Pleasant Lake
Deerfield/Northwood

Lake and Watershed Diagnostic Study

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Final Report
September 2002

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Pleasant Lake and Watershed Diagnostic Study

Final Report
September 2002

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ABSTRACT

The Pleasant Lake Diagnostic Study presents twelve months of limnological data and discusses watershed water quality trends over time. The diagnostic data can be used to determine where problem areas occur in the watershed.

The Pleasant Lake Diagnostic Study accomplished each of the following objectives defined in the work plan. The following tasks were completed during the study and research phases of this project:

1. Identified the historical and existing water quality of Pleasant Lake;

2. Identified the water quality of Pleasant Lake's inflowing tributaries and outlet;

3. Developed estimated hydrological and phosphorus budgets for Pleasant Lake;

4. Documented sources of phosphorus to the lake;

5. Compared trophic models that classified Pleasant Lake;

6. Reviewed many potential non-point sources of phosphorus to the lake;

7. Recommended non-point source Best Management Practices that will help protect the lake for future generations;

8. Recommended management strategies to minimize nutrient additions to the lake, and how to protect the lake in the future.

The results and recommendations of the Pleasant Lake Diagnostic Study provide a basis for lake protection through watershed management. Watershed management activities should be the immediate goals of the lake association, towns, and watershed residents.

Although this project was successful in accomplishing its goals, only upon the implementation of a watershed management program, which includes phosphorus reduction, will this project be considered a complete success.

ACKNOWLEDGEMENTS

Special thanks to the Pleasant Lake volunteers for their help in data gathering, and in lake and tributary water sampling. This group of hard working volunteers did all the work that they were asked to perform. From hot, muggy mosquito laden brooks in summer to icy, frigid water sampling and stream flow reading in winter. These individuals did not utter a complaint, and performed these tasks with enthusiasm and professionalism. This total two year process could not have been successful without them. Thank you all.

Pleasant Lake Volunteers Included:

Jackie Blanchard, Beth and Milton Bourassa, B.J. and Wendy Branch, Tom Brown, Mike Bugnacki, Bill Bushnell, Bob Cavanaugh, Stan Clark, Dave Coffman, Bob Durfee, Joe Farrelly, Dick and Elaine Fregosi, Charlie and Janet Henry, Pat Hume, Glenn Martin, Andy Partridge, Dick and Mary Ellen Pitman, Tony Spinazzola, Andy Turner, and Pete Wilson.

GLOSSARY OF TERMS

ALGAL BLOOM: A dense concentration of algae due to an increase of nutrients to the water body, such as phosphorus.

ANOXIC: Lack of oxygen (also, anaerobic).

AQUATIC PLANT GROWTH: The growth of plants living in a water system.

CHLOROPHYLL-a ANALYSIS: Measurement of the chlorophyll-a, which occurs in aquatic plants and algae.

COLOR: A visual measure of the water color. Decaying organic matter and metals contribute to water color.

CULTURAL EUTROPHICATION: The addition of nutrients to a water body due to human activity, including fertilizing, dumping of yard wastes, failing septic systems, and increasing impervious surfaces and runoff.

CYANOBACTERIA: The blue-green algae.

DECOMPOSITION: The breakdown of an organic substance.

DECOMPOSING BACTERIA: Bacteria which break down organic matter.

DIAGNOSTIC STUDY: An intensive and comprehensive study of a lake and its watershed.

DIMICTIC: Lakes that circulate freely twice a year in the spring and in the fall. They are directly stratified in the summer and inversely stratified in the winter.

DISSOLVED OXYGEN: The oxygen that is in solution, i.e., dissolved in the water.

EPILIMNION: The upper, well-circulated, warm layer of a thermally stratified lake.

EUTROPHIC: Nutrient rich waters, generally characterized by high levels of biological production.

EUTROPHICATION: The addition of nutrients to a water body due to the natural aging of the water body or to human activity.

HYDROLOGIC BUDGET: A compilation of the total water inputs and outputs to and from a lake.

HYPOLIMNION: The deep, cold, relatively undisturbed bottom waters of a thermally stratified lake.

IPWS: Interstitial Pore Water Sampler. This device is used to collect the water held in the pore spaces of soil.

LIMNOLOGIST: A scientist who studies freshwater ecology.

MESOTROPHIC: Waters containing an intermediate level of nutrients and biological production.

METALIMNION: The middle layer of water in a thermally stratified lake, between the epilimnion and hypolimnion, where the decrease in temperature with depth is at its greatest.

NITROGEN: A necessary nutrient for life, fixed by some bacteria and plants.

OLIGOTROPHIC: Nutrient poor waters, generally characterized by low biological production.

ORGANIC MATERIAL: Matter making up dead or living organisms.

PHOTIC ZONE: The depth of lake water that receives sufficient sunlight to permit photosynthesis.

PHYTOPLANKTON: Microscopic plant life that float within or on top of lake water.

PLANKTON: General term for plant and animal life that float within or on top of a water body (see also phytoplankton and zooplankton).

RESPIRATION: The exchange of gases, such as carbon dioxide, between a living organism and its environment.

STRATIFICATION: The layering of water due to temperature differences (see also epilimnion, hypolimnion, and metalimnion).

TRANSPARENCY: The clarity of the water, commonly measured with a Secchi disk.

TROPHIC STATUS: The degree of lake aging or nutrient status of a lake (see oligotrophic, mesotrophic, and eutrophic).

WATERSHED: The total area draining into a lake, including the area of the lake itself. Also called drainage basin.

ZOOPLANKTON: Microscopic animal life that floats within or on top of a water body.

EXECUTIVE SUMMARY

1. Introduction

The Pleasant Lake Diagnostic Study began in August of 1998, at the request of the Pleasant Lake Association. The project was scheduled to end December 1999, but due to a dry summer of 1999, the project was extended until August 2000 to allow for the collection of data for a consecutive twelve months during active flow conditions. The lake's watershed is located in the towns of Deerfield and Northwood.

The goals of the diagnostic study were to identify and monitor the sources of water and nutrients (phosphorus) to Pleasant Lake, to identify the degree of phosphorus loading, and make recommendations about lake and watershed management activities to improve lake water quality.

Prior to making recommendations for protective and restorative measures, a fuller understanding of such processes as lake flushing, watershed land use, and nutrient sources had to be achieved. To this end, biologists began an intensive study to document the physical, chemical and biological processes of Pleasant Lake.

2. Hydrologic Budget

The hydrologic budget for the gauging period (September 1, 1999 through August 31, 2000) provided estimates of all significant sources of flow into Pleasant Lake by gauging the inlets and outlet, estimating direct surface runoff, and measuring precipitation and evaporation. Tributaries provided the greatest input to the lake (56 percent). Precipitation contributed 23 percent of the total inputs. Finally, direct surface runoff from the lake area plus a 1000-foot buffer around the lake provided an estimated 21 percent of the water contributed to the lake. Overall, most water enters the lake from streams that travel through the entire watershed of the lake.

Discharge over the dam represented an estimated 94 percent of the outflow budget for the sample year. Evaporation accounted for 6 percent of the outflow. These estimates are typical for lakes that have large outflow structure.

3. Phosphorus Budget

Phosphorus loading, the primary factor limiting algae growth, was determined through water quality sampling and analysis of many of the sources quantified in the hydrologic budget. One of the most important goals of this study was to quantify phosphorus inputs to Pleasant Lake.

Study year mean phosphorus concentrations for the inlets to Pleasant Lake ranged from a low of 6 ⊙g/L in Wilson Brook, to a high of 42 ⊙g/L in Loon Cove Inlet. Both Loon Cove Inlet and Veasey Brook had phosphorus concentrations that were higher than desirable, though the range of phosphorus concentrations fluctuated often during the study period. The mean phosphorus concentration at the outlet stream was 7 ⊙g/L.

The greatest contributor of phosphorus to Pleasant Lake was estimated to be precipitation (47 percent). Direct surface water runoff provided 31 percent of the phosphorus to the lake, and tributaries contributed the remaining 22 percent of the nutrients during the budget year. Just over half of the budget can be influenced by land-based activities.

In-lake phosphorus concentrations at Pleasant Lake ranged from an average of 4 ⊙g/L in the upper layer (0.1-7 m) during the summer of 1999 to a mean of 9 ⊙g/L in the lower layer (>12m), also in the summer of 1999. The mean phosphorus concentration in the middle layer (8-11m) was 6 ⊙g/L in 1999 and 8 ⊙g/L in 2000. Total phosphorus concentrations in all layers fall within the "low" classification, which is the most desirable.

Three different classification methods were utilized, and their results are compared for this study. One method classified the lake as oligotrophic, which is at the least aged end of the trophic spectrum, however the lake is very close to the mesotrophic classification. The other two models also classified Pleasant Lake as oligotrophic.

4. In-Lake and Tributary Data

Pleasant Lake is a typical northeastern temperate lake exhibiting temperature-based stratification into three layers during the summer months. Pleasant Lake shows declining oxygen concentrations below 10 - 12 meters, where late summer oxygen concentrations had reached 0 mg/L. Fish species can become impacted when oxygen concentrations drop below 4

mg/L. This low oxygen forces fish out of the cooler deeper waters and into the warmer shallower waters during the summer months, potentially impacting the health of the fish. Over time, many lakes will experience anoxic waters deeper in the lake, but in a lake like Pleasant, it is an indicator that nutrient and organic loading may be taking place faster than we would like to see.

Mean summer pH values for the lake ranged from a high of 6.41 units in the epilimnion to a low of 5.83 units in the hypolimnion. The waters of Pleasant Lake would fall within the 'endangered' category, meaning the lake is on the acidic side. The acid neutralizing capacity (ANC) of the lake was low at 1.48 mg/L (during 2000) as $CaCO_3$, which places the lake in the 'extremely vulnerable' category for acid inputs.

Mean summer conductivity values in Pleasant Lake ranged from a low of 66.07 umhos/cm in the metalimnion, to a high of 72.11 umhos/cm in the hypolimnion. These are slightly higher than the average conductivity value of 56.8 umhos/cm for New Hampshire water bodies.

The turbidity values in the lake were low, with a summer mean of .26 - .31 NTU in the epilimnion and .92 – 1.35 NTU in the hypolimnion

Algal populations during the summer months were comprised of a mix of golden brown algae and diatoms, dinoflagellate algae, and a low number of cyanobacteria. Filamentous green algae became common around the lake later in the summer months, forming bright green and "cloudy" algae growths. The 1999 and 2000 in-lake monthly mean summer chlorophyll-a concentrations in Pleasant Lake were 2.13 mg/m^3 and 2.77 mg/m^3, respectively. Both these values fall within the "good" range for algal abundance. Overall algal abundance has not increased markedly since regular sampling began in 1989. Also, NHDES has no records of any algal blooms in Pleasant Lake.

The mean monthly summer clarity was 6.88 meters in 1999 and 6.63 meters in 2000. Pleasant Lake clarity is higher than the mean clarity of most lakes and ponds in New Hampshire, and has been increasing slowly but steadily since Pleasant Lake joined VLAP in 1989.

Plant growth in Pleasant Lake is sparse to scattered, consisting of yellow water lilies, a few species of pondweed, and various rushes and sedges. Pleasant Lake has currently not been

impacted by exotic nuisance species such as milfoil or fanwort, but it is recommended that the Weed Watcher Program be continued, as nearby lakes and ponds do have milfoil.

Tributary Data

Mean summer pH values in the tributaries ranged from a low of 4.34 units in Atherton Brook to a high of 5.98 in the outlet. These pH values are below the state mean and within the "endangered" range for New Hampshire surface waters.

Conductivity values varied between tributaries, with the highest mean values in Farelly Brook and Veasey Brook, which both cross under Route 107 and are subjected to road runoff and erosion from development.

Tributary turbidities were higher than those in the lake, as is to be expected. The summer mean low turbidity value was in Wilson Brook (0.62 NTU), and the mean high turbidity was 2.72 NTU in Veasey Brook. Farelly Brook also had a relatively high mean turbidity of 1.68 NTU. Overall, there does not appear to be an excessive amount of sediment entering the lake.

5. Lake and Watershed Recommendations

To create a more intensive and comprehensive protection and preservation strategy for water resources in Northwood/Deerfield, specifically within the Pleasant Lake watershed, the following watershed management strategies are recommended:

Stormwater Management and Erosion Control

The Pleasant Lake Association and the Towns of Deerfield and Northwood Departments of Public Works should focus on stabilizing runoff ditches, culverts, and basins within the watershed. Specifically, Route 107 margins and shoulders, Basin Road, the areas surrounding Loon Cove Brook stream crossing, and dirt camp roads are all areas in which Best Management Practices should be developed and implemented to minimize erosion.

Stormwater management improvements could also be implemented to reduce sediment and nutrient inputs into the lake. Street sweeping and catchment basin flushing or suctioning on tar roads would help remove pollutants before they reach the lake. Riprapping drainage ditches and vegetating settling basins along dirt roads would lessen sediment transport.

Beaches

To prevent runoff and subsequent erosion from beaches, all sandy areas should be stabilized by 'perching' beaches with a low rock wall at the toe of the slope, and installing a drainage ditch along the upper margin of the beach to divert runoff around the sand, rather than across the sand. These activities, and any shoreline activities, require a permit from the NHDES Wetland Bureau.

It is also recommended that the Pleasant Lake Association and the Town of Deerfield monitor Veasey Beach during heavy rain and snowmelt to ensure that newly installed erosion control measures have been effective.

Septic System Management

All of the homes around Pleasant Lake are on subsurface systems or holding tanks, and these systems can be phosphorus contributors to the lake. It is therefore recommended that shorefront residents pump their systems every 1-3 years.

Shoreland Protection

The protected shoreland is the area of land between the reference line (high water mark of the waterbody), to a point 250 feet upslope. To minimize erosion and the input of nutrients, a well-vegetated buffer should be established and maintained. There is a list of native plants, shrubs, and trees available for vegetating the shorefront. A well-distributed stand of trees, shrubs, and groundcover can help maintain a healthy shoreline. Setbacks under the Shoreland Protection Act for buildings and other such structures should be strictly adhered to.

Zoning

The towns of Deerfield and Northwood should work toward enacting ordinances that are consistent on both sides of the lake through the creation of an environmental overlay or watershed district that takes into consideration the areas of concern highlighted by this report. This would not change the zoning for the whole of each town, but simply for the delineated watershed area of Pleasant Lake. The Comprehensive Shoreland Protection Act is a good starting point to use as a model in developing guidelines for the overlay. NHDES recommends

that representatives from the Pleasant Lake Association and the towns of Deerfield and Northwood form a subcommittee to review alternatives and formulate a plan for the development of appropriate zoning ordinances and protective overlays for areas near the lake.

It is recommended that the towns of Deerfield and Northwood cautiously plan further development around the lake, as it is becoming more important to protect natural spaces along the shoreline.

Education

The towns of Northwood/Deerfield, and the Pleasant Lake Association should initiate an education program and intensify existing educational efforts aimed at lake residents, transient lake recreationalists, and private/public beach users. The elementary and secondary schools can participate in the NHDES Interactive Lake Ecology Program.

Future Monitoring

The Pleasant Lake Association should continue to participate in the Volunteer Lake Assessment Program, monitoring once a month in the summer. It is also recommended that volunteers conduct stream bracketing to target areas of pollution.

Exotic Plant Prevention and Early Detection

With increasing numbers of exotic plant infestations throughout New Hampshire, and especially with the nearby milfoil infestation in Northwood Lake, it is important that lake association members monitor Pleasant Lake for new growths of exotic plant infestations. NHDES coordinates a Weed Watcher program to assist in such monitoring.

Lake and Watershed Restoration Projects

Alternative funding sources may be required to implement some of the recommendations of this report. One possible funding source is the NHDES Nonpoint Source (NPS) Local Initiative Grant Program. In order to apply for the grant program, you must submit a proposal the meets the requirements of the annual Request for Proposal, usually issued in early

September. Please contact the NPS Program Coordinator if you are interested in pursuing water quality improvement funds through this grant program.

1.0 INTRODUCTION AND WATERSHED CHARACTERISTICS

1.1 Purpose of Study

The Pleasant Lake Diagnostic Study began in October of 1998 and was completed in October of 2000. The study was funded by a Local Lake and Watershed Non-Point Source grant through NHDES. The Pleasant Lake Association provided volunteer monitors throughout the course of the study. This project was undertaken to allow both limnologists and lake residents the opportunity to learn more information about the watershed and the lake, as well as to determine nonpoint sources of pollution to the lake.

The Pleasant Lake Association has now been actively monitoring water quality for over 13 years through the Volunteer Lake Assessment Program (VLAP). Recently, lake monitors and biologists have noted an increase in erosion problems associated with the roads around the lake, decreased Secchi depth readings, increased total phosphorus levels, and decreases in hypolimnetic oxygen concentrations. Pleasant Lake is used mostly by the lake residents, transient boaters, and visitors to the Deerfield Town Beach at Veasey Park.

The goal of this study was to determine the watershed sources of nutrients to the lake and to make recommendations for the overall enhancement and protection of Pleasant Lake. To achieve this, tributaries were monitored for their phosphorus inputs to the lake. Rainfall, evaporation, in-lake samples, and outflow were also monitored throughout the study. Water and phosphorus budgets were developed to determine the nutrient loading from the watershed to the lake. Finally, recommendations were made to suggest how to improve the quality of Pleasant Lake, and to protect the future health and uses of the lake.

1.2 Lake and Watershed History

At one time, the land surrounding Pleasant Lake was called the town of Nottingham. Nottingham was one of the first 13 towns to be incorporated in New Hampshire. Now Pleasant Lake is surrounded by two towns: Northwood and Deerfield.

Northwood was incorporated in February 1773 at the request of the people in the northwest portion of Nottingham. Deerfield was incorporated on January 7, 1766 at the request of the people in the southwest portion of Nottingham. This town took its name from the fact that it abounded with numerous herds of deer, many of which, in its early settlement, were slain (Bicentennial Celebration, Deerfield Public Library).

In 1909, Mary Veasey Towle, whose original home was the Pettigrew place on the Pond Road, presented Deerfield the piece of land on the lake that is now known as Veasey Park. As the years passed camps became more and more numerous on the lake, and the townspeople and camp owners frequently used Veasey Park for recreation.

In 1913 the state legislature awarded water rights in Pleasant Lake to the town of Pembroke, which proceeded to lay the wooden water main which supplied water to Pembroke and Epsom from 1913 to 1960.

Also in the history of Pleasant Lake, the lake waters were used as a part of the Suncook valley watershed power supply for the textile mills located in Pembroke and Allenstown. The mills utilized the entire river system, including the Suncook Ponds in Barnstead, and Northwood and Pleasant Lakes to keep their mill wheels turning from the Civil War times until later years; water power has since been wholly discontinued. During the latter part of the 19th century, the Pembroke, China and Webster Mills were purchasing the rights to use the water along the streams and lakes of the Suncook watershed. The landowners to the companies deeded these "flowage" rights although sometimes land was sold outright.

On Pleasant Lake the companies bought flowage rights along the shore and the right to erect a dam and maintain it. A sluiceway was built out into the water to supply the outflow, and an attendant daily opened and closed the gates when the mills were running.

In 1914, Deerfield was a favorite resort for the summer tourists, and Pleasant Lake attracted many visitors. Nearby the lake, farm houses kept "summer boarders", and at least one of these houses kept as many as 20 guests who would go down to the lake each day for swimming and boating.

With increasing numbers of people around the lake, The Pleasant Lake Association (PLA) was formed in the early 1950s. The purpose of the group is to act as a conduit for the owners of the 170+ properties on the shore of the lake. In the early 1960s the lake association began to take on the task of assessing the water quality of the lake. A new "Water Quality Committee" was formed to spearhead this effort. The committee was later named the "Environmental Committee" as they took on more watershed related tasks. The initial sampling conducted at Pleasant Lake was for bacterial analysis during the summer months.

To get a better understanding of the lake as a whole, the PLA contracted with Normandeau Associates to conduct a lake-wide sampling event. This was one of the first comprehensive assessments of Pleasant Lake.

Following this study, the PLA contracted with the University of New Hampshire Lake Lay Monitoring Program (LLMP) to conduct some follow-up studies in 1983 and 1988. UNH still periodically samples the lake for various parameters.

In 1989, the PLA joined the state's Volunteer Lake Assessment Program (VLAP), and has been conducting regular sampling events with them ever since.

1.3 Lake Characteristics

Pleasant Lake is a naturally occurring lake in south-central New Hampshire, located in the towns of Deerfield and Northwood. The lake is impounded by a dam at the northern end. Table 1-1 summarizes the characteristics of the lake (descriptions of data are detailed in Appendix 1). A bathymetric (depth) map is shown in Figure 1-1. A map delineating the watershed boundary can be found in Figure 1-2.

1.4 Climate

The climate of the region is characterized by moderately warm summers, cold, snowy winters, and ample rainfall. Precipitation in this region is typically acidic (NHDES, 1999/2000). Generally, snow is present from mid-December until the end of March or early April. Ice-out for the lake is usually mid-April.

1.5 Watershed Characteristics

The Pleasant Lake watershed encompasses an area of approximately 895 hectares (3.46 square miles). This watershed contains the major lake and several wetland areas. The lake covers 197.32 hectares (493.3 acres), and wetlands comprise approximately 129.5 acres. In addition, there are six year-round streams, two seasonal streams and several areas of overland seasonal runoff entering Pleasant Lake (see Figures 1-1 and 1-2).

Table 1-1
Morphometric Data

Parameter	Lake Information/ Morphometric Data
Lake Name	Pleasant Lake
Towns	Deerfield/Northwood
County	Rockingham
River Basin	Merrimack
Latitude	43°11'N
Longitude	71°16'W
Elevation (ft)	578
Shoreline Length (meters)	7200
Watershed Area (ha)	895.0
Lake Area (ha)	197.32
Maximum Depth (m)	19.8
Mean Depth (m)	7.0
Volume (m^3)	13,995,000
Areal Water Load (m/yr)	2.53
Flushing Rate (yr^{-1})	0.4
Phosphorus Retention Coefficient	0.78
Lake Type	Natural/raised by dam

Figure 1-1
Pleasant Lake Bathymetric Map

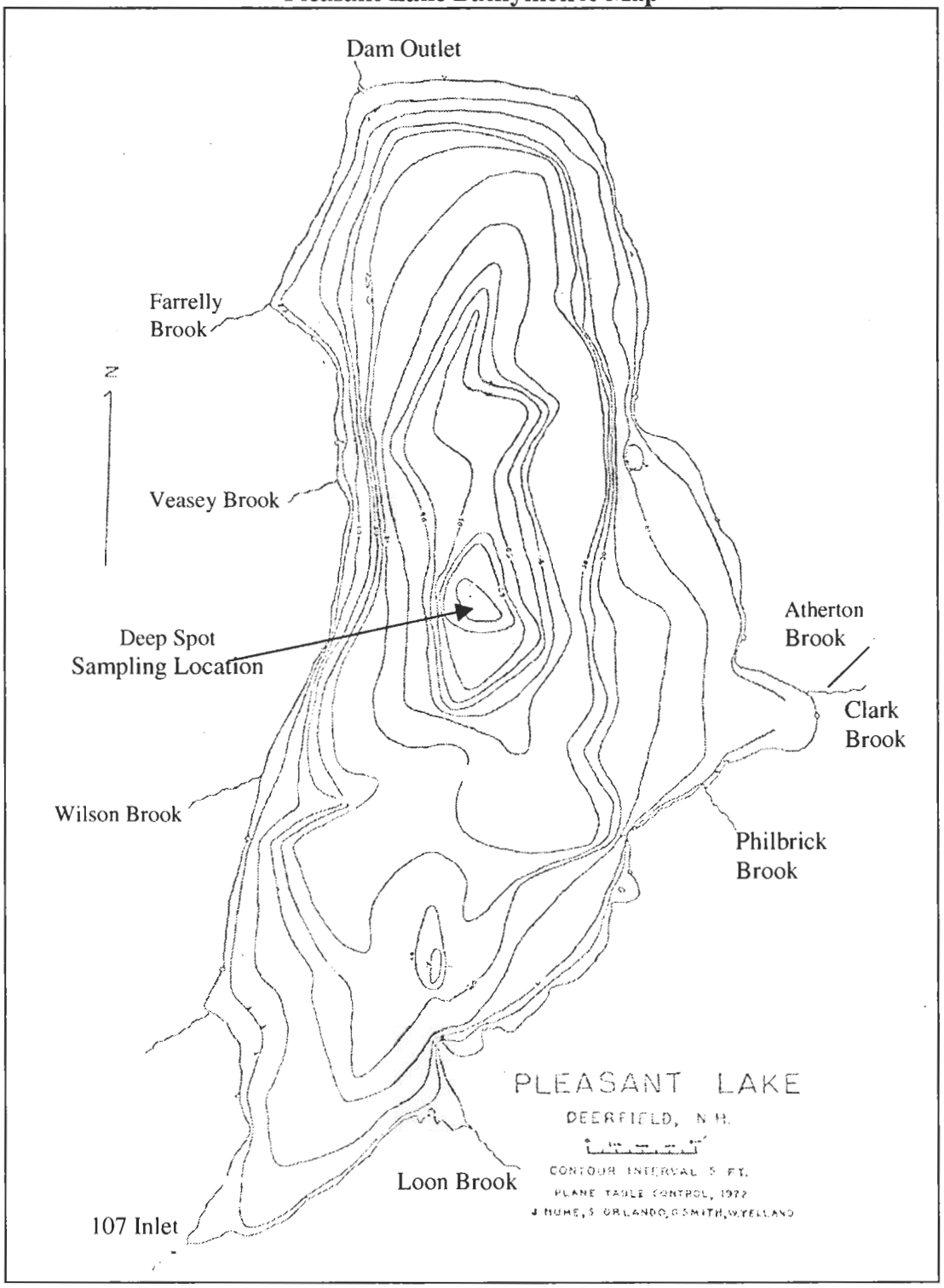
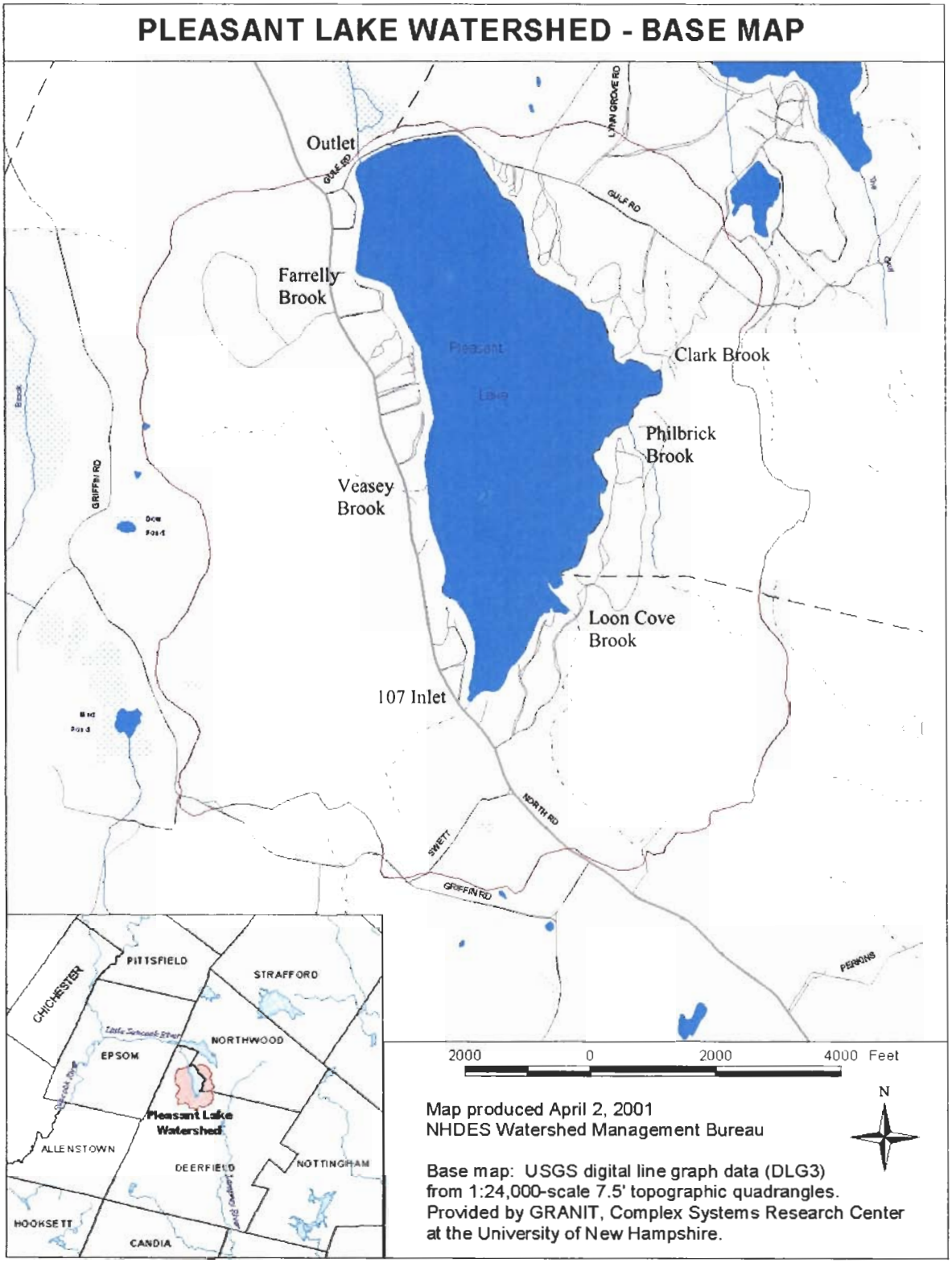


Figure 1-2
Pleasant Lake Base Map



Seasonal runoff, direct runoff, tributary flow, and groundwater seepage contribute to the hydrologic inputs of Pleasant Lake. The inlets and the outlet are shown in Figure 1-1. The outlet stream flows in a northwesterly direction from the lake where it eventually enters Northwood Lake to the north.

1.6 Land Cover and Land Use Patterns

The quality of the lake is influenced, in part, by the type of human and natural activities that occur within the confines of a watershed. Much of the rainwater, snow melt-water and groundwater found within the watershed will eventually end up in the lake. The downward migration of the surface and groundwater carries pollutants found in the watershed, including nutrients such as phosphorus and nitrogen. Inputs of phosphorus to the lake may cause algae blooms and accelerate eutrophication.

Increases in developed areas, failed septic systems, the removal of native vegetation during construction, and increases in impervious surfaces are the most common human activities that impair lake quality and accelerate cultural eutrophication in the Pleasant Lake watershed. Human intrusions into a watershed will accelerate the degradation of water quality much faster than natural processes.

1.6.1 Pleasant Lake Land Use

Data pertaining to existing land use in the Pleasant Lake watershed were derived from a land use map prepared by the Informational Resources Management Unit at NHDES. The map was derived from a 1990-1993 Landsat TM image and supplemental data sources. Figure 1-3 illustrates the land use cover in the Pleasant Lake watershed. Table 1-2 shows an estimated breakdown (in acres) of the current land use in the Pleasant Lake watershed.

As the figure and table indicate, the predominant land cover type within the Pleasant Lake watershed is forested. The forested portion of the watershed can be characterized as a mixed forest, with white pine and eastern hemlock comprising the evergreen component, and beeches, maples, and oaks comprising the majority of the deciduous trees.

Table 1-2
Pleasant Lake Watershed Land Use (Acres)

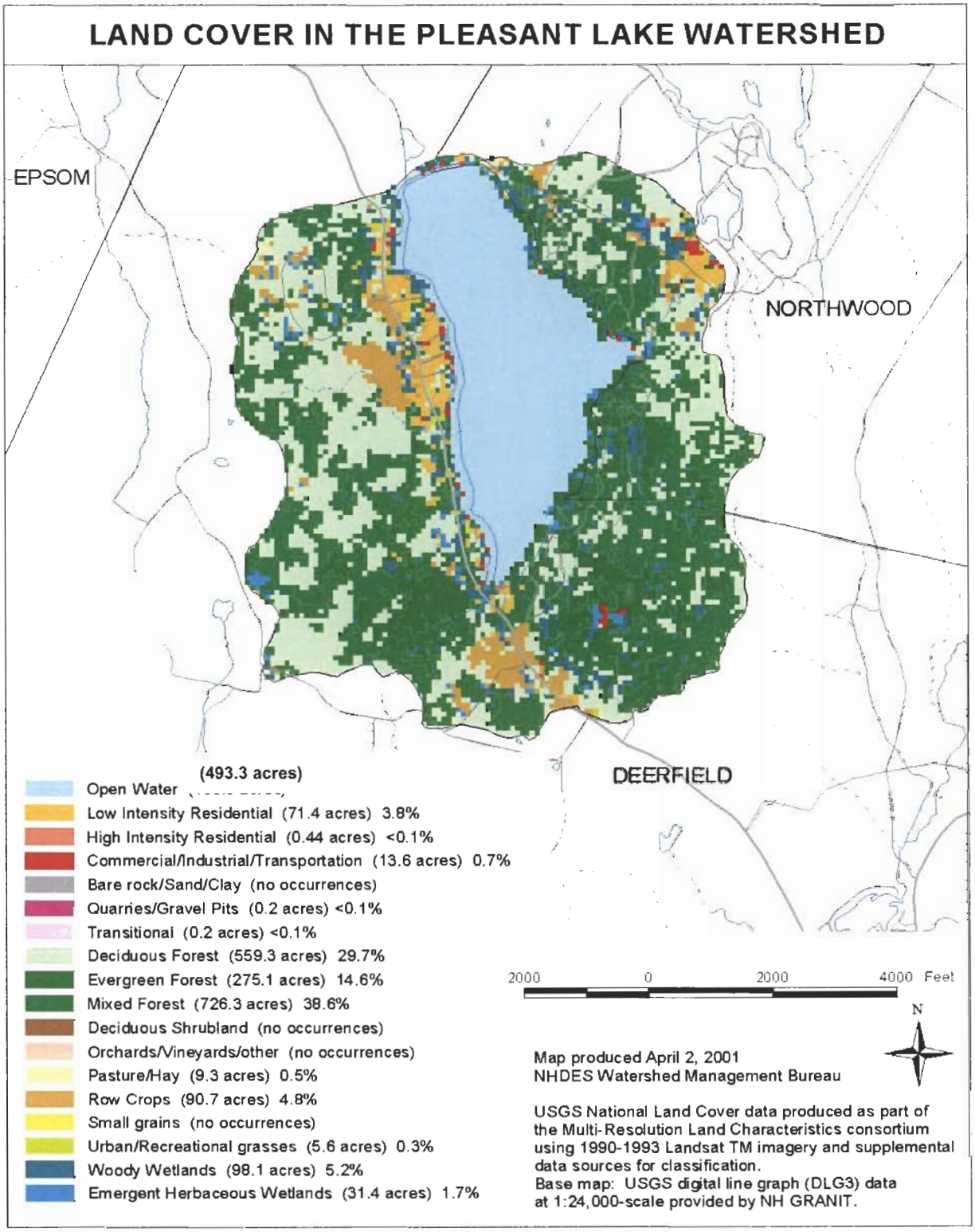
Land Use	Acreage
Forested	1560.7
Surface Water (including lake)	493.3
Residential/Commercial	85.4
Wetland	129.5
Active Agriculture	100
Cleared/Other	6

Forested lands are beneficial in that the rooting systems of the plants and trees take in excess nutrients from the soil, thereby preventing the likelihood of these nutrients entering the lake. These rooting systems also provide the added benefit of soil stabilization. The root masses from the trees and shrubs form a support network, holding soil particles together, thereby preventing erosion. In addition, forests provide a shading effect around the edge of the lake, preventing excessive heating of the lake water.

Surface water is the next largest land coverage in the watershed. This category includes Pleasant Lake and the open water or ponded areas of wetland habitats. For the most part, wetlands in the watershed do not have large areas of open water. Most of the wetlands are forested or emergent marshes.

Residential development covers a total 71.8 acres of the watershed. Areas of low intensity residential development occur along nearly the entire shoreline of Pleasant Lake. Development in the Pleasant Lake watershed is characterized by seasonal cottages along the shoreline, with larger year round homes farther back from the lake edge. Recent trends towards conversion of these seasonal homes to large permanent homes with all modern commodities (i.e. washing machines, dishwashers, showers) can lead to the increase in impervious surfaces and the decrease in forest cover. Both of these factors, in close proximity to the lake, result in the increase of direct surface water runoff without the benefit of uptake by trees or infiltration to the ground.

Figure 1-3
Pleasant Lake Watershed Land Use Map



2.0 HYDROLOGIC BUDGET

2.1 Introduction

Knowing the volume of water flowing through the lake, along with the concentration of nutrients in that water, will yield a better understanding of nutrient loading to the lake. Further, since water is considered a universal solvent that picks up traces of what it has been in contact with, it is important to know the source of that water. To accurately account for the water (and nutrients) entering and exiting Pleasant Lake, many different factors were considered. Inflows such as tributary flow, overland flow, precipitation and groundwater all contribute to the water budget of the lake. The outflow of the lake, evaporation, and areas of groundwater recharge from the lakebed are all sources of outflow. Groundwater seepage was the only factor that was not included during the lake study, and is usually assumed to be equivalent to groundwater recharge. This can be assumed because of the influx of water into the lake at the deep spot equals the water released from the lake and therefore there is a balance between the two. (All Standard Operating Procedures for Chapters 2.0-4.0 are included in Appendix Two).

2.2 Budget Components

2.2.1. Precipitation/Evaporation

The data for the precipitation and evaporation calculations were obtained from the Manchester Water Works where daily weather trends are recorded. Just over 42 inches of precipitation occurred during the study year. This weather station is nearest to the Pleasant Lake area (roughly 30 miles south of the lake). Tables 2-1 and 2-2 summarize the precipitation and evaporation trends, respectively, during the study year.

The total monthly precipitation and evaporation are multiplied by the surface area of the lake to determine the volume of water that fell directly on the lake, and that evaporated directly from the lake surface area.

2.2.2. Tributary Inputs/Outflow

Tributary inputs, as well as the outflow, are calculated using regression analysis based on the monthly stream flow readings conducted by NHDES, and on the bi-weekly staff gauge readings by the Pleasant Lake volunteers (raw data and statistical summaries for the Hydrologic Budget can be found in Appendix 3).

Table 2-1
Pleasant Lake Monthly Precipitation (September 1999-August 2000)

Month	Monthly Total (in)	Monthly Total (m)	Precipitation (m^3)	Precipitation ($10^3 m^3$)	Percent Annual Contribution
Sep 99	5.90	0.15	299288.85	299.29	13.99
Oct 99	3.99	0.10	202400.43	202.40	9.46
Nov 99	2.20	0.06	111599.23	111.60	5.22
Dec 99	2.05	0.05	103990.19	103.99	4.86
Jan 00	2.75	0.07	139499.04	139.50	6.52
Feb 00	2.48	0.06	125802.77	125.80	5.88
Mar 00	3.06	0.08	155244.39	155.22	7.26
Apr 00	6.23	0.16	316028.74	316.03	14.77
May 00	2.89	0.07	146600.81	146.60	6.85
Jun 00	3.45	0.09	175007.89	175.01	8.18
July 00	4.86	0.12	246532.85	246.53	11.52
Aug 00	2.31	0.06	117179.19	117.18	5.48
Total	**42.17**	**1.07**	**2139154.39**	**2139.15**	**100.00**

Surface Area= 1,997,123 m^2 Precip (m^3)=Monthly (m) X Surface area

Table 2-2
Pleasant Lake Monthly Evaporation Rates (May 2000-July 2000)
(Pan Coef.)(Lake Surface Area)(Monthly Evap.)

Month	Total Evap (in)	Total Evap (m)	Evap (m^3)	Evap ($10^3 m^3$)	Evap (Pan Coef)
May 00	4.30	0.11	218125.77	218.13	167.96
Jun 00	4.57	0.12	231822.04	231.82	178.5
Jul 00	3.62	0.09	183631.47	183.63	141.4
Total	**12.49**	**0.32**	**633579.28**	**633.58**	**487.86**

Surface area = 1,977,123 m^2 Pan Coef = EV($10^{-3} m^{-3}$) X .77

2.2.3. Surface Runoff

The water volumes calculated for this section are not derived from actual field measurements, but from land use and runoff maps produced for the New England area (Knox and Nordenson, 1955). Runoff values from the maps were multiplied by the estimated area of land within a 1000-foot setback from the lake edge of Pleasant Lake. It is important to

remember that this value is not exact, but rather an estimate of the volume of direct runoff (raw data and statistical summaries can be found in Appendix 3).

2.3 Water Budget

Each of the previously detailed components are combined to form a water budget based on the following equation:

Tributary Inputs + Precipitation Inputs + Surface Runoff = Outflow + Evaporation

Raw tributary data and stage-discharge relationships can be found in Appendix 3.

According to the completed water budget (Table 2-3), tributaries contribute more than one half of the water to Pleasant Lake (56%), which means that the most water that enters the lake comes from streams that travel through the entire watershed of the lake, bringing with it chemicals, nutrients, and particles that are accumulated along the way. The next largest contributor of water to the lake was precipitation (23%). Direct runoff contributes the remaining water to Pleasant Lake (21%). This is the incoming component that flows over the landscape nearest the lake before entering the lake. Figure 2-1 summarizes the hydrologic inputs to Pleasant Lake.

Precipitation and runoff contributions for December through February are added to the March value. It is assumed that precipitation in these months is in the frozen form, and is not mobile until the spring melt.

Tributary inputs are detailed in Figure 2-2. The 107 Inlet provided the greatest volume of water to Pleasant Lake (nearly half of the total tributary contributions). This was one of the largest and most consistently flowing streams in the watershed. Loon Cove Brook was the next largest contributor to the hydrologic budget. Wilson Brook made the third largest contribution to the lake (15%), and Philbrick Brook contributed 11% of the tributary water inputs. The remaining four streams contributed the remaining 17% of the tributary inputs, with Farrelly Brook contributing the least water to the lake.

Table 2-3
Pleasant Lake Hydrologic Budget Table ($10^3 m^3$)

Hydrologic Component	Sep-99	Oct-99	Nov-99	Dec-99	Jan-00	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Annual Total	Monthly Average
107 Inlet	24.24	89.34	76.87	69.80	74.05	441.54	273.21	46.95	142.29	879.67	29.40	58.77	***2206.12***	***183.84***
Atherton Brook	0.00	0.00	0.00	9.00	28.13	29.80	40.73	20.18	12.65	4.20	20.40	1.77	***166.85***	***13.90***
Clark Brook	0.80	35.98	43.30	25.03	40.33	49.86	117.74	51.09	37.35	8.95	12.90	8.50	***431.83***	***35.99***
Farrelly Brook	1.31	6.37	9.14	7.02	6.50	22.35	19.92	6.04	7.22	3.88	2.39	3.72	***95.85***	***7.99***
Loon Cove Brook	4.83	85.14	71.45	57.01	49.35	212.50	180.71	61.04	64.50	9.51	21.14	8.27	***825.45***	***68.79***
Philbrick Brook	42.49	31.04	29.03	31.56	53.98	135.67	108.56	55.64	38.96	16.22	27.93	20.98	***592.07***	***49.34***
Veasey Brook	5.20	11.06	11.54	9.58	16.05	61.13	25.43	20.73	16.89	7.64	10.05	8.57	***203.87***	***16.99***
Wilson Brook	6.19	55.27	59.29	63.35	88.92	198.68	100.07	73.52	94.19	22.01	17.22	13.27	***792.00***	***66.00***
Precipitation	299.29	202.40	111.60	snow/ice	snow/ice	snow/ice	524.51	316.03	146.60	175.01	246.53	117.18	***2139.15***	***237.68***
Runoff	273.16	184.73	101.85	snow/ice	snow/ice	snow/ice	478.72	288.43	133.80	159.73	225.01	106.95	***1952.37***	***216.93***
Total Inflow	**657.49**	**701.33**	**514.08**	**272.33**	**357.30**	**1151.53**	**1869.60**	**939.65**	**694.46**	**1286.83**	**612.97**	**347.98**	***9405.55***	***783.80***
Outlet/Dam	421.92	882.90	654.28	654.71	680.44	582.51	625.41	689.25	704.20	534.38	403.38	665.04	***7498.41***	***624.87***
Evaporation									167.96	178.50	141.40		***487.86***	***162.62***
Total Outflow	421.92	882.90	654.28	654.71	680.44	582.51	625.41	689.25	872.16	712.88	544.78	665.04	*7986.27*	*787.49*

Figure 2-1
Pleasant Lake Hydrologic Inputs

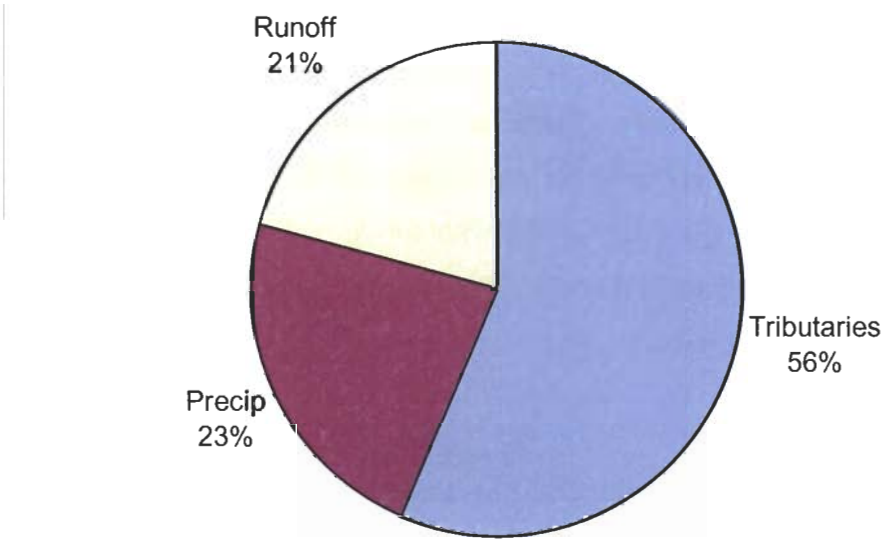
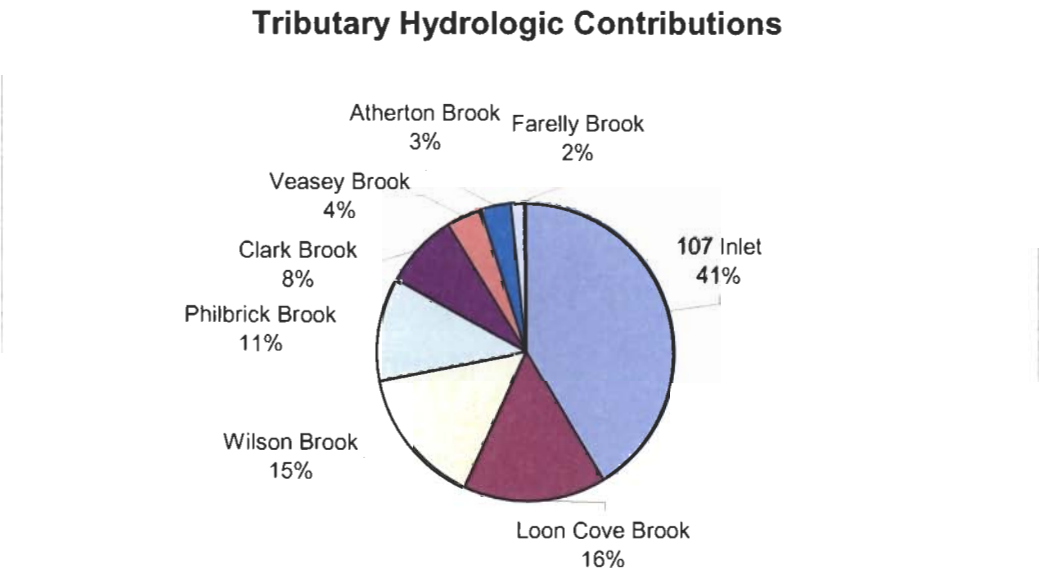


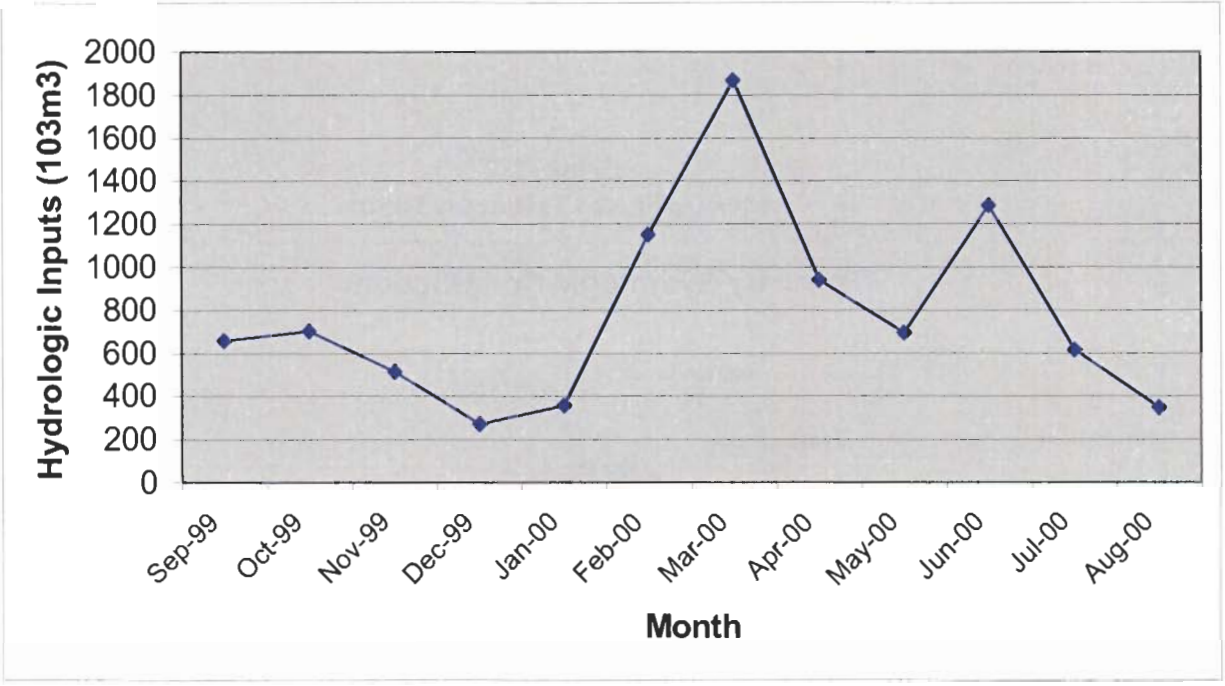
Figure 2-2
Pleasant Lake Tributary Inputs



Most of the hydrologic outputs were through direct outflow over the dam (94%). Only 6% of the water left the lake through evaporation in the summer months.

For half of the water budget year, the volume of water leaving the lake was greater than the volume entering the lake (resulting in a lower water level in the lake). October 1999, November 1999, December 1999, January 2000, May 2000, and August 2000 were months that had higher outputs of water from the lake than those entering. The fall months are the time for the annual lake drawdown to take place. Boards are removed from the dam for large volumes of water to leave the lake, thereby lowering the water level. In the late winter and into the spring the boards are replaced to allow the lake to fill with spring melt water. These are the months when the inputs exceed the outputs of the lake. Figure 2-3 illustrates the total monthly inputs of water to Pleasant Lake from all sources.

Figure 2-3
Pleasant Lake Total Monthly Hydrologic Inputs



The greatest overall water contributions to Pleasant Lake occurred in March 2000, when spring melt waters were on the increase. A wetter June caused a second peak in overall hydrologic inputs to the lake. December and August contributed the least amounts of water to the lake.

The hydrologic inputs and outputs that were derived in this chapter will be used to determine a nutrient budget for Pleasant Lake in Chapter 3 of this report.

3.0 PHOSPHORUS BUDGET AND LOADING IMPLICATIONS

3.1 Introduction

This chapter analyzes the inputs of phosphorus to Pleasant Lake. The previous chapter detailed the components of the water budget for Pleasant Lake. Those calculations are essential in calculating the nutrient budget. Each incoming component and volume of water brings with it varying concentrations of phosphorus.

Phosphorus is a naturally occurring nutrient in our environment. Phosphorus is found in sedimentary rocks, and is released into the soil. Once released from the sedimentary rocks, phosphorus can attach to sediment particles, and may be blown up to circulate through the atmosphere. Phosphorus that does reach the atmosphere can again return to the earth attached to droplets of precipitation. Phosphorus is also tied up in organic matter (living things), like animals, plants, insects, and humans.

In addition to natural sources of phosphorus, there are many other human generated contributions of phosphorus to the lake. Human waste products, dishwashing detergents, gasoline, and fertilizers all contribute varying amounts of phosphorus to our environment.

It is important to remember that a little phosphorus in lakes and ponds is needed to aid in plant growth. Plants and algae use this nutrient in the process of photosynthesis to produce their food. Just a little too much phosphorus in the lake, however, can lead to a lot of excess plant and algae growth. This is why phosphorus is referred to as the 'limiting nutrient'.

Phosphorus concentrations for each of the inputs were measured throughout the study year, and these concentrations, multiplied by the volumes of water entering the lake from each component of the water budget will yield the total amount of phosphorus entering the lake. The nutrient budget is essential in pointing out the greatest sources of phosphorus in the watershed so that they can be addressed first.

3.2 Tributary Phosphorus Concentrations

This section will discuss the total phosphorus concentrations in the tributaries feeding Pleasant Lake. It is important to monitor the concentration of phosphorus in the tributaries feeding Pleasant Lake because a high concentration of this nutrient is often indicative of watershed pollutants entering the streams. In some cases, wetlands naturally release phosphorus from decaying plants and other organic substances. In these cases, it is difficult, if not impossible to control the phosphorus level. In many cases, however, the phosphorus

concentration is influenced by watershed activities such as fertilizing, failed septic systems, or erosion problems from unstabilized soils created by development. These are all activities that can be proactively addressed through Best Management Practices (BMPs). Table 3-1 summarizes the average phosphorus concentrations in the tributaries to Pleasant Lake.

Table 3-1
Pleasant Lake Average Tributary Total Phosphorus Concentrations (µg/L)

Tributary	Mean	Median	Standard Deviation
107 Inlet	11	7	13
Atherton Brook	8	7	4
Clark Brook	7	6	5
Farrelly Brook	11	6	15
Loon Cove Inlet	42	22	57
Philbrick Brook	10	6	9
Veasey Brook	21	10	19
Wilson Brook	6	5	7
Outlet	7	8	3

Atherton, Clark, and Wilson Brooks showed low, or 'ideal', phosphorus concentrations. Each of these tributaries, which have wooded and less developed watersheds, had mean total phosphorus concentrations less than 10 µg/L. Farrelly Brook and Route 107 Inlet both had mean phosphorus concentrations in the 'average' range. Only two tributaries had mean total phosphorus levels that were of concern. Loon Cove Inlet and Veasey Brook both had phosphorus concentrations that were more than desirable, with Loon Cove phosphorus levels falling within the 'excessive' category, though the range of total phosphorus concentrations fluctuated often during the study period. There was a fairly large standard deviation around the mean, suggesting that the watersheds show varying responses to the changing environment, namely storm events and periods of dry weather.

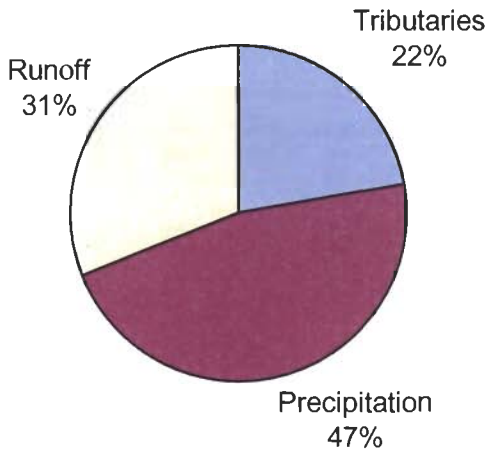
3.3 Nutrient Budget Components

The nutrient budget is based on the same components that were used to develop the water budget:

Tributary Inputs + Precipitation + Runoff = Outflow

Using the volumes from the hydrologic budget, many of these calculations in this chapter were derived by simply multiplying the average phosphorus concentrations for each input by the volume of water from each input to yield total phosphorus loading. Calculations and raw data for the nutrient budget calculations can be found in Appendix 4. Table 3-2 details the total phosphorus inputs to Pleasant Lake, and Figure 3-1 graphically depicts the loading of phosphorus to Pleasant Lake.

Figure 3-1
Pleasant Lake Total Phosphorus Inputs



Phosphorus loading derived from precipitation provides the largest source of phosphorus to the lake (47%). Phosphorus that is blown up into the atmosphere mixes with rain and snow and is brought back down to the land to move into lakes and other surface waters. Though this is the largest contributor of phosphorus to the lake, it is the most difficult source to control.

Direct surface runoff from the steeply sloped watershed was the next largest contributor of phosphorus to Pleasant Lake (31% of the total loading). This component of the nutrient budget was not directly measured in the study, but was determined based on coefficients of nutrient loading developed in other studies. It is realistic that this is one of the highest inputs because as water hits the land it must travel a fair distance before it reaches the lake, allowing for more substances to be dissolved in runoff water.

Table 3-2
Pleasant Lake Nutrient Budget (Kg P)

Nutrient Contributor	*Sep-99*	*Oct-99*	*Nov-99*	*Dec-99*	*Jan-00*	*Feb-00*	*Mar-00*	*Apr-00*	*May-00*	*Jun-00*	*Jul-00*	*Aug-00*	***Annual Total***	***Monthly Average***
107 Inlet	0.65	0.17	0.03	0.20	0.20	0.35	0.17	0.70	0.59	2.12	0.04	0.04	***5.26***	***0.44***
Atherton Brook	0.00	0.00	0.00	0.00	0.05	0.08	0.00	0.00	0.40	0.18	0.59	0.27	***1.56***	***0.13***
Clark Brook	0.04	0.00	0.00	0.02	0.03	0.03	0.04	0.14	0.05	0.05	0.08	0.02	***0.49***	***0.04***
Farrelly Brook	0.02	0.03	0.00	0.00	0.00	0.11	0.00	0.04	0.05	0.02	0.04	0.02	***0.32***	***0.03***
Loon Cove Brook	0.16	2.30	1.29	0.63	0.54	2.76	3.43	1.04	1.68	1.82	1.65	0.53	***17.82***	***1.48***
Philbrick Brook	0.55	0.19	0.15	0.28	0.16	0.00	0.54	0.28	0.43	0.08	0.67	0.55	***3.88***	***0.32***
Veasey Brook	0.30	0.11	0.15	0.06	0.35	2.51	0.18	0.15	0.19	0.18	0.24	0.50	***4.90***	***0.41***
Wilson Brook	0.06	0.17	0.24	1.27	0.44	0.79	0.40	0.44	0.66	0.11	0.12	0.08	***4.78***	***0.40***
Precipitation	1.12	1.92	0.78	1.51	3.07	0.96	2.64	12.33	8.65	15.23	28.35	5.51	***82.06***	***6.84***
Runoff													***54.59***	***4.55***
Total Inflow	**2.90**	**4.88**	**2.63**	**3.97**	**4.85**	**7.59**	**7.40**	**15.10**	**12.68**	**19.79**	**31.77**	**7.51**	***175.66***	***10.09***
Outlet/Dam	2.53152	5.29739	5.8885	6.54708	1.36087	4.07755	3.12705	3.44625	7.74625	5.34377	4.03384	5.98534	***55.39***	***4.62***
Total Outflow	**2.53**	**5.30**	**5.89**	**6.55**	**1.36**	**4.08**	**3.13**	**3.45**	**7.75**	**5.34**	**4.03**	**5.99**	***55.39***	***4.62***

A phosphorus coefficient for each land use was selected by matching similar land uses at Pleasant Lake to those with a known phosphorus export. These land use types and their associated phosphorus export coefficients are shown in Table 3-3. The direct phosphorus runoff was calculated by multiplying the land use area within 1000' from the lake edge by the phosphorus coefficient.

Table 3-3
Pleasant Lake Watershed Phosphorus Export

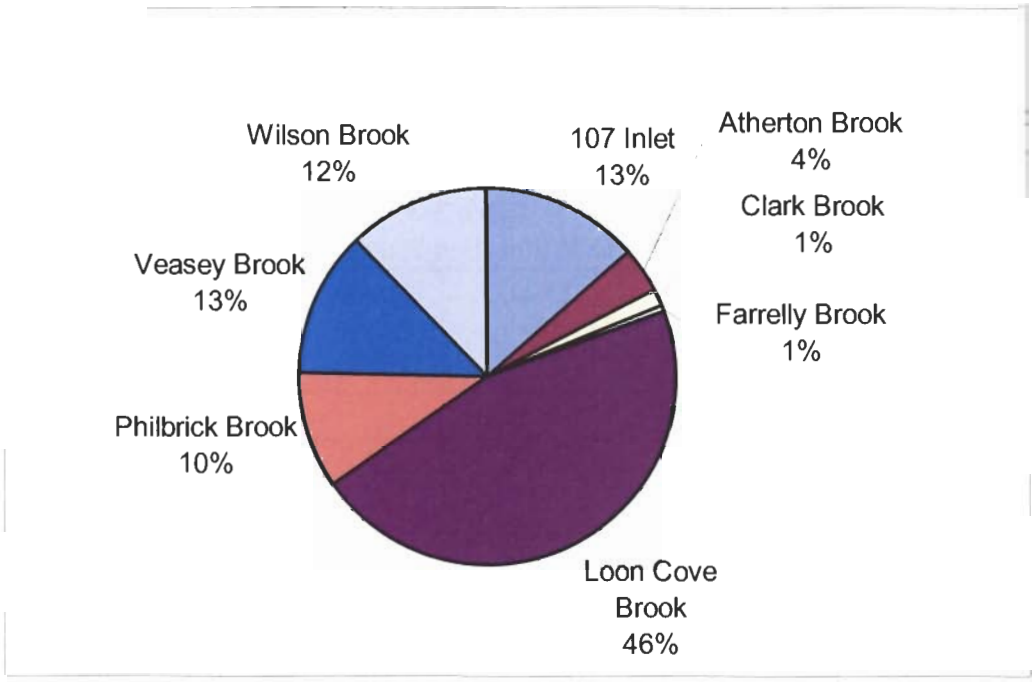
Land Use Type	Area (ha)	Runoff Volume (L)	Total Phosphorus Loading (kg)
Forested	396.7	0.19	30.50
Developed Residential	60.74	0.90	22.04
Agriculture	25	0.20	2.02
Total	482.44	0.20	54.59

Increased phosphorus loading to a lake from direct runoff corresponds to the area's weather patterns. Periods of frozen ground, snowmelt, and high intensity rainstorms usually contribute an increased phosphorus load via runoff. Direct runoff contributed an estimated 54.59 kg of phosphorus to Pleasant Lake during the study period.

Tributary inputs were the next largest source of phosphorus to the lake (22%). Tributaries start at the highest reaches of the watershed, and travel sometimes great distances, and through many landscapes, before reaching the lake. This allows streams the opportunity to pick up nutrients along the way to the lake. Figure 3-2 illustrates the tributary phosphorus inputs to Pleasant Lake.

Loon Cove Brook was by far the largest tributary contributor of total phosphorus to Pleasant Lake (46%). This stream provides the second highest volume of water from the tributaries to Pleasant Lake. The stream flows through a long complex of wetlands which contribute organic matter and nutrients to the water. At times, depending on their location and the type of vegetation, some wetlands can take up nutrients and prevent the downstream flow of large concentrations of phosphorus. Sometimes, as in the case of the Loon Cove wetland, these systems release large amounts of nutrients to downstream receiving waters (like the lake) through release of decaying plant materials and dissolved nutrients.

Figure 3-2
Pleasant Lake Tributary Phosphorus Contributions



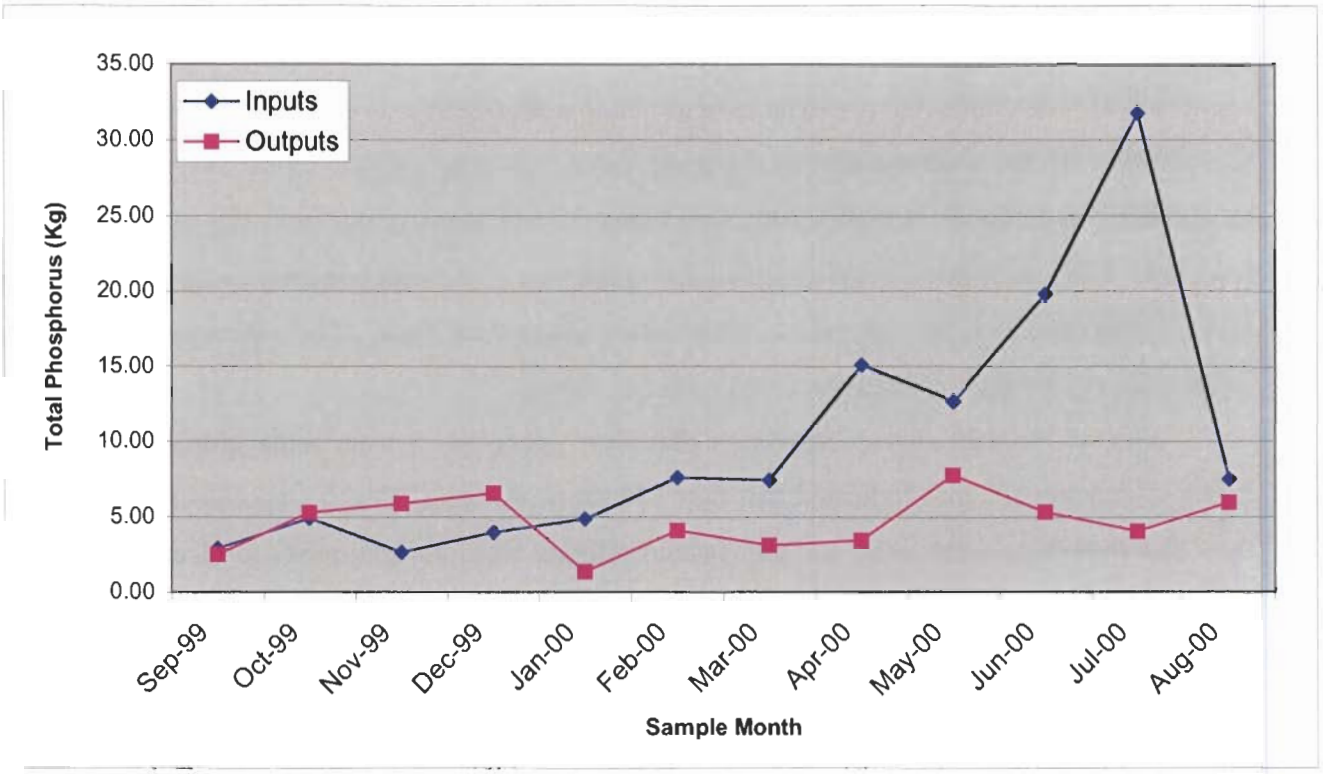
Veasey Brook and the Route 107 Inlet each provided 13% of the phosphorus (~5 Kg P each). Wilson Brook contributed the next largest amount of phosphorus to Pleasant Lake.

3.4 Seasonal Contributions of Nutrients

Looking at all inputs and outputs (excluding groundwater), total inflow of phosphorus exceeded total outflow for most of the year. From October through December, total outflow of phosphorus exceeded the amount of phosphorus entering the lake. This is likely the result of decaying plant and algal material exiting the lake from fall die off. In all other months phosphorus inflow was higher than outflow, suggesting the loading of phosphorus into the sediments of the lake. Figure 3-3 shows the trends of phosphorus inputs and outputs.

Table 3-4 summarizes individual tributary contributions from each season during the study period. All but two of the tributaries (Loon Cove Brook and Wilson Brook) had their highest concentrations of phosphorus in the summer months when the water volume is low and the phosphorus is more concentrated in the water. Only three of these tributaries, however, had their highest Kg loading of phosphorus to the lake at that time (107 Inlet, Atherton Brook and Philbrick Brook).

Figure 3-3
Pleasant Lake Monthly Phosphorus Inputs and Outputs for the Budget Year



Loon Cove Brook had its highest phosphorus concentration in the fall, with its highest loading of phosphorus taking place in the spring months. Wilson Brook had both its highest concentration and highest loading in the winter months. Farrelly Brook and Veasey Brook also had their highest loading of phosphorus in the winter.

Table 3-4
Seasonal Mean Tributary Total Phosphorus Concentrations (ug/L P)
and Mean Tributary Loadings (Kg P)

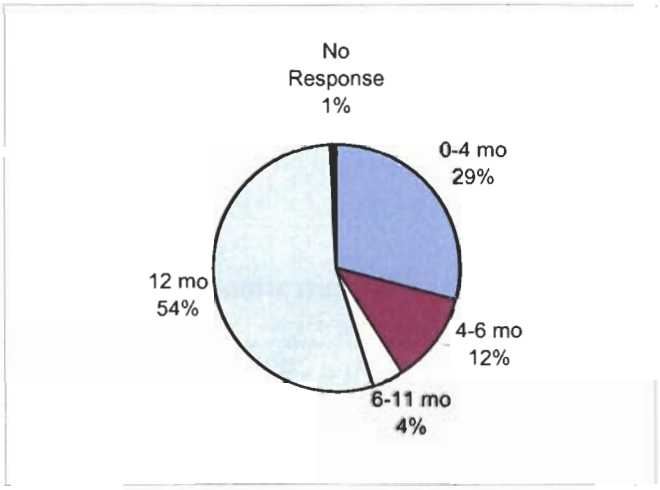
Tributary	Fall 1999		Winter 1999		Spring 2000		Summer 2000	
	ug/L	Kg	ug/L	Kg	ug/L	Kg	ug/L	Kg
107 Inlet	6	0.28	8	0.25	6	0.49	23	0.73
Atherton Brook	---	---	9	0.04	6	0.13	11	0.35
Clark Brook	9	0.01	5	0.03	5	0.07	11	0.05
Farrelly Brook	8	0.02	12	0.04	5	0.03	20	0.03
Loon Cove Brook	26	1.25	12	1.31	20	2.05	11	1.33
Philbrick Brook	7	0.29	6	0.15	7	0.42	18	0.43
Veasey Brook	20	0.19	19	0.97	8	0.17	37	0.31
Wilson Brook	5	0.15	10	0.84	5	0.50	6	0.10
Outlet	7	4.57	6	4.00	7	4.77	10	5.12

3.5 Septic System Survey Results

In 2000, an anonymous septic system survey was conducted of residents along the Pleasant Lake shoreline and watershed area. Septic system condition tends to be a controversial topic around lakes, especially since a lot of systems are aging or inadequate. As a result, the septic survey was conducted anonymously to obtain a representation of the current conditions of the majority of the systems around Pleasant Lake. A copy of the septic system survey is included in Appendix 5. Roughly 200 anonymous surveys were mailed, and 129 responses were received. The return rate for the completed surveys was 65%, which is an outstanding response and representation of the watershed immediately around the lake. The following paragraphs summarize the results that were received from the survey.

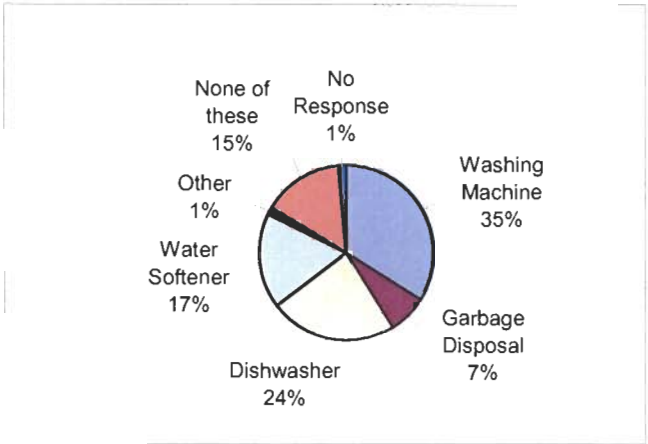
Out of the 129 survey responses that were received, 5 were undeveloped lots. One hundred seventeen homes indicated that they had septic systems. Seven responses indicated that they had something other than a septic system ranging from holding tanks to electric toilets to cesspools. The percentages used in the following discussion are based on the 117 households having septic systems.

Figure 3-4
Year Round vs. Seasonal Residents



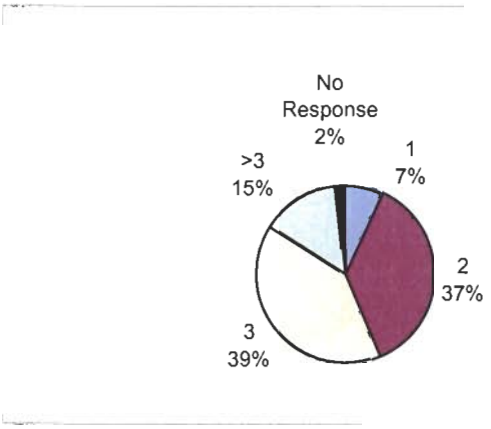
Of the people responding to the survey, 54% represented year-round homes in the watershed. Twenty-nine percent of the people responding represented 0-4 month residences, 12% represented 4-6 month residences, and 4% represented 6-11 month residences. One percent of the returned surveys had no response to the question. Seasonal dwellings totaled 45%. This is significant because a recent trend is to convert seasonal cottages into year-round homes. Septic systems must be upgraded to meet the needs of full-time loading on the systems. In fact, this is a stipulation in the zoning ordinances of most towns.

Figure 3-5
Water-Using Machines at Lake Area Dwellings



Today, septic systems receive higher volumes of water and waste than originally intended due to the use of dishwashers, garbage disposals, water softeners, washing machines, and other such water using machines. Of those responding to the survey, 35% have washing machines, 24% have dishwashers, 17% have water softeners, and 7% have garbage disposals. Fifteen percent of the people surveyed had no water using machines.

Figure 3-6
Number of Bedrooms Per Home



Septic system size is based on the number of bedrooms in each dwelling, as well as the number of appliances that drain into the system. Of those responding, 7% had only one bedroom. Thirty-seven percent of the responses indicated a two-bedroom home. Three bedroom homes composed only 15% of the responses, and 39% of those responding said they had greater than three bedrooms. Two percent had no response to this question.

The age of septic systems around the lake ranges from one year old to greater than 30 years old. The estimated life span of an approved septic system is between 15 and 20 years. That is considering that the system is used within the design specifications. Thirty-eight percent of those responding to the survey said that their septic systems were 10 years old or less. Fourteen percent said their systems were between 10 and 15 years old, 8% between 15 and 20 years, 25% between 20 and 25 years, and 5% were older than 30 years. Ten percent of the

people responding did not know the age of their septic system. Cumulatively 38% of the responses indicated that the septic systems have reached or exceeded the normal life expectancy for approved systems.

Figure 3-7
Age of Septic Systems

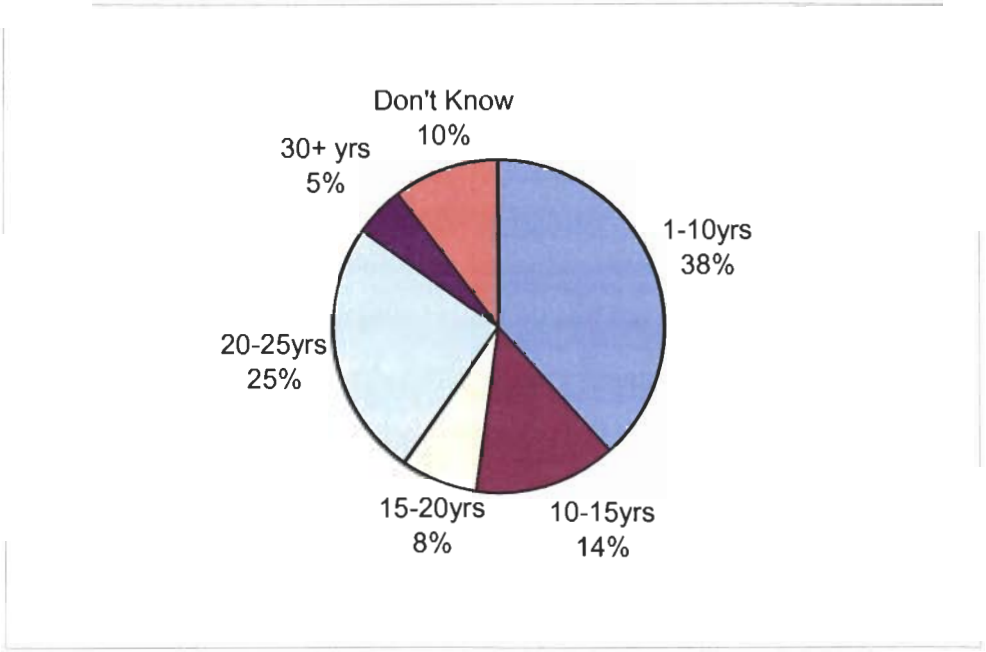
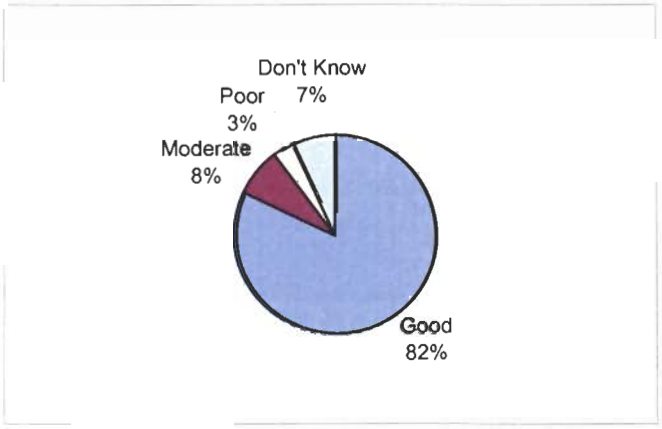


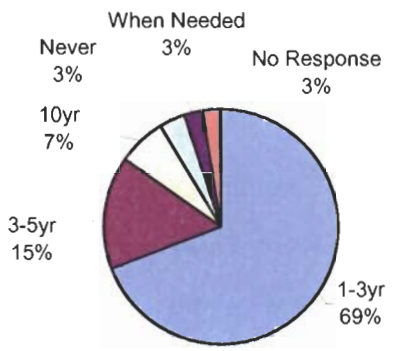
Figure 3-8
Condition of Septic System



To determine the perceived health of the septic systems, the participants in the survey were asked to rate the condition of their systems. Eighty-two percent of those responding believe that their systems are in good condition. Eight percent of those responding indicated that their septic systems are in moderate condition. Only 3% of the people responding believe their systems to be in poor condition. Seven percent were unsure of the condition of their septic systems. When asked if they have experienced problems with their systems, 97% responded no,

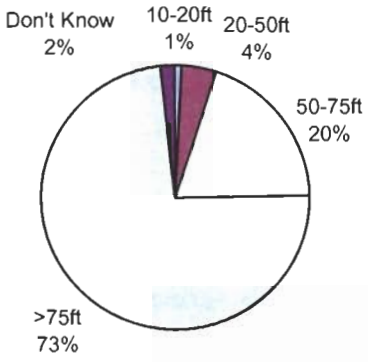
and only 3% indicated that they have had problems. Eighty percent of those surveyed said that they have never made repairs to their system while 20% indicated a repair at some point in the system's life.

Figure 3-9
Frequency of Septic System Maintenance



To prevent problems, it is recommended that those living along the lake edge have their septic systems pumped and inspected every one to three years. Beyond the lake edge, residents are recommended to pump their systems every 5 years. During pumping, the service person can inspect the system for any problems, and determine loading to the system. Encouragingly, 69% of those responding indicated that they have their septic pumped every 1-3 years. Fifteen percent of those responding indicated that they have their systems pumped every 3-5 years. Seven percent responded that their systems are pumped every 10 years, 3% responded that theirs are pumped when needed, and only 3% have never had their septic system pumped. Three percent had no response to this question.

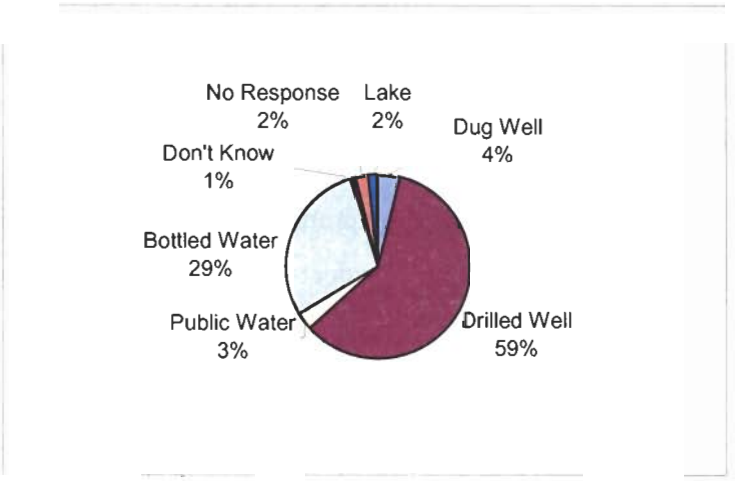
Figure 3-10
Distance of Septic System from Lake Edge



When septic systems go into failure, they release high amounts of nutrients and bacteria that can travel into lakes or the surrounding area. Because of this, it is important to determine the proximity of the systems to the lake. More than half (73%) of those

responding indicated that their systems were located greater than 75 feet from the lake edge. Twenty percent of the responses indicated that their septic systems were located 50-75 feet from the lake edge, and only 4% said that their systems were 20-50 feet from the shoreline. Only 1% indicated that their septic systems were very close to the lake edge at 10-20 feet. These systems are in danger of flooding during times of high water, potentially causing system failure and water quality problems.

Figure 3-11
Drinking Water Sources



When a failing septic system contaminates the lake and surrounding areas, it is only logical that they can also impact dug drinking water wells located near them. Because of this, the lake residents were asked to indicate their drinking water source. Over half of those responding have drilled wells (59%), which tend to be deeper into bedrock and have a casing to protect against contamination near the surface. Well-heads usually extend about one foot above the ground to prevent contamination of the well from bacteria and runoff. Four percent of the responses said they had dug wells, which tend to be shallower and can be more impacted by land use and surface runoff. Twenty-nine percent use bottled water as their drinking source, only 3% use public water for drinking, and 2% use water from the lake. Three percent had no response or did not know the answer to this question.

Maintaining proper septic system health is important along a lake. Old, failing, or improperly maintained septic systems can cause odors, bacteria problems, aesthetic and health problems, and can seriously degrade the quality of surface waters.

3.6 In-Lake Phosphorus Concentrations

In-lake phosphorus was measured on a bi-weekly basis during the summer months of the

sampling period. The following table summarizes the average monthly phosphorus, as well as the median and standard deviation of those means.

Table 3-5
Mean In-Lake Phosphorus Concentrations

Sample Depth	Year	Average	Median	Standard Deviation
Epilimnion (surface layer)	1999	4	4	2
	2000	6	6	1
Metalimnion (middle layer)	1999	6	7	3
	2000	8	8	2
Hypolimnion (bottom layer)	1999	10	9	4
	2000	8	8	3

3.7 Trophic Classification Scheme

3.7.1 State of New Hampshire Trophic Classification System

The classification system developed by the NHDES Biology Section (Table 3-6) utilizes four parameters, including dissolved oxygen concentration in the bottom layer of the lake, clarity, plant abundance, and the chlorophyll-a concentration of the water.

Table 3-7 presents the calculated value of each classified parameter for the 1976 and 2000 summer surveys of Pleasant Lake. In 1982, Pleasant Lake received a total of 3 trophic points, placing it within the oligotrophic range. Trophic classification ranges are explained in Appendix 1.

In 2000, Pleasant Lake received a total of 6 trophic points and was *narrowly* classified as oligotrophic. Vascular plants were rated as sparse, and chlorophyll-a concentrations at 2.77 µg/L fell within the low range. The transparency was in the oligotrophic range with a Secchi depth of 6.63 meters. The lower oxygen concentration in the hypolimnion resulted in a greater number of points earned in the model. As the points increase in this model, the lake is placed in a more advanced trophic classification.

Table 3-6

1. Summer Bottom Dissolved Oxygen:	Trophic Points
a. D.O. > 4 mg/L	0
b. D.O. = 1 – 4 mg/L & hypolimnion volume 10% lake volume	1
c. D.O. = 1 mg/L & hypolimnion volume > 10% lake volume	2
d. D.O. < 1 mg/L in<1/3 hypolimnion volume 10% lake volume	3
e. D.O. < 1 mg/L in 1/3 hypolimnion volume & hypolimnion volume 10% lake volume	4
f. D.O. < 1 mg/L in < 1/3 hypolimnion volume & hypolimnion volume > 10% lake volume	5
g. D.O. < 1 mg/L in 1/3 hypolimnion volume & hypolimnion volume>10% lake volume	6
2. Summer Secchi Disk Transparency:	**Trophic Points**
a. > 7 meters	0
b. > 5 to 7 meters	1
c. > 3 to 5 meters	2
d. > 2 to 3 meters	3
e. > 1 to 2 meters	4
f. > 0.5 to 1 meter	5
g. 0.5 meter	6
3. Aquatic Vascular Plant Abundance:	**Trophic Points:**
a. Sparse	0
b. Scattered	1
c. Scattered/Common	2
d. Common	3
e. Common/Abundant	4
f. Abundant	5
g. Very abundant	6
4. Summer Epilimnetic Chlorophyll-a (mg/m^3):	**Trophic Points:**
a. <4	0
b. 4 to < 8	1
c. 8 to < 12	2
d. 12 to < 18	3
e. 18 < 24	4
f. 24 < 32	5
g. 32	6

	Trophic Points	
Trophic Classification	Stratified	*Unstratified
Oligotrophic	0-6	0-4
Mesotrophic	7-12	5-9
Eutrophic	13-24	10-18

*Unstratified lakes are not evaluated by the bottom dissolved oxygen criterion

Table 3-7
Trophic Classification of Pleasant Lake Using New Hampshire Classification Methods

Trophic Classification – Summer 1982 (NHDES Survey Data)		
Parameter	**Value**	**Trophic Points**
Dissolved Oxygen	3.8 mg/L	2
Secchi Disk	4.9 M	1
Plant Abundance	Sparse	0
Chlorophyll-a	2.68 mg/m^3	0
Classification: Oligotrophic		Total = 3
Trophic Classification – Summer 2000 (NHDES Survey Data)		
Parameter	**Value**	**Trophic Points**
Dissolved Oxygen	0.25	5
Secchi Disk	6.63 m	1
Plant Abundance	Sparse	0
Chlorophyll-a	2.77 mg/m^3	0
Classification: Oligotrophic		Total = 6

3.7.2. Dillon/Rigler Permissible Loading Model

Mathematical models can also be useful both in diagnosing lake problems and in evaluating potential solutions. They represent, in quantitative terms, the cause-effect relationships that determine lake quality. The Dillon/Rigler Model classifies a lake as oligotrophic, mesotrophic or eutrophic by comparing calculated annual phosphorus loadings with permissible annual phosphorus loadings. The tolerance of the lake to phosphorus loading is predicted as a function of two lake characteristics, mean depth (z) and water retention (T), which have been proven by several researchers to be the primary determinants of loading permissibility.

Table 3-8 shows the relationship between the inputs and the lake's phosphorus loading tolerance.

Table 3-8
Dillon/Rigler Permissible Loading Tolerance

High Phosphorus Loading Tolerance	Low Phosphorus Loading Tolerance
Large mean water depth	Small mean water depth
Rapid flushing rate	Slow flushing rate
High sediment retention	Low sediment retention

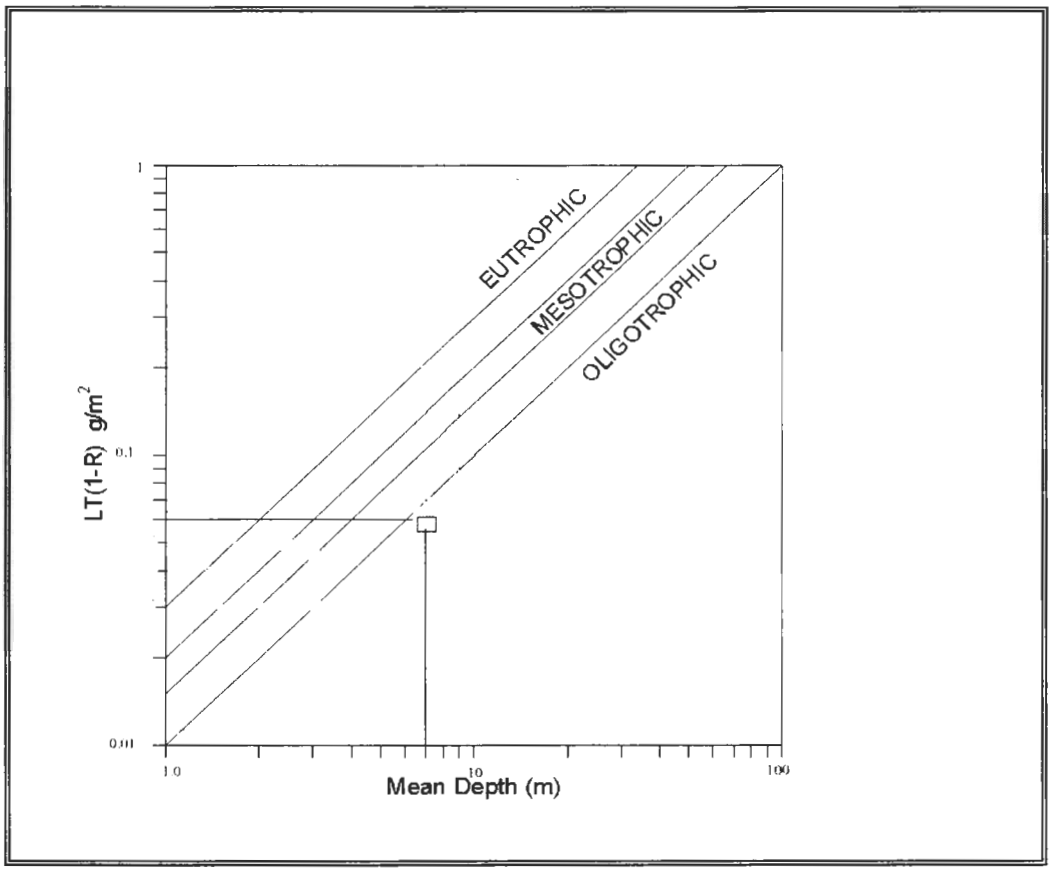
Thus, the existing trophic status is set by existing values for these parameters and annual phosphorus loading. Table 3-9 presents the Dillon/Rigler trophic status calculations for Pleasant Lake.

Table 3-9
Dillon/Rigler Trophic Status Calculations for Pleasant Lake

Parameter	Calculation
Lake area (m^2)	1,997,123.0
Mean depth (m)	7
Total loading (kg)	175.66
Flushing rate (yr^{-1})	0.4
Water retention time (yr) (T)	2.5
P coefficient (R)	0.78
Total aerial loading ($g/m^2/yr$) (Lp)	0.088
LT (1-R)/qs (g/m^2)	0.006

Figure 3-4 is a graph showing where Pleasant Lake would fall in the range of trophic conditions according to the Dillon/Rigler model. The solution of the Dillon/Rigler equation for Pleasant Lake data shows the existing trophic status of the lake as oligotrophic. This determination is based on the amount of phosphorus loading the lake actually receives.

Figure 3-12
Dillon-Rigler Model Graph



The Dillon/Rigler model also predicts in-lake phosphorus concentration based on characteristics of the lake. Utilizing the Dillon/Rigler equation P=Lp (1-R)/qs, the calculated predicted in-lake epilimnetic phosphorus concentration for Pleasant Lake was 6 µg/L. This was less than the actual study year mean bottom layer phosphorus concentration of 10 µg/L. This was equal to the mean upper layer phosphorus concentration of 6 µg/L. The actual mean upper and lower layer phosphorus concentrations were calculated from the summer phosphorus data collected by the Biology Section during the 2000 sample year. In other words, based on the lake characteristics that were plugged into the model, the model yielded a phosphorus concentration that is actually lower than what is really in the lake, showing that the lake phosphorus concentration is higher than a predictable number from the model.

3.7.3. Vollenweider Phosphorus Loading and Surface Overflow Rate Relationship

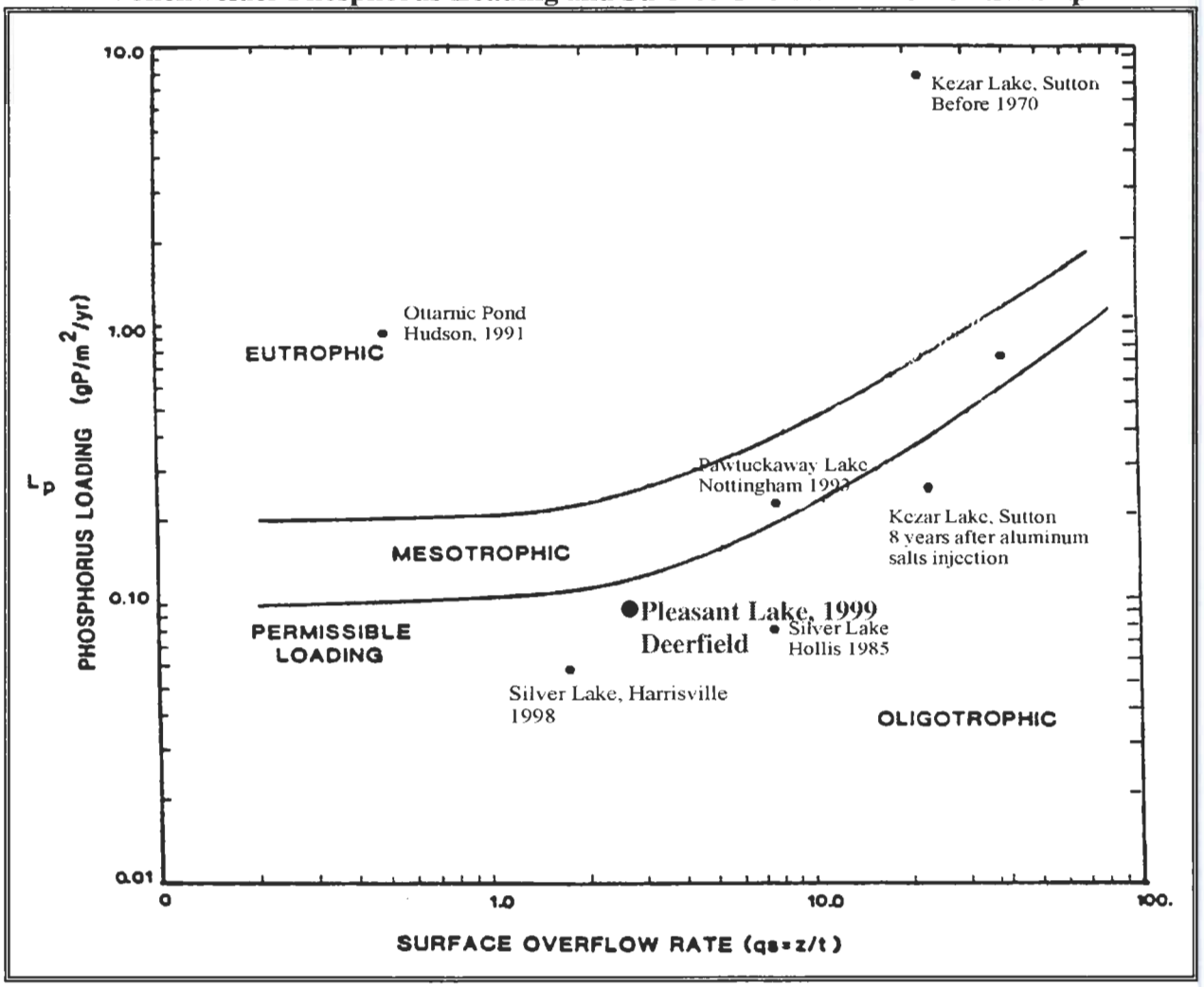
The Vollenweider model is based on a five-year study involving the examination of phosphorus load and response characteristics for about 200 waterbodies in 22 countries in Western Europe, North America, Japan and Australia. Vollenweider, working on the Organization for Economic Cooperation and Development (OECD) Eutrophication Study, developed a model describing the relationship of phosphorus load and the relative general acceptability of the water for recreational use (Vollenweider, 1975). Table 3-10 summarizes the Vollenweider model parameters for the Pleasant Lake sample year.

Table 3-10
Vollenweider Phosphorus Concentration Prediction

Parameter	Equation	Pleasant Lake
1. Hydraulic residence time (T)	$T = \frac{V}{Q}$	2.5
2. Surface overflow rate (qs)	$qs = \frac{z}{T}$	2.8
3. Areal phosphorus load (Lp)	$Lp = \frac{P\ load}{lake\ surface\ area}$	0.088
4. Mean depth (Z)	*measured*	7
5. Phosphorus concentration prediction (P)	$P = \frac{Lp}{qs} \quad \frac{1}{1+\frac{z}{qs}}$	0.01

Figure 3-12 graphically portrays the measured loading rates for Pleasant Lake and compares Pleasant Lake with other New Hampshire Diagnostic/Feasibility studies.

Figure 3-13
Vollenweider Phosphorus Loading and Surface Overflow Rate Relationship



Based on the calculations for this model, it can be seen that Pleasant Lake falls within the oligotrophic category.

3.8 Trophic Classification Summary

A summary of the three classification schemes utilized in this study (Table 3-11) shows that the New Hampshire lake classification system places Pleasant Lake in the oligotrophic category, though the trophic points have increased over the past several years, bringing the lake closer to a mesotrophic classification. Both the Vollenweider Phosphorus Loading model and the Dillon/Rigler model also classify the lake as oligotrophic.

Table 3-11
Pleasant Lake Trophic Classification Summary

Classification Model	Trophic Status
1. New Hampshire Lake Classification	Oligotrophic
2. Dillon/Rigler	Oligotrophic
3. Vollenweider	Oligotrophic

4.0 AQUATIC ECOLOGY

4.1 In-Lake Data

4.1.1 Temperature And Dissolved Oxygen

Temperature is measured to determine the degree of stratification in the lake. In the summer months the surface temperatures rise, and this water, which is less dense (or lighter), floats on top of the cooler and heavier water below. Swimmers may have noticed this occurrence when diving deep into the lake and encountering cool water.

Because of density differences, these layers do not mix throughout the summer. Each layer, including a middle layer of rapidly changing temperatures (the metalimnion) is physically, chemically and biologically different than the other two. This layering breaks up in the fall when the top layer cools and sinks to the bottom. When the lake, influenced by air temperature, is again all one temperature full mixing of the entire water column can take place. The lake is usually thermally stratified by mid to late May, after which point mixing along the water column ceases until fall turnover.

Stratification, or layering, is typical for a lake with the size and depth of Pleasant. Summer temperatures near the surface averaged approximately 77° F, and bottom temperatures averaged approximately 57° F.

Oxygen concentrations are very important to the chemical and biological processes that take place in the lake. Oxygen enters a lake from the atmosphere and from wind and wave action. Plants in the lake also produce oxygen. Fish, insects, and other organisms rely on oxygen for their survival. Bacteria use up oxygen at the bottom of the lake as they break down organic material. Because of the summer stratification, new oxygen from the atmosphere cannot be mixed to the bottom of the pond to replenish the supply. Decreased oxygen lower in the water column could result in decreased fish habitat in a lake. Decreases in oxygen result in a process called internal loading, which is the release of phosphorus from the sediments into the overlying water, thereby enriching the lake from within.

In-lake oxygen profiles were sampled twice per month from June 1999 through August 1999, and again from June through September 2000. Pleasant Lake shows signs of declining oxygen concentrations below 10 – 12 meters as the summer progresses, where oxygen concentrations have reached nearly 0 mg/L. A low oxygen trend exists in Pleasant Lake today, with oxygen levels dropping to nearly zero in the bottom layers as the summer progresses. With

very little oxygen below 10 meters (33 feet), fish habitat at the deeper portions of the lake diminishes rapidly (this is nearly half of the water column at the deep site). In the early part of the summer (May and June), oxygen is still fairly high in the bottom layer. By later in June and into July, oxygen begins its decline, with the lowest readings occurring in August and September.

This continued trend in low oxygen concentrations is due to the accumulation of organic matter in the lake bottom, providing plenty of food for oxygen-using bacteria. Decaying plant material, algae, leaf litter, animal waste products, and debris from the surrounding watershed all contribute to the accumulation of this organic material in the bottom of the lake. These are all natural processes, but activities in the lake's watershed, like tree clearing, fertilizing lawns, increasing impervious areas, and leaking septic systems can accelerate the accumulation.

Temperature and oxygen profiles and raw data can be found in Appendix 6

4.1.2 pH And Acid Neutralizing Capacity (ANC)

The pH scale ranges from 0 – 14 units with a pH of 7 units being a neutral value. "Pure" water has a pH of 7 units. Most New Hampshire lakes are slightly acidic, with pH values between 6 and 7 units. When the pH value falls between 6 and 5.5 units, the waters are considered endangered. Lakes with pH units of 5.4 to 5 are considered in the critical range, and below this point, lakes are considered acidified. Table 4-1 summarizes the true mean pH of Pleasant Lake during the summer of 1999 and the summer of 2000.

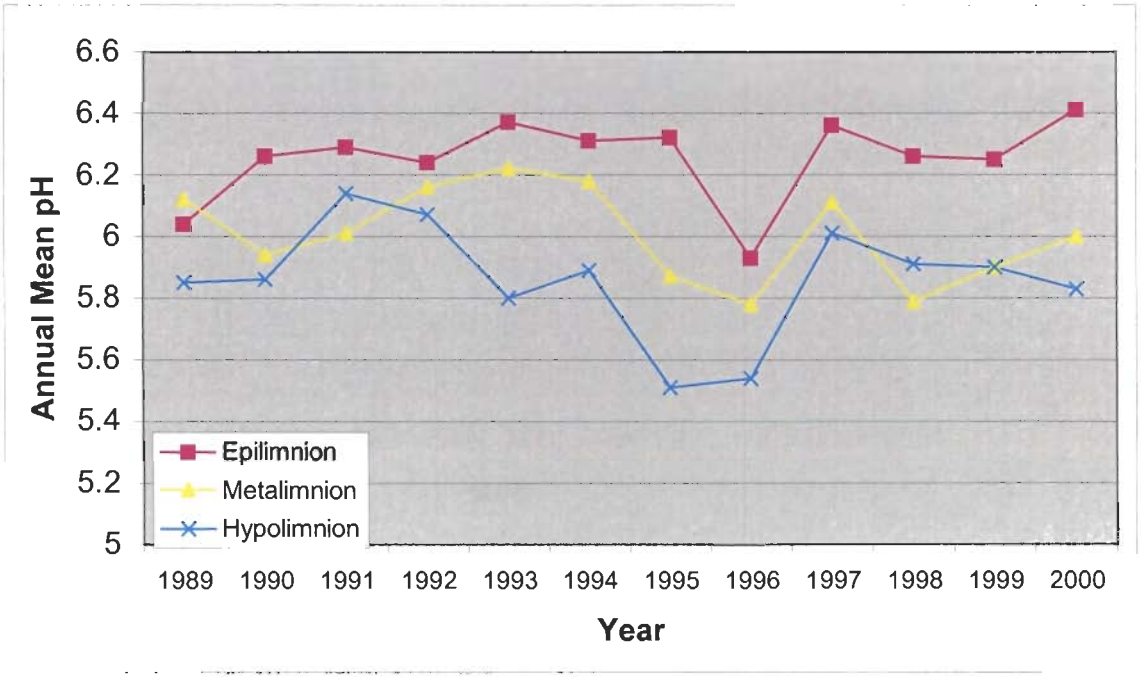
Table 4- 1
In-Lake True Mean pH Values for Summers 1999 and 2000

Sample Depth	Year	Average	Median	Standard Deviation
Epilimnion (surface layer)	1999	6.24	6.29	0.12
	2000	6.41	6.49	0.24
Metalimnion (middle layer)	1999	5.95	6.02	0.29
	2000	6.00	6.07	0.18
Hypolimnion (bottom layer)	1999	5.93	5.93	0.24
	2000	5.83	5.82	0.21

The true mean pH of the epilimnetic waters was slightly below neutral during both summer sampling periods, meaning that the upper layer of the lake is slightly acidic. The pH decreased slightly with increased depth in the lake, dropping to pH 5.95 and 6.00 in 1999 and 2000, respectively, in the middle layer. The bottom layer of the lake was the most acidic, dropping to 5.93 (1999) and 5.83 (2000). The pH of lakes is typically lower at the bottom due to microbial activity and other chemical processes.

The waters of Pleasant Lake would fall within the 'endangered' category, meaning that the lake is on the acidic side. When the pH of a waterbody becomes too low, fish, insects, and other aquatic life can be threatened. For the most part, the pH of Pleasant Lake has remained within the same relative range since 1989 when the lake association began monitoring Pleasant Lake with the Volunteer Lake Assessment Program (VLAP). Figure 4-1 illustrates the annual trend in mean pH since Pleasant Lake joined VLAP in 1989.

Figure 4-1
Historical True Mean pH of Pleasant Lake (from VLAP data)

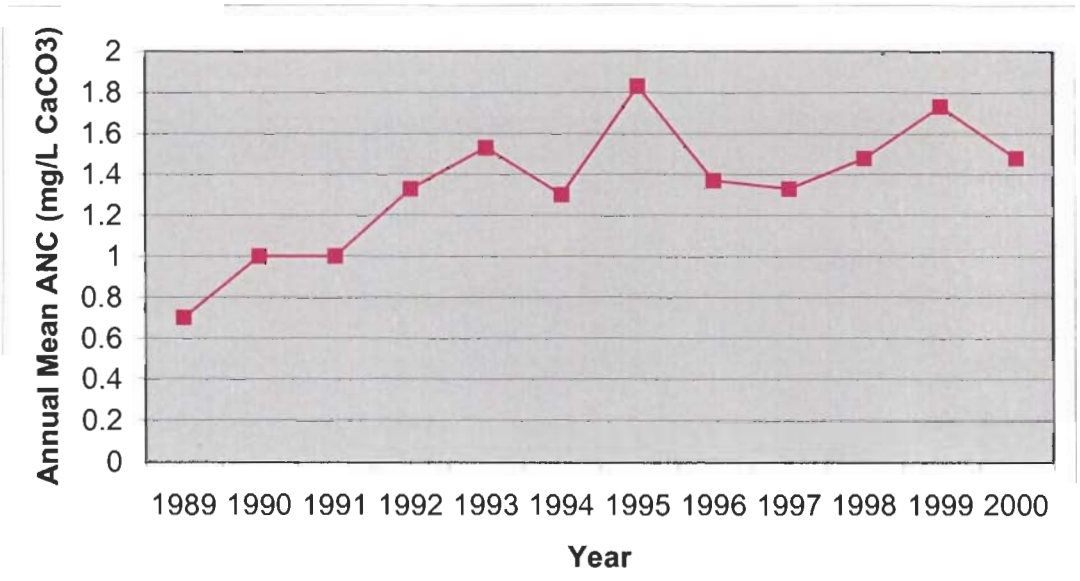


The Acid Neutralizing Capacity (ANC) is the capacity of water to neutralize acid inputs. This concept is much like the use of an antacid tablet to buffer acid reflux in the stomach. New Hampshire lake waters are generally low in ANC (ranging from 2 to 20 mg/L of $CaCO_3$). This is

due in part to the State's granite bedrock, which contains few of the compounds that buffer acids (like calcium). As a result, New Hampshire lakes have a poor buffering capacity, and thus are more susceptible to acid rain than lakes with a higher acid neutralizing capacity. Acid neutralizing capacity is only measured in the upper water layer.

The average ANC value for the epilimnion of Pleasant Lake during the 1999 study year was 1.73 mg/L (median of 1.60 mg/L) as calcium carbonate, and 1.48 mg/L (median of 1.40 mg/L) in the 2000 summer study period. This places the lake within the 'extremely vulnerable' category to acid additions. This means the lake is not able to effectively buffer against acid additions from precipitation and runoff. This reading is much lower than the average of lakes and ponds in New Hampshire (epilimnetic average of 6.4 mg/L as calcium carbonate). Figure 4-2 shows the trend in epilimnetic ANC levels.

Figure 4-2
Historical Trends in In-Lake ANC Levels (from VLAP) data



On a positive note, the overall trend for ANC in Pleasant Lake since 1989 has been for an increase in the buffering capacity. Both VLAP data and data from the annual acid outlet surveys conducted by the Biology Section support this increasing trend. These increases in ANC are likely the result of more stringent restrictions on smoke stack emissions both nationally and more locally at the Bow Power Plant. This increasing trend is encouraging; especially in New Hampshire where our lakes are naturally low in buffering capacity.

4.1.3 Conductivity

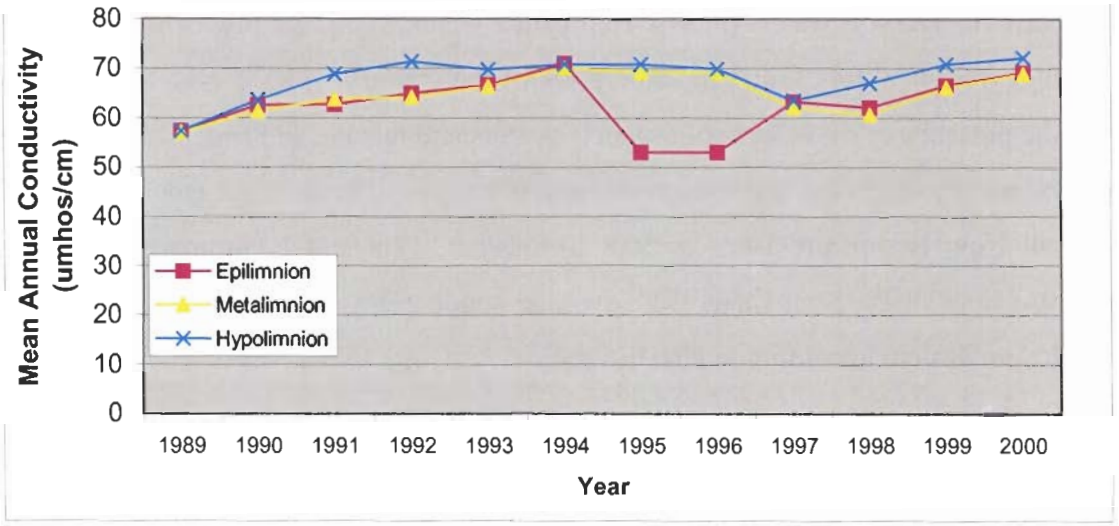
Specific conductance (conductivity) is a measure of the capacity of water to conduct an electrical current. The soft waters of New Hampshire generally have a low conductance relative to highly mineralized waters found in some parts of the country. The conductance of water is related to the presence of dissolved solids, such as salts and metals, and thus is usually higher in sewage and heavily impacted areas than in natural waters. The average (mean) conductivity value for all New Hampshire lakes is 56.8 µmhos/cm. Table 4-2 summarizes the average conductivity values of Pleasant Lake. The average conductivity for New Hampshire lakes and ponds is 56.8 umhos/cm according to NHDES data.

Table 4-2
In-Lake Average Conductivity Values (µmhos/cm)

Sample Depth	Year	Average	Median	Standard Deviation
Epilimnion (surface layer)	1999	66.45	66.44	1.20
	2000	69.16	69.18	0.45
Metalimnion (middle layer)	1999	66.07	66.20	1.20
	2000	68.93	68.91	1.90
Hypolimnion (bottom layer)	1999	70.84	67.20	8.64
	2000	72.11	70.61	4.72

The average conductivity values for Pleasant Lake are higher than the average for New Hampshire lakes and ponds. Land use practices, old and failing septic systems, road salting, fertilizers, and natural runoff and soil types may contribute to these higher-than-average levels. The average levels show that conductivity is higher at the bottom of the pond where the salts and other metals accumulate. Typically, excessively high conductivity values can indicate human induced sources of pollution. As shown in Figure 4-3, mean summer conductivity levels have not increased markedly over the 13 years since Pleasant Lake joined the VLAP program, and for the most part remain below 70 umhos/cm.

Figure 4-3
Historical In-Lake Conductivity Trends for Pleasant Lake (from VLAP data)



4.1.4 Turbidity

Turbidity is caused by the presence of suspended particles of clay, silt, organic matter, and algal cells in the water. As light passes through the water, it is scattered, reflected or absorbed by these suspended particles. Erosion creates high turbidity values, which are often highest during storm events. Also, high numbers of algae in the water column can contribute to higher turbidity. As these particles enter the lake they slowly fall through the water column and accumulate at the bottom of the lake. Table 4-3 summarizes the average turbidity levels in each layer of Pleasant Lake.

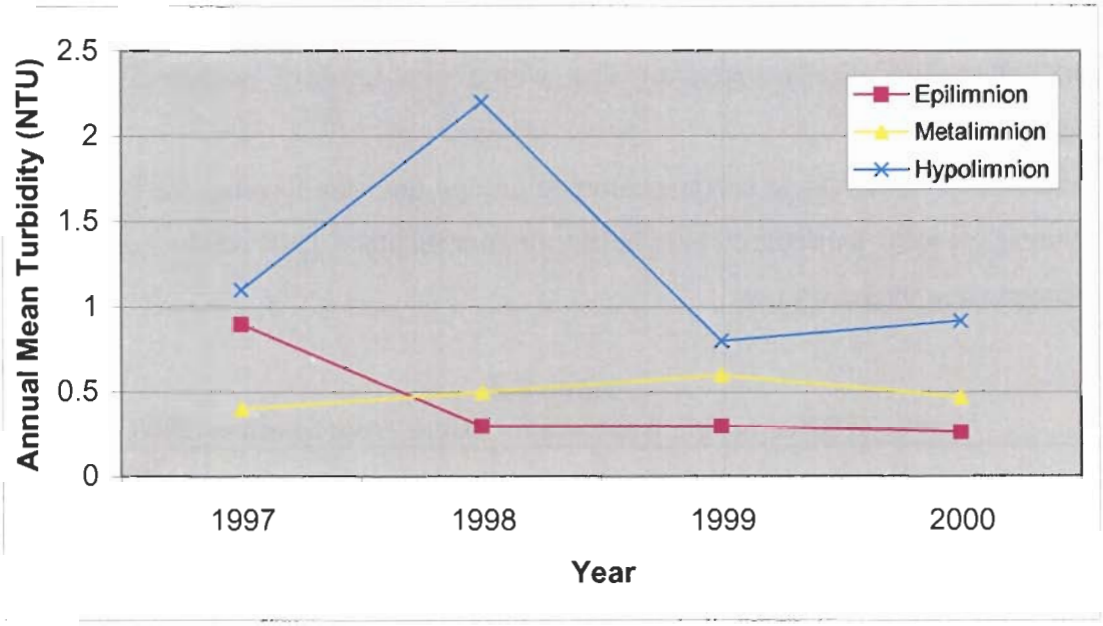
Table 4-3
In-Lake Average Turbidity Levels (NTU)

Sample Depth	Year	Average	Median	Standard Deviation
Epilimnion (surface layer)	1999	0.31	0.33	0.06
	2000	0.26	0.27	0.05
Metalimnion (middle layer)	1999	0.62	0.58	0.21
	2000	0.47	0.43	0.17
Hypolimnion (bottom layer)	1999	1.35	0.91	1.83
	2000	0.92	0.65	0.63

The average turbidity values show that the suspended sediments increase closer to the bottom of the lake. In some lakes, bottom sediments are loose, or flocculent. When the water sampling bottle is sent down to sound the bottom or obtain a sample, these loose sediments may become disturbed, thereby elevating the turbidity levels in the bottom layer of the lake. Boat traffic, with high horsepower engines, can also disrupt the bottom in fairly shallow areas of the lake.

Mean epilimnetic and metalimnetic turbidity for Pleasant Lake during the 1999 and 2000 summer period were lower than the NH VLAP mean of 0.8 NTU for the lakes in that program. The mean hypolimnetic turbidity levels were higher than the NH VLAP mean summer levels (1.0 NTU) during 2000; though the range of the samples varied considerably. It is conceivable that one or two of the readings skewed the average. Overall, however, the turbidity levels in the lake remain low. Figure 4-4 illustrates the trend in turbidity in Pleasant Lake since 1997.

Figure 4-4
Historical In-Lake Turbidity Readings for Pleasant Lake (from VLAP data)



4.1.5 Algae

Algae, or phytoplankton, are the microscopic plants that are free-floating in the water column of the lake. Algae, like plants and trees, photosynthesize. They use energy from the sun, nutrients from the water, and carbon dioxide from the air to produce both their food source

(carbohydrates) and oxygen, which is released to the water and air.

Algae are a necessary component in any waterbody. These small plants are consumed by microscopic animals (zooplankton), aquatic insects, tadpoles, crayfish, fish, and other organisms. The algae are essentially the base of the aquatic food web.

Varying water quality conditions can influence the growth or abundance of algae. Typically, when a waterbody is rich in nutrients it is also abundant in algae. Oftentimes algal blooms can occur, including those caused by nuisance cyanobacteria (that turn the water bluish-green), green algae, diatoms, and golden brown algae.

Because algae are for the most part free-floating (some, like the cyanobacteria can control their location in the water column by regulating their cell buoyancy) blooms may occur only in portions of a waterbody and not in others. Wind, currents, and morphological characteristics of waterbodies can dictate the location of blooms.

The results of the summer 1999 and 2000 plankton analyses are listed in Table 4-4. A mix of diatoms, golden brown algae, dinoflagellate algae, and low numbers of cyanobacteria represent the Pleasant Lake algal communities. The golden-brown algae were typically dominant, with *Synura* and *Dinobryon* as the most abundant species throughout the summer. The overall algal abundance was relatively low, with a usual rating of 'scattered' being assigned to the algae population.

Filamentous green algae become common around the lake, forming the bright green and 'cloudy' algae growths, particularly later in the summer months. This usually occurs during hot and dry summers in Pleasant Lake.

Table 4-4
Results of Microscopic Analyses for Algae from Summer 2000

Date	Species	Algal Groups	Relative Abundance (%)
6/8/00	*Uroglenopsis*	Golden Brown	27
	Synura	Golden Brown	24.1
	Dinobryon	Golden Brown	17.8
6/21/00	*Synura*	Golden Brown	39.2
	Dinobryon	Golden Brown	35.1
	Anabaena	Cyanobacteria	10.5

7/13/00	*Chrysosphaerella*	Golden Brown	44
	Synura	Golden Brown	27
	Dinobryon	Golden Brown	19
7/25/00	*Chrysosphaerella*	Golden Brown	39
	Tabellaria	Diatom	20
	Staurastrum	Green	16
8/8/00	*Dinobryon*	Golden Brown	45
	Tabellaria	Diatom	33
	Synura	Golden Brown	8
8/22/00	*Dinobryon*	Golden Brown	60
	Tabellaria	Diatom	25
	Synura	Golden Brown	4

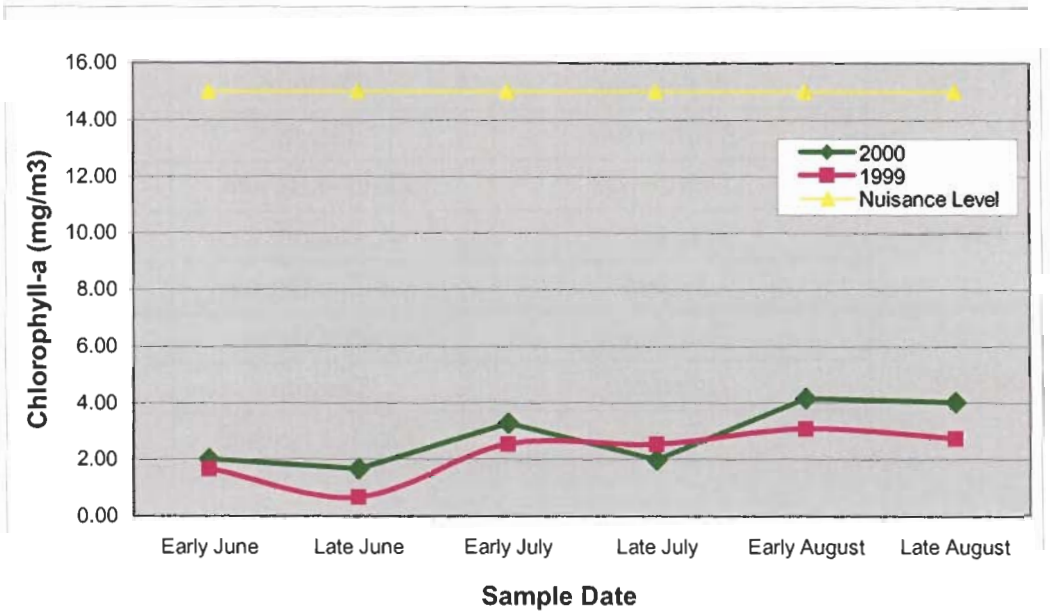
4.1.6 Chlorophyll-a

Chlorophyll-a is the measure of the amount, or density, of the green photosynthetic pigment in algal cells. Measuring chlorophyll-a gives biologists an indication of how much algae is in the water column at any given time. Figure 4-5 shows the trend in chlorophyll-a densities from June 1999 to August 1999, and again from June 2000 through August 2000.

The mean chlorophyll-a value for the summer of 1999 was 2.13 mg/m^3. In 2000, the mean was 2.77 mg/m^3. This has not changed greatly since the surveys conducted in 1982 when a chlorophyll-a reading of 2.68 mg/m^3 was recorded (NHDES Lake Assessment Files, 1982)

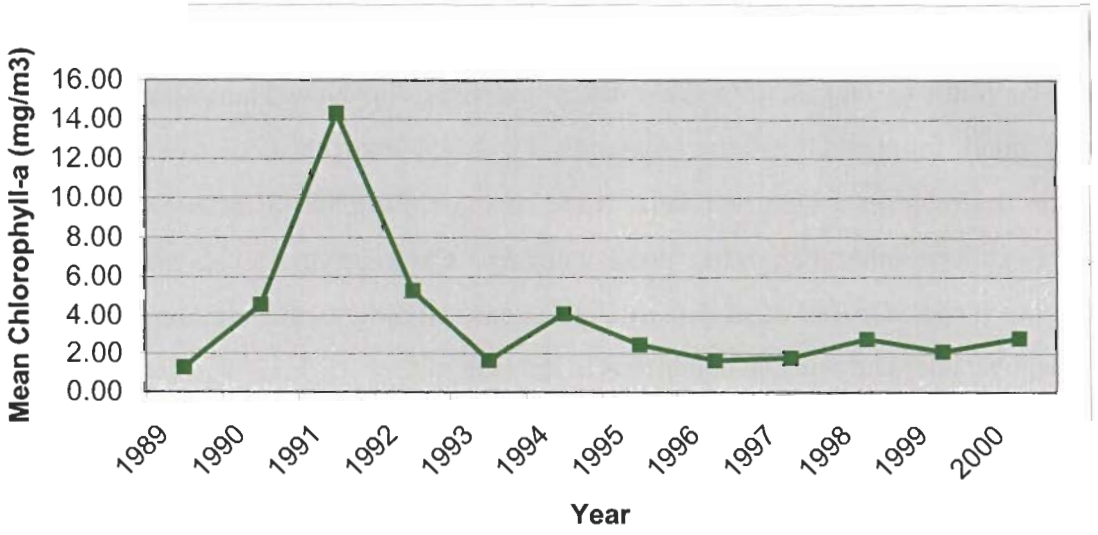
According to ranges from other lakes and ponds in New Hampshire, a range of 0-5 mg/m^3 is 'good' for algal abundance (Appendix 1). Algal abundances between 5.1-15 mg/m^3 are more than desirable in a lake or pond. None of the chlorophyll-a measurements taken from Pleasant Lake were other than in the 'good' category. Chlorophyll-a levels remained well below the nuisance range. Overall algal density did increase slightly as the summer progressed, likely due to ideal weather and nutrient conditions in the lake.

Figure 4-5
Pleasant Lake Chlorophyll-a Levels
June through August, 1999 & 2000



Examining the historical trend in chlorophyll-a for the lake, overall algal abundance has not increased markedly since regular sampling began in 1989. Figure 4-6 shows the trend in chlorophyll-a concentrations in Pleasant Lake.

Figure 4-6
Historical Trends in Chlorophyll-a Concentrations (from VLAP data)



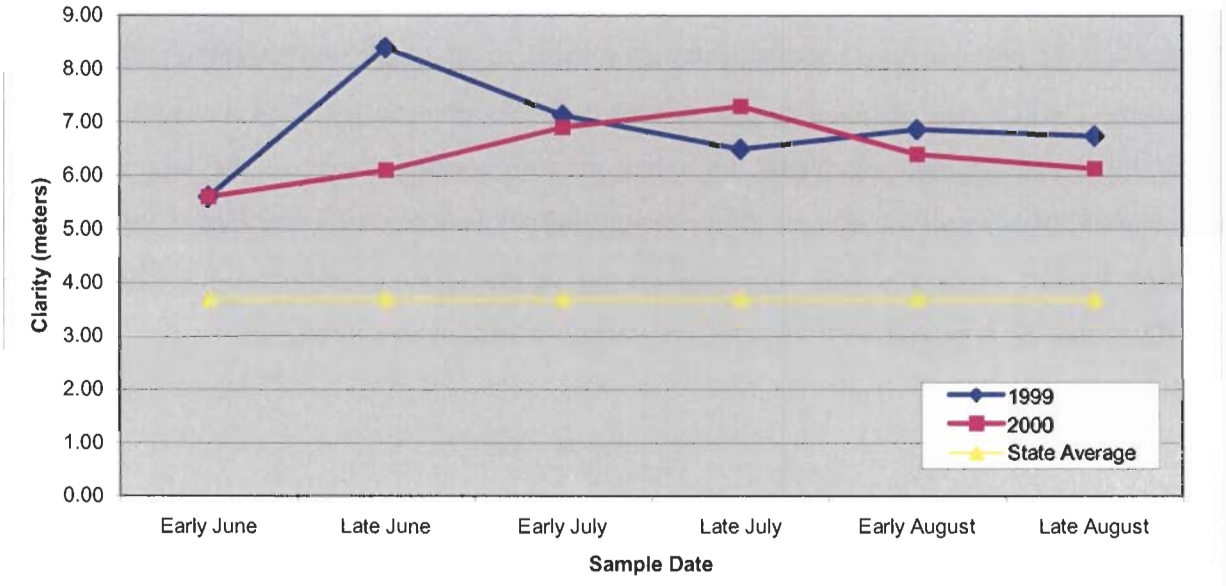
4.1.7 Transparency

Transparency is the measure of water clarity. Algae growth, water color, suspended sediments, waves, and reflection on the water's surface influence water clarity.

Figure 4-7 shows the trends in clarity at Pleasant Lake during the summers of 1999 and 2000, as well as a line indicating the average clarity in New Hampshire lakes and ponds in 2000. Pleasant Lake clarity is higher than the mean clarity of most lakes and ponds in New Hampshire. In 1999, the mean recorded clarity of Pleasant Lake was 6.88 meters, and in 2000 the mean clarity was 6.63 meters.

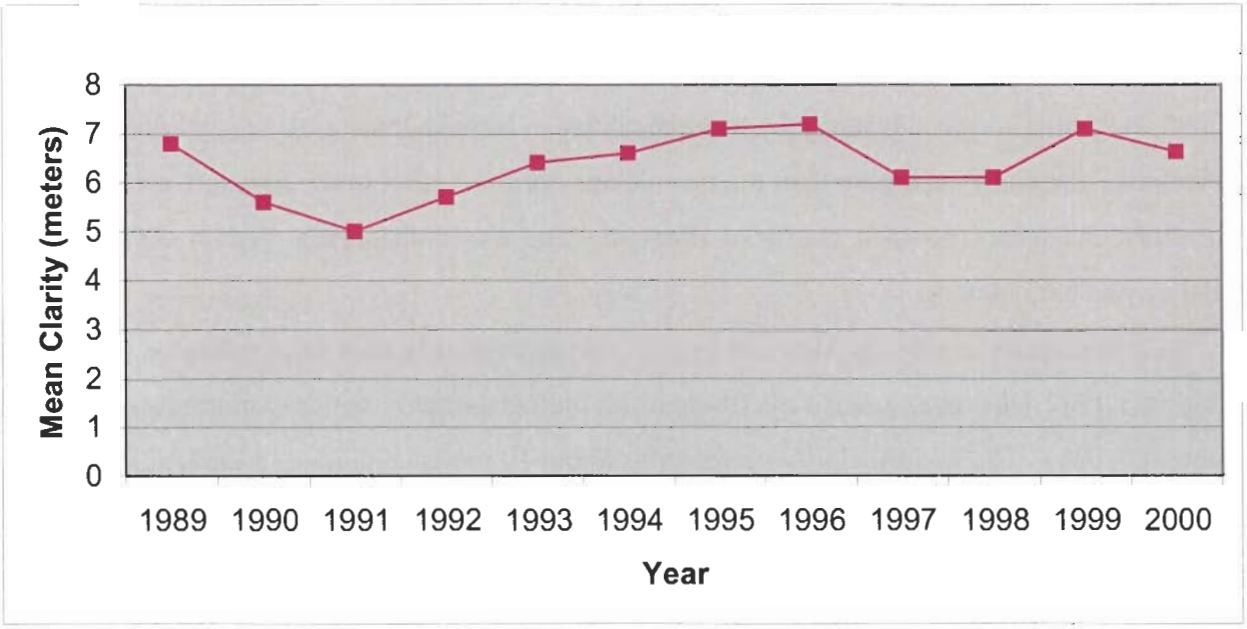
The clarity during the study summers is actually higher than the reading of 4.9 m taken during a 1982 lake assessment visit (though the biologists noted windy conditions on the 1982 sampling day). The highest clarity on record is about 10 meters recorded in the late 1930s by the New Hampshire Fish and Game Department.

Figure 4-7
Pleasant Lake Clarity
June 2000-August 2000



Overall, clarity has been increasing slowly but steadily since 1989 when Pleasant Lake joined VLAP. Figure 4-8 shows the trends in lake clarity since 1989.

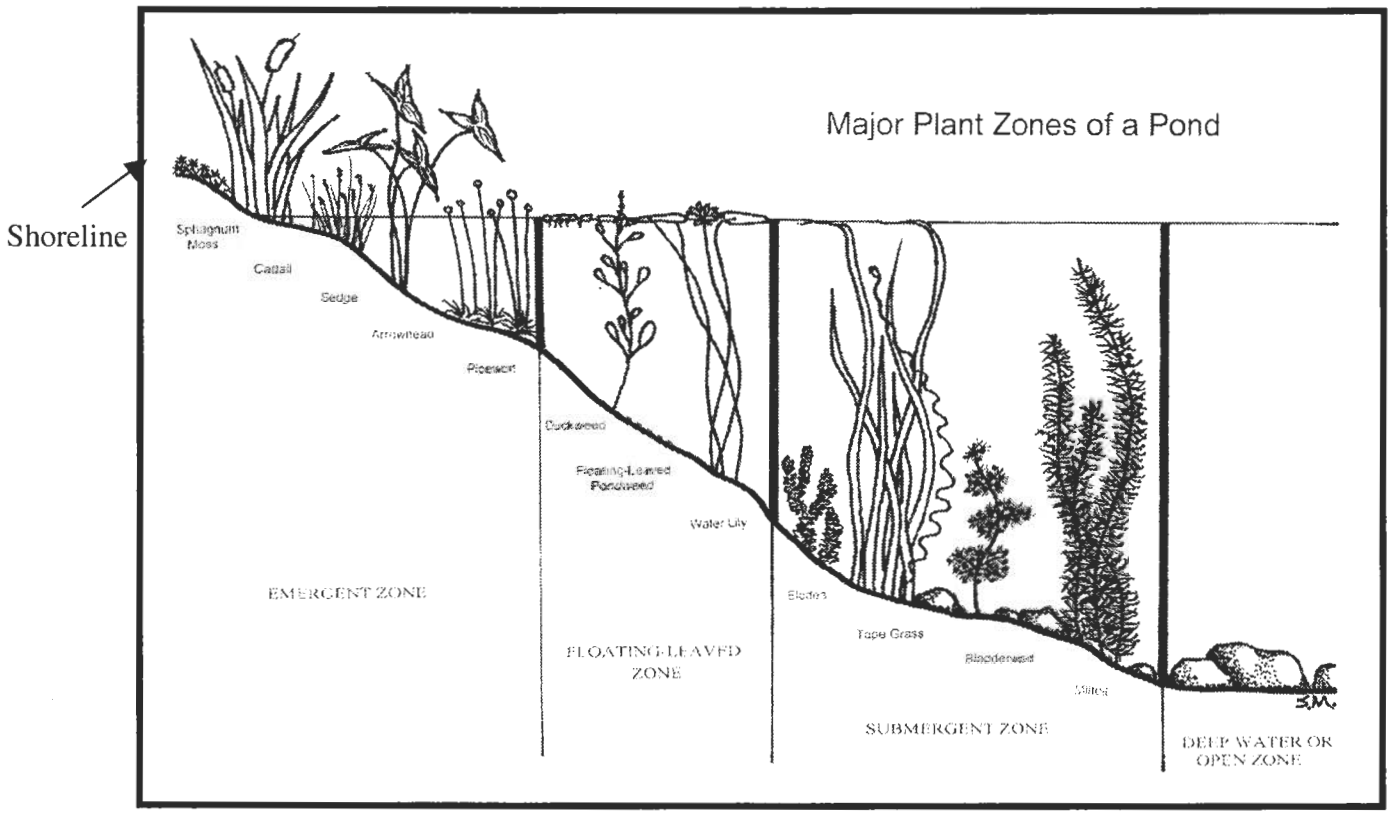
Figure 4-8
Historical Trends in Pleasant Lake Clarity (from VLAP data)



4.1.8 Aquatic Plants

Aquatic plants are another necessary component to a healthy aquatic environment. Aquatic plants provide deep rooting systems to stabilize lake beds and shorelines, they provide surfaces on which algae grow, they produce oxygen, they provide food and nesting materials for many birds and aquatic organisms, and they provide cooling shade to the lake bed. Most importantly, plants provide diverse above-water and below-water structure that many organisms need for habitat, especially fish. These plants can be emergent, submergent or floating. Figure 4-9 illustrates the approximated zonations of various common aquatic plants.

Figure 4-9
Aquatic Plant Zonations*



*Note: Actual depths at which these plants are found can vary considerably depending on water clarity, substrate type, and shoreline configuration.

Aquatic plant surveys of Pleasant Lake were conducted in 1982, 1996, and 2000. Figures 4-9a through 4-9c show the results of each year's plant survey. Tables 4-5a through 4-5c list the symbol, common name, and genus of each of the macrophytes identified during the plant surveys.

The plant community of Pleasant Lake is represented by scattered yellow water lilies, a few species of pondweed, and various rushes and sedges. Scattered patches of the white button-like flowered pipewort can also be found around the lake edge.

Fortunately, Pleasant Lake has been spared the impacts of nuisance growths of exotic plants like milfoil or fanwort, though nearby lakes and streams are affected by such exotics. It is recommended that the Weed Watcher Program be continued to monitor the lake for any possible introductions and infestations.

Figure 4-9a
Pleasant Lake Plant Survey, Summer 1982

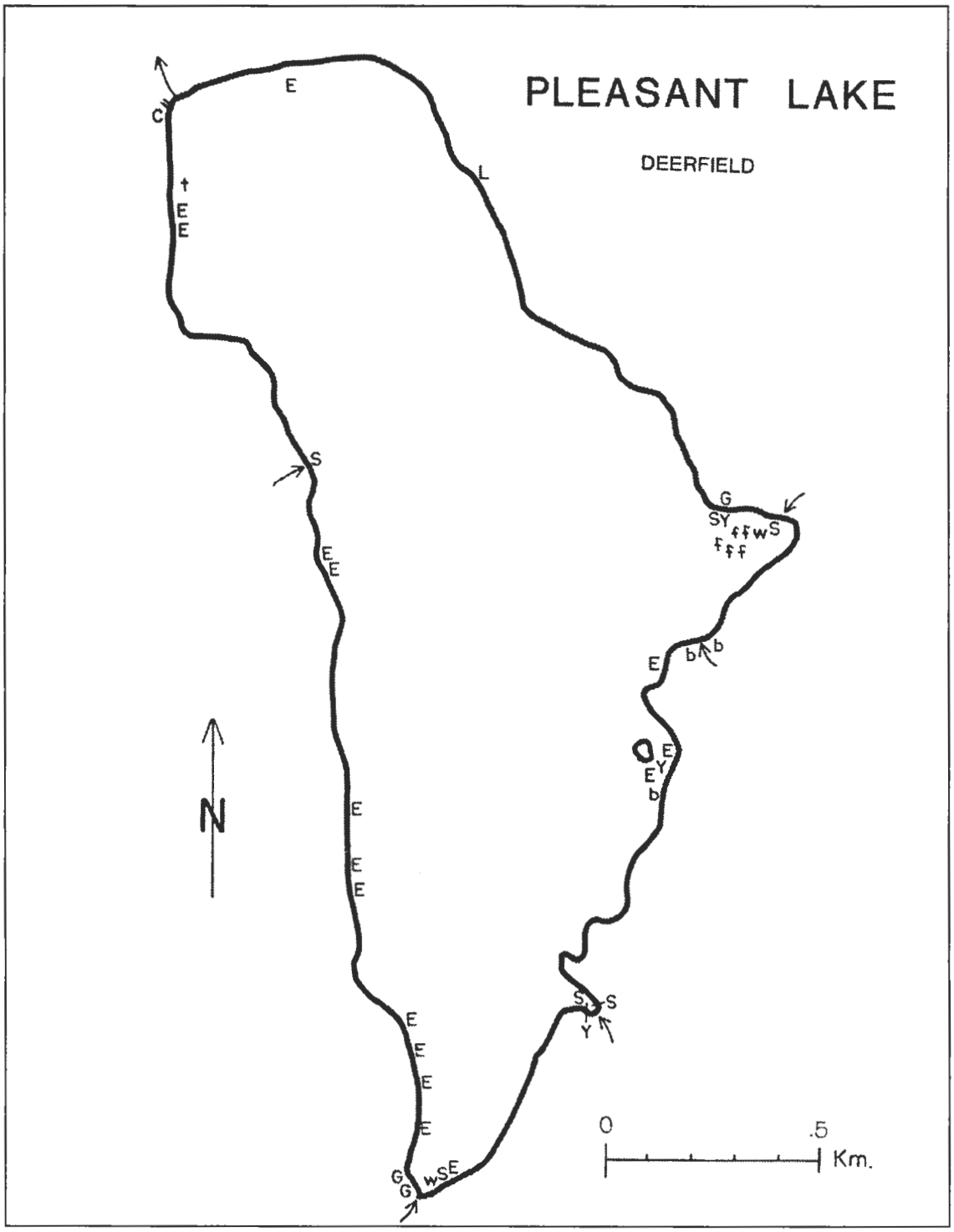


Figure 4-9b
Pleasant Lake Plant Survey, Summer 1996

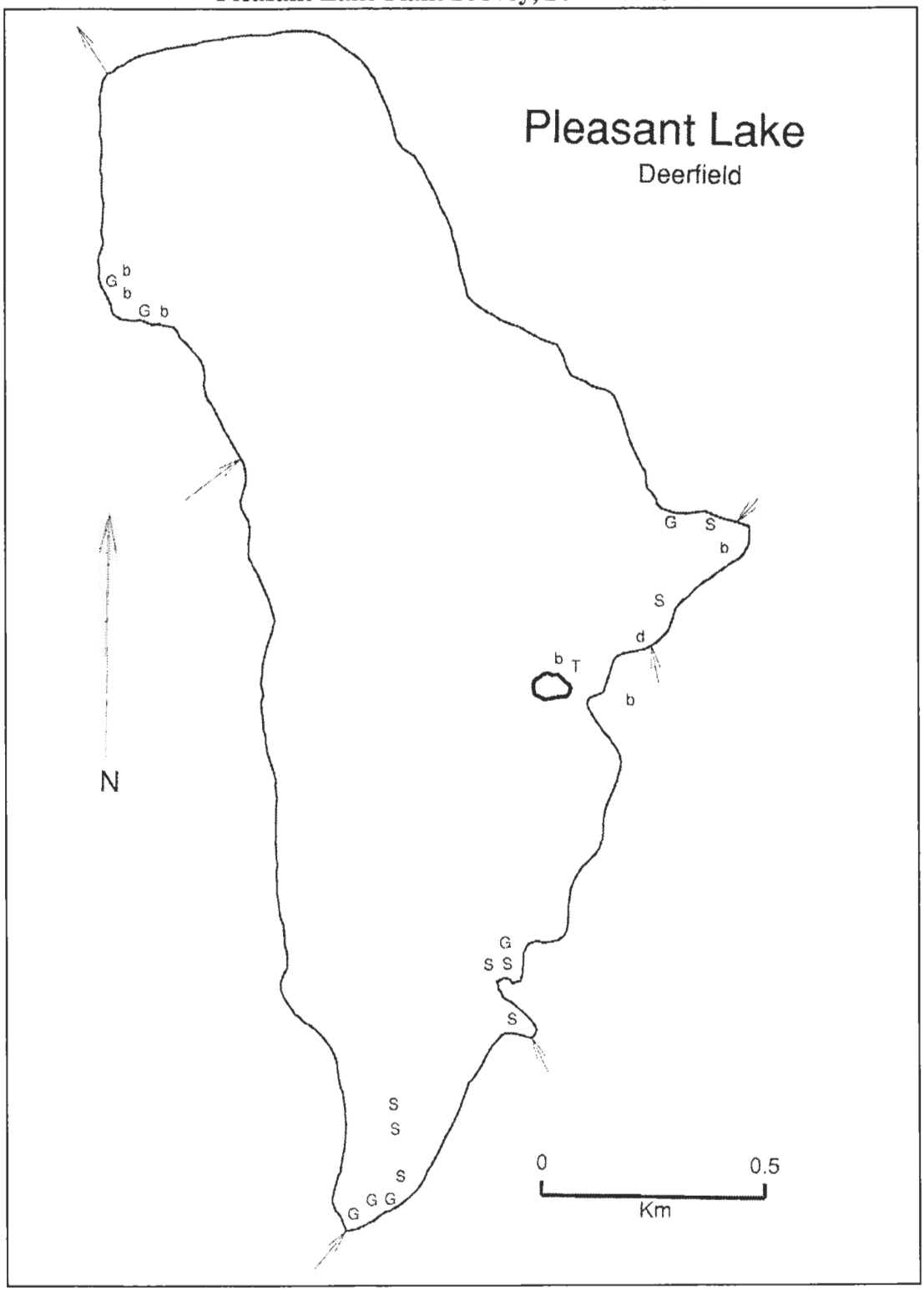


Figure 4-9c
Pleasant Lake Plant Survey, Summer 2000

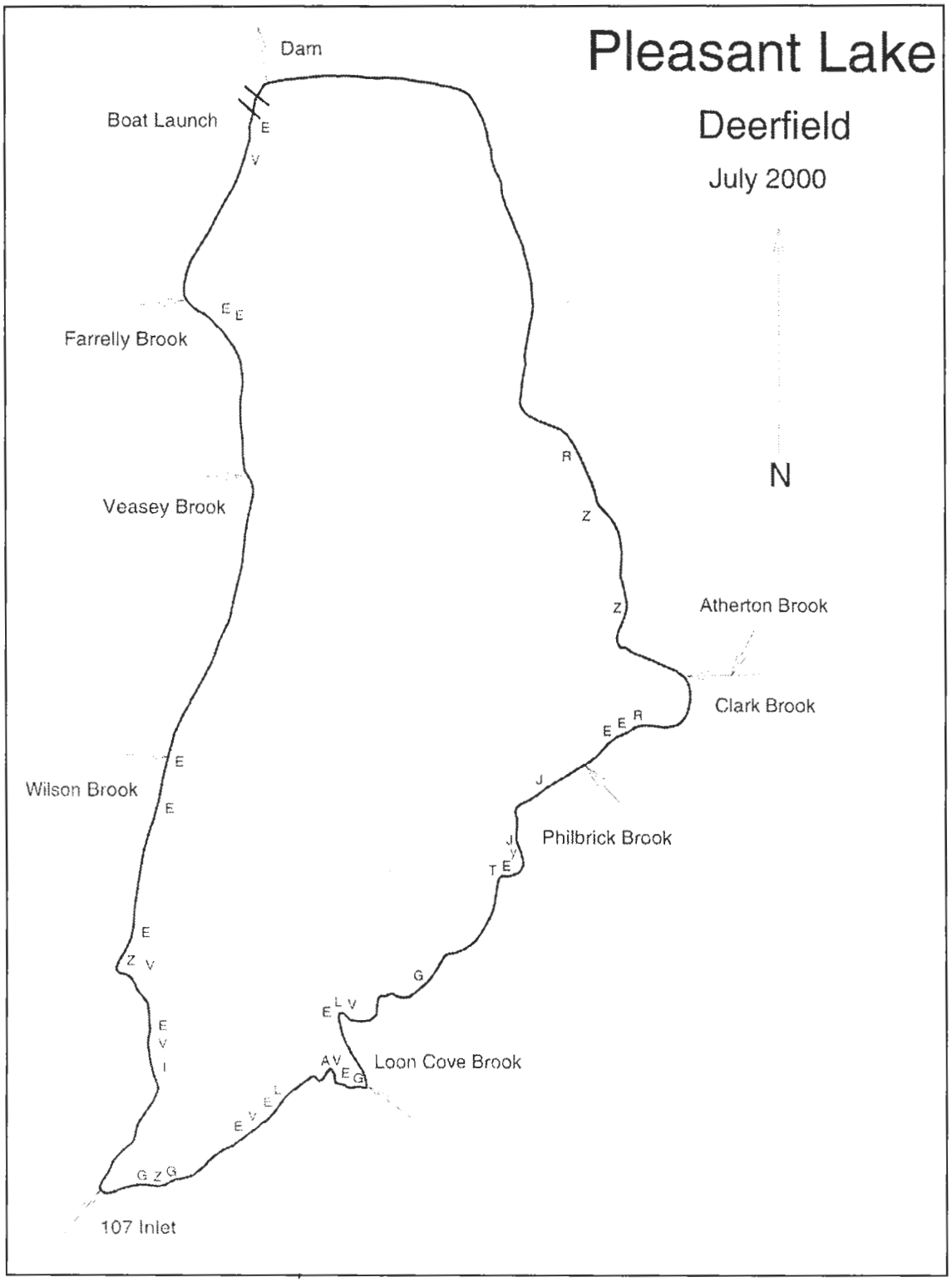


Table 4-5a
Pleasant Lake Plant Survey, Summer 1982

Symbol	Latin Name	Common Name	Abundance
E	*Eriocaulon septangulare*	Pipewort	Scattered
Y	*Nuphar*	Yellow water lily	Sparse
A	*Potamogeton*	Pondweed	Scattered
W	*Potamogeton spp.*	Pondweed	Scattered
b	*Scirpus*	Bulrush	Scattered
f		Green Filamentous Bottom growth	Abundant
C	*Cyperaceae*	Non-flowering sedge	Sparse
t	*Ceratophyllum demersum*	Coontail	Sparse
L	*Lysimachia*	Swamp Candle	Scattered
S	*Sparganium*	Bur-reed	Sparse
G	*Gramineae*	Grass Family	Sparse

Table 4-5b
Pleasant Lake Plant Survey, Summer 1996

Symbol	Latin Name	Common Name	Abundance
T	*Typha*	Cattail	Sparse
Y	*Nuphar*	Yellow Water Lily	Sparse
b	*Scirpus*	Bulrush	Sparse
G	*Gramineae*	Grass Family	Sparse
S	*Sparganium*	Bur-reed	Sparse
d	*Dulichium arundinaceum*	Three-Way Sedge	Sparse

Table 4-5c
Pleasant Lake Plant Survey, Summer 2000

Symbol	Latin Name	Common Name	Abundance
E	*Eriocaulon septangulare*	Pipewort	Scattered
Y	*Nuphar*	Yellow water lily	Sparse
A	*Potamogeton robbinsii*	Pondweed	Scattered
L	*Lobelia dortmanna*	Lobelia	Sparse
I	*Iris*	Iris	Sparse
A		Filamentous Bottom growth	Scattered
J	*Juncus*	Rush spp.	Sparse
T	*Typha*	Cattail	Sparse
G	*Gramineae*	Grass Family	Sparse
Z	*Lysimachia*	Swamp Candle	Scattered
V	*Vallisneria*	Tapegrass	Sparse

4.2 Tributary Data

The following sections of this chapter will describe the results of the water quality data from the tributaries and the outlet of Pleasant Lake collected from September 1999 through August 2000. Raw tributary data can be found in Appendix 6.

Unlike in-lake samples, there are no NH ranges or means calculated for water quality in tributaries. The ranges for lake quality will be loosely applied to the interpretation of data for tributaries (Appendix 1).

4.2.1 pH

Tributary pH was monitored throughout the study period. Table 4-6 shows the average pH values for each tributary in the Pleasant Lake watershed. (Reference Appendix 1 for more information on pH).

Table 4-6
Pleasant Lake Tributary True Mean pH

Tributary	True Mean pH	Median	Standard Deviation
107 Inlet	5.53	5.67	0.30
Atherton Brook	4.34	4.33	0.06
Clark Brook	4.66	4.71	0.15
Farrelly Brook	5.40	5.56	0.53
Loon Cove Inlet	5.61	5.68	0.33
Philbrick Brook	4.86	4.89	0.16
Veasey Brook	5.28	5.37	0.31
Wilson Brook	5.83	5.90	0.29
Outlet	5.98	6.01	0.23

The average pH of lakes and ponds in NH is about 6.5 units (not true mean pH). The tributary pH values for Pleasant Lake fall below the state mean of almost 800 lakes and ponds, and are within the 'endangered' range for New Hampshire surface waters. When pH values fall below a pH of 6, these waters may become too acidified for some wildlife species. The pH of streams may be affected by acid rain, soil characteristics, land use patterns, photosynthesis and decaying plant materials.

The data show that the pH of the water leaving the lake is higher than the pH of the water

entering the lake. As algae and plants in the surface waters of Pleasant Lake photosynthesize they increase the pH of the surface water. For the most part, the water flowing out of the lake in the summer is representative of the pH in the upper layer of the lake.

Because the soils and the rocks in the Pleasant Lake watershed have very few minerals to buffer against acid additions, tributary water is not buffered before it enters the lake.

4.2.2 Conductivity

Tributary conductivity values can be indicative of subwatershed pollution. When conductivity values in tributaries are elevated it can be the result of road salt runoff, fertilizer runoff, septic system inputs, land use patterns and natural soil characteristics in the subwatershed. It is important to monitor conductivity to determine if there are any potential water quality problems within a tributary subwatershed. Table 4-7 lists the average tributary conductivity values for Pleasant Lake.

Table 4-7
Pleasant Lake Tributary Average Conductivity (µmhos/cm)

Tributary	Mean	Median	Standard Deviation
107 Inlet	50.10	46.04	14.01
Atherton Brook	77.53	80.69	8.83
Clark Brook	48.76	42.09	17.85
Farrelly Brook	139.42	123.8	44.45
Loon Cove Inlet	76.07	76.63	13.01
Philbrick Brook	24.71	25.40	5.81
Veasey Brook	167.28	164.22	28.97
Wilson Brook	55.39	51.23	15.83
Outlet	68.05	67.03	3.10

Conductivity values between the Pleasant Lake subwatershed tributaries are variable. The lowest mean conductivity was recorded at Philbrick Brook, a seasonal stream that tends to dry up as the summer progresses. This stream is derived from a forested wetland that is relatively unimpacted by development. Farrelly Brook and Veasey Brook had the highest mean conductivity values throughout the study period. Both of these tributaries cross under Route 107 and are frequently subjected to road runoff, road salting, and erosion from development, which

could influence their conductivity values.

It was at first thought that the higher conductivity levels in Farrelly Brook were the result of development in the subwatershed. After bracketing the stream it was determined that the higher conductivity levels stem from the source, at the top of the watershed, where there is no influence from development. The stream starts off as seeps from the ground, and the conductivity at these seeps is similar to those readings recorded closer to the lake.

4.2.3 Turbidity

Table 4-8 summarizes the average turbidity levels for the Pleasant Lake tributaries.

Table 4-8
Pleasant Lake Average Tributary Turbidity (NTU)

Tributary	Mean	Median	Standard Deviation
107 Inlet	0.74	0.28	0.10
Atherton Brook	0.59	0.43	0.56
Clark Brook	1.05	0.45	1.99
Farrelly Brook	1.68	0.71	3.25
Loon Cove Inlet	0.89	0.72	0.56
Philbrick Brook	0.55	0.33	0.54
Veasey Brook	2.72	0.99	4.42
Wilson Brook	0.35	0.19	0.29
Outlet	0.70	0.47	0.61

Veasey Brook and Farrelly Brook had the highest mean tributary turbidity during the study period. The elevated mean turbidity in Farrelly Brook is likely due to roadside drainage ditch erosion feeding sediment into the stream. Portions of the stream channel on the west side of Route 107 are comprised of gravelly and sandy substrates that were eroding throughout the study period. This stream also receives considerable road runoff from drainage ditches along Route 107. Road salting and sanding, erosion from steep slopes, and erosion in the drainage channels have all been documented during the study. Also, both of these streams had considerable fluctuations in turbidity levels as shown by the larger standard deviations.

As streams enter the lake, heavier sediment particles will settle out closer to the mouth of the stream. This will eventually build up over time and cause shifts in the stream channel as it

enters the lake, possibly altering flow. Lighter sediment particles will travel farther into the lake with the flow of the stream, and may settle and accrete in slightly deeper waters.

For the most part there does not appear to be an excess amount of sediment entering the lake. Observations of substrates at the mouth of the tributaries do not indicate areas of significant deposition.

5.0 WATERSHED MANAGEMENT AND LAKE PROTECTION

From a review of the data collected during the two-year diagnostic study of Pleasant Lake and its surrounding watershed, NHDES has documented that certain activities around the watershed may be contributing to the decrease in overall water quality over time. It is important to note that the lake is classified as oligotrophic, though two of the three models depict trends towards the mesotrophic classification. This indicates that the lake is clearly showing signs of excess phosphorus inputs, and that lake aging may be accelerated because of those additions. Now is the time to take action to prevent the further degradation of Pleasant Lake.

The following observations and recommendations have been formulated to help maintain the current trophic status of the lake through slowing the aging process, and to perhaps increase the water quality over time through conscientious watershed management. For each section in this chapter, a review of the general ecological and biological impacts will be made, followed by recommendations, related rules and statutes (if applicable), and finally a summary of the areas of concern around Pleasant Lake.

5.1 Stormwater Management and Erosion Control

Development of residential areas around the lake has two main effects on stormwater. The first is the increase in the volume and rate of runoff as development occurs in a watershed. The second effect is the significant increase of phosphorus loading, which would result in the degradation of not only the surface water, but the groundwater as well (Regional County Conservation Districts (RCCD), 1992). In addition to promoting erosion and sedimentation, increased runoff acts as a medium for transporting pollutants which can contaminate surface waters and contribute to cultural eutrophication (human induced and accelerated eutrophication).

When development occurs, vegetation is removed and replaced with impervious surfaces. These surfaces include roads, streets, parking lots, rooftops, paved driveways and walkways, etc., which reduce the surface area for runoff filtration into the soil. The result is more untreated runoff entering into the surface water system directly. Natural drainage patterns are also modified as a result of development, and runoff is transported via road ditches, drainage swales and constructed channels. This can be seen by the many culverts used in road construction around Pleasant Lake, particularly under Route 107.

These modifications concentrate and increase the velocity of the runoff, which in effect decreases the time for runoff to travel through the watershed. The increases in flow and decreased travel time of runoff have adverse impacts on the natural stream channel. The increased runoff volumes caused by residential development cause flooding to occur more frequently which causes the stream channel to widen and deepen to accommodate the increased flows. This natural process of stream channel erosion creates a sediment problem downstream. These observations were made during the two-year field study of Pleasant Lake. The areas of concern were identified by NHDES biologists as sites for implementation of Best Management Practices (BMPs). Figures 5-1 through 5-3 detail particular areas of concern in the Pleasant Lake watershed.

Figure 5-1: Clark Brook Headwall

This picture shows an accumulation of sediment and organic debris over the headwall of the Clark Brook stream channel. Basin Road passes over this stream. During each rain event and snowmelt road runoff brings loose sediment material into the stream. Roadside ditches are bare gravel with no stabilization.

Figure 5-2: Clark Brook Headwall Showing Runoff

The arrow indicates channelized water flow along the sides of the Clark Brook headwall. This flow causes a 'chocolate milk' appearance to the stream on the lake side of the road. Total phosphorus and suspended sediments are higher downstream than upstream.

Figure 5-3: Potential Road Runoff Issues

This picture is typical of road conditions immediately around the lake during the spring season. Though erosion and sedimentation are not yet evident in most locations, continuous freeze-thaw action and use of these roads may eventually wear down the road edges, causing erosion and gullying along the roadside. This could eventually impact water quality if these locations are adjacent to water, or if gullies drain into main tributaries of the lake.

Stormwater management within the Pleasant Lake watershed should focus on developing and implementing appropriate BMPs on a site-specific basis for individual sub-watersheds. Table 5-1 identifies and prioritizes these areas.

Table 5-1
Areas for Stormwater Management BMPs in the Pleasant Lake Watershed

Location	Management Recommendation
Route 107 margins and shoulders	Stabilize drainage ditch and slopes with rip-rap or deep rooting vegetation
Basin Road	Stabilize banks of stream crossings under road and headwalls around culverts
All dirt camp roads	Vegetate or rip-rap soft or eroding shoulders
Area surrounding Loon Cove Brook stream crossing	Stabilize shoulders and headwalls on both sides of road crossing

NHDES, local conservation districts and the Natural Resources Conservation Service (NRCS) can assist in choosing site specific BMPs. Appropriate permits or certifications may be necessary from the New Hampshire Wetlands Bureau, Shoreland Protection Program, and Subsurface Bureau, in addition to any local permits.

Further, the lake association, along with other volunteers, and the Towns of Deerfield and Northwood Departments of Public Works (DPWs), should locate all storm drains and runoff ditches, culverts, and basins within the watershed. Each device or structure should be examined for fitness, including the capacity of the basin, that the basins and the culverts are free of debris

and are regularly inspected and maintained, and that culverts are appropriately seated to prevent break-through flow around the edges of the pipe.

Since a fair amount of the nutrient loading entering Pleasant Lake occurs via direct runoff (31% of the budget), storm water is an obvious focus for reducing nutrient inputs to the lake. Street sweeping and catchment basin flushing or suctioning can be important non-structural practices to reduce stormwater runoff to the lake, especially along Route 107 following winter snow management activities. The intent of these practices is to remove the pollutants before they reach the lake. Dirt roads in the watershed should be inspected, and their shoulders stabilized to prevent runoff from occurring. Riprapping drainage ditches and vegetating settling basins along these dirt roads would do much for lessening sediment transport. These locations are identified in Table 5-1.

Additionally, it is very important to remember that anything that is applied on the land near the lake or near a stream will eventually find its way into the lake. Oils and grease should never be applied to gravel roads to keep dust down. No fertilizers should be used within 25 feet from the reference line (high water mark), and beyond 25 feet (and up to 250 feet) only slow release nitrogen fertilizers with very low phosphorus contents can be used. Conscientious land-use management activities should always be practiced near the lake to prevent any unnecessary contaminants from entering the water. Remember, water is the universal solvent.
Examples of BMPs are included in Appendix 7.

5.2 Beach Erosion

Sand beaches are potentially damaging to the lake due to the filling in of shoreline habitat and the introduction of nutrients into the lake from imported sand (phosphorus binds to sediment particles). For some time, especially at the beginning of the Pleasant Lake Diagnostic Study, Veasey Beach was a large source of sediment to the lake because of repeated sand additions to the beach. Large erosion gullies were evident across the face of the beach, and fresh sand accumulations were evident in the lake following rain events. Figure 5-4 shows Veasey Beach prior to construction.

Figure 5-4: Veasey Beach Prior to Stabilization

Before Veasey Beach was re-graded and stabilized sediment was observed flowing uninhibited into the lake due to poor stormwater and overland runoff management practices. The land gradually sloped down into the lake, and overland runoff from the compacted gravel parking lot would flow across the beach, forming an erosion channel and carrying large amounts of sand into the lake. Now, the beach has been perched, and runoff has been diverted around the beach and into well-stabilized soils so as not to flow over the sand.

Other smaller and private beaches around Pleasant Lake should be stabilized to prevent erosion from occurring. By installing a NHDES Wetland Bureau permitted or perched beach with a diversion trench along the upper limit of sand, overland runoff is diverted around a sloping beach, and rocks at the toe of the sand deposit prevent direct washing of the sand to the lake. The NHDES Wetlands Bureau has further guidelines for establishing perched beaches to reduce the likelihood of erosion and sedimentation. Examples of a perched beach are included in Appendix 8. The Wetlands Bureau not only requires permits for beach construction and replenishment, but also restricts the time interval between beach replenishment to once every 6 years with a permit.

It is recommended that the Pleasant Lake Association and the Town of Deerfield continue to monitor Veasey Beach during heavy rain and snowmelt events to determine if the reconstruction continues to prevent erosion from occurring.

5.3 Septic System Management

All of the homes directly around Pleasant Lake are on subsurface systems or holding tanks. It is very important to have residents aware of where their systems are located, how old the systems are, and the need to have them regularly pumped and examined by a specialist. It is recommended that shorefront residents pump their systems every 1-3 years, preferably yearly.

From the 1999/2000 septic system surveys conducted around Pleasant Lake, it was determined that 38% of the septic systems survey respondents have systems that have reached or

exceeded their designed life span (most septic systems, when properly maintained, have a life expectancy of 15-20 years). Other studies conducted on New Hampshire lakes (Connor et al., 1992, and Connor and Bowser, 1997) concluded that much of the phosphorus from septic systems, regardless of their design or age, reach the groundwater, and from there the nutrient is transmitted to the shallow areas of the lake. More information on septic systems and alternatives can be found in Appendix 9.

Recommendations for Subsurface Systems

The Pleasant Lake watershed residents should consider alternative disposal systems, such as a community septic system. If alternate systems are not a consideration, water conservation efforts should be made, and an organized pumpout program should be developed. There may be a cost reduction by having many residents around the lake coordinate a day or two once a year to have septic systems pumped by one company.

5.4 Shoreland Protection Activities

The theme throughout this study has been that activities taking place within the watershed affect the quality of the lake and other downstream surface waters. Evaluating this theory on a closer level, it should be evident that activities that take place directly adjacent to the lake are especially impacting to water quality (for both overland flow and tributary flow).

The Comprehensive Shoreland Protection Act (CSPA) establishes guidelines for activities taking place within 250 feet of the high water line of the lake (or the elevation of the top of the dam), commonly called "the protected shoreland." The activities addressed within these rules include building, development, and forestry activities, to name a few. A complete copy of "The Protected Shoreland" guide to the Comprehensive Shoreland Protection Act can be found online at *www.des.state.nh.us*, or can be purchased through the NHDES Public Information Center at 271-2975. General fact sheets and a list of native plantings recommended by the Shoreland Protection Act can be found in Appendix 10.

It has been shown that maintaining or establishing a well-vegetated buffer along a water body can minimize erosion and nutrient inputs from the land surrounding the lake. In addition, establishing building and accessory structure setbacks allows for a buffer of natural land surrounding the lake for infiltration and uptake of nutrients prior to their entering the lake. Since

a lot of the immediate shoreline area around Pleasant Lake is already developed, maintaining the trees that are still standing is now critical.

In addition to establishing setbacks, the Comprehensive Shoreline Protection Act provides lists of native plants, shrubs, and trees that could be used to revegetate shorefront properties. Residents of shoreline areas must maintain a healthy, well-distributed stand of trees, shrubs, and groundcovers. These plants not only serve to take up nutrients and stabilize soils, but they also provide privacy and shade.

Native plant sales are offered by a number of state and local offices. The Department of Resources and Economic Development has a nursery that is specific to species native to New Hampshire. Local and county conservation districts also have annual plant and tree sales to promote the use of native species. The lake association is encouraged to identify local native plant sales and publicize them in their newsletters.

Residents of the Pleasant Lake area who reside along the lake shorelines must be aware of the provisions of the Comprehensive Shoreland Protection Act, and both towns and the Pleasant Lake Association must cooperate in enforcement of this law.

5.5 Zoning

The purpose of a zoning ordinance is to regulate the use of land in a manner that promotes the health and welfare of a municipality. It includes requirements to lessen congestion, secure safety from fires, panic and other dangers, to provide adequate light and air, to prevent the overcrowding of land and to avoid undue concentrations of populations. Ordinances need to be designed to facilitate the adequate provision of an infrastructure to meet municipal needs for such services as transportation, solid waste facilities, water, sewerage, schools and parks.

Some towns also establish ordinances that pertain to surface water protection in their town's watersheds. These may include environmental characteristics, like wetlands zoning, to protect special or unique natural resources. The Towns of Deerfield and Northwood have included a number of environmental protection provisions within their respective town zoning ordinances, as shown below, but both towns should work towards enacting ordinances that are consistent on both sides of the lake through the creation of an environmental protection overlay or watershed district. Grants may also be available to aid towns in these activities.

Following is a summary of the zoning ordinances in each town. The type of zoning is briefly described, and then any zoning regulations that Northwood or Deefield has that pertains to that category of zoning is inserted into this document.

Deerfield Wetlands Zoning

Section 210 Wetlands Conservation District

210.1 Purpose: The purpose of this ordinance is to protect the public health, safety and general welfare by controlling and guiding the use of land areas that have been found to be subjected to high water tables for extended periods of time.

It is intended that this ordinance shall:

A. Control the development of structures and land uses on naturally occurring wetlands that will contribute to pollution of surface and ground water by sewage or toxic substances.

B. Prevent the destruction of, or significant changes to natural wetlands that provide flood protection, groundwater recharge, pollution abatement, and augmentation of stream flow during dry periods.

C. Protect unique and unusual natural areas.

D. Protect wildlife habitats and maintain ecological balances.

E. Prevent expenditure of municipal funds for the purposes of providing and/or maintaining essential services and utilities, which might be required as a result of misuse, or abuse of wetlands.

F. Encourage those low-intensity uses that can be harmoniously, appropriately and safely located in wetlands.

G. Docks, Open Decks, and Stairways: Docks, Open Decks, and Stairways proposed to be located within the building setback from any body of water, including rivers, streams, lakes, or ponds shall be subjected to obtaining a Special Exception from the Zoning Board of Adjustment. No such improvement shall be enclosed. All other required permits from other regulatory agencies shall be obtained before making application to the Board of Adjustment.

210.2 Wetlands Defined: Soil series and land types commonly associated with wetlands, as described by the "Soil Information For Resource Planning, Town of Deerfield, Rockingham County, New Hampshire" dated June, 1985, include the following "very poorly drained" and "poorly drained soils":

"Very Poorly Drained" Soils:

Scarboro, fsl-15
Greenwood and Ossipee soils, ponded-197
Chocorua mucky peat-6 and 395
Greenwood mucky peat-295
Scarboro muck, very stony-549
Ossipee mucky peat-495

"Poorly Drained" Soils:

Ridgebury very fine sandy loam—646
Ridgebury very fine sandy loam, very stony—647
Walpole very fine sandy loam, very stony—547
Rayham silt loam—533
Pipestone sand—214
Rippowam-Pootatuck complex—4 & 5

210.3 District Boundaries:

A. The Deerfield Wetlands Conservation District is defined as those areas of the town that contain marshes, ponds, bogs, lakes, streams and rivers as well as soils that are defined as poorly or very poorly drained by the National Cooperative Soil Survey conducted by the U.S. Department of Agriculture Soil Conservation Service. Poorly drained soils less than one quarter (1/4) acre in area shall be excluded from definition provided that these soils are at least one hundred feet (100') from any wetlands.

B. "Town of Deerfield Wetlands Conservation District Map" is hereby deemed to be a part of the official zoning map of the Town of Deerfield.

C. Wetlands incorrectly delineated: where it is alleged that an area has been incorrectly delineated as a wetland, or that an area not so designated meets that criteria for wetland designation, the Planning Board shall determine whether the regulations contained herein have application.

The Planning Board shall make their judgment under this section only upon the determination by a qualified soil scientist(s) and/or plant scientist(s) on the basis of additional on-site investigation or other suitable research that the information contained on the Wetlands Map is incorrect. This evidence shall be acceptable only when presented in written form by said scientist(s) to the Planning Board. Any necessary soil testing procedures shall be conducted at the expense of the landowner or developer.

210.4 Relation to Other Districts: Where the Wetlands Conservation District is superimposed over another zoning district; the more restrictive regulations shall apply.

210.5 Permitted Uses:

A. Poorly Drained Soils: Permitted uses in areas of poorly drained soils are as follows:

1. Agriculture, including grazing, hay production, truck gardening and silage production provided that such use is shown not to cause significant increases in surface or groundwater contamination by pesticides or other toxic or hazardous substances and that such use will not cause or contribute to soil erosion.

2. Forestry and tree farming to include the construction of access roads for said purposes.

3. Wildlife habitat development and management.

4. Recreational uses consistent with the purpose and intent of this section as defined in Part A.

5. Conservation areas and nature trails.

6. Water impoundment and the construction of well water supplies.

7. Drainage ways to include streams, creeks, or other paths of normal runoff water and common agricultural land drainage.

8. Any use otherwise permitted by the Zoning Ordinance and state and federal laws that does not involve the erection of a structure or that does not alter the surface configuration of the land by the addition of fill or by dredging except as a common treatment associated with a permitted use.

B. Very Poorly Drained Soils: Permitted uses in areas containing very poorly drained soils, marshes, bogs, open water and major streams are as follows:

1. Use specified under Part 210.5.A (1 through 8) above shall be permitted except that no alteration of the surface configuration of the land by filling or dredging and no use which results in the erection of a structure, except as provided for in Part 210.5.B.2 below, shall be permitted.

2. The construction of fences, foot bridges, catwalks, and wharves only, provided: (1) said structures are constructed on posts or pilings so as to permit the unobstructed flow of water; (2) the natural contour of the wetland is preserved; and, (3) the Planning Board has reviewed and approved the proposed construction.

210.6 Conditional Use:

A. A Conditional Use Permit may be granted by the Planning Board (RSA 674:21,II) for the construction of roads and other access ways, and for utility pipelines, power lines, and other transmission lines provided that all of the following conditions are found to exist:

1. The proposed construction is essential to the productive use of land not within the Wetlands Conservation District.

2. Design and construction methods will be such as to minimize detrimental impact upon the wetland and will include restoration of the site as nearly as possible to its original grade and condition.

3. No alternative route that does not cross a wetland or has less detrimental impact on the wetland is feasible.

4. Economic advantage alone is not reason for the proposed construction.

B. Prior to granting of a Conditional Use Permit under this Part, the applicant shall agree to submit a performance security to the Board of Selectmen. The security shall be submitted in a form and amount, with surely and conditions satisfactory to the Selectmen and approved by Town Council, to ensure that the construction has been carried out in accordance with the approved design. The security shall be submitted and approved prior to the issuance of any permit authorizing construction.

C. The Planning Board, with the concurrence of the Conservation Commission, may require the applicant to submit an environmental impact assessment when necessary to evaluate an application made under this Part. The cost of this assessment shall be borne by the applicant. The Planning Board may also assess the applicant reasonable fees to cover the costs of other special investigative studies and for review of documents required by particular applications.

210.7 General Provisions:

A. No septic tank or leach field may be constructed or enlarged closer than seventy-five (75) feet to any wetland.

B. No part of areas designated as having very poorly drained soils, or bodies of water, may be used to satisfy minimum lot size.

C. Areas designated as having poorly drained soils may be used to fulfill up to 25% of the minimum lot size required by town ordinances and subdivision regulations, provided that the non-wetland area is sufficient in size and configuration to adequately accommodate all required utilities such as sewage disposal and water supply, including primary and auxiliary leach field locations.

D. All land included in the Wetlands Conservation District shall be appraised for tax purposes at its full and true value in money, based on the market value as undevelopable land required to remain in open space.

E. No building shall be erected within 75 feet of any wetland.

210.8 Separability: If any section, provision, portion, clause or phrase of this ordinance shall be held to be invalid or unconstitutional by any court or competent authority, such holdings shall not affect, impair or invalidate any other section, provision, portion, clause or phrase of this ordinance.

210.9 Conflict With Other Regulations: Where any provision of this ordinance is in conflict with State law or other local ordinance, the more stringent provision shall apply.

210.10 Special Exception for Non-Conforming Lots: Upon application to the Board of Adjustment, a special exception shall be granted to permit the erection of a structure within the Wetlands Conservation District on vacant lots provided that all of the following conditions are found to exist:

A. The lot upon which an exception is sought is an official lot of record, as recorded in the Rockingham County Registry of Deeds, prior to the date on which this amendment was posted and published in the town.

B. The use for which the exception is sought cannot feasibly be carried out on a portion of portions of the lot, which are outside the Wetlands Conservation District.

C. Due to the provisions of the Wetlands Conservation District, no reasonable and economically viable use of the lot can be made without the exception.

D. The design and construction of the proposed use will, to the extent practical, be consistent with the purpose and intent of this Section.

E. The proposed use will not create a hazard to individual or public health, safety and welfare due to the loss of wetland, the contamination of groundwater, or other reason.

The Board of Adjustment may themselves, or upon petition from the Building Inspector, Conservation Commission or abutters, hire a qualified consultant or consultants to prepare such studies necessary to determine whether the conditions set forth above have been met. The cost of such studies shall be borne by the applicant.

210.11 Exception of Residential Structures: Not withstanding other provisions of this Section, the construction of additions and extensions to one and two family dwellings shall be permitted

within the Wetlands Conservation District provided that: (1) the dwelling lawfully existed prior to the effective date of this Section; and (2) that the proposed construction conforms with all other applicable ordinance and regulations of the Town of Deerfield.

210.12 Exception for Existing Septic System Permits: Any septic system design approved for construction by the State of New Hampshire Water Supply and Pollution Control Commission, for which date of approval is prior to the effective date of this Section, will be valid for building permit approval.

210.13 Docks, Open Decks, and Stairways: Docks, open decks, and stairways proposed to be located within the building setback from any body of water, including rivers, streams, lakes, or ponds shall be subjected to obtaining a Special Exception from the Zoning Board of Adjustment. No such improvement shall be enclosed. All other required permits from other regulatory agencies shall be obtained before making application to the Board of Adjustment.

Section 211 Floodplain Development Regulations

A. Applicability

These floodplain development regulations shall overlay and supplement the regulations in the Town of Deerfield Zoning Ordinance, and shall be considered part of the Zoning Ordinance for purposes of administration and appeals under state law. If any provision of these regulations differs or appears to conflict with any other provision of the Zoning Ordinance or other ordinance or regulation, the provision imposing the greater restriction or more stringent standard shall be controlling.

The following regulations shall apply to all lands designated as "Special Flood Hazard Areas" by the Federal Emergency Management Agency (FEMA) in its Flood Insurance Rate Maps dated September 1, 1989 that are declared to be a part of this Ordinance and are hereby incorporated by reference.

B. Definition of Terms

The following definitions shall apply only to these floodplain development regulations, and shall not be affected by the provisions of any other ordinance of the Town of Deerfield.

1. "Area of Special Flood Hazard" is the land in the Town of Deerfield subject to a one-percent or greater possibility of flooding in any given year. The area is designated as Zone A on the FIRM.

2. "Base Flood" means the flood having a one-percent possibility of being equaled or exceeded in any given year.

3. "Basement" means any area of a building having its floor sub grade on all sides.

4. "Building"- see "Structure."

5. "Development" means any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operation.

6. "FEMA" means that Federal Emergency Management Agency.

7. "Flood" or "Flooding" means a general and temporary condition of partial or complete inundation of normally dry land areas from:

a. the overflow of inland or tidal waters; or

b. the unusual and rapid accumulation or runoff of surface waters from any source.

8. "Flood Insurance Rate Map" (FIRM) means an official map incorporated with this

Ordinance, on which FEMA has delineated both the special flood hazard areas and the Risk premium zones applicable to the Town of Deerfield.

9. "Floodplain" or "Flood-prone Area" means any land area susceptible to being inundated by water from any source (see definition of "Flooding").

10. "Flood Proofing" means any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitation facilities, structures and their contents.

11. "Floodway" -see "Regulatory Floodway."

12. "Functionally Dependent Use" means a use that cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking and port facilities that are necessary for the loading/unloading of cargo or passengers, and ship building/repair facilities, but does not include long-term storage or related manufacturing facilities.

13. "Highest Adjustment Grade" means the highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

14. "Historic Structure" means any structure that is:

a. Listed individually in the National Register of Historic Places (a listing maintained by the Department of the Interior) or preliminary determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register;
b. Certified or preliminary determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminary determined by the Secretary to qualify as a registered historic district;

c. Individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the Secretary of the Interior; or

d. Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either:

(1) By an approved state program as determined by the Secretary of the Interior, or

(2) Directly by the Secretary of the Interior in states without approved programs.

15. "Lowest Floor" means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided, that such an enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of these regulations.

16. "Manufactured Home" means a structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities. For floodplain management purpose, the term "manufactured home" includes park trailers, travel trailers, and other similar vehicles placed on site for greater than one hundred and eighty (180) days.

17. "Mean Sea Level" means the National Geodetic Vertical Datum (NGVD) of 1929 or other datum, to which base flood elevations shown on a community's Flood Insurance Rate Map are referenced.

18. "100-year Flood" - see "Base Flood."

19. "Regulatory Floodway" means the channel of a river, stream or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without increasing the water surface elevation. These areas are designated as floodways on the Flood Boundary and Floodway Map.

20. "Recreational Vehicle" means a vehicle which is (a) built on a single chassis; (b) 400 square feet or less when measured at the largest horizontal projection; (c) designed to be self propelled or permanently towable by a light duty truck; and (d) designed primarily not for use as a permanent dwelling but as temporary living quarters for recreational, camping, travel or seasonal use.

21. "Special Flood Hazard Area" means an area having flood, mudslide, and/or flood-related erosion hazards, and shown on the FHBM or FIRM as zone A, A0, A1-30, AE, or A99. (see- "Area of Special Flood Hazard").

22. "Structure" means, for floodplain management purposes, a walled and roofed building, including a gas or liquid storage tank that is principally above ground, as well as a manufactured home.

23. "Start of Construction" includes substantial improvements, and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, placement, or other improvement was within one hundred and eighty (180) days of the permit date. The actual start means either the first placement of permanent construction of a structure on site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of a manufactured home on a foundation.

Permanent construction does not include land preparation, such as clearing, grading and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation of the property of accessory buildings, such as garages or sheds not occupied as dwelling units or part of the main structure.

24. "Substantial Damage" means damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed fifty (50) percent of the market value of the structure before the damage occurred.

25. "Substantial Improvement" means any combination of repairs, reconstruction, alteration, or improvements to a structure in which the cumulative cost equals or exceeds fifty (50) percent of the market value of the structure. The market value of the structure should equal: (a) the appraised value prior to the start of the initial repair or improvement, or (b) in the case of damage, the value of the structure prior to the damage occurring. For the purposes of this definition, "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. This term includes structures that have incurred substantial damage, regardless of actual repair work performed. The term does not, however, include any project for improvement of a structure required to comply with existing health, sanitary, or safety code specifications which are solely necessary to assure safe living conditions or any alteration of an "historic structure," provided that the alteration will not preclude the structure's continued designation as an "historic structure."

26. "Water Surface Elevation" means the height, in relation to the National Geodetic Vertical Datum (NGVD) of 1929, (or other datum, where specified) of floods of various magnitudes and frequencies in the floodplains.

C. Permit Required

All proposed development in any special flood hazard area shall require a building permit.

D. Permit Provisions

The Building Inspector shall review all building permit applications for new construction or substantial improvements to determine whether the proposed building sites will be reasonably safe from flooding. If a proposed building site is located in a special flood hazard area, all new construction or substantial improvements shall:

1. Be designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy;

2. Be constructed with materials resistant to flood damage;

3. Be constructed by methods and practices that minimize flood damages; and

4. Be constructed with electrical, heating, ventilation, plumbing, and air conditioning equipment, and other service facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding.

E. Water Supply and Wastes Disposal

Where new or replacement water or sewer systems (including on-site systems) are proposed in a special flood hazard area, the applicant shall provide the Building Inspector with assurance that these systems will be designed to minimize or eliminate infiltration of flood waters, and that on-site wastewater disposal systems will be located to avoid impairments of them or contamination from them during periods of flooding.

F. Elevations and Floodproofing

For all new or substantially improved structures located in special flood hazard areas, the applicant shall furnish the following information to the Building Inspector:

1. The as-built elevation (in relation to NGVD) of the lowest floor (including the basement) and include whether or not such structures contain a basement.

2. If the structure has been floodproofed, the as-built elevation (in relation to NGVD) to which the structure was floodproofed.

3. Any certification of floodproofing.

The Building Inspector shall maintain for public inspection, and shall furnish such information upon request.

G. Building Permit to be Withheld

The Building Inspector shall not grant a building permit until the applicant verifies that all necessary permits have been received from those governmental agencies from which approval is required by federal or state law, including Section 404 of the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1334.

H. Altered or Relocated Watercourses

1. In riverine situations, prior to the alteration or relocation of a watercourse, the applicant for such authorization shall notify the Wetlands Board of the New Hampshire Department of Environmental Services and submit copies of such notification to the Building Inspector, in addition to the copies required by N.H. RSA 482-A: 3. Further, the applicant shall be required to submit copies of said notification to those adjacent communities, as determined by the Building Inspector, including notice of all scheduled hearings before the Wetlands Board.

2. The applicant shall submit to the Building Inspector, certification provided by a registered professional engineer, assuring that the flood carrying capacity of an altered or relocated watercourse can and will be maintained.

3. The Building Inspector shall obtain, review, and reasonably utilize any floodway data available from Federal, State, or other sources as criteria for requiring that all development located in Zone A meet the following floodway requirement:

"No encroachments, including fill, new construction, substantial improvements, and other development are allowed within the floodway that would result in any increase in flood levels during the base discharge."

I. Building Provisions

1. In unnumbered A zones, the Building Inspector shall obtain, review, and reasonably utilize any 100-year flood elevation data available from any Federal, State, or other source, including data submitted for development proposals submitted to the community (i.e. subdivisions and site plan approvals).
2. The Building Inspector's 100-year flood elevation determination will be used as criteria for requiring in Zone A that:

a. All new construction or substantial improvements of residential structures have the lowest floor (including basement) elevated to or above the 100-year flood elevation;
b. That all new construction or substantial improvements of non-residential structures have the lowest floor (including basement) elevated to or above the 100-year flood level; or together with attendant utility and sanitary facilities, shall:

(1) be floodproofed so that below the 100-year flood elevation, the structure is watertight with walls substantially impermeable to the passage of water;
(2) have structural components capable of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy; and
(3) be certified by a registered professional engineer or architect that the design and methods of construction are in accordance with accepted standards of practice for meeting the provisions of this section;

c. All manufactured homes to be placed within or substantially within special flood hazard areas shall be elevated on a permanent foundation such that the lowest floor of the manufactured home is at or above the 100-year flood elevation; and be securely anchored to resist flotation, collapse, or lateral movement. Methods of anchoring may include, but are not limited to, the use

of over-the-top or frame ties to ground anchors. This requirement is in addition to applicable state and local anchoring requirements for resisting wind forces;
d. For all new construction and substantial improvements, fully enclosed areas below the lowest floor that are subject to flooding are permitted provided they meet the following requirements:

(1) the enclosed area is unfinished or flood resistant, usable solely for the parking of vehicles, building access, or storage;
(2) the area is not a basement; and
(3) shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing the entry and exit of floodwater.

Designs for meeting this requirement must either be certified by a registered professional engineer or architect or must meet or exceed the following minimum criteria: (a) a minimum of two openings having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding shall be provided; (b) the bottom of all openings shall be no higher than one foot above grade; and (c) openings may be equipped with screens, louvers, or other coverings or devices provided that they permit the automatic entry and exit of floodwater.
e. Recreational vehicles placed on sites within Zones A1-30, AH and AE or designated in the Flood Insurance Rate Maps dated September 1, 1989 also known as Flood Hazard Boundary Map shall either (i) be on the site for fewer than 180 consecutive days, (ii) be fully licensed and ready for highway use, or (iii) meet all standards of Section 60.3 (b)(1) of the National Flood Insurance Program Regulations and the elevation and anchoring requirements for "manufactured homes" in Paragraph (c)(6) of Section 60.3.

J. Variances and Appeals

1. Any order, requirement, decision, or determination of the Building Inspector made under these floodplain development regulations may be appealed to the Zoning Board of Adjustment as set forth in N.H. RSA 676:5.

2. If the applicant, upon appeal, requests a variance as authorized by N.H. RSA 674:33,H (b), in determining whether or not any variance will be contrary to the spirit of these regulations, the Board of Adjustment shall consider the following:

a. that the variance will not result in increased flood heights, additional threats to public safety, or extraordinary public expenses;
b. that if the requested variance is for activity within a designated regulatory floodway, no increase in flood levels during the base flood discharge will result; and
c. that the variance is the minimum necessary, considering the flood hazard, to afford relief.

3. The community shall:

a. maintain a record of all variance actions, including their justification for their issuance; and
b. report such variances issued in its annual or biennial report submitted to FEMA's Federal Insurance Administrator.

Northwood Wetlands Zoning

Section 5.00 Overlay Districts (Wetlands)

A. Purpose. In the interest of public health, convenience, safety and general welfare, the regulations of this District are intended to guide the use of areas of land that have soils that are saturated or inundated for extended periods of time during the growing season, and:

1. To allow those uses that can be located appropriately and safely in wetland areas and ensure their proper design.

2. To protect naturally occurring wetlands from pollution of surface and ground water by sewage or other contaminants.

3. To protect potential water supplies and existing aquifers and aquifer recharge areas.

4. To prevent the destruction of wetlands which provide flood protection, recharge of ground water supply, retention of sediments, attenuation of nutrients, augmentation of stream flow during dry periods and continuing existence of important wildlife areas.

5. To protect the Town from unnecessary or excessive expenses in providing or maintaining essential services and/or utilities that might be required as a result of misuse or abuse of wetlands.

B. Overlay District Boundaries. The Wetlands Conservation Overlay District shall include all areas of poorly and very poorly drained soils as defined by the National Cooperative Soil Survey conducted by the US Department of Agriculture in their Soil Survey of Rockingham County, New Hampshire, dated October 1994. Nineteen wetland areas, as listed on page 9 of the "Northwood Wetlands Inventory and Prime Wetland Designation Project Final Report, April 1999" and as identified on the map titled "Prime Wetlands of Northwood, December 1999" are designated prime wetlands within the scope of RSA 482-A: 15 and the NH Code of Administrative Rules WT700 and are included in the district.

1. The location of a wetland boundary in any particular case must be determined by on-sites inspection of all three characteristics of wetlands, namely, hydrology, hydric soils, and hydrophytic plants, as recognized by the Army Corps of Engineers in Technical Report Y-87-1, The Corps of Engineers Wetland Delineation Manual, and as cited in the New Hampshire Wetland Rules WT 101.82. This shall be undertaken by a licensed soil scientist or licensed wetland scientist using the above Army Corps delineation method, the Site-Specific Soil Mapping Standards for New Hampshire or other appropriate standards as listed in the New Hampshire Wetland Rules WT 100 through 800. When such information is submitted, it shall supercede more generalized information, such as that obtained from the county soil survey.

2. If there is question or dispute as to the boundary of this overlay district, the owner of the property or any abutter may petition the Town to hire a licensed soil scientist or licensed wetland scientist to examine the area and report all findings to the Town. The petitioner shall pay the cost of such action.

C. Permitted Uses. Permitted uses are those that will not require the erection or construction of any permanent structure or building, will not alter the natural surface configuration by the addition of fill or by dredging, or will not compromise the purpose of this overlay district, and that are otherwise permitted by the Development Ordinance. Such uses may include the following or similar uses:

1. Forestry activities. It is recommended that these activities be conducted in accordance with Best Management Practices for Erosion Control on Timber Harvesting Operations in New Hampshire, as published by the NH Department of Resources and Economic Development, and with suitable notification to the New Hampshire Wetlands Bureau, when required;

2. Agriculture activities. It is recommended that the activities be conducted in accordance with the manual of Best Management Practices for Agriculture in New Hampshire, published by the NH Department of Agriculture;

3. Ponds and well recharge sources conducted in accordance with any dredge and fill permitting requirements of the State of New Hampshire;

4. Wildlife refuges;

5. Parks and such recreational uses as are consistent with the purpose and intent of the Ordinance;

6. Conservation areas, nature trails, and other educational or scientific purposes; and

7. Open spaces are permitted or required by the Subdivision Regulations, the Development Ordinances, or in conjunction with a use which may be permitted in an adjacent district where an adequate open space area is not available within the adjacent district.

D. Uses allowed by Special Exceptions. Special exceptions may be granted by the Board of Adjustment, upon notice and hearing as prescribed in RSA Chapter 676, for the following uses within the Wetlands Conservation Overlay District and its setbacks:

1. Those uses essential to the productive use of land not within the Wetlands Conservation Overlay District shall be allowed by Special Exception. Those uses include, but are not limited to: the construction of roads, other access ways, utility rights-of-ways and easements, including power lines and pipelines, with adequate provisions where called for, for the continued, uninterrupted flow of surface run-off water. The ZBA shall grant a Special Exception, provided the following are met:

a. after the applicant meets with the Conservation Commission, findings by the Northwood Conservation Commission regarding the proposal are submitted with the Special Exception application, are reviewed by the ZBA, and are made part of the record of the case; and
b. dredging, filling or other alteration shall be designed to minimize adverse impact on the wetland and its setbacks, even if this requires adjustments in design outside of this overlay district; and
c. such activity is required for the legitimate use of land areas outside of this overlay district, and there is no reasonable way to eliminate the impact and still accommodate the use; and
d. there shall be provisions made to restore the site as nearly as possible to its original grade and condition; and
e. a state wetlands permit shall be obtained when required.
f. a Special Exception is not required when the use meets the criteria for "Expedited Minimum Impact Project" as defined by the NH Wetlands Bureau Code of Administrative Rules.

2. The undertaking of a use permitted by the Ordinance but not otherwise permitted in the Wetlands Conservation Overlay District shall be allowed provided the following conditions are met:

a. after the applicant meets with the Conservation Commission, findings by the Northwood Conservation Commission regarding the proposal are submitted with the Special Exception application, are reviewed by the ZBA, and are made part of the record of the case; and

b. dredging, filling or other alteration shall be designed to minimize adverse impact on the wetland and its setbacks, even if this requires adjustments in design outside of this overlay district; and

c. there is no reasonable way to eliminate the impact and still accommodate the use; and

d. there shall be provisions made to restore the site as nearly as possible to its original grade and condition; and

e. a state wetlands permit shall be obtained when required.

E. Setbacks

1. Where the Wetland Conservation Overlay District and the Conservation Area Overlay District overlap, or where there exists a prime wetland, a 100-foot setback area shall be maintained. No structures shall be constructed within this setback. Vegetation within this buffer area shall remain in its natural state.

2. Structures shall not be placed within 20 feet of the edge of a wetland unless a Special Exception for the structure and use have been obtained in accordance with §5.01(D)(2). The 20-foot setback may be reduced on pre-existing non-conforming lots in accordance with §1.04(C)(2). If the setback is reduced in accordance with §1.04(C)(2), structures shall not be closer to the wetland than the reduced setback allows unless a Special Exception for the structure and use have been obtained in accordance with §5.01(D)(2).

F. All newly created lots shall contain a minimum of 1 acre of contiguous upland soil for development purposes.

5.6.3 Shoreland Zoning

A concern about disturbance of natural shoreland areas arose from the increase in demand for, and the value of, waterfront property. Devegetated, exposed shoreland areas are subject to

erosion from increased wave action due to storm and boating pressures. Further removal of natural shoreline vegetation leaves the land vulnerable to storm event related erosion. The installation of lawns along the shore often leads to the introduction of fertilizers and pesticides. Many municipalities with lake and river shoreland areas are responding to this concern by developing overlay zoning ordinances that address specific lacustrine (lake) and riverine habitat problems.

The Shoreland Protection Act was passed in 1991 and it became effective, in its entirety, on July 1, 1994. With the concern that the protection of this state's waterbodies is a primary goal, the general court found:

- *The shoreland areas of the state are among its most valuable and fragile natural resources and that their protection is essential to maintain the integrity of public waters.*
- *The public waters of New Hampshire are valuable resources held in trust by the state. The state has an interest in preserving those waters and has the jurisdiction to control the use of the public waters and the adjacent shoreland for the greatest public benefit.*
- *There is great concern throughout the state relating to the utilization, protection, restoration and preservation of shoreland areas because of their effect on state waters.*
- *Under current law the potential exists for uncoordinated, unplanned and piecemeal development along the state's shorelines, which could result in significant negative impacts on the public waters of New Hampshire.*
- *To fulfill the state's role as trustee of its waters and to promote public health, safety, and the general welfare, the General Court declared that the public interest requires the establishment of standards for the subdivision, use and development of the shoreland areas of the state's public waters. The development standards provided in this Chapter shall be the minimum standards necessary to protect the public waters of the State of New Hampshire.*

The Shoreland Protection Standards are designed to minimize shoreland disturbance so as to protect the public waters, while still accommodating reasonable levels of development in the protected shoreland. Development outside the protected shoreland shall conform to local zoning and local ordinances and shall not be subject to standards established in this chapter. Following are the provisions set forth by the towns of Deerfield and Northwood with regards to shoreland protection.

Deerfield Shoreland Zoning

Section 305 Set-Back From Water Bodies

No building permit will be issued for any structure having a set-back of less than 75 feet from any river or stream, lake or pond.

Northwood Shoreland Zoning

Section 1.04 Non-Conformity

C. Non-conforming Lot. The following control non-conforming lots:

2. If water body or wetland setbacks can not be achieved on an underdeveloped pre-existing lot because the lot does not have sufficient depth from the water body or wetland, a new structure shall be permitted if granted a Special Exception by the ZBA. The ZBA shall grant the Special Exception only if the following conditions are met:

a. Sanitary water supply and sewage disposal are provided, and if on-site, the sewage disposal is located as far from the water body or wetland as is feasible or necessary;
b. Non-water body or non-wetland setbacks shall be reduced by up to 50% before the water body or wetland setback is reduced, ensuring maximum protection of the water body, shoreline, or wetland.
c. The structure shall not be located within the 100-year floodplain.
d. Non-waterbody and non-wetland setbacks shall not be reduced to less than 10 feet.

Zoning Recommendation

The previous study by Normandeau Associates made the recommendation that the towns of Deerfield and Northwood, along with the Lake Association, cautiously plan further development around the lake. Houses already line the lake edge (Figure 5-5), but it is becoming more important to protect the natural spaces around the lake. Maintaining permeable areas, forested and ground cover buffers, and keeping lawns and paved areas to a minimum are critical in maintaining the health of the lake. Zoning ordinances and overlay districts should be created or expanded in ways that are consistent with the provisions of the Shoreland Protection Act. It is recommended that the Pleasant Lake Association and the Towns of Deerfield and Northwood

designate a subcommittee to investigate options for developing town and watershed wide zoning overlays and districts.

Figure 5-5
A Portion of the Pleasant Lake Shoreline

This subcommittee should look to plans that are already established to use as guidelines when formulating appropriate zoning and overlay districts for the watershed area of Pleasant Lake. The Squam Lakes area (in the *Squam Lakes Watershed Plan*, August 1991), as well as the NH Lakes Region (in *Lakes Region Water Quality Management Plan*, September 1978), has watershed plans in the printed form that can be used as reference when formulating plans for Pleasant Lake.

5.6 Public Education

The Pleasant Lake Association should initiate a program aimed at educating lake residents, transient lake recreationists, and private/town beach users. This education program should be designed to encompass residents within the entire watershed, while specifically targeting developed areas adjacent to surface waters. The ultimate goal of this type of program is to reduce the amount of nonpoint source pollution within the watershed and to eliminate the effects of cultural eutrophication upon Pleasant Lake. Pollution prevention is much less costly than rehabilitation and remediation techniques.

Given a choice and a better understanding of the consequences of their actions, most people will opt to improve their environment. If all residents of the Pleasant Lake watershed could enjoy the benefits of a choice recreational resource, they would likely take a greater interest in protecting water quality.

The Lake Association and town agencies are a valuable and effective vehicle for conveying information to the residents and transient population of the Pleasant Lake watershed. The existing infrastructure and long term goals of the Pleasant Lake Association, Town Commissioner, Selectmen, and Zoning Board will coincide with the recommendations for public education outlined in this study and should include the following:

· Continuation of Pleasant Lake Association sponsored activities revolving around public education as it pertains to shoreland protection, watershed management and lake ecology. Your lake association has developed folders or binders of information that are distributed to lakeshore residents. These folders contain fact sheets, laws and regulations dealing with Subsurface Bureau Rules, Shoreland Protection Rules, Wetlands Bureau rules, and other pertinent information.

- Development of a lake association website. Put links to relevant permitting agencies and educational materials on the website.
- Continued participation in an organized volunteer monitoring program and the dissemination of those data to the lake residents for their continued education on the status of the lake.
- Participation in the New Hampshire Lakes Association (NHLA) watershed stewardship program. This program utilizes a 'report card' type of checklist for property owners. Sound land use practices, waste management, and other issues are considered in this program that is geared to lakeshore residents. The Pleasant Lake Association should look into this program and encourage all households in the watershed to participate on a 'self-check' basis. This program raises awareness of how individuals can impact a lake, and how to minimize those impacts.
- The towns of Deerfield and Northwood should encourage their elementary and secondary schools to participate in the NHDES Interactive Lake Ecology program. This program is designed to educate the young on principles of lake ecology and preservation of these resources, ensuring that the future residents of the area have the necessary education to safeguard their water resources.
- Promote the use of new technology efficient marine engines
- Obtain grant money or other funds to purchase and distribute low flow showerheads to residents adjacent to the lake.

- Establish educational kiosks at the public access site.
- Mark all stormwater drains/grates. Stencils have been used in the past at other lakes. The stencils read something along the lines of "Dump no waste, drains to lake."
- Establish a shoreland vegetation program to promote a well-vegetated buffer of native plant species along shorelines. Perhaps the lake association can work with local garden centers to establish a list of native plants, and work on an annual plant sale for the Pleasant Lake watershed.

Seasonal to year-round residence conversions on Pleasant Lake, coupled with the increased utilization emphasize the necessity of a comprehensive educational program within the Pleasant Lake watershed, as well as structure requirements for conversion.

5.7 Future Monitoring

Because the Pleasant Lake Diagnostic Study was conducted during a confined time frame, only a representative data set could be collected for that period in time. Variations in water chemistry, physics, and biology and ecology can change between seasons, between weather events, with development, and with time.

To be sure that residents, biologists, and the community as a whole understand the activities taking place in both the watershed and the lake, it is important to continue with monitoring the lake and watershed.

Recommendations for Monitoring

- Continue monitoring the lake once a month in the summer with the Volunteer Lake Assessment Program. Continuous data collection over a long period of time enables scientists to determine realistic trends in the watershed and the lake. These trends may be from year to year, or may only occur once every two, five, ten, or one hundred years. Pleasant Lake has been monitored regularly for over 13 years, and this trend should be continued in the future.
- Conduct stream bracketing to target areas of pollution. If possible, collect storm event samples and obtain a 'first flush' sample a few minutes following the beginning of a heavy downpour.

- Encourage lake residents to continue to volunteer as Weed Watchers. Long-term records of plant growth (both native and exotic) can be valuable tools in tracking the aging of a lake.

5.8 Exotic Aquatic Plant Prevention and Early Detection

With increasing numbers of exotic plant infestations throughout New Hampshire, and especially with a nearby infestation of variable milfoil in Northwood Lake, each lake association member should take an active role in monitoring Pleasant Lake for new growths of exotic plant infestations. Because of their rapid growth rate, if exotic plants go undetected for even just one season, large areas of a waterbody may be overrun with these invasives within just one year.

NHDES coordinates a Weed Watcher Program to assist lake associations and lake residents in monitoring their lakes for invasive plants. Weed Watchers are provided a binder full of identification information, plant information, and survey instructions to assist them in monitoring their lakes. Volunteers are also trained by a NHDES biologist in plant identification in their lakes.

For Pleasant Lake, Weed Watching would not be difficult as there is not an abundance of plant growth. Most of the plant species are sparse, and all are native to the state. Spotting an exotic plant in the lake will likely be easy. Particular emphasis should be placed on the access site and its surround shallow areas.

With a lake the size of Pleasant Lake, it is recommended that volunteers from around the lake meet to determine how to best separate the lake into cove and shoreline segments for ease of monitoring. A group of 2-3 individuals should be in charge of a small section, and there should be one overall coordinator, or Lead Weed Watcher, to gather the reports (verbal is ok) of the small shoreline segment groups, and that person would report any suspicious plants to the Exotic Species Coordinator at DES.

This program does not have a cost associated with it, and it can be done at the volunteer's leisure (but at least once a month from May through September).

5.9 Lake and Watershed Restoration Projects

To implement some of the recommendations of this report, alternative funding sources will likely be required. One possible funding source for implementation and/or further

watershed assessment is the NHDES Nonpoint Source (NPS) Local Initiative Grant Program. This NHDES administered program is the result of Clean Water Act, Section 319 (h) nonpoint source funding provided by the United States Environmental Protection Agency (USEPA).

The NPS Local Initiative Grant Program is available to municipalities, regional planning agencies, non-profit organizations and conservation districts, and can be used to address nonpoint source issues ranging from contaminated storm water runoff to streambank erosion to watershed planning. In order to apply for the grant program, you must submit a proposal that meets the requirements of the annual Request for Proposal, which historically has been issued in early September with a deadline of early November. While the requirements may change, presently applicants need to meet two key criteria:

1. 40% of the total project expense must be provided by the applicant

This 40% soft match can include volunteer time, town employee time, donated materials, etc. For example, the lake association or town Conservation Commission could submit a NPS Local Initiative proposal for storm event monitoring to identify pollution sources. The proposal could be crafted so that 60% of the total funding amount could pay for sample analysis, and the remaining soft match could be the volunteer time (presently valued at $10/hr) used to collect the samples.

2. Projects should indicate a clear path towards implementation

This simply means the applicant has to outline the schedule for the project from start to finish. Using the above example, the applicant would provide estimated dates for recruiting and training of volunteers, when the sampling window would be*, and when the final report would be submitted to the DES. (*Note: Since the theoretical proposal would include a monitoring component, a Quality Assurance Project Plan would have to be submitted and approved by the USEPA prior to commencement of monitoring).

The NPS Local Initiative Grant Program is the logical next step to help protect Pleasant Lake. The lake association already received one of these grants to carry out the study phase of this project. Monies are also available to implement the recommendations in this chapter of the report (especially the BMP and/or educational components).

The Biology Section of NHDES has a staff person designated to assist lake associations and communities develop and submit grant proposals, and assist with the implementation of grants that are awarded. Please contact the NPS Program Coordinator at 603-271-8801 if you are interested in pursuing water quality improvement funds through the NPS Local Initiative Grant Program.

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Appendix 1

Pleasant Lake Diagnostic Study

NH Data Ranges and Averages

Introduction to Limnological Data Ranges and Explanations

Lakes are important natural resources to both the citizens of New Hampshire and to its visitors. Lakes provide enjoyment through many recreational activities such as swimming, fishing, and boating. The people who utilize these lakes provide an important source of revenue for many New Hampshire communities and the State of New Hampshire. It must be realized that lakes are not unalterable systems. The natural lake aging process whereby a lake becomes enriched and gradually fills in can be greatly accelerated by the activities of people. It is extremely important that we all take the necessary steps to preserve New Hampshire's lakes and ponds as valuable recreational resources and to minimize our impacts on them. The Biology Bureau of the New Hampshire Department of Environmental Services, Water Division, serves an important role in the preservation of New Hampshire lakes by determining the condition of the lakes, by identifying problem areas and initiating corrective action, and by informing the public of its findings.

Considerable amounts of chemical and biological data have been collected from New Hampshire's lakes since 1975. A listing of the data most often sought by lake residents, lake associations, homebuyers and real estate professionals is presented here, and the sources and explanation of that data are itemized below. If you require additional information or just have a particular question, please feel free to call or write this office at 603-271-2963. Thank you for being concerned about the well-being of the quality of New Hampshire's lakes and ponds.

This report lists water quality data from 749 different lakes and ponds.

Sources and Explanation of Data

This section describes the lake quality data which follows. The sources of the data listed, or the methodologies of calculating those data, are outlined. Also, generalized explanations in layman's terms are provided for the data to assist the reader in understanding a particular lake or pond of interest.

LAKE

The name of the lake, pond, or reservoir, as listed in the New Hampshire State Planning Project publication (NHSPP, 1964). There may be alternate names used locally for a lake.

TOWN

The municipality in which the largest part of the waterbody is located, from NHSPP, 1964.

COUNTY

The county in which the waterbody (or largest portion) is located, from NHSPP, 1964.

AREA

The surface area of the lake to the nearest 0.1 acre, from NHDES, 1991.

ZMAX

The maximum depth, to the nearest 0.1 foot, found in the lake during the current survey. Prior to 1986 a field value was listed only if greater than any published historical value.

DATE

The date the summer field survey was conducted.

pH

A measure of the hydrogen ions in the water or, in general terms, the acidity. New Hampshire lakes historically have had pH values in the mid to upper sixes in most cases. As the pH decreases to between 5 and 6, many fish and other aquatic organisms become stressed, and some disappear. Little or no fish life remains when the pH falls much below 5.

Category	pH (units)
Acidified	<5
Critical	5.0 – 5.4
Endangered	5.5 – 6.0
Satisfactory	6.0 – 8.0

ALK

Alkalinity or acid neutralizing capacity (ANC) measures the buffering capacity of a lake to neutralize acid inputs. New Hampshire has historically had naturally low alkaline waters because of granitic bedrock. The median ANC for New Hampshire's lakes is only 4.9 mg/L.

TP

A measure of all the phosphorus forms present in the water, including both inorganic and organic forms. This directly relates to trophic state and the perceived aesthetics of the lake or pond. Values less than 0.010 mg/L generally indicate oligotrophic waters, values greater than 0.020 mg/L indicate eutrophic waters, while mesotrophic conditions exist between these two values. Excessive amounts of total phosphorus may impair the aesthetics and recreational use of a waterbody by causing increased weed growth and obnoxious blooms of algae.

Category	TP (mg/L)
Low (good)	0.001-0.010
Average	0.011-0.020
High	0.021-0.040
Excessive	>0.040

CHL-A

Chlorophyll-a is a measure of the phytoplankton or algae biomass (abundance) found in lakes and ponds.

Category	Chlorophyll-a (mg/m^3)
Good	0-5
More Than Desirable	5.1-15
Nuisance Amounts	>15

SECCHI

A measure of water clarity or a measure of the distance one can see into the water. This depth is variable with weather conditions, suspended matter (usually algae) in the water and the eyesight of the observer. A 20 centimeter black and white disk (Secchi Disk) lowered into the water on a calibrated chain is used to estimate this depth.

Category	Transparency (m)
Poor	<1

Sensitivity Category	ANC (mg/L)
Acidified	<0
Critical	>0-2
Endangered	>2-5
Highly Sensitive	>5-10
Sensitive	>10-20
Not Sensitive	>20

COLOR

A visual measure of the color of water. This color is generally caused by naturally occurring metals in soils, such as iron and manganese, and by decaying organic matter. A highly colored lake generally has extensive wetlands along the shore or within the watershed, and often a mucky bottom. Color itself usually does not indicate the quality of a particular waterbody.

Apparent Color	Units
Clear	0-25
Light Tea-colored	25-40
Tea-colored	40-75
Highly Colored	>75

COND

Conductivity is a measure of the ability of water to conduct an electric current. It is determined primarily by the number of ionic particles present. The soft waters of New Hampshire have traditionally had low conductivity values. Specific categories of good and bad levels cannot be constructed for conductivity because variations in watershed geology can result in natural fluctuations in conductivity. However, values in New Hampshire lakes exceeding 100 generally indicate cultural (man-made) sources of ions, such as salted highways and runoff from urbanized areas.

Good	1-5
Exceptional	>5

PLANTS

A measure of the abundance of rooted (usually) aquatic plants in a lake. They can be found in most of the lakes and ponds in New Hampshire. Aquatic plants are a natural component and vital link to a healthy and diverse aquatic ecosystem. When aquatic plants interfere with man's activities, the plants are quickly designated "weeds." Complete eradication of native weeds is not recommended! Plant abundance in a lake is categorized using the following terms in order of relative abundance.

Abundance	**Description**
Sparse	Few emergent plants observed; submerged plants not obvious.
Scattered	Several small patches or 1 or 2 large patches or much of shoreline with a sparsely growing plant; submerged plants not obvious.
Scattered/Common	Intermediate between Scattered and Common.
Common	Plants around most of the shoreline but not a problem to navigation or several large patches of plants.
Common/Abundant	Intermediate between Common and Abundant.
Abundant	Plants around entire shoreline and with thick patches in some areas.
Very Abundant	At least 1/2 of the surface area with emergent plants or submerged plants thick throughout the lake; navigation and swimming impaired.

CLASS

Class is a designation of the trophic classification of a lake. New Hampshire's Trophic Classification System places lakes into similar groups according to algal production, weed growth, water clarity and bottom dissolved oxygen levels. A lake or pond can be placed in one of the following classes:

OLIGO - Oligotrophic lakes are usually nutrient poor and as a result do not support nuisance algae blooms and massive weed infestations. Aesthetically, these lakes are the best of the three ratings.

MESO - Mesotrophic is intermediate between an oligotrophic and eutrophic waterbody. Algal production is moderate. Phosphorus input and water clarity are also intermediate compared to the other two lake ratings. If the lake is abused it eventually may move into the eutrophic category.

EUTRO - Eutrophic lakes are characterized by high production of algae and aquatic weeds, which indicates that the system is receiving excessive amounts of phosphorus or nitrogen. Water clarity is reduced dramatically during algae blooms.

A BLANK entry under class indicates that sufficient data is not available to properly classify the pond.

BTTM DO

A measure of the dissolved oxygen concentration at the deepest point in the lake during the summer. Adequate dissolved oxygen is important for the ongoing survival of fish populations, especially cold-water species, such as trout and salmon. A full understanding of the significance of a given dissolved oxygen level to a lake is possible only if temperature data from that lake is known. Temperature data is not presented in this report.

Statistical Summary Information

To provide an understanding of how a particular lake compares to other New Hampshire lakes, the following table summarized key biological and chemical parameters for all the state's lakes surveyed since 1975.

Parameter*	Number	Min.	Max.	Mean	Median
pH (units)	736	4.3	9.6	**6.5	6.6
Alkalinity	737	-3	77	6.4	4.8
Color (units)	718	<5	250	---	28
Conductivity (μmhos/cm)	727	13.1	629	56.8	37.2
Total Phosphorus	729	<0.001	0.121	---	0.012
Chlorophyll-a (μg/L)	732	0.19	143.8	7.4	4.51
Secchi Disk (ft.)	628	0.25	13.0	3.7	3.3

* All parameters in mg/L unless otherwise noted. ** True mean pH

Appendix 2

Pleasant Lake Diagnostic Study

NHDES Limnology Center
Standard Operating Procedures (SOPs)

APPENDIX 2
NHDES Limnology Center Standard Operating Procedures (SOPs)

A. STATION LOCATIONS AND DESCRIPTIONS

Sampling locations were chosen to include all major and year-round inlets and outlets. Table III-1 presents a brief description of each sampling station. In-lake monitoring stations were established at the deepest section of Pleasant Lake (refer to Table 1 for sample locations). The in-lake station was sampled at three layers: the epilimnion (upper water layer), the metalimnion (middle layer), and the hypolimnion (bottom layer). Chemical, physical, and biological results varied somewhat with depth, which is typical in a dimictic lake during times of stratification.

Table 1
Description of Sampling Station

Tributary	Description of Sampling Location
107 Inlet	Sampled on lake side of Route 107 as water flowed out of culvert
Atherton Brook	Sampled on lake side of dirt road approximately 15 feet downstream of culvert
Clark Brook	Sampled on lake side of dirt road approximately 25 feet downstream of culvert
Farrelly Brook (seasonal)	Sampled on lake side of Route 107 as water flowed out of culvert
Loon Cove Brook	Sampled on lake side of dirt road as water flowed out of culvert
Philbrick Brook (seasonal)	Sampled on lake side of right fork of dirt road as water exited box culvert
Veasey Brook	Sampled on lake side of Route 107 as water flowed out of culvert
Wilson Brook	Sampled on lake side of road as water flowed out of culvert
Dam/Outlet	Sampled on downstream side of road (west side) as water flowed out of culvert

B. LAKE FIELD PROCEDURES

The deep spot of the lake was sampled twice per month from June 1999 to August 1999 and again from June through September 2000. Volunteer monitors collected these samples throughout the study period accompanied by a DES biologist on one (or more) trips per month.

Temperature and dissolved oxygen were measured at one meter intervals along the water column using a YSI model 50, 54 or 57 oxygen meter. Temperature was recorded to the nearest 0.1 degree Celsius. Dissolved oxygen was recorded to the nearest 0.1 mg/L.

Transparency was measured to the nearest 0.1 meter using a 20 cm Secchi disk with alternate white and black quadrants. Net phytoplankton and zooplankton were collected by hauling an 80 micron mesh net vertically from one meter below the Secchi depth reading to the surface. Plankton

samples were preserved in the field with Lugol's solution.

Water samples were collected for chemical analyses from the middle of each layer using a Wildco Kemmerer water sampler. Integrated samples along the Secchi disk depth were collected for chlorophyll-a analysis using the tube method (a long tube is placed in the water, crimped, and pulled up quickly to obtain a small volume of water from each depth) and were placed in an amber 1 liter bottle. All samples were preserved according to EPA Standard Procedures and the approved Limnology Center Quality Assurance and Quality Control protocols which are updated yearly. Samples were stored in a cooler and immediately returned to the NHDES laboratories in Concord, New Hampshire for analysis.

More specific descriptions of each sampling activity are provided in the following Standard Operating Procedures (SOPs) documents.

C. STREAM FIELD PROCEDURES

The tributary stations were monitored every two weeks for height of water and nutrient concentration from October 1998 through October 2000. Staff gauge measurements were recorded bi-weekly by volunteers from the Pleasant Lake Association. Biologists collected flow measurements once per month using a Marsh McBirney FlowMate 2000 flow meter. Tributary samples were collected by dipping laboratory bottles to mid-depth at mid-stream into the flow of the water (according to Volunteer Lake Assessment Protocols). Bottles were rinsed with sample water then filled. Bottles containing acid preservative were filled from another sample vessel. Table 2 summarizes the sampling parameters for the Pleasant Lake Study.

Table 2
Sampling Parameters for Pleasant Lake Diagnostic Study

Parameter:	Location:		Parameter:	Location:
Specific Conductance	Lake and Streams		pH	Lake and Streams
Acid Neutralizing Capacity	Lake (Epilimnion only)		Turbidity	Lake and Streams (1996)
Total Phosphorus	Lake and Streams		Chlorophyll-a	Lake
Temperature/Dissolved Oxygen	Lake		Plankton	Lake
Transparency	Lake			

More specific descriptions of each sampling activity are provided in the following Standard Operating Procedures (SOPs) documents.

D. LABORATORY METHODOLOGY

1. Chemical and Physical

Table 3 presents the laboratory methods utilized for chemical and physical parameters. Acid neutralizing capacity, pH, turbidity and specific conductance were performed by biologists in the NHDES Limnology Center. Total phosphorus analyses were performed by the NHDES Laboratory Services Unit. Both the Limnology Center and the Laboratory Services Unit are EPA inspected with approved quality assurance and quality control programs.

2. Biological

Table 3 also presents the laboratory methods utilized for biological parameters. All analyses were performed by biologists in the Limnology Center. Phytoplankton and zooplankton were identified to the genus level under 100x magnification using a Sedgwick Rafter cell according to Standard Method procedures. Relative abundance was computed for net phytoplankton. Chlorophyll-a measurements were also conducted to EPA standards to determine approximate algal biomass in the water column.

Table 3
Laboratory Parameters and Methods Used for Analysis

Parameter:	Method:
pH	Electrometric
Acid Neutralizing Capacity	Titration, Electrometric, Granplot
Total Phosphorus	Colorimetric, Persulfate, Digestion ***365.2 PQL 0.001 mg/L*
Specific Conductance	Electrometric
Turbidity	Nephelometric turbidity meter
Net Phytoplankton (relative abundance)	Phase Contrast Microscopy, Sedgwick-Rafter Cell
Chlorophyll-a	Spectrophotometric, Trichromatic

More specific descriptions of each sampling activity are provided in the following Standard Operating Procedures (SOPs) documents.

STANDARD OPERATING PROCEDURES
YSI DISSOLVED OXYGEN/TEMPERATURE CALIBRATION and COMPUTER PROCEDURES

Dissolved Oxygen Calibrations to be performed daily.

A. Calibration

1. Turn selection switch to O2-TEMP position and allow meter to perform system check (appx 10 seconds).

2. Remove probe cover and moisten in sample water. Place probe cover back on probe, ensuring it formed a tight seal around the probe.

3. Turn selection switch to CALIBRATE position, press CONFIRM

4. Screen will read: "Enter cal value-Last= 100.0%". Press CONFIRM

5. Screen will read "Calibrating-Please wait". Then it will read "Calibrated to 100.0%".

6. Calibration is complete. Turn selection switch to 02-TEMP position and proceed with Section B.

B. Data Collection

1. Beginning at the bottom of the pond, use the depth markers on the calibrated cable to take a temperature and oxygen reading at each meter from the bottom of the lake to the surface, including a 0.10 M sample. Conducted a 10% duplicate sampling. Record data on field data sheet, or store data on meter as detailed in C below.

C. Data Storage

1. Press up arrow key (↑) once. Screen will read "Erase memory?". Press CONFIRM.

2. Screen will read "Erase DATA? NO". Press up arrow key once (↑).

3. Screen will read "Erase DATA? YES". Press CONFIRM.

4. Screen will read "Erase memory?". Press down arrow key (↓) twice .

5. Screen will read "Recording Mode?". Press CONFIRM.

6. Press CONFIRM to store each reading.

7. Turn selection Switch to OFF position when finished.

Standard In-lake Field Sample Collection Procedures

Reminders:

- Sample the lake between 10:00 am and 2:00 pm for most accurate results.
- *Be Safe:* Never sample during thunder and lightning; Abide by state and local boating regulations.
- Schedule a lake visit from a DES biologist once each year for refresher training and to carry out plankton analysis and a dissolved oxygen/temperature profile on your lake. This visit is free of charge.
- NHVLAP is a state-assisted program. Most samples are analyzed free of charge with the exception of phosphorus ($10) and E.coli bacteria ($11).

Procedures:

1. Label *all* bottles with lake name, date, town, and sample depth.

2. Locate the deepest spot in the lake using previously marked reference points on your lake map. Drop anchor. To ensure that you have found the deepest point in the lake, fill the Kemmerer bottle with water to give it weight and lower it down to the bottom to obtain a bottom depth. Record the depth on your Field Data Sheet. Empty the Kemmerer bottle over the side of the boat and rinse with lake water.

3. Collect samples from each of the predetermined depths listed below. Be sure there is **no sediment** in your samples.

_____m _____m _____m

(Some lakes will have as many as 3 layers, others will have no layering)

Large white bottle: Rinse first with sample water, then fill to the top.
Small brown bottle: *Do not rinse* or overflow when filling; contains strong acid preservative.

4. Collect a composite sample for chlorophyll-a analysis from the following total depth:

_____m Composite

a. Kemmerer Bottle Method: Rinse a large bucket with lake water and discard over side of boat. Take one Kemmerer bottle sample at each meter from your assigned composite depth (mid-thermocline in stratified lakes; 2/3 depth in lakes with no layers) up to 1.0 meter. Empty half of the Kemmerer bottle sample from each depth into the bucket. Mix well. Rinse the large brown bottle with water from the bucket, then fill bottle to the top. Label the bottle with "_____m Comp".

b. Integrated Sampler Method (optional): If you have an integrated tube sampler, follow the following instructions. Rinse a bucket with lake water and discard over side of boat. With a calibrated rope or chain attached, lower the weighted end of the tube down to the assigned sample depth (mid-thermocline in stratified lakes; 2/3 depth in lakes with no layers). Be sure both the tube and the rope are straight, with no slack. Crimp the upper end of the tube

tightly. Carefully haul up the weighted end of the tube *using the attached rope/chain*. With the weighted tube end in the bucket, raise the crimped end of the tube above your head and release the crimp. Make sure all water is emptied from the tube. Rinse the large brown bottle with water from the bucket, then fill. Label the bottle with "_____m Tube".

5. Measure transparency using the Secchi disk. Lower the Secchi disk over the shady side of the boat until it disappears from sight. Slowly raise the disk until the white is just visible. Record the average of these two sightings. Repeat this process yourself or with other monitors. Record both transparency readings on the Field Data Sheet, then calculate the average.

6. Collect a plankton haul from mid-thermocline in stratified lakes, or 2/3 depth in lakes with no layers. Lower the plankton net on the calibration chain to the desired depth and slowly haul the net vertically through the water column. When the net reaches the surface dip it into the lake one or twice (without putting the rim back underwater) to force plankton to the cup at the bottom of the net. Empty collected sample into a 250 mL glass jar and preserve with 1-2 drops of Lugol's solution. Swirl gently, and put sample in cooler.

7. Complete the Field Data Sheet. Store samples in a cooler with ice and return to the Concord Laboratory *within 24 hours*. Remember, laboratories have limited hours during the week. **Please turn in samples well before closing time to allow for the necessary immediate analysis of some samples.**

Standard Tributary Field Sampling Procedures

When NOT To Sample:

1. **Do not** sample water that is not flowing. Stagnant water sampling will result in values that are not representative of the water entering or leaving the lake.
2. **Do not** sample an area where the bottom sediments have been recently disturbed. If you must wade into the water, take the sample in an undisturbed upstream area. Sediment particles in a sample will complicate and sometimes invalidate laboratory analysis.

When To Sample:

1. Sample water that is flowing **only**. Even at low flow you are likely to see clues that water is moving. Submerged aquatic vegetation leaning in a downstream direction and surface debris moving gently downstream are good indicators of flowing water.

How To Sample:

*If bacteria samples are to be collected, see below. Bacteria samples **must** be taken first and with caution so as not to contaminate the sample.*

1. Ensure that both a white 1000 mL bottle & a brown 250 mL bottle preserved with acid are properly labeled with lake name, town, location, date and sampler's initials.
2. Dip the white bottle into the flow to obtain a sample of rinse water. Try to avoid catching surface debris.
3. Cap the bottle, shake and discard rinse water **downstream**.
4. Refill the white bottle and pour the sample into the brown bottle. The brown bottle contains acid and will burn skin & dissolve clothing, so please be careful not to spill the acid or overflow the bottle. It is recommended that you wear safety glasses and disposable gloves when dealing with the brown bottle containing acid.
5. Top off the white bottle.
6. Store all samples in a cooler with ice and return to the Concord or Sunapee laboratory within 24 hours. Remember, laboratories have limited hours during the week. Please call in advance to notify the labs of your sampling date.

Taking Bacteria Samples:

1. A sterile (indicated by a dated sticker) 250 mL bottle must be labeled as above.
2. Aseptically remove the cap, making sure not to touch the inside of the cap and bottle.
3. Point the mouth of the bottle down towards the water's surface.
4. Using a continuous "U-shaped" motion, thrust the bottle under the water's surface and fill in one continuous upstream motion. In this fashion, the water will flow into the bottle, then over your hand. If sampled in a downstream fashion, the water would flow over your hand then into the bottle causing contamination from the sampler.
3. Place sample in a cooler with ice, and submit to the laboratory as soon as possible. Samples turned in on Friday must be submitted well in advance of closing time to allow time for pre-weekend analysis.

Standard Operating Procedure for Stream Flow Determinations

Equipment: Marsh-McBirney Model 2000 Flo-Mate, Flow field sheet
Velocity Measurement: Electromagnetic
Zero Stability: +/- 0.05 ft/sec
Accuracy: +/- 2% of reading + zero stability
Range: -0.5 to +19.99 ft/sec (-0.15 m/sec to 6 m/sec)

Calibration:

1. Turn meter on and look for 'low battery' display. If display does not come on, proceed as follows. If light comes on, change batteries, then proceed with the following procedures.

2. Set meter reading to 'fixed point averaging' for a 30 second interval. Do this by simultaneously pressing the up/down arrows to toggle to the FPA display. Set the averaging time to 30 seconds by using the up arrow.

3. Fill bucket with water from stream. Insert probe into bucket, clear meter reading, and check for zero reading (no flow should be going on in bucket, thus zero reading).

Measuring Stream Channel Flow:

1. Select an area of the stream in which to flow (area near staff gauge is usually selected)

2. Stream bottom should be relatively flat and free of obstructions (large rocks, plants)

3. Measure the width of the stream from bank to bank using a measuring tape. Record width of stream of flow sheet below name of stream or sample location.

4. Using the measuring tape, break the stream width into equal segments (6 inches,1-foot, 2-foot)

5. Take a depth reading at each interval across the stream, starting at bank one and ending at bank two. Record these depths on the flow sheet.

6. Next, take fixed point averaged flow readings (this is the 30 second average) in between each point where depth was measured. This is done by placing the flow probe into the stream, facing into the direction of flow. Probe should be 1/3 of the way down from the surface of the stream, and 2/3 of the way above the sediments. Record flow reading on flow sheet between the two recorded depth readings. Continue until flow readings are collected for entire stream segment.

7. Take a reading off the staff gauge in the stream, recording this number in the appropriate column on the field data sheet.

Measuring Stream Flow from a Culvert:

1. Find downstream end of culvert

2. Using a yardstick or other measuring device, take a depth reading in the center of the culvert invert. Record this on the field data sheet.

3. Next, take a measure of the width of the entire culvert. Record this on the data sheet.

4. Next, place the flow probe into the flow of the water in the center of the culvert invert. Take a fixed point averaged flow reading as described above. Record in appropriate column on field data sheet.

5. Take a reading off the staff gauge in the stream below the culvert, and recordin in appropriate column of the field data sheet.

Calculating Stream Channel Discharge:

1. Back in the laboratory, open the lab calculation software on the computer. Double click on Flow.exe icon.

2. Answer the questions as you go through the blue dialog box choices.

3. Are you depths in inches or feet- TYPE 'F' FOR FEET

4. Which meter did you use- TYPE 'M' FOR MARSH MCBIRNEY

5. Are your flows in feet, meters, or centimeters/second- TYPE 'F' FOR FEET PER SECOND

6. Enter number of intervals (this is the number of stream width segments at the point that you conducted the flow, ie, how many flow readings did you take---count them on the field data sheet). TYPE IN THE NUMBER OF INTERVALS AND PRESS ENTER.

7. Next you will see a screen where you will enter your flow data from your field sheet. Width is the width of the stream segment that you broke the entire channel width into (ie, 6 inches/1-foot, 2-foot). TYPE IN THE WIDTH AND PRESS ENTER. Velocity is the flow meter reading in f/s. TYPE IN THE FLOW READING AND PRESS ENTER. Number of depths is the depth readings surrounding where you took the flow reading (the one before and the one after). There will usually be 2. TYPE IN THE NUMBER OF DEPTH READINGS AND PRESS ENTER. Finally, it will ask you flow the depth readings. ENTER THE DEPTH READINGS FROM YOUR FIELD SHEET AND PRESS ENTER AFTER EACH.

8. Once you have completed one line it will automatically switch you to line two. Enter the next set of data from that stream, continuing this process until all data are entered for that stream.

9. Next, at the bottom of the blue dialog box you will be asked if you want to accept what you have entered, or if you want to change data. You will not be allowed to change data during the first entry. Now is the only time you can change mistakes. ENTER 'A' TO ACCEPT OR 'C' TO CHANGE DATA.

10. When you choose 'A', the screen will switch and give you the 'Result of your calculation' in cubic feet per second, your stream discharge for that point in the stream. Enter this number onto your field data sheet.

Calculating Culvert Discharge:

1. Double click on the Lotus 'Shortcut to Culverts' icon.

2. This spreadsheet will calculate culvert discharge. The top group of calculations will calculate flow for culverts where water is going directly through the culvert. You will use this one most of the time. The bottom set of equations is for when water is breaching culvert headwalls or circumventing the culvert.

3. Where it asks for culvert width- ENTER CULVERT WIDTH MEASUREMENT IN INCHES AND HIT DOWN ARROW

4. Where it asks for depth of water- ENTER DEPTH OF WATER IN INCHES AS MEASURED FROM CENTER OF CULVERT INVERT AND HIT DOWN ARROW

5. Where it asks for flow- ENTER FLOW IN FEET/SEC AS MEASURED WITH FLOW METER AND HIT DOWN ARROW

6. Discharge is automatically calculated. RECORD THE DISCHARGE IN CFS ON FIELD DATA SHEET IN APPROPRIATE COLUMn.

STANDARD OPERATING PROCEDURES
INTERSTITIAL PORE WATER SAMPLING FOR TOTAL PHOSPHORUS

A. Sampling Methodology

1.	**Preservation:**	0.5 ml sulfuric acid
2.	**Holding Time:**	28 days
3.	**Required Volume:**	250 mls
4.	**Container Type:**	Amber polypropylene

B. Data Collection

Interstitial pore water samples will be collected from the vicinity of the established seepage meter locations in the lake. Six locations will be established in sandy subtrates around the perimeter of the lake.

1. Connect peristaltic pump to IPWS probe with rubber tubing
2. Pump 250 mls of deionized water through probe to clear lines
3. Insert steel IPWS probe into sediments to a depth of approximately 0.5 meters.
4. Turn on peristaltic pump and pump sample into 250 mls amber bottle until full (do not overflow).
5. Cap and store bottle on ice.
6. Return sample to laboratory and analyze in Laboratory Services Unit per specified total phosphorus method in Appendix C.

SEEPAGE METER SAMPLING

A. Equipment

- 7 seepage meters (made out of the top and bottom 1/3 portions of 55 gallon steel drums)
- 7 spickets inserted and sealed into tops of barrels
- Rubber tubing
- 7 stopper plugs with attached bags
- Steel clamps
- Graduated cylinder

B. Meter Installation

1. Dig meters into ~3-foot depth water zone in lake, into sandy substrate
2. Place meters so that near shore side is higher than lake side of meter (so that meter is on an angle with the slope of the substrate
3. Compress edges of meter into sediment so that the bottom rim of the meter is completely pressed into sediments
4. Allow to equilibrate with surroundings for at least two weeks

C. Sample Collection

1. Select a starting location (Meter #1)
2. Pour 100 measured mls of lake water into bag through tube.
3. Fit clamp over tube and squeeze all air from the bag (do not allow water to escape). Tighten clamp.
4. Fit tube end of collection bag over the spicket of the seepage meter, release clamp, and note time. Record time on data sheet.
5. Continue as in steps 1-4 for remaining meters in lake.
6. Allow at least one hour to pass until returning to Meter #1.
7. Re-clamp tube on the bag now attached to meter.
8. Note time and record on data sheet.
9. Carefully remove tube from meter spicket.
10. Unclamp tube and pour contents of bag into graduated cylinder and measure volume. Record on field data sheet.

D. Seepage Calculation

Calculate seepage contribution to lake per methods outlined in Appendix F.

Standard Method for Determination of pH Value using Beckman pH Meter

Sampling Methodology

1.	**Preservation:**	Analyze immediately
2.	**Holding Time:**	.25 hours
3.	**Required Volume:**	50 ml
4.	**Container Type:**	Polyethylene or glass
5.	**Reference Number:**	2310B (Standard Methods 20th Ed. 1998)

Equipment Calibration and Setup (once per day) – 2 point calibration with standard buffers.

1. Rinse probe with DI water and blot with KIMWIPE.

2. Press the **Power Button** (○) and then the **Clear Button** ©.

3. Place probe in pH 4.0 buffer and swirl solution.

4. Press the **pH Button** followed by the **STD Button**.

5. When the flashing "eye" stabilizes record Ph in the Std 4.0 column.

6. Remove probe from pH 4.0 buffer, rinse with DI water, and blot with KIMWIPE.

7. Place probe in pH 7.0 buffer and swirl solution.

8. Press the **STD Button** and when the flashing "eye" stabilizes record pH in the Std 7.0 column.

ARROWS SHOULD APPEAR ON RIGHT SIDE OF SCREEN NEXT TO STD 1 AND STD 2 WHEN CALIBRATION IS COMPLETED. DO NOT PRESS CLEAR OR TURN OFF THE MACHINE-THIS WILL CLEAR THE CALIBRATION.

8. Remove probe from pH 7.0 buffer, rinse with DI water, and blot with KIMWIPE.

9. Place probe in pH 6.0 buffer and press the **pH Button**.

11. When the flashing "eye" stabilizes record pH in the Std 6.0 column.

12. Readings should be within 0.10 of buffer strength. If not, recalibrate the meter.

13. **pH Sample Analysis Procedure**

14. Rinse probe and sample vessel with DI water. Gently tip sample bottle to disperse solids from the bottom of the bottle and then rinse probe and sample vessel with a

small volume of sample.

15. Place probe into 50-100 ml of sample and swirl once.

16. Press the **pH Button** to take measurement. ***Ensure auto eye is displayed. If not press the Auto button.***

17. Record pH in bench book when reading stabilizes.

18. Follow Steps 1 through 4 for next sample.

Replicate analysis is performed on every tenth sample. Replicate data is entered in highlighted data entry lines in bench book.

19. **Shut-Down Procedures:**

20. Rinse probe with DI and blot with KIMWIPE.

21. Press **Power Button** to shut off instrument.

22. **Never leave probe immersed in sample or DI water.**

23. No cover necessary for probe.

STANDARD METHOD FOR DETERMINATION OF ACID NEUTRALIZING CAPACITY (ANC) BY GRAN PLOT TITRATION BECKMAN pH METER

A. Sampling Methodology:

1.	**Preservation:**	Refrigerate
2.	**Hold Time:**	24 Hours
3.	**Required Volume:**	50 ml
4.	**Required Titrant:**	.020N HCL
5.	**Container Type:**	Polyethylene or glass
6.	**Reference Number:**	2320B (Standard Methods 20th Ed. 1998)

B. Equipment Calibration and Set Up - 2 point calibration with standard buffers.

1. Follow calibration procedures 1 - 14 from Beckman pH Equipment Calibration and Setup section.

C. ANC Sample Analysis Procedures

1. **ANC analysis is required for the top layer (epilimnion) of all lakes.**

2. Rinse probe and sample vessel with a small volume of DI water then sample water.

3. Place probe into exactly 50 ml of sample water, swirl once, and press the **Read Button**. ***Ensure auto eye is displayed. If not press the Auto button.***

4. When pH stabilizes ("eye" stops flashing), record initial pH in appropriate column in the ANC Data Section of the Beckman ANC/pH book.

5. Add 0.05 ml increments of .020N HCL to sample with pipetter, swirl sample, Press **Read button**, and allow pH to stabilize. **REPEAT UNTIL pH STABILIZES AT APPROXIMATELY 4.60.** (Record number of .05mL increments of titrant required to reach pH 4.60 for titrant volume calculation.)

REMEMBER TO SWIRL SAMPLE ONCE AFTER EACH ADDITION OF ACID.

6. When pH value has been titrated to a pH of approximately 4.60, enter this pH value and the corresponding titrant volume on line one (1) of the ANC data sheet.

7. Add 0.05 ml acid, swirl sample, press the **Read Button** and record the pH after it stabilizes.

8. Continue adding 0.05 ml increments of acid and recording the stabilized pH values and titrant volumes until a pH of approximately 3.60 is reached. ***Do not end titration on an odd numbered line in the bench book.*** Continue titration to

an even numbered line to facilitate computer calculations.

9. Remove probe from sample, rinse probe and sample vessel with DI water and prepare next sample by following steps 1 through 8 or continue with shut-down procedures.

Replicate analysis is performed on every tenth sample. Replicate data is entered in highlighted data entry boxes in bench book.

D. Shut-down Procedures

1. Follow Shut-Down procedures 1 - 4 from Beckman pH Model 360 shut-down section.

COMPUTER CALCULATION PROCEDURE
FOR DETERMINATION OF
ACID NEUTRALIZING CAPACITY (ANC)
BY GRAN PLOT TITRATION

1. Turn computer on.
2. Enter login ID and Password:
3. At program manager, select lab calculations ICON.
4. At laboratory calculations menu, select option number 3.
5. At next screen, type Y to enter titrant increments.
6. Enter titration increment (mL): type 0.05 and press ENTER.
7. Enter titrant normality: Type 0.02 or 0.0199 (depending upon titrant stock) and press ENTER.
8. Enter number of titrations from column 1 in bench book and press ENTER.
9. Enter initial amount of titrant from column 1, row 1 in bench book and press ENTER.
10. Enter pH of associated titrant volumes from column 2 in bench book and press ENTER.
11. Repeat step 10 for each pH value in column 2.
12. At final calculation screen, record the r value, slope (m), y-intercept (b) and gran plot alkalinity value (mg/L), in bench book.
13. Type R to calculate additional alkalinity values for samples and repeat steps 8 through 12.
14. To Exit, type E to return to laboratory calculations menu and press 7 and ENTER to return to main menu.

15. Select file then exit windows to shut computer down. Type logout at the C: prompt.

STANDARD METHOD FOR DETERMINATION OF CONDUCTIVITY USING ORION 162A METER

A. Sampling Methodology

1. **Preservation:** Refrigerate
2. **Holding Time:** 24 hours
3. **Required Volume:** 100 ml
4. **Container Type:** polyethylene or glass
5. **Reference Number:** 2510B (Standard Methods 20th Ed. 1998)

B. Instrument Set-Up and Calibration

1. Plug the power cord into the back of the meter. When meter is ready, TC, °C, µS/cm, **and** Ready icons will appear with the display showing a Temperature Reading, a Conductivity reading, and *AUTO*.

2. Remove the Conductivity Cell from the DI water storage bottle. Rinse the Conductivity Cell with DI water and blot dry with KIMWIPE.

3. Immerse the Conductivity Cell in the 100 µS/cm Conductivity Standard solution.

4. When Temperature and Conductivity readings stabilize, press the **Cal Button**.

5. Display will stabilize. Cal icon will be lit and the display will read "Set, Cell, and flashing 0.###".

6. Press the **Yes/Log View Button.** Display will read "P-1 and ----".

7. When display reads "100.0 µS/cm" **and** Ready icon is illuminated, press the **Yes/Log View Button**

8. Display will read "P-2 and ----". Remove Conductivity Cell from 100 µS/cm Conductivity Standard solution, rinse the Conductivity Cell with DI water and blot dry with KIMWIPE.

9. Immerse the Conductivity Cell in the 1413 µS/cm Conductivity Standard solution.

When display reads "1413 µS/cm" **and** Ready icon is illuminated, press the **Yes/Log View Button.**

10. When meter display is the same as described in Step 1, make appropriate notation in

calibration section of Bench Book and remove probe from Conductivity Standard. **Note: If E-22 appears in meter display, recalibrate the meter using fresh calibration standards and note in the bench book that the new calibration standards were used.**

C. Sample Analysis:

1. Samples should be warmed to 25^0 c (+/- 2^0 c).

2. Remove the Conductivity Cell from the DI water storage bottle. Rinse the Conductivity Cell with DI water followed by small volume of sample. Fill sample vessel with 100 ml of sample and immerse Conductivity Cell.

4. Slightly agitate sample water with probe and wait for Ready icon to appear.

5. Record Conductivity reading in Bench Book under **Conductivity µS/cm** column.

5. Follow steps 1 through 4 for next sample.

D. Instrument Shut-Down Procedure

1. Rinse Conductivity Cell well with DI water.

2. Replace Conductivity Cell in its storage bottle.

3. Unplug power cord from back of meter.

STANDARD OPERATING PROCEDURES
TURBIDITY

A. Sampling Methodology

1. **Preservation:** Refrigerate
2. **Holding Time:** 24 Hours
3. **Required Volume:** 100 mL
4. **Container Type:** polyethylene or glass
5. **Reference Number:** 2130B (Standard Methods 20th Ed. 1998)

B. Initial Instrument Set-Up and Calibration

1. Turn meter on and allow it to warm up for 30 minutes.

2. Remove any sample or standards from the sample chamber and replace cover.

3. Turn lamp on and set the RANGE switch at 2 NTU. Turn the ZERO adjust knob until a .00 reading appears on the display. Record .00 in ZERO column of Turbidity Calibration section of bench book and *indicate if meter had to be set to read zero.*

4. Turn lamp off.

5. Wipe 1.00 NTU standard sample cell, clean and dry with a KIMWIPE, insert sample cell holder in turbidimeter and replace cover. Turn lamp on and use the STANDARDIZE knob to adjust reading to 1.00 NTU. Record value in bench book under 1.00 NTU standard value column and *indicate if 1.00 NTU standard reading had to be set.*

6. Turn lamp off and remove standard sample cell.

7. Fill a sample cell with DI water and wipe cell clean and dry with a KIMWIPE.

8. Insert sample cell into sample cell holder in turbidimeter and cover.

9. Put lamp switch into the "on" position and read turbidity directly from digital display. Record turbidity reading in BLANK column of Turbidity Calibration section of bench book. It should not read over 0.10 NTU.

10. **Always turn lamp off before removing sample cells from holder.**

C. Sample Preparation and Analysis:

SAMPLES WITH TURBIDITIES LESS THAN 2 NTUs

1. Warm samples to 25^0 c.

2. **Check calibration records and verify that meter has been calibrated and standardized versus a 1.00 NTU standard.**

3. Vigorously shake the sample to thoroughly disperse the solids.

4. Rinse sample cell with DI water and small volume of sample and pour sample into the sample cell. Wipe cell clean and dry with a KIMWIPE. The meter reads through the cell wall and it must be free of water and fingerprints.

5. Insert sample cell into sample cell holder in turbidimeter and cover.

6. Set Range switch at 2 NTU, put lamp switch into the "on" position and ***AFTER APPROXIMATELY 5 SECONDS*** read turbidity directly from digital display. If two horizontal bars appear on the digital display, proceed to *SAMPLES WITH TURBIDITIES EXCEEDING 2 NTUs BUT LESS THAN 20 NTUs*. If not, record turbidity value in bench book

7. Turn lamp off and remove sample cell from holder. Repeat steps 2 through 6 with next sample or continue with shutdown procedures.

Notes:*Assure no bubbles are present in sample cell and that the cell is free from fingerprints and water on the outside surface.
***Run a replicate sample every 10th sample in highlighted row of bench book.**

SAMPLES WITH TURBIDITIES EXCEEDING 2 NTUs BUT LESS THAN 20 NTUs

1. Remove any sample or standards from the sample chamber and replace cover.

2. Turn lamp on and set the RANGE switch at 20 NTU. Turn the ZERO adjust knob until a 0.0 reading appears on the display. Record 0.0 in ZERO column of Turbidity Calibration section of bench book and *indicate if meter had to be set to read zero.*

3. Turn lamp off.

4. Wipe 10.0 NTU standard sample cell, clean and dry with a KIMWIPE, insert sample cell holder in turbidimeter and cover. Turn lamp **on and** set the RANGE switch at **20 NTU and** use the STANDARDIZE knob to adjust reading to 10.0 NTU. Record value in bench book under 10.0 NTU standard value column and *indicate if 10.0 NTU standard reading had to be set.*

5. Turn lamp off and remove standard sample cell.

6. Fill a sample cell with DI water and wipe cell clean and dry with a KIMWIPE.

7. Insert sample cell into sample cell holder in turbidimeter and cover.

8. Turn lamp on, ensure the RANGE switch is at **20 NTU** and read turbidity directly from digital display. Record turbidity reading in BLANK column of Turbidity Calibration section of bench book. It should not read over 0.1NTU.

9. Warm samples to 25^0 c.

10. Vigorously shake the sample to thoroughly disperse the solids.

11. Rinse sample cell with DI water and small volume of sample and pour sample into the sample cell. Wipe cell clean and dry with a KIMWIPE. The meter reads through the cell wall and it must be free of water and fingerprints.

12. Insert sample cell into sample cell holder in turbidimeter and cover.

13. **Set Range switch to 20.** **Put lamp** switch into the "on" position and ***AFTER APPROXIMATELY 5 SECONDS*** read turbidity directly from digital **display.** If the sample reading is less than 2.0 NTU or greater than 20 NTU, recalibrate and analyze according to appropriate procedure. If not, record turbidity value in bench book.

14. Turn lamp off and remove sample cell from holder. Repeat steps 10 through 13 with next sample unless a sample produces a meter reading of less than 2.0 NTU or greater than 20 NTU.

15. If sample analysis is complete, continue with shut down procedures.

Notes: ***Assure no bubbles are present in sample cell and that the cell is free from fingerprints and water on the outside surface.**
***Run a replicate sample every 10th sample in highlighted row of bench book.**

SAMPLES WITH TURBIDITIES EXCEEDING 20 NTUs

1. Remove any sample or standards from the sample chamber and replace cover.

2. Turn lamp on and set the RANGE switch at 200 NTU. Turn the ZERO adjust knob until a 00 reading appears on the display. Record 00 in ZERO column of Turbidity Calibration section of bench book and *indicate if meter had to be set to read zero.*

3. Turn lamp off.

4. Wipe 100 NTU standard sample cell, clean and dry with a KIMWIPE, insert sample cell holder in turbidimeter and cover. Turn lamp on and set the RANGE

switch at **200 NTU** and use the STANDARDIZE knob to adjust readings. Record value in bench book under 100 NTU standard value column and *indicate if 100 NTU standard reading had to be set.*

5. Turn lamp off and remove standard sample cell.

6. Fill a sample cell with DI water and wipe cell clean and dry with a KIMWIPE.

7. Insert sample cell into sample cell holder in turbidimeter and cover.

8. Turn lamp on, ensure the RANGE switch is at **200 NTU** and read turbidity directly from digital display. Record turbidity reading in BLANK column of Turbidity Calibration section of bench book. It should not read over 00 NTU.

9. Warm samples to 25^0 c.

10. Vigorously shake the sample to thoroughly disperse the solids.

11. Rinse sample cell with DI water and small volume of sample and pour sample into the sample cell. Wipe cell clean and dry with a KIMWIPE. The meter reads through the cell wall and it must be free of water and fingerprints.

12. Insert sample cell into sample cell holder in turbidimeter and cover.

13. **Set Range switch to 200.** Put lamp switch into the "on" position and ***AFTER APPROXIMATELY 5 SECONDS*** read turbidity directly from digital display. If the sample reading is less than 20 NTU, recalibrate and analyze according to appropriate procedure. If not, record turbidity value in bench book.

14. Turn lamp off and remove sample cell from holder. Repeat steps 10 through 13 with next sample unless a sample produces a meter reading of less than 20 NTU.

15. If sample analysis is complete, continue with shut down procedures.

Notes: ***Assure no bubbles are present in sample cell and that the cell is free from fingerprints and water on the outside surface.**
***Run a replicate sample every 10th sample in highlighted row in bench book.**

D. Shut-Down Procedure

1. Switch lamp and power to the "off" positions.

2. Remove sample cell from turbidimeter. Empty and rinse with DI water.

3. Fill sample cell with DI water for storage.

4. Ensure that all information from sample bottles has been entered correctly into bench book and that the appropriate number of replicates has been run.

STANDARD OPERATING PROCEDURES
CHLOROPHYLL-A

A. Sampling Methodology

1. **Preservation:** unfiltered, dark, 4°C/filtered, dark, -20°C
2. **Holding Time:** 24 hrs/28d
3. **Required Volume:** 500 mL
4. **Container Type:** polyethylene, opaque/dark
5. **Reference Number:** 10200H (Standard Methods 20th Ed. 1998)

B. Special Reagents

1. **Saturated Magnesium Carbonate Solution**: Dissolve approximately 2-3g of finely powdered magnesium carbonate in 200 mL of DI water. Shake to suspend the powder and allow it to settle for at least 24 hours before use.

2. **Aqueous Acetone Solution**: Prepare a 90% acetone solution by filtering 100 mL of saturated magnesium carbonate solution in to 900 mL of reagent grade (100%) acetone, using volumetric pipettes (note: the final volume will be less than 1 liter after completely mixing). The 100% acetone should be shaken with a little granular anhydrous sodium carbonate and decanted before being used to make this solution.

C. Procedure

1. Place chlorophyll-a sample bottles on lab bench next to vacuum rack.

2. Copy sample information from bottles into bench book and assign each bottle a plastic centrifuge tube. Record the tube # in bench book.

3. Attach plastic filter collars securely to vacuum rack.

4. Using forceps, place .45µm (47 mm), filter onto filter collar and dampen with small volume of DI water. Avoid contact with filter. **NEVER TOUCH WITH FINGERS AND ENSURE THAT FILTER HAS BEEN SEPARATED FROM BLUE DIVIDER PAPER BEFORE PLACING ON HOLDER.**

5. Thread plastic 250 mL millipore funnel onto filter collar. Avoid any tearing or wrinkling of filter paper.

6. Shake sample vigorously and pour off appropriate volume into plastic in order to pass 250 mL (or whatever volume that will pass within 15-20 minutes) through a 47 mm diameter 45 micron pore size, membrane filter at 5 p.s.i.

7. Drain the filter thoroughly under suction by turning on vacuum pump. Rinse sides of filter funnel with DI water during last 10 mL of sample. Remove filter with

forceps, fold, and place in a 15 mL stoppered centrifuge tube. Never touch filter with fingers. Add sufficient 90% acetone to bring the final volume up to 8 mL. Stopper and shake vigorously until the filter is completely dissolved, and wrap the tube in aluminum foil then place in the freezer in complete darkness for 20-24 hours.

Ensure that large flask (1st in series) is not full before turning vacuum pump on or water will be drawn into pump and a short will occur.

One replicate sample should be run on every tenth sample and entered in highlighted boxes in bench book.

D. Determination of Chlorophyll-a (Sample and Equipment Prep)

1. Turn spectrometer power on (button on top right rear).

2. Turn printer power on (button on right side rear).

3. Allow spectrometer to warm up approximately 5 minutes.

4. Remove rack of chlorophyll-a sample tubes from freezer and sequence in order of bench book numbers.

5. Place the first six sample tubes in series into centrifuge on lab bench. In the remaining two centrifuge tube holders, insert two centrifuge tubes filled with 8 mL of 90% Acetone. These are blanks used as background correction in the spectrometer.

6. Centrifuge samples and blanks for 10 minutes at full power.

7. After first 10-minute cycle, remove tubes and tap on hard surface to settle out cells. Return to centrifuge and spin for another 10 minutes.

8. While samples are in centrifuge and spectrometer is warming up, set up a run sheet to ensure proper sample order:

First Run: Second Run:

Bench Book Sample #	Sample Tube #		Bench Book Sample #	Sample Tube #
BLANK	--		320	91
BLANK	--		321	17
314	10		322	22
315	75			
316	62		Etc.....	
317	4			

318	11			
319	96			

9. After two ten-minute spin cycles in centrifuge, move tubes to rack in drawer below spectrometer. Place in sequential order to match run-sheet.

E. Chlorophyll-a Analysis:

****ALL ACETONE WASTE SHOULD BE DISPOSED OF VIA EVAPORATION UNDER THE VENTILATION HOOD****

1. After spectrometer has warmed up for approximately 5 minutes, press the METHOD button.

2. Screen appears:

```
SELECT METHOD >  <
```

3. Type 7 and press ENTER.
4. Screen appears:

```
METHOD 7 WAVPR/MAN
<-->/PARAM/START
```

5. Press START. Screen appears:

```
FIRST SAMPLE # & --
ENTER:          >  <
```

6. Enter the first bench book sample number from the run-sheet. Press ENTER and START.

7. Printer will activate and display method parameters. Verify method 7 and first sample number.

8. Screen appears:

```
BACK CORR
```

PRESS START

9. Remove chlorophyll-a cuvettes from drawer below spectrometer. Empty and rinse with small volume of 90% ACETONE.

10. Rinse blank cuvette with small volume of centrifuged blank. Fill cuvette with blank, gently stopper and place in rear cuvette holder of spectrometer. ENSURE THAT CUVETTE SURFACES ARE FREE FROM MOISTURE AND FINGERPRINTS BEFORE PLACING IN SPECTROMETER. USE KIMWIPE TO REMOVE MOISTURE AND FINGERPRINTS FROM CUVETTES.

11. Rinse sample cuvette with small volume of 90% ACETONE and small amount of second centrifuged blank. Fill to volume with blank solution and place in forward cuvette holder in spectrometer.

12. Shut sample bay door and press START. Spectrometer will conduct back correction and screen will appear:

METH 7 SAMPLE # PRESS START

13. Remove forward sample cuvette, empty and rinse with small volume of 90% ACETONE and small volume of sample.

14. Fill to volume with sample, place in cuvette holder and shut compartment door. Press START.

15. When analysis is complete, screen will read:

METH 7 SAMPLE # PRESS START

REPEAT STEPS 13 AND 14 FOR NEXT SAMPLE OR PRESS STOP TO INITIATE SHUT-DOWN PROCEDURE.

F. Shut-Down Procedure

1. Remove cuvettes from spectrometer, empty and rinse with 90% ACETONE. Rinse and fill with DI water for storage.

2. Return cuvettes to case and store in drawer below spectrometer.

3. Shut spectrometer and printer OFF.

4. COVER INSTRUMENTS

4. Transfer wavelength differences from print sheet to bench book and refer to **Section VII: Computer Procedures & Calculations** to calculate chlorophyll-a values.

COMPUTER CALCULATION PROCEDURE FOR DETERMINATION OF CHLOROPHYLL-A CONCENTRATION

1. Turn computer power on.

2. Enter login ID and Password:

3. At program manager, select **lab calculations** ICON

4. At laboratory calculations menu, select option number 1 for chlorophyll-a and press ENTER.

5. At next screen, type 16 and press ENTER.

6. Enter the A630 value from the bench book and press enter. (Make sure the extinction values at 750b have been subtracted from the 630, 647, and 664 readings prior to computer calculation. Use the subtracted values for data entry).

7. Enter the A647 value and press ENTER.

8. Enter the A664 value and press ENTER.

9. Enter volume filtered (L), and press ENTER.

10. Record final chlorophyll-a concentration (mg/m^3), in bench book.

11. Type "r" to calculate additional chlorophyll-a concentrations and follow steps 5 through 10.

12. Type "E" to exit calculation program and select option number 7 and press ENTER to return to main menu.

13. To logout of Program Manager: select file then exit windows and type logout at the C:

prompt.

STANDARD OPERATING PROCEDURES
YSI DISSOLVED OXYGEN COMPUTER PROCEDURES

A. Data Download

1. Turn DO meter selection switch to O2-TEMP position and allow meter to perform system check (approx. 10 seconds).

2. Connect computer DO download cable to DO meter.

3. Turn computer power on.

4. Enter login ID and Password.

5. Double Click on "Download" icon.

6. Open C:/MyDocuments. Click on *Download.txt.* Screen will read "Do you want to replace existing file?" Click on "Yes".

7. Press up arrow key (↑) twice on DO meter. Screen will read "Print data?" Press CONFIRM.

8. Once all data appears on in the *Download.txt* window, click on "Stop" button in lower left hand corner.

9. Shut off Dissolved Oxygen meter by turning the selection switch to the off position, and disconnect the meter from the computer.

10. Double click on the "Temp_do" icon. In pop-up window click on "Enable Macros" button.

11. Enter Lake and Town data according to Fox Pro lists in bench book.

12. Enter Zmax and weather data.

13. Press CTRL+I keys. In pop-up window change file type to "All Files". Double click on *Download.txt.*

14. Import pop-up window will appear. Double Click on "Finish".

15. Verify that data has been transferred correctly to the Lotus worksheet, and that the data is correct.

16. Select FILE from the button bar.

17. Select SAVE AS from pull-down menu.

18. Change Drive to "J" in pop-up window. Open J/Projects/DO and Appropriate Program Folder.

19. Type the name of the file under the Filename section of the pop-up window. The file name should be in the following format: MMDD lake name.
Example: Samples collected from Pawtuckaway Lake on June 5 would be saved as ***0605 Pawtuckaway***.

20. Click on "Yes" and ***fill in Data Download section of the bench book.***

21. Return Temp.-DO Field Data Sheet to biologist/intern whose initials are on the Field Data sheet.

D. Shut-Down Procedure

1. Select FILE from button bar.

2. Select EXIT from pull-down menu.

3. Select NO from pop-up window.

4. At main menu, select File then exit windows to logout or leave computer on program manager for Internet Access.

STANDARD OPERATING PROCEDURES
HYDROLAB CALIBRATION and COMPUTER PROCEDURES

Hydrolab Calibrations to be performed daily.

A. Conductivity

1. Rinse sensors several times with DI water.
2. Rinse sensors twice with specific conductance standard.
3. Screw on calibration cup and point sensors upward.
4. Pour in standard to within 1 centimeter from top of cup making sure there are no air bubbles in the cell block.
5. When specific conductance readings stabilize select CALIBRATE SpC/S from the calibration menu.
6. Type in the calibration standard value and press ENTER.

B. pH

1. Rinse sensors several times with DI water.
2. Rinse sensors twice with pH 7.0 buffer solution.
3. Screw on calibration cup and point sensors upward.
4. Pour in 7.0 buffer solution and wait until pH readings stabilize.
5. Select CALIBRATE pH from the calibration menu and type in the value of the buffer (7.0).
6. Repeat steps 1-5 with pH 4.0 buffer solution to set slope.

C. Dissolved Oxygen

1. Put sensor in bucket of air saturated, temperature stable water.
2. Wait for DO readings to stabilize.
3. Select CALIBRATE %S/DO from calibration menu.

4. Press ENTER twice.

D. Depth

1. Place transmitter at water surface.

2. Select

3. Type 0 (zero) and ENTER.

One replicate sample should be run on every tenth sample.

E. Annotation and Logging

1. Select ANNOTATE, then use the shift keys next to the SPACE.

2. When the station name has been typed onto the screen press ENTER.

3. Lower transmitter to desired depth.

4. When readings stabilize press STORE.

5. Repeat steps 1-4 for each station.

F. Downloading Files

1. Connect Data logger to terminal at the Limnology center workstation.

2. Switch port selector to D "*hydrolab*".

3. Log into computer and enter *Windows*.

4. When main menu pops up; select F. *Lab Software* menu.

5. Select C. *Hydrolab Download.*

6. When the file opens; hit the space bar twice.

7. Follow the instructions below:

HydroLab Surveyor 3 V1.03
(P)arameters,
(C)alibrate,

(V)ariables,
(L)ogging,
(H)eader,
(M)easure,
(I)dentify,
or (Escape or Ctrl X to Cancel)
Select: Logging----------Type L
(D)ump,
(E)rase,
(S)etup,
S(t)atus,
(R)eview,
(A)nnotate,
St(o)re,
or (Escape or Ctrl X to Cancel)
Select: Dump----------Type D

Power down probes during dump?
(Y)es,
(N)o,
or (Escape or Ctrl X to Cancel)
Select: Yes----------Type Y

###	Log File Name	Start	Stop	Interval
		MMDDYY	HHMMSS	HHMMSS	HHMMSS
5⇨	MANUAL⇦	010100	000000	010100	000000	000000

Select Log File: 5----------Type 5

(P)rinter ready,
(S)preadsheet importable,
or (Escape or Ctrl X to Cancel)

Select: Follow variable and calibration changes----------Type F

(N)o statistics,
(D)aily statistics,
(T)otal statistics,
(B)oth daily and total statistics,
or (Escape or Ctrl X to Cancel)

Select: No statistics----------Type N

Activate printer and/or open capture file, then press any key to continue.....Hit Space bar.

After space bar is hit, the data logger will download all information stored.

G. Printing Files:

1. Capture data to be printed with the mouse.

2. Click on *Edit - Copy*.

3. Minimize *Hydrolab* file (arrow in right hand corner of screen).

4. Select H. Windows from main menu; then *F. Notepad*.

5. When *Notepad* opens Click on *Edit - Paste*.

6. This pastes data from Hydrolab file to Notepad.

7. Click on *File - Print*.

8. Initial and date printouts in upper right hand corner and insert in Printout section of Hydrolab benchbook.

Standard Operating Procedure
Orthophosphate Analysis

TECHNIQUE: Automated colorimetric

REFERENCES:

1. Lachat QuikChem Method 10 -115-01-1-B Determination of Ortho -Phosphate by Flow Injection Colorimetry

O. METHOD DETECTION LIMIT, **January 2001**

	MDL	RDL	TRUE
ortho-P	0.004	0.01	0.01

Standard Operating Procedure
Total Phosp horus Analysis

TECHNIQUE: Persulfate digestion, automated colorimetric

REFERENCES:

1. Lachat QuikChem Method 10 -115-01-1-F Total Phosphorus in Persulfate Digests.

O. METHOD DETECTION LIMIT, January 2001

mg/L	MDL	RDL	TRUE
TP- Lachat	0.0008	0.005	0.005

Standard Operating Procedure
Total Suspended Solids

REFERENCES:

1. Standard Methods for the Examination of Water and Wastewater, 19th ed., 1995, part 2540 D., p 2-53

2..EPA Methods for Chemical Analysis of Water and Wastes, 600/4-79-020, March 1979, Revised March 1983, Method 160.2.

TECHNIQUE USED: Gravimetric, Dried at 103-105°C.

No MDL determined for this test because it is a gravimetric measurement and no detection is based on balance sensitivity.

Laboratory Equipment Maintenance and Cleaning
Standard Operating Procedure

Bottle Washing & Care Procedures

1. Glassware (flasks, graduated cylinders, beakers, etc.)
    a. Remove old labels.
    b. Wash with hot water and soap in lab sink. Use brushes if necessary.
    c. Rinse three times with warm water.
    d. Rinse three times with DI water.
    e. Hang on rack for drying.

2. Plastic Sample Bottles (chlorophyll-a, large white NHVLAP sample bottles)
    a. Remove labeling and dump contents into the sink.
    b. Fill the sink with warm water, adding soap while water is running.
    c. Rinse and wash bottles three times in soapy water.
    d. Rinse two times in warm running water without soap.
    e. Rinse three times with DI water.
    f. Hang bottles on the rack for drying.
    g. Re-label with blank masking tape before putting away.

3. Chlorophyll-A Centrifuge Tubes
    a. Allow material in tube to thoroughly dry before washing.
    b. Scrub the inside of the tube with a centrifuge tube brush until dried material has been removed from the bottom of the tube.
    c. Rinse tubes three times in warm, soapy, water.
    d. Rinse two times with warm running water without soap.
    e. Rinse three times with DI water.
    f. Hang on rack for drying.
    g. Remove any remaining materials from tubes with the centrifuge tube brush

MICROSCOPIC ANALYSES
STANDARD PROCEDURES

Equipment
American Optical, phase contrast, binocular compound microscope (Series 10 Microstar)

Calibration
The compound microscopes were calibrated using a Whipple grid and stage micrometer, as outlined in Standard Methods (20th Edition, p 10-11 through 10-13).

Cell Counts
The procedure for performing cell counts is outlined in Standard Methods (20th Edition, p 10-13 through 10-16). The strip counting method (Sedgwick-Rafter (S-R) cell only) is used. In this method the number of cells observed in the field of vision for the entire length of the Sedgwick-Rafter cell are recorded, and cells/mL are calculated. ONLY PHYTOPLANKTON ARE ENUMERATED FOR THIS STUDY. ZOOPLANKTON SPECIES ARE RECORDED, BUT NOT COUNTED.

1. A well mixed (not swirled) aliquot of sample is placed in the counting chamber using a wide mouth pipette. The S-R cell accommodates approximately 1 mL of sample.

2. To fill the cell, place the cover glass diagonally across the cell and transfer sample from sample jar to sample cell using large-mouthed pipette. Do not overfill the cell. If cell overfills, suction out excess or use Kim wipe to clear excess sample from edge of cover slip.

3. Let filled cell stand for 15 minutes to allow for cell settling.

4. Conduct a random scan of the cell contents, checking off identified plankton on plankton sheet.

5. When random scan is complete, position slide so that view is on one corner. Perform a scan across the length of the S-R cell, identifying and counting plankton as they appear. Make tally marks in the appropriate column on the lab sheet.

6. Continue counting until number reaches 100 total cells, or you have performed a total of 5 consecutive scans across the S-R cell. Mark the total number of scans or views in the appropriate location on the lab sheet.

7. Sum tally marks in appropriate column for each genus identified.

8. Determine total cell count on the sheet.

9. Determine relative percent for each organism by dividing individual organism count by total count, then multiplying by 100. Put this number in the appropriate column on the lab sheet.

10. Determine Relative Abundance by dividing total number of cells by sample depth and then by total number of scans. Record this number in the appropriate space on the lab sheet, and refer to the following set of ranges for abundance rating:

Sparse	0-10
Scattered	10.1-25
Moderate	25.1-35
Common	35.1-45
Abundant	45.1-55
Very Abun.	>55

Sample Volume is calculated using the following equation:

Vol. (L) = 10.26 X Depth of Haul (m)

Data Management and Reporting
Standard Operating Procedures

A. QAQC

To be valuable in decision-making processes, the data generated in the Limnology Center must be accurate. In many cases, because they lead to faulty interpretations, approximate or incorrect results are worse than no result at all. Therefore, Limnology Center personnel should support the data with adequate documentation and a Quality Assurance and Quality Control program that provides valid records of all control measures that are performed.

Quality assurance programs have two primary functions in the laboratory. First, the programs should continually monitor the reliability (accuracy and precision), of the results reported; i.e. they should continually provide answers to the question "How accurate and precise are the results obtained?" This function is the determination of quality. The second function is the control of quality (to meet the program requirements of reliability). As an example of the distinction between the two functions, the processing of spiked samples may be a determination of measurement quality, but the use of analytical grade reagents is a control measure.

Each analytical method has a specific and rigid protocol. Similarly, QC associated with a test must include definite required steps for monitoring the test and insuring that its results are correct. The steps in QC vary with the type of analysis. For example, in any instrumental method, calibrating or checking out the instrumental response are functions of QC. All of the experimental variables that affect the final results should be considered, evaluated and controlled.

This handbook discusses procedures and protocols for the Limnology Center Quality Assurance and Quality Control program and analytical methodologies for sample analysis.

When recording sample information and results into bench books, do not make any extraneous marks on pages and be neat and accurate. **ALWAYS USE BLACK OR BLUE BALL POINT PENS!!**

B. Critical Range Tables

Due to the nature of the analyses, most quality control (QC) activities in the Limnology Center involve lab split samples, also referred to as lab replicate samples. A lab replicate sample is a single sample collected in the field and returned to the laboratory, with two or more aliquots removed for analysis. This provides a measure of the precision (reproducibility) of the method. For the majority of the analyses performed in the Limnology Center, 10% are replicate analyses.

QC has been practiced and recorded in the Limnology Center since 1976. Although standard deviations and ranges were computed and recorded on the QC samples, no standard method of evaluating replicate sample results has been used since 1995. As of April 1, 2000, Critical Range tables were established for the majority of parameters analyzed in the Limnology Center. The tables

are based on previous QC data with the average replicate range at varying concentrations identified as R, and a critical range calculated as 3.27 R. The Critical Range tables will be updated every calendar year as more QC data becomes available.

Sample Critical Range Table

NHDES LIMNOLOGY CENTER LABORATORY CRITICAL RANGE TABLE: BECKMAN METER PH			
Concentration (Units)	***Average Range (R)***	***Warning Range (2.51R)***	***Critical Range (3.27R)***
0.0 – 10.0	***0.074***	***0.19***	***0.24***

Critical Range Procedure

1. A replicate sample must be run every tenth analysis for the majority of analyses performed in the Limnology Center. The Critical Range Table applies to highlighted Replicate data entry lines in data sheet section of Limnology Center Bench Books.

2. Once a replicate sample has been run and the data has been entered in the bench book, compare the difference between the original sample and the replicate with the critical range column of the appropriate critical range table.

3. If the replicate difference is less than the critical range, circle Y in the Bench Book critical range box and proceed with non-QC sample analysis.

4. If the replicate difference is greater than the critical range, circle N in the Bench Book critical range box and perform another replicate analysis. Enter the second replicate's data in the data entry line immediately below the original replicate data entry line. ***Note: If it is impossible to run a second replicate analysis, write an asterisks (*) and "validity questionable" to the right of the original sample's data entry line and proceed with non-QC sample analysis.***

5. Calculate the difference between the original sample data and the second replicate. If the replicate difference is less than the critical range, circle Y under Retest CR in the Bench Book critical range box and proceed with non-QC sample analysis.

6. If the second replicate difference is great than the critical range, circle N under Retest CR in the Bench Book critical range box and write an asterisks (*) and "validity questionable" to the right of the original sample's data entry line.

7. Proceed with non-QC sample analysis.

Appendix 3

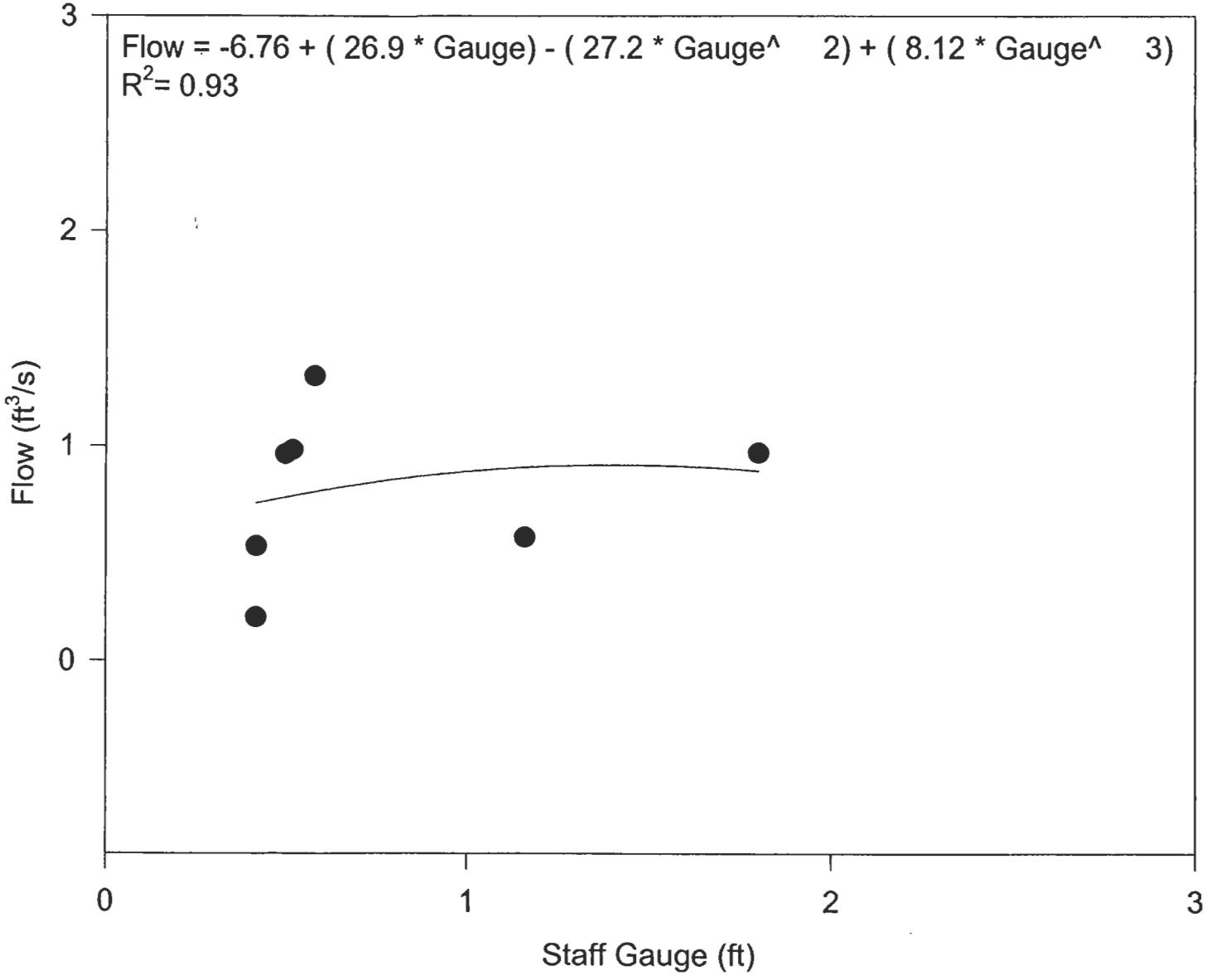
Pleasant Lake Diagnostic Study

Hydrologic Budget Raw Data and Calculations

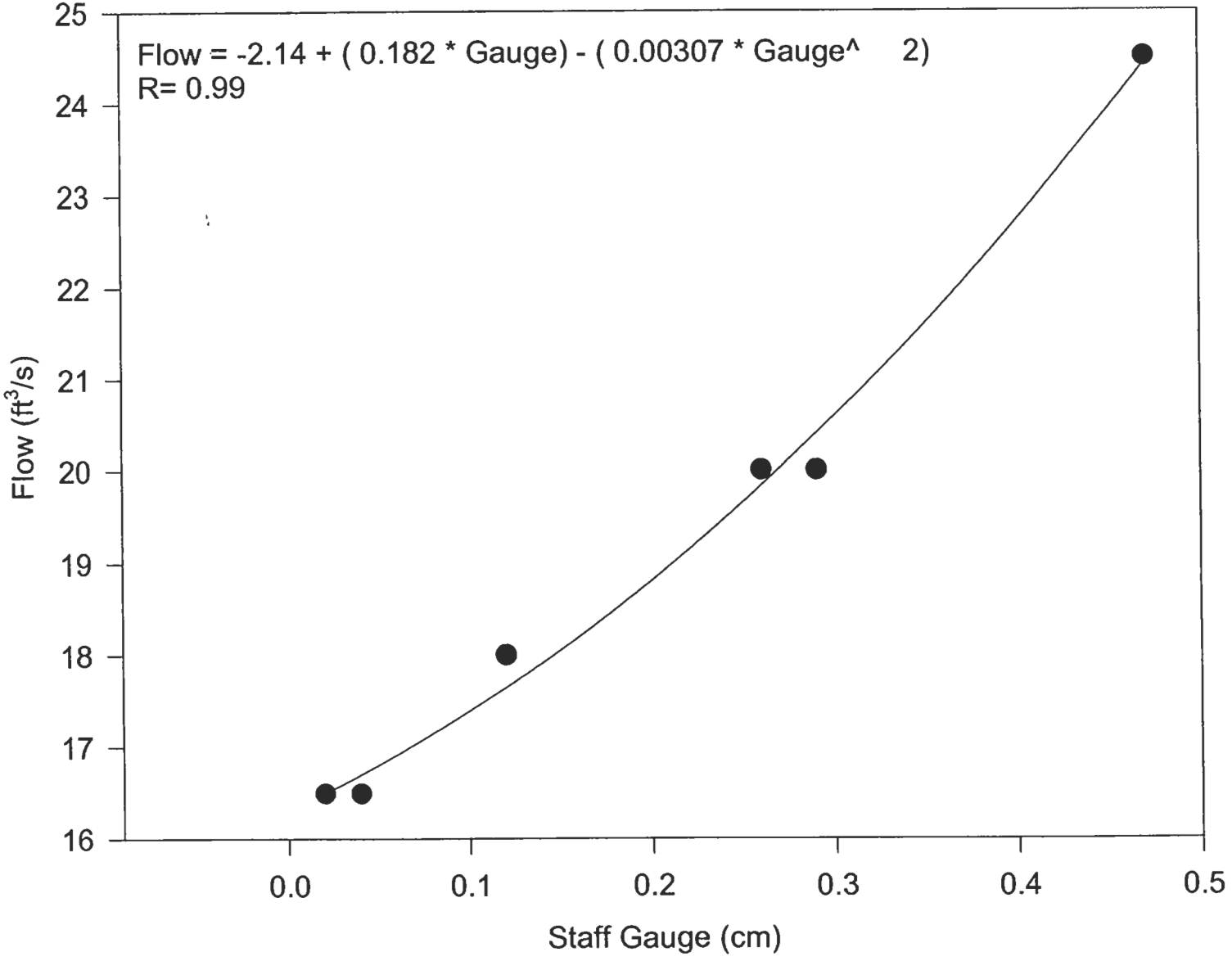
Pleasant Lake Tributary Flow and Gauge Readings

Tributary	Date	Gauge Reading	Calculated Flow
107 Inlet	09/30/99	0.42	0.159
107 Inlet	01/26/00	0.42	0.53
107 Inlet	11/23/99	0.5	0.962
107 Inlet	06/21/00	0.52	0.362
107 Inlet	12/15/99	0.52	0.982
107 Inlet	10/26/99	0.58	1.327
107 Inlet	08/08/00	1.16	0.57
107 Inlet	07/25/00	1.25	0.067
107 Inlet	03/29/00	1.28	8.082
107 Inlet	02/28/00	1.35	17.808
107 Inlet	04/18/00	1.8	0.968
107 Inlet	05/26/00	1.88	4.099
Atherton	06/21/00	16.5	0.04
Atherton	08/08/00	16.5	0.02
Atherton	12/15/99	18	0.12
Atherton	04/18/00	20	0.29
Atherton	05/26/00	20	0.26
Atherton	03/29/00	22	0.76
Atherton	02/28/00	24.5	0.47
Clark Brook	07/25/00	0.37	0
Clark Brook	09/30/99	0.48	0.012
Clark Brook	06/21/00	0.5	0.09
Clark Brook	08/08/00	0.5	0.2
Clark Brook	10/26/99	0.56	0.52
Clark Brook	01/26/00	0.6	0.13
Clark Brook	11/23/99	0.61	0.57
Clark Brook	12/15/99	0.64	0.41
Clark Brook	05/26/00	0.69	0.65
Clark Brook	02/28/00	0.9	1.1
Clark Brook	03/29/00	0.9	2.55
Farelly Brook	06/21/00	0.02	0.039
Farelly Brook	09/30/99	0.05	0.018
Farelly Brook	07/25/00	0.16	0.01
Farelly Brook	08/08/00	0.16	0.011
Farelly Brook	04/18/00	0.18	0.107
Farelly Brook	05/26/00	0.18	0.156
Farelly Brook	12/15/99	0.28	0.099
Farelly Brook	01/26/00	0.3	0.043
Farelly Brook	02/28/00	0.3	0.75
Farelly Brook	03/29/00	0.3	0.632
Farelly Brook	11/23/99	0.34	0.126
Farelly Brook	10/26/99	1.12	0.081

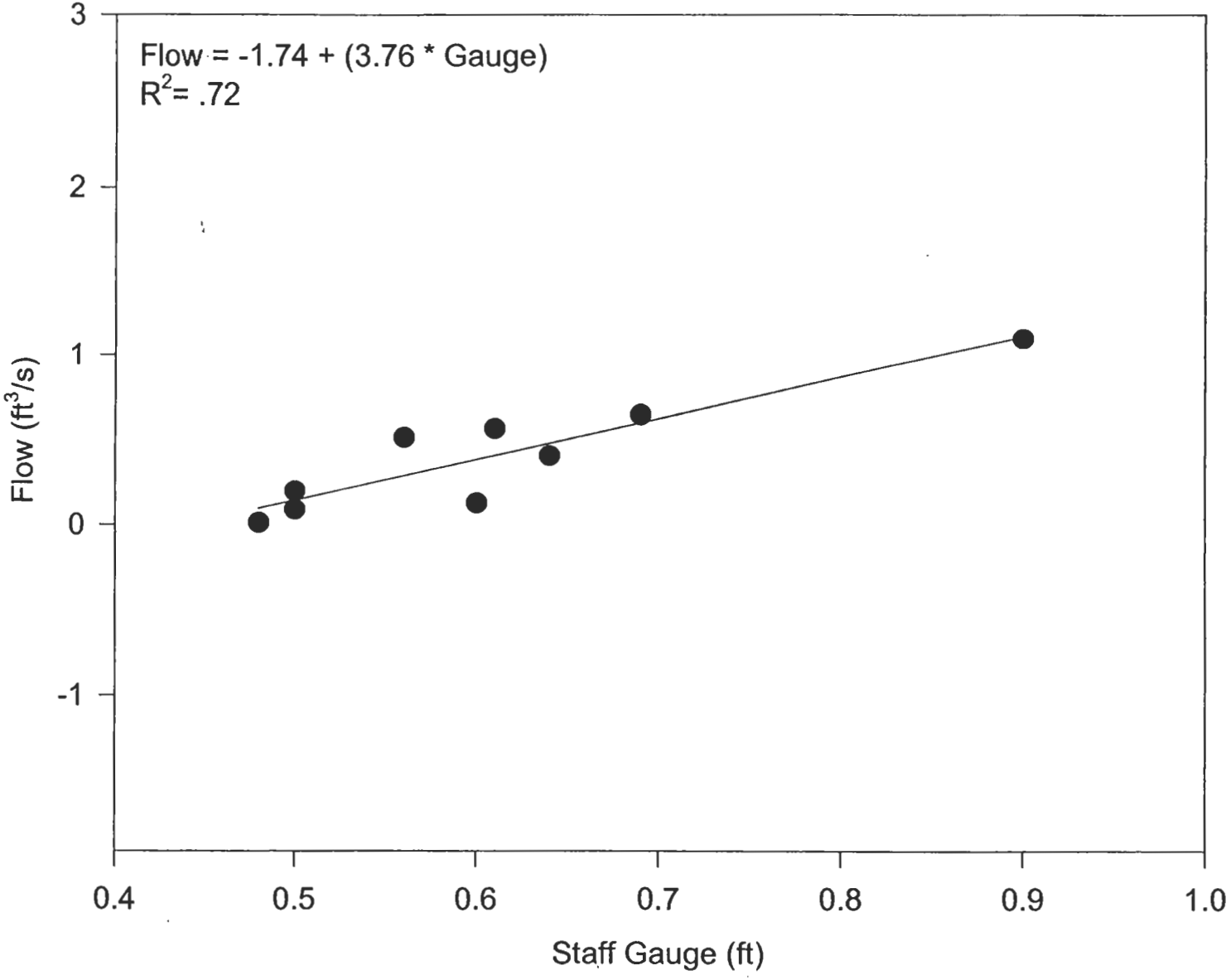
Pleasant Lake, Deerfield
107 Inlet Staff Gauge Correlation
September 1999-August 2000



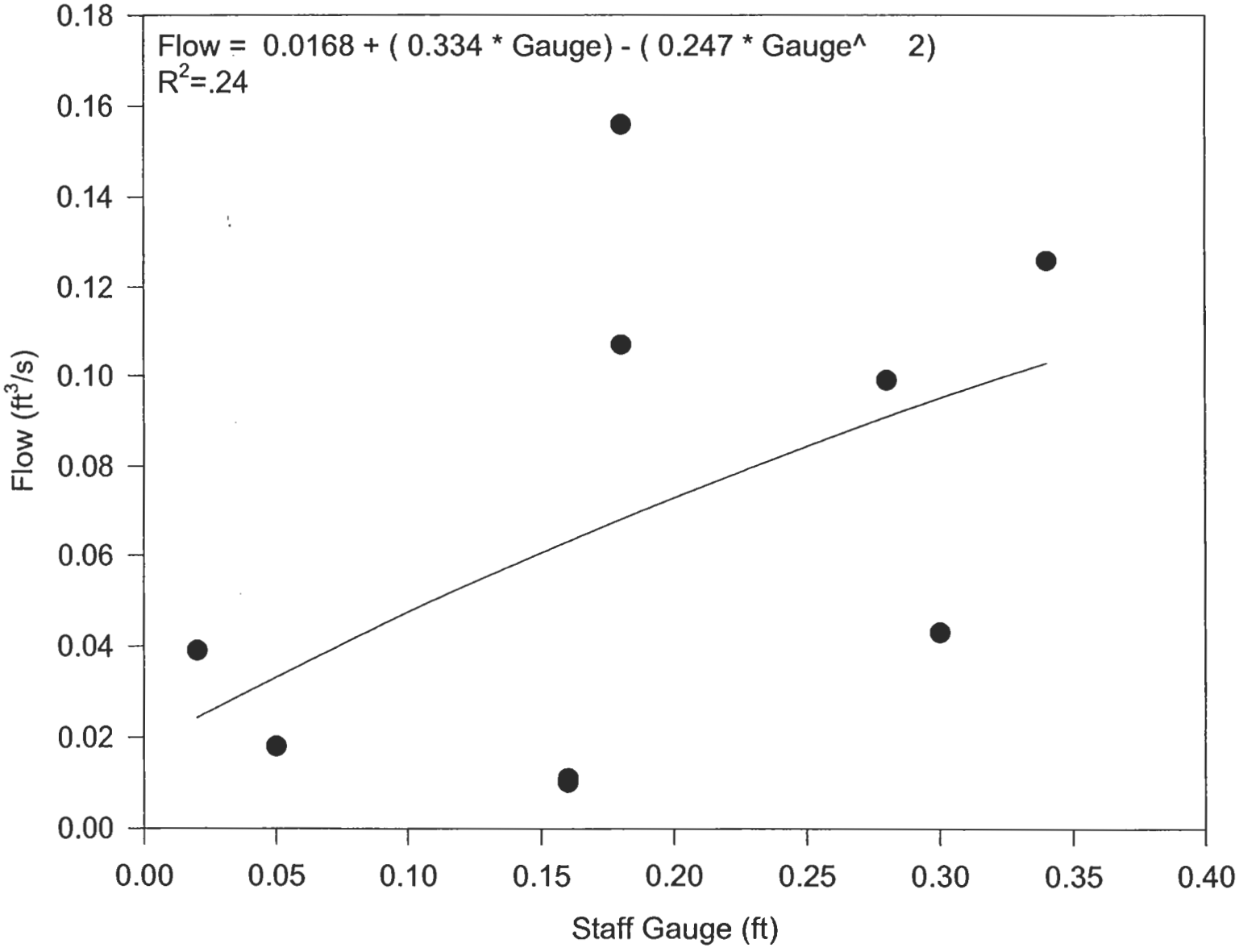
Pleasant Lake, Deerfield
Atherton Inlet Staff Gauge Correlation
September 1999-August 2000



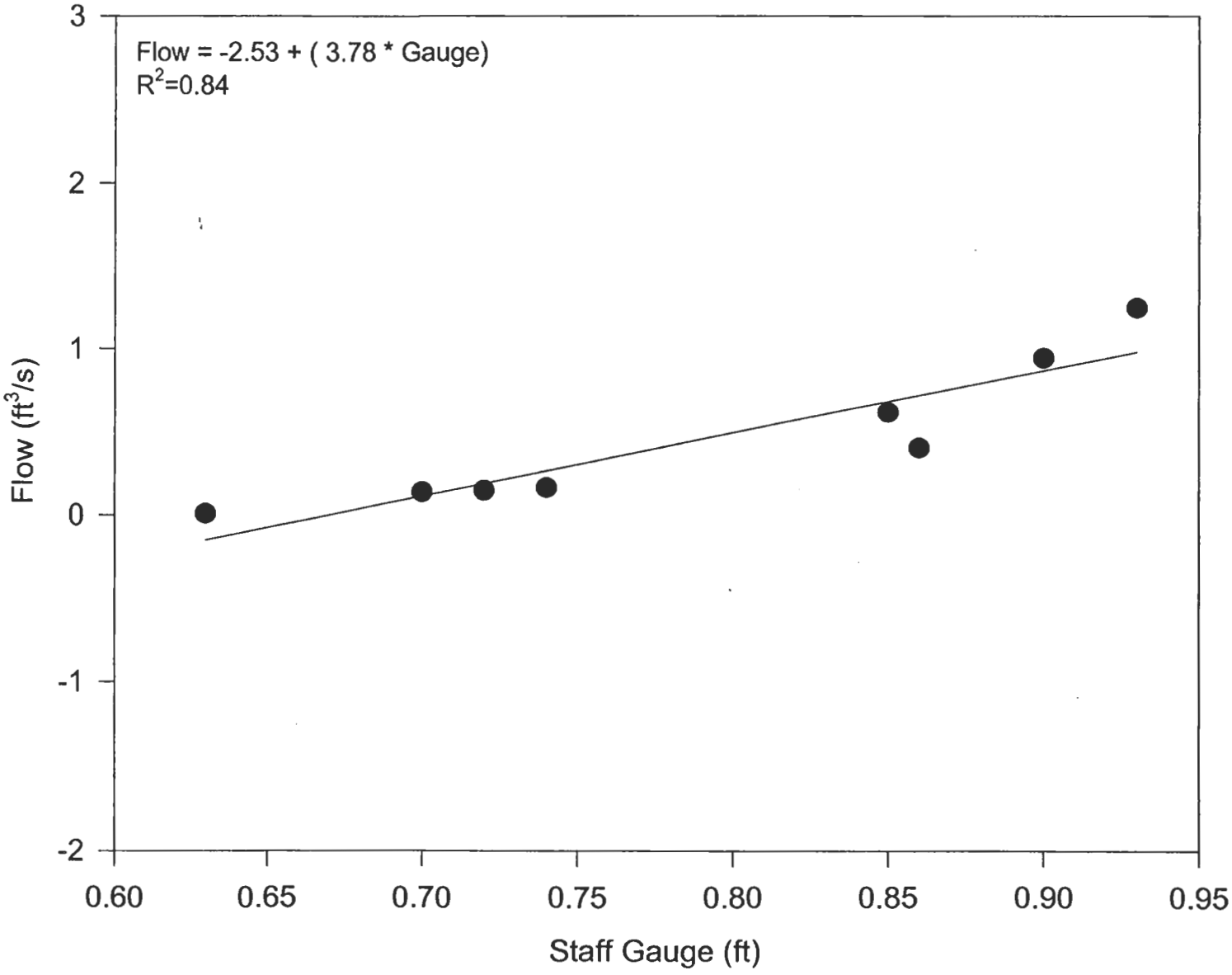
Pleasant Lake, Deerfield
Clark Brook Staff Gauge Correlation
September 1999-August 2000



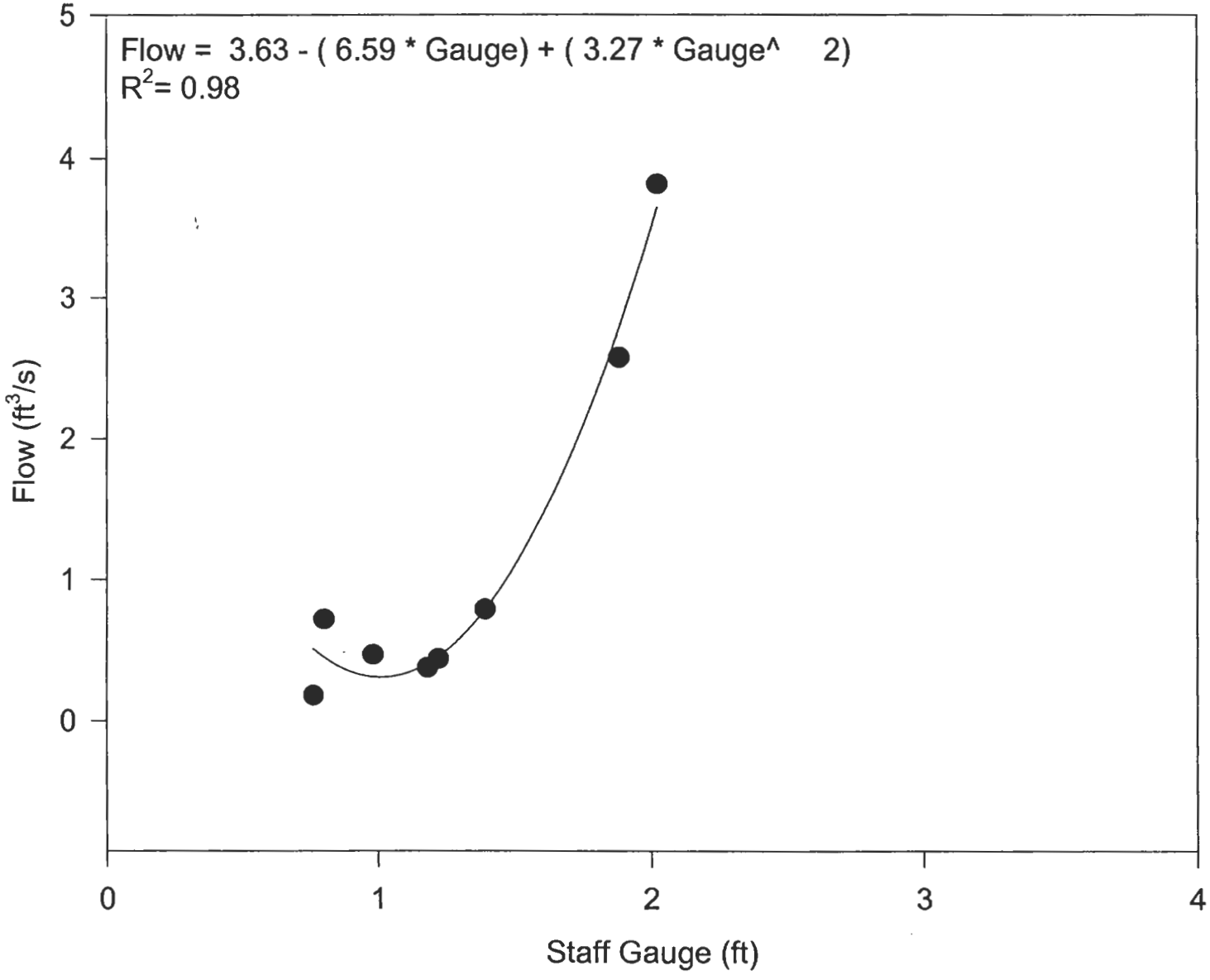
Pleasant Lake, Deerfield
Farrelly Brook Staff Gauge Correlation
September 1999-August 2000



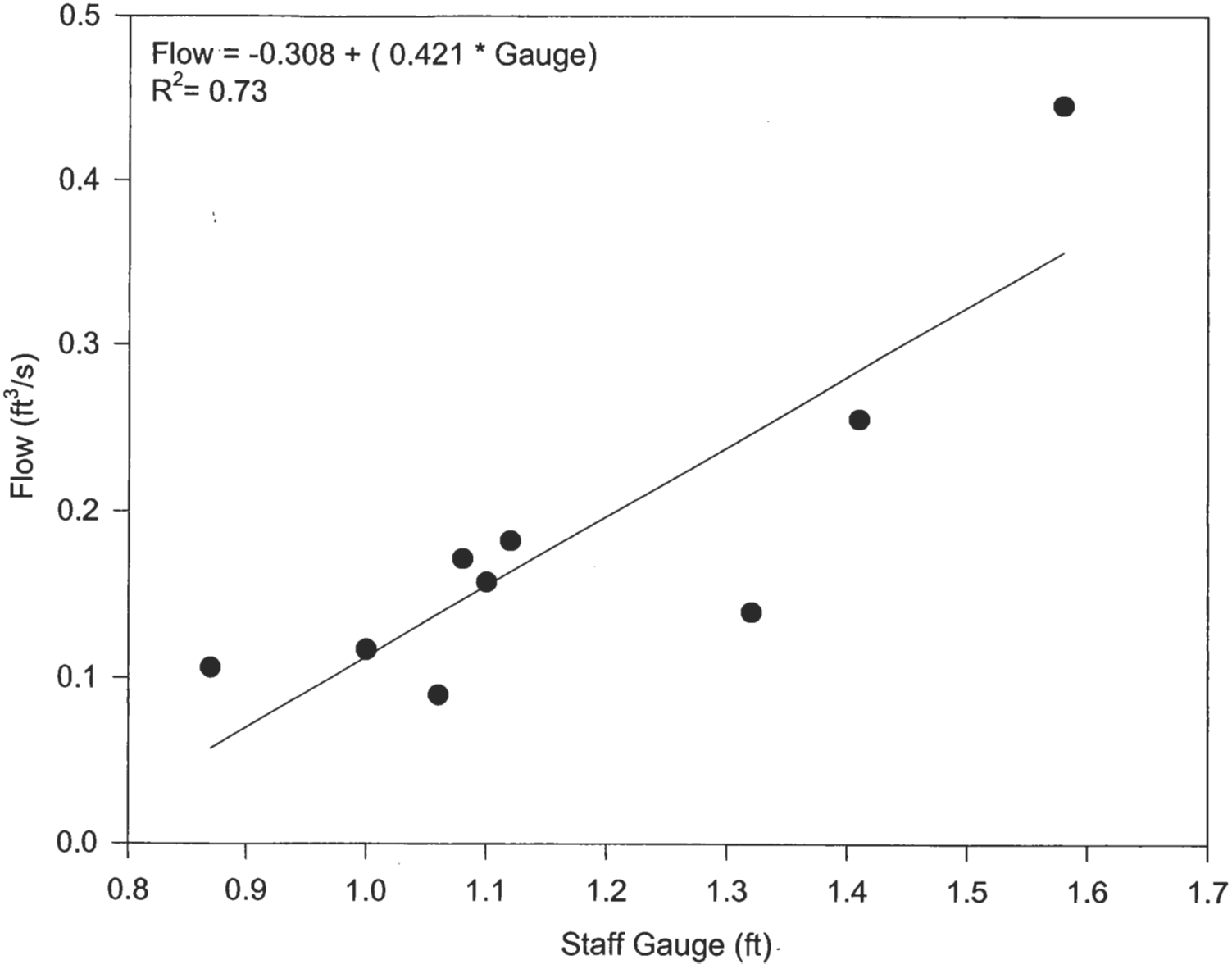
Pleasant Lake, Deerfield
Loon Cove Brook Staff Gauge Correlation
September 1999-August 2001



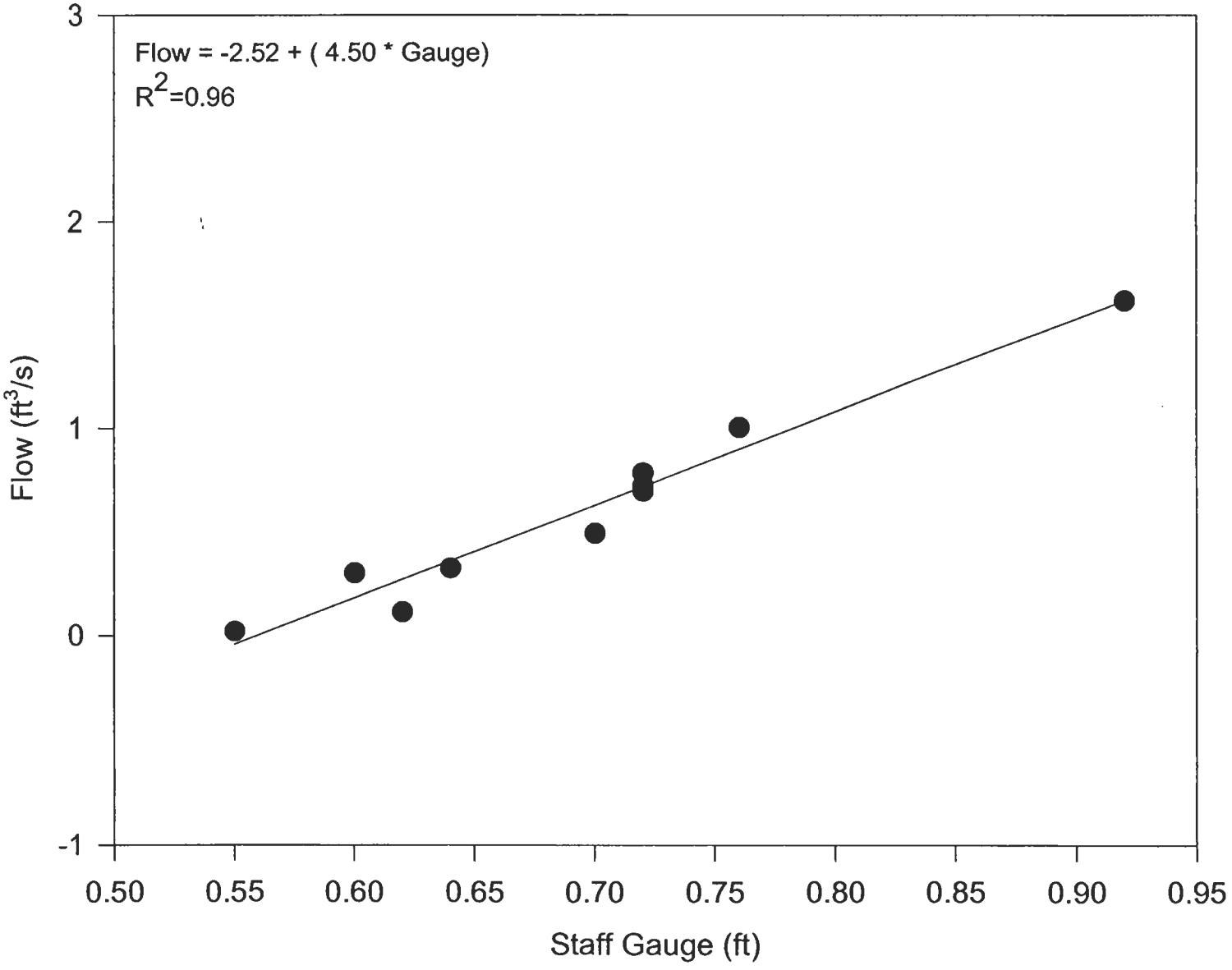
Pleasant Lake, Deerfield
Philbrick Brook Staff Gauge Correlation

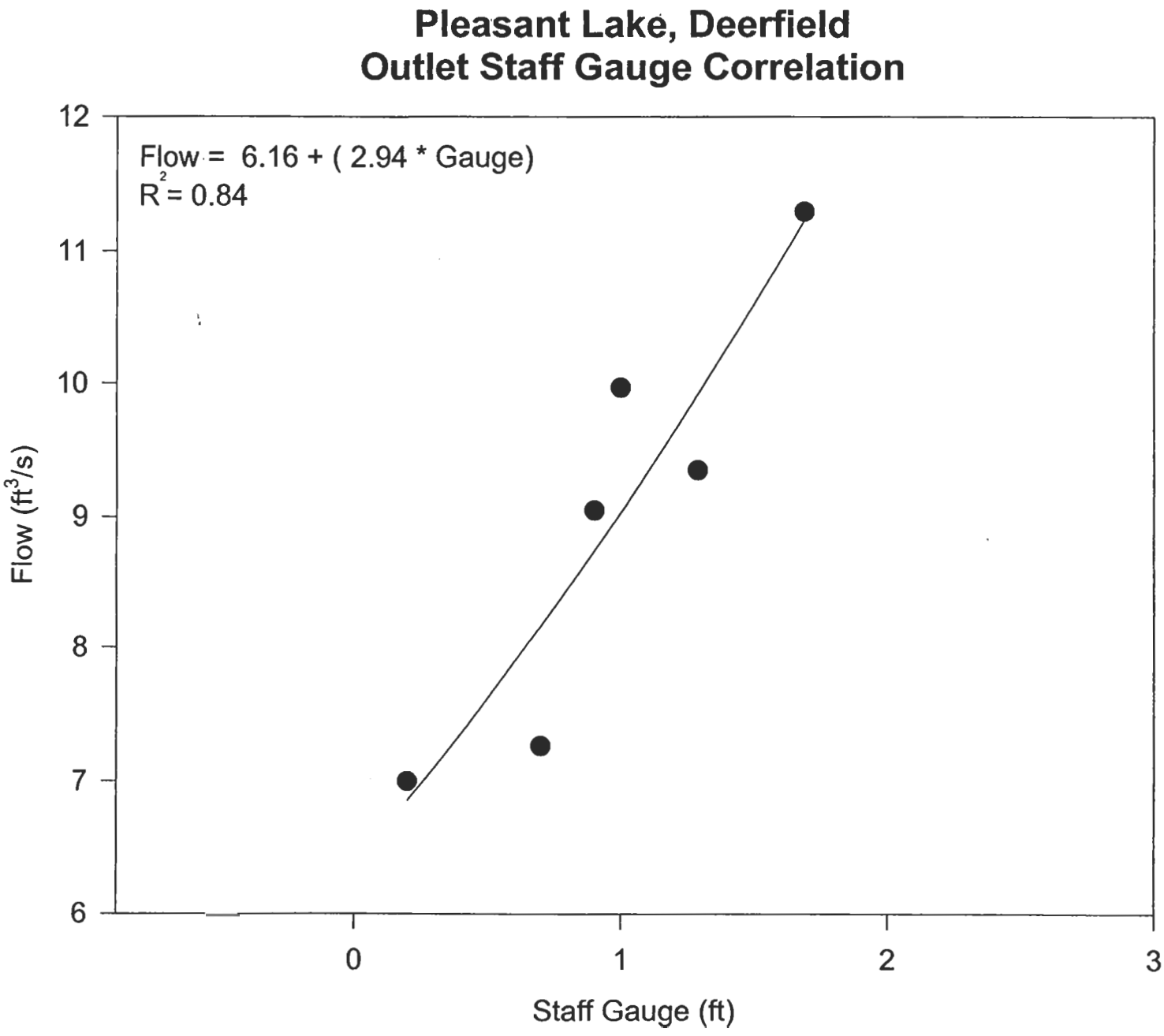


Pleasant Lake, Deerfield
Veasey Brook Staff Gauge Correlation



Pleasant Lake, Deerfield
Wilson Brook Staff Gauge Correlation




Pleasant Lake, Deerfield
Outlet Staff Gauge Correlation
Flow = 6.16 + (2.94 * Gauge)
R2 = 0.84
12
11
10
9
8
7
6
Flow (ft3/s)
0
1
2
3
Staff Gauge (ft)

Pleasant Lake Tributary Flow and Gauge Readings

Date	Tributary	Gauge Reading	Calculated Flow
09/30/99	107 Inlet	0.42	0.2
01/26/00	107 Inlet	0.42	0.53
11/23/99	107 Inlet	0.5	0.962
12/15/99	107 Inlet	0.52	0.982
10/26/99	107 Inlet	0.58	1.327
08/08/00	107 Inlet	1.16	0.57
04/18/00	107 Inlet	1.8	0.968
05/26/00	107 Inlet	1.88	4.099
06/21/00	Atherton	16.5	0.04
08/08/00	Atherton	16.5	0.02
12/15/99	Atherton	18	0.12
04/18/00	Atherton	20	0.29
05/26/00	Atherton	20	0.26
02/28/00	Atherton	24.5	0.47
07/25/00	Clark Brook	0.37	0
09/30/99	Clark Brook	0.48	0.11
06/21/00	Clark Brook	0.5	0.1
08/08/00	Clark Brook	0.5	0.2
10/26/99	Clark Brook	0.56	0.52
11/23/99	Clark Brook	0.61	0.57
05/26/00	Clark Brook	0.69	0.65
02/28/00	Clark Brook	0.9	3.35
03/29/00	Clark Brook	0.9	2.55
06/21/00	Farelly Brook	0.02	0.039
07/25/00	Farelly Brook	0.16	0.01
08/08/00	Farelly Brook	0.16	0.011
04/18/00	Farelly Brook	0.18	0.11
05/26/00	Farelly Brook	0.18	0.156
12/15/99	Farelly Brook	0.28	0.1
01/26/00	Farelly Brook	0.3	0.43
02/28/00	Farelly Brook	0.3	0.75
03/29/00	Farelly Brook	0.3	0.632
07/25/00	Loon Cove	0.63	0.009
09/30/99	Loon Cove	0.7	0.138
08/08/00	Loon Cove	0.72	0.147
06/21/00	Loon Cove	0.74	0.161
12/15/99	Loon Cove	0.85	0.612
04/18/00	Loon Cove	0.85	0.401
11/23/99	Loon Cove	0.9	0.945
05/26/00	Loon Cove	0.93	1.252
03/29/00	Loon Cove	1.2	4.351
02/28/00	Loon Cove	1.76	5.453

07/25/00	Outlet	0.2	7
06/21/00	Outlet	0.7	7.27
08/08/00	Outlet	0.9	9.05
05/26/00	Outlet	1	9.97
04/18/00	Outlet	1.29	9.35
03/29/00	Outlet	1.36	3.29
11/23/99	Outlet	1.5	5.72
12/15/99	Outlet	1.52	5.05
01/26/00	Outlet	1.52	5.55
10/26/99	Outlet	1.62	14.09
02/28/00	Outlet	1.69	11.3
07/25/00	Philbrick	0.76	0.18
11/23/99	Philbrick	1.18	0.38
04/18/00	Philbrick	1.22	0.44
05/26/00	Philbrick	1.39	0.79
03/29/00	Philbrick	1.8	2.58
02/28/00	Philbrick	2.02	3.82
10/26/99	Veasey Brook	0.56	0.182
09/30/99	Veasey Brook	0.87	0.106
08/08/00	Veasey Brook	1	0.117
06/21/00	Veasey Brook	1.06	0.1
11/23/99	Veasey Brook	1.08	0.171
12/15/99	Veasey Brook	1.1	0.157
05/26/00	Veasey Brook	1.41	0.256
03/29/00	Veasey Brook	1.58	0.446
02/28/00	Veasey Brook	1.93	2.009
07/25/00	Wilson Brook	0.55	0.019
08/08/00	Wilson Brook	0.6	0.301
06/21/00	Wilson Brook	0.64	0.325
01/26/00	Wilson Brook	0.7	0.497
10/26/99	Wilson Brook	0.72	0.726
11/23/99	Wilson Brook	0.72	0.786
12/15/99	Wilson Brook	0.76	1.004
05/26/00	Wilson Brook	0.8	2.328
02/28/00	Wilson Brook	1.18	7.056

Loon Cove	07/25/00	0.63	0.009
Loon Cove	09/30/99	0.7	0.138
Loon Cove	08/08/00	0.72	0.147
Loon Cove	06/21/00	0.74	0.161
Loon Cove	12/15/99	0.85	0.612
Loon Cove	04/18/00	0.86	0.401
Loon Cove	11/23/99	0.9	0.945
Loon Cove	05/26/00	0.93	1.252
Loon Cove	01/26/00	0.98	0.23
Loon Cove	10/26/99	1	0.679
Loon Cove	03/29/00	1.2	4.351
Loon Cove	02/28/00	1.76	5.453

Outlet	07/25/00	0.02	0.7
Outlet	09/30/99	0.56	0.07
Outlet	06/21/00	0.7	7.27
Outlet	08/08/00	0.9	9.05
Outlet	05/26/00	1	9.97
Outlet	04/18/00	1.29	9.35
Outlet	03/29/00	1.36	3.29
Outlet	11/23/99	1.5	5.67
Outlet	12/15/99	1.52	5.05
Outlet	01/26/00	1.52	5.55
Outlet	10/26/99	1.62	14.09
Outlet	02/28/00	1.69	3.71

Philbrick	10/26/99	0.19	0.43
Philbrick	07/25/00	0.76	0.18
Philbrick	09/30/99	0.8	0.72
Philbrick	12/15/99	0.98	0.47
Philbrick	06/21/00	0.98	0.04
Philbrick	08/08/00	1.01	0.05
Philbrick	11/23/99	1.18	0.38
Philbrick	04/18/00	1.22	0.44
Philbrick	05/26/00	1.39	0.79
Philbrick	03/29/00	1.8	2.58
Philbrick	02/28/00	2.02	3.82

Veasey Brook	10/26/99	0.56	0.182
Veasey Brook	09/30/99	0.87	0.106
Veasey Brook	08/08/00	1	0.117
Veasey Brook	06/21/00	1.06	0.09
Veasey Brook	11/23/99	1.08	0.171
Veasey Brook	12/15/99	1.1	0.157
Veasey Brook	05/26/00	1.41	0.256
Veasey Brook	03/29/00	1.58	0.446
Veasey Brook	02/28/00	1.93	2.009

Wilson Brook	07/25/00	0.55	0.019
Wilson Brook	08/08/00	0.6	0.301
Wilson Brook	09/30/99	0.62	0.116
Wilson Brook	06/21/00	0.64	0.325
Wilson Brook	01/26/00	0.7	0.497
Wilson Brook	10/26/99	0.72	0.726
Wilson Brook	11/23/99	0.72	0.786
Wilson Brook	12/15/99	0.76	1.004
Wilson Brook	05/26/00	0.8	2.328
Wilson Brook	03/29/00	0.92	1.618
Wilson Brook	02/28/00	1.18	7.056
Wilson Brook	04/18/00	1.32	0.699

Appendix 4

Pleasant Lake Diagnostic Study

Nutrient Budget Raw Data and Calculations

Total Phosphorus Inputs through Precipitation				
Month	*Precip (m^3)*	*Precip (L)*	*Precip (L) X TP (ug/L)*	*TP Loading (Kg)*
Sep-99	299288.85	299288852.8	1122333198	1.122333198
Oct-99	202400.43	202400427.6	1922804062	1.922804062
Nov-99	111599.23	111599233.2	781194632.7	0.781194633
Dec-99	103990.19	103990194.6	1507857822	1.507857822
Jan-00	139499.04	139499041.6	3068978914	3.068978914
Feb-00	125802.77	125802772	956101067.3	0.956101067
Mar-00	155224.39	155224388.1	2638814597	2.638814597
Apr-00	316028.74	316028737.8	12325120773	12.32512077
May-00	146600.81	146600810.9	8649447845	8.649447845
Jun-00	175007.89	175007888.5	15225686299	15.2256863
Jul-00	246532.85	246532851.6	28351277935	28.35127794
Aug-00	117179.19	117179194.9	5507422160	5.50742216
				82.05703931

Tributary Phosphorus Concentrations

Station	Date	Flow (103m3)	Flow (m3)	Flow (L)	Trib TP (ug)	Trib Loading (ug)	Trib TP (Kg)
107 Inlet	Sep-99	59.51	59512.32	59512320	11	654635520	0.7
107 Inlet	Oct-99	33.75	33747.84	33747840	5	168739200	0.2
107 Inlet	Nov-99	9.00	8999.424	8999424	3	26998272	0.0
107 Inlet	Dec-99	20.32	20321.28	20321280	10	203212800	0.2
107 Inlet	Jan-00	33.00	32997.888	32997888	6	197987328	0.2
107 Inlet	Feb-00	43.18	43182.72	43182720	8	345461760	0.3
107 Inlet	Mar-00	28.50	28498.176	28498176	6	170989056	0.2
107 Inlet	Apr-00	100.49	100493.568	100493568	7	703454976	0.7
107 Inlet	May-00	98.22	98219.52	98219520	6	589317120	0.6
107 Inlet	Jun-00	41.62	41622.336	41622336	51	2122739136	2.1
107 Inlet	Jul-00	4.72	4717.44	4717440	8	37739520	0.0
107 Inlet	Aug-00	3.75	3749.76	3749760	11	41247360	0.0
							5.3
Atherton Brook	Sep-99		0	0		0	0.0
Atherton Brook	Oct-99	13.06	13063.68	13063680		0	0.0
Atherton Brook	Nov-99	15.75	15748.992	15748992		0	0.0
Atherton Brook	Dec-99	13.50	13499.136	13499136		0	0.0
Atherton Brook	Jan-00	10.89	10886.4	10886400	5	54432000	0.1
Atherton Brook	Feb-00	7.12	7124.544	7124544	11	78369984	0.1
Atherton Brook	Mar-00	10.16	10160.64	10160640	4		0.0
Atherton Brook	Apr-00	38.25	38247.552	38247552	9		0.0
Atherton Brook	May-00	66.00	65995.776	65995776	6	395974656	0.4
Atherton Brook	Jun-00	25.06	25062.912	25062912	7	175440384	0.2
Atherton Brook	Jul-00	42.00	41997.312	41997312	14	587962368	0.6
Atherton Brook	Aug-00	18.14	18144	18144000	15	272160000	0.3
							1.6
Clark Brook	Sep-99	2.25	2249.856	2249856	16	35997696	0.0
Clark Brook	Oct-99	0.73	725.76	725760	6	4354560	0.0
Clark Brook	Nov-99	0.75	749.952	749952	5	3749760	0.0
Clark Brook	Dec-99	3.94	3937.248	3937248	6	23623488	0.0
Clark Brook	Jan-00	6.89	6894.72	6894720	4	27578880	0.0
Clark Brook	Feb-00	5.25	5249.664	5249664	6	31497984	0.0
Clark Brook	Mar-00	11.98	11975.04	11975040	3	35925120	0.0
Clark Brook	Apr-00	19.50	19498.752	19498752	7	136491264	0.1
Clark Brook	May-00	7.87	7874.496	7874496	6	47246976	0.0
Clark Brook	Jun-00	6.10	6096.384	6096384	8	48771072	0.0
Clark Brook	Jul-00	6.00	5999.616	5999616	13	77995008	0.1
Clark Brook	Aug-00	1.45	1451.52	1451520	11	15966720	0.0
							0.5
Farrelly Brook	Sep-99	1.31	1306.368	1306368	15	19595520	0.0
Farrelly Brook	Oct-99	6.37	6365.84256	6365842.56	4	25463370.24	0.0
Farrelly Brook	Nov-99	9.14	9140.70528	9140705.28	5		0.0
Farrelly Brook	Dec-99	7.02	7017.37086	7017370.86	9		0.0
Farrelly Brook	Jan-00	6.50	6498.376577	6498376.58	1		0.0
Farrelly Brook	Feb-00	22.35	22348.44864	22348448.6	5	111742243.2	0.1
Farrelly Brook	Mar-00	19.92	19915.60532	19915605.3	3		0.0
Farrelly Brook	Apr-00	6.04	6039.223142	6039223.14	6	36235338.85	0.0
Farrelly Brook	May-00	7.22	7220.387866	7220387.87	7	50542715.06	0.1
Farrelly Brook	Jun-00	3.88	3881.6064	3881606.4	6	23289638.4	0.0

Farrelly Brook	Jul-00	2.39	2392.776852	2392776.85	16	38284429.64	0.0
Farrelly Brook	Aug-00	3.72	3720.621865	3720621.86	5	18603109.32	0.0
							0.3
Loon Cove	Sep-99	4.83	4826.304	4826304	33	159268032	0.2
Loon Cove	Oct-99	85.14	85139.55072	85139550.7	27	2298767869	2.3
Loon Cove	Nov-99	71.45	71453.4912	71453491.2	18	1286162842	1.3
Loon Cove	Dec-99	57.01	57006.35136	57006351.4	11	627069865	0.6
Loon Cove	Jan-00	49.35	49346.8416	49346841.6	11	542815257.6	0.5
Loon Cove	Feb-00	212.50	212504.9472	212504947	13	2762564314	2.8
Loon Cove	Mar-00	180.71	180713.4336	180713434	19	3433555238	3.4
Loon Cove	Apr-00	61.04	61036.416	61036416	17	1037619072	1.0
Loon Cove	May-00	64.50	64500.87168	64500871.7	26	1677022664	1.7
Loon Cove	Jun-00	9.51	9507.456	9507456	191	1815924096	1.8
Loon Cove	Jul-00	21.14	21143.64672	21143646.7	78	1649204444	1.6
Loon Cove	Aug-00	8.27	8269.47072	8269470.72	64	529246126.1	0.5
							17.8
Outlet	Sep-99	421.92	421920.576	421920576	6	2531523456	2.5
Outlet	Oct-99	882.90	882898.4909	882898491	6	5297390945	5.3
Outlet	Nov-99	654.28	654277.4784	654277478	9	5888497306	5.9
Outlet	Dec-99	654.71	654708.096	654708096	10	6547080960	6.5
Outlet	Jan-00	680.44	680436.4493	680436449	2	1360872899	1.4
Outlet	Feb-00	582.51	582507.2333	582507233	7	4077550633	4.1
Outlet	Mar-00	625.41	625409.9712	625409971	5	3127049856	3.1
Outlet	Apr-00	689.25	689249.4336	689249434	5	3446247168	3.4
Outlet	May-00	704.20	704204.928	704204928	11	7746254208	7.7
Outlet	Jun-00	534.38	534377.088	534377088	10	5343770880	5.3
Outlet	Jul-00	403.38	403384.1818	403384182	10	4033841818	4.0
Outlet	Aug-00	665.04	665037.4349	665037435	9	5985336914	6.0
							55.4
Philbrick	Sep-99	42.49	42485.9904	42485990.4	13	552317875.2	0.6
Philbrick	Oct-99	31.04	31044.888	31044888	6	186269328	0.2
Philbrick	Nov-99	29.03	29025.12614	29025126.1	5	145125630.7	0.1
Philbrick	Dec-99	31.56	31564.47974	31564479.7	9	284080317.7	0.3
Philbrick	Jan-00	53.98	53983.15736	53983157.4	3	161949472.1	0.2
Philbrick	Feb-00	135.67	135669.4069	135669407		0	0.0
Philbrick	Mar-00	108.56	108564.9264	108564926	5	542824632	0.5
Philbrick	Apr-00	55.64	55637.72928	55637729.3	5	278188646.4	0.3
Philbrick	May-00	38.96	38960.0064	38960006.4	11	428560070.4	0.4
Philbrick	Jun-00	16.22	16224.9696	16224969.6	5	81124848	0.1
Philbrick	Jul-00	27.93	27927.01256	27927012.6	24	670248301.4	0.7
Philbrick	Aug-00	20.98	20980.35717	20980357.2	26	545489286.5	0.5
							3.9
Veasey	Sep-99	5.20	5197.16736	5197167.36	57	296238539.5	0.3
Veasey	Oct-99	11.06	11061.792	11061792	10	110617920	0.1
Veasey	Nov-99	11.54	11539.34208	11539342.1	13	150011447	0.2
Veasey	Dec-99	9.58	9576.88704	9576887.04	6	57461322.24	0.1
Veasey	Jan-00	16.05	16051.97261	16051972.6	22	353143397.4	0.4
Veasey	Feb-00	61.13	61127.61984	61127619.8	41	2506232413	2.5
Veasey	Mar-00	25.43	25428.87245	25428872.4	7	178002107.1	0.2
Veasey	Apr-00	20.73	20728.43136	20728431.4	7	145099019.5	0.1
Veasey	May-00	16.89	16890.41894	16890418.9	11	185794608.4	

Veasey	Jun-00	7.64	7644.672	7644672	24	183472128	0.2
Veasey	Jul-00	10.05	10053.10656	10053106.6	24	241274557.4	0.2
Veasey	Aug-00	8.57	8574.4512	8574451.2	58	497318169.6	0.5
							4.9
Wilson Brook	Sep-99	6.19	6187.104	6187104	9	55683936	0.1
Wilson Brook	Oct-99	55.27	55271.4624	55271462.4	3	165814387.2	0.2
Wilson Brook	Nov-99	59.29	59294.592	59294592	4	237178368	0.2
Wilson Brook	Dec-99	63.35	63345.9456	63345945.6	20	1266918912	1.3
Wilson Brook	Jan-00	88.92	88919.3088	88919308.8	5	444596544	0.4
Wilson Brook	Feb-00	198.68	198684.0576	198684058	4	794736230.4	0.8
Wilson Brook	Mar-00	100.07	100068.5952	100068595	4	400274380.8	0.4
Wilson Brook	Apr-00	73.52	73519.488	73519488	6	441116928	0.4
Wilson Brook	May-00	94.19	94193.9712	94193971.2	7	659357798.4	0.7
Wilson Brook	Jun-00	22.01	22014.72	22014720	5	110073600	0.1
Wilson Brook	Jul-00	17.22	17223.8976	17223897.6	7	120567283.2	0.1
Wilson Brook	Aug-00	13.27	13274.1504	13274150.4	6	79644902.4	0.1
							4.8

Appendix 5

Pleasant Lake Diagnostic Study

Septic System Survey Form

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
6 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095
(603) 271-2457 FAX (603) 271-7894

December 5, 2000

Dear Pleasant Lake Shorefront and Watershed Property Owners:

Greetings! As you may know, the field-sampling component of the now almost 2-year Pleasant Lake Study has come to an end. Lake residents and volunteers have spent countless hours collecting water samples from the streams and the lake, as well as conducting watershed walks and keeping me up to date on the day-to-day changes in and around the lake. I thank you all for your commitment to both this project and to the lake that you all love. This project would not have been feasible without your efforts.

Before report writing can begin, there is one more phase of the study that must be completed. A septic system survey form (enclosed) needs to be completed by a member of each household in the watershed of Pleasant Lake. The reason for this is to help us better understand the state of the septic systems in the area, allowing us to have a better grasp of the impacts that these systems may be having on the water quality of your lake.

Because these issues are sometimes sensitive, I have decided to conduct an anonymous survey. You need only fill out the questions that are asked on the enclosed blue sheet of paper, and you do not need to include your name, address, or lot number. I would encourage you to be honest in your responses, as this will assist us in better protecting and rehabilitating the lake. Remember, as the lake quality declines, so too can property values and the recreational values of your waterbody. Biologists can help the lake maintain its good health, and can intercept symptoms of decline before the lake starts showing impacts through loss of the fishery or prolonged algal blooms.

If you have comments, or would like to include your name and address, please feel free to include this information on the back of the survey in the indicated location. If not, thank you for participating in the survey, and I hope to see you at the summer 2001 meeting when the results of the study will be presented along with recommendations for lake and watershed management options.

I can be reached anytime at 603-271-2248 or *asmagula@des.state.nh.us*. Thank you again for your time and cooperation. Happy Holidays!

Sincerely,

Amy P. Smagula
Aquatic Biologist, NHDES

Anonymous Septic System Survey

Pleasant Lake

Deerfield/Northwood

1. Do you have a septic system?

   Yes No

2. How old is your septic system (in years)?

   1-10 10-15 15-20 20-25 I don't know

3. At least how many feet from the shore of the lake is your septic system located?

   10-20 20-50 50-75 Greater than 75 feet

4. Are you a year round resident or seasonal?

   Year round Seasonal

5. If you are a season resident, how many months out of the year do you spend in your lake home?

   _____

6. In what condition is your septic system?

   Good Moderate Poor I don't know

7. Do you have any problems with your septic system (odors, surface discharge, clogging)?

   Yes No

8. Have you made any repairs on your septic system?

   Yes No

9. How often do you have your septic tank pumped?

   Every 1-3 years Every 3-5 years Every 10 years Never

Septic System Survey, cont.

10. What size lot do you own?

    1/4 acre 1/2 acre 1 acre >1 acre

11. How far away from the lake edge is your home located?

    10-20 feet 20-50 feet 50-75 feet >75 feet

12. What is your drinking water source?

    Dug Well Drilled Well Public Water Bottled Water I don't know

13. How many bedrooms does your home/cottage have?

    1 2 3 More than 3

14. How many people typically occupy your lot?

    1 2 3 4 5 >5

15. Which of the following water-using machines do you have on your lakefront dwelling?

    Washing Machine Garbage Disposal Dishwasher Water Softener

    Other_____

Comments (optional):

When form is complete, please mail to:

Amy P. Smagula
NH Department of Environmental Services
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095

or fax to (603)271-7894

For more information, I can be reached at (603)271-2248 or asmagula@des.state.nh.us

Appendix 6

Pleasant Lake Diagnostic Study

In-Lake and Tributary Raw Data

Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
107 INLET	9/13/99	5.830		0.6		70.1		0.014	
107 INLET	9/27/99	5.710		0.3		43.89		0.008	
107 INLET	10/12/99	5.330		0.19		46.4		0.004	
107 INLET	10/26/99	5.190		0.75		46		0.005	
107 INLET	11/8/99	5.680		1.78		45.9		0.002	
107 INLET	11/22/99	5.770	5.585	0.17	0.632	42.5	49.132	0.003	0.006
107 INLET	12/6/99	5.690		0.25		41.06		0.009	
107 INLET	12/20/99	5.540		1.98		41		0.01	
107 INLET	1/12/00	5.590		1		36.2		0.007	
107 INLET	1/18/00	5.640		0.54		41.58		0.005	
107 INLET	2/7/00	5.620		0.63		37.6		0.009	
107 INLET	2/22/00	5.060	5.523	0.21	0.768	42.53	39.995	0.006	0.008
107 INLET	3/6/00	5.160		0.16		87.2		0.009	
107 INLET	3/19/00	5.140		0.1		55.69		0.002	
107 INLET	4/5/00	5.420		0.17		46.09		0.005	
107 INLET	4/17/00	5.650		0.09		51.69		0.009	
107 INLET	5/8/00	5.980		0.25		46.08		0.007	
107 INLET	5/18/00	5.91	5.543	0.38	0.192	47.27	55.670	0.005	0.006
107 INLET	6/6/00	5.98		2.3		68.82		0.05	
107 INLET	6/21/00	5.74		5		49.08		0.051	
107 INLET	7/6/00	6.15		0.42		83.1		0.008	
107 INLET	7/17/00	5.53		0.2		34.98		0.007	
107 INLET	8/9/00	5.81		0.16		38.75		0.015	
107 INLET	8/23/00	6.1	5.885	0.16	1.373	58.86	55.598	0.007	0.023
Mean		5.53		0.74125		50.09875		0.010708	
Median		5.665		0.275		46.04		0.007	
Standard Deviation		0.299622		1.095677		14.00844		0.012661	
ATHERTON BF	1/18/00	4.53		0.67		73.01		0.005	
ATHERTON BF	2/7/00	4.31		0.92		76.6		0.015	
ATHERTON BF	2/22/00	4.33	4.39	0.64	0.743333	68.34	72.65	0.007	0.009
ATHERTON BF	3/6/00	4.27		0.16		66.5		0.006	
ATHERTON BF	3/19/00	4.33		0.2		62.53		0.002	
ATHERTON BF	4/5/00	4.36		0.42		70.14		0.012	
ATHERTON BF	4/17/00	4.35		0.17		81.1		0.006	
ATHERTON BF	5/8/00	4.34		0.43		80.69		0.007	
ATHERTON BF	5/18/00	4.4	4.341667	0.41	0.298333	83.78	74.12333	0.005	0.006333
ATHERTON BF	6/6/00	4.3		2.3		90.85		0.005	
ATHERTON BF	6/21/00	4.29		0.59		89.38		0.008	
ATHERTON BF	7/17/00	4.32		0.48		83		0.014	
ATHERTON BF	8/9/00	4.35	4.315	0.26	0.9075	81.91	86.285	0.015	0.0105
Mean		4.34		0.588462		77.52538		0.008231	
Median		4.33		0.43		80.69		0.007	
St. Deviation		0.064886		0.559998		8.830663		0.004304	
CLARK BROOI	9/13/99	4.34		0.63		117.2		0.023	
CLARK BROOI	9/27/99	4.42		0.4		86.12		0.009	

Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
CLARK BROO	10/12/99	4.45		0.64		59.85		0.003	
CLARK BROO	10/26/99	4.53		1.83		49.9		0.009	
CLARK BROO	11/8/99	4.54		0.86		41.4		0.004	
CLARK BROO	11/22/99	4.82	4.516667	0.23	0.765	42.6	66.17833	0.006	0.009
CLARK BROO	12/6/99	4.87		1.45		40.8		0.005	
CLARK BROO	12/20/99	4.92		0.52		41.2		0.006	
CLARK BROO	1/12/00	4.79		9.2		42.6		0.005	
CLARK BROO	1/18/00	4.65		0.51		42.46		0.003	
CLARK BROO	2/7/00	4.65		0.43		44.8		0.004	
CLARK BROO	2/22/00	4.85	4.788333	0.29	2.066667	41.7	42.26	0.008	0.005167
CLARK BROO	3/6/00	4.71		0.18		39.47		0.003	
CLARK BROO	3/19/00	4.77		0.3		37.38		0.002	
CLARK BROO	3/28/00			5.29					
CLARK BROO	4/5/00	4.69		0.17		41.72		0.004	
CLARK BROO	4/17/00	4.69		0.16		41.66		0.01	
CLARK BROO	5/8/00	4.74		0.47		40.66		0.006	
CLARK BROO	5/18/00	4.77	4.728333	0.37	0.991429	39.56	40.075	0.005	0.005
CLARK BROO	6/6/00	4.79		0.19		38.69		0.005	
CLARK BROO	6/21/00	4.7		0.45		42.63		0.011	
CLARK BROO	7/6/00	4.86		0.5		40.71		0.014	
CLARK BROO	7/17/00	4.53		0.45		58.47		0.012	
CLARK BROO	8/9/00	4.64		0.3		51.28		0.009	
CLARK BROO	8/23/00	4.81	4.721667	0.31	0.366667	47.42	46.53333	0.012	0.0105
Mean		4.66		1.0452		48.76167		0.007417	
Median		4.705		0.45		42.09		0.006	
St. Dev.		0.153122		1.986777		17.85464		0.004699	
COMP/TUBE 6	8/8/00					4.15			
COMP/TUBE 7	5/26/00					3.11			
COMP/TUBE 5	6/8/00					2.01			
COMP/TUBE 7	6/21/00					1.66			
COMP/TUBE 7	7/13/00					3.27			
COMP/TUBE 7	8/22/00					4.01			
COMP/TUBE 8	7/25/00					1.99			
COMP/TUBE 8	9/14/00					2.35			
Mean						2.81875			
Median						2.73			
St. Deviation						0.954919			
DAM OUTLET	9/13/99	6.38		0.63		67.3		0.004	
DAM OUTLET	9/27/99	5.98		0.47		67.2		0.007	
DAM OUTLET	10/12/99	6.03		0.52		66.83		0.004	
DAM OUTLET	10/26/99	6		1.11		66		0.008	
DAM OUTLET	11/4/99	5.99				65.6			
DAM OUTLET	11/8/99	5.88		1		65.1		0.006	
DAM OUTLET	11/22/99	6.01	6.038571	0.47	0.7	67.7	66.53286	0.011	0.006667
DAM OUTLET	12/6/99	5.94		1.31		69.78		0.01	
DAM OUTLET	12/20/99	5.92		0.98		66.8		0.009	

Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
DAM OUTLET	1/12/00	6		3		66.1		0.001	
DAM OUTLET	1/18/00	5.93		1.3		70.07		0.003	
DAM OUTLET	2/7/00	5.85		0.81		78.3		0.005	
DAM OUTLET	2/22/00	6.07	5.951667	0.31	1.285	74.3	70.89167	0.008	0.006
DAM OUTLET	3/6/00	5.63		0.2		66.86		0.005	
DAM OUTLET	3/19/00	5.48		0.3		65.38		0.004	
DAM OUTLET	4/5/00	5.79		0.41		66.66		0.005	
DAM OUTLET	4/17/00	6.06		0.34		65.49		0.005	
DAM OUTLET	5/2/00					64.8			
DAM OUTLET	5/8/00	6.19		0.48		65.29		0.011	
DAM OUTLET	5/18/00	6.08	5.871667	0.37	0.35	65.6	65.72571	0.01	0.006667
DAM OUTLET	6/6/00	6.12		1.19		71.44		0.01	
DAM OUTLET	6/21/00	6.15		0.35		70.18		0.01	
DAM OUTLET	7/6/00	6.4		0.32		68.6		0.01	
DAM OUTLET	7/17/00	6.3		0.34		69.34		0.01	
DAM OUTLET	8/9/00	6.31		0.24		68.97		0.01	
DAM OUTLET	8/23/00	6.46	6.29	0.26	0.45	69.54	69.67833	0.007	0.0095
Mean		5.98		0.69625		68.04731		0.007208	
Median		6.01		0.47		67.03		0.0075	
St. Deviation		0.229001		0.607502		3.102527		0.002919	
EPILIMNION	5/14/99	6.28		0.25		64.79		0.007	
EPILIMNION	5/25/99	6.15		0.2		65		0.003	
EPILIMNION	6/10/99	6.2		0.37		66.3		0.006	
EPILIMNION	6/24/99	6.34		0.38		67.32		0.007	
EPILIMNION	7/8/99	6.31		0.33		67.62		0.004	
EPILIMNION	7/20/99	6.34		0.32				0.001	
EPILIMNION	8/12/99	6.05		0.3		67.7		0.002	
EPILIMNION	8/26/99	6.4		0.33		66.44		0.004	
Mean		6.24		0.31		66.45286		0.00425	
Median		6.295		0.325		66.44		0.004	
St. Deviation		0.11655		0.06		1.195055		0.002252	
EPILIMNION	5/26/00	6.57		0.27		68.28		0.006	
EPILIMNION	6/8/00	6.57		0.33		68.94		0.007	
EPILIMNION	6/21/00	6.41		0.26		69.01		0.007	
EPILIMNION	7/13/00	6.85		0.25		69.79		0.006	
EPILIMNION	7/25/00	6.4		0.19		69.53		0.005	
EPILIMNION	8/8/00	6.18		0.2		69.23		0.008	
EPILIMNION	8/22/00	6.13		0.3		69.38		0.006	
EPILIMNION	9/14/00	6.61		0.3		69.13		0.006	
Mean		6.41		0.2625		69.16125		0.006375	
Median		6.49		0.265		69.18		0.006	
St. Deviation		0.236643		0.048917		0.452499		0.000916	
FARRELLY BR	9/13/99	6.36		0.37		221.5		0.013	
FARRELLY BR	9/27/99	6.14		1.09		191.7		0.016	
FARRELLY BR	10/12/99	5.58		0.6		176.05		0.002	

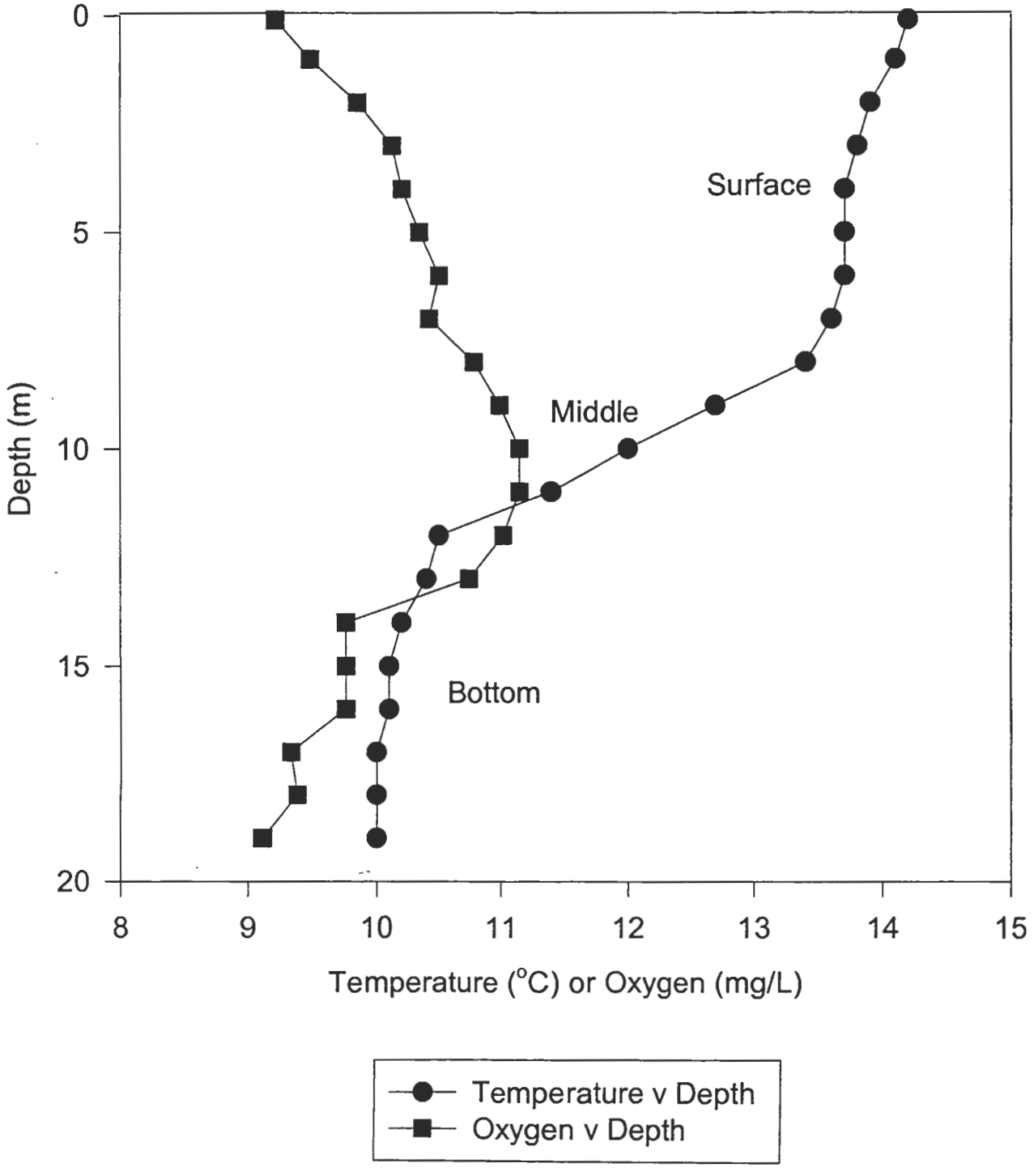
Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
FARRELLY BR	10/26/99	5.07		0.82		182.7		0.005	
FARRELLY BR	11/8/99	4.98		0.69		163.1		0.006	
FARRELLY BR	11/22/99	5.36	5.581667	0.43	0.666667	135.6	178.4417	0.003	0.0075
FARRELLY BR	12/6/99	5.35		0.7		129.27		0.009	
FARRELLY BR	12/20/99	5.21		0.76		122.21		0.008	
FARRELLY BR	1/12/00	5.03		1.75		112.7		0.001	
FARRELLY BR	1/18/00	5.24		2.5		110.11		0.041	
FARRELLY BR	2/7/00	5.43		15.1		123.3		0.003	
FARRELLY BR	2/22/00	5.56	5.303333	0.97	3.63	139.2	122.7983	0.007	0.0115
FARRELLY BR	3/6/00	5.2		0.3		104.24		0.002	
FARRELLY BR	3/19/00	4.97		0.6		138.21		0.003	
FARRELLY BR	4/5/00	5.2		0.3		93.18		0.006	
FARRELLY BR	4/17/00	5.59		0.22		92.76		0.005	
FARRELLY BR	5/8/00	5.95		0.77		94.29		0.008	
FARRELLY BR	5/18/00	5.92	5.471667	0.51	0.45	98.14	103.47	0.006	0.005
FARRELLY BR	6/6/00	6.13		0.72		110.2		0.005	
FARRELLY BR	6/21/00	5.98		1.42		111.4		0.007	
FARRELLY BR	7/17/00	5.75		0.28		123.8		0.016	
FARRELLY BR	8/9/00	6.69		6.1		167.1		0.005	
FARRELLY BR	8/23/00	6.8	6.27		2.13	266	155.7	0.066	0.0198
Mean		5.4		1.681818		139.4243		0.010565	
Median		5.56		0.71		123.8		0.006	
St. Deviation		0.534671		3.246879		44.44581		0.014619	
HYPOLIMNION	5/14/99	5.8		0.55		64.9		0.006	
HYPOLIMNION	5/14/99	5.91		0.99		65.37		0.006	
HYPOLIMNION	5/25/99	6.23		0.26		64.7		0.007	
HYPOLIMNION	6/10/99	5.73		0.56		64.9		0.009	
HYPOLIMNION	6/24/99	5.98		0.97		68.82		0.008	
HYPOLIMNION	7/8/99	5.69		0.82		65.89		0.009	
HYPOLIMNION	7/20/99	5.78		1.01		68.5		0.008	
HYPOLIMNION	8/12/99	6.08		0.95		74.6		0.011	
HYPOLIMNION	8/26/99	6.23		0.87		79.76		0.013	
HYPOLIMNION	10/5/99	6.38		6.5		90.97		0.021	
Mean		5.93		1.348		70.841		0.0098	
Median		5.93		0.91		67.195		0.0085	
St. Deviation		0.240113		1.826824		8.635631		0.004492	
HYPOLIMNION	5/26/00	5.9		0.51		68.82		0.007	
HYPOLIMNION	6/8/00	5.73		0.39		68.96		0.01	
HYPOLIMNION	6/21/00	5.68		0.6		70.09		0.007	
HYPOLIMNION	7/13/00	5.72		0.57		70.73		0.005	
HYPOLIMNION	7/25/00	5.81		0.99		71.53		0.008	
HYPOLIMNION	8/8/00	5.82		1.3		70.49		0.008	
HYPOLIMNION	8/22/00	5.96		2.3		72.99		0.008	
HYPOLIMNION	9/14/00	6.33		0.7		83.3		0.014	
Mean		5.83		0.92		72.11375		0.008375	
Median		5.815		0.65		70.61		0.008	
St. Deviation		0.208699		0.629739		4.71597		0.002669	

Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
LOON COVE	9/13/99	5.81		0.62		92.5		0.028	
LOON COVE	9/27/99	5.71		0.64		91.3		0.038	
LOON COVE	10/12/99	5.24		0.45		115.91		0.026	
LOON COVE	10/26/99	5.24		1.23		71.7		0.027	
LOON COVE	11/8/99	5.58		1.16		85.5		0.02	
LOON COVE	11/22/99	5.55	5.521667	0.35	0.741667	83.6	90.085	0.016	0.025833
LOON COVE	12/6/99	5.65		0.81		80.99		0.012	
LOON COVE	12/20/99	5.57		0.8		79.6		0.01	
LOON COVE	1/12/00	5.48		1.61		51.2		0.01	
LOON COVE	1/18/00	5.4		0.61		75.26		0.012	
LOON COVE	2/7/00	5.56		1.07		68.3		0.015	
LOON COVE	2/22/00	5.75	5.568333	0.61	0.918333	66.3	70.275	0.011	0.011667
LOON COVE	3/6/00	5.49		0.38		64.06		0.023	
LOON COVE	3/19/00	5.19		0.2		60.08		0.014	
LOON COVE	4/5/00	5.47		0.62		78.34		0.015	
LOON COVE	4/17/00	5.78		0.47		84.15		0.019	
LOON COVE	5/8/00	5.99		0.48		69.5		0.034	
LOON COVE	5/18/00	5.96	5.646667	0.42	0.428333	79.58	72.61833	0.017	0.020333
LOON COVE	6/6/00	6.07		0.92		78.56		0.27	
LOON COVE	6/21/00	6.07		1.33		69.46		0.113	
LOON COVE	7/6/00	6.31		2.7		64.66		0.112	
LOON COVE	7/17/00	5.89		0.83		69.23		0.044	
LOON COVE	8/9/00	6.26		1.23		77.99		0.048	
LOON COVE	8/23/00	6.29	6.148333	1.7	1.451667	67.81	71.285	0.079	0.111
Mean		5.61		0.885		76.06583		0.042208	
Median		5.68		0.72		76.625		0.0215	
St. Deviation		0.329708		0.557596		13.00524		0.056651	
METALIMNION	5/25/99	6.26		0.31		64.2		0.005	
METALIMNION	6/10/99	6.42		0.88		65.3		0.01	
METALIMNION	6/24/99	6.15		0.5		66.15		0.007	
METALIMNION	7/8/99	5.89		0.62		64.97		0.007	
METALIMNION	7/20/99	5.7		0.49		66.6		0.006	
METALIMNION	8/12/99	5.83		0.53		67.4		0.003	
METALIMNION	8/26/99	5.68		0.92		67.7		0.008	
METALIMNION	10/5/99	6.36		0.72		66.25		0.002	
Mean		5.95		0.62125		66.07125		0.006	
Median		6.02		0.575		66.2		0.0065	
St. Deviation		0.297366		0.208082		1.197932		0.002619	
METALIMNION	5/26/00	6.28		0.33		68.39		0.009	
METALIMNION	6/8/00	6.2		0.32		68.84		0.01	
METALIMNION	6/21/00	6.12		0.35		68.73		0.007	
METALIMNION	7/13/00	6.13		0.52		68.97		0.005	
METALIMNION	7/25/00	5.74		0.46		69.81		0.008	
METALIMNION	8/8/00	5.88		0.5		70.15		0.009	
METALIMNION	8/22/00	6.01		0.4		64.97		0.008	
METALIMNION	9/14/00	5.88		0.84		71.55		0.008	

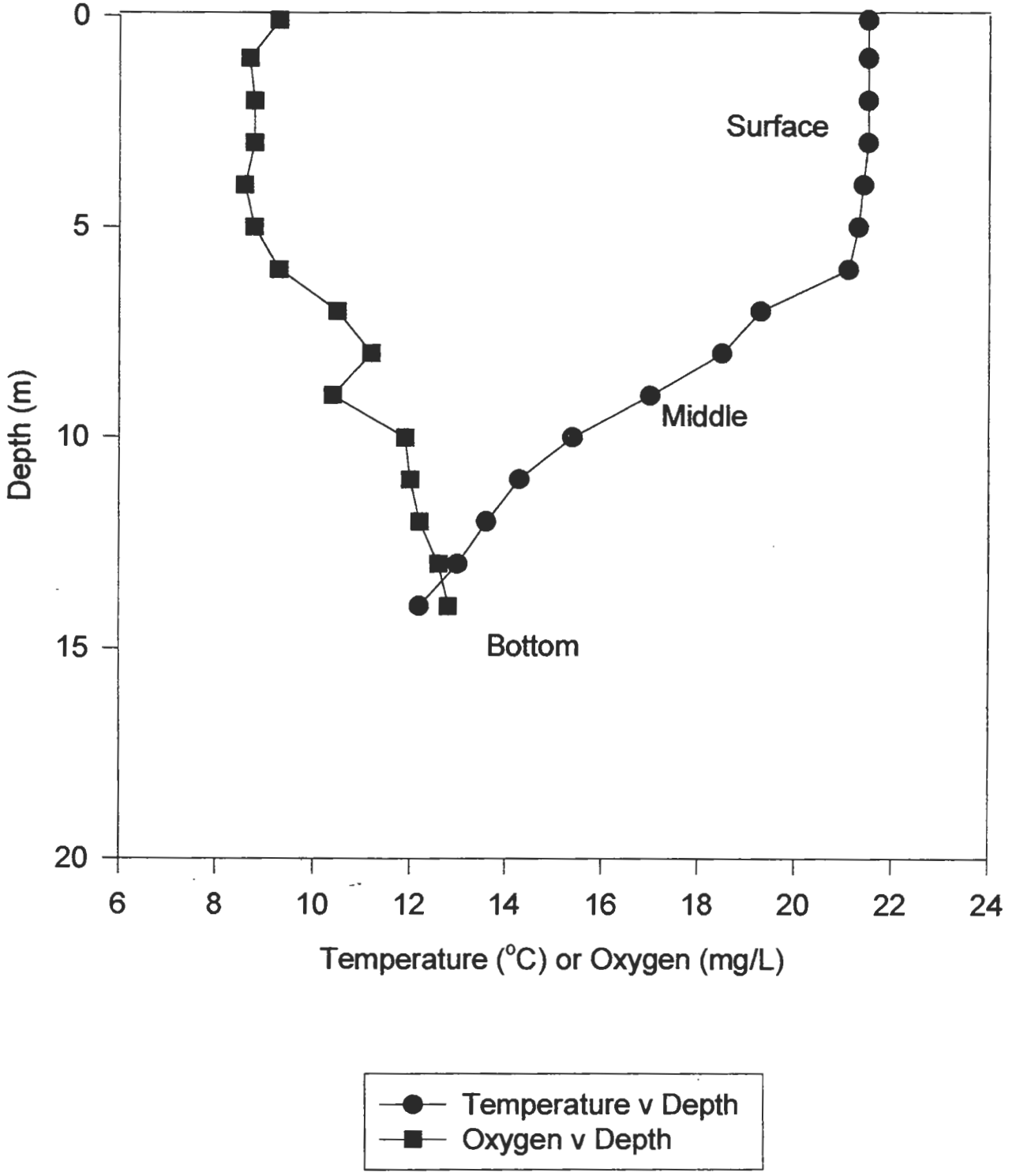
Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
Mean		6		0.465		68.92625		0.008	
Median		6.065		0.43		68.905		0.008	
St. Deviation		0.184778		0.169706		1.895483		0.001512	
PHILBRICK BR	9/27/99	4.62		0.51		43		0.013	
PHILBRICK BR	10/12/99	4.55		0.51		26.95		0.006	
PHILBRICK BR	10/26/99	4.72		0.49		29.1		0.005	
PHILBRICK BR	11/8/99	4.77		1.01		26		0.004	
PHILBRICK BR	11/22/99	4.89	4.71	0.22	0.548	26.06	30.222	0.006	0.0068
PHILBRICK BR	12/6/99	4.99		0.19		25.27		0.015	
PHILBRICK BR	12/20/99	4.88		0.33		27.37		0.003	
PHILBRICK BR	1/12/00	4.83		1.36		25.9		0.001	
PHILBRICK BR	1/18/00	4.9	4.9	2.4	1.07	27.65	26.5475	0.005	0.006
PHILBRICK BR	3/6/00	4.94		0.12		25.4		0.007	
PHILBRICK BR	3/19/00	4.87		0.1		23.97		0.002	
PHILBRICK BR	4/5/00	4.85		0.09		25.54		0.005	
PHILBRICK BR	4/17/00	4.99		0.28		23.75		0.005	
PHILBRICK BR	5/8/00	4.92		0.32		21.95		0.012	
PHILBRICK BR	5/18/00	4.95	4.92	0.28	0.198333	20.08	23.44833	0.009	0.006667
PHILBRICK BR	6/6/00	4.96		0.41		18.7		0.005	
PHILBRICK BR	6/21/00	4.84		0.25		20.78		0.005	
PHILBRICK BR	7/6/00	5.23		0.7		16.45		0.029	
PHILBRICK BR	7/17/00	4.68		0.97		30.46		0.018	
PHILBRICK BR	8/9/00	5		0.26		17.51		0.015	
PHILBRICK BR	8/23/00	5.22	4.988333	0.7	0.548333	17.1	20.16667	0.037	0.018167
Mean		4.86		0.547619		24.71381		0.009857	
Median		4.89		0.33		25.4		0.006	
St. Deviation		0.158642		0.538358		5.805363		0.009051	
VEASEY BRO(	9/27/99	4.82		1.03		248.3		0.057	
VEASEY BRO(	10/12/99	4.96		0.61		215.34		0.009	
VEASEY BRO(	10/26/99	5.14		1.31		192.2		0.01	
VEASEY BRO(	11/8/99	4.94		1.48		186.6		0.019	
VEASEY BRO(	11/22/99	5.32	5.036	0.72	1.03	169.6	202.408	0.006	0.0202
VEASEY BRO(	12/6/99	5.83		0.99		164.74		0.009	
VEASEY BRO(	12/20/99	5.17		0.72		169.93		0.003	
VEASEY BRO(	1/12/00	5.35		1.3		131.2		0.005	
VEASEY BRO(	1/18/00	5.16		7.3		160.48		0.039	
VEASEY BRO(	2/7/00	5.37	5.376	2.5	2.562	147.7	154.81	0.041	0.0194
VEASEY BRO(	3/6/00	5.35		0.28		179.8		0.009	
VEASEY BRO(	3/19/00	5.14		0.4		164.22		0.005	
VEASEY BRO(	4/5/00	5.43		0.45		145.54		0.009	
VEASEY BRO(	4/17/00	5.49		0.48		145.8		0.005	
VEASEY BRO(	5/8/00	5.72		0.79		127.6		0.015	
VEASEY BRO(	5/18/00	5.48	5.435	0.68	0.513333	137	149.9933	0.007	0.008333
VEASEY BRO(	6/6/00	5.4		4.1		153.6		0.019	
VEASEY BRO(	6/21/00	5.49		1.05		152.4		0.028	
VEASEY BRO(	7/17/00	5.6		0.72		152.1		0.024	
VEASEY BRO(	8/9/00	5.83		15.8		171.1		0.049	

Pleasant Lake Tributary and In-Lake Raw Data									
Station	Date	pH	Seasonal	Turb	Seasonal	Conductiv	Seasonal	TP	Seasonal
VEASEY BRO(	8/23/00	6.02	5.668	14.4	7.214	197.6	165.36	0.066	0.0372
Mean		5.28		2.719524		167.2786		0.020667	
Median		5.37		0.99		164.22		0.01	
St. Deviation		0.309229		4.418501		28.96801		0.018893	
WILSON BRO(	9/13/99	6.35		0.18		124.3		0.008	
WILSON BRO(	9/27/99	6.19		0.62		50.42		0.009	
WILSON BRO(	10/12/99	5.91		0.12		46.1		0.003	
WILSON BRO(	10/26/99	5.65		1.18		58.3		0.003	
WILSON BRO(	11/8/99	5.62		0.55		59.2		0.004	
WILSON BRO(	11/22/99	5.72	5.906667	0.11	0.46	55	65.55333	0.004	0.005167
WILSON BRO(	12/6/99	5.86		0.4		55.22		0.037	
WILSON BRO(	12/20/99	5.7		0.19		55.59		0.003	
WILSON BRO(	1/12/00	5.63		1.1		51.7		0.009	
WILSON BRO(	1/18/00	5.64		0.41		46.64		0.001	
WILSON BRO(	2/7/00	5.73		0.52		50.4		0.002	
WILSON BRO(	2/22/00	5.93	5.748333	0.5	0.52	59.77	53.22	0.006	0.009667
WILSON BRO(	3/6/00	5.38		0.16		60.91		0.003	
WILSON BRO(	3/19/00	5.7		0.4		66.61		0.004	
WILSON BRO(	4/5/00	5.57		0.18		50.75		0.006	
WILSON BRO(	4/17/00	5.88		0.26		48.86		0.005	
WILSON BRO(	5/8/00	6.12		0.14		43.57		0.008	
WILSON BRO(	5/18/00	5.99	5.773333	0.17	0.218333	45.51	52.70167	0.005	0.005167
WILSON BRO(	6/6/00	6.16		0.09		47.16		0.005	
WILSON BRO(	6/21/00	6.08		0.13		47.87		0.005	
WILSON BRO(	7/6/00	6.34		0.18		56.12		0.006	
WILSON BRO(	7/17/00	5.97		0.39		44.24		0.007	
WILSON BRO(	8/9/00	6.31		0.13		49.09		0.006	
WILSON BRO(	8/23/00	6.44	6.216667	0.18	0.183333	55.92	50.06667	0.005	0.005667
Mean		5.83		0.345417		55.38542		0.006417	
Median		5.895		0.185		51.225		0.005	
St. Deviation		0.287664		0.292084		15.83066		0.006846	

Pleasant Lake, Deerfield
Temperature and Oxygen Profile
May 14, 1999



Pleasant Lake
Temperature and Oxygen Profile
June 10, 1999



Pleasant Lake, Deerfield
Temperature and Oxygen Profile
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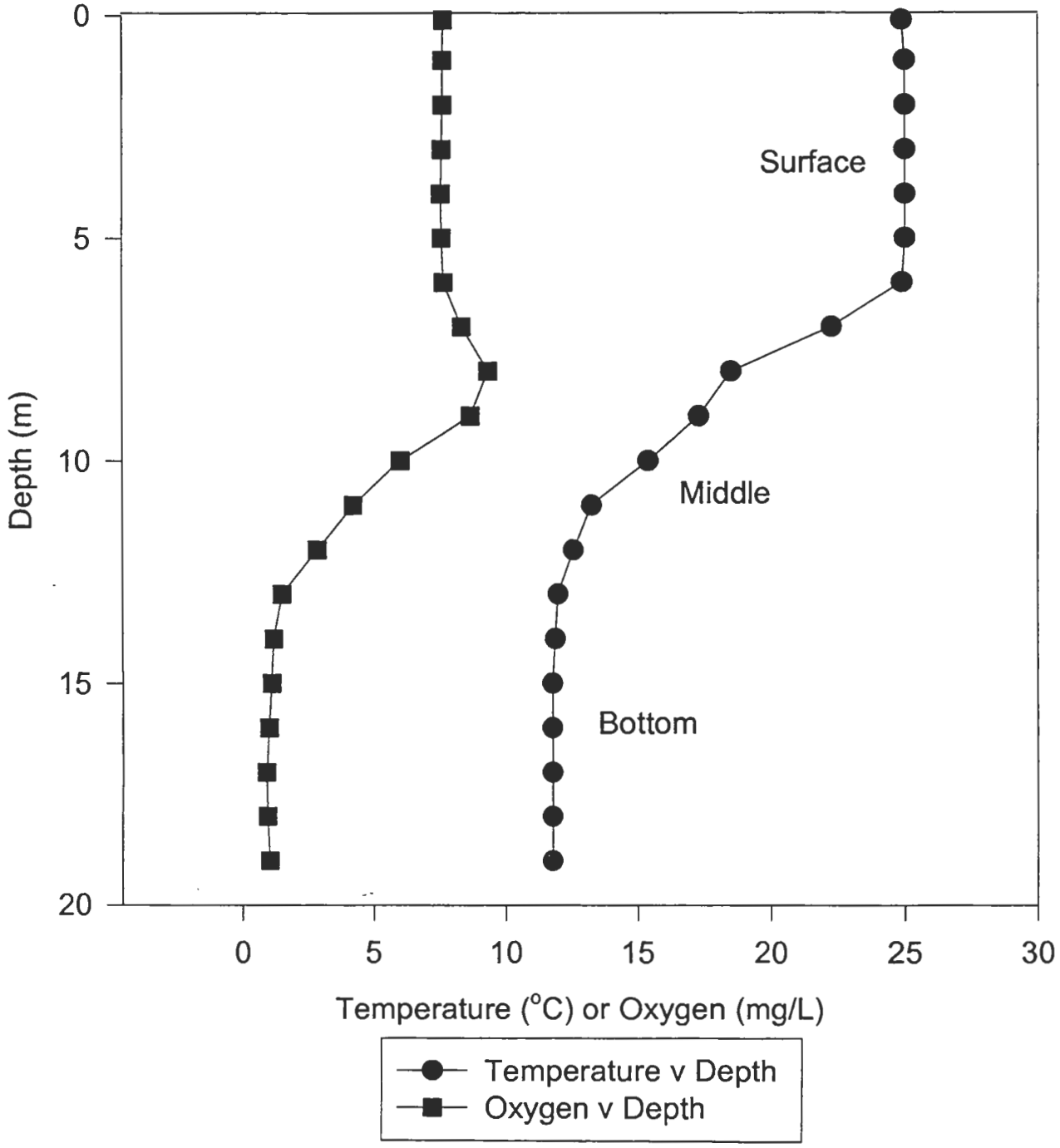
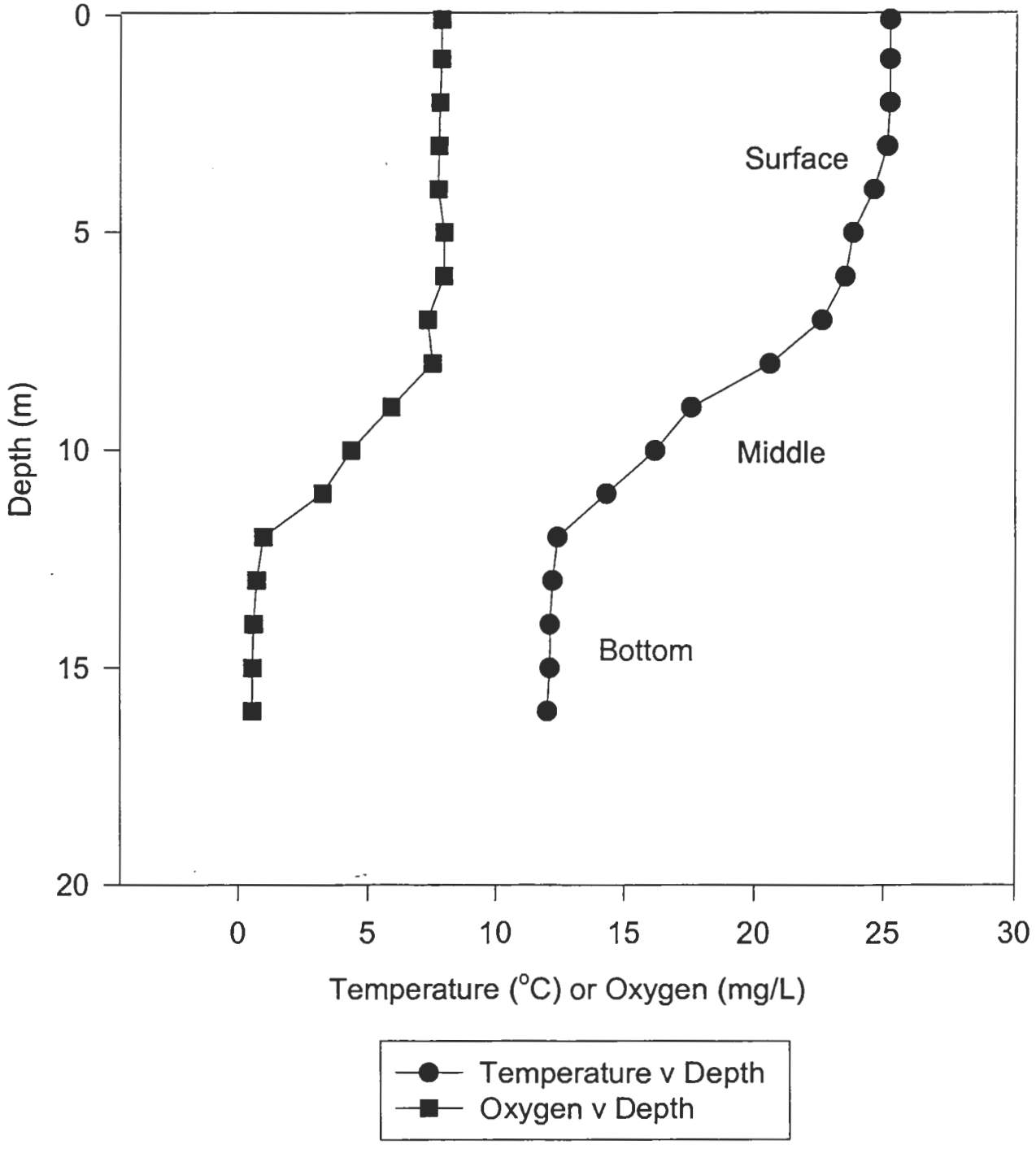
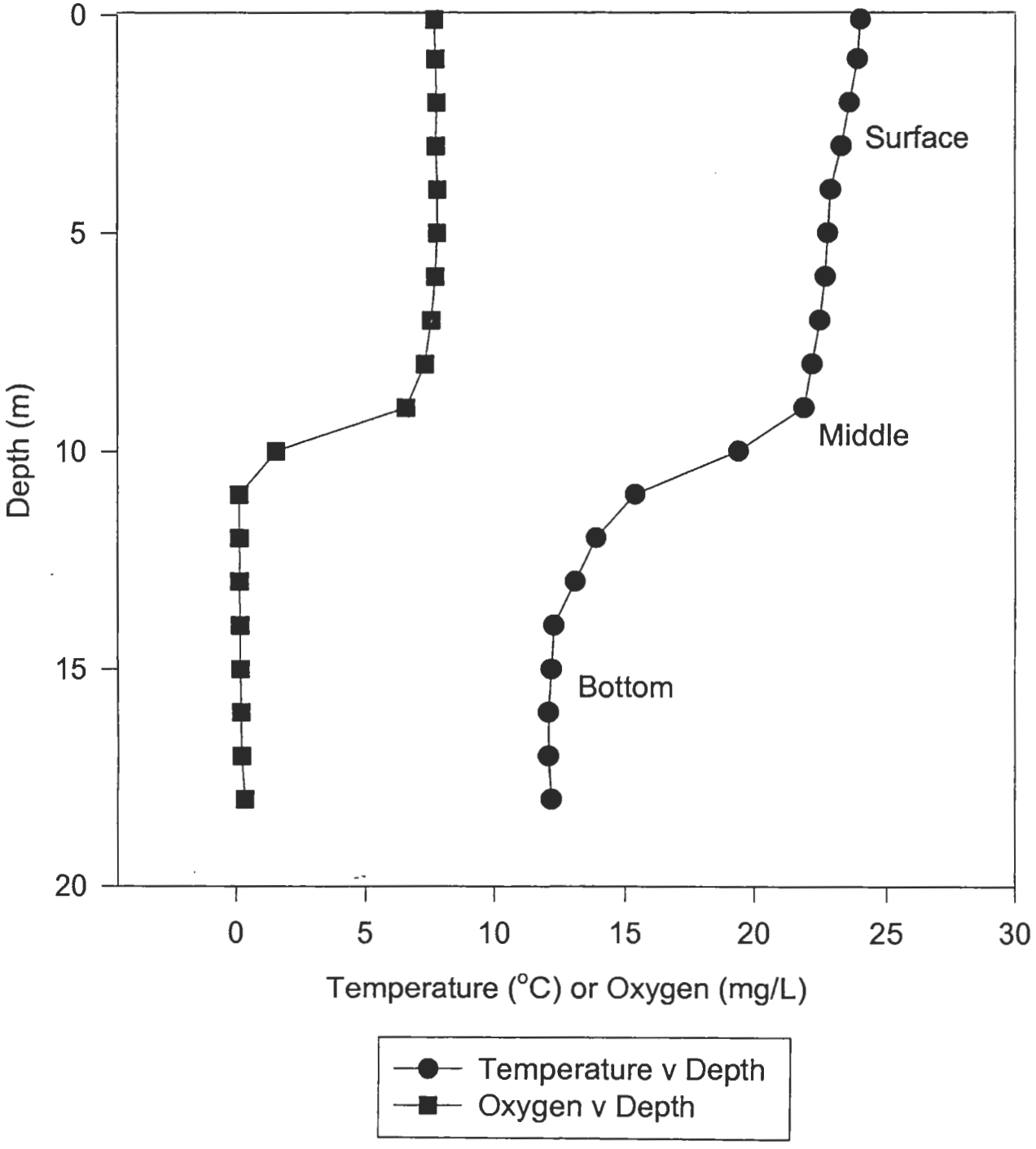


Pleasant Lake, Deerfield
Temperature and Oxygen Profile
July 20, 1999



Pleasant Lake, Deerfield
Temperature and Oxygen Profile
August 26, 1999



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Temperature and Oxygen Profile
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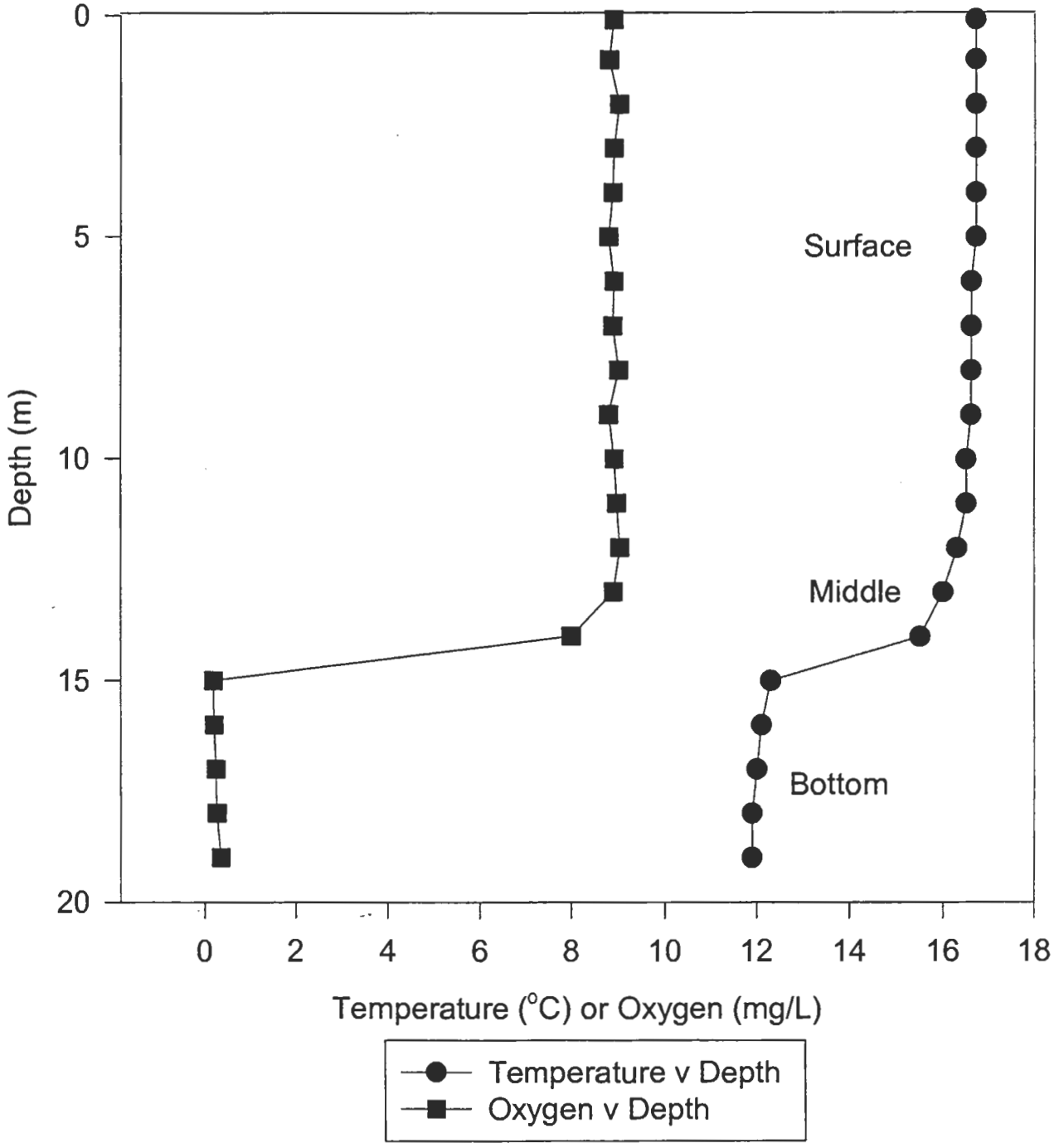
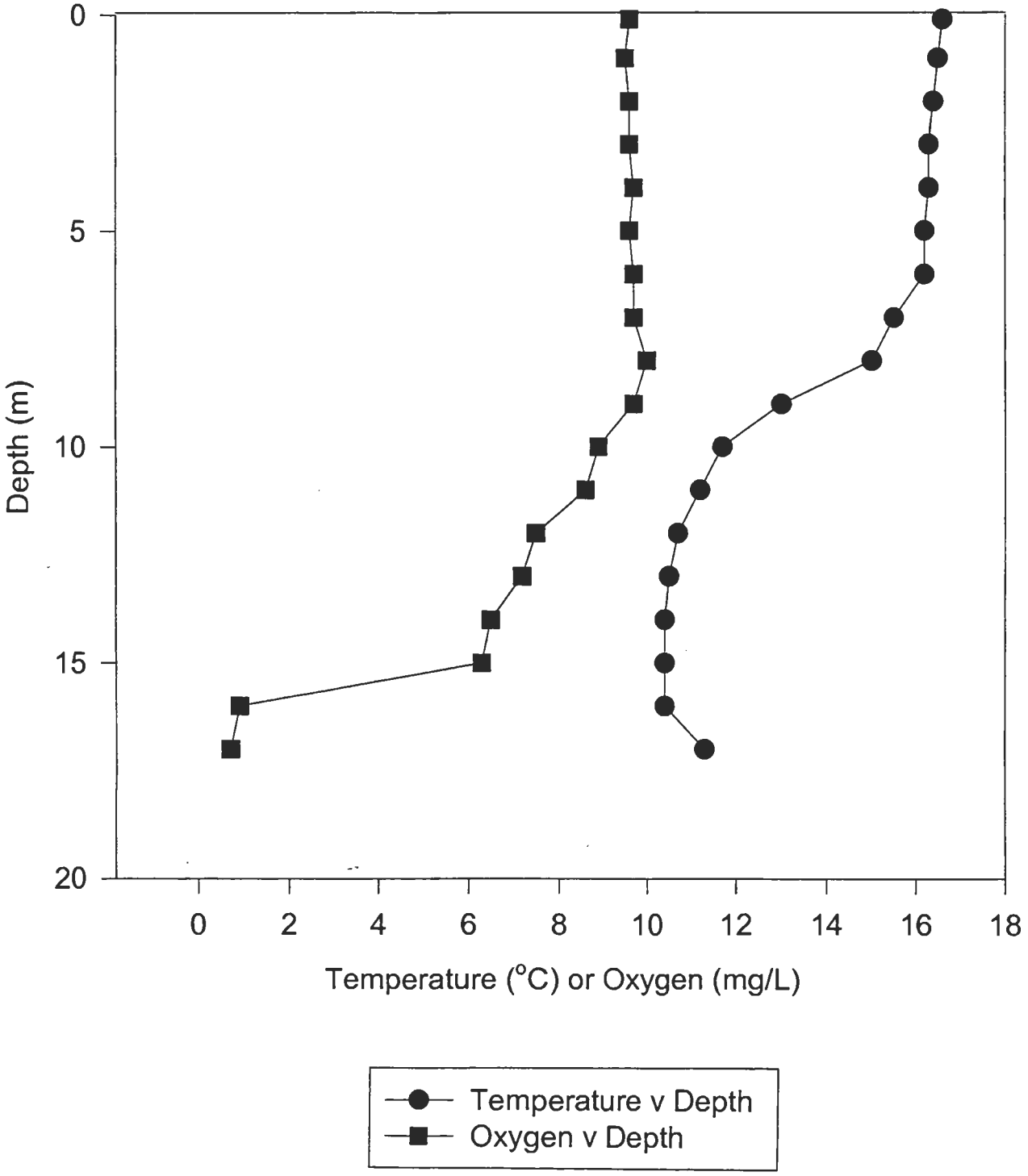


Pleasant Lake, Deerfield
Temperature and Oxygen Profile
June 8, 2000



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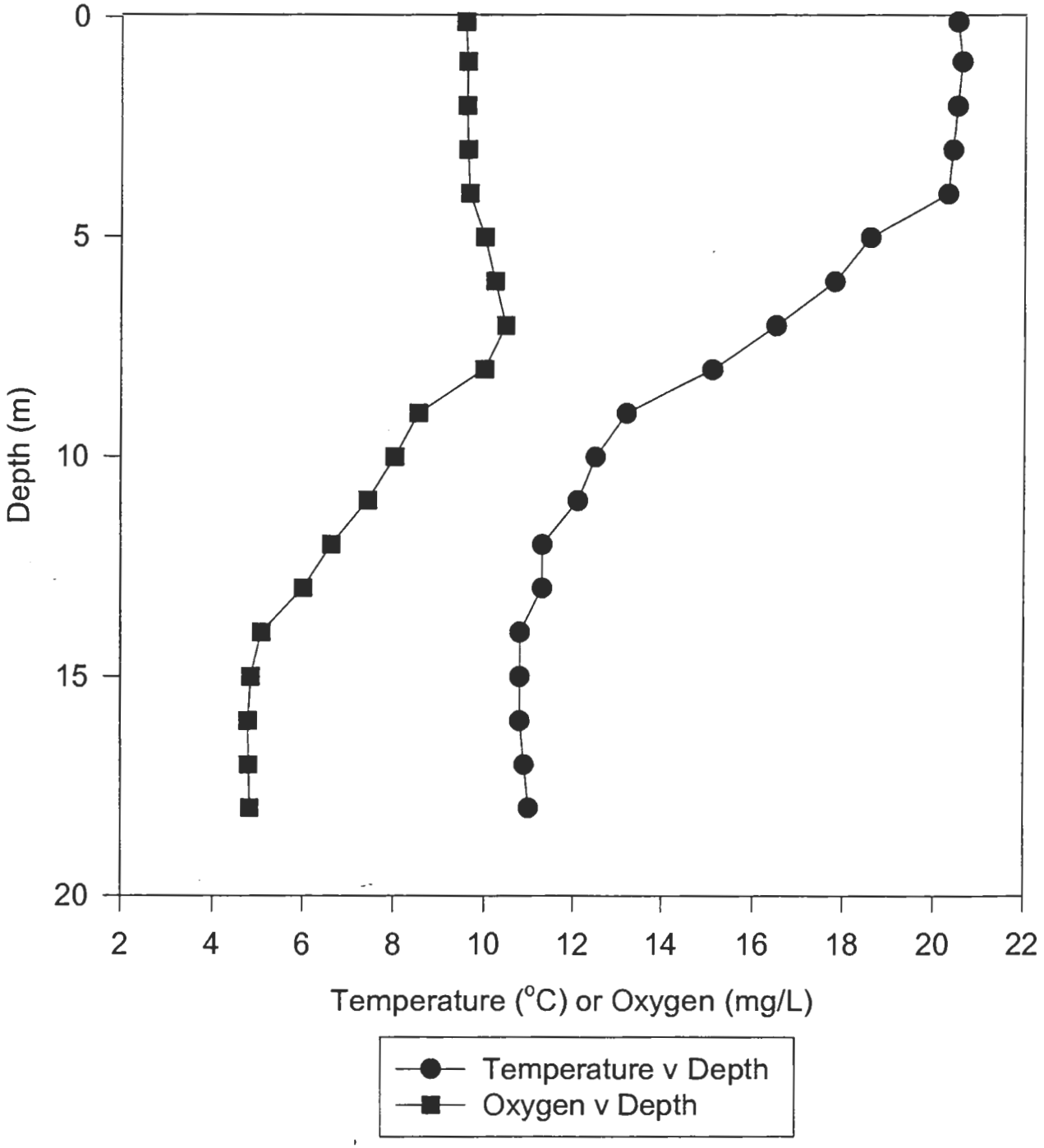
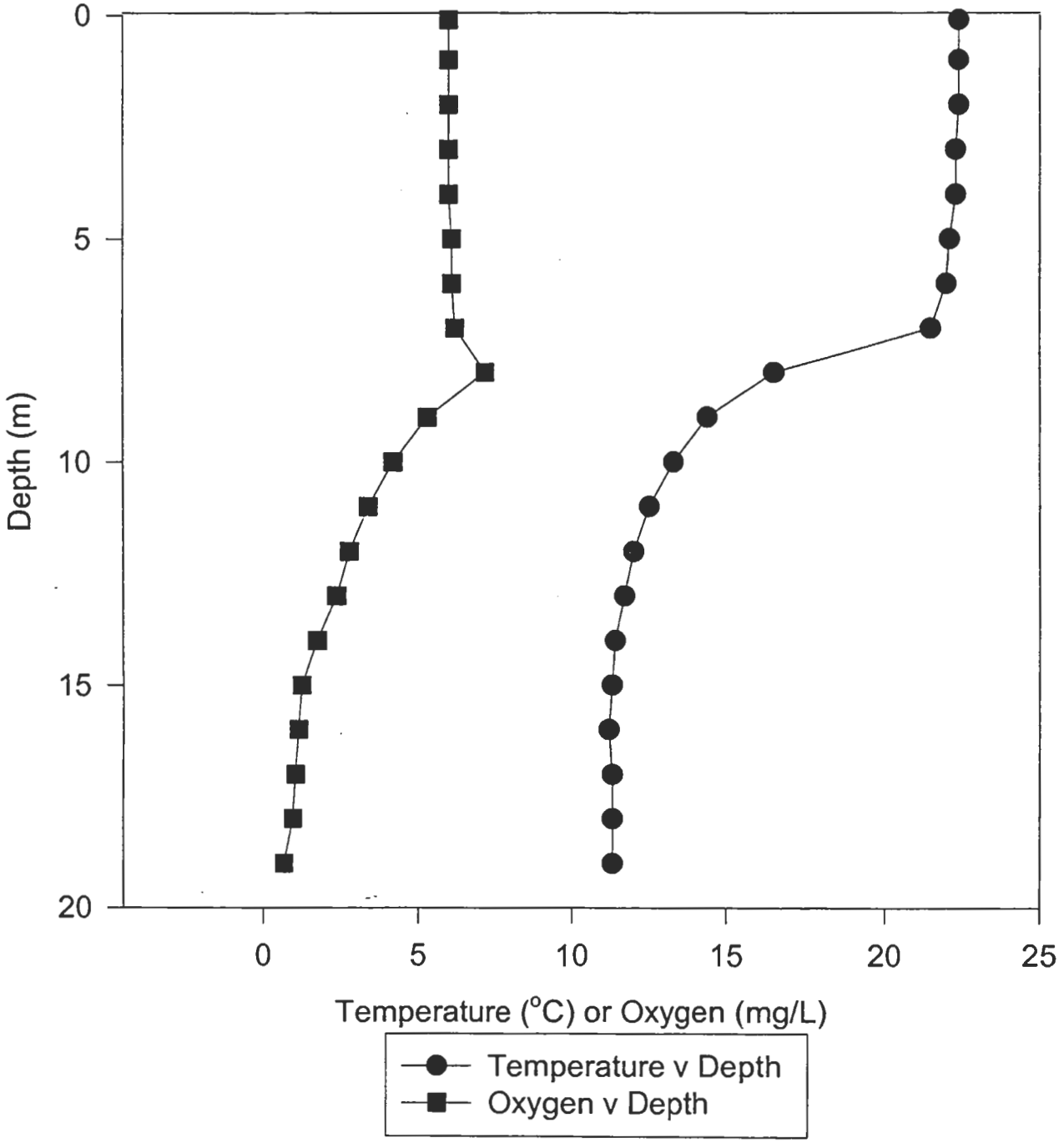
Temperature and Oxygen Profile
June 21, 2000



Pleasant Lake, Deerfield
Temperature and Oxygen Profile
July 13, 2000



Pleasant Lake, Deerfield
Temperature and Oxygen Profile
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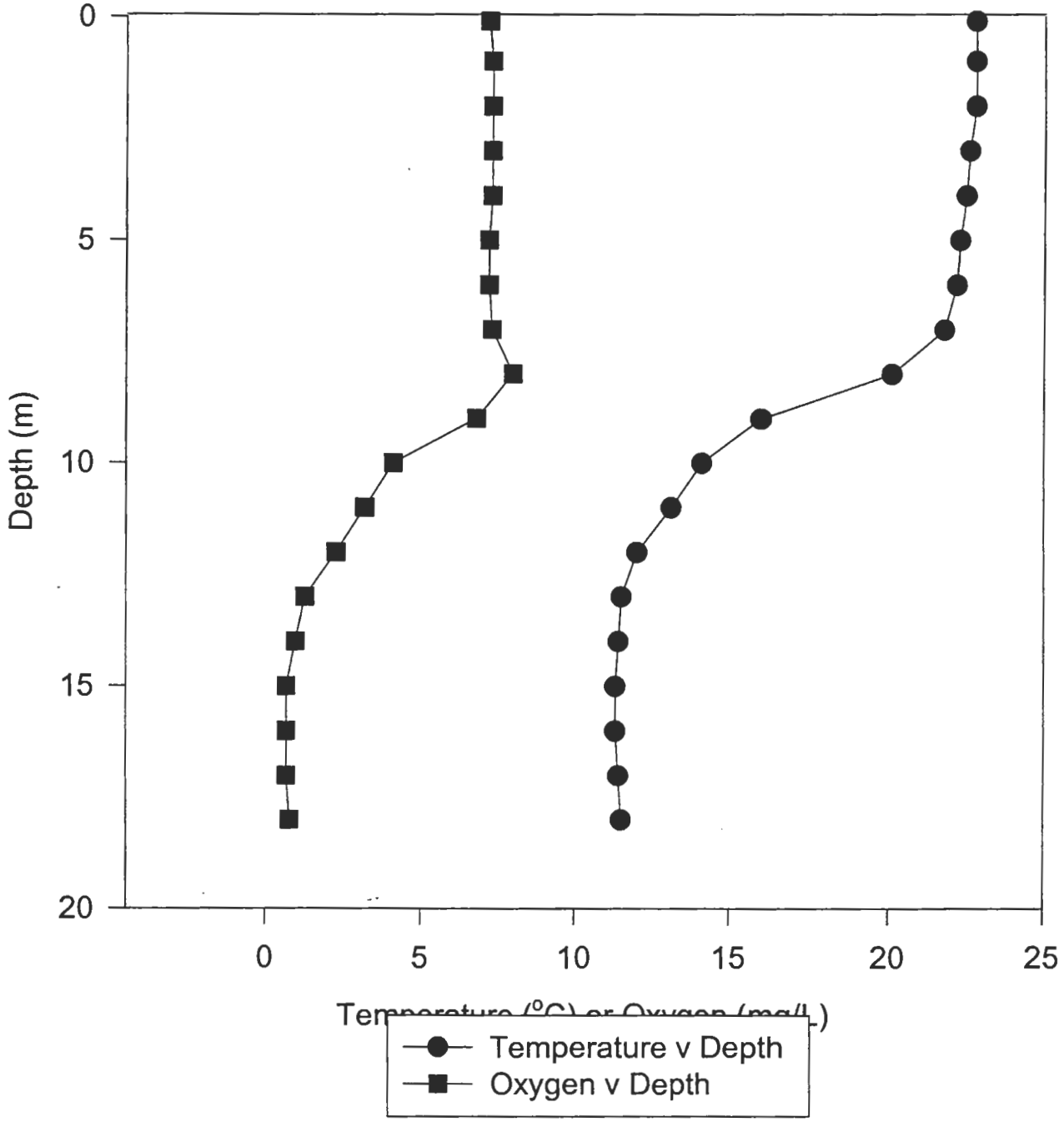
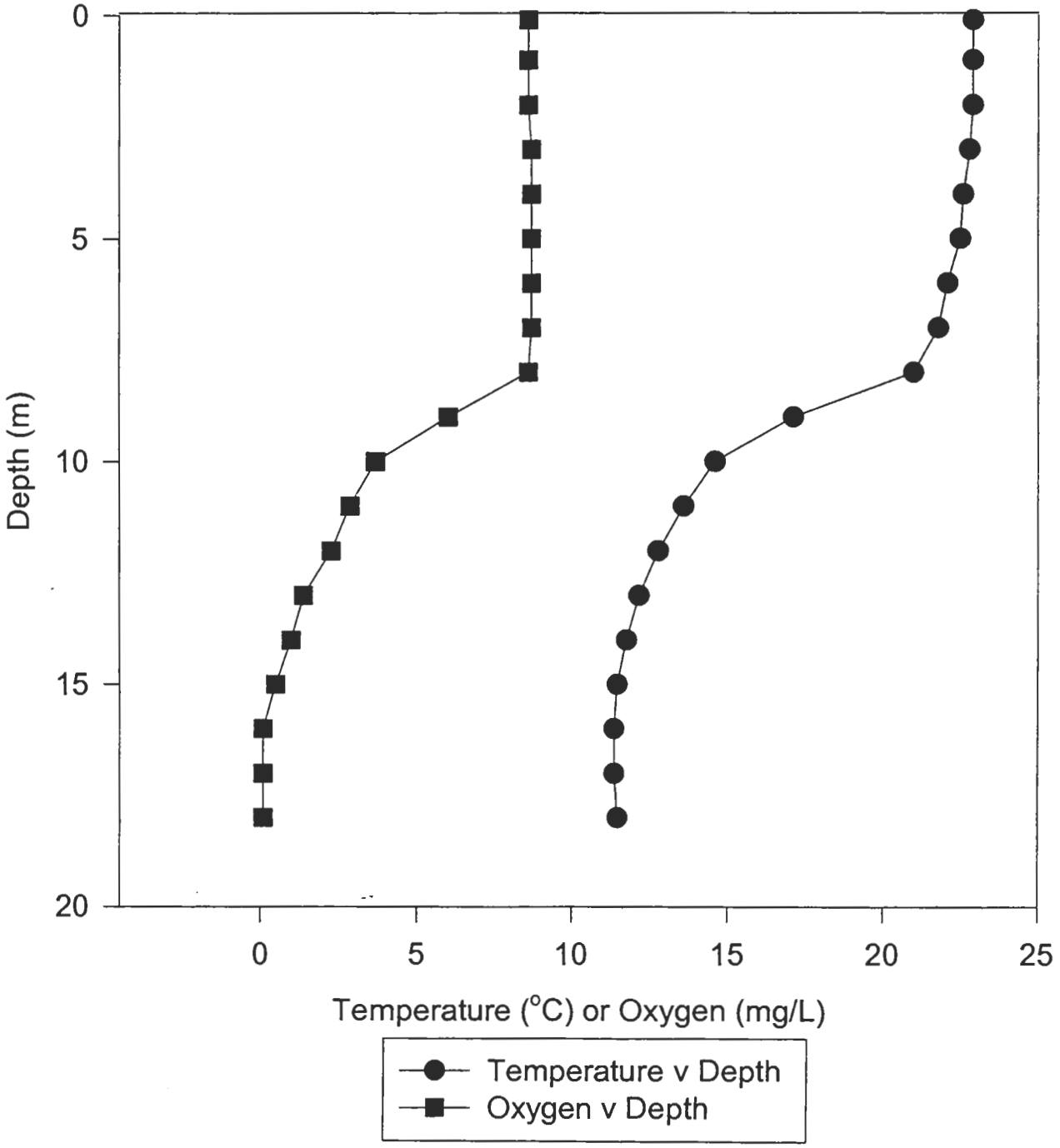


Pleasant Lake, Deerfield
Temperature and Oxygen Profile
August 8, 2000



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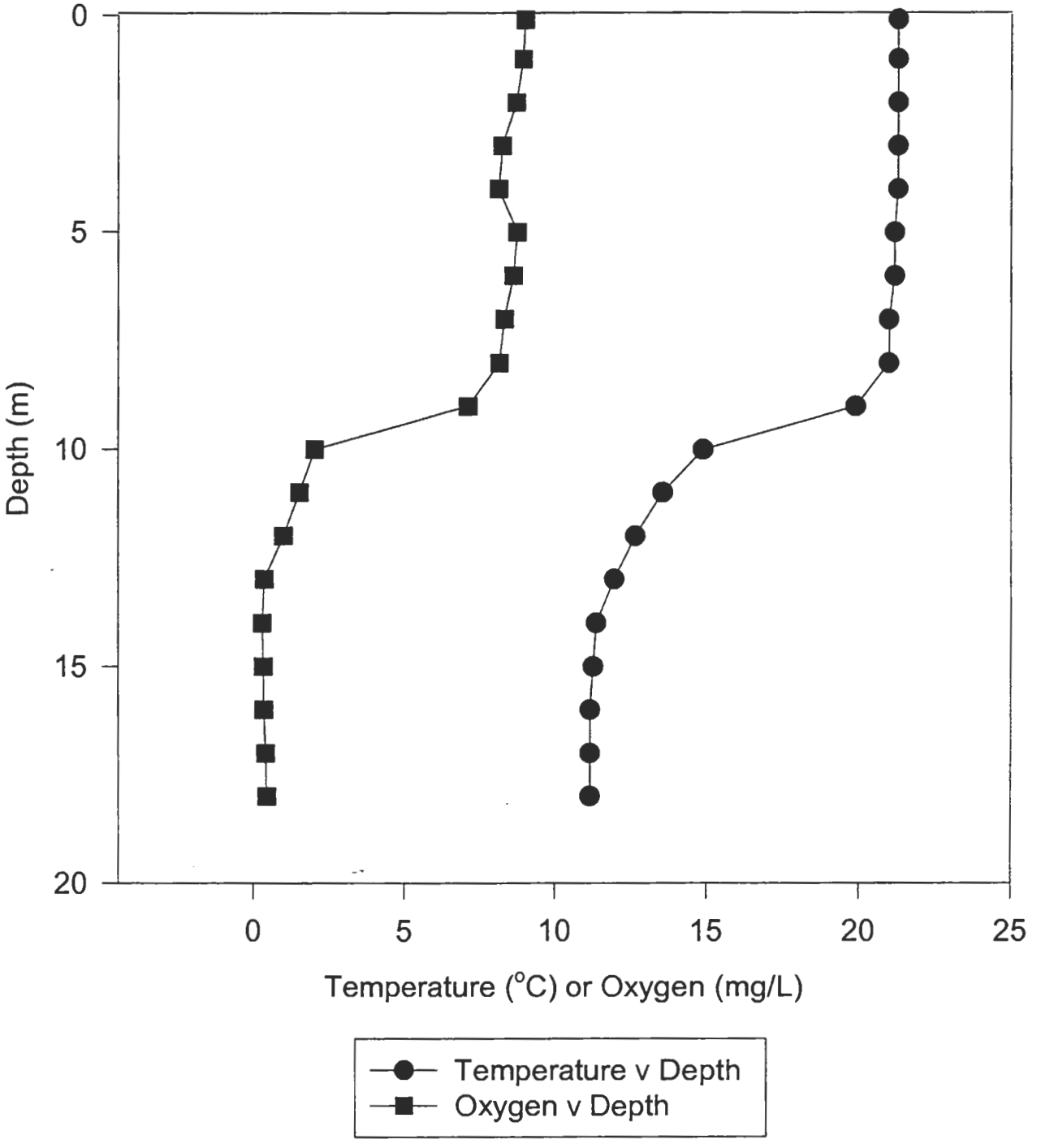
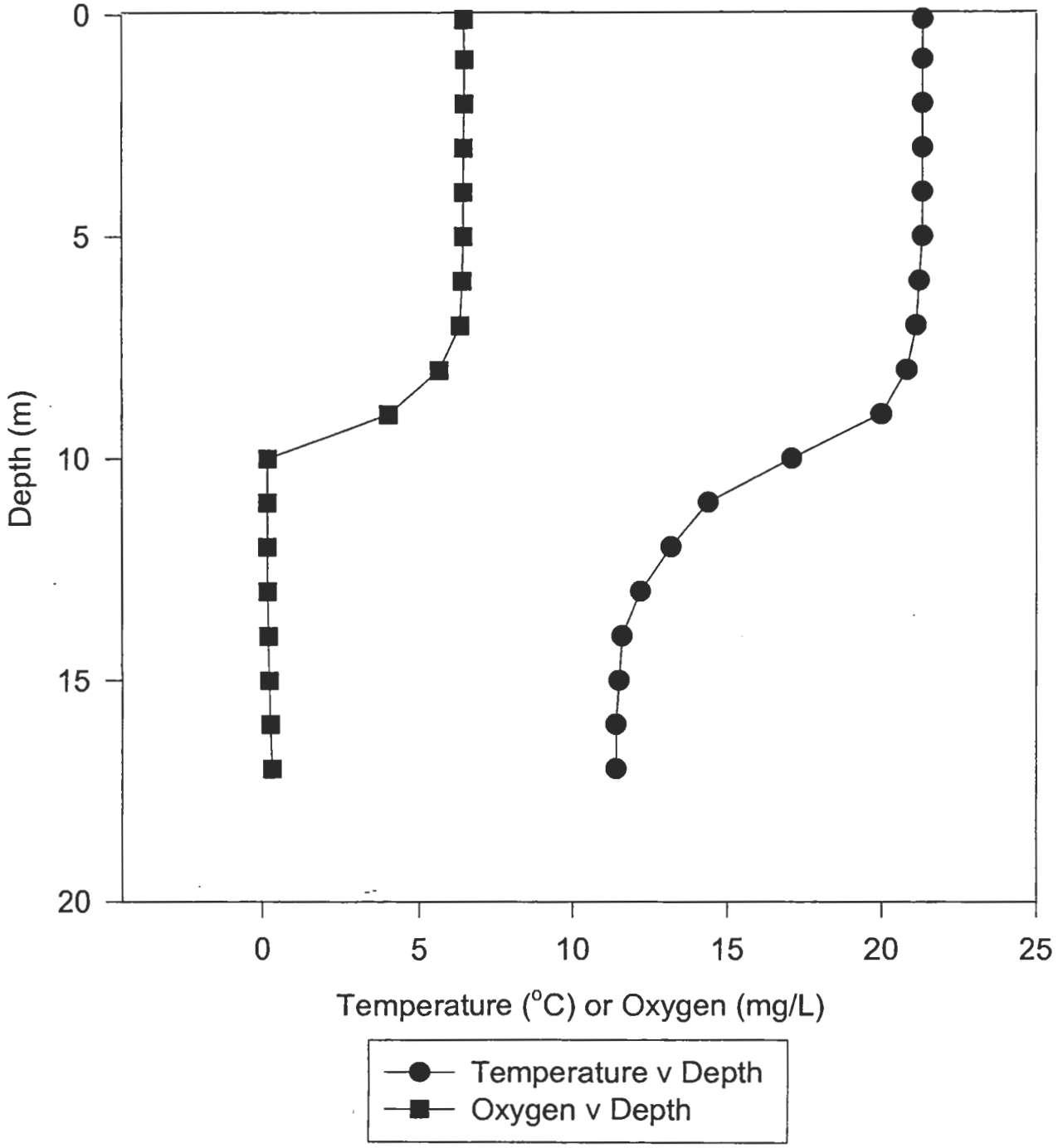
Temperature and Oxygen Profile
August 22, 2000



Pleasant Lake, Deerfield
Temperature and Oxygen Profile
September 14, 2000



Appendix 7

Pleasant Lake Diagnostic Study

Best Management Practices

Stormwater BMPs

Stormwater runoff increases the pollution potential within a watershed. Several nonpoint pollution sources commonly associated with stormwater runoff are listed below (RCCD, 1992):

- Pleasant Lake's largest residential nonpoint pollution source is sediment and the nutrients and trace metals attached to it. In addition to this, the runoff from these areas may also carry bacteria, toxic chemicals, hydrocarbons, and organic substances such as leaf litter, animal fecal material, and septage.
- Runoff from construction sites during residential development is the largest source of sediment.
- Nutrients from residential areas are a major concern to surface water quality because of their effects on waterbodies. The two major nutrients are nitrogen and phosphorus. Phosphorus is the limiting nutrient to New Hampshire lakes, and even in small concentrations increases the growth of both macrophytes and microscopic algae. Nitrogen consumes oxygen in the nitrification process and is necessary for algal growth. An excess of both nutrients can impair the use of our surface waters for water supply, recreation, and fish and wildlife habitat.
- The main source of nutrients in developed portions of Pleasant Lake can be related to improper use of fertilizers including over-fertilization, use of fast-release fertilizers that are readily soluble, and improperly disposing of organic matter from lawn clippings and leaves, which can all, be illegal activities.
- Bacteria levels can increase due to increased development. Most of this bacterial contamination is *E. coli* bacteria which can be associated with animal wastes and from failed or improperly maintained septic systems. Both of these pollution sources are also sources of phosphorus.
- Salt is used in large quantities in New Hampshire during the winter to melt ice from sidewalks, roads, streets, and parking lots. Salt is very soluble and therefore ends up in both the surface water and groundwater.

Uncontrolled runoff, accelerated soil erosion and the associated increase in pollution potential result in costly and unnecessary environmental degradation and damage. Well-planned implementation of stormwater best management practices (BMPs) can prevent or control much of this damage.

The following is a select list of stormwater management BMPs for New Hampshire (RCCD, 1992):

- ***Detention and Retention Basins*** control the runoff from a given storm event and release the excess runoff in a way that reduces the impact on downstream systems. The basin releases the temporarily stored runoff over an extended period of time at a rate equal to or less than the pre-development conditions. This practice applies to sites where the physical conditions are conducive to constructing an embankment, emergency spillway, a storage area and a structural outlet system.
- ***Diversions*** intercept and divert water from areas where it is in excess to sites where it can be used or disposed of safely.

  Diversions are used to:

  - Divert runoff from highly erodible areas where the runoff is damaging property, causing erosion, or interfering with the establishment of vegetation;
  - Divert surface flow and subsurface flow away from steeply sloping land.

    (This type of BMP is beneficial with lakeshore beaches.)
- ***Stone lined infiltration trenches*** provide temporary storage of runoff in the void spaces around the stone and allow the stored runoff to infiltrate the surrounding soil. This practice is not recommended where runoff water contains a high percentage of suspended materials, oils and greases unless measures are taken to remove them before they reach the trench.
- An ***extended detention dry basin*** is used to reduce peak discharges from a given storm event by controlling the release rate, and to improve water quality by removing pollutants from runoff.
- A ***dry well*** is similar to an infiltration trench. It provides temporary storage of runoff in the constructed chamber and/or in the void spaces in the aggregate, and allows the stored runoff to infiltrate the soil. This practice is not recommended where runoff water contains high concentrations of sediment, oils, greases, and floatable organic materials unless measures are taken to remove them before they reach the well. Dry wells are generally used to store runoff from rooftop areas; however, they can be used to provide

storage and infiltration from catch basins where conditions permit.

- A ***level spreader*** changes concentrated flow into sheet flow and then outlets it onto stable areas without causing erosion. An example would be at the outlet of a diversion or a waterway.
- ***Rock riprap*** protects soil from erosion due to concentrated runoff. It is used to stabilize slopes that are unstable due to seepage. It is also used to slow the velocity of concentrated runoff which in turn increases the potential for infiltration. Rock riprap can be used at the outlets of pipes and constructed channels where the velocity of flow from these structures exceeds the capacity of the downstream area to resist erosion. Rock riprap can be used for wave protection on lakeshores and beaches. The practice can be used for storm drain outlets, in channels, in roadside ditches, on unstable slopes, at the top of slopes, and for drop structures.
- A ***vegetated filter strip*** improves water quality by removing sediment, nutrients, and other pollutants from runoff as it flows through the filter strip. Some of the sediment and pollutants are removed by filtering, absorption, adsorption and settling as the velocity of flow is reduced. This practice applies to any site where adequate vegetation can be established and maintained.
- ***Vegetated swales*** improve water quality by treating and removing pollutants from stormwater runoff, increasing infiltration, and reducing potential erosion from the discharge of runoff. This practice applies to all sites where a dense stand of vegetation can be established and where either a stable outlet exists or can be constructed as a suitable conveyance system to safely dispose of the runoff flowing from the swale.

Appendix 8

Pleasant Lake Diagnostic Study

Perched Beaches

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

6 Hazen Drive, Concord, New Hampshire 03301 · (603) 271-3503 · www.state.nh.us/des

~~WD-BB-15~~

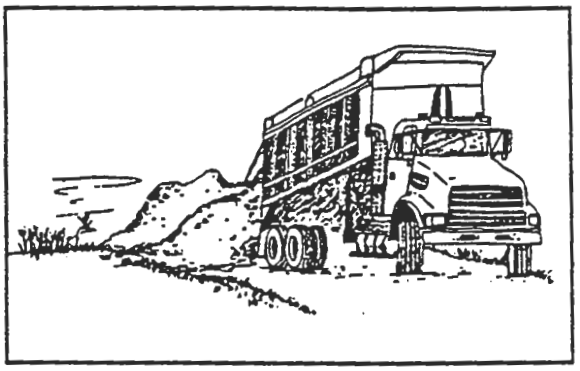
Revised 1997

Sand Dumping - Beach Construction

The dumping of sand into New Hampshire lakes or along their shores to create or replenish a swimming beach is an all-too-common practice. In fact, it is so common that many shore-front residents assume that they have a right to dump sand along their shores, and that sand dumping causes no harm to the lake. Both assumptions are false. This fact sheet explains the regulation of sand dumping and discusses lake impacts that can occur.

Sand Dumping Regulations

The construction and/or replenishment of beaches is regulated by the N.H. Department of Environmental Services' Wetlands Bureau and Water Quality Engineering Section. A single application is required, using the Wetlands Bureau application form, and a joint permit is issued for projects that meet all wetlands and water quality criteria.



The above permit is required before any sand can be dumped or work begun. Any work completed without a permit may result in the imposition of a fine and/or a removal and restoration order. Civil or criminal penalties may apply for repeat offenders.

Physical Impacts

Lakes act as settling basins for their watersheds, collecting and accumulating materials that drain into them. This process results in the gradual filling-in of lakes over geological time until they become a marsh and then dry land. Any activity that adds material to a lake over the natural supply will increase the rate of lake filling. The regular addition of sand to a lake, or to the shoreline of a lake where it can erode into the lake, greatly accelerates the process.

If a shoreline does not have a natural beach, it is likely that conditions are such that a constructed beach will not remain indefinitely. The dumped sand will either drift away with shoreline currents or slowly settle through the soft, mucky bottom sediment. Although the sand disappears from view, it does not leave the lake. It is added to the natural sediment load to the lake and hastens the filling-in process.

Chemical Impacts

The mineral composition of sand is not consistent. Although clean, washed beach sand is primarily quartz, which is relatively inert, sand can contain other materials. In New Hampshire, iron is a common component of sand and gravel. Iron-rich sand will frequently result in the presence of iron bacteria. Although not a health hazard, these bacteria cause aesthetic problems by creating rust-colored slime deposits and oil-like films on the sand as they oxidize the iron.

Sand may also contain contaminants other than iron, all of which have the potential to wash out of the sand and into the water. Clay is a material that, if present in the deposited sand, can cause turbidity problems (reduced water clarity) in the pond. If there is any phosphorus associated with the dumped sand, it will contribute to increased plant growth in the pond.

Biological Impacts

Dumping sand along the shore of a lake can smother benthic (bottom dwelling) algae and invertebrates, causing a disruption in the food chain of higher organisms including fish. Spawning or nesting sites for fish may also be destroyed by deposited sand, and turbidity from the deposited sand may interfere with normal fish behavior by clogging gills. The physical process of filling-in of a lake from deposited sand has two major biological impacts. First of all, a shallower lake has a lesser volume of water to dilute and assimilate in-coming contaminants, including phosphorus. At a given level of phosphorus loading, a lake's productivity (algae growth) will increase as the lake's mean depth decreases, all other factors remaining constant. Secondly, as a lake becomes shallower, more of the bottom enters the sun-lit zone and thus the potential for increased rooted plant growth occurs.

Local Protection Activities

Activities that local residents and lake association members can undertake to help protect a lake from excessive sand dumping include the following:

1. Educate residents, association members, and town officials about the requirement for a state permit to create or enhance a beach, and about the negative impacts of such activities.
2. Encourage association members to minimize the use of sand dumping by adopting an association policy to that effect.
3. Work with town officials to adopt a local ordinance to prohibit or restrict the use of sand dumping along lake shores. One approach is to limit the size of beaches.
4. Report illegal sand dumping incidents to the Wetlands Bureau.

State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES
6 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095
(603) 271-2457 FAX (603) 271-7894

Protect Your Lake!: Beaches and Water Quality

Many waterfront owners feel that having a beach greatly improves the value of their frontage. It provides a place to relax in the sun or play a little volleyball. Beaches provide easy access to the water for swimming and a place for the kids to play. Beaches are great, right? WRONG! Improperly constructed and maintained beaches are endangering the quality of many lakes and ponds. Beach construction damages the environment in many ways.

The first damaging factor lies in beach construction. Removal of shoreline vegetation also means removal of valuable habitat and food for a variety of wildlife, both terrestrial and aquatic. This vegetation also protects your shores from eroding. The second damaging factor is SAND. Let's face it, you can't build a beach without sand. Unfortunately, sand can both physically and chemically damage a waterbody. Sand inevitably washed from beaches with wave and ice action, and carries with it phosphate. Phosphorus feeds the growth of aquatic plants and algae. You may have noticed green "clouds" along the bottom in some areas. High concentrations of algae , which may color the water, can be considered algae blooms. The more phosphorus available, the larger the algae bloom. If phosphorus levels are high enough, the nuisance types of algae may become dominant creating undesirable scums and odors. As the algae decays, it will consume oxygen, perhaps even endangering fish survival. Physically, sand can smother bottom-dwelling organisms as well. Environmental damage aside, decreased water clarity from algae problems often results in decreased property values and increased water treatment costs.

The sand which erodes from beaches does not simply disappear. This sand is deposited by natural and man-made currents in places like boat slips, navigational channels, behind dams, and natural and man-made inlets where it may become a safety hazard. Slips become unusable without expensive and once again, environmentally damaging, maintenance dredging. Navigational channels may be choked with sand causing damage to boats which bottom out. The storage capacity of dams may be reduced, increasing the risk of flooding and decreasing valuable water supplies. Coves gradually become more and more shallow, making the shoreline inaccessible by boats. The shallower water coupled with increased nutrient levels then promotes the growth of emergent vegetation, further reducing residents' ability to use their frontages for activities like swimming.

For these reasons, the construction and replenishment of beaches requires a permit from the NH Department of Environmental Services Wetlands Bureau. New beaches must use no more than 20% of an applicant's shoreline (50 ft. Max.) and be constructed using a perched type design which has little to no slope and utilizes some form of barrier, typically the natural rock at the waterline, to reduce if not eliminate the erosion of sand into the water. Replenishment of existing beaches is limited to no more than 10 cubic yards which may be placed once every 6 years. If a beach requires sand more often, it is a good indicator that it is improperly constructed. The need for sand may be reduced by diverting surface water runoff away from the area or reducing the slope of the beach. Altering the slope will require a Wetlands permit. Failure to obtain a permit to construct or replenish a beach may result in fines between $300 and $2000 as well as required restoration.

Please help us take care of our lakes to ensure that they will provide water, recreation and wildlife habitat for many generations. For more information on proper beach construction and filing an application, please review the attached fact sheet or contact the NH Wetlands Bureau at 271-3503.

BEACH CONSTRUCTION AND MAINTENANCE

DESIGN GUIDELINES:

The design guidelines detailed below provide information which will allow you to design your project in accordance with the bureau's rules. Incorporating all of these guidelines into your design, plans, and application materials will increase the likelihood of receiving a permit.

SITE SELECTION:

The beach needs to be placed in the least environmentally impacting location on the frontage. When selecting an appropriate location look for a position which requires the least amount of tree and vegetation removal and the least amount of rock and earth removal preferably in an area where the slope is naturally more flat. The beach should be positioned in an area where the swimming is not mucky and where there is little aquatic weed growth since the bureau rarely allows dredging of the lake bottom or placement of sand in the water for beach construction. Beaches may not be constructed in wetland areas.

BEACH CONFIGURATION AND LOCATION:

Current policy requires that new beaches be "perched". A perched beach is located entirely out of the water above the existing undisturbed natural bank and has little or no slope. All sand must be placed out of the water and above the high water mark. The objective of constructing perched beaches is to insure that sand does not erode into the water over time. In the long run this is better for both the environment and the homeowner since such beaches require less maintenance.

Preferably the beach should be constructed in a manner which leaves any naturally existing boulders on the shoreline in their existing location. If the frontage is not naturally rocky, rocks should be placed along the lakeward side to separate the perched beach area from the water. If excavation into the bank is required then an acceptable method of stabilizing the landward side of the cut must be incorporated. Many designs propose to stabilize this landward side with a stone retaining wall.

A beach, as with all shoreline structures, must be located at least 20 feet from each of the property boundaries. The project should be designed so that construction activities required for beach construction are also located at least 20 feet from the boundary.

SIZE:

Most beaches may be no larger than 20 percent of the entire contiguous frontage up to a maximum of 50 linear feet and cannot alter more than 900 square feet of total area. Beaches larger than this are considered major impact projects and must have a demonstrated need to be larger for the bureau to consider approving them.

ACCESS TO WATER FROM BEACH:

Steps leading to the water from the beach may be included in the design but should be constructed so that they are cut back into the bank rather than extending out into the lake. Step width should generally be kept to less than 4 feet.

SURFACE WATER DIVERSION:

Beach projects must incorporate methods for diverting surface runoff around the beach area. Such diversion helps to eliminate erosion of the sand into the lake during storm events. Many beach designs incorporate a shallow grass or stone lined swale around the landward most periphery of the beach.

CONSTRUCTION MATERIALS AND CONSTRUCTION GUIDELINES:

Any sand placed in the beach area must be clean. Clean sand is sand which contains little or no silt or loam which can cause water quality problems if it enters the lake. No more than 10 cubic yards of sand may be used.

Construction should be planned to take place during the lake drawdown if possible. If this is not possible the work should scheduled for when the lake is at its lowest level. Appropriate siltation controls need to be installed prior to the commencement of construction and maintained until all disturbed areas are stabilized. Machinery should not be entering the water during construction.

BEACH REPLENISHMENT:

Beach sand replenishment is permissible only once every six years and in general may not exceed more than 10 cubic yards. Sand is no longer allowed to be placed below the high water mark even on previously permitted or grandfathered beaches. Applications for beach replenishment must also incorporate methods for diverting surface runoff around the beach area.

BEACH CONSTRUCTION AND MAINTENANCE

PROJECT CLASSIFICATION:

Use the chart below to determine the classification of your project.

Your project is **MAJOR** if...	the beach construction or replenishment project: 1. Is NOT for a privately owned single family residence; or 2. Requires dredge or fill below the high water line; or 3. Involves more than 900 square feet of dredge or fill; or 4. Is located in a swamp, marsh, tidal buffer zone, bog, or in or adjacent to prime wetland; or 5. Alters more than 20 percent of frontage (or more than 50 foot); or 6. Involves placement of more than 20 cubic yards of sand; or 7. Requires replenishment more than once during a 6 year period.
	the project involves work in or adjacent to prime wetlands
	it involves work in an area identified as an exemplary natural community and/or has documented occurrences of state or federally listed Endangered or Threatenend species
	it requires removal of more than 20 cubic yards of material from public waters
Your project is **MINOR** if...	the beach construction or replenishment project: 1. Is for a privately owned single family residence; and 2. Requires no dredge or fill below the high water line; and 3. Involves no more than 900 square feet of dredge or fill; and 4. Is not located in a swamp, marsh, tidal buffer zone, bog, or in or adjacent to prime wetland; and 5. Alters no more than 20 percent of frontage (50 foot maximum); and 6. Involves placement of between 10 and 20 cubic yards of sand
	it requires removal of less than 20 cubic yards of material from public waters and is not otherwise major
	it involves removal of emergent or submergent vegetation requiring disturbance of the bottom sediments and is not otherwise major. See minimum below for projects involving control of exotic aquatic weeds Cabomba carolina (fanwort) and/or Myrophyllum heterophyllum (exotic milfoil).
Your project is **MINIMUM** if...	the beach construction or replenishment project: 1. Is for a privately owned single family residence; and 2. Requires no dredge or fill below the high water line; and 3. Involves no more than 900 square feet of dredge or fill; and 4. Is not located in a swamp, marsh, tidal buffer zone, bog, or in or adjacent to prime wetland; and 5. Alters no more than 20 percent of frontage (50 foot maximum); and 6. Involves placement of 10 cubic yards of sand or less; and 7. Requires replenishment once during a 6 year period.
	it involves cutting of aquatic weeds above the roots provided that: 1. there is no disturbance of the bottom sediments; and 2. it is not in prime wetlands, marshes, bogs and does not impact an exemplary natural community or endangered or threatened species.
No permit is required if...	it involves control of exotic aquatic weeds Cabomba carolina (fanwort) and/or Myrophyllum heterophyllum (exotic milfoil) as authorized by RSA 487:17, provided: 1. work is conducted under the supervision of DES; and 2. is not in or adjacent to prime wetlands, marshes, bogs, and does not impact an exemplary natural community or endangered or threatened species.
	it involves hand raking of leaves or other organic debris from the shoreline or lakebed provided that: 1. At the time the raking is done, the area raked is exposed by drawdown; or 2. Raking does not disturb vegetative roots and is limited to 900 square feet of area.

BEACH CONSTRUCTION AND MAINTENANCE

PLAN CRITERIA:

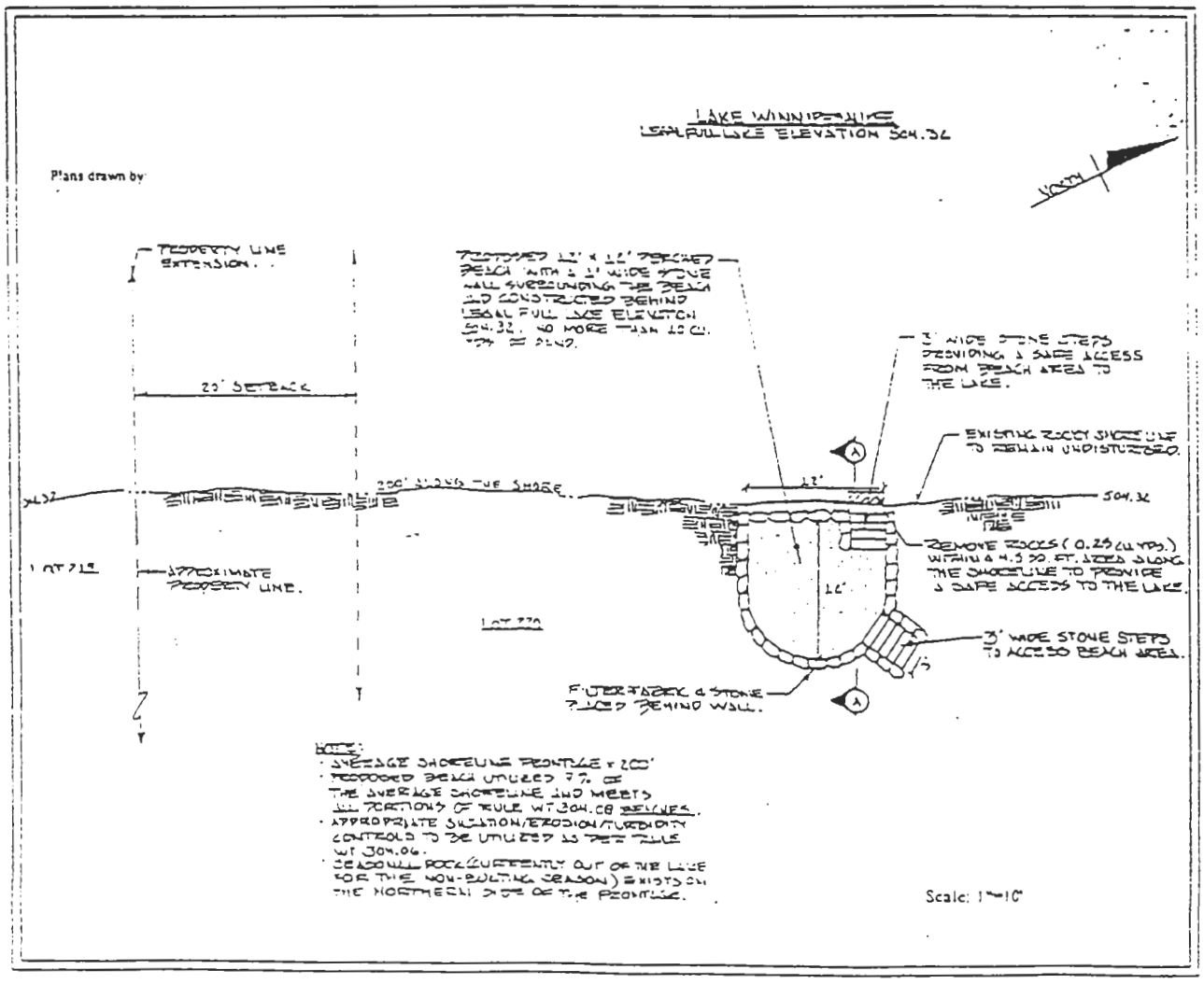
Applications for beach construction must include two different views of the project: a "plan view plan" and a "cross-sectional plan". Examples of each of these plans are shown below. Both plans must clearly show that the design considerations and criteria for beach construction described in earlier sections of this document have been incorported into the design.

PLAN VIEW:

A "plan view" plan can be visualized as drawing a plan as if you were looking down on the land from an airplane. This plan must show the following information:

- ☐ The entire frontage of the parcel in question accurately depicting the shape or contour of the frontage;
- ☐ The linear feet of the shoreline frontage;
- ☐ The location and aerial dimensions of the proposed beach area (and access steps if applicable);
- ☐ The distance from the edges of the proposed beach area to each abutting property boundary;
- ☐ The location and aerial dimensions (ex. length and width) of all other existing structures on the frontage;
- ☐ An arrow showing the direction north;
- ☐ The scale of the plan (ex. 1"=20');
- ☐ Notes indicating how much sand is proposed to be placed and that it is not to be placed in the water;
- ☐ Notes indicating the proposed sequence of construction activities;
- ☐ The location and diameter of any trees which need to be removed as part of the beach construction.

SAMPLE PLAN VIEW:



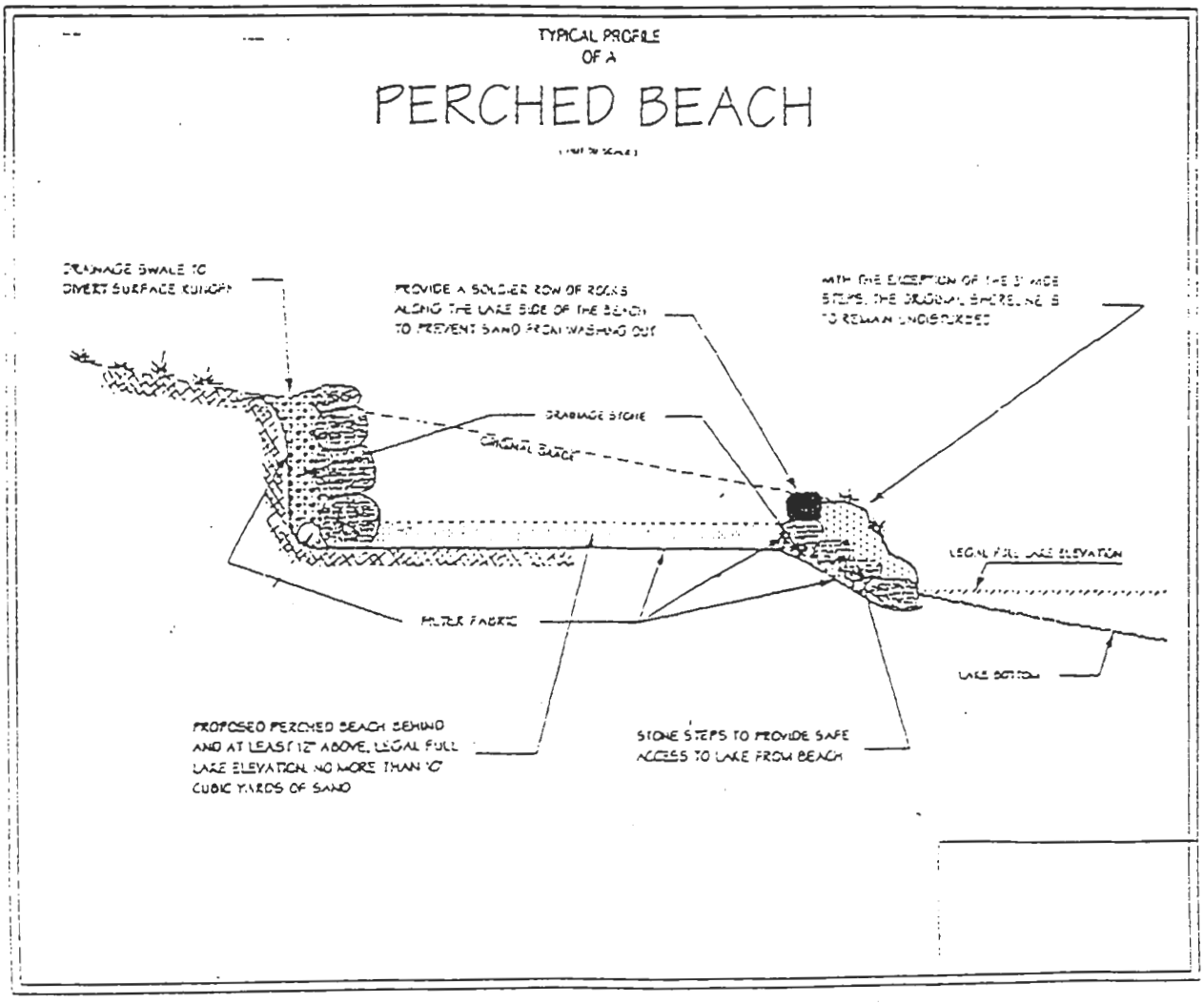
BEACH CONSTRUCTION AND MAINTENANCE

PLAN CRITERIA:

Cross-Sectional View:

- ☐ A "cross-sectional view" can be visualized as drawing a plan as if you were looking at a vertical slice through the bank. This plan must show the following information:
- ☐ The slope of the existing bank;
- ☐ The proposed slope after the beach has been constructed;
- ☐ The location of the high water mark in relation to the proposed beach;
- ☐ The vertical distance between the high water mark and the perched beach;
- ☐ The method by which the sand will be separated from the water (ex. natural undisturbed boulders, placed boulders, etc.);
- ☐ The method by which the landward side of the beach will be stabilized (ex. retaining wall, etc.);
- ☐ The scale of the plan (ex. 1"=20').

SAMPLE CROSS-SECTIONAL PLAN VIEW:



Appendix 9

Pleasant Lake Diagnostic Study

Septic System Information: Fact Sheets

Septic Systems and Septic System Alternatives

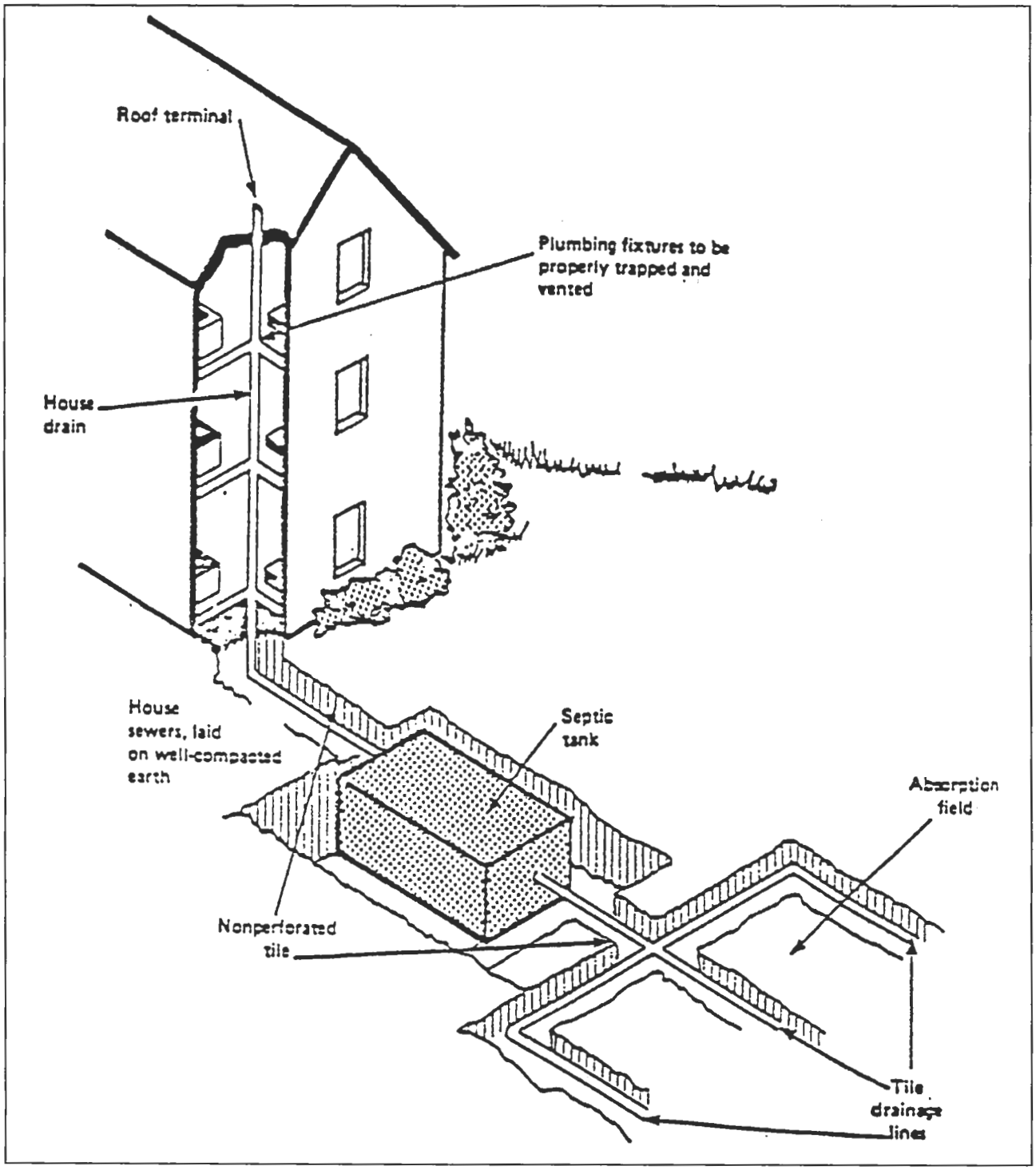
The most common type of individual disposal system is the septic tank - leachfield system as shown in Figure 1. The septic tank functions to separate the solids, both floating and settleable, from the liquid material. The accumulated sludge should be pumped out every three to five years (annually for shorefront residents). The liquid is discharged from the tank through piping material and distributed over the leaching area, which is designed to absorb the effluent and to remove the impurities before it percolates to the groundwater.

In 1967, the New Hampshire legislature enacted a law to protect water supplies from pollution by subsurface disposal systems, and directed the Water Supply and Pollution Control Commission to establish minimum, statewide requirements for properly designed systems. However, this law provided no control over existing systems. The requirements most pertinent to the prevention of surface water contamination by phosphorus are:

- Location of the system with respect to the surface water body,
- Soil permeability: the rate of water transmission through saturated soil, of which estimated soil retention coefficients varied with different lake sections,
- Land slope: steep slopes may cause erosion problems when associated with low soils of low permeability. This is the result of overland flow of water due to the lack of absorptive qualities of the soil.
- System age: soils have only a finite capacity for phosphorus absorption,
- Per capita occupancy: household population based on sanitary survey,
- Fraction of year system is in use (e.g., summer cottages or year-round dwellings), and
- Additional water utilizing machinery (e.g., washing machines, dish washers, or garbage disposals). Systems should be specially sized if additional machinery is used on the premises.

When septic systems fail, they present a potential health hazard associated with the presence of untreated human wastes above ground and in surface waters. Groundwater contamination and subsequent pollution of drinking water is probable in many areas. Many systems will leach phosphorus into the groundwater and lake, accelerating the eutrophication process in Pleasant Lake. The upgrading of old or failing septic systems could occur through four channels:

Figure 1
Diagram of Septic System Layout



- Voluntary replacement;
- Proven failure and subsequent order to replace from the health officer or the DES Subsurface Bureau;
- Conversion from seasonal to year-round use or addition of bedrooms; or
- Engineering study conducted prior to the house sale showing evidence that the septic system was in need of repairs or replacement.

2. Wastewater Treatment Considerations and Alternatives

a. No Action. The septic system is left unmanaged.

b. Regional Waste Treatment. There is currently no sewage system used by shoreline residents. State revolving fund monies can be used as low interest loans to support sewer installation.

c. Cluster Systems. Cluster systems are innovative systems that collect and treat sewage for many homes or groups of homes around a lake. First tier development around Pleasant Lake could elect for the alternative of subsurface treatment systems with conventional collection from clusters or groups of individual homes. These cluster systems are usually simple and cost effective alternatives for the secondary treatment of small flows. Installations are suitable for discharge volumes of 500 gpd to 300,000 gpd. Small areas of land (perhaps shared lots or open lots) are necessary for the installation of such systems. One company has developed a system that removes nitrogen and phosphorus. This system was developed especially for areas that are environmentally sensitive.

Cluster systems are becoming more popular as alternative systems, and research conducted on these units shows that more nutrients are trapped than by individual septic systems so less enter the waterbody. There are several cluster systems that are now operational in New England.

Acquisition of funds by the Towns of Deerfield and Northwood through the State's Revolving Loan Fund (SRF) would be the most cost-effective method of constructing cluster systems around the Pleasant Lake shoreline. SRF funds are loaned to communities at a low rate of interest for eligible non-point source pollution control management programs. These funds cover one hundred percent of the project costs and may be paid back to the state over a five to twenty year period, depending on the town budget and loan agreement.

Although a user fee would be required of all involved homes around the lake, the environmental and economic benefits greatly outweigh the option of individual subsurface system upgrades that can cost up to $10,000 each.

d. Upgrading of Individual Systems. A wide range of individual treatment systems has been explored in the last few years due to a renewed interest in on-site disposal systems. The Federal Environmental Protection Agency has a thorough review system in their draft report "Innovative and Alternative Technology Assessment Manual." The fact sheets from that manual give a good outline of available alternatives.

Individual treatment systems installed in recent years normally consist of a septic tank for solids separation and degradation, and a soil absorption system or leachfield to aid liquid percolation into the soil. The size of the tank is proportional to the expected usage, and the leaching field is sized according to both usage and soil characteristics. When soils are poor (i.e., low permeability) or flows are high, the leaching field must be large. Problems arise when the required design of the field is impractical or impossible due to lot restrictions and/or soil and groundwater conditions.

e. Compost Toilets. A reduction in wastewater volume entering the leaching field is possible by the use of a waterless toilet of the composting type. A discussion of this alternative requires an understanding of domestic wastewater composition. Wastewater is the by-product of all water used within the home including toilet facilities, cleaning, cooking and personal hygiene. The wastewater associated with toilet and urinal usage is considered concentrated human waste and classified as black water. Gray water comprises the remainder of the domestic wastewater such as water from baths, showers, sinks and clothes washers. By eliminating black water about a 40% reduction in total flow can be achieved.

Compost toilets decompose human wastes by a natural biological process. With the aid of air and/or some heat, human waste will degrade itself over an extended period of time. This process is similar to the decomposition process in composting leaves and manure piles used for garden and agricultural crop enrichment.

A compost system utilizes a large compost chamber that must be installed in the basement or underground, and is called an external unit. The larger external units rely completely on natural processes. They have no external heat addition or composting aids as in the smaller internal units. The addition of heat and compost aids (such as a starter bed or

enzymes) speeds the degradation process thereby decreasing the required volume. Toilet wastes enter through a toilet chute and accumulate in the compost chamber. Here, with air supplied through ventilation, warm temperatures and humidity, the waste begins to decompose. The process should create no odor since released gases and water are removed by outside ventilation and evaporation. Organic material such as food wastes should be introduced into the chamber to aid in the composting process.

The total decomposition time ranges from 1-1/2 to 2 years initially, and from 3 to 12 months thereafter. At the end of this time, the wastes have been reduced to rich, odorless humus that can be removed and used as garden soil. This is the only required maintenance except for the occasional addition of enzymes for certain internal units. For the internal units, electricity is required for heating and a ventilation fan, while some external units utilize convection currents for ventilation. The amount of humus produced varies with the system and ranges from 15 to 60 pounds per year per person.

f. Individual Treatment and Recycle. The recycle system is a self-contained, package treatment unit specifically designed to treat black water. Wastes are transported in about 2 quarts of water per flush, by means of vacuum, to the self-contained unit where the black water is treated by a combination of anaerobic and aerobic decomposition, settling, filtering, and purification by ultraviolet light. This treatment and purification process operates efficiently at temperatures between 55°F and 120°F and must be protected against freezing. The recycled water is returned to a flush holding tank. The recycle toilet operates on 110 volts AC and consumes from 300 to 500 KWH of electricity per month of operation. The system requires regular maintenance. Since the recycle toilet uses cultured bacteria to accelerate digestion of solids, the bacteria must be added periodically in the form of dry packets. The water level should be checked every two weeks. Periodic replacement of some parts is required. Activated carbon, used in the filtering system, needs annual replacement as does the ultraviolet lamp bulb used in purification, the air filter cartridges on the vacuum and aeration pumps and the three-way solenoid valve regulating vacuum and aeration.

g. Low Water Flush Toilets. Several low water flush toilets are available which utilize from one quart to two gallons of water instead of the average five to eight gallons used by a standard flush toilet. A limited capacity self-contained tank controls the volume of flushing water. Air in the tank is compressed as it is filled with water. When flushed, the compressed air

forces the water through the toilet bowl at a faster rate, thereby requiring a lower volume to empty the bowl.

h. Gray Water Flow Reduction. Unlike concentrated human waste, gray water cannot be completely eliminated as domestic wastewater by recycling or composting. However, many devices are available for water conservation that greatly reduce gray water quantities. Flow restrictors and regulators can be placed on faucets and showerheads. The average person showering will use 6 gallons of water per minute for 7.5 minutes with a standard showerhead. Should a 3-gallon per minute flow reduction be installed, an average family of four persons could save 90 gallons of water per day, assuming each took one shower per day. Many of these flow reduction devices cost less than $15.00, and can be purchased at local hardware stores.

Water conservation and wastewater treatment methods described above may result in significant flow reduction to the ultimate treatment and disposal system. Assuming the average family produced 75 gallons per day per person, an estimated flow for their household is about 300 gallons/day. Table X-2 displays estimated resulting flows.

Table X-2
Household Wastewater Flow Quantities With Water Conservation and Separation

Item	Design Criteria	Percentage Flow Reduction	Reduced Wastewater Flow*
1. Compost incinerator or recycle toilet	Flow-300 gpd for average dwelling	3.5%	195
2. Low water gravity flush toilet	Flow-300 gpd limited to 3½ gallons per cycle	7.5%	278
3. Shower flow control device	Limited to 2 gpm	4.0%	288
4. Combination of 1 and 4 above		7.5%	483
5. Combination of 2 and 3 above		11.5%	566

*Gallons Per Day

Wastewater Treatment Alternatives Summary

A variety of alternatives are possible for the upgrading of individual treatment systems. Each alternative has limitations for proper operation including difficult climate, terrain, soils and/or groundwater conditions, personal acceptance, technical and administrative problems. A

summary of advantages and disadvantages is shown in Table X-3 for all of the alternatives previously discussed.

Septage Handling Alternatives

The cluster system alternative includes large septic tanks that require pumping every other year. One septage-handling alternative would involve pumping of the septage by a tank truck, owned and operated by a management district for Pleasant Lake or the Town of Deerfield or Northwood. Septage would be hauled to the nearest approved disposal site or wastewater treatment plant for further treatment. Wastewater treatment plants vary in their fees for septage disposal. It is cheaper and timelier to hire a contractor to suction a series of systems (such as a street or neighborhood) on a one to two day period than it is to schedule individual and random cleanings.

Table X-3
Advantages and Disadvantages of Various Alternative Waste Disposal Systems

TREATMENT METHOD	ADVANTAGES	DISADVANTAGES
1. Septic tank and field	Simple operation and maintenance. Good public acceptance.	Dependent on soil and site conditions - percolation rate, depth to ledge, seasonal high water level, distance to well or surface water.
2. Compost toilets.	Eliminates black water flow.	Gray water still requires septic tank and soil absorption system. Potential for breeding of flies, odors and hydraulic overload. Problem with public acceptance.
3. Individual treatment and recycle.	Reduces flow from home.	Still requires septic tank and soil absorption system. High cost and high maintenance.
4. Low water flush	Reduces black water flows.	Concentration of organic loading still high. Gray water still requires treatment and disposal.
5. Gray water flow	Reduces volume of wastewater requiring treatment.	Concentration of organic loading still high. Treatment and disposal still required.

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

6 Hazen Drive, Concord, New Hampshire 03301 · (603) 271-3503 · www.state.nh.us/des

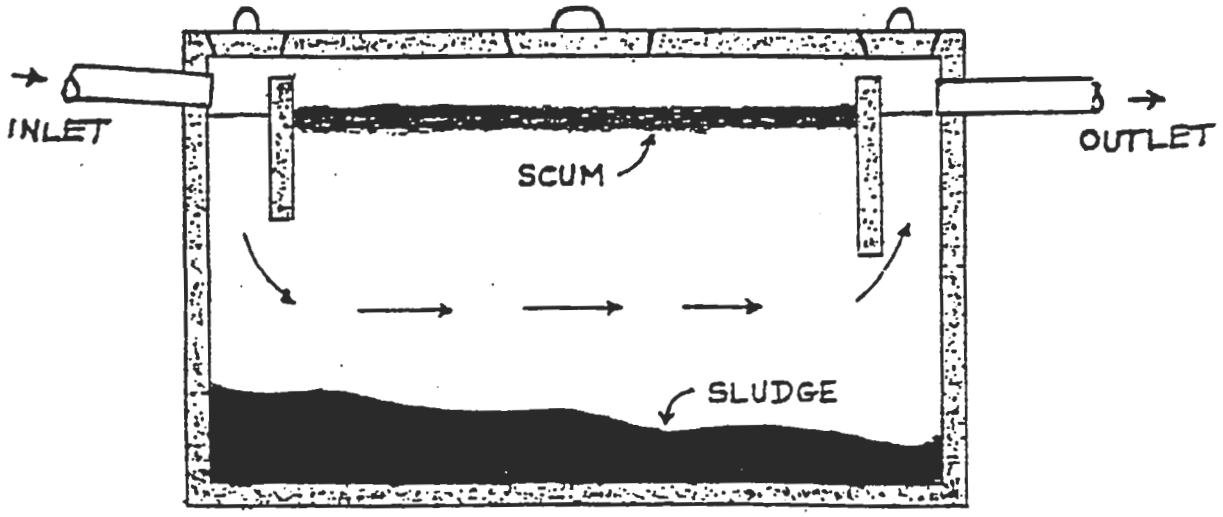
WD-SSB-11

1993

Septic Tank Function

What is a septic tank?

Your septic tank is the first step in the process of sewage conditioning, in a subsurface disposal system. Without it the untreated sewage would quickly clog the receiving soil and prevent the purification process of leaching and soil percolation.



Septic tanks serve three functions:

1. Removal of solids. As sewage enters the septic tank, its rate of flow is reduced so that the larger solids sink to the bottom and soaps, grease, and smaller solids rise to the surface. These solids are retained in the tank, and the clarified effluent with suspended and dissolved solids is discharged.

2. Bacterial Action. The solids and the liquids in the tank are partially decomposed by bacteria and other natural processes. These bacteria are called anaerobic because they thrive in the absence of free oxygen. This decomposition of sewage under anaerobic conditions is termed "septic", hence the name of the system (and the cause of the odor).

3. Sludge & scum storage. Sludge is the accumulation of solids at the bottom of the tank, while scum is a partially submerged mat of floating solids that may form at or near the surface. Space must exist in the tank to store these residues during the intervals between pumping. Otherwise, the sludge and scum will eventually be scoured from the tank and will clog the leach field and receiving soil.

The Final Stage of Disposal:

The treated effluent from the septic tank is discharged to the leach field where it percolates through suitable "septic stone" and finally into the subsoil for further purification.

Will the Use of Chemical Additives Solve Septic System Problems?

There are currently a wide variety of chemical additives available for use in septic systems. They purportedly help improve the functioning of septic systems. The majority of these additives are a combination of the various types of bacteria commonly found in a septic tank.

While it cannot be said that the addition of these additives will in any way harm your septic system, there is no scientific documentation that chemical additives will improve its operation. The number of bacteria contained in a chemical additive is very small in relation to the bacteria already present in your septic system.

Note: The Use of Chemical Additives Will In No Way Eliminate The Need For Routine Maintenance Of The Septic System And Periodic Pumping Of The Tank.

For More Information:

For further information concerning the use and care of your septic system contact:

N.H. Department of Environmental Services
Water Division
Subsurface Systems Bureau
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
Telephone: (603) 271-3501
Fax: (603) 271-6683

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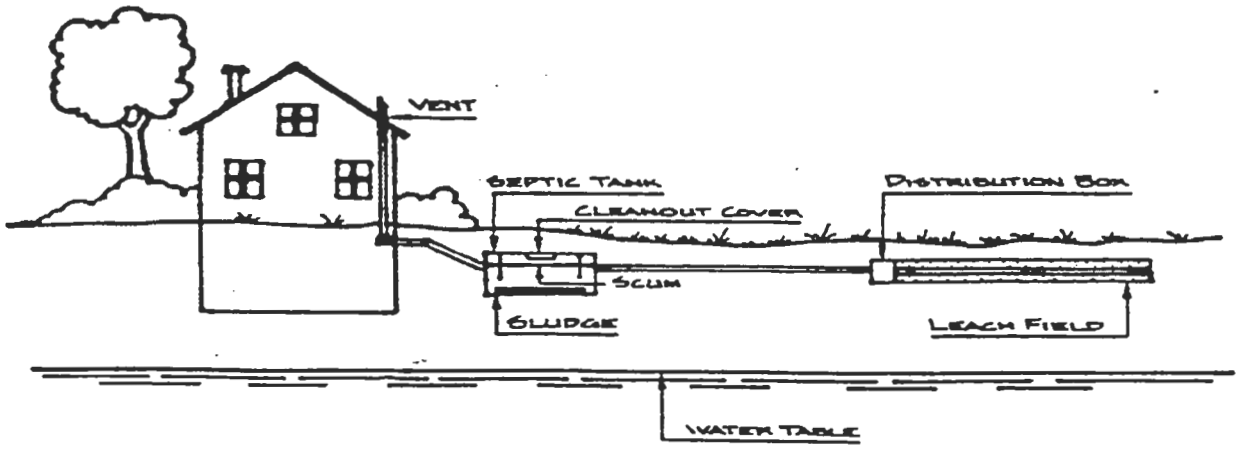
WD-SSB-2 1991

Care And Maintenance Of Your Septic System

What is a septic system?

- A septic system is a two part treatment and disposal system designed to condition untreated liquid household waste (sewage) so that it can be readily dispersed and percolated into the subsoil. Percolation through the soil accomplishes much of the final purification of the effluent, including the destruction of disease-producing bacteria.

- A septic tank provides the first step in the process by removing larger solid materials, decomposing solids by bacterial action, and storing sludge and scum. The liquid between sludge and scum is then passed along to the leaching area for final treatment and absorption into the ground. Remember: A properly maintained septic system will adequately treat your sewage.



What should I do to maintain my septic system?

- Know the location of your septic tank and leaching area.

- Inspect your tank yearly and have the tank pumped as needed and at least every three years.

- Do not flush bulky items such as throw-away diapers or sanitary pads into your system.

- Do not flush toxic materials such as paint thinner, pesticides, or chlorine into your system as they may kill the bacteria in the tank. These bacteria are essential to a properly operating septic system.

- Repair leaking fixtures promptly.

- Be conservative with your water use and use water-reducing fixtures wherever possible.

- Keep deep-rooted trees and shrubs from growing on your leaching area.

- Keep heavy vehicles from driving or parking on your leaching area.

For more information:

If you have any questions regarding your septic system, please contact:

N.H. Department of Environmental Services
Water Division
Subsurface Systems Bureau
PO Box 95
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Concord, NH 03302-0095
Telephone: (603) 271-3501
Fax: (603) 271-6683

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WD-SSB-1 2000

Replacement Of A Failed Subsurface Disposal System

- **What is a Failed Subsurface Disposal System?**

New Hampshire Revised Statutes Annotated (RSA) 485-A:2 defines failure as "the condition produced when a subsurface sewage or waste disposal system does not properly contain or treat sewage or causes or threatens to cause the discharge of sewage on the ground surface or into adjacent surface or groundwater."

- **Special Requirements for Replacing a Failed Subsurface Disposal System.**

To ensure prompt and effective replacement of a failed subsurface system, the following steps must be taken in accordance with Env-Ws 1003.19:

1) The Town Health Officer, or other local official responsible for health code enforcement, must prepare a written statement verifying that the existing system is in failure. This statement must be submitted to DES with the application to replace the existing system.

2) If construction approval is granted, the construction must be completed within 90 days. Failure to complete construction and obtain operational approval of the system within the 90-day period will result in invalidation of DES approval.

3) In the event that your construction approval becomes invalid as a result of exceeding the 90-day construction period, a request for extension must be submitted to the Department of Environmental Services, Water Division. The request for extension must include all the information required by New Hampshire Administrative Rule Env-Ws 1004.10 (b).

This fact sheet is intended as a basic source of information concerning the replacement of a failed subsurface disposal system; it is not intended to replace the administrative rules contained in Env-Ws Chapter 1000. It is also important to remember that some municipalities have additional requirements, and you should check with your local officials before beginning any project.

- **For Further Information**

For more information concerning subsurface disposal systems contact:

N.H. Department of Environmental Services
Subsurface Systems Bureau
6 Hazen Drive
Concord, NH 03302-0095
Telephone: (603) 271-3501
Fax: (603) 271-6683

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WD-SSB-12 1999

Approved Technologies for Septic Systems

Over the past several years, the N.H. Department of Environmental Services (DES) has approved several new "innovative technologies" for the treatment and disposal of wastewater to subsurface systems. All new "innovative/alternative" systems need approval from DES under the provisions of NH Administrative Rule Env-Ws 1024. The following is an overview of the various products and technologies that DES has approved to date. But before listing the currently-approved systems, we must present these caveats and warnings:

- Systems are listed in random order.
- Mention of a company name, system or device in this list does not constitute DES approval to use that system or device to address any specific problem. Consult a licensed septic system designer to learn what solutions may be appropriate for your problem.
- Remember: PUMP OUT YOUR SEPTIC TANK *BEFORE* THERE'S A PROBLEM. Many times, a "technological" solution is not necessary because ordinary maintenance may solve the problem. See Env-Ws 1023 for operating requirements.
- Where a designer specifies a certain product such as a brand of septic tank effluent filter, and a different (but similar) brand is used in the actual installation, DES will require the written concurrence of the system designer before approving the tank/septic system for operation.

As of December 1999, these are the approved systems in New Hampshire:

Leaching Systems

Stone/pipe - field, trench, drywell	"Standard" systems.
Chambers - concrete, plastic	"Standard" systems, but field sizing may be product-specific.
"Enviro-Septic" system	A "standard" system, field sizing is product-specific.
"Geo-Flow" system	A "standard" system, field sizing is product-specific.
Eljen "In-Drain"	A "standard" system, field sizing is product-specific. Manufacturer's review required for larger commercial systems.
Ruck "A-Fin"	A "standard" system, field sizing is product-specific. Manufacturer's review required for larger commercial systems.

Mechanical treatment devices with leach field reduction allowed

Norweco "Singulaire"	Mechanical unit, approved under Env-Ws 1024. Leach field size reduction.
Wastewater Alternatives, Inc. "The Clean Solution"	Mechanical unit, approved under Env-Ws 1024. Leach field size reduction.
Jet Package Sewage Treatment Plant	Mechanical unit, approved under Env-Ws 1024. Leach field size reduction.
Spec Industries AIRR trickling filter	Mechanical unit, approved under Env-Ws 1024. Leach field size reduction.
SeptiTech Recirculating Trickling Filter	Mechanical unit, approved under Env-Ws 1024. Leach field size reduction.
BioMicrobics FAST system	Mechanical unit, approved under Env-Ws 1024. Leach field size reduction.

For new construction where one of these devices is proposed for use, the designer must show that a standard-sized leach field can be constructed on the lot. All mechanical systems require on-going professional maintenance. You may need a licensed treatment plant operator for this maintenance.

Other treatment devices and methods

Aeration tank (in lieu of septic tank)	A "standard" system.
"Bio-Clere" trickling filter	Mechanical unit, has been approved for a few sites.
M.C.C., Inc. "Cajun Aire"	Mechanical unit, approved under Env-Ws 1024.
Cromaglass Sequencing Batch Reactor	Mechanical unit, approved under Env-Ws 1024.
Constructed Wetlands	Innovative, has been approved for a few sites. Significant engineering required.
Spray Irrigation	Has been approved for a few sites. Very significant engineering required.
Sand Filters	Innovative, has been approved for a few sites. Significant engineering required.

Other systems & devices

Septic tank effluent filters	Allowed and encouraged.
Presby "Maze"	Device inserted into septic tank. 30% reduced field size allowed for commercial systems.
Holding Tank	Only applicable in very limited circumstances, see Env-Ws 1022.03
Composting toilets	Allowed, but no leach field reduction allowed for the remaining wastewater.
"Mini dry well" and privies	Only allowed for buildings with no running water.

For more information about the above list, or to apply for approval from DES innovative product, please contact: Robert P. Minicucci II, PE, NH Department of Environmental Services, 6 Hazen Drive, Concord, NH 03301; (603) 271-2941.

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

6 Hazen Drive, Concord, New Hampshire 03301 · (603) 271-3503 · www.state.nh.us/des

WD-SSB-6 1991

Buying A Home Or Business? Questions You Should Ask On Sewage Disposal

When purchasing a home or business it is important to inquire about the sewage disposal system on the property. The following are suggested questions to ask the owner before you buy.

- What type of sewage disposal system serves the property, a municipal sewer system or a septic system? (If there is running water in the structure, it must have one or the other.) Note: If the property is served by a municipal sewer system, you usually don't need to inquire further.

- Is the lot part of a state approved subdivision? If so, try to get the subdivision approval number. If the lot was created prior to 1967, there will be no state approval for the subdivision since the state approval program was not implemented until July 1, 1967. This may affect the marketability and development potential of a lot. For previously developed lots, it may prohibit further expansion or conversion.

- Has the septic system received both state approvals for construction and operation? If so, does the owner have a copy of the approved plans, or the construction approval and approval for operation numbers?
  Please note: If the lot has questionable characteristics such as ledge outcrops or steep slopes, it is strongly advised to have a site assessment performed by a permitted septic system designer.

- Does the number of bedrooms on the approval match the number of bedrooms in the house? (There is no problem if there are less than the approved number of bedrooms.)

- Where is the system located, in particular, where is the tank clean-out located?

- How old is the septic system?

- When was the last time the tank was pumped? (This becomes particularly important if a garbage disposal has been used.)

- Do you have a maintenance record for the system? (While a maintenance record is not required, it is a good idea to get one if possible.)
- Has the system ever failed, or are there signs of failure like soggy grass or odor?
- What type of water supply serves the structure, municipal water supply or well?
- If there is a well, where is it located?
- Is the well a dug well or a drilled well?
- Is the well properly sealed?
- Has the well water ever been tested? If so, when? What were the results?
- Has the well ever been disinfected? If so, when?

For Further Information:

If you have any questions concerning septic systems, contact:

NH Department of Environmental Services
Water Division
Subsurface Systems Bureau
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
Telephone: (603) 271-3501
Fax: (603) 271-6683

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WD-SSB-8 2000

"Approval For Operation" Requirements For Subsurface Disposal Systems

- Inspections

The New Hampshire Department of Environmental Services (DES) is required by RSA 485-A:29 to inspect all newly constructed subsurface disposal systems within seven business days after receipt of a written request for inspection from the installer or owner.

Inspections are made to ensure that the subsurface disposal systems are installed in strict accordance with plans approved for construction by DES' Subsurface Systems Bureau.

The inspection process includes steps to verify that the proper materials have been used in the construction of the system and to ensure that the design intent has been met. Additionally, the DES inspector will make observations as to the distance from the system to seasonal high water, wetlands, and surface waters.

- Copies

Once the inspector determines that the system meets all of the requirements of RSA 485-A, a written Approval for Operation will be completed. Copies of the Approval for Operation are provided to the owner, the town in which the system is located, and the State of New Hampshire.

- Requests

Requests for inspection of approved construction may be made by calling the appropriate DES field office, the locations of which are listed on the back. Any request made by telephone should be supplemented by a written request.

-over-

- ## Subsurface Regional Offices

Region I
Frederick Treiss
PO Box 180
Glen, NH 03838-0180
(603) 383-4516
FAX (603) 383-4516

Region 3
Brenda Hayward
PO Box 7279
Village West
Gilford, NH 03249-7279
(603) 524-7730
FAX (603) 524-7730

Region 4
Eric Merrill
260 Elm Street, Suite 5
Milford, NH 03055-4758
(603) 673-0405

Region 5
Peter Hammen
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
(603) 271-2913
FAX (603) 271-6683

Region 6
James Berg
Sawyers Brook Plaza, Unit 7
PO Box 1283
Grantham, NH 03753-1283
(603) 863-3266
FAX (603) 863-3266

Region 7
Dennis Plante
360 Corporate Drive, Suite 2
Portsmouth, NH 03801
(603) 431-8141
FAX (603) 430-2142

Region 8
Real Mongeau
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
(603) 271-2182
FAX (603) 271-6683

Region 9
Douglas Smith
50 Northwestern Drive
Building A Unit 108
Salem, NH 03079
(603) 893-3637
FAX (603) 893-3602

- ## Additional Information

For more information concerning subsurface disposal systems contact:

N.H. Department of Environmental Services
Water Division
Subsurface Systems Bureau
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
Telephone (603) 271-3501
FAX (603) 271-6683

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WD-SSB-9 Revised 1999

Repair/Replacement of Existing Septic Systems Without Obtaining Prior DES Approval.

Often, homeowners and permitted septic system installers and designers ask the N.H. Department of Environmental Services (DES) if an existing failed septic system can be replaced without obtaining an Approval for Construction or an Approval for Operation from DES. The answer is yes, provided that the following conditions from administrative rule Env-Ws 1003.10 are met.

A septic tank may be replaced with one or more tanks of the same or larger size, without DES approval. This replacement of *tanks* only (not leachfields), applies to commercial and non-commercial systems.

To see if your system qualifies for replacement, please answer the following questions.

1. **Is the septic system serving a commercial building?** YES☐ NO☐
   A commercial building is anything other than a one or two family private residence. If you answer yes to this question, you need to obtain a construction approval to replace the system.

2. **Is the leaching portion of the septic system within 75 feet of <u>any</u> surface water?** YES☐ NO☐
   Surface water is a lake, pond, stream, river, tidal water, marsh or other body of water, natural or artificial. If you answer yes to this question, you must obtain a construction approval in order to replace the system.

3. **Is the leaching portion of the septic system within 75 feet of <u>any</u> wells?** YES☐ NO☐
   If you answer yes to this question, a construction approval is needed prior to any work

on the system.

4. **Is the leaching portion of the septic system less than 24 inches above the seasonal high water table?** YES☐ NO☐

This will have to be determined by a permitted designer or homeowner reading a test pit dug next to the existing septic system. Again if the answer is yes, a construction approval is needed.

Remember, if you've answered yes to any of the above questions, your septic system does not qualify for Repair and Replacement of Existing systems under Env-Ws 1003.10.

Please note, only New Hampshire permitted installers and designers or a homeowner for his/her domicile, can do repair work on existing septic systems. Additionally, it is necessary to submit a Repair/Replacement Questionnaire to DES. A copy of this questionnaire can be obtained in the appendix of the Env-Ws 1000 rules or by calling (603) 271-3711.

This fact sheet is intended as a general summary of regulations concerning the replacement of a subsurface disposal system; it is not intended to replace the Administrative Rules contained in Env-Ws Chapter 1000. It is also important to remember that some municipalities may have additional requirements. Therefore, you should check with your local officials before beginning any project.

For more information concerning subsurface disposal systems contact:

N.H. Department of Environmental Services
Subsurface Systems Bureau
6 Hazen Drive, PO Box 95
Concord, New Hampshire 03302-0095
Telephone: (603) 271-3711
Fax: (603) 271-6683

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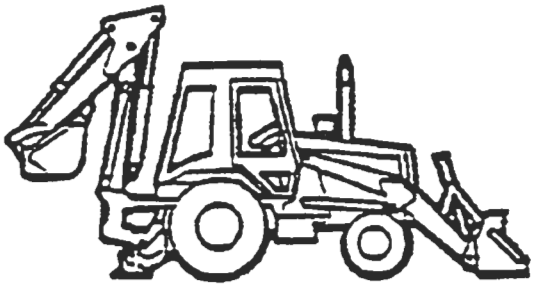
WD-SSB-7 1993

Test Pits And Percolation Tests For Subsurface Disposal Systems



• Two Early Steps

The design and construction of a subsurface sewage disposal (septic) system involves several key steps including; (1) digging test pits and (2) conducting percolation (perc) tests.

• Why are Test Pits and Perc Tests Required?

Septic system leach fields must be designed and constructed in locations with suitable soils. An adequate location with proper drainage and with sufficient distance from the underlying water table, is necessary to ensure that the leach field will operate both properly and in an environmentally sound manner. Test pits are holes that must be excavated into the soil within the area of a septic system's proposed leach bed. These pits are necessary to determine the level of the seasonal high water table and/or the depth of impermeable substratum. Percolation tests are necessary to determine the soil's ability to leach liquid at an adequate rate.

• How must test pits be dug and evaluated?

Test pits are normally dug with a backhoe to a sufficient depth and large enough to visually inspect the soil layers (horizons). A description of the predominant soil layers, including color notations based on the Munsell Soil Color Book, shall be recorded for each test pit dug. In addition the following depths shall be reported for a complete evaluation of the pit; seasonal high water table, observed water table, and impermeable substratum.

- **How must perc tests be conducted?**

A perc test requires a small test hole dug in the area of the proposed leach bed. The percolation test shall be conducted in the most restrictive permeable soil horizon above the seasonal high water table and below the A horizon, via the test pit inspection. The perc test shall be located at least 5 feet from the test pit to ensure it's located in undisturbed soil. The hole shall be dug 4 to 12 inches in diameter to a depth of at least 14 inches and the smeared soil surfaces removed. Two inches of coarse sand or fine gravel must be placed in the bottom of the test hole to protect it from scouring.

After placing the sand or fine gravel in the perc test hole, the hole must be slowly filled with clear water to a minimum depth of 12 inches over the sand or gravel. This water level should be maintained for at least 2 hours. In sandy soils containing little or no fines, the soaking procedure is not necessary and the test may be performed after the water from 2 fillings has completely seeped away.

The next step in the perc test is to adjust the water level to 6 inches over the sand or gravel. The drop in the water level should be measured from a fixed reference point, at approximately 10 minute intervals for one hour. The drop that occurs during the final 30 minute period of time shall be used to calculate the percolation rate. The rate of absorption is expressed in number of minutes required for water to drop one inch.

For information concerning subsurface sewage disposal systems contact:

NH Department of Environmental Services
Water Division
Subsurface Systems Bureau
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
Telephone (603) 271-3501

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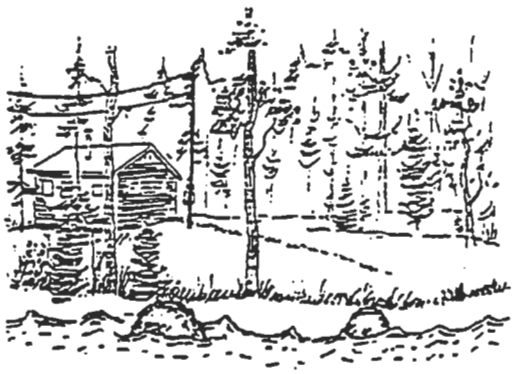
WD-SSB-10 1993

Selling Developed Waterfront Property
Site Assessment Study Required

Relevant Law: RSA 4:40-a, 485-A:2, 485-A:39.
Relevant Adm. Rule: Env-Ws 1025



•Statutory Requirements

Prior to executing a purchase and sale agreement for any "developed waterfront property" using a septic disposal system, an owner shall, at his expense, engage a permitted subsurface sewer or waste disposal system designer to perform an on-site assessment study.

"Developed waterfront property" means any parcel of land which is contiguous to or within 200 feet of a great pond as defined in RSA 4:40-a and upon which stands a structure suitable for either seasonal or year-round human occupancy. A great pond is defined in RSA 4:40 as "... a public water body of more than 10 acres." (Note that a site assessment study must be conducted whenever any part of the property is within 200 feet of the great pond, not merely when the structure or the septic disposal system is within 200 feet of the water.)

The site assessment study is a report prepared by a DES-permitted septic system designer that you as the seller hire to determine if your site meets the current standards for septic disposal systems established by DES.

The assessment originally had been required prior to listing or offering the waterfront property for sale, but effective January 1, 1993, it will be required prior to executing a purchase and sale agreement and must include an on-site inspection. The Site Assessment form may be found in the Appendix Section of Administrative Rules Env-Ws 1000 or may be obtained from DES' Subsurface Systems Bureau.

For More Information Contact:

NH Department of Environmental Services
Water Division
Subsurface Systems Bureau
PO Box 95
6 Hazen Drive
Concord, NH 03302-0095
Telephone: (603) 271-3501
Fax: (603) 271-6683

Appendix 10

Pleasant Lake Diagnostic Study

Shoreland Protection Act: Fact Sheets and Recommended Native Plantings

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WD-BB-35 1997

CHAPTER 483-B
COMPREHENSIVE SHORELAND PROTECTION ACT

Recognizing that the shorelands of the State of New Hampshire are among its most valuable and fragile natural resources, and that the protection of these shorelands is essential to maintain the integrity and exceptional quality of the state's public waters, the General Court passed the Comprehensive Shoreland Protection Act in 1991. It became effective in its entirety on July 1, 1994.

The Act establishes minimum standards for the future subdivision, use, and development of the shorelands within 250 feet of the state's public waters (see DES fact sheet WD-BB-34 for an explanation of the Act's jurisdiction). When repairs, improvements, or expansions are proposed to existing development, the law requires these alterations to be consistent with the intent of the Act. The Department of Environmental Services (DES) is responsible for enforcing the standards within the protected shoreland, unless a community adopts an ordinance or shoreland provisions which are equal to or more stringent than the Act. In addition to the standards of the Act, development within the protected shoreland must always comply with **all** applicable local, state, and federal regulations.

The following is the Minimum Standards section of the Shoreland Protection Act 483-B:9 I through V, the Penalties of the Shoreland Protection Act 483-B:18, and a diagram of the minimum standards and setbacks (also see fact sheet WD-BB-36). For a copy of the entire Comprehensive Shoreland Protection Act, please call DES at 271-2975.

483-B:9 Minimum Shoreland Protection Standards.

I. The standards in this section are designed to minimize shoreland disturbance so as to protect the public waters, while still accommodating reasonable levels of development in the protected shoreland. Development outside the protected shoreland shall conform to local zoning and local ordinances and shall not be subject to standards established in this chapter.

II. Within the protected shoreland the following restrictions shall apply:

a. The establishment or expansion of salt storage yards, automobile junk yards, and solid or hazardous waste facilities shall be prohibited.

b. Primary structures shall be set back behind the primary building line. This line shall initially be set back 50 feet from the reference line. Upon the establishment of a shoreland building setback by a municipality, that standard, whether greater or lesser than 50 feet, shall define the primary building line in that municipality.

c. A water dependent structure, meaning one which is a dock, wharf, pier, breakwater, or other similar structure, or any part thereof, built over, on, or in the waters of the state, shall be constructed only as

approved by the department, pursuant to RSA 482-A *Fill and Dredge in Wetlands* (which refers to the DES Wetlands Program).

d. No fertilizer, except limestone, shall be used within 25 feet of the reference line of any property. Twenty-five feet beyond the reference line, low phosphate, slow release nitrogen fertilizer or limestone, may be used on lawns or areas with grass.

III. Public water supply facilities, including water supply intakes, pipes, water treatment facilities, pump stations, and disinfection stations shall be permitted by the commissioner as necessary, consistent with the purposes of this chapter and other state law. Private water supply facilities shall not require a permit.

IV. The placement and expansion of public water and sewage treatment facilities shall be permitted by the commissioner as necessary, consistent with the purpose of this chapter and other state law.

IV-a. Hydroelectric facilities, including, but not limited to, dams, dikes, penstocks, and powerhouses, shall be recognized as water dependent, and shall be permitted by the commissioner as necessary, consistent with the purposes of this chapter and other state law.

IV-b. Public utility lines and associated structures and facilities shall be permitted by the commissioner as necessary, consistent with the purposes of this chapter and other state law.

IV-c. An existing solid waste facility which is located within 250 feet of the reference line of public waters under this chapter may continue to operate under an existing permit, provided it does not cause degradation to an area in excess of that area under permit.

IV-d. No solid waste facility shall place solid waste within 250 feet of the reference line of public waters under this chapter except as expressly permitted under RSA 483-B:9, IV-c. However, any solid waste facility may be allowed, subject to permitting conditions under RSA 149-M:10 *Solid Waste Management*, to erect accessory structures and conduct other activities consistent with the operation of the facility within 250 feet of the reference line of public waters under this chapter, such as filling, grading and installing monitoring wells and other drainage structures as is consistent with its solid waste permit as issued by the department of environmental services. Under no circumstances shall the toe of any slope encroach within 150 feet of the reference line.

V. The following minimum standards shall apply to the protected shoreland provided that forest management not associated with shoreland development nor land conversion and conducted in compliance with RSA 227-J:9 *Cutting of Timber Near Certain-Waters and Public Highways Of The State*, forestry involving water supply reservoir water management or agriculture conducted in accordance with best management practices, shall be exempted from the provisions of this chapter:

a. Natural woodland buffer.

1. Where existing, a natural woodland buffer shall be maintained within 150 feet of the reference line. The purpose of this buffer shall be to protect the quality of public waters by minimizing erosion, preventing siltation and turbidity, stabilizing soils, preventing excess nutrients and chemical pollution, maintaining natural water temperatures, maintaining a healthy tree canopy and understory, preserving

5) Primary structures shall be set back at least 50 feet from the reference line. However, a shoreland building setback of a municipality, whether greater or lesser than 50 feet, shall define the primary building line in that municipality.

6) Accessory structures located between the reference line and the primary building lien shall be setback at least 20 feet from the reference line. The structure height shall not exceed 20 feet and the footprint shall be no larger than 150 square feet. Refer to Administrative Rules Env-Ws 1405 for more information.

7) The law addresses minimum lost size for residential and non-residential development in the following manner:

a) for residential and non-residential development, the minimum size for new lots in areas dependent upon on-site septic systems shall be determined by soil type lot size calculations;

b) residential and non-residential lots in areas serviced by municipal sewers shall conform to municipal minimum lot standards;

c) for residential and non-residential development, waterfront parcels held in common by one or more owners of contiguous interior parcels may be developed, but only in a manner consistent with the law;

d) for projects dependent upon on-site sewage and septic systems, the total number of residential units, whether built on individual lots or grouped as cluster or condominium developments, shall not exceed one unit per 150 feet of shoreland frontage; and

e) non-residential development requiring on-site water and sewage shall not be constructed on lots less than 150 feet in width.

The Commissioner has the authority to grant variances from the minimum standards using criteria that are modeled after municipal variance criteria.

D) The stipulations for non-conforming lots and structures, as outlined in the law are as follows:

Non-conforming, undeveloped lots of record that are located within the protected shoreland shall comply with the following, in addition to any local requirements:

> Present and successive property owners may construct a single family residential dwelling and related facilities, but must show compliance with the intent of the law. The Commissioner may impose conditions while still accommodating the applicant's rights.

Except as otherwise prohibited by law, pre-existing non-conforming structures may be repaired, improved, or expanded. No alteration shall extend the structure closer to the reference line, except that the addition of an open deck or porch is permitted to a maximum of 12 feet toward the reference line.

E) Exemptions from the law shall apply in the following situations:

1) A municipality may request the Commissioner to exempt all or a portion of the protected shoreland within its boundaries from the provisions of this chapter if the municipality finds that special local urbanization conditions exist in the protected shoreland.

2) All agricultural practices and operations, provided they are in conformance with the most recent best management practices.

3) All forest management conducted in compliance with RSA 227-J:9 and not associated with shoreland development or land conversion.

4) The State Port Authority may request an exemption.

5) A municipality which adopts a shoreland protection ordinance with requirements which are equivalent to or more stringent than the Act. The Office of State Planning shall certify to DES that the ordinance provisions are at least as stringent as the Act.

6) Rivers, or segments thereof, designated by the legislature and approved for management and protection under RSA 483 prior to January 1, 1993.

F) The violations outlined in the law, are:

1) Failure to comply with the provisions of the chapter.

2) Failure to obey an order of the commissioner or a municipality issued relative to this chapter.

3) Misrepresentation by any person of a material fact made in connection with any activity regulated or prohibited by this chapter.

Any person who violates this chapter and any person who purchases land affected by a violation of this chapter who knew or had reason to know of the violation shall be liable for remediation or restoration of the affected land.

If you should have any questions, or need additional information regarding the Comprehensive Shoreland Protection Act (RSA 483-B), please call DES at 271-3503.

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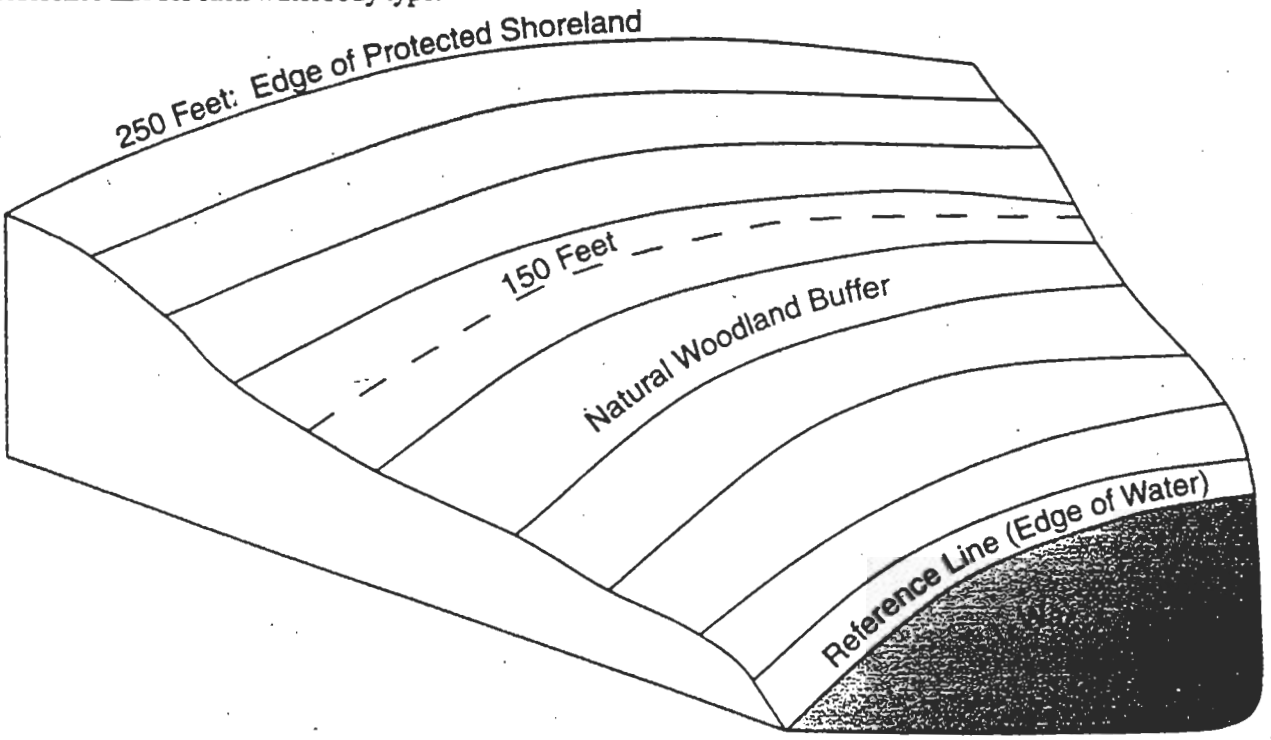
WD-BB-34 1997

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act

The N.H Comprehensive Shoreland Protection Act (CSPA), RSA 483-B, became effective on July 1, 1994 and established the "protected shoreland." The protected shoreland is all the land located within 250 feet of the "reference line" of public waters.

Within the protected shoreland, certain activities are restricted or prohibited, and others require a permit from the New Hampshire Department of Environmental Services (DES). All activities that are regulated by DES must comply with applicable local, state, and federal regulations. For a summary of the minimum standards of the Shoreland Protection Act listing activities and the distances they must be set back from the reference line, see DES fact sheet WD-BB-35 or WD-BB-36 for more complete documentation of the minimum standards.

The protected shoreland is the area of land that exists between the reference line and 250 feet from the "reference line." The reference line is the delineation between the water and the land for purposes of this act. The actual definition of the reference line is different for each type of waterbody. Waterbodies that fall under the jurisdiction of the CSPA are listed below as well as the definition of the reference line for each waterbody type.



Lakes and Ponds

All fresh waterbodies listed in the *Official List of Public Waters* published by DES are under the jurisdiction of the CSPA; this includes great ponds and artificial impoundments.

The **reference line for fresh waterbodies** is determined in one of three ways:

A. For **natural fresh waterbodies without artificial impoundments,** it is the natural mean high water level as determined by the DES.

B. For **artificially impounded fresh waterbodies with established flowage rights,** it is the limit of the flowage rights.

C. For **artificially impounded fresh waterbodies without established flowage rights,** it is the waterline at full pond as determined by the elevation of the spillway crest.

Coastal Waters

All coastal waters subject to the ebb and flow of the tide, including the Great Bay Estuary and the associated tidal rivers, are under the jurisdiction of the Act. The reference line for coastal waters is the highest observable tide line, which means a line defining the furthest landward limit of tidal flow This does **not** include storm events, which can be recognized by indicators such as the presence of a strand line of flotsam and debris, the landward margin of salt tolerant vegetation, or a physical barrier that blocks further flow of the tide.

Rivers

The jurisdiction of the Act includes most major rivers and river segments, with certain exceptions. All rivers determined to be fourth order or higher using the Strahler method are under the jurisdiction of the Act. A listing of these *Fourth Order Streams and Higher* was compiled by the Office of State Planning (OSP), and can be obtained from OSP at (603) 271-2155 or the DES PIP Office at (603) 271-2975.

The reference line for streams and rivers under the jurisdiction of the Act is the ordinary high water mark. The ordinary high water mark is defined as the line on the shore, running parallel to the main stem of the river, established by the fluctuations of water. It is indicated by physical characteristics such as a clear, natural line impressed on the immediate bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. Where the ordinary high water mark is not easily discernible, the ordinary high water mark may be determined by DES.

Fourth order streams that may be exempt from the Shoreland Protection Act are rivers or river segments designated under the New Hampshire Rivers Management and Protection Program prior to January 1, 1993. Shoreland protection for these rivers, or river segments, designated into the NH Rivers Management and Protection Program is the responsibility of the local river management advisory committee and local municipalities. Among other responsibilities, the local river management advisory committee is responsible for developing a river corridor management plan. For a list of designated rivers and more information on the New Hampshire Rivers Management and Protection Program see DES fact sheet R&L-2.

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Accessory Structures Within The Protected Shoreland

Many of us enjoy living near the shimmering waters of a river or the tranquility of a lake. There is a way to live near these places that ensures these waterbodies are protected from pollutants. A wise man from Lake Sunapee once said, "Green shores, blue lake." This simple phase encourages us to keep the trees along the shore as a way of keeping the waters clean. The forested or vegetative buffer is a fragile strip of land that borders our lakes, ponds, rivers, and coastal waters providing a defense against pollution.

A waterbody's worst enemy is a paved or non-porous surface. Roof tops, driveways, and parking areas do not allow water to absorb into the ground. Paved areas channel water and create runoff which may carry pollutants including oil, gasoline, bacteria, and metals as well as nutrients such as phosphorus and nitrogen. These pollutants can be toxic to marine plants and animals and may create unsafe swimming conditions.

Under the statewide Comprehensive Shoreland Protection Act (RSA 483-B), accessory structures built between the primary building line and public waters are subject to some restrictions. The primary building line is 50 feet from public waters unless there is an existing local setback for primary structures. Primary structures include houses and commercial buildings.

Accessory structures must be set back 20 feet from public waters, although some towns may have more stringent setbacks. Examples of accessory structures include sheds, gazebos, and garages. Other statewide restrictions for accessory structures include a maximum height allowance of 20 feet and a maximum footprint allowance of 150 square feet. In addition, no accessory structure may be built on land having greater than 25% slope.

The minimum 20-foot setback for accessory structures does not apply to structures that require direct access to the water as an operational necessity, including but not limited to piers, docks, boathouses, pump houses, and other functionally water-dependent structures, however, these structures do require a permit from the Wetlands Bureau (RSA 482-A).

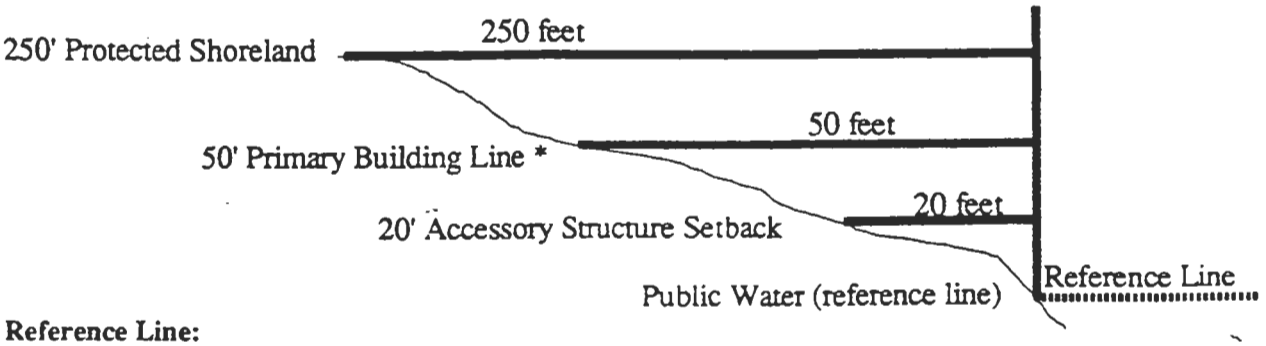
If you are developing a waterfront parcel, try to avoid placing accessory structures in this vegetated buffer. Green shores help insure blue lakes. Keep the trees, shrubs, and ground covers along the shore instead of building structures in this buffer. The plants protect the water by removing pollutants from the runoff. If there is no other space on the property to build it may be necessary to build a structure close to the water. Local regulations may limit the size of the structure and require a minimum setback from the water. Before building, check with your local building inspector for city or town regulations.

Before you build in the Protected Shoreland and for more information regarding the Shoreland Protection Act please refer to Environmental Fact Sheet WD-BB-36. Also, feel free to call the NHDES Shoreland Program at (603) 271-7109

Here is a checklist to keep in mind if you must build an accesory structure within 50 feet of a lake, a river, or tidal waters.

Checklist for Accessory Structures

Question Regarding Proposed Structure	Y	N	Comments Regarding Response
Is there any land outside the 50 foot buffer area that you could place the structure?			If yes, place it outside this protective buffer.
Did you look for a location that does not require excavating or filling?			If no, take a look at the terrain. Finding a level site for the structure reduces the costs for excavation and/or fill materials.
Is the structure allowed by local zoning?			Contact your local building inspector.
Does the design meet local building codes?			Contact your local building inspector.
Does the structure exceed 20 feet in height?			If yes, the height of the structure must be reduced.
Does the structure meet the 20 foot setback from water as required by the state regulations?*			If no, the setback must be increased to at least 20 feet from the water.
Does the structure have a footprint larger than 150 square feet?			If yes, the footprint size must be reduced to 150 square feet.
Is the structure being built on land having greater than 25% slope?			If yes, move the proposed structure to another location. Building on a site with a slope greater than 25% is prohibited under Env-Ws 1405.05.



Reference Line:
For coastal waters=highest observable tide line
For rivers=ordinary high water mark
For natural fresh water bodies=natural mean high water level
For artificially impounded fresh water bodies=water line at full pond

* The local setback for accessory structures may be more stringent.

Native and Naturalized Shoreland Plantings For New Hampshire

Common Name	Scientific Name	Height	Habitat/Soil Preference
American Beech	Fagus grandfolia	70-80'	Bottomlands, gentle slopes
American Linden	Tilia americana	60-100'	Moist soils of valleys and uplands
Balsam Fir	Abies balsamea	40-60'	Swamps to well-drained soils
Black Tupelo	Nyssa sylvatica	60-80'	Bottomlands, gentle slopes
Common Sassafras	Sassafras albidum	30-40'	Well drained fields & woods
Eastern Hemlock	Tsuga canadensis	60-70'	Moist cool valleys, acidic soils
Eastern White Pine	Pinus strobus	80-100'	Rock ridges, bogs, sandy loam
Green Ash	Fraxinus pennsylvanica	50-60'	Streams, floodplains, moist alluvial soils,
Northern Red Oak	Quercus rubra	60-80'	Bottomlands,slopes,moist soils
Paper Birch	Betula papyrifera	50-70'	Streambanks, lakeshores, moist sandy
Red Maple	Acer rubrum	50-70'	Swamps, bottomlands, moist soils
Red Pine	Pinus resinosa	50-80'	Sandy soils, rocky slopes
Scarlet Oak	Quercus coccinea	70-80'	Dry sandy to gravelly soils
Shadbush	Amelanchier sp.	30-40'	Edges of streams,moist woods,ravine
Smooth-Leaved Shadbush	Amelanchier laevis	Up to 30'	Damp wooded banks, swamps, thickets
Sugar Maple	A. saccharum	60-80'	Uplands, valleys moist rich soils
Swamp White Oak	Quercus bicolor	60-70'	Wet sites, areas of flooding
White Ash	Fraxinus americana	70-80'	Valleys, slopes, moist soil, well-drained loam
White Oak	Quercus alba	80-100'	Uplands, sandy plains, rich soils
Whire Spruce	Picea glauca	60-70'	Streambanks, lakeshores, flats, slopes
Yellow Birch		Up to 100'	Hilly terrain, high elevation

Common Name	Scientific Name	Height	Habitat/Soil Preference
American Cranberry	Viburnum opulus		
American Elder	Sambucus canadenis	3-10'	Swamp edges, along fences and roads
American Hazelnut	Corylus americana	3-8'	Borders of woods, hillsides, thickets
Arrowwood	Viburnum dentatum	3-15'	Wet/dry thickets,borders of woods
Bayberry	Myrica pensylvanica	Up to 6'	Sandy, sterile areas
Beech Plum	Pinus maritima	Up to 8'	Near coast, sandy soil
Black Chokeberry	Aronia meloncarpa	2-4'	Rocky uplands, thickets, clearings
Blackhaw	Viburnum prunifolium	Up to 20'	Valleys, slopes, boders of forests, moist soils
Bog Rosemary	Andromeda glaucophylla	.5-1.5"	Bogs, peaty to sandy soils
Buttonbush	Cephalanthus occidentalis	5-15"	Swamps, borders of ponds, streams
Common Witchazel	Hamamelis virginiana	10-15"	Dry or moist woods
Eastern Red Cedar	Juniperus virginiana	40-50'	Fields, poor dry soils
Gray Dogwood	Cornus racemosa	Up to 9'	Roadsides,thickets,swamps dry or moist.
Highbush Blueberry	Vaccinium corymbosum	5-15"	Swamps or dry upland woods
Hobblebush	Viburnum alnifolium	3-10"	Shrub layer of cooler NE forests
Ironwood	Ostrya virginiana	3-9'	Cool moist forests
Juniper	Juniperus communis	1-3'	Fields, sandy to rocky flats, slopes
Labrador Tea	Ledum groeniacdicum	1-3'	Bogs, High Mountains
Lowbush Blueberry	Vaccinium angustifolium	3-15"	Bogs, dry sandy flats, rocky slopes
Mapleleaved Viburnum	Viburnum acerifolium	3-6"	Shrub layer of moist upland forest
Meadowsweet	Spiraea latifolia	1-5'	Low moist ground, meadows,fields

Common Name	Scientific Name	Height	Habitat/Soil Preference
Mountain Holly	Ilex montana	Up to 30'	Mixed hardwood forest, moist soils
Mountain	LaurelKalmia latifolia	3-15'	Open hardwood forests
Mugo Pine	Pinus mugo	12-15'	Fields, roadsides, wet places
Nannyberry	Viburnum lentago	10-30'	Swamp and forest edges
Pagoda Dogwood	Cornus alternifolia	Up to 25'	Hardwood & coniferous forests,Moist soils
Red Chokeberry	Pyrus arbutifolia	3-12'	Thickets, clearings, swamps
Red Osier Dogwood	Cornus sericea	3-10'	Short thickets
Rhodora	Rhododendron canadense	1-3'	Bogs, wet slopes, rocky summits
St. Johnswart	Hpericum perforatum	1-3"	Fields, roadsides, wet places
Sheep Laurel	Kalmia angustifolia	1-3"	Fields, bogs, dry/wet, sandy/sterile soils
Shinning Sumac	Rhus copallina	Up to 25'	Uplands, valleys, grasslands, clearings
Shrubby Cinquefoil	Potentilla fruticosa	1-3"	Wet or dry open ground, meadows
Silky Dogwood	Cornus amomum	Up to 10'	Wooded swamps, low wet woods, shrub swamps
Snowberry	Symphoricarpos albus	1-4'	Rocky banks and roadsides
Staghorn Sumac	Rhus typhina	3-30'	Fields, clearings, dry soils
Steeplebush	Spiraea tomentosa	2-4'	Old fields, meadows, low grounds
Sweet Pepperbush	Clethra alnifolia	3-10'	Wetlands, swamps, sandy woods
Sweetgale	Myrica gale	Up to 6'	Streams, low wet woods, borders of swamps
Winterberry	Ilex verticillata	3-10'	Swamps, thickets, pond margains
Witherod Viburnum	Viburnum cassinoides	3-12'	Wet thickets, swamps, clearings