinguish the source of NPS pollution either via a "point source" (i.e., stormwater outfall) or "non-point source".
2. Areas were assigned according to the density of development within each sub-watershed area and the ability for stormwater to be conveyed to the receiving water. Increased slopes and conveyance structures associated with developed areas tended to receive a high priority ranking. Less densely developed areas and low sloping areas which would naturally tend to prolong the introduction of runoff to open water (e.g., adjacent to relatively extensive wetland areas) will receive a medium priority ranking.

Best professional judgement based on field observations was also incorporated. A total 20 subwatershed areas were assigned for Deer Head, Lake Barnegat and Lower Lake (Figure 11-1); Figure 11-2 illustrates sub-water shed boundaries for Bamber Lake. Table 11-1 provides a list of the subwatershed areas by acreage and relative priority. Bamber lake is entirely within the Pinelands

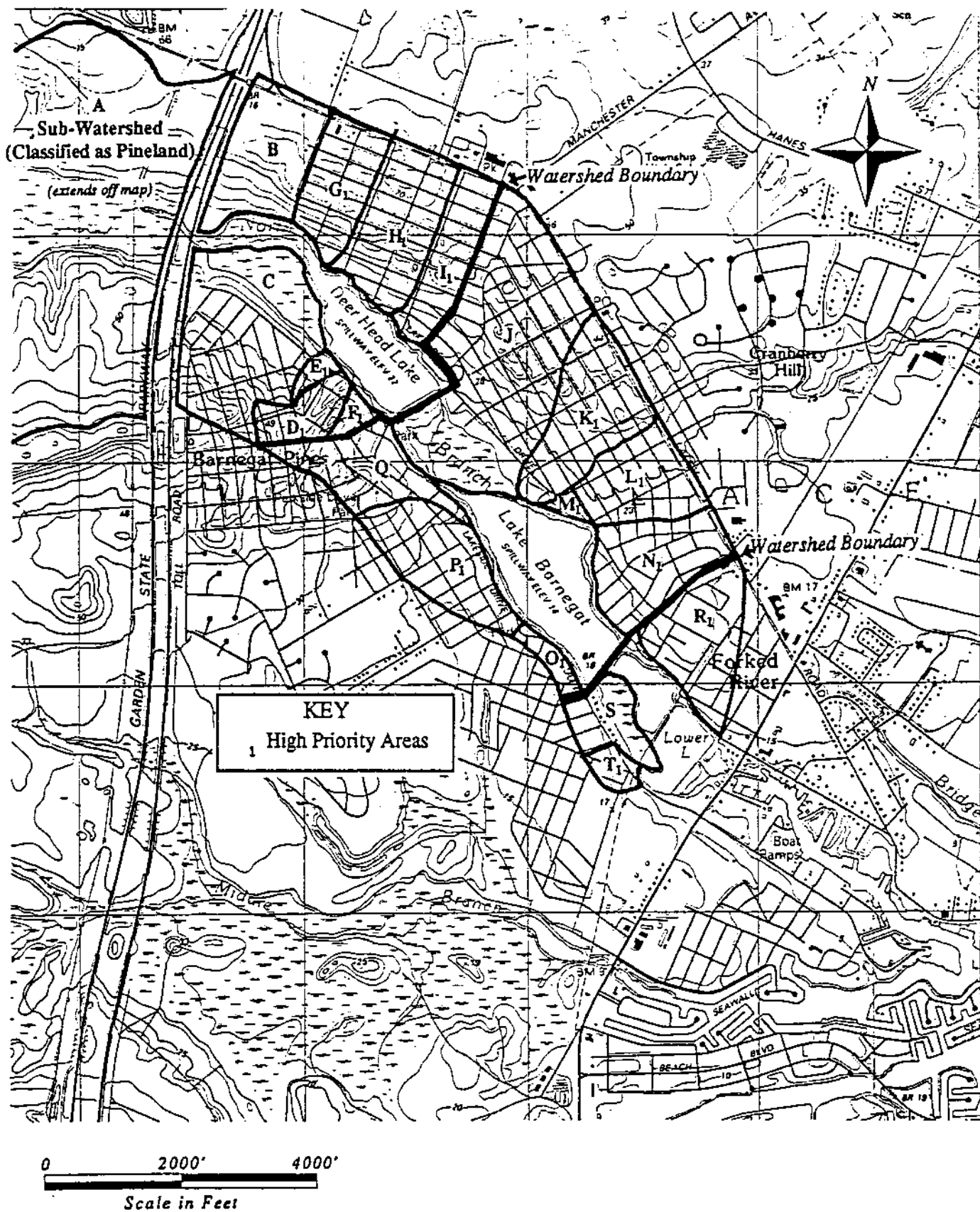


Figure 11-1. Sub watershed areas identified for Deerhead, Barnegat and Lower Lakes.

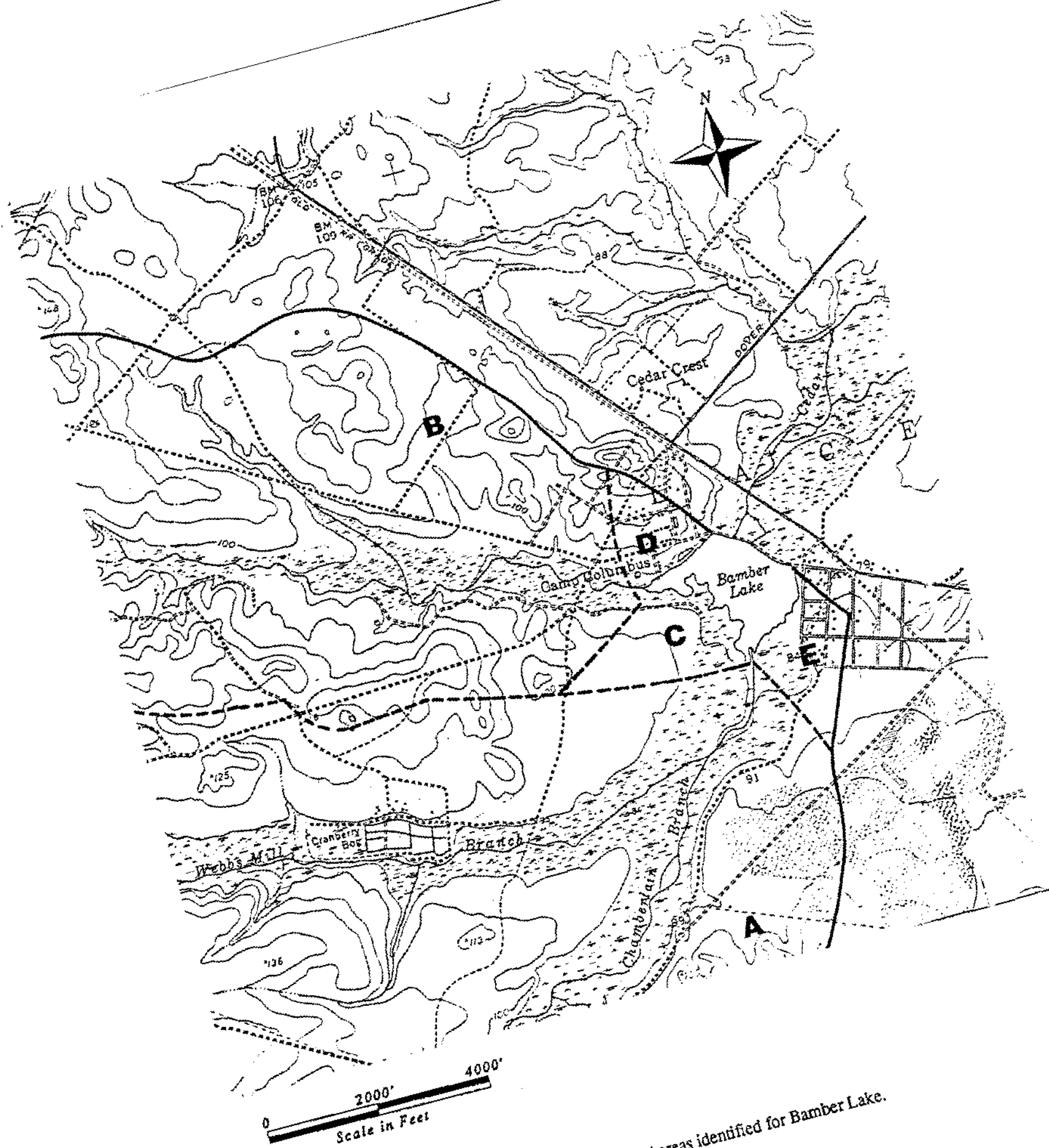


Figure 11-2. Sub watershed areas identified for Bamber Lake.

TABLE 11-1
PRIORITY RANKING OF SUBWATERSHED AREAS FOR
DEER HEAD LAKE, LAKE BARNEGAT AND LOWER LAKE¹

<u>Subwatershed</u>	<u>Area</u>	<u>Priority Ranking</u>
A	8,587	Low
B	106	Medium
C	95	Medium
D	27	High
E	6	High
F	19	High
G	42	High
H	57	High
I	33	High
J	150	Medium
K	67	High
L	44	High
M	4	High
N	61	High
O	10	High
P	59	High
Q	27	Medium
R	62	High
S	26	Medium
T	6	Medium
Lakes	139	
TOTAL	9,627	
Total low priority	8,587 (89.2%)	
Total medium priority	410 (4.3%)	
Total high priority	491 (5.1%)	
Lakes	<u>139</u> (1.4%)	
TOTAL	9,627 (100%)	

¹ All sub-watershed areas for Bamber lake are categorized as "low".

and does not have the development intensity of the other lakes; therefore, it's entire watershed area was assigned a low priority for applying watershed control techniques for this analysis. The subwatershed area east of the Garden State Parkway (not including open water associated with the lakes) has a total of 410 acres classified as medium, and a total of 491 acres classified as high priority areas; this total (891 acres) was less than 10% of the total watershed area (9,627 acres).

The results of this evaluation provided the basis for assessing alternative watershed control techniques. Should costs associated with the selected management plan be "impracticable", a cost benefit threshold should be considered in order to maximize appropriate management practices and reduce costs. However, it is best to use conservative (i.e., worse case) assumptions in managing for improved stormwater runoff quality.

11.2.3 Best Management Practices Alternatives

"Best Management Practices" (BMPs) are officially approved procedures for reducing NPS through structural and nonstructural controls, including operation and maintenance procedures (NJDEP, 1989).

NPS controls utilizing structural and non-structural BMPs include a combination of government action, citizen education and various programs dealing with minimizing pollutant input. These include reduction at the source (i.e., source controls), treatment prior to entering or within a conveyance system and a program that controls the location and quality of discharges to selected waterways. BMPs have been developed and refined to mitigate some of the adverse impacts associated with development activity. Each BMP option has both unique capabilities and persistent limitations. These, in turn, must be balanced with both the social and physical constraints imposed by the development site and the overall management objectives for the watershed. Accordingly, the following factors were considered in assessing BMPs.

- * BMP options that are suitable for a site, given its physical condition and development status.
- * Stormwater control benefits provided by each BMP option.
- * The expected pollutant removal capability for each BMP option, under several different design scenarios.
- * Environmental and human amenity values associated with the BMP option selected.

The Goals of BMPs are as follows:

- * Simulate predevelopment hydrological conditions.
- * Provide a moderate level of removal for most urban pollutants.
- * Be appropriate for the site, given physical constraints.
- * Be reasonably cost-effective in comparison with other BMPs.
- * Have an acceptable future maintenance burden.
- * Minimize impacts on the natural and human environment.

BMP Constraints and Opportunities

The use of BMPs are applicable to new and existing development. The land areas designated as high and medium priority pertaining to suspected land areas contributing NPS pollution can be referenced in Figure 11-1. Again, these areas comprise less than 10% of the total watershed area for these lakes. The land areas designated as having a high priority are predominately developed with residential dwellings and commercial development, with approximately 30 percent of the land having impervious coverage. The total land area designated as high priority was approximately 491 acres; therefore, it was estimated that nearly 150 acres is covered by impervious structures and paving. In general there are few opportunities for utilizing relatively large land masses for implementing structural BMPs.

The medium priority areas consist of about 405 acres and have approximately 10 percent coverage with structures and paving; approximately 81

acres. Although these areas are less densely developed, the wetland areas are generally more expansive; this reduces the ability for additional development and also lessening the land area opportunities for implementation of BMP.

Design Goals

Although 100% removal or prevention of the introduction of contaminants is desired, there are several limitations particularly stormwater volumes that make this impractical. The concept of implementing BMPs is to provide appropriate management techniques to maximize the percent removal of contaminants within the boundaries of physical, fiscal and regulatory constraints.

BMP Alternatives and Screening

Schueler (1987), has summarized the comparative pollutant removal capabilities associated with urban BMP designs (Table 11-2). The diagram shows that designs targeted for removal of bacteria will, at a minimum, moderately reduce the introduction of other pollutants consistent with the established goals.

Table 11-2 also provides an initial screening of the structural BMP alternatives with respect to achieving water quality control of bacteria. This does not mean to say that non-structural controls should not be implemented as a first level of control. Eight structural BMP practices are presented; only three designs are documented to control runoff of bacteria. Based on the constraints and opportunities established earlier, the unavailability of relatively large contiguous land masses in the high and medium priority areas would further discourage the use of extended detention ponds and wet ponds.

Of the three designs which can help reduce bacteria input (i.e., infiltration trench, infiltration basin, and porous pavement) both infiltration basins and porous pavement are, to some extent, in conflict with established site feasibility constraints. Porous pavement is generally not practicable because road and parking areas currently exist. The use of infiltration basins may be

TABLE 11-2. COMPARATIVE POLLUTANT REMOVAL OF URBAN BMP DESIGNS USED FOR LACEY LAKES.

BMP/Design		SUSPENDED SEDIMENT	TOTAL PHOSPHOROUS	TOTAL NITROGEN	OXYGEN DEMAND	TRACE METALS	BACTERIA	OVERALL REMOVAL CAPABILITY
EXTENDED DETENTION POND								
	DESIGN 1	◐	◐	◐	◐	◐	⊗	MODERATE
	DESIGN 2	◐	◐	◐	◐	◐	⊗	MODERATE
	DESIGN 3	◐	◐	◐	◐	◐	⊗	HIGH
WET POND								
	DESIGN 4	◐	◐	◐	◐	◐	⊗	MODERATE
	DESIGN 5	◐	◐	◐	◐	◐	⊗	MODERATE
	DESIGN 6	◐	◐	◐	◐	◐	⊗	HIGH
INFILTRATION TRENCH								
	DESIGN 7	◐	◐	◐	◐	◐	◐	MODERATE
	DESIGN 8	◐	◐	◐	◐	◐	◐	HIGH
	DESIGN 9	◐	◐	◐	◐	◐	◐	HIGH
INFILTRATION BASIN								
	DESIGN 7	◐	◐	◐	◐	◐	◐	MODERATE
	DESIGN 8	◐	◐	◐	◐	◐	◐	HIGH
	DESIGN 9	◐	◐	◐	◐	◐	◐	HIGH
POROUS PAVEMENT								
	DESIGN 7	◐	◐	◐	◐	◐	◐	MODERATE
	DESIGN 8	◐	◐	◐	◐	◐	◐	HIGH
	DESIGN 9	◐	◐	◐	◐	◐	◐	HIGH
WATER QUALITY INLET								
	DESIGN 10	○	⊗	⊗	⊗	⊗	⊗	LOW
FILTER STRIP								
	DESIGN 11	◐	○	○	○	◐	⊗	LOW
	DESIGN 12	◐	◐	◐	◐	◐	⊗	MODERATE
GRASSED SWALE								
	DESIGN 13	○	○	○	○	○	⊗	LOW
	DESIGN 14	◐	◐	◐	◐	○	⊗	LOW

KEY

- 0 TO 20% REMOVAL
- ◐ 20 TO 40% REMOVAL
- ◑ 40 TO 60% REMOVAL
- ◒ 60 TO 80% REMOVAL
- ◓ 80 TO 100% REMOVAL
- ⊗ INSUFFICIENT KNOWLEDGE

DESIGN 1: FIRST-FLUSH RUNOFF VOLUME DETAINED FOR 6-12 HOURS.
 DESIGN 2: RUNOFF VOLUME PRODUCED BY 1.0 INCH, DETAINED 24 HOURS.
 DESIGN 3: AS IN DESIGN 2, BUT WITH SHALLOW MARSH IN BOTTOM STAGE.
 DESIGN 4: PERMANENT POOL EQUAL TO 0.5 INCH STORAGE PER IMPERVIOUS ACRE.
 DESIGN 5: PERMANENT POOL EQUAL TO 2.5 (V_r); WHERE V_r = MEAN STORM RUNOFF.
 DESIGN 6: PERMANENT POOL EQUAL TO 4.0 (V_r); APPROX. 2 WEEKS DETENTION.
 DESIGN 7: FACILITY EXFILTRATES FIRST-FLUSH; 0.5 INCH RUNOFF/IMPER. ACRE.
 DESIGN 8: FACILITY EXFILTRATES ONE INCH RUNOFF VOLUME PER IMPER. ACRE.
 DESIGN 9: FACILITY EXFILTRATES ALL RUNOFF, UP TO THE 2 YEAR DESIGN STORM.
 DESIGN 10: 400 CUBIC FEET WET STORAGE PER IMPERVIOUS ACRE.
 DESIGN 11: 20 FOOT WIDE TURF STRIP.
 DESIGN 12: 100 FOOT WIDE FORESTED STRIP, WITH LEVEL SPREADER.
 DESIGN 13: HIGH SLOPE SWALES, WITH NO CHECK DAMS.
 DESIGN 14: LOW GRADIENT SWALES WITH CHECK DAMS.

Source: Schueler (1987)

suitable from a soils perspective but is severely limited from a land availability perspective; opportunities for their use should be investigated, but may not be possible. Infiltration trenches appear to be consistent with the constraints and opportunities previously established. Specifically, such techniques are an adaptable BMP and well suited to manage small land areas. The following addresses infiltration trenches in greater detail.

Infiltration Trenches

Infiltration trenches are an adaptable structural BMP. Individual trenches are primarily an on-site control, and are seldom practical or economical on larger sites. Trenches are feasible when soils are permeable, as is the case in Lacey Township, and the water table is situated well below the bottom of the trench.

Specific advantages of infiltration trenches are that they are adaptable to the physical constraints in communities adjacent to Lacey's lakes, they preserve the natural groundwater recharge capabilities, are relatively easy to fit into the margins, perimeters and other unutilized areas of a developed site, and are one of the few BMPs that provide pollutant removal on small sites and may be retrofitted to existing developments. The smaller size and area requirements of water quality exfiltration systems allows considerable flexibility in their placement. This is an important factor in retrofitting any Lacey Lakes' community areas.

Basically, runoff is diverted into a shallow (3-8 foot deep) excavated trench that has been backfilled with stone to form an underground reservoir. Trench size depends on two factors: the volume of runoff controlled, and the degree to which exfiltration is used to dispose of runoff. Typically, larger trenches are needed for stormwater control, whereas smaller versions can be employed for water quality purposes. Since water quality is the concern, and specifically bacteria, any proposed trench should be targeting the water quality component of runoff.

Beyond non-structural controls, the implementation of certain

structural BMP's to control NPS pollution is the best available technology at this time and recommended by the NJDEP. However, the level of effectiveness is dependent on several factors including design, construction, maintenance, monitoring and modification, if necessary, to assure effectiveness.

As with all BMP's infiltration trenches have observed limitations. It is important to note the disadvantages associated with infiltration trenches as a recommended structural BMP, but it is more important to focus on the design and maintenance procedures prescribed for such technologies to minimize recognized disadvantages. Disadvantages noted by the NJDEP for infiltration trenches are as follows:

1. High rate of failure due to improper design, pollutant loading and maintenance.
2. Need for frequent maintenance.
3. Susceptible to clogging by sediment increasing difficulty of maintenance.
4. Landscaping requirements may produce aesthetically objectionable conditions or safety hazards.
5. Limited in application to small sources of runoff such as roof drains and small parking lots.
6. Focuses runoff and associated pollutants into a smaller area with less available soil capacity for attenuation and biological degradation. Device may create a greater likelihood for ground water contamination.

The effectiveness of BMP's, both structural (i.e., infiltration trenches) and non-structural (i.e., public education and associated activities) will depend on the residents of Lacey Township as participants in both the implementation phase and, equally important, the on-going monitoring and maintenance phase.

Table 11-3 provides estimates of pollutant removal rates that might be expected for full exfiltration systems, based on field testing of similar rapid infiltration land treatment systems (NVPDC, 1979; USEPA, 1977).

TABLE 11-3:
ESTIMATED LONG-TERM POLLUTANT REMOVAL RATE FOR FULL EXFILTRATION TRENCHES

URBAN POLLUTANT	REMOVAL RATE	LIMITING FACTOR
SEDIMENT	99%	Should actually be trapped before reaching the trench.
TOTAL PHOSPHORUS	65-75%	Leaching of remineralized organic P.
TOTAL NITROGEN	60-70%	Leaching of soluble nitrate
TRACE METALS	95-99%	Behavior similar to sediment.
BOD	90%	Leaching of dissolved organic matter.
BACTERIA	98%	Straining

If a significant portion of the annual runoff volume will bypass a water quality trench, then it is not subject to removal by exfiltration.

SIZING RULE 1. Trench storage volume should be equivalent to 0.5 inches of runoff per impervious acre in the contributing watershed (Md WRA, 1986b).

SIZING RULE 2. Trench storage volume should be capable of storing the runoff produced from a one inch storm over the contributing watershed ($1.0 \cdot R_v \cdot A$).

In assessing the required storage volume for the use of infiltration trenches, sizing rule #2 (the more conservative sizing rule) has been applied. While the required storage volume for the entire watershed can be assessed with this method, a smaller scale example is provided to illustrate how this method is applied.

Assuming that the area contains 30% coverage with structures and paving. The required storage volume (Vs) to handle a one inch storm is calculated to be 1,089 cubic feet from the formula:

$(Vs) = 1.0 \text{ inch} \times Rv \times A$, where

(Vs) - Storage Volume

(Rv) - Runoff Coefficient

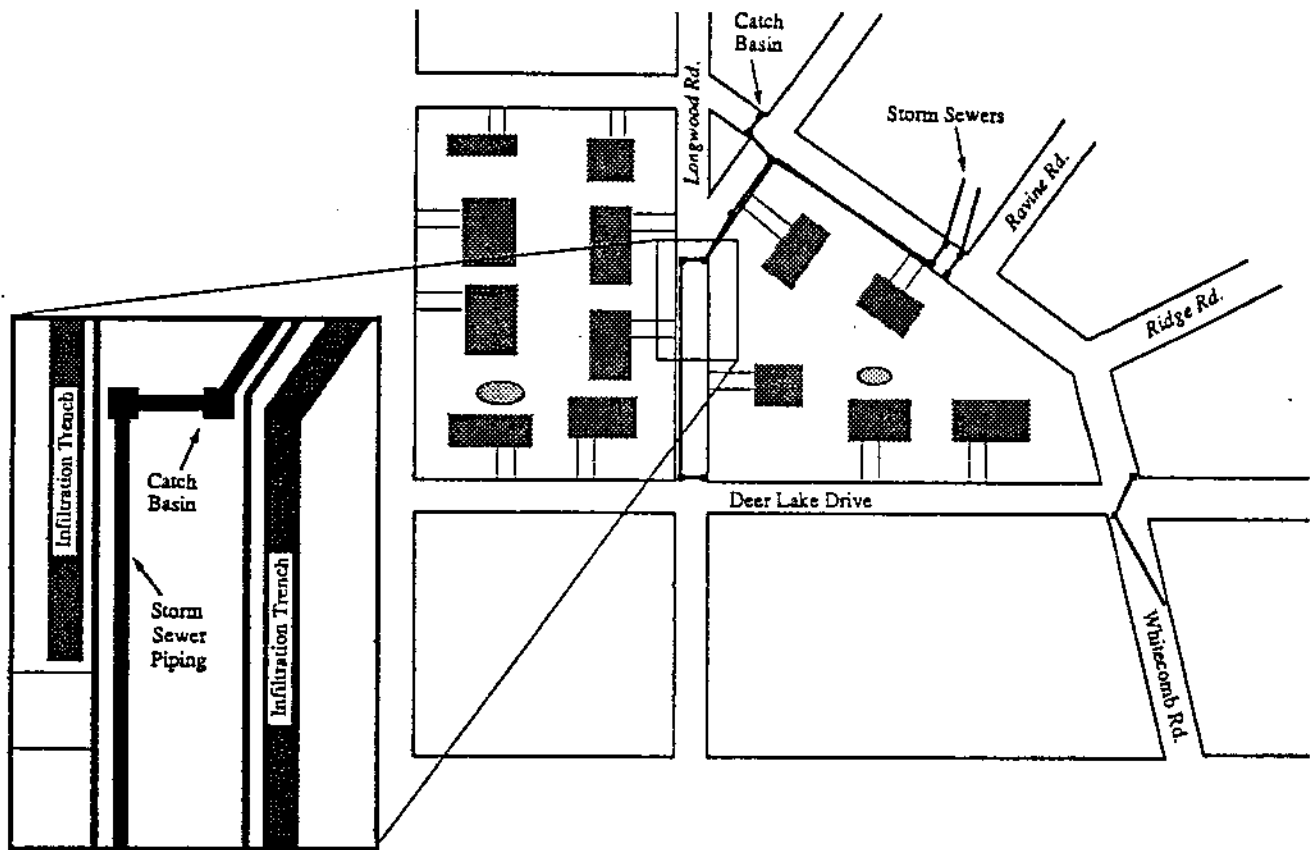
(A) - Area

Porosity may vary from about 20% to 60% depending on the material used, highly angular particles increase porosity. For the purposes here we have utilized a porosity value of 30% (which is a Barnegat township ordinance requirement) for estimating trench size. A standard trench for the subject area could have dimensions of 6 feet wide by four feet deep and backfilled with 1-3 inch stone; trench length is variable. Working in units of 10 linear feet. The storage capacity of a 6' x 4' x 10' trench with 1-3" diameter stone (porosity 30%) is about 78 cubic feet (2.89 cubic yards). Thus 140 linear feet is preferred per 1 acre. This can be decreased by supplementing the storage capacity with other BMP's (i.e., roof drain dry wells). Alternatively the width and depth of the trench could be modified.

Based on this simple example, one could surmise that in a lake community such as Lacey Township, (assuming average lot size of 100 x 100) if each lot implemented a minimum of a 35 linear foot infiltration trench, the preferred capacity would be met. While such action may be desired, there are additional constraints that need to be addressed. When utilizing storage volume for stormwater management, the location of the facilities are critical to maximize benefits. Since runoff travels via the path of least resistance, intercepting runoff from specific areas are a priority. Consequently, in general, we have highlighted areas where increasing the intensity of infiltration trenches will logistically aid in the collection of runoff prior to entering the lakes. The closer to the lakes, the greater the intensity of storage volume that should be provided.

The overall purpose of the above exercise is to demonstrate a technique that will divert and filter rainfall runoff prior to being discharged from the existing storm drains. Again, these storm drains are felt to be a source of bacteria that are contributing to some of the beach closings.

PLAN VIEW



SIDE VIEW

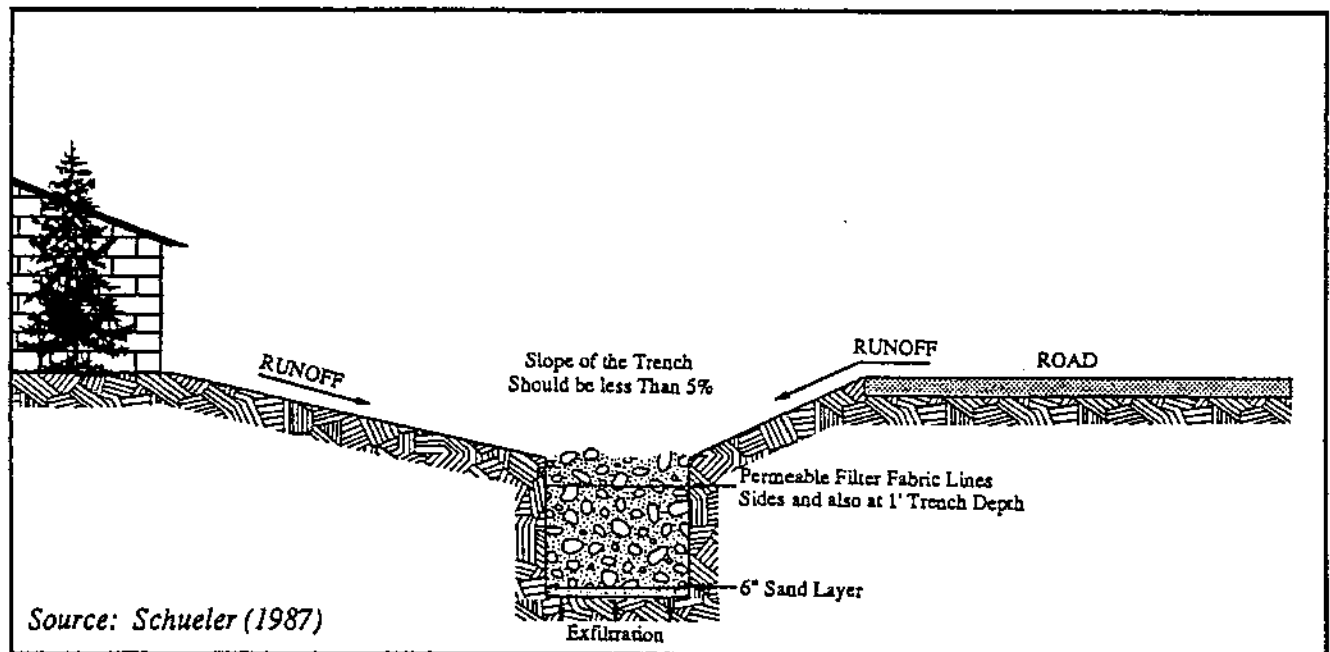


Figure 11-3. Example of Infiltration Trench Siting in the Watershed Community of Deer Head Lake, Lacey Township.

The Lacey Township's four lakes, which are a valuable resource to Township residents, have experienced a combination of problems which has limited the use of each lake. There are two common problems, of varying degrees, which affect each of the four lakes: bacteria contamination and excessive aquatic vegetation. Lower Lake exhibits these problems to the greatest degree with indications that additional nutrients inputs may also be affecting that lake. Other than the problems associated with the lakes as stated below, the data evaluated also suggests that the lakes are otherwise relatively "healthy" and that the opportunities for implementing successful remedial actions are encouraging, particularly for lake Barnegat, Deer Head Lake, and Bamber Lake.

The primary causes of the above problems also appear to vary among the lakes. The data evaluated suggest a correlation between rainfall and NPS pollution as a primary cause for beach closings at Lake Barnegat and Deer Head Lake. Waterfowl also likely contribute to NPS pollution, but more sporadically; it may depend on where the birds congregate in relation to the beach locations.

The data evaluated also suggest that there is some correlation of rainfall events and beach closings at the Bamber lake beaches. However, dissimilar from Lake Barnegat and Deer Head Lake, the increased intensity of rainfall does not seem to result in either higher bacteria counts nor additional beach closings, on a percentage basis. In addition, the comparison of several pairs of bacteria samples collected at two separate locations on Bamber Lake show large spatial variations, for rainfall events ranging from 0.5 inches to 1.0 inches. It is possible that the flocking of waterfowl during rainfall events in addition to shoreline runoff where waterfowl congregate may cause the spatial variation in bacteria counts. The land use patterns of the Bamber lake area also differ from the lakes associated with the Forked River watershed east of the Garden State Parkway. The primary cause of NPS pollution may be waterfowl and secondarily runoff; regular site specific waterfowl counts would help confirm this.

A summary of costs associated with select management options for Lacey Lakes was prepared (Tables 12-1 and 12-2). The cost estimates are intended to provide a perspective of the relative costs that may be required for select alternatives. The report provides an assessment of alternatives which are technically appropriate in light of the data and evaluation referred to herein. While such techniques may be recommended in concept, the recommendation of such techniques must be evaluated in light of the Township's objectives and budget allocation. Some costs are annual while others involve longer-term solutions which should suffice for several years, provided objectives and conditions do not change. There are also other generic recommendations that could be improved upon to maximize the use of the lakes, they are:

- * Waterfowl management
- * Regular street sweeping/catch basin cleaning
- * Enforcement of strict pet control ordinances
- * Educate the public about NPS pollution; implement other non-structural BMP's.

The analysis of alternatives evaluated indicates that a combination of watershed and in-lake management techniques would be important to minimize the causes of the problems identified. This way the Township could look to see the degree of improvement from the techniques having lower costs. A step-wise institution of long-term restoration methods beginning with the easiest and least costly may be the most appropriate way to proceed. The following recommendations are summarized for each lake. All costs are relative values (in 1990 dollars) for evaluating alternatives; and could only be fixed based on project-specific bidding.

Lower Lake

Lower Lake has the greatest potential for improvements pertaining to water quality, but the least potential for improvements that would sustain prolonged use of the beaches due to the current degree of water quality problems. However, the use of the lake for other activities other than swimming, i.e., fishing and visual enjoyment, are not limited. The process of dredging the lakes

TABLE 12-1
SUMMARY OF ESTIMATED COSTS* OF SELECT IN-LAKE
LAKE MANAGEMENT ALTERNATIVES FOR LACEY LAKES

LAKE	DREDGING			WEED HARVESTING		HERBICIDE TREATMENT	
	Area (ac.)	Dredge Quantity (cubic yds)	Cost ¹	Area (ac)	Cost ²	Area (ac)	Cost ³
Lower Lake	4	9,500	95,000	5	5,000	5	1,250
Lake Barnegat	7	18,000	180,000	10	10,000	10	2,500
Deer Head Lake	5	13,000	130,000	10	10,000	10	2,500
Bamber Lake	5	13,000	130,000	5	5,000	N/A	N/A

¹ Estimated cost of \$10.00 per cubic yard.

² Estimated cost at \$1,000.00 per acre; annual cost.

³ Estimated cost at \$250.00 per acre; annual cost.

TABLE 12-2
SUMMARY OF ESTIMATED COSTS* FOR SELECTED WATERSHED
MANAGEMENT ALTERNATIVE FOR LACEY LAKES

LAKE WATERSHED AREA				
Lake	Land Area Acres	Storage Vol. (Cubic Yards)	Infiltration Trench Length (ft)	Cost ¹ (\$)
Lower Lake				
High Priority	68	2,750	9,520	238,000
Medium Priority	28	435	1,500	37,500
Lake Barnegat				
High Priority	245	9,912	34,300	857,500
Medium Priority	177	2,850	9,900	247,500
Deer Head Lake				
High Priority	184	7,450	25,760	644,000
Medium Priority	201	3,229	11,180	279,500

¹ Trench profile assumed at 6' x 4'; Estimated cost of \$25/LF.

* Estimated costs for construction activities are subject to site specific bids, which may vary. Costs do not include estimates for design or permitting requirements.

to increase open water for activities such as swimming and boating is applied starting with the most upstream lake (i.e., Deer Head Lake) and working downstream. Consequently, Lower Lake would not be a first priority for dredging from a logistical perspective. Improvements to Lower Lake from dredging would provide limited benefits (i.e., boating but not swimming). Before any dredging is conducted, documented improvements to lake water quality via watershed management techniques and further investigation of undocumented sources of bacteria and nutrients should be conducted if swimming within the lake is a priority for the Township. The volume of material that would appear reasonable to dredge (if dredging were recommended) could include approximately 4 acres of the lake's 27 acres; this would cost on the order of \$95,000.

Watershed management techniques should focus on NPS pollution, including waterfowl management, and the further identification of undocumented sources of bacteria and nutrients. The portion of the watershed area of concern for further runoff control includes approximately 96 acres; 68 acres ranked as high priority. If infiltration trenches are utilized, approximately 9,520 linear feet (6' x 4' profile) at an estimated cost of \$238,000 would satisfy this need. The medium priority area would require approximately 1500 linear feet of infiltration trench at an estimated cost of \$37,000. The relative cost of dredging Lower lake may be high compared with the potential recreational gain.

The cost associated with constructing infiltration trenches are significant. However, the cost can be minimized by utilizing the Township's equipment and labor force. Alternatively, new development could be designated the responsibility of constructing infiltration trenches (10 CY storage capacity required per home or a 6'x4'x35' stone filled trench) via amended ordinance requirements. However, it would first be important to verify the location of proposed management structures to insure they meet the objective of their intended use.

Lake Barnegat

Primary control techniques for Lake Barnegat include 1) decreasing the bacterial load by implementing BMP's (possibly including infiltration trenches) to control NPS pollution; 2) dredging to increase the usable open water area by removal of nutrient and organically rich sediments which enable aquatic vegetation to thrive; and, 3) waterfowl management to control to minimize bacteria input near beach areas.

The alternative analysis section addresses the variety of BMP's to control NPS pollution; from an engineering/control perspective, infiltration trenches would appear to be the most appropriate if other BMP's such as pet control, street sweeping, etc., are not effective. The watershed area of concern includes 431 acres. The 245 acres of the high priority area would cost an estimated \$857,500 to install infiltration trenches. The medium priority area (245 acres) would require 9,900 linear feet of infiltration trench, at an estimated cost of \$247,500. Again, the cost could be reduced by utilizing township equipment and staff or individual home owners constructing infiltration trenches at appropriate locations.

For aquatic vegetation control, the maximum amount of material that could be dredged from approximately 50 acres of open water area has an estimated cost of 1.6 million dollars. Dredging approximately 7 acres adjacent to the beach area is estimated to cost about \$180,000. The township should evaluate the relative cost expenditure to increase open water area and determine their use objectives. Based on preliminary calculation, cost versus benefit would appear to indicate that dredging less than the maximum technically permissible may be more appropriate; this could be supplemented with other shorter-term management techniques (i.e., weed harvesting) see Table 12-1. However, it must be realized that harvesting must be implemented every year whereas dredging is more long term solution.

Deer Head Lake

The problems and remedial measures associated with Deer Head Lake are similar to Lake Barnegat. Dredging adjacent to the beach areas could cover an area of about 5 acres and cost an estimated \$130,000; dredging the entire lake is estimated to cost as much as \$800,000. The process of controlling NPS pollution by use of infiltration trenches appears to be the most appropriate watershed control method (once other, easier techniques are implemented), although costly. The necessary 25,760 linear feet of infiltration trench (6'x 4' profile) for the high priority areas (184 acres) is estimate to cost approximately \$644,000, while the cost associated with construction of infiltration trenches for the medium priority areas (201 acres) is estimated to be \$279,500.

Bamber Lake

Bamber Lake appears to be affected most by aquatic vegetation and secondarily by bacteria inputs with high spatial variation; waterfowl are likely contributors. Consequently, dredging and waterfowl control would appear to improve conditions stemming from these problems. Dredging the majority of Bamber Lake's area would require the removal of as much as an estimated 230,000 cubic yards of material at a cost of over 12 million dollars. This cost may be impracticable. The focus of the dredging effort could be reduced to the beach areas and other select open water areas to increase recreational capacities. Since Bamber Lake's depth is relatively shallow and low sloping, the cost benefit appears to be generally linear pertaining to dredging quantities and open water gain. Dredging approximately 5 acres, a portion adjacent to each of the beach area, would cost an estimated to be \$130,000. Dredging of Bamber lake could also be supported by weed harvesting to increase boating areas. Techniques for waterfowl management have been addressed elsewhere, but further information on waterfowl occurrences and numbers would help develop control strategies.

If the Township wants to have a successful lake restoration program, it is important to understand what objectives are reasonably attainable; plans should then be implemented which specifically target those objectives. Specific monitoring will be necessary to measure the program's success.

ACKNOWLEDGMENTS

Normandeau Associates wishes to acknowledge the dedication of the residents of Lacey Township in their efforts to maintain and improve the resource value of the Township's Lakes. Data collected by resident volunteers were invaluable in prioritizing lake usage and assessment of the areal coverage of macrophytes. Aquatic vegetation maps were provided by Mr. John Tangeman, Ms. Sharon Busch, and Mr. and Mrs. Robert Landrum,.

The guidance provided by Township's professionals who assisted in this effort; Mr. Chris Connors, Mayor Debra Madensky, Mr. Leonard Roeber. Special thanks go to the endless hours and technical assistance provided by the Lake Sub-Committee headed by committeeman Mr. Phil Luccarelli and members including Mr. Richard Watson, Mr. Kerry Jennings, Mr. Jake Kilmurray, and Mr. Jay Vougilitis. Technical information was also provided from the Ocean County Health Department, Mr. Ray Ferrera.

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A SUMMARY OF
LAKE RESTORATION/MANAGEMENT
PROBLEMS AND ALTERNATIVES
FOR THE FOUR LAKES OF THE
TOWNSHIP OF LACEY:
BAMBER LAKE, LAKE BARNEGAT,
DEER HEAD LAKE, AND LOWER LAKE
EXHIBITS

Prepared For:

Township of Lacey
Lake Restoration Sub-Committee
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Forked River, NJ 08731

Prepared By:

Normandeau Associates, Inc.
170 Oberlin Avenue North
Lakewood, NJ 08701

NAI-NJ Project No. 10181

OCTOBER, 1991

EXHIBITS

1. Lacey Township population survey on lake usage and trends.
2. Water quality results from lakes in the Township of Lacey, Ocean County, New Jersey.
3. Correspondence pertaining to regulatory jurisdiction for lake dredging.
4. Bathymetric maps for Lower Lake, Lake Barnegat, Deer Head Lake and Bamber Lake.
5. Plan for removal of accumulated sediments from detention pond located at Lakeside and Ravine Drive; NJDEP Wetlands Permit; Ocean County SCS soil erosion approval.

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The following are additional comments included by some residents:

- 1) "Lakes were fine until storm drains were installed."
- 2) "The "bad mouthing" of the lakes is exaggerated. Close up the street drains and all will be okay.

These lakes have a huge amount of water change (due to the dams and water falls) every minute - 24 hours a day and night of which I am sure you are aware."

- 3) "Attempt to stabilize the tons of sand being washed into the lakes from the bathing beaches.

"Carefully" monitor water quality west of the parkway on the north branch. Southern Ocean County Landfill reaches into the drainage via Long Cave Cabin Branch.

Construct "catch basins" and dredge."

- 4) "Lakes have deteriorated ever so much since drainage systems have been led into our lakes. Lakes should have been dredged as promised. These are for our children and something should be done NOW!"
- 5) "Close down drainage pipe into second lake and let water go into retention basin that is between Leeway and Kay Street. This has the pipes in place already, just need to close up pipe at Lake Barnegat."

Put aeration spray caps in all lakes.

Put some type of drain at south end of Lake Barnegat Beach to move water."

- 6) "Plant ivy on fence surrounding sandy beaches to prevent erosion.

Special sediment pond must be developed with bacteria filtering plants.

Sediment removal, suction, similar to dredging, will not remove stumps (habitat). Sediment can be used with leaf piles to make topsoil for sports field on old town dump."

- 7) "Feel most problems caused by storms which were installed by Township years ago."

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- 8) "I've been snorkeling in Lake Barnegat now for the last five summers. The first two summers it was like an aquarium, the water was clear. I could see from the surface as far as 6-7 feet to the bottom. There was a lot of weed growth on the north side which housed pickerel, perch, schools of small fish, trout, catfish, eels and snapping turtles in abundance.

It was quite beautiful and obviously relatively healthy. In the last two summers I went only a few times because the turbidity of the water was so bad. I could only see about a foot in front of me. This depressed me a lot since it seemed to be a permanent condition. However, this unique experience of the lake gave me a good perspective on it.

RECOMMENDATIONS: (included with response (8))

Outlaw the use of any non-organic fertilizers and weed killers, especially Chemlawn and companies like it.

Establish and enforce a strong pooper-scooper law.

Make the bathrooms more accessible to the swimmers so they won't be tempted to pee in the lake.

Instead of dredging the lakes to get rid of weeds, hire a few kids each summer, give them a few rowboats, and have them spend a few hours each day chopping off the top few feet of weeds in the bothersome areas. This would be cheaper than dredging, eliminate increased turbidity, maintain the ecology of the lakes, especially the fish populations, provide summer employment, provide the Township with high quality mulch, not need permits, eliminate the problem of where to put dredged material, and keep the weeds away from swimmers and boaters.

Stop completely draining the lakes. They cannot establish a balanced ecosystem until we do.

Much of the problem is lack of water exchange. It seems the water on top flows okay but the water on the bottom does not. This is because the water flows over the top of the dam. If we put in an on/off drain at the bottom of the dam. We would drain of a few thousands gallons on bottom water whenever bacteria or phosphorus levels got too much. This might just help stop beach closing.

Do not reroute the storm drains, instead seek to eliminate pollutants at the source. This requires strong legislation and especially enforcement.

It's my feeling that a lake with lots of plant growth and fish and other aquatic creatures would be able to metabolize the unavoidable pollutants like bird droppings and road runoff. One of the best things we can do for the lakes is mess with them as little as possible so that they can achieve their own balance."

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- 9) "We have been coming to Lacey for the past 15 years. In that time, the quality of lake water has steadily declined. There is entirely too much weed growth and sediment accumulation with leaves in all of the lakes. Outside of a central channel, a lot of the lake water remains stagnant. I am sure this adds to the increased insect problem especially mosquitoes. I've seen in the local paper a floating weed remover being used in Bamber Lake. I am still waiting to see it used in the Lacey Lakes. Last summer, weed growth on the small beach at Deerhead Lake made swimming far less enjoyable and allowed lily pond growth to ruin the lake's aesthetic value. I take great pride in Lacey Township and believe the community is becoming a "younger family" town. I hope some consideration will be given to insure that the youth the future of Lacey Township has a clean, safe, recreational area to use."

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LACEY LAKES QUESTIONNAIRE RESULTS

The following results reflect the opinions of 63 Lacey Lakes residents. The percentages were calculated as the number of affirmative answers per 63 residents. Other results are the average of all answers given for that specific question.

1. NAME (optional) _____
2. ADDRESS _____
3. How long have you lived in Lacey Township? 16.5 years
4. Do you use any of the Township lakes for recreational activities? 87.3% Yes 12.7% No
My activities on the lake are: 27.0% Fishing 25.4% Boating
79.4% Swimming _____ Other, please specify.
5. Do you use a boat on Lacey's lakes? X Yes _____ No
If yes, how often? 6.6 times per year
6. Which lake do you visit most often?
3.2% Bamber 55.6% Barnegat 52.4% Deerhead 1.6% Lower
7. Please enter the number that best describes your opinion on how suitable the water of each lake is for recreation and aesthetics:
 - 1) Beautiful, could not be any nicer.
 - 2) Very minor aesthetic problems; excellent for swimming, boating and enjoyment.
 - 3) Swimming and aesthetic enjoyment slightly impaired.
 - 4) Desire to swim and level of enjoyment of the lake substantially reduced (would not swim, but boating is okay).
 - 5) Swimming and aesthetic enjoyment of the lake nearly impossible. Lake water quality is terrible.4.5 Bamber 3.5 Barnegat 3.2 Deerhead 4.8 Lower
8. In your opinion, has the quality of the lakes, 0% Improved;
92.6% Declined; or, 7.4% Stayed about the same, over the past years.

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9. Indicate which category(s) reflects your concerns about the lakes.

<u>69.9%</u>	Excessive weed growth
<u>63.5%</u>	Excessive sediment accumulation
<u>76.2%</u>	Bacterial contamination
<u>23.8%</u>	Taste and odor problems
<u>27.0%</u>	Poor fishery
_____	Other, please specify _____

10. Do you fertilize your lawn? 50.0% YES 50.0% NO

a) If so, how often? 2.2 times per year

b) What season(s) do you fertilize in? 48.1% Spring
16.7% Summer 3.7% Winter 31.5% Fall

c) What type of fertilizer do you use? (Brand name or
N-P-K ratio) Lofts, 10-6-4 Organic (2), 24-8-4,
Weed-n-Feed (3), Scotts 4-step plan (7), Turf Builder,
Glorion 10-16-8 (3), Agway, 10-10-10, Lime, 25-15,
Compost.

d) What sorts of pesticides/herbicides do you use? _____
Diazinon (3), Sevin (Liquid and Dust), Orthene, Benomyl,
Safer's Soap, Raid, & Termite companies.

11. Do you feed the ducks and geese? 25.0% YES 75.0% NO

12. Is your home on septic system? 3.2% YES 96.8% NO

a) If your answer is yes, please answer the following
questions, numbers 12-35.

Please use the space below for any additional comments.

* QUESTIONS 13-35 WERE ANSWERED BY ONLY ONE PERSON.

13. Was your home ever converted from seasonal to year round use?
X YES _____ NO

14. How many bedrooms are in the house? 2 Bedrooms

15. How many people live in the house? 2 Persons

16. What is your lot size? 100'x160' Acres _____ Don't know

17. How old is your present septic system?
_____ Years X Don't know

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18. Have you made any alterations to your system? ☒ YES ☐ NO

19. Were alterations made:

- to enlarge existing system? _____
- to correct malfunctioning system? ☒

If yes, please check appropriate box, and make any comments you feel are appropriate.

_____ repair broken pipe
_____ replace tank
☒ replace disposal field
_____ install additional disposal field
_____ install new system
_____ other, please explain

20. What kind of system do you have?

☒ Septic tank _____ Cess pool
_____ Other, please explain _____

If septic tank, what size?

_____ 500 gallons _____ 750 gallons
_____ 1,000 gallons _____ other

Is your tank _____ Steel ☒ Cement _____ Don't know

21. Disposal field (if known, please indicate size).

_____ Pit No. of pits _____ Approx. size _____
_____ Trench No. of trenches _____ Approx. size _____
_____ Bed Approximate field size _____ (square feet)
_____ Other ☒ Don't know

22. What kind of trouble, if any, have you had with your system?

☒ None _____ Odor _____ Surfacing of sewage
_____ Sewage backing up into the house
_____ Other, please explain _____

23. When was the last time your tank was pumped?

2 Years _____ Don't know

24. How often do you have the tank pumped?

Every 2 years _____ Don't know

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25. If you are experiencing difficulties, please indicate cause, if known:

☐ Shallow bedrock ☐ Steep slopes
☐ High water table ☐ Slowly permeable soil
☐ Extremely stony soils
☐ Other, please explain _____

26. Does your basement flood during any part of the year?

 Yes No - NO BASEMENT -

If yes, what season(s)? _____

How often? _____ Once or twice a year
 _____ Three or four times a year
 _____ Five or six times a year
 _____ Other, please explain _____

27. Does your home have a garbage grinder unit?

 Yes X No Don't know

28. Do both laundry and sanitary wastes enter septic system?

 Yes X No Don't know

If no, how do you dispose of laundry water? Separate systems

29. Are your roof rain spouts drained to your disposal area?

 Yes No X Don't know

30. Does water drain from other parts of your yard into the disposal area?

 Yes No X Don't know

31. What is the approximate distance between septic system and home?

20 feet; property line? feet; well? 300 feet;
Lacey Lake? feet (if you live within 500' of the lakes).

32. What brand(s) of laundry detergent do you use? (Indicate brand name and specify if it is liquid or powder) Liquid Wisk

33. How many loads of laundry do you do each week?

 X 1-5 6-10 11-15 16-20

34. What brand(s) of dish soap do you use? Electrosol in dishwasher
once a week

Table A-1. Water Quality Results from lakes in the Township of Lacey, New Jersey.

Lower Lake 1	pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	Total N/
	(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Ratio
	(units)																	
Aug	4.1	24.6	6.8	a	40	7.13	<1	1.62	0.39	10	0.053	0.06	0.008	b	10f	<10f	a	56
Sept	a	a	a	1	63	7.42	<1	2.00	0.39	5	0.057	0.03	0.008	b	520	210	40	53
Oct	3.7	11.7	9.6	<1	59	6.95	<1	1.75	0.33	6	0.090	0.07	0.007	b	360	110	<10	57
Nov	4.4	6.0	11.9	2	21	6.73	<1	1.90	<0.2	6	0.036	0.06	0.008	b	150	10	10	c
Dec	4.1	2.4	13.9	4	33	7.54	<1	1.00	<0.2	13	0.020	0.07	0.008	b	230	10	<10	c
Jan	4.4	5.1	12.6	4	39	6.15	<1	1.71	<0.2	14	0.048	0.10	d	b	20	a	10	c
Feb	4.3	3.3	13.4	3	29	7.09	<1	3.60	0.22	57	0.056	0.08	0.012	b	40	<10	<10	25
March	4.4	8.1	12.3	1	34	6.81	<1	1.60	<0.2	12	0.022	0.04	0.007	b	110	<10	<10	c
April	4.0	16.0	9.6	2	39	6.60	<1	2.20	<0.2	18	0.040	0.09	0.013	b	80	<10	<10	c
May	4.1	16.1	9.2	9	48	7.18	<1	4.00	<0.2	47	0.101	0.10	0.015	b	20	<10	20	c
June	4.4	23.8	7.1	<1	40	6.61	<1	3.00	0.32	12	0.032	0.06	0.020	b	40	20	<10	19
July	3.3	25.9	6.9	24	122	6.56	<1	2.20	0.34	a	0.076	0.10	0.013	b	360	210	20	34

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lower Lake 2		pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	Total N/
		(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	Coliform	Coliform	Strep	Total P
		(units)														(col./100ml)	(col./100ml)	(col./100ml)	Ratio
Aug		4.2	24.4	4.6	a	45	7.55	<1	1.68	0.40	11	0.067	0.06	0.008	5.9	50f	<30f	a	58
Sept		a	a	a	<1	57	7.33	<1	1.95	0.44	6	0.079	0.04	0.008	4.3	580	160	<10	60
Oct		3.9	13.0	8.6	<1	62	7.22	<1	3.20	0.33	5	0.096	0.05	0.007	1.2	410	50	<10	54
Nov		4.5	6.0	11.1	1	26	7.33	<1	2.50	0.20	7	0.060	0.08	0.008	1.0	150	10	20	35
Dec		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan		4.4	5.3	12.3	1	39	6.18	<1	1.30	<0.2	18	0.046	0.10	d	0.9	110	<10	<10	c
Feb		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March		4.1	8.4	1.2	1	61	7.14	<1	1.40	<0.2	11	0.035	0.06	0.007	1.3	40	<10	<10	c
April		4.0	15.0	8.8	<1	37	6.67	<1	1.52	0.20	21	0.045	0.08	0.009	a	100	<10	10	31
May		4.1	16.6	8.9	3	45	6.88	<1	1.80	<0.2	78	0.106	0.06	0.013	1.8	80	30	10	c
June		4.1	23.6	5.6	<1	39	6.88	<1	2.80	0.28	12	0.033	0.05	0.019	2.0	50	30	<10	17
July		a	26.1	7.3	20	62	6.79	<1	2.60	0.61	a	0.084	0.12	0.013	31.1	280	170	20	56

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lower Lake 3		pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal Total N/
	(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Ratio
	(units)																	
Aug	4.1	24.4	5.4	a	43	7.64	<1	1.66	0.29	12	0.083	0.06	0.008	b	20f	<10f	a	44
Sept	a	a	a	<1	63	7.62	<1	1.81	0.45	6	0.103	0.05	0.008	b	670	240	<10	63
Oct	3.7	11.8	8.9	<1	53	7.37	<1	1.69	0.33	5	0.105	0.07	0.010	b	420	40	<10	40
Nov	4.5	5.2	11.9	2	26	7.04	<1	2.40	0.23	11	0.043	0.07	0.008	b	40	<10	<10	38
Dec	4.0	2.6	12.6	2	36	7.90	<1	0.89	0.21	14	0.037	0.08	0.008	b	150	<10	<10	36
Jan	4.5	5.3	12.1	1	39	6.22	<1	1.95	0.24	13	0.049	0.10	d	b	50	<10	<10	6
Feb	4.0	3.1	12.8	2	27	6.97	<1	2.90	<0.2	20	0.043	0.07	0.010	b	40	<10	<10	c
March	4.4	7.1	10.2	1	44	6.97	<1	2.50	<0.2	13	0.034	0.05	0.007	b	10	<10	<10	c
April	3.8	15.1	8.8	<1	45	6.58	<1	1.82	<0.2	11	0.049	0.16	0.012	b	80	<10	<10	c
May	4.1	15.8	8.3	1	47	6.88	<1	1.80	0.22	22	0.087	0.05	0.013	b	40	<10	<10	21
June	4.2	23.4	5.7	<1	41	7.09	<1	3.30	0.36	16	0.023	0.05	0.019	b	70	10	<10	22
July	a	26.0	6.6	21	53	6.78	<1	2.20	0.30	a	0.079	0.14	0.013	b	200	100	<10	34

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lower Lake 4		pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	Total N/
		(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	Coliform	Coliform	Strep	Total P
		(units)														(col./100ml)	(col./100ml)	(col./100ml)	Ratio
Aug		4.2	24.3	5.3	a	41	7.54	<1	4.70	0.35	11	0.087	0.06	0.010	5.0	30f	10f	a	41
Sept		a	a	a	<1	57	7.27	<1	1.72	0.39	5	0.085	0.04	0.008	4.6	680	230	<10	54
Oct		3.8	11.4	7.7	<1	61	7.10	<1	1.23	0.25	3	0.097	0.07	0.007	1.2	330	40	<10	46
Nov		4.5	5.8	11.7	2	31	7.12	<1	22.50	0.21	9	0.050	0.07	0.008	1.0	50	<10	30	35
Dec		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan		4.6	5.5	12.0	1	41	6.30	<1	1.33	0.22	11	0.048	0.09	d	1.0	120	<10	<10	3
Feb		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March		4.0	7.5	9.9	1	40	7.04	<1	1.50	<0.2	8	0.031	0.12	0.007	1.4	80	20	<10	c
April		3.9	14.9	8.7	<1	47	6.84	<1	1.52	<0.2	17	0.048	0.08	0.012		110	<10	<10	c
May		4.1	16.3	9.0	1	46	6.72	<1	1.50	0.31	16	0.094	0.05	0.012	1.8	10	10	<10	30
June		5.7	23.8	4.3	<1	36	7.06	<1	2.10	0.29	14	0.026	0.06	0.017	2.7	20	20	<10	21
July		3.2	25.5	6.5	19	48	7.19	<1	2.10	<0.2	14	0.084	0.11	0.013	0.9	160	120	10	c

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lower Lake 5																		
	pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	Fecal Total N/
	(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Strep Total P
	(units)																	Ratio
Aug	4.0	24.1	6.3	a	42	7.61	<1	1.89	0.31	11	0.058	0.05	0.008	b	60f	70f	a	45
Sept	a	a	a	<1	52	7.57	<1	2.00	0.04	6	0.097	0.04	0.010	b	330	270	20	8
Oct	3.7	11.1	9.8	<1	53	7.08	<1	1.33	0.24	6	0.094	0.04	0.008	b	250	90	<10	35
Nov	4.4	5.8	11.9	1	30	7.00	<1	2.10	0.20	11	0.044	0.11	0.007	b	110	<10	10	44
Dec	4.1	2.6	13.5	1	27	7.73	<1	0.92	0.20	10	0.029	0.08	0.008	b	210	10	<10	35
Jan	4.5	5.2	12.6	2	38	6.38	<1	1.95	0.22	17	0.041	0.09	d	b	70	10	<10	1
Feb	4.2	3.2	13.5	4	38	6.57	<1	3.50	0.21	62	0.036	0.08	0.010	b	30	<10	<10	29
March	4.5	7.1	12.1	1	40	7.10	<1	1.80	<0.2	12	0.030	0.04	0.067	b	20	<10	<10	c
April	3.9	15.4	9.3	<1	41	6.85	<1	1.75	<0.2	19	0.047	0.07	0.012	b	70	<10	<10	c
May	4.3	16.3	9.1	1	39	6.70	<1	2.10	0.30	22	0.073	0.05	0.012	b	30	40	<10	29
June	4.6	23.6	7.3	<1	40	7.13	<1	2.50	0.28	12	0.024	0.03	0.032	b	30	30	<10	10
July	3.3	25.4	7.3	20	44	6.90	<1	2.00	<0.2	a	0.077	0.08	0.012	b	70	80	10	c

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lake Brngt 1	pH (Std) (units)	Temp (C)	D.O. (mg/l)	TSS (mg/l)	TDS (mg/l)	Chlor (mg/l)	Alk (mg CaCO ₃ /L)	Turbid (NTU)	TKN (mgN/L)	Hard- ness (mg CaCO ₃ /L)	NH ₄ (mgN/L)	NO ₃ (mgN/L)	Total P (mgP/L)	Chloro (mg/l)	Total Coliform (col./100ml)	Fecal Coliform (col./100ml)	Fecal Strep (col./100ml)	Total N/ Total P Ratio
Aug	4.1	24.3	5.8	a	42	6.90	<1	1.47	0.33	10	0.058	0.05	0.008	b	80f	10f	a	48
Sept	a	a	a	<1	62	6.81	<1	1.15	0.34	5	0.056	0.04	0.007	b	560	230	30	54
Oct	3.7	9.9	9.2	<1	54	6.36	<1	0.90	0.34	5	0.081	0.05	0.007	b	260	<10	<10	56
Nov	4.4	5.8	10.4	<1	24	6.92	<1	1.15	<0.2	7	0.039	0.05	0.007	b	80	<10	<10	c
Dec	3.9	1.6	13.3	87	29	7.33	<1	0.25	0.96	9	0.021	0.10	0.067	b	230	20	10	16
Jan	4.3	5.1	12.0	5	39	6.78	<1	2.60	0.23	14	0.048	0.14	a	b	150	<10	10	7
Feb	4.1	4.0	10.7	13	37	7.98	<1	7.50	0.32	35	0.034	0.11	0.021	b	320	10	<10	20
March	4.4	8.6	12.2	3	46	7.27	<1	2.50	<0.2	11	0.026	0.07	0.008	b	180	<10	<10	c
April	4.0	14.1	9.1	<1	36	6.61	<1	1.34	<0.2	11	0.039	0.08	0.010	b	180	20	40	c
May	4.0	16.4	8.7	2	43	6.73	<1	1.10	0.21	16	0.070	0.05	0.012	b	980	580	<10	22
June	4.0	23.4	5.4	<1	46	7.36	<1	2.00	0.36	14	0.044	0.05	0.024	b	170	120	480	17
July	3.4	23.5	5.4	22	43	6.55	<1	2.30	0.30	10	0.078	0.11	0.027	b	180	90	30	15

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lake Brogt 2		pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	Total N/
		(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	Coliform	Coliform	Strep	Total P
		(units)														(col./100ml)	(col./100ml)	(col./100ml)	Ratio
Aug		4.1	25.2	5.5	a	42	7.24	<1	1.46	0.35	8	0.055	0.04	0.010	1.5	50f	10f	a	39
Sept		a	a	a	<1	65	7.02	<1	1.40	0.33	5	0.071	0.05	0.005	2.0	370	290	<10	76
Oct		3.7	11.9	8.3	<1	54	6.74	<1	1.60	0.31	4	0.080	0.05	0.010	1.2	230	50	<10	36
Nov		4.4	4.0	11.9	<1	24	6.31	<1	1.50	<0.2	6	0.055	0.08	0.007	a	a	a	a	c
Dec		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan		4.2	5.5	12.0	2	28	6.49	<1	1.06	0.25	11	0.044	0.10	d	1.3	80	<10	<10	7
Feb		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March		4.4	7.6	11.0	<1	44	6.79	<1	1.30	<0.2	7	0.026	0.05	0.005	1.0	30	<10	<10	c
April		4.1	15.9	8.4	<1	39	6.44	<1	1.31	0.23	18	0.042	0.08	0.012	a	100	<10	<10	26
May		4.0	16.1	8.0	1	44	6.46	<1	1.40	0.20	42	0.083	0.05	0.013	1.4	70	10	10	19
June		6.6	24.8	4.2	<1	41	6.86	<1	2.30	0.34	12	0.022	0.05	0.020	0.8	10	<10	10	20
July		a	25.9	7.6	25	40	6.46	<1	1.96	0.30	13	0.052	0.14	0.012	0.8	290	290	20	37

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Lake Bragt 3		pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	Total N/
		(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Ratio
		(units)																	
Aug		4.1	24.5	5.4	a	45	7.52	<1	1.72	0.34	8	0.047	0.05	0.008	2.3	30f	<10f	a	54
Sept		a	a	a	<1	68	7.09	<1	1.68	0.41	5	0.071	0.04	0.007	2.4	470	280	<10	64
Oct		3.7	12.0	8.2	<1	58	7.15	<1	1.40	0.33	4	0.086	0.03	0.007	1.1	330	110	<10	51
Nov		4.4	12.0	4.9	1	34	6.63	<1	2.10	0.20	9	0.039	0.06	0.008	0.7	a	a	a	33
Dec		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan		4.3	5.1	12.0	2	34	6.03	<1	1.08	<0.2	10	0.042	0.10	d	0.6	50	<10	<10	c
Feb		e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March		4.4	7.6	11.1	<1	43	6.58	<1	1.50	<0.2	9	0.021	0.05	0.007	1.0	10	<10	<10	c
April		4.1	15.6	8.3	<1	43	6.51	<1	1.30	0.22	15	0.049	0.08	0.012		90	<10	<10	25
May		3.9	16.6	8.1	<1	39	6.17	<1	1.10	<0.2	26	0.077	0.07	0.012	1.5	60	10	<10	c
June		4.1	24.4	5.6	<1	41	6.50	<1	3.00	0.36	12	0.018	0.06	0.012	2.4	70	40	<10	35
July		a	26.6	6.9	24	45	6.63	<1	2.30	0.33	20	0.072	0.11	0.013	1.5	160	160	<10	34

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Deer Head 1	pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal Total	N/
	(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Strep Total P
	(units)																	Ratio
Aug	4.1	18.2	4.4	a	33	5.00	<1	0.60	0.19	12	0.042	0.04	<0.004	b	110f	10f	c	
Sept	a	a	a	<1	63	5.65	<1	1.02	0.41	5	0.077	0.03	0.007	b	370	80	10	63
Oct	3.7	8.6	8.1	<1	39	5.36	<1	0.64	0.10	2	0.093	0.05	0.005	b	150	10	<10	30
Nov	4.3	6.7	9.7	<1	23	4.50	<1	1.00	0.21	9	0.037	0.01	0.006	b	90	<10	<10	37
Dec	3.9	3.8	11.8	3	55	4.44	<1	1.00	<0.2	10	0.020	0.04	0.007	b	450	<10	<10	c
Jan	4.3	6.8	10.3	<1	31	4.05	<1	1.41	0.21	6	0.034	0.06	d	b	160	<10	<10	3
Feb	4.1	4.0	11.2	<1	18	3.34	<1	0.85	<0.2	39	0.030	0.04	0.005	b	200	10	<10	c
March	4.1	6.7	10.2	<1	34	4.57	<1	0.70	<0.2	9	0.020	0.03	0.005	b	30	<10	<10	c
April	4.1	11.0	9.0	<1	36	4.51	<1	0.72	<0.2	10	0.028	0.06	0.010	b	840	<10	<10	c
May	4.0	a	a	<1	34	4.54	<1	0.47	<0.2	26	0.031	0.01	0.007	b	<10	<10	<10	c
June	4.1	17.3	7.4	<1	37	5.06	<1	0.95	0.21	8	0.026	0.04	0.013	b	50	40	10	19
July	a	21.1	7.8	26	53	5.00	<1	0.81	0.39	12	0.060	0.08	0.007	b	160	70	10	67

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Deer Head 2	pH (Std) (units)	Temp (C)	D.O. (mg/l)	TSS (mg/l)	TDS (mg/l)	Chlor (mg/l)	Alk (mg CaCO ₃ /L)	Turbid (NTU)	TKN (mgN/L)	Hard- ness (mg CaCO ₃ /L)	NH ₄ (mgN/L)	NO ₃ (mgN/L)	Total P (mgP/L)	Chloro (mg/l)	Total Coliform (col./100ml)	Fecal Coliform (col./100ml)	Fecal Strep (col./100ml)	Total N/ Total P Ratio
Aug	4.1	23.4	6.7	a	36	6.33	<1	0.98	0.29	11	0.046	0.04	0.007	2.3	10f	10f	a	47
Sept	a	a	a	<1	57	6.38	<1	0.99	0.36	5	0.057	0.03	0.005	1.2	540	250	20	78
Oct	3.6	11.3	7.2	<1	60	7.02	<1	1.15	0.16	5	0.091	0.06	0.005	1.0	420	20	<10	44
Nov	4.4	6.4	12.0	2	11	6.18	<1	1.48	0.21	8	0.035	0.02	0.007	0.7	a	a	a	33
Dec	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan	4.2	5.6	11.9	<1	30	5.21	<1	1.04	<0.2	7	0.032	0.05	d	1.2	a	a	a	c
Feb	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March	4.3	8.3	11.7	<1	39	5.98	<1	1.00	<0.2	7	0.023	0.04	0.005	1.4	290	<10	<10	c
April	4.1	14.7	8.2	<1	36	5.65	<1	0.83	<0.2	9	0.045	0.02	0.012		170	10	<10	c
May	4.0	15.8	9.7	<1	37	5.58	<1	0.65	<0.2	16	0.050	0.02	0.007	1.3	110	10	<10	c
June	4.1	23.4	6.6	<1	43	6.26	<1	2.20	0.41	12	0.023	0.03	0.017	1.1	20	20	<10	26
July	a	22.4	8.6	26	47	7.44	<1	1.44	0.32	11	0.052	0.13	0.010	0.8	430	230	<10	45

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Deer Head 3		pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal Total	N/
		(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	Coliform	Coliform	Strep	Total P
		(units)														(col./100ml)	(col./100ml)	(col./100ml)	Ratio
Aug		4.1	23.3	6.9	a	40	6.59	<1	101.00	0.29	9	0.042	0.03	0.005	b	20f	<10f	a	64
Sept		a	a	a	1	59	6.74	<1	1.20	0.33	5	0.050	0.02	0.007	b	360	210	<10	50
Oct		3.7	9.8	9.9	<1	59	5.88	<1	0.73	0.16	4	0.086	0.04	0.005	b	220	10	<10	40
Nov		4.3	5.9	11.8	<1	24	6.03	<1	1.20	<0.2	7	0.032	<0.01	0.005	b	120	<10	<10	c
Dec		4.3	1.8	13.6	14	31	6.38	<1	2.60	<0.2	15	0.018	0.07	0.008	b	340	<10	<10	c
Jan		3.9	5.5	12.1	1	37	5.45	<1	1.33	<0.2	12	0.038	0.08	d	b	20	<10	<10	c
Feb		4.1	3.3	13.2	7	31	6.02	<1	3.90	<0.2	47	0.043	0.05	0.013	b	320	10	<10	c
March		4.3	7.2	12.3	<1	45	5.87	<1	1.15	<0.2	12	0.026	0.03	0.005	b	<10	<10	<10	c
April		3.9	14.5	10.2	<1	38	5.58	<1	10.20	<0.2	14	0.042	0.03	0.010	b	200	10	10	c
May		4.1	15.5	9.5	1	44	5.59	<1	0.80	<0.2	14	0.053	0.02	0.010	b	120	30	<10	c
June		4.1	21.9	8.1	<1	42	6.20	<1	2.50	0.31	10	0.026	0.06	0.017	b	20	20	<10	22
July		3.6	23.6	8.2	22	47	5.80	<1	1.68	0.29	12	0.043	0.09	0.008	b	380	140	20	47

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Station 1	pH (Std) (units)	Temp (C)	D.O. (mg/l)	TSS (mg/l)	TDS (mg/l)	Chlor (mg/l)	Alk (mg CaCO ₃ /L)	Turbid (NTU)	TKN (mgN/L)	Hard- ness (mg CaCO ₃ /L)	NH ₄ (mgN/L)	NO ₃ (mgN/L)	Total P (mgP/L)	Chloro (mg/l)	Total Coliform (col./100ml)	Fecal Coliform (col./100ml)	Fecal Total N/ Strep Total P (col./100ml)	Ratio
Aug	4.4	16.8	7.0	a	22	3.41	<1	0.27	<0.1	6	0.025	0.03	<0.004	b	30f	<10f	a	c
Sept	a	a	a	<1	80	3.52	<1	0.36	0.27	5	0.044	0.03	<0.004	b	860	10	140	c
Oct	3.9	9.8	8.3	<1	33	3.44	<1	0.54	<0.1	2	0.068	0.04	0.005	b	700	<10	<10	c
Nov	4.6	8.2	9.2	<1	12	3.20	<1	0.32	<0.2	9	0.026	0.02	<0.005	b	80	<10	<10	c
Dec	3.9	4.4	10.9	<1	15	3.09	<1	0.28	<0.2	5	0.010	0.02	0.007	b	230	<10	<10	c
Jan	4.7	8.8	9.7	<1	20	3.34	<1	0.35	<0.2	5	0.030	0.06	d	b	210	20	<10	c
Feb	4.0	5.9	10.4	<1	18	3.04	<1	0.67	<0.2	53	0.018	0.02	0.005	b	70	<10	<10	c
March	3.9	7.6	10.8	<1	34	3.08	<1	0.26	<0.2	12	0.013	0.02	<0.005	b	240	<10	<10	c
April	4.6	10.6	8.4	<1	23	3.06	<1	0.52	<0.2	7	0.022	0.05	0.008	b	190	<10	70	c
May	4.2	12.2	9.0	1	26	3.61	<1	0.41	<0.2	8	0.027	0.02	0.005	b	20	30	<10	c
June	4.3	17.6	7.4	<1	21	3.31	<1	0.40	<0.2	12	0.019	0.03	0.019	b	70	10	20	c
July	a	17.9	7.7	23	30	3.07	<1	0.61	<0.2	10	0.021	0.08	0.005	b	30	20	<10	c

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Sanber 2	pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NR4	NO3	Total P	Chloro	Total	Fecal	Fecal	Total N/
	(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Ratio
	(units)																	
Aug	4.4	18.9	7.1	a	23	3.68	<1	0.40	0.11	8	0.020	0.02	<0.004	b	30f	30f	a	c
Sept	a	a	a	<1	63	3.86	<1	0.92	0.35	6	0.053	0.03	<0.004	b	270	30	440	c
Oct	3.7	8.8	8.4	<1	36	3.56	<1	0.80	<0.1	3	0.063	0.04	0.005	b	280	10	<10	c
Nov	4.5	4.9	10.6	<1	18	3.48	<1	0.65	<0.2	5	0.053	0.09	<0.005	b	a	a	a	c
Dec	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan	4.5	7.0	10.6	<1	31	3.12	<1	0.45	0.22	6	0.029	0.05	d	b	180	<10	10	2
Feb	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March	4.0	6.6	11.4	<1	36	3.26	<1	0.37	<0.2	7	0.015	0.02	<0.005	b	20	<10	<10	c
April	4.3	11.1	8.3	<1	27	3.26	<1	0.65	<0.2	11	0.026	0.04	0.010	b	40	10	<10	c
May	4.2	12.5	9.6	<1	29	3.31	<1	0.48	<0.2	22	0.033	0.01	0.007	b	30	<10	<10	c
June	4.9	18.2	7.2	<1	26	3.61	<1	0.72	<0.2	10	0.018	0.04	0.013	b	90	10	60	c
July	a	19.6	7.2	27	34	3.43	<1	0.58	<0.2	7	0.040	0.06	0.007	b	100	10	40	c

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Barber 3	pH	Temp	D.O.	TSS	TDS	Chlor	Alk	Turbid	TKN	Hard-	NH4	NO3	Total P	Chloro	Total	Fecal	Fecal	N/P
	(Std)	(C)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg CaCO3/L)	(NTU)	(mgN/L)	(mg CaCO3/L)	(mgN/L)	(mgN/L)	(mgP/L)	(mg/l)	(col./100ml)	(col./100ml)	(col./100ml)	Ratio
	(units)																	
Aug	4.1	22.6	7.6	a	22	3.55	<1	0.35	0.16	8	0.025	0.04	<0.004	b	10f	<10f	a	c
Sept	a	a	a	<1	49	3.64	<1	0.41	0.22	5	0.036	0.02	0.005	b	290	130	<10	48
Oct	3.7	10.7	9.2	<1	38	3.74	<1	0.80	0.11	4	0.070	0.04	0.005	b	270	<10	<10	30
Nov	4.5	6.3	11.5	<1	19	3.60	<1	0.89	<0.2	5	0.035	0.01	<0.005	b	50	<10	<10	c
Dec	3.8	1.1	13.5	2	18	3.30	<1	0.70	<0.2	7	<0.01	0.01	0.008	b	a	a	a	c
Jan	4.3	6.9	11.6	1	31	2.98	<1	1.15	<0.2	6	0.027	0.03	d	b	70	<10	<10	c
Feb	3.9	3.1	12.9	<1	18	3.34	<1	0.85	<0.2	39	0.030	0.02	0.005	b	70	<10	<10	c
March	3.8	6.6	12.2	<1	33	3.28	<1	0.34	<0.2	8	0.014	0.01	<0.005	b	10	<10	<10	c
April	4.4	15.2	8.8	<1	27	3.24	<1	0.57	<0.2	9	0.022	0.04	0.010	b	20	<10	<10	c
May	4.0	15.5	9.8	2	30	3.32	<1	0.85	<0.2	10	0.031	0.01	0.008	b	10	<10	<10	c
June	4.4	23.9	7.7	<1	29	3.61	<1	1.00	<0.2	6	0.017	0.03	0.015	b	80	20	<10	c
July	a	24.2	7.9	10	33	3.26	<1	0.66	<0.2	6	0.041	0.09	0.008	b	60	30	<10	c

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Barber 4	pH (Std) (units)	Temp (C)	D.O. (mg/l)	TSS (mg/l)	TDS (mg/l)	Chlor (mg/l)	Alk (mg CaCO3/L)	Turbid (NTU)	TKN (mgN/L)	Hard- ness (mg CaCO3/L)	NH4 (mgN/L)	NO3 (mgN/L)	Total P (mgP/L)	Chloro (mg/l)	Total Coliform (col./100ml)	Fecal Coliform (col./100ml)	Fecal Total N/ Strep Total P (col./100ml)	Ratio
Aug	4.3	21.1	6.9	a	29	3.70	<1	0.36	0.18	9	0.041	0.03	<0.004	1.1	10f	10f	a	c
Sept	a	a	a	<1	51	3.94	<1	0.55	0.28	5	0.050	0.03	0.007	2.2	110	50	20	44
Oct	3.7	10.6	8.5	<1	39	3.76	<1	0.40	0.13	3	0.079	0.05	0.007	1.2	310	<10	<10	26
Nov	4.5	4.7	11.0	6	19	3.41	<1	2.60	<0.2	5	0.040	0.02	0.010	1.1	a	a	a	c
Dec	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
Jan	4.6	7.1	11.3	1	28	3.02	<1	1.03	<0.2	7	0.026	0.03	d	0.9	90	<10	<10	c
Feb	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e	e
March	3.8	9.1	11.8	<1	31	3.22	<1	0.39	<0.2	6	0.014	0.02	<0.005	1.1	60	<10	<10	c
April	4.2	13.9	8.6	<1	24	3.29	<1	0.54	<0.2	3	0.022	0.04	0.008	a	60	<10	<10	c
May	4.3	15.5	9.2	<1	27	3.36	<1	0.86	<0.2	20	0.034	0.01	0.007	1.1	20	<10	20	c
June	4.2	22.5	6.7	<1	29	3.58	<1	0.65	<0.2	8	0.016	0.03	0.017	1.6	40	<10	<10	c
July	a	22.7	7.9	24	34	3.45	<1	0.71	<0.2	17	0.052	0.09	0.008	1.1	<10	<10	<10	c

For footnotes, see end of Table A-1.

Table A - 1. (continued).

Det. Pond	pH (Std)	Temp (C)	D.O. (mg/l)	TSS (mg/l)	TDS (mg/l)	Chlor (mg/l)	Alk (mg CaCO ₃ /L)	Turbid (NTU)	TKN (mgN/L)	Hard- ness (mg CaCO ₃ /L)	NH ₄ (mgN/L)	NO ₃ (mgN/L)	Total P (mgP/L)	Chloro (mg/l)	Total Coliform (col./100ml)	Fecal Coliform (col./100ml)	Fecal Strep (col./100ml)	Total N/ Total P Ratio
Feb	5.3	3.8	9.4	7	124	43.80	15	21.00	0.63	45	0.029	0.01	0.034	b	40	<10	<10	19
March	6.1	9.4	7.8	2	81	19.40	15	4.20	<0.2	30	0.026	0.07	0.022	b	30	<10	<10	c
April	5.3	15.9	9.0	7	49	5.54	12	8.00	0.72	28	0.039	0.06	0.054	b	20	10	<10	14
May	5.3	16.4	1.6	13	57	5.58	13	6.50	1.49	30	0.621	0.04	0.100	b	580	160	90	15
June	4.9	24.3	4.2	4	40	2.33	8	5.60	0.66	17	0.021	0.18	0.061	b	180	200	20	12
July	a	25.3	4.4	31	53	2.86	7	12.50	0.73	a	0.067	0.22	0.093	b	2160	2080	680	10

a data not collected

b chlorophyll data for mid-lake stations only

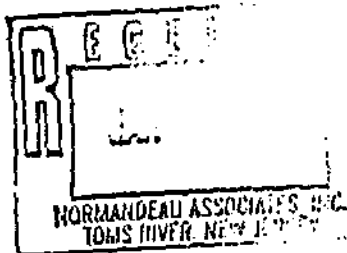
c not calculated; TKN below detection limit

d data questionable

e ice not safe; no mid lake samples

f August coliform values measured as MPN/100ml;
multiply August total coliform X 1000;

NOTE: Data collected from 8/90 through 7/91



Let's protect our earth



State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES

CN 029

Trenton, N.J. 08625-0029

(609) 292-1637
Fax # (609) 984-7938

Eric J. Evanson

Acting Director

Normandeau Associates, Inc.

1415 Hooper Avenue

Toms River, NJ 08753-2887

JAN 12 1990

Attn: Bradley Tombs, Manager

Dear Mr Tombs:

Re: Lacey Township Lakes Restoration Project
Disposal of Dredge Spoils

On December 19, 1989, a pre-application meeting was conducted between yourself and the Department of Environmental Protection/Bureau of Ground Water Discharge Control (BGWDC) representatives (Ruth Foster and Susan Harasty). The objective of this meeting was to discuss New Jersey Pollutant Discharge Elimination Systems/ Discharge to Ground Water (NJPDES/DGW) permit requirements for the disposal of dredge spoils resulting from the Lacey Township Lake Restoration Project.

Provided spoils are accepted by a licensed solid waste facility which is permitted to receive this waste type, no NJPDES/DGW permit would be required by the BGWDC specifically for this project. The lead state agency, for further guidance in this situation would be the Division of Solid Waste at (609) 292-8000.

Any other disposal methods, pursuant to N.J.A.C. 7:14A-1.2 of the NJPDES regulations require a NJPDES/DGW permit. In such cases, the BGWDC would be the lead agency. For further information, Susan Harasty of my staff may be contacted at (609) 292-0424.

Sincerely,

Erick Kinsel, Acting Section Chief
Bureau of Ground Water Discharge Control

GWQM354

c. Nelson Hausman, Bureau of Landfill Engineering/DSW

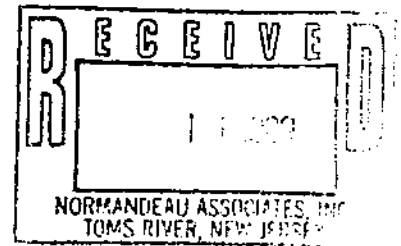


The Pinelands Commission

P.O. Box 7, New Lisbon, N. J. 08064 (609) 894-9342

September 7, 1989

Mr. Barry Krinsky
Normandeau Associates, Inc.
1415 Hooper Ave.
Toms River, NJ 08753



Please Always Refer
To This App. No.

RE: Bamber Lake
App. No. 87-0725
Lacey Township

Dear Mr. Krinsky:

In response to your letter of June 28, 1989, please be advised of the following. It has been the policy of the Pinelands Commission to permit the dredging of recreational lakes in the Pinelands Area, providing the removal of material is limited to the accumulated organic sediments and silts.

Assuming the absence of accumulated sediments, the dredging of undisturbed lake bottom would generally not be permitted. The limited removal of stumps for swimming safety is an example of when such dredging may be permitted.

Please submit the following additional information to complete your application for the dredging of Bamber Lake:

1. Fill out, sign, have notarized and return the Pinelands Comprehensive Management Plan's Application. If the applicant is not the owner of the property, the address and written consent of the owner must be submitted.
2. The location and results of a series of lake bottom sediment cores.
3. A plan prepared by an engineer identifying the existing and proposed lake bottom profile. Those portions of Bamber Lake which were previously dredged should be identified. Sediment cores would be needed to document recently accumulated sediments to be removed.

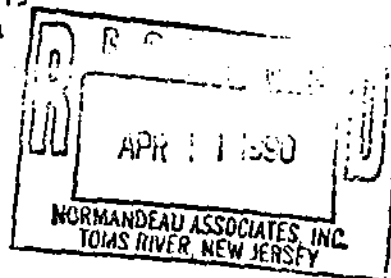


REPLY TO
ATTENTION OF



PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE-2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106-2991

APR 09 1990



Regulatory Branch

SUBJECT: CENAP-OP-R-90-0621-22 (NJD)

Mr. R. Bradley Tombs
Normandeau Associates, Incorporated
1415 Hooper Avenue
Toms River, New Jersey 08753-5795

Dear Mr. Tombs:

This is in regard to your letter of February 26, 1990 concerning Department of the Army jurisdiction over mechanical dredging in Lower Lake, Lake Barnegat and Deer Head Lake, on the North Branch of the Forked River, and Bamber Lake on Cedar Creek, Lacey Township, Ocean County, New Jersey. A Department of the Army permit is not required for this activity because it does not involve work or structures in navigable waters of the United States or the discharge of dredged or fill material into waters of the United States including adjacent and isolated wetlands. All excavated material must be placed in upland, non-wetland areas and stabilized to prevent it from reentering adjacent waterways.

This letter does not affect your responsibility to obtain any other Federal, State or local approvals required by law for your proposed development. If you should have any further questions regarding this matter, please contact Mr. John Brady of this office at (215) 597-4722 between 1:00 and 3:30 p.m., or write to the above address.

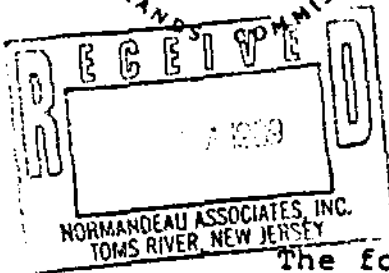
Sincerely,

Frank J. Cianfrani
Chief, Regulatory Branch

CF: NJDEP, Division of Coastal Resources/Wetlands

The Pinelands Commission

P.O. Box 7, New Lisbon, N.J. 08064 (609) 894-9342



GUIDELINES FOR CHEMICAL TREATMENT OF LAKES AND PONDS WITHIN THE PINELANDS AREA

The following guidelines will be used in the review of applications to chemically treat lakes and ponds for the purpose of enhancing the recreational use of the water bodies.

1. Generally, in Regional Growth Areas, Rural Development Areas, Agricultural Production Areas, Pinelands Towns and Villages not located in the Preservation Area or Forest Area:
 - A. Treatment may be permitted where it can be demonstrated that the water body does not exhibit the characteristics of waters within the Pinelands. This demonstration may include evidence that:
 1. the water body supports a predominance of atypical Pinelands aquatic species;
 2. the water body exhibits elevated pH (>6 units) and nitrate/nitrogen (>.7 mg/L.).
 - B. In water bodies that do exhibit the characteristics of typical waters within the Pinelands, treatment may be permitted provided that the frequency and intensity of the proposed treatment is the minimum necessary to support the recreational use of the water body and the same objectives cannot feasibly be achieved through mechanical control (harvesting, use of barriers, lake drawdown or other means)
 1. to demonstrate that treatment is necessary to support the recreational use of the water body evidence may be submitted that indicates that a lack of treatment in the year proposed will significantly impede boating, swimming, fishing or other recreational uses.
 2. to demonstrate that mechanical controls are not feasible evidence may be submitted that the use of such controls will not adequately render the water

body suitable for recreational use, or that the cost of such measures will exceed the cost of chemical application by 200%.

2. Generally, in Forest Areas or the Preservation Area and Villages therein, treatment may be permitted in defined swimming beach areas provided that the frequency and intensity of the proposed application is the minimum necessary to support swimming within the defined area and the same objective cannot be achieved through mechanical control. See B(1) and 2) above for evidence that may be submitted for demonstrations that application is necessary to support the swimming use and for lack of feasibility of mechanical controls.
3. Should rare or endangered species occur in or adjacent to any water body proposed for treatment, or downstream from any such water body, treatment may be permitted when it is demonstrated that the treatment will not impact said species.
 - A. to demonstrate lack of impact on rare or endangered species, evidence may be submitted that indicates that the water body has previously been treated with the proposed chemical to be applied in two or more years immediately preceding the proposed year of treatment and the species remain present; or
 - B. evidence may be submitted that the rare and endangered species are tolerant to the chemical application being proposed.


 STATE OF NEW JERSEY
 DEPARTMENT OF ENVIRONMENTAL PROTECTION

 CN 402
 Trenton, N.J. 08625

 PERMIT
 DRAINAGE: Cedar Creek

The New Jersey Department of Environmental Protection grants this permit in accordance with your application, attachment accompanying same application, and applicable laws and regulations. This permit is also subject to the further conditions and stipulations enumerated in the supporting documents which are agreed to by the permittee upon acceptance of the permit.

Permit No. 1319	Issuance Date August 24, 1990	Effective Date December 1, 1990	Expiration Date March 1, 1991
Name and Address of Applicant Lacey Township 818 Lacey Rd. Forked River, NJ 08731	Location of Activity/Facility	Name and Address of Owner	
Issuing Division Fish, Game and Wildlife	Type of Permit Water Lowering	Permit(s) No. 23:5-29	Application No.

This permit grants permission to:

draw off the waters of Bamber Lake, located off Good Luck Rd/Lake Dr., Lacey Twp., Ocean County, provided measures are taken to prevent the destruction of fish. The water level may be lowered a maximum of 4.0 feet, as measured from the crest of the spillway.

This permit is subject to the following conditions:

1. During lowering, the rate of water release must be controlled such that there is no over-bank flow of the primary downstream channel.
2. Refilling must commence no later than the expiration date, and during refilling water flow out of the impoundment must be maintained so that fish life downstream is protected.

The permittee assumes all responsibility for protecting and salvaging fish affected by this lowering (NOTE: The salvage of live fish requires a Scientific Collectors Permit and the transfer of live salvaged fish to other bodies of water requires a Stocking Permit, which are issued by this Division.).

This Water Lowering Permit is issued for the purpose of protecting the state's fishery resources and for no other purpose. It does not relieve the permittee from any liabilities to any persons or property affected by the lowering and does not authorize the permittee to conduct any construction or alteration activities in conjunction with the lowering.

Violation of any provision of this permit shall render this permit void.

Approved by the Department of Environmental Protection

Fisheries Lab
A.B. Pyle

Central District (2)

Div Water Res., R. Runyon

George P. Howard, Director

August 24, 1990

DATE

Word permit means "approval, certification, registration, etc."

(GENERAL CONDITIONS ARE ON THE REVERSE SIDE.)



STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

CN-402
Trenton, N.J. 08625



PERMIT

DRAINAGE: Forked River

The New Jersey Department of Environmental Protection grants this permit in accordance with your application, attachment accompanying same application, and applicable laws and regulations. This permit is also subject to the further conditions and stipulations enumerated in the supporting documents which are agreed to by the permittee upon acceptance of the permit.

Permit No. 1320	Issuance Date August 24, 1990	Effective Date December 1, 1990	Expiration Date March 1, 1991
Name and Address of Applicant Lacey Township 818 Lacey Rd. Forked River, NJ 08731	Location of Activity/Facility	Name and Address of Owner	
Issuing Division Fish, Game and Wildlife	Type of Permit Water Lowering	Statute(s) 23:5-29	Application No.

This permit grants permission to:

draw off the waters of Deer Head Lake, located off Lakeside Drive, Lacey Twp., Ocean County, provided measures are taken to prevent the destruction of fish. The water level may be lowered a maximum of 4.0 feet, as measured from the crest of the spillway.

This permit is subject to the following conditions:

1. During lowering, the rate of water release must be controlled such that there is no over-bank flow of the primary downstream channel.
2. Refilling must commence no later than the expiration date, and during refilling water flow out of the impoundment must be maintained so that fish life downstream is protected.

The permittee assumes all responsibility for protecting and salvaging fish affected by this lowering (NOTE: The salvage of live fish requires a Scientific Collectors Permit and the transfer of live salvaged fish to other bodies of water requires a Stocking Permit, which are issued by this Division.).

This Water Lowering Permit is issued for the purpose of protecting the state's fishery resources and for no other purpose. It does not relieve the permittee from any liabilities to any persons or property affected by the lowering and does not authorize the permittee to conduct any construction or alteration activities in conjunction with the lowering.

Violation of any provision of this permit shall render this permit void.

Approved by the Department of Environmental Protection

Fisheries Lab
J.B. Pyle

Central District (2)

Div. Water Res., R. Kunyon
"word permit means 'approval, certification, registration, etc.'"

George F. Howard, Director

August 24, 1990

DATE

(GENERAL CONDITIONS ARE ON THE REVERSE SIDE.)



STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
CN-402
Trenton, N.J. 08625



PERMIT

DRAINAGE: Forked River

The New Jersey Department of Environmental Protection grants this permit in accordance with your application, attached, accompanying same application, and applicable laws and regulations. This permit is also subject to the further conditions and stipulations enumerated in the supporting documents which are agreed to by the permittee upon acceptance of the permit.

Permit No. 1321	Issuance Date August 24, 1990	Effective Date December 1, 1990	Expiration Date March 1, 1991
Name and Address of Applicant Lacey Township 818 Lacey Rd. Forked River, NJ 08731	Location of Activity/Facility	Name and Address of Owner	
Issuing Division Fish, Game and Wildlife	Type of Permit Water Lowering	State(s) NJ 23:5-29	Application No.

This permit grants permission to:

draw off the waters of Lower Lake, located off Lakeside Drive South, Lacey Twp., Ocean County, provided measures are taken to prevent the destruction of fish. The water level may be lowered a maximum of 4.0 feet, as measured from the crest of the spillway.

This permit is subject to the following conditions:

1. During lowering, the rate of water release must be controlled such that there is no over-bank flow of the primary downstream channel.
2. Refilling must commence no later than the expiration date, and during refilling water flow out of the impoundment must be maintained so that fish life downstream is protected.

The permittee assumes all responsibility for protecting and salvaging fish affected by this lowering (NOTE: The salvage of live fish requires a Scientific Collectors Permit and the transfer of live salvaged fish to other bodies of water requires a Stocking Permit, which are issued by this Division.).

This Water Lowering Permit is issued for the purpose of protecting the state's fishery resources and for no other purpose. It does not relieve the permittee from any liabilities to any persons or property affected by the lowering and does not authorize the permittee to conduct any construction or alteration activities in conjunction with the lowering.

Violation of any provision of this permit shall render this permit void.

Approved by the Department of Environmental Protection

Fisheries Lab
J.B. Pyle

Central District (2)

George P. Howard
George P. Howard, Director

August 24, 1990

DATE

Div Water Res., R. Kunyon
"This permit means approval, certification, registration, etc."
Buf. Pesticide Control

(GENERAL CONDITIONS ARE ON THE REVERSE SIDE.)



STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

CN-402
Trenton, N.J. 08625



PERMIT

DRAINAGE: Forked River

The New Jersey Department of Environmental Protection grants this permit in accordance with your application, attachments accompanying same application, and applicable laws and regulations. This permit is also subject to the further conditions and stipulations enumerated in the supporting documents which are agreed to by the permittee upon acceptance of the permit.

Permit No. 1322	Issuance Date August 24, 1990	Effective Date December 1, 1990	Expiration Date March 1, 1991
Name and Address of Applicant Lacey Township 818 Lacey Rd. Forked River, NJ 08731		Location of Activity/Facility	Name and Address of Owner
Issuing Division Fish, Game and Wildlife	Type of Permit Water Lowering	Statute(s) 23:5-29	Application No.

This permit grants permission to:

draw off the waters of Lake Barnegat, located off Lakeside Drive South, Lacey Twp., Ocean County, provided measures are taken to prevent the destruction of fish. The water level may be lowered a maximum of 6.0 feet, as measured from the crest of the spillway.

This permit is subject to the following conditions:

1. During lowering, the rate of water release must be controlled such that there is no over-bank flow of the primary downstream channel.
2. Refilling must commence no later than the expiration date, and during refilling water flow out of the impoundment must be maintained so that fish life downstream is protected.

The permittee assumes all responsibility for protecting and salvaging fish affected by this lowering (NOTE: The salvage of live fish requires a Scientific Collectors Permit and the transfer of live salvaged fish to other bodies of water requires a Stocking Permit, which are issued by this Division.).

This Water Lowering Permit is issued for the purpose of protecting the state's fishery resources and for no other purpose. It does not relieve the permittee from any liabilities to any persons or property affected by the lowering and does not authorize the permittee to conduct any construction or alteration activities in conjunction with the lowering.

Violation of any provision of this permit shall render this permit void.

Approved by the Department of Environmental Protection

Fisheries Lab
A.B. Pyle

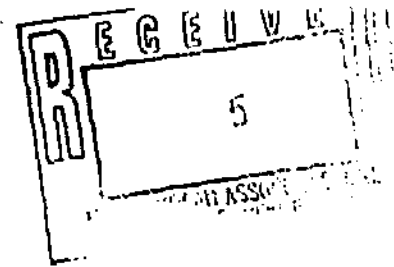
Central District (2)

George F. Howard
George F. Howard, Director August 24, 1990
DATE

Div. Water Res. R. Runyon
Bur. Pesticide Control
"word permit means approval, certification, registration, etc."

(GENERAL CONDITIONS ARE ON THE REVERSE SIDE.)

Let's protect our earth



State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

TRENTON

MAY 31 1990

DIVISION OF COASTAL RESOURCES

PLEASE ADDRESS REPLY TO:
CN 401
TRENTON, N.J. 08625

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753-2887

Attn: Mr. R. Bradley Tombs

Re: Authorization for Freshwater Wetlands Statewide General Permit and Waiver of Transition Area for Access

Project Name: Lacey Lakes

Permit #1512-90-0006.1 Statute N.J.S.A. 13:9B-1 et seq.

Effective date MAY 31 1990 . Expiration date MAY 31 1995

Block 1358; Lot 66

Lacey Township, Ocean County

Forked River Watershed

Nearest Water Body: Dear Head Lake

Dear Ms. Tombs,

The Division of Coastal Resources has reviewed the referenced application for a Freshwater Wetlands Statewide General Permit authorization pursuant to the requirements of Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A. Based on plans entitled "Maintenance Plan for Removal of Accumulated Sediments", Lacey Township, Ocean County, New Jersey," consisting of 1 sheet, dated December 12, 1989, no revisions, and prepared by Normandeau Associates Inc. The proposed activities are authorized by Freshwater Wetlands Statewide General Permit #1. Statewide General Permit #1 authorizes regulated activities, including the repair, rehabilitation and maintenance of a stormwater management facility lawfully existing prior to July 1, 1988.

Project description

The authorized activity involves the maintenance dredging of an existing retention basin. The project proposes to dredge approximately two feet of accumulated sediments from the basin. In addition, approximately 100 square yards of freshwater wetlands will be temporarily disturbed during the dredging process to allow access for construction equipment. Any additional disturbance of freshwater wetlands or State open waters shall be considered

a violation of the Freshwater Wetlands Protection Act unless a permit is obtained prior to the start of the disturbance from the Division of Coastal Resources.

Permit Conditions

The activities allowed by this authorization shall comply with the following conditions. Failure to comply with these conditions shall constitute a violation of the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et.seq.)

Special conditions:

1. The project must meet Soil Erosion and Sediment Control Standards, and be approved by the Ocean County Soil Conservation District.
2. Prior to commencing work the applicant will be required to submit the location of the disposal area for the dredge spoils and the upland dewatering area to the Division for review and approval.
3. Prior to commencing work the applicant will be required to submit a restoration plan for the disturbed wetland and upland areas to the Division for review and approval.
4. The proposed dredging activity shall maintain a 3 : 1 slope along the perimeter of the retention basin.

In addition to the above conditions and the conditions noted at N.J.A.C. 7:7A 9.2 and 9.3, the following general conditions must be met for the activity authorized under this Statewide General Permit:

General conditions:

1. This permit is revocable, or subject to modification or change at any time, when in the judgement of the Department of Environmental Protection of the State of New Jersey, such revocation, modification or change shall be necessary.
2. The issuance of this permit shall not be deemed to affect in any way other actions by the Department on any future application.
3. The activities shown by plans and/or other engineering data, which are this day approved, subject to the conditions herewith established, shall be constructed and/or executed in conformity with such plans and/or engineering data and the said conditions.

4. No change in plans or specifications shall be made except with the prior written permission of the Department.
5. The granting of this authorization shall not be construed to in any way affect the title or ownership of the property, and shall not make the Department or the State a party in any suit or question of ownership of the property.
6. This authorization is not valid and no work shall be undertaken until such time as all other required approvals and permits have been obtained.
7. A copy of this authorization shall be kept at the work site and shall be exhibited upon request of any person.

Waiver of Transition Area

The Division of Coastal Resources has determined that the wetlands affected by this permit authorization are of ordinary resource value. The resource value classification is the basis for determining the standard width of transition area required for the wetlands affected by this permit authorization. The authorization of activities under this Freshwater Wetlands Statewide General Permit includes a transition area waiver. This waiver allows encroachment only in that portion of the transition area that has been determined by the Division to be necessary to accomplish the authorized activities.

Any additional prohibited activities conducted within the standard transition area on-site shall require a separate transition area waiver from the Division. Prohibited activities within a transition area are defined at N.J.A.C. 7:7A-6.2(a).

Duration of Authorization/Notification of Work

This authorization for a Freshwater Wetlands Statewide General Permit is valid for five years from the effective date noted in this letter. The permittee shall allow an authorized Division representative the right to inspect the construction site. The permittee will notify, in writing, the Division of Coastal Resources 7 days prior to commencement of work authorized by this letter.

Appeal of Decision

The applicant or other affected party, if aggrieved by this decision to authorize the activities specified in this correspondence, may request a hearing on this decision by submitting a written request for an administrative hearing

to the Commissioner of the Department of Environmental Protection within 30 days of the date of this decision.

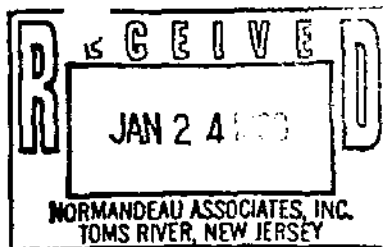
If you have any questions regarding this Freshwater Wetlands Statewide General Permit authorization, please contact Charles Welch of my staff at (609) 984-0042. Please reference the permit number in any communication concerning this action.

Sincerely,


Ruth Ehinger, Manager
Bureau of Coastal Regulation

- c. U.S. Army Corps of Engineers: Philadelphia District
Ocean Township Planning Board
Lacey Township Construction Official
Lacey Township Clerk
Ocean County Planning Board
Ocean County Soil Conservation District

Let's protect our earth



State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON

January 22, 1990

DIVISION OF COASTAL RESOURCES

PLEASE ADDRESS REPLY TO:
CN 401
TRENTON, N.J. 08625

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753

ATTN: R. Bradley Tombs, Branch Manager
RE: NA1-NJ Project 10181 Lacey Township Lakes
Dredging of Wet Detention Pond-Stream File 1512-90

Dear Mr. Tombs:

This is with reference to your request for the determination of the requirement for a Stream Encroachment Permit for the maintenance dredging of a wet detention pond located at the intersection of Lakeside Drive South and Ravine Drive within Lot No. 21 of Block No. 1358 in Lacey Township, Ocean County, New Jersey.

Please be advised that a review of the submitted material indicates that no stream encroachment permit will be required, provided:

1. All areas are stabilized in accordance with "Standard for Soil Erosion and Sediment control in New Jersey".
2. All dredged material shall be deposited outside the 100 year flood plain or Flood Hazard Area of any stream.

This letter is valid for two (2) years from the date of issuance and does not exempt you from obtaining any Federal, Local, or State consents that may be necessary.

If you have any further questions, please contact William M. Berns at (609) 984-0162.

Very truly yours,

Mohammed Q. Husain, P.E.
Section Chief
Southern Engineering Section
Bureau of Coastal Regulations

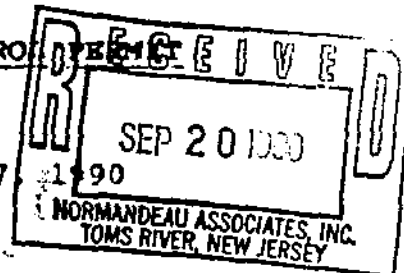
c: Lacey Twp. Engineer and Clerk
Ocean County Engineer
Darryl Jennus



OCEAN COUNTY SOIL CONSERVATION DISTRICT

6 Mott Place • C.N. 2191 • Toms River, N.J. 08754-2191
(201) 244-7048

SOIL EROSION AND SEDIMENT CONTROL



Honorable Debra L. Madensky
Mayor of Lacey Township
818 W. Lacey Road
Forked River, NJ 08731

September 17, 1990

RE: SCD #4207; Detention Basin Dredging; Block 1358, Lot 21;
Ravine & Lakeside Drives; Lacey Township

Dear Mayor Madensky:

Pursuant to Chapter 251, Soil Erosion and Sediment Control Act, P.L. 1975, the Ocean County Soil Conservation District hereby grants certification of the soil erosion and sediment control plan for the above captioned project, subject to the following:

1. That the applicant carries out all land disturbance activities in accordance with the Standards for Soil Erosion and Sediment Control in New Jersey promulgated by the State Soil Conservation Committee.
2. The applicant must notify the District office, by mail, at least 72 hours prior to initial land disturbance.
3. A letter must be written notifying the District office of project completion within 48 hours immediately following completion.
4. Changes in the certified plan relating to or that will affect land disturbance on the site must be submitted to the District office for reevaluation and approval.
5. A copy of the certified plan and a copy of these provisions must be kept on the job site at all times.

Failure to comply with any of the above conditions may result in the issuance of a Stop Construction Order.

NOTE: This certification is limited to the controls specified in this plan. It is not authorization to engage in the proposed land use unless such use has been previously approved by the municipality or other controlling agency.

WS:bb

Distribution:

White - Applicant
Green - Construction Official
Tanary - Planning Board
Pink - Applicant's Engineer
Goldenrod - District

Sincerely,

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753-2887
(201) 240-5795
(201) 240-4922 (Fax)

NORMANDEAU ASSOCIATES

September 17, 1990

Mr. Charles Welsh
N.J.D.E.P.
Division of Coastal Resources
CN 401
Trenton, NJ 08625

NAI-NJ Project No. 10181
Lacey Lakes
Statewide General Permit No. 1512-90-0006.1
Lacey Township, Ocean Co., NJ

Dear Mr. Welsh:

In response to the NJDEP Authorization for Freshwater Wetlands Statewide General Permit and Waiver of Transition Area, dated May 31, 1990 (see attached) Please find the following documentation in fulfillment of the conditions.

The enclosed documentation includes the following:

- 1) The Soil Erosion and Sediment Plan, as submitted to the Ocean County Soil Conservation District for review and approval.
- 2) A copy of the agreement between the applicant, Lacey Township, and Parker Associates for the disposal of dredge spoils upon completion of the permitted activities.
- 3) The restoration plan for the disturbed wetland and upland areas.
- 4) The proposed dredging area shall also maintain a 3:1 slope along the detention pond's perimeter upon completion of the permitted activity.

Please note that the proposed Soil Erosion and Sediment Plan has been submitted to the Ocean County Soil Conservation District and approval is expected shortly.

Please be advised that upon receipt of soil erosion approval, the township will commence work. The anticipated start date is October 15, 1990.

Bedford, NH
Hampton, NH
Williston, VT

Yarmouth, ME
Peekskill, NY
Toms River, NJ

Aiken, SC
Greenville, SC
LaCaire, LA

NORMANDEAU ASSOCIATES

Mr. Welsh

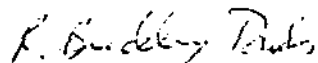
-2-

September 17, 1990

Should you have any questions please advise us immediately.

Very truly yours,

NORMANDEAU ASSOCIATES, INC.



R. Bradley Tombs
Branch Manager

RBT\rph
enc.
cc:Phil Luccarelli

P 324 906 256

RECEIPT FOR CERTIFIED MAIL

NO INSURANCE COVERAGE PROVIDED

NOT FOR INTERNATIONAL MAIL

(See Reverse)

U.S.G.P.O. 1989-234-555

PS Form 3800, June 1985

Sent to <i>Charles Welsh - NDEP</i>	
Street and No. <i>Div. of Coastal Resources</i>	
P.O., State and ZIP Code <i>C.N. 401 Trenton NJ 08625</i>	
Postage	\$
Certified Fee	
Special Delivery Fee	
Restricted Delivery Fee	
Return Receipt showing to whom and Date Delivered	
Return Receipt showing to whom, Date, and Address of Delivery	
TOTAL Postage and Fees	\$
Postmark or Date	



State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

TRENTON

MAY 31 1990

DIVISION OF COASTAL RESOURCES

PLEASE ADDRESS REPLY TO:
CN 401
TRENTON, N.J. 08625

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753-2887

Attn: Mr. R. Bradley Tombs

Re: Authorization for Freshwater Wetlands Statewide General Permit and Waiver of Transition Area for Access

Project Name: Lacey Lakes

Permit #1512-90-0006.1 Statute N.J.S.A. 13:9B-1 et seq.

Effective date MAY 31 1990 . Expiration date MAY 31 1995

Block 1358; Lot 66

Lacey Township, Ocean County

Forked River Watershed

Nearest Water Body: Dear Head Lake

Dear Ms. Tombs,

The Division of Coastal Resources has reviewed the referenced application for a Freshwater Wetlands Statewide General Permit authorization pursuant to the requirements of Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A. Based on plans entitled "Maintenance Plan for Removal of Accumulated Sediments", Lacey Township, Ocean County, New Jersey," consisting of 1 sheet, dated December 12, 1989, no revisions, and prepared by Normandeau Associates Inc. The proposed activities are authorized by Freshwater Wetlands Statewide General Permit #1. Statewide General Permit #1 authorizes regulated activities, including the repair, rehabilitation and maintenance of a stormwater management facility lawfully existing prior to July 1, 1988.

Project description

The authorized activity involves the maintenance dredging of an existing retention basin. The project proposes to dredge approximately two feet of accumulated sediments from the basin. In addition, approximately 100 square yards of freshwater wetlands will be temporarily disturbed during the dredging process to allow access for construction equipment. Any additional disturbance of freshwater wetlands or State open waters shall be considered

a violation of the Freshwater Wetlands Protection Act unless a permit is obtained prior to the start of the disturbance from the Division of Coastal Resources.

Permit Conditions

The activities allowed by this authorization shall comply with the following conditions. Failure to comply with these conditions shall constitute a violation of the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 et seq.)

Special conditions:

1. The project must meet Soil Erosion and Sediment Control Standards, and be approved by the Ocean County Soil Conservation District.
2. Prior to commencing work the applicant will be required to submit the location of the disposal area for the dredge spoils and the upland dewatering area to the Division for review and approval.
3. Prior to commencing work the applicant will be required to submit a restoration plan for the disturbed wetland and upland areas to the Division for review and approval.
4. The proposed dredging activity shall maintain a 3 : 1 slope along the perimeter of the retention basin.

In addition to the above conditions and the conditions noted at N.J.A.C. 7:7A 9.2 and 9.3, the following general conditions must be met for the activity authorized under this Statewide General Permit:

General conditions:

1. This permit is revocable, or subject to modification or change at any time, when in the judgement of the Department of Environmental Protection of the State of New Jersey, such revocation, modification or change shall be necessary.
2. The issuance of this permit shall not be deemed to affect in any way other actions by the Department on any future application.
3. The activities shown by plans and/or other engineering data, which are this day approved, subject to the conditions herewith established, shall be constructed and/or executed in conformity with such plans and/or engineering data and the said conditions.

4. No change in plans or specifications shall be made except with the prior written permission of the Department.
5. The granting of this authorization shall not be construed to in any way affect the title or ownership of the property, and shall not make the Department or the State a party in any suit or question of ownership of the property.
6. This authorization is not valid and no work shall be undertaken until such time as all other required approvals and permits have been obtained.
7. A copy of this authorization shall be kept at the work site and shall be exhibited upon request of any person.

Waiver of Transition Area

The Division of Coastal Resources has determined that the wetlands affected by this permit authorization are of ordinary resource value. The resource value classification is the basis for determining the standard width of transition area required for the wetlands affected by this permit authorization. The authorization of activities under this Freshwater Wetlands Statewide General Permit includes a transition area waiver. This waiver allows encroachment only in that portion of the transition area that has been determined by the Division to be necessary to accomplish the authorized activities.

Any additional prohibited activities conducted within the standard transition area on-site shall require a separate transition area waiver from the Division. Prohibited activities within a transition area are defined at N.J.A.C. 7:7A-6.2(a).

Duration of Authorization/Notification of Work

This authorization for a Freshwater Wetlands Statewide General Permit is valid for five years from the effective date noted in this letter. The permittee shall allow an authorized Division representative the right to inspect the construction site. The permittee will notify, in writing, the Division of Coastal Resources 7 days prior to commencement of work authorized by this letter.

Appeal of Decision

The applicant or other affected party, if aggrieved by this decision to authorize the activities specified in this correspondence, may request a hearing on this decision by submitting a written request for an administrative hearing

to the Commissioner of the Department of Environmental Protection within 30 days of the date of this decision.

If you have any questions regarding this Freshwater Wetlands Statewide General Permit authorization, please contact Charles Welch of my staff at (609) 984-0042. Please reference the permit number in any communication concerning this action.

Sincerely,


Ruth Ehinger, Manager,
Bureau of Coastal Regulation

- c. U.S. Army Corps of Engineers: Philadelphia District
Ocean Township Planning Board
Lacey Township Construction Official
Lacey Township Clerk
Ocean County Planning Board
Ocean County Soil Conservation District

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753-2887
(201) 240-5795
(201) 240-4922 (Fax)

NORMANDEAU ASSOCIATES

August 23, 1990

Mr. Philip Luccarelli
Lakes Management Sub-Committee
Township of Lacey
818 West Lacey Road
Forked River, NJ 08731

NAI-NJ Project No. 10181.02
Lacey Lakes
Lacey Twp., Ocean Co., NJ

Dear Phil:

Enclosed are the laboratory results from the detention pond sediment sampling. The textural analysis which was performed for us by Melick-Tully & Associates, Inc. indicates that the sediment could best be described as a coarse sand, relatively free of fines. Because of the absence of fines, we did not attempt to determine the plastic or liquid limits for the sediment, as these tests were developed to determine the properties of much finer textured materials.

The Nytest Environmental, Inc., analyses confirm that the material is relatively clean. The only parameters which were found to be above the detection limits were Petroleum Hydrocarbons (741 ppm), lead (5.40 ppm) and zinc (12.20 ppm). All concentrations are expressed on a dry weight basis.

The analyses lead us to the following findings:

1. The sediment would not be considered to be a hazardous waste.
2. The sediment could be disposed of at a landfill licensed to accept I.D. 13 or 27 wastes. If this were a soil rather than a sediment, there would be no restrictions placed on its use or disposal. The Parker Associates landfill can accept material classified as I.D. 13.

Because it is a dredged sediment rather than a soil, it is defined by N.J.S.A. 58:10A-1 et. seq. and N.J.A.C. 7:14A as a pollutant, even though it is relatively clean material. As such, disposal must occur at an approved facility. Due to its coarse textural properties, the sediment alone may not be useful as final cover due to its relative inability to support vegetation and its highly permeable nature. If mixed with other suitable material it may be useful as landfill final cover. It may, however, be acceptable as daily cover at an operating landfill.

Bedford, NH
Hampton, NH
Williston, VT

Yarmouth, ME
Peekskill, NY
Toms River, NJ

Aiken, SC
Greenville, SC
LeClaire, IA

NORMANDEAU ASSOCIATES

Mr. Luccarelli

- 2 -

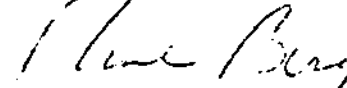
August 23, 1990

With your permission, we will forward the analytical results to the Division of Solid Waste Management to request their written determination to confirm that the sediment may be utilized as cover at the Parker Associates landfills.

Please feel free to contact us if you have any questions on this matter.

Very truly yours,

NORMANDEAU ASSOCIATES, INC.



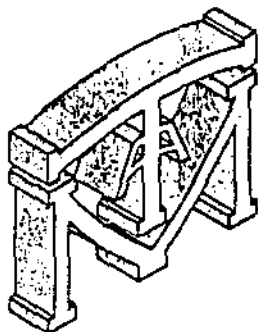
Robert Berg, CPSS
Water Resources Manager

RB\sm

enc.

c: D. Kretchmer

B. Tombs



**MELICK-TULLY
AND ASSOCIATES, INC.**

CONSULTING GEOTECHNICAL ENGINEERS
117 CANAL RD., SOUTH BOUND BROOK, NJ 08880
(201) 356-3400 TELECOPIER: (201) 356-9054

PRINCIPALS:
THOMAS E. TULLY, P.E.
CHARLES T. MELICK, P.E.
ROBERT J. VAN ORDEN, P.E.
RAYMOND J. TULLY, P.E.
EUGENE M. GALLAGHER, P.E.
ROBERT E. SCHWANKERT, P.E.

ASSOCIATES:
TODD E. HOROWITZ, P.E.
PETER G. MICKLUS, P.E.
WILLIAM M. STRUBEL

August 8, 1990

Normandeau Associates
1415 Hooper Avenue
Toms River, New Jersey 08753

Attention: Mr. Robert Berg

Re: Laboratory Testing
Detention Basin
Sample SED-1
Normandeau Project No. 10181-02

This letter presents the results of the laboratory testing performed on a soil sample delivered to our office on July 17, 1990. The testing which you had requested included a combined sieve/hydrometer analysis and an Atterberg Limits test. After examining the sample in our laboratory, and based on our subsequent telephone conversation, it was agreed that the Atterberg Limits test was not an appropriate test due to the clean, granular nature of the soil.

The soil sample was subjected to a combined sieve/hydrometer analysis. The results of the testing are presented below:

<u>Sieve Size or Particle Diameter</u>	<u>Percent Finer (by weight)</u>
3/4"	100.0
1/2"	98.7
#4	92.6
#10	83.8
#40	42.8
#60	16.3
#100	5.6
#200	3.1
#270	2.7
.020 mm	2.3
.005 mm	2.1
.002 mm	1.9
.001 mm	1.8

Normandeau Associates
August 8, 1990
Page 2

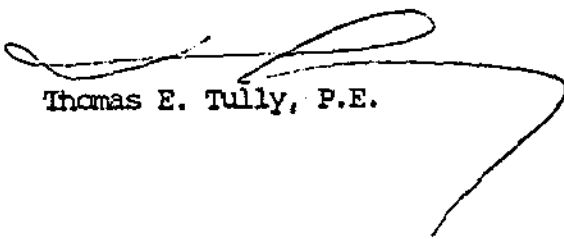
Please do not hesitate to contact us if you have any questions regarding this information.

Very truly yours,

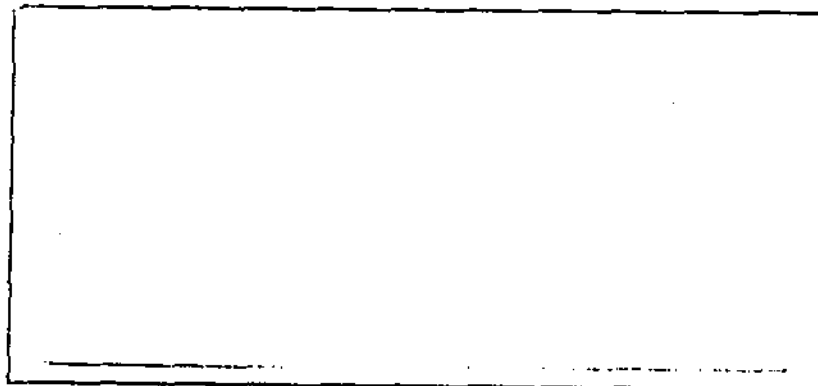
MELICK-TULLY and ASSOCIATES, INC.

Burton H. Turner

Burton H. Turner


Thomas E. Tully, P.E.

BHT:TET/odg
4451-001



TOTAL ANALYTICAL SERVICES FOR A SAFE ENVIRONMENT

nytest environmental inc.

box 1518 □ 60 seaview blvd., port washington, ny 11050 □ (516) 625-5500 □ fax (516) 625-1274



TOTAL ANALYTICAL SERVICES FOR A SAFE ENVIRONMENT

nytest environmental inc.

Project No.: 9017138

Log in No: 5324

P.O. No.: PENDING

Date: AUGUST 15, 1990

ANALYTICAL DATA REPORT PACKAGE
FOR

NORMANDEAU

1415 HOPPER AVENUE

TOMS RIVER, N.J. 08753

ATTN: RICH HUBNER
REF: PROJECT NO. 10181.02, LACREY LAKES

SAMPLE IDENTIFICATION	LABORATORY NUMBER	TYPE OF SAMPLE
SED-1	5324001	SOIL

REPORT PREPARED BY:
PARAG K. SHAH, Ph. D.
ORGANIC LAB. MANAGER

FRANK BUCZYNSKI
INORGANIC LAB. MANAGER

DOUGLAS SHEELEY
LABORATORY DIRECTOR

N.J. Cert. # 73469

SR

Report on sample(s) furnished by client applies to sample(s). Report on sample(s) obtained by us applies only to lot sampled. Information contained herein is not to be used for reproduction except by special permission. Sample(s) will be retained for thirty days maximum after date of report unless specifically requested otherwise by client. In the event that there are portions or parts of sample(s) remaining after Nytest has completed the required tests, Nytest shall have the option of returning such sample(s) to the client at the client's expense.

WE CERTIFY THAT THIS REPORT IS A
TRUE REPORT OF RESULTS OBTAINED
FROM OUR TESTS OF THIS MATERIAL.

RESPECTFULLY SUBMITTED,
NYTEST ENVIRONMENTAL INC.

Remo Gigante

... REMO GIGANTE
EXECUTIVE V.P.

Table of Contents

LOG IN NO.: 5324

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I. Sample Analysis Request Form	NA
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IX. Quality Assurance Summary (Including Initial and Continuing Calibration Time and Date)	17 - 23

CHAIN OF CUSTODY RECORD

Page 1 of 1

REPORT TO: Client Name Mr. [illegible]
Address [illegible]
Phone [illegible]
Attn. [illegible]

Project No. 10187-92		Project Name LAMPV LACS		Date Shipped 7/6/75	Carrier UPS
Sampler: (Signature) <i>[Signature]</i>		Analytical Protocol		Air Bill No. N280 547	Cooler No.
Sample I.D.	Date/Time Sampled	Sample Description	No. Of Containers	ANALYSIS REQUESTED	
SED - 1	7/6/75 16:45	Detection Pond Sediment	1	EPIES & BOD CONC MEASUREMENTS = 3711	
Retransmitted by (Signature)	Date / Time	Rec'd By (Signature)	Date / Time		
<i>[Signature]</i>	7/6/75 5:00 PM	<i>[Signature]</i>			
Print Name		Print Name			
Retransmitted by (Signature)	Date / Time	Rec'd by (Signature)	Date / Time		
<i>[Signature]</i>		<i>[Signature]</i>			
Print Name		Print Name			
Retransmitted by (Signature)	Date / Time	Received Laboratory by (Signature)	Date / Time		
<i>[Signature]</i>		<i>[Signature]</i>	7/17/75		
Print Name		Print Name			

Special Instructions/Comments

~~00001~~

nyfest environmental inc

Laboratory Chronicle

LOG IN NO.: 5324

Client Name: NORMANDEAU

Date Received: 7/17/90

Sample ID: SED-1

Organics Extraction:

1. Acids _____
2. Base/Neutrals _____
7/21/90
3. Pesticides/PCBs _____
4. Dioxin _____

Analysis:

1. Volatiles _____
2. Acids _____
3. Base/Neutrals _____
8/2/90, 8/3/90
4. Pesticides/PCBs _____
5. Dioxin _____

Section Supervisor
Review & Approval

DLG

Inorganics:

EXTRACTION: 7/21/90, 7/22/90, 8/7/90
ANALYSIS: 7/23/90, 8/13/90

1. Metals _____
2. Cyanides _____
3. Phenols _____

Other Analysis:

TOTAL PETROLEUM HYDROCARBONS: EXTRACTION: 7/17/90
ANALYSIS: 7/17/90

Section Supervisor
Review & Approval

DLG

Quality Control Supervisor
Review & Approval

DLG

00003

If fractions are re-extracted and re-analyzed include dates for both.

NON CONFORMANCE SUMMARY
(Case Narrative)

LOG IN NO.: 5324

Sample SED-1 (5324001) was analyzed as per required protocols, no problems were encountered.

00004

METHODOLOGY SUMMARY

AQUEOUS METHODOLOGIES:

	<u>REF 1</u>	<u>REF 2</u>	<u>REF 3</u>
BNA, Pesticides/PCB's Extraction		3510	
AA/ICP Sample Preparation	200.7		
Furnace Sample Preparation	200.0		
Mercury Sample Preparation	245.1		
Hexavalent Chromium Sample Preparation	218.5		
Clean-Up		3610/3640	

Organochlorine Pesticides and PCB's by Gas Chromatography			608
Herbicides by Gas Chromatography			362
Purgeable Organics by GC/MS			624
Base/Neutral, Acids by GC/MS			625
2,3,7,8-TCDD by GC/MS			613/625
BTEX			602

NON-AQUEOUS METHODOLOGIES:

BNA, Pesticides/PCB's Extraction	3550	
AA/ICP Sample Preparation	3050	
Furnace Sample Preparation	3020/3030/3050	
Mercury Sample Preparation	7471	
Clean-Up	3610/3640	

Gas Chromatography/Mass Spectrometry:

Purgeable Organics	8240
Base/Neutral and Acid Extractables	8270
Organophosphorous Pesticides	8140
Organochlorine Pesticides and PCB's by Gas Chromatography	8080
BTEX	8020

00005

METHODOLOGY SUMMARY

INDUCTIVELY COUPLED PLASMA (ICP):

REFERENCE 1

REFERENCE 2

Aluminum	200.7	6010
Antimony	200.7	6010
Barium	200.7	6010
Beryllium	200.7	6010
Cadmium	200.7	6010
Calcium	200.7	6010
Chromium	200.7	6010
Cobalt	200.7	6010
Copper	200.7	6010
Iron	200.7	6010
Lead	200.7	6010
Magnesium	200.7	6010
Manganese	200.7	6010
Molybdenum	200.7	6010
Nickel	200.7	6010
Potassium	200.7	6010
Silver	200.7	6010
Sodium	200.7	6010
Tin	200.7	6010
Titanium	200.7	6010
Vanadium	200.7	6010
Zinc	200.7	6010

FURNACE -AA:

Antimony	204.1	7041
Arsenic	206.2	7060
Lead	239.2	7421
Selenium	270.2	7740
Thallium	279.2	7841
Tin	282.2	
Vanadium	286.2	7911
Mercury	245.1	7470

00006

METHODOLOGY SUMMARY

ADDITIONAL INORGANIC PARAMETERS:

REFERENCE 1

REFERENCE 2

Bromide	320.1	
Color	110.2	
Conductance	120.1	
Conductance		9050
Odor	140.1	
pH	150.1	
pH		9040
TDS	160.2	
TSS	160.2	
TS	160.3	
Hardness	130.1	
Temperature	170.1	
Turbidity	180.1	
Acidity	305.1	
Alkalinity	310.1	
Ammonia	350.2/350.3	
Chloride	325.3	
Chloride		9252
Residual Chlorine	330.2	
COD	410.3/405.1	
Cyanide	335.3	
Oil and Grease	413.1/413.2	
Oil and Grease		9070
Fluoride	340.2	
TKN	351.2	
NO2/NO3	353.2	
D.O.	360.2	
Petroleum Hydrocarbons (Reference 4)	418.1	
Phenol	420.2	
Phosphorous	365.1	
Silica	370.1	
Sulfate	375.2/375.4	
Sulfide	376.1	
Surfactants	425.1	
TOC	415.1	

MISCELLANEOUS ANALYSIS:

Extraction Procedure Toxicity	1310
Ignitability	1010
Corrosivity	1110
Reactivity	Chapter 8.3
Toxicity Characteristic Leaching Procedure (TCLP)	(Ref. 5)

00007

METHODOLOGY SUMMARY

REFERENCES:

- (1) USEPA-600/4-79-020, Methods for Chemical Analysis of Water and Waste
- (2) USEPA SW 846, Test Methods for Evaluating Solid Waste, Third Edition
- (3) Federal Register 40 CFR Part 136, Vol. 49, No. 209 Test Parameters for the Analysis of Pollutants
- (4) as modified by NJDEP-BISE (for non-aqueous samples)
- (5) Federal Register Vol. 51, No. 216 Friday, 11/7/86, pp. 40643-40652

00008

nytest environmental_{inc.}

DATA REPORTING QUALIFIERS

- U Indicates compound was analyzed for but not detected. Report the minimum detection limit for the sample with the U (e.g. 10U) based on necessary concentration dilution actions. (This is not necessarily the instrument detection limit.) The footnote should read U-Compound was analyzed for but not detected. The number is the minimum attainable detected limit for the sample.
- J Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero (e.g.: If limit of detection is 10 ug/l and a concentration of 3 ug/l is calculated, report as 3J.)
- B This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
- T This flag identifies all targeted compounds that were found above the method detection limits.
- NA This flag indicates that the data is not applicable

Note: Data on soil samples expressed on a dry weight basis.

00009

nytest environmental inc.

LOG IN NO: 5324

Sample Identification and Results

Sample No: SED-1

Lab Sample ID No.: 5324001

Results	Max. Allowable Levels	Found
PCB's, PPM	-	<2.0
Petroleum Hydrocarbons, PPM (Dry Wt.)	-	741

E P Toxicity (PPM)

Arsenic	5.0	< .5
Barium	100.0	<10.0
Cadmium	1.0	< .1
Chromium	5.0	< .5
Lead	5.0	< .5
Mercury	0.2	< .02
Selenium	1.0	< .1
Silver	5.0	< .5
Endrin	0.02	< .01
Lindane	0.4	< .01
Methoxychlor	10.0	<1.0
Toxaphene	0.5	< .01
2,4-D	10.0	<1.0
2,4,5-TP (Silvex)	1.0	< .1

ND = None Detected

< = Less than

00010

1 E
NYTEST ENVIRONMENTAL INC.

INORGANICS ANALYSIS DATA SHEET

SAMPLE MATRIX: SOIL

SAMPLE ID: SED-1

LAB ID: 5324001

CHPD #	CAS Number	INORGANIC PARAMETERS	PPM (DRY BASIS)
1			
2	7440-36-0	Antimony	NA
3	7440-38-2	Arsenic	2.00 U.
4	7440-41-7	Beryllium	NA
5	7440-43-9	Cadmium	1.000 U.
6	7440-47-3	Chromium	5.00 U.
7	7550-50-8	Copper	5.000 U.
8	7439-92-1	Lead	5.40 T.
9	7439-97-6	Mercury	0.1000 U.
10	7440-02-0	Nickel	10.00 U.
11	7782-49-2	Selenium	NA
12	7440-22-4	Silver	NA
13	7440-28-0	Thallium	NA
14	7440-66-6	Zinc	12.20 T.
15			
16			
17			
18			
19			
20			

00011

Normandeau Chromatogram SED-1 N5324001

FileName : C:\2700\DATA\A077002.raw

Date : 05/07/90 05:42 PM

Page 1 of 1

Start Time : 0.00 min

End Time : 30.00 min

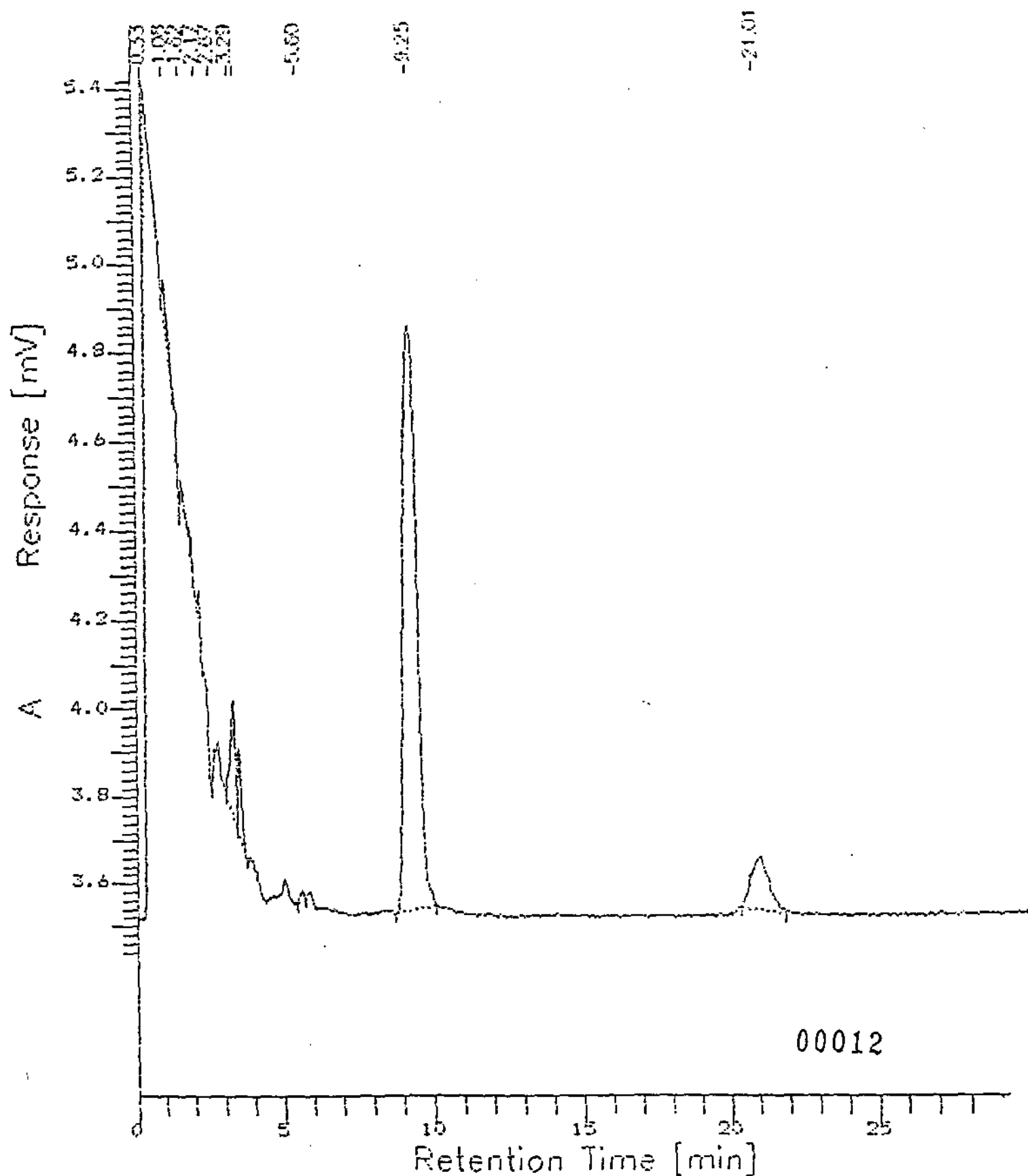
Low Point : 3.45 mV

High Point : 5.44 mV

Scale Factor: 1

Plot Offset: 3 mV

Plot Scale: 2 mV



=====

Sample Name	: SED-1	Time	: 08/03/90 05:42 PM
Sample Number	: N5324001	Study	: NORMANDEAU 7/17-21/
Operator	: jr		

Interface # : 0 Channel : A A/D mV Range : 1000
AutoSampler : None attached
Rack/Vial : 0/0

Data Acquisition Time: 08/02/90 05:57 PM
Delay Time : 0.00 min.
End Time : 30.00 min.
Sampling Rate : 1.0989 pts/sec

Raw Data File : C:\2700\DATA0\A07Y002.raw
Result File : C:\2700\DATA0\A07Y002A.rst
Instrument File: C:\2700\DATA\A1.ins
Process File : C:\2700\DATA\A1.prc
Sample File : C:\2700\DATA\A1.smp
Sequence File : C:\2700\DATA0\A07Y1.seq

Inj. Volume : 2 ul Area Reject : 100.00
Sample Amount : 1.0000

=====

PEST/PCB

=====

550A CHANNEL 1 (or chan. A): 3% OV 1 ISO 200°C. (PCB ONLY) 25/10ml

=====

Peak #	Ret Time [min]	Area [uV-sec]	Height [uV]	Area %	A/H Ratio [sec]	BL
1	0.33	4934	1256	9.59	3.93	BB
2	1.08	974	128	1.69	7.61	BB
3	1.62	370	70	0.64	5.32	BB
4	2.17	430	90	0.75	4.80	BB
5	2.67	195	29	0.34	6.78	BB
6	3.29	2928	263	5.09	11.15	BB
7	3.49	1839	202	3.20	9.09	BB
8	5.60	213	22	0.37	9.73	BB
9	9.25	40529	1323	70.52	30.63	BB
10	21.01	5061	125	8.81	40.64	BB
		57472	3506	100.00		

00013

3476.90

1.44

Eptox Res

6.58

7.53

S.F 300

22.57

23.60 DBC

TEMP:ISO 200 C
1.5%SP2250/1.95%SP2401
6FT:4MM ID ECD
TRACOR 222 A 2
METH'S 608 /509B /8080 /8150

D-2000

08/06/90 10:29

SAMPLE: QQQQ/PCB/HRE TAG: 469 CH: 2

FILE: 1 CALC-METHOD: AREA% TABLE: 0 CONC: AREA

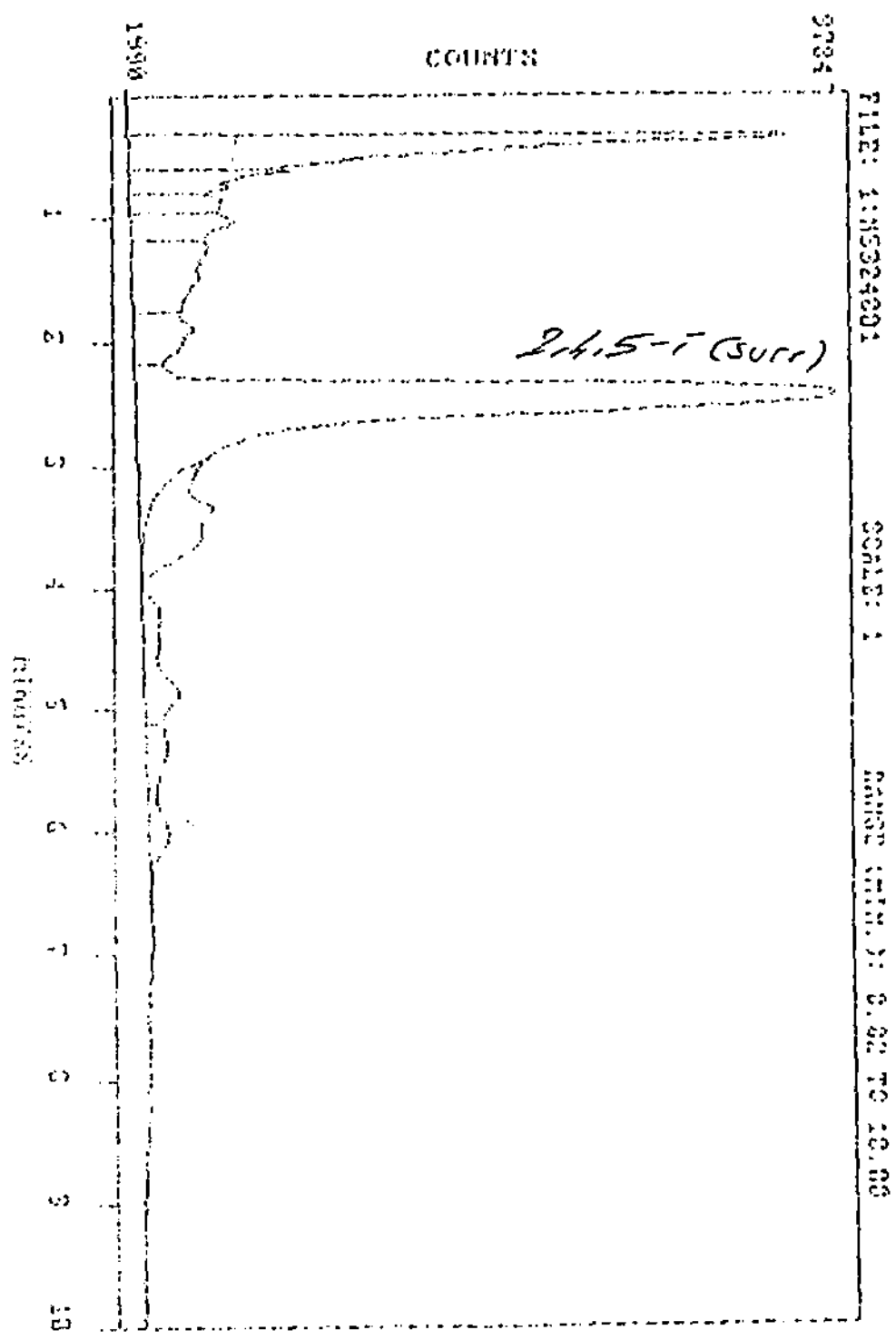
NO.	RT	AREA	HEIGHT	FRT	BC	NAME
2	0.38	4002	1146	0.38	BU	
5	0.90	364	119	0.90	BB	
7	6.58	27136	360	6.58	BB	
8	7.53	30293	266	7.53	BB	
9	22.57	9923	415	22.57	BB	
10	23.60	41234	411	23.60	BB	
TOTAL						

00014

price in

ARMAND OF AD 5324001

RECONSTRUCT SCREEN SCHEM
DATA ACQUISITION
TIME 14 13:17 DATE 01 03 AUG 78
TIME 14 07:07 DATE 01 03 AUG 78
METHOD USED
5ED1
2m / 3m



00015

Channel N.....4

Time: 14-17.33

Date: 03 AUG 90

END

Sample Name.....HORMAIDEN 7/17-7/21/90

File.....TETOS.H325001

Method Name.....HERES

Author.....JCR

Instrument.....TRACOR 211

Column.....1.50 SP250 3.1.25% SP2101

Notes.....REPTON HERES AT PEST CONTROL CO. CO.

QVE CONCLUSION

Run time.....10.00 min

Delay time.....0.00 min

Acq. time.....14.07 17

Acq. date.....FRI 03 AUG 90

Start PM.....10.00 sec

End PM.....00.00 sec

Actual PM.....00.00

Slope sens.....5.00 uv/sec

Area reject.....100

peaks found.....13

AREA PERCENT REPORT

Peak	R.T. (min)	R/S	Peak Name	Area %	Area	Peak Ht.	EC
1	0.362			13.111	60241	7257	2V
2	0.628			4.422	15362	1796	4V
3	0.824			2.574	6931	1062	4V
4	1.039			3.686	12810	1139	4V
5	1.229			7.163	24927	369	4V
6	1.891			3.639	12784	684	4V
7	2.440			23.717	151395	1703	4E
8	3.247			7.188	24914	113	2V
9	4.862			5.069	14100	292	4V
10	5.323			1.934	6752	223	4V
11	6.031			1.477	5119	226	4E
12	6.915			0.060	238	23	4E
TOTAL				100.000	74613		

00016

WETLANDS RESTORATION PROPOSAL
LACEY LAKES DETENTION POND CLEANING
BLOCK 1358, LOT 661
LACEY TOWNSHIP, OCEAN COUNTY

Submitted to:

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF COASTAL RESOURCES
INLAND ENFORCEMENT SECTION
CN 401
Trenton, NJ 08625-0401

Prepared for:

LACEY TOWNSHIP

Prepared by:

NORMANDEAU ASSOCIATES, INC.
1415 Hooper Avenue
Toms River, N.J. 08753

NAI-NJ Project No. 10181.01

21' 000000 500000 1000000
001' 000000 1000000 2000000

AREA PERCENT REPORT			
Area	Area %	Area	Area %
1	0.362	13.111	66.241
2	0.628	4.402	15.002
3	0.854	4.402	15.002
4	1.039	2.634	8.931
5	1.229	2.167	7.467
6	1.691	2.639	8.931
7	2.440	4.402	15.002
8	2.947	7.188	24.914
9	4.662	4.402	15.002
10	5.332	1.804	6.252
11	6.031	1.447	5.139
12	6.915	2.85	10.000
TOTALS			

nytest environmental inc.

LOG IN NO: 5324

Sample Identification and Results

Sample No: METHOD BLANK
Lab Sample ID No.: BLANK

Results	Max. Allowable Levels	Found
PCB's, PPM	-	<2.0
Petroleum Hydrocarbons, PPM (Dry Wt.)	-	<10.0

E P Toxicity (PPM)

Arsenic	5.0	< .5
Barium	100.0	<10.0
Cadmium	1.0	< .1
Chromium	5.0	< .5
Lead	5.0	< .5
Mercury	0.2	< .02
Selenium	1.0	< .1
Silver	5.0	< .5
Endrin	0.02	< .01
Lindane	0.4	< .01
Methoxychlor	10.0	<1.0
Toxaphene	0.5	< .01
2,4-D	10.0	<1.0
2,4,5-TP (Silvex)	1.0	< .1

ND = None Detected

< = Less than

00017

I E
NYTEST ENVIRONMENTAL INC.

(INORGANICS ANALYSIS DATA SHEET)

SAMPLE MATRIX: SOIL

SAMPLE ID: METHOD BLANK

LAB ID: BLANK

Q#	CAS Number	INORGANIC PARAMETERS	PPM (DRY BASIS)
1			
2	7440-36-0	Antimony	NA
3	7440-38-2	Arsenic	2.00 U.
4	7440-41-7	Beryllium	NA
5	7440-43-9	Cadmium	1.000 U.
6	7440-47-3	Chromium	5.00 U.
7	7550-50-8	Copper	5.000 U.
8	7439-92-1	Lead	5.00 U.
9	7439-97-6	Mercury	0.1000 U.
10	7440-02-0	Nickel	10.00 U.
11	7782-49-2	Selenium	NA
12	7440-22-4	Silver	NA
13	7440-28-0	Thallium	NA
14	7440-66-6	Zinc	5.00 U.
15			
16			
17			
18			
19			
20			

00018

20
NYTEST ENVIRONMENTAL INC.
PESTICIDE SURROGATE RECOVERY

LOG IN #: 5324

MATRIX: SOIL

||<<<PESTICIDE>>>||

SAMPLE #	DBC	PEST
		OUT
01	SED-1	22 OK 0
02	PBLK1	30 OK 0
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

LIMITS
DBC 5 - 325

* SURROGATES OUTSIDE QC LIMITS

00019

30
MYTEST ENVIRONMENTAL INC.

PESTICIDE MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

LOGIN #: 5324 MATRIX: SOIL PAGE: 1

FRACTION	COMPOUND	CONC. SPIKE ADDED (ug)	SAMPLE RESULT	CONC. MS	% RECOVERY	CONC. MSD	% RECOVERY	RPD	QC LIMITS	
									RPD	RECOVERY
SAMPLE #	LINDANE	29.6	0.00	28.20	95.27 OK	20.70	69.93 OK	30.67 *	23	10 ~230
	HEPTACHLOR	29.6	0.00	27.00	91.22 OK	23.70	80.07 OK	13.02 OK	27	10 ~245
	ALDRIN	29.6	0.00	28.20	95.27 OK	25.00	84.46 OK	12.03 OK	25	10 ~265
MYTEST #	DIELDRIN	74.1	0.00	72.80	98.25 OK	75.60	102.02 OK	3.77 OK	28	10 ~195
14297001	ENDRIN	74.1	0.00	73.70	99.46 OK	66.50	89.74 OK	10.27 OK	23	10 ~185
	4,4- DDT	74.1	0.00	63.40	85.56 OK	42.50	57.35 OK	39.47 *	21	10 ~300

OF % MS/MSD .0 OF 12
PEST OUT: —

OF RPD 2 OF 6
PEST OUT: —

00022

30
MYTEST ENVIRONMENTAL INC.

PESTICIDE MATRIX SPIKE/MATRIX SPIKE DUPLICATE RECOVERY

LOGIN #: 5324 MATRIX: WATER (EPTOX) PAGE: 1

FRACTION	COMPOUND	CONC. SPIKE ADDED (ug)	SAMPLE RESULT	CONC. MS	% RECOVERY	CONC. MSD	% RECOVERY	RPD	QC LIMITS	
									RPD	RECOVERY
SAMPLE #	LINDANE	4	0.00	4.85	121.25 OK	5.98	149.50 OK	20.87 OK	23	10 - 230
	HEPTACHLOR	4	0.00	2.85	71.25 OK	4.47	111.75 OK	44.26 *	27	10 - 245
MMH-058	ALDRIN	4	0.00	2.95	73.75 OK	3.65	91.25 OK	21.21 OK	25	10 - 265
MYTEST #	DIELDRIN	10	0.00	6.12	61.20 OK	7.03	70.30 OK	13.84 OK	28	10 - 195
5153001	ENDRIN	10	0.00	11.95	119.50 OK	15.15	151.50 OK	23.62 *	23	10 - 185
	4,4- DDT	10	0.00	5.57	55.70 OK	7.61	76.10 OK	30.96 *	21	10 - 300

OF % MS/MSD 0 OF 12

PEST CUT: —

OF RPD 3 OF 5

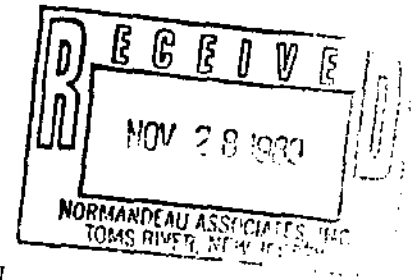
PEST CUT: —

00023

Let's protect our earth



State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF WATER RESOURCES
CN 029
Trenton, N.J. 08625-0029



Eric J. Evenson
Acting Director

(609) 292-1637
Fax # (609) 984-7938

Mr. R. Bradley Tombs
Normandeau Associates
1415 Hooper Avenue
Toms River, New Jersey 08753-2887

NOV 27 1989

Re: Maintenance Dredging of a Retention Basin in Lacey Township,
Ocean County.

Dear Mr. Tombs:

I am writing in response to your letter dated November 13, 1989 regarding the above referenced dredging project. We understand that the planned operation will involve pumping water from a residential retention basin to Deerhead Lake (already the receptor of basin overflow) to allow dredging of basin sediments. Since no treatment is involved, no contaminants will be added, and the operation will simply expedite a natural drainage process, a New Jersey Pollutant Discharge Elimination System/ Discharge to Surface Water (NJPDES/DSW) permit will not be required. However, I recommend that you contact the Bureau of Groundwater Discharge Control at (609) 292-0424 to see if a permit is required for disposal of the dredge spoils.

If you have any further questions, please contact Robert Draper at (609) 292-4860.

Sincerely,

William F. Boehle

William F. Boehle, P.E.
Chief, Surface Water Section
Bureau of Industrial Discharge Permits

WFM333:rd

c: Dan Zeppenfeld, Bureau of Municipal Discharge Permits
Steve Johnson, Bureau of Groundwater Discharge Control

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753-2887
(201) 240-5795
(201) 240-4922 (Fax)

NORMANDEAU ASSOCIATES

December 18, 1990

Mr. Richard Lane
Ocean County Engineering Dept.
CN 2191
Toms River, NJ 08754

NAI-NJ Project No. 10181.01
Lacey Lakes

Dear Mr. Lane:

I am pleased that Ocean County will be assisting Lacey Township with the removal of accumulated sediment from the settling pond at Ravine and Lakeside Drive pursuant to Mr. Phil Luccarelli's request. Enclosed are the plans and associated permits for this work.

Please let me know if you would like to schedule a pre-work meeting to brief you on the objectives and details of this plan. Lastly, the issue of spoil disposal needs to be resolved.

Sincerely,

NORMANDEAU ASSOCIATES, INC.

R. Bradley Tombs
Branch Manager

RBT/db
cc: P. Luccarelli
L. Roeber

Bedford, NH
Hampton, NH
Williston, VT
Yarmouth, ME

Middleboro, MA
Northampton, MA
Bloomfield, CT
Peekskill, NY

Toms River, NJ
Aiken, SC
Greenville, SC
LeClaire, IA

the fill, and the final destination of the removed fill.

4. A Description of the Existing and Proposed Vegetation of the Restoration Site Including Scientific Names

Existing and Proposed Vegetation

COMMON NAME:

SCIENTIFIC NAME:

Black rush
Switch grass

Juncus gerardii
Panicum virgatum

As stated previously, it is anticipated that the disturbed area will be naturally recolonized. If during the monitoring phase, recolonization is found to be ineffective, additional methods of revegetation shall be implemented.

5. A Description of the Existing and Proposed Hydrology of the Site Including the Elevation of Surface Water and the Depth to Seasonal High Water Table

The restoration plan proposes to remove the deposited stone for access to pre-existing grade, thereby not affecting the hydrology on or adjacent to the site. Surface water elevation in the detention pond is 24 feet above MSL.

The depth to seasonal high water table in the area is approximately 0-3 feet below grade. The restoration plan will not disturb below pre-existing grade.

6. Existing Soil Types and Proposed Soil Characteristics

The Ocean County Soil Survey maps Lakehurst sand as underlaying the site.

7. A Schedule from Initiation to Completion of the Project

The removal of the material within the wetland area will commence within fourteen (14) calendar days after completion of the project. The removal of fill will be completed within two weeks of commencement of the proposed restoration notwithstanding weather delays.

8. A Metes and Bounds Description for the Proposed Mitigation Site

The metes and bounds of the project site are shown on the accompanying site plan.

9. Copies of a Site Plan for the Restoration Project

A copy of the site plan has been included with the proposed restoration plan. These plans include project location lot and block number, name and address of the property owner, and existing elevations prior to placement of the fill material.

INTRODUCTION

In accordance with the wetland permit condition for maintenance dredging of an existing retention basin for Permit #1512-90-0006.1, this document is submitted in compliance with these NJDEP wetland guidelines.

RESTORATION PLAN

The NJAC 7:7A-14.2 distinguishes between four types of mitigation; restoration, creation, enhancement, and contribution. Based on this section, mitigation at the site would be considered restoration as:

"Restoration refers to actions performed on the site of a regulated activity, within six months of the regulated activity, in order to reverse or remedy the effects of the activity on the wetland, and to restore the site to pre-activity condition."

Section 7:7A-14.2(a) states:

"Restoration will be required at a ratio of one acre restored to one acre lost or disturbed."

The following details the proposed restoration plan. Information provided has been based on the requirements stated in NJAC 7:7A-14.4 and additional information requested in the Order.

1. Description of the Size and Type of the Restoration Project

The project consists of approximately 1.0 acre located on Block 1358, Lot 66 in Lacey Township, Ocean County. The area of wetland restoration includes approximately 100 square yards of wetlands that will be temporarily disturbed and revegetated in accordance with the Soil Erosion and Sediment Control Plan and approval.

The proposed restoration plan will involve removal of the stone within wetlands and placement on the upland portion of the site. It is anticipated that the disturbed area will be naturally revegetated due to the resident hydrology, adjacent hydrophytic vegetation and the resident seed source remaining in the soil. An experienced wetland scientist will monitor the site according to the procedures documented in the monitoring and maintenance plan.

2. Current owner of the Project Site

The current owner of the project site is Lacey Township.

3. Monitoring and Maintenance Plan

Within sixty (60) calendar days after the commencement of the restoration work, respondents will submit a report on the progress of the restoration and revegetation of the site. The report shall include the volume of the fill removed, the dates the fill was removed, the name of the contractor who removed

Normandeau Associates, Inc.
1415 Hooper Avenue
Toms River, NJ 08753-2887
(201) 240-5795
(201) 240-4922 (Fax)

NORMANDEAU ASSOCIATES

RECEIVED BY: _____ DATE: _____

September 12, 1990

Mr. David B. Friedman
District Director
CN 2191
Toms River, NJ 08754-2191

NAI-NJ Project No. 10181.00
Lacey Lakes
Intersection of Ravine & Lakeside Drive

Dear Mr. Friedman:

Enclosed please find an application for Soil Erosion and Sediment control certification for the above referenced project including:

1. Completed application form
2. Application fee (NAI check #1285 for \$600.00)
3. Four copies of the plan showing soil erosion protection methods inclusive of the proposed activity.

The dredge spoil material will be brought to an approved landfill site, most likely the Parker Associates facility in Lacey Township. It is my understanding that all approved landfill sites receive soil erosion approval prior to operation, closure, etc.

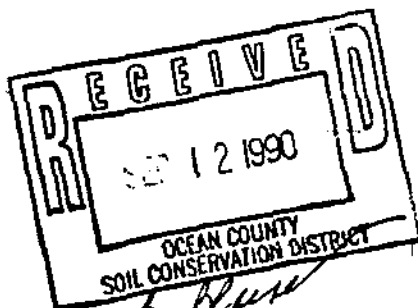
Unfortunately, we have little control of dictating the amount of area the landfill facility will use to accommodate to spoil. However, I am confident that it would be placed in an area where other material is being placed on a daily basis. Consequently, it is my understanding that soil erosion approval was previously granted.

Thank you for your attention to this application.

Very truly yours,

NORMANDEAU ASSOCIATES, INC.

Brad
R. Bradley Tombs
Branch Manager



RBT/db

Bedford, NH
Hampton, NH
Williston, VT

Yarmouth, ME
Peekskill, NY
Toms River, NJ

Aiken, SC
Greenville, SC
LeClaire, IA

OCEAN COUNTY
SOIL CONSERVATION DISTRICT
6 Mott Place
CN 2191
Toms River, New Jersey 08754-2191
201-244-7048



Application Number
Disposition

APPLICATION FOR SOIL EROSION AND SEDIMENT CONTROL PLAN CERTIFICATION

The enclosed soil erosion and sediment control plan and supporting information are submitted for certification pursuant to the Soil Erosion and Sediment Control Act, Chapter 251, P.L. 1975 as amended (NJSA 4:24-39 et seq.). An application for certification of a soil erosion and sediment control plan shall include the items listed on the reverse side of this form.

Name of Project Detention Pond Dredging		Project Location: Municipality Lacey Township	
Project Street Address Ravine and Lakeside Dr.		Block 1358	Lot 21
Project Owner(s) Name Mayor Madensky Township of Lacey		Phone (609) 693-7489	
Project Owner(s) Address 818 West Lacey Rd		City Forked River	State NJ
Total Area of Project 0.5 acres		Total Area of Land to be Disturbed 12,000 ft²	No. Dwelling or other Units none
Plans Prepared by Normandeau Associates/TWM Inc.		Fee \$600.00	
Address 1415 Hooper Ave, Toms River		State NJ	Zip 08753
		Phone (201) 240-5795	

*(Engineering related items of the Soil Erosion and Sediment Control Plan MUST be prepared by or under the direction of and be sealed by a Professional Engineer or Architect licensed in the State of New Jersey, in accordance with NJAC 13:27-6.1 et. seq.)

Agent Responsible During Construction Benjamin Steltzer		Job Supervisor Benjamin Steltzer or designee	
Address Lacey Township Public Works Dept. 818 West Lacey Rd		Address Lacey Township Public Works Dept. 818 West Lacey Rd.	
State NJ	Zip 08731	State NJ	Zip 08731
Phone (609) 693-1100	Phone (609) 693-1100	Phone (609) 693-1100	Phone (609) 693-1100

The applicant hereby certifies that all soil erosion and sediment control measures are designed in accordance with current Standards for Soil Erosion and Sediment Control in New Jersey and will be installed in accordance with those Standards and the plan as approved by the Soil Conservation District and agrees as follows:

1. To notify the District in writing at least 48 hours in advance of any land disturbance activity. Failure to provide such notification may result in additional inspection fees.
2. To notify the District upon completion of the Project. (Note: No certificate of occupancy can be granted until a report of compliance is issued by the District.
3. To maintain a copy of the certified plan on the project site during construction.
4. To allow District agents to go upon project lands for inspection.
5. That any conveyance of this project or portion thereof prior to its completion will transfer full responsibility for compliance with the certified plan to any subsequent owners.
6. To comply with all terms and conditions of this application and certified plan including payment of all fees prescribed by the district fee schedule hereby incorporated by reference.

The applicant hereby acknowledges that structural measures contained in the Soil Erosion and Sediment Control Plan are reviewed for adequacy to reduce offsite soil erosion and sedimentation and not for adequacy of structural design. The applicant shall retain full responsibility for any damages which may result from any construction activity notwithstanding district certification of the subject soil erosion and sediment control plan. It is understood that approval of the plan submitted with this application shall be valid only for the duration of the initial project approval granted by the municipality. All municipal renewals of this project will require resubmission and approval by the district. In no case shall this approval extend beyond three and one half years at which time resubmission and certification by the district will be required.

1. Applicant Certification <i>Debra L. Madensky</i> 8/6/90 Signature Date <i>Debra L. Madensky</i> Applicant Name (Print)		3. Plan determined complete: Signature of District Official _____ Date _____	
2. Receipt of fee, plan and supporting documents is hereby acknowledged: Signature of District Official _____ Date _____		4. Plan certified, denied or other action as noted above. Special Remarks: Signature of District Official _____ Date _____	

Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03102-5999
(603) 472-5191
(603) 472-7052 (Fax)

NORMANDEAU ASSOCIATES

M 01285

AUGUST 29 19 90

5-39
110

PAY TO THE ORDER OF O.C. Soil Conservation District

\$ 600.00

SIX HUNDRED AND 00/100**

DOLLARS

BANK OF BOSTON
THE FIRST NATIONAL BANK OF BOSTON

TWO SIGNATURES REQUIRED IF OVER \$5000.00

[Signature]

⑈001285⑈ ⑆011000390⑆501⑈17080⑈

Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03102-5999

M

ITEM DESCRIPTION	AMOUNT	PROJECT	ACCOUNT
Application fee SEE P.O. 836375	600.00	10181.00	409.00