PECONIC ESTUARY PROGRAM
TIDAL CREEK STUDY

Prepared For:

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I. ABSTRACT

EEA evaluated ten tidal creeks throughout the Peconic Estuary representing a wide range of watershed variables. Primary focus was directed towards the collection and analysis of the macrobenthic invertebrate communities of these ten tidal creeks. Analysis of the macrobenthic communities indicated the relative health of the creeks. Land use, water quality, bathymetry, hydrodynamics, physical chemistry, grain size, and wildlife was also evaluated, with the intention of obtaining an overall analysis of the ten creeks, and also to assess whether the land use surrounding each creek could be correlated to the water quality and macrobenthic community structures found in each system. The ultimate goal of this study was to understand the relationship between nutrient inputs, primary productivity, and the biotic communities within the creeks and land use of immediately adjacent shorelines by comparing collected data for each selected creek.

Nutrient loading appeared to be the primary impact to the creeks. Of the ten creeks, four clearly had a benthic community structure which was more representative of a nutrient rich environment closely resembling communities found in water bodies such as Jamaica Bay, New York and the New York Harbor: Meetinghouse, West Neck, Ligonee, and Alewife. This is not totally unexpected, as the drainages these creeks are associated with have been previously identified by the Suffolk County Department of Health Service as areas with above normal levels of nitrogen. In all cases, the source of nitrogen has been identified as a municipal sewage treatment plant, or in the case of Meetinghouse Creek, an active duck farm. In most cases, the diversity in each creek was low, and the density of a single species extremely high. The amphipod *Ampelisca abdita* was the dominant identified species. In some cases, *Ampelisca* abundances exceeded 30,000/m^2. These species and densities indicate a stressed environment, which is most likely the result of nutrient loading. The organisms present are not necessarily detrimental to the environment, as they provide an excellent food source for many juvenile finfish species.

The remaining six creeks (Fresh Pond, Northwest Creek, West Creek, Goose Creek, Bass Creek, and Little Bay) all appear to support well established benthic communities. This determination is based on the presence of a diverse benthic community that is not dominated by large numbers of pioneering organisms, such as the ampeliscids, spionid worms, and oligochaetes. In general, as one would expect, these six creeks are the more underdeveloped systems, with predominantly open space (i.e., intertidal marsh) surrounding them. Goose Creek is the most developed of the six. It would appear that the presence of extensive intertidal marsh is extremely beneficial in maintaining the equilibrium in the creek, even though it would appear that most of the nutrients are coming through the groundwater.

II. INTRODUCTION

The overall objective of this study was to examine ten tidal creeks feeding Peconic Bay, New York and to assess whether the degree of urbanization surrounding each creek could be correlated to the water quality and macrobenthic community structures found in each system. The creeks chosen for study reflected a wide range of varying watershed conditions from the near pristine (e.g. wildlife refuges) to the heavily urbanized (e.g., hardened shoreline, residential or industrial uplands).

Field data collection included water quality measurements, hydrodynamics, sediment chemistry and macrobenthic fauna. In addition, a land use review and categorization was conducted of the uplands surrounding each creek.

Locations of the ten creeks studied are shown on Figure 1, and were:

- ♦ Fresh Pond Creek
- ♦ Northwest Creek
- ♦ Ligonee Creek
- ♦ Alewife Creek
- ♦ Meetinghouse Creek
- ♦ West Creek
- ♦ Goose Creek
- ♦ Bass Creek
- ♦ West Neck Creek
- ♦ Little Bay Creek

Macrobenthic samples were collected during December 1997 and July 1998 at both the headwaters and mouth of each of the tidal creeks. The sampling locations (head and mouth) of each creek are shown in Figures 2 through 11. Water chemistry and hydrodynamic samples were also collected throughout the program.

The biological and hydrological analysis of the data was completed by EEA, Inc. The land use analysis was completed by Allee King Rosen & Fleming, Inc. (AKRF). This project was funded by the U.S. Environmental Protection Agency (EPA) and implemented under the direction of the Suffolk County Department of Health Services (SCDHS). Invaluable assistance was provided by Mr. Vito Minei, Mr. Walter Dawydiak, and Mr. Robert "Mack" Waters and their staffs for providing necessary resources to complete the program. Additional acknowledgment to Mr. Mike Scheibel of "The Nature Conservancy" and Mr. Larry Penny of the East Hampton Town Natural Resource Department for allowing permission to sample their waters and provide use with previously collected data. The following sections of the report will discuss the methodology, results, and discussion of the tidal creek survey.

Literature Review

Literature pertaining to this project was obtained in several different ways. Initial investigation began with EEA's in-house library where many papers pertaining to estuarine ecology have been gathered over the years. A review of these papers and report bibliographies was undertaken. Concurrently, a computerized search of the Internet and research file (DIALOG) was also completed. The results of these studies were taken to the libraries, such as MSRC Stony Brook in an attempt to obtain the documents for review.

In addition to published documents, EEA contacted the various agencies and local town natural resource departments for unpublished "gray literature." This included the New York State Department of Environmental Conservation (NYSDEC) Shellfish Department which maintains water quality data on all the creeks, Suffolk County Department of Health Services which provided water quality data, watershed analysis, shellfish densities and natural resource date for some of the areas. Additional town agencies, in particular the East Hampton Natural Resource Department and the Southampton Department of Land Management, and the Nature Conservancy on Shelter Island were able to provide assistance with studies associated with creeks found within their municipalities.

All data were reviewed for applicability to the project. Whenever relevant, these data were incorporated and cited within the report.

III. METHODOLOGY

A. Water Quality

Water quality data were collected in two forms. Physical chemistry (i.e., temperature, salinity, conductivity, pH, and Secchi readings) were taken every time a site was visited. This consisted of two readings each at the head and mouth of each creek. The surface reading was taken in the upper six inches of the water column. The bottom reading is defined as within the lowest six inches of the water column. Additionally, two rounds of nutrient analysis samples were taken by EEA with an additional round supplemented by SCDHS. Surface water was collected at the head and mouth of each creek at the location of the benthic sampling station. Samples were collected and analyzed for: Total Kjeldahl Nitrogen (TKN), Total Dissolved Kjeldahl Nitrogen (TDKN), Total Organic Carbon (TOC), Total Dissolved Organic Carbon (TDOC), Nitrogen-Ammonia (NH_3), Nitrite (NO_2), Nitrate (NO_3), Total Phosphorus (TPO_4), Total Dissolved Phosphorus ($TDPO_4$), Ortho-Phosphorus ($O\text{-}PO_4$), Total Coliforms (TCOL), Fecal Coliforms (FCOL), Total Suspended Solids (TSS), and Chlorophyll-a (Chl. "A").

Sample analysis was performed by Chesapeake Biological Laboratory (CBL) for NH_3, NO_2, NO_3, $TDPO_4$, TPO_4, $O\text{-}PO_4$, and TSS. Sample analysis for TKN, TDKN, TOC, DTOC was conducted by Chemtech. The coliform analysis was conducted by Environmental Testing Laboratories; the chlorophyll-a samples by the Suffolk County Department of Health Services.

All sample analytsis conformed with ASTM standards. Results of the water quality analysis appear in Appendix A.

The water quality sampling program that was initiated for this study included three separate collection periods. All three collection periods collected the water samples from both the head and mouth of each of the ten tidal creeks. EEA collected water samples in July and September of 1998. Suffolk County Department of Health Services collected water samples in June of 1998. All three sampling periods were analyzed for the same parameters and at the same locations, and were therefore utilized to indicate the general water quality of these creeks during this study.

B. Bathymetric Survey

The bathymetric profile of each of the ten creeks was determined utilizing one of two methods. In creeks with a water depth of greater than three feet, a sub-acoustical bottom profiler was towed behind a boat at a slow speed behind a small outboard vessel. Coastal Oceanographic HYPACK survey software acquired data from the DGPS (Differential Geographic Positioning System) and echo sounder twice per second. In the four shallowest creeks (i.e., Fresh Pond, West Creek, Bass Creek and Ligonee Creek), the bathymetry was determined by utilizing a staff gauge to determine water depth. Each depth was manually entered into the computer which logged the GPS coordinates, as well.

In both cases, the data were downloaded to a topographic plotting program. The bathymetric data were plotted on a base map provided by the Suffolk County Department of Health Services in a GIS format. Additionally, all depths were normalized to reflect mean-low water (MLW) at NGVD. Results of the bathymetric survey appear in Appendix B.

C. Hydrodynamic Survey

At the mouth of each of the ten tidal creeks, a Falmouth Scientific 3DACM flow meter was deployed for a minimum of 24 hours. The meter collected data regarding the vector (direction) and velocity (speed) of the current. In May of 1998, in conjunction with the eelgrass water quality project, a turbidity sensor was added to collect additional data. The data were downloaded to a laptop computer at the end of each period and returned to the office to be printed out and reviewed. Collected data was backed-up in the office.

The meter was programmed to record data once every 15 seconds of every 15 minutes for the following creeks: Northwest Creek, West Creek, Bass Creek, Ligonee Creek, Alewife Creek, and Meetinghouse Creek. The meter was programmed to record data once every 15 minutes for the following creeks: West Neck Creek and Fresh Pond. Finally, the meter was programmed to record data once every 30 minutes, in two consecutive minutes for the following creeks: Goose Creek and Little Bay Creek.

Temperature

Temperature was taken directly from the data, averaged for every hour, and graphed using Excel. The graphs compare time versus temperature. The x-axis shows the time, and to make the graph legible, only a few representations of the times are shown (a general pattern can therefore be interpreted). For most creeks, only one time per hour is shown on the x-axis, though there are several data points in between the times which are shown.

An average was computed for every hour for each of the parameters (velocity, vector and turbidity). The data which was downloaded from the meter for velocity and vector was given in the form of Vn and Ve, which were used to derive the vector and velocity values. The following equations were used to derive the velocity and vector:

Velocity:

Velocity = square root (Vn^2 + Ve^2)
where Vn = Average velocity north in cm/sec, and
Ve = Average velocity east in cm/sec.

Vector:

Angle = atan (Vn/Ve)

After calculating the angle, the vector is determined by the following equations:

When Vn and Ve are greater than 0: Vector = (90 - angle)
When Vn is greater than 0, and Ve is less than 0: Vector = (270 - angle)
When Vn is less than 0, and Ve is less than 0: (Vector = (270 - angle)
When Vn is less than 0, and Ve is greater than 0: Vector = (90 + angle)

Finally, checks must be made for the following exceptions:

When Vn = 0, and Ve is less than 0: Vector is 270
When Vn = 0, and Ve is greater than 0: Vector is 90
When Ve = 0, and Vn is less than 0: Vector is 180
When Ve = 0, and Vn is greater than 0: Vector is 0

Turbidity:

Turbidity was computed by multiplying the AUX1 value that the meter reported by (.0061) to convert the reading into FTU (Formazin Turbidity Units).

The vector, velocity, and turbidity were graphed in the same form as the temperature. The results of the hydrodynamic survey appear in Appendix C.

D. Land Use

For land use information pertaining to land-based activities, the following parameters were considered. These include: general residential land use categories, such as residential, commercial, industrial, agricultural, recreational, and open space. Additional land uses evaluated included roadway coverage and the availability of utilities. Also included in the land use section were the water-related activities, such as marinas and mooring areas.

The data were obtained through the evaluation of existing land use data previously gathered by the local towns, and the examination of recent aerial photography. During the course of the field sampling program, the field crew spot checked and validated the information. The land-based information included the coverage data for the watershed residential land use categories and densities with estimates of areas within privately owned lots by distinguishing the percentage dedicated to built coverage, the percentage dedicated to commercial and industrial centers, agricultural uses, recreational uses such as gold courses, and protected parklands. A separate identification was made for protected areas such as public, private and not-for-profit owned wetlands and natural resource areas on subdivision plans. Roadway coverages were estimated based on length and type (e.g., collector, arterial). Availability of utilities was stated as would areas of septic systems.

The water-related uses were quantified through the use of aerial photography. The presence and location of the mooring fields and bulkhead frontage was initially determined by the photography and later ground truthed in the field. Additionally, the dredging records of each creek were evaluated. Detailed results of land use and water basins of each of the creeks appears in Appendix D.

E. Wildlife

Observations of wildlife species were made during each of the visits to a site. Specifically, the presence and relative abundance (if applicable) of finfish, shellfish, avian fauna, mammalian species, and herpetile fauna was recorded. These observations were made in conjunction with some other aspect of the study. The U.S. Fish & Wildlife Service and NYSDEC Natural Heritage Program were contacted to determine the presence of rare, endangered, threatened, or species or special concern in the study area. The results are provided in the narrative discussion of this report for each of the ten study areas.

F. Grain Size and Macrobenthic Invertebrates

Twenty grab stations were located within the ten tidal creeks surveyed (one at the head waters and at the mouth of each creek). Station locations are illustrated in the "Sampling Locations" maps within each study area narrative. Samples were collected with a 0.025 meter-square Petite bottom grab.

A single Ponar grab sample will be collected for grain size analysis. A total of 20 samples were collected, one at each location for laboratory analysis. For the grain size analysis, the entire contents of the Ponar grab were transferred into a container which was sent to Chemtech for analysis. Only full grab samples were utilized. For the macrobenthic analysis, three replicates were collected at each station. Two of the three replicates were randomly chosen for analysis with the remaining samples archived. Individual samples (entire contents of the Ponar grab) were washed on a 0.5 millimeter mesh sieve (to remove fine particles), and then transferred to a jar, labeled, and preserved with a buffered 10 percent formalin solution. Only full grab samples were utilized. Rose bengal stain was added to the formalin to aid in later sorting of the organisms.

In the laboratory, all macroinvertebrates were removed from the samples and identified to species level, whenever possible. The oligochaetes, chironomids, nemerteans, anthozoa, and hydrozoans were left as high taxonomic groupings because of the difficulty associated with their identification or the small size and scarcity of specimens. Detailed results of macrobenthic invertebrate densities and grain size analysis appears in Appendix E.

IV. REPORT OF FINDINGS

1. Water Quality

The water quality analysis of these ten tidal creeks was done using a limited data set. The parameters mentioned above were all tested in three sampling periods (June of 1998 by SCDHS, July 1998 by EEA, and September 1998 by EEA). Water quality data provided by SCDHS which could be applied to this study was also utilized in this analysis. Also, physical chemistry data which was collected by EEA upon each site visit (which consisted of dissolved oxygen, conductivity, water temperature, pH, and salinity) was also analyzed. However, general water quality trends were not within the scope of this project and could not be identified with the limited data set. It is anticipated that the water quality model being developed by TetraTech will address these general trends. The overall impact of water quality on the benthic communities was given greater consideration in this study, rather than the causes of water quality degradation. The water quality analysis is presented in Appendix A.

Sampling Rationale

To completely understand the relationship between nutrient inputs, primary productivity, and the biotic communities associated with each of the creeks investigated, the analysis of several parameters at each trophic level was required. . An analytical review of the chemical constituents found within each creek included total organic carbons (TOCs), coliform bacteria, nitrogen, and phosphorus. In addition to the laboratory analysis, each creek was evaluated for temperature, salinity, conductivity, dissolved oxygen, pH, and transparency (Secchi) each time a field crew visited the site. All of the analytical parameters evaluated were sampled within the same tidal phase (e.g. low slack) each time sampling occurs, to negate differences in chemistry and biological activity due to tidal stage variations. This provided valuable data for understanding the chemistry and the structure of the biological communities found within each creek system. The biological communities most influenced by these parameters would be the phytoplankton, zooplankton, and macrobenthic invertebrate populations. These, in turn, would influence the finfish (ichthyoplankton -- eggs and larvae through adult), and shellfish (bay scallops, hard clam, and blue crabs) populations found throughout the bay, which are economically important to both the commercial and recreational fishermen that utilize the bay. The following detailed descriptions will provide the rationale for the sampling analysis that was conducted by EEA for this study:

Total Organic Carbon

Carbon enters the ecosystem in many different forms, in particular as part of living tissue. Large amounts of total organic carbon (TOC) can be derived from the accumulation of plant material both from vascular plants and minute planktonic plant species, known as phytoplankton, which show up as Chlorophyll-a in water samples. Nutrient rich systems increase the potential for plankton blooms which help increase the carbon loading of the sediment. Also, the presence of high TOC levels may indicate the presence of petroleum hydrocarbons or that contaminated runoff is entering the system. The amount of organic material will strongly influence the benthic invertebrate communities that are established within each creek system, as well as the plant species. A total of 30 samples for TOC analysis were collected. Collections occurred in July and September of 1998 by EEA and throughout the summer of 1998 by SCDHS.

Total organic carbon levels increased from June to September for all tidal creeks. Slightly higher levels of TOC relative to the other sampling locations were observed for the headwaters of Northwest Creek and West Creek.

Nitrogen

Nitrogen is a building block of protein and a part of enzymes. It is needed in an abundant supply for reproduction, growth, and respiration. Plants can only utilize nitrogen in a fixed form, such as nitrites and nitrates, with the exception of nitrogen-fixing bacteria and blue-green algae. Nitrates leached from the soil and transported by drainage water are an important source of nitrogen for aquatic communities. During the summer months, the nitrogen supply to an aquatic resource area may be utilized completely by phytoplankton, in addition to many green filamentous algae. Nitrates may disappear from the surface water. As a result, phytoplankton growth, or a "bloom" is typically reduced in late summer. A reduction in phytoplankton concentrations in the spring and summer months may also be caused by increased grazing by phytoplankton. Nitrates build up again in the winter. Nitrogenous wastes draining from sewage disposal plants and other sources often overload the aquatic ecosystem with nitrogen. This can result in massive plankton growth and other undesirable changes in the community structure. Samples were collected in the same frequency as TOC.

Exceptionally high levels of nitrogen were observed in the water quality analysis for Meetinghouse Creek headwaters, while the waters at the mouth of Meetinghouse Creek, and the headwaters of both Ligonee Creek and Alewife Creek both indicate slightly higher nitrogen levels relative to the other sampling stations.

Phosphorous

Phosphorous is involved in photosynthesis, as well as in energy transfer within the plant and in animals. Animals require an adequate supply of calcium and phosphorous in the proper ratio, preferably 2:1 in the presence of vitamin D. When the supply of phosphorus in plants is low, growth is arrested, maturity delayed, and roots stunted. Samples were collected in the same frequency as TOC.

Exceptionally high phosphorus levels were observed in the water quality analysis for the headwaters of Meetinghouse Creek. The waters at the mouth of Meetinghouse Creek andAlewife Creek, along with the waters at the mouth and head of Ligonee Creek indicate slightly higher levels of phosphorus relative to the other sampling stations.

Coliform Bacteria

Coliform bacteria is an indication of waste product deposition within the Estuary. The coliforms can originate from many sources including duck farms, waterfowl, or sewage treatment plant effluent. The coliform bacteria is easily transported via storm water runoff into the Estuary. Coliforms have a significant impact to the water quality and water-related resources. High levels of coliform bacteria detection by NYSDEC can temporarily suspend the harvesting of existing shellfish beds. High coliform detection levels have facilitated beach closings. Water samples were collected three times from each of the selected tidal creeks to establish baseline conditions.

The mouth waters of West Neck Creek had the highest values of total coliforms. The head waters of West Neck Creek, Northwest Creek, West Creek, Alewife Creek, and the mouth waters of Alewife Creek also indicate high levels of Total Coliform. The headwaters of Northwest Creek, Alewife Creek, Meetinghouse Creek, and Fresh Pond indicate high values of fecal coliform.

General Physical Characteristics.

During each site survey, EEA collected a series of basic water quality measurements (e.g., temperature, salinity, conductivity, dissolved oxygen, pH, and transparency [Secchi]). Readings were taken with a Yellow Spring Instrument (YSI) salinity and S-C-T meter, and a Standard Secchi disk. All readings were transcribed into a field notebook or standard data sheets. These data sheets appear in Appendix F. A table of the physical chemistry readings conducted at each site visit is included in the waterquality section of each creek.

Chlorophyll-a

A good measure of water quality and a reflection of the volume and source of nutrient loading within a system can be calculated by the level of Chlorophyll-a that was present during the sampling program of this study. High levels of Chlorophyll-a were good indicators that high levels of nitrogen are present. The Chlorophyll-a samples were collected in conjunction with other chemical sampling by utilizing a 6-liter Van Dorn bottle. Samples were drawn off into the appropriate one-liter bottle and placed in a cooler. EEA was required by ChemTech to filter the samples through a millipore filter with a vacuum pump. The filters containing samples were frozen and shipped or delivered frozen to the analytical laboratory. Chlorophyll-a was analyzed three times, along with the chemical analyzation.

Stations which indicate high levels of total chlorophyll-a include Ligonee Creek head waters, Meetinghouse Creek head waters and mouth waters, and Bass Creek head waters. Relatively low levels were evident at the mouth and headwaters of Fresh Pond and Northwest Creek.

2. Bathymetric Survey

The results of the bathymetric survey provide the physical structure of the ten creeks. Depth of the creeks can be correlated with light extinction, varying subaquatic vegetation (SAV) communities, and therefore benthic communities. Dredging of these tidal creeks can also greatly impact the benthic community structure, as the immotile organisms will be displaced along with the dredge material. The Suffolk County Department of Works files have indicated the recent dredging history of the ten creeks. Though this is valuable data, dredging may also be done by private homeowners or businesses, which is not typically recorded data.

Tidal Creek	Last Dredged
Fresh Pond	Yearly
Northwest Creek	1961/1965/1971
Ligonee Creek	Never
Alewife Creek	Never
Meetinghouse Creek	Spring, 1998

West Creek	1982/1994/1996
Goose Creek	1995
Bass Creek	Never
West Neck Creek	Fall, 1998
Little Bay Tributary	Never

3. Hydrodynamic Survey

The hydrodynamic survey provided data which was utilized in the analysis of the general relative health and attributes of each creek. Though general hydrodynamic trends could not be observed over a 24-hour period, minimum and maximum velocities, vectors, turbidities and temperatures were calculated and analyzed. These results appear in the results of each creek.

4. Land Use

The results of the land use survey for the ten tidal creeks demonstrated many attributes which can be correlated to other findings within this study. There was a direct correlation between watersheds with high development and in-water-uses with high nutrient loads and stressed benthic communities in some creeks (Meetinghouse Creek and Ligonee Creek). There was also a direct correlation with relatively low-land-use/development shorelines, encompassed by salt marsh with nutrient loads which did not appear significantly elevated and relatively stable benthic communities (Bass Creek, Northwest Creek, and West Creek). Finally, the historic and/or present use of the watersheds for agricultural purposes was directly correlated with high nutrient loading (particularly nitrogen compounds), and relatively stressed benthic communities (West Neck Creek, Meetinghouse Creek and, to a lesser extent, Little Bay Creek). Stress, in this report is defined as a habitat indicative of change. This change is usually caused by antropogenic sources. Stressed communities are usually represented by rapid-reproductive, pioneer species, as opposed to "un-stressed" communities, which would be dominated by more stable species.

5. Wildlife

Incidental occurrences of wildlife were recorded each time a site was visited. In general, all creeks were found to support species which are common to this region. Any sightings of endangered, threatened or species of special concern which were observed were documented. These observations appear in the results of each creek and full tables appear in the field data sheets (Appendix F).

6. Grain Size and Macrobenthic Invertebrates

Much can be learned from observing macrobenthic invertebrate communities. Benthic communities must conform to the overall water and sediment quality. This was determined by the diversity and abundance of each species. In general, if a benthic community is represented by low diversity with high abundance, the system is likely to be degraded to some extent (Cerrato, 1983). If the community contains high diversity, with fewer individuals per species, this would be indicative of a healthy system. Benthic samples for all 10 creeks were taken in July and December of 1998.

In the laboratory, all macroinvertebrates were removed from the samples and identified to species level, whenever possible. The oligochaetes, chironomides, nemerteans, anthozoa, and hydrozoans were distinguished in high taxonomic groupings because of the difficulty associated with their identification or the small size and scarcity of specimens. All replicate samples were analyzed from each station for each of the three sampling periods. The benthic analysis was the major scope of this project and is discussed for each creek and the general conclusions of the benthic analysis is discussed in the conclusions of this report.

V. RANKING SYSTEM OF TEN TIDAL CREEKS

EEA developed a system where the ten creeks were evaluated, using several parameters, to develop a ranking system among the creeks. The three main parameters that were utilized for this ranking system were: water quality, macrobenthic invertebrate densities, and land use. Though these three were the main parameters, consideration was given to such aspects as wildlife, hydrography, bathymetry and any other field observations throughout this study. These parameters were given a value of one through five, which represented a sliding gradient, with a value of one indicating an oligotrophic system, and a value of five indicating a relatively eutrophic system. After each of the three parameters were quantified, these values were added together to assign an overall numerical value to each creek.

Water Quality Quantification System

The creeks were evaluated with respect to water quality by analyzing the water quality data and physical chemistry data that was obtained throughout this study. The values were analyzed relatively to each other, instead of to standard levels.

	Nutrient Loading	Physical Chemistry	Other Parameters	Rank (1-5)
	(Total Nitrogen, Phosphorus, etc.)	(Salinity, Dissolved Oxygen, Temperature, pH)	(Fecal coliforms, TOC, etc.)	
Fresh Pond Creek	Average	Average	Average	2
Northwest Creek	Average - Low	Average	Poor	2
Ligonee Creek	High	Poor	Poor	4
Alewife Creek	Low	Average	Average - Poor	2
Meetinghouse Creek	Very High	Poor	Poor	5
West Creek	High	Average	Average	3
Goose Creek	Average	Average	Average	3
Bass Creek	Average	Average	Average	2
West Neck Creek	High	Average	Average - Poor	3
Little Bay Creek	Average	Average	Average	2
The ranking system represents a sliding gradient with a value of 1 indicating an oligotrophic system, and a value of 5 indicating a eutrophic system. Note: This ranking system was compiled using very limited monitoring data in some instances.				

Macrobenthic Invertebrate Quantification System

The creeks were evaluated for the overall abundance of benthic invertebrates and also the overall diversity that was observed. The presence or lack of pioneer species was also considered. *Capitella capitata, Ampelisca abdita, oligochaetes*, and *Streblospio benedicti* among others, are considered pioneer species, which are indicators of a disturbed system, or a system which is stressed to some degree. An abundance of the above-mentioned pioneer species would indicate a relatively stressed system, while a high abundance and diversity, but low occurrence of pioneer species would indicate a relatively unstressed system.

	Overall Abundance	Overall Diversity	Presence or Lack of Pioneer Species	Rank (1-5)

Fresh Pond Creek	Low	High	Average	3
Northwest Creek	Average - High	High	Low	1
Ligonee Creek	Average	Average	High - Very High	4
Alewife Creek	Low - Average	Low - Average	Low - Average	3
Meetinghouse Creek	Very High	Low	Very High	5
West Creek	Average	Low	Low	2
Goose Creek	Low - Average	High	High	4
Bass Creek	High	High	High	2
West Neck Creek	Very High	Low	Very High	5
Little Bay Creek	Low	Average	High	4
The ranking system represents a sliding gradient with a value of 1 indicating an oligotrophic system, and a value of 5 indicating a eutrophic system				

Land Use Quantification Sytem

The creeks were evaluated for development density for the land use quantification. Such attributes as numbers of houses, boats, docks, residential houses, and commercial buildings were considered.

	Development Density	Edge Quality (Agricultural stresses, shoreline hardening, natural vegetation)	Rank (1-5)
Fresh Pond Creek	1	1	1
Northwest Creek	2	3	3
Ligonee Creek	4	3	4
Alewife Creek	4	3	4
Meetinghouse Creek	5	5	5
West Creek	3	4	4
Goose Creek	4	3	4
Bass Creek	1	1	1
West Neck Creek	4	3	4
Little Bay Creek	1	4	3

	Development Density	Edge Quality (Agricultural stresses, shoreline hardening, natural vegetation)	Rank (1-5)
The ranking system represents a sliding gradient with a value of 1 indicating a relatively undeveloped watershed, and a value of 5 indicating a relatively developed watershed.		This ranking system represents a sliding gradient with a value of 1 indicating a relatively naturally vegetated watershed (and a substantial vegetative buffer), and a value of 5 indicating a watershed relatively stressed from agriculture or shoreline hardening (with little or no natural vegetative buffer), etc.	

Overall Ranking System

Tidal Creek	Water Quality Rank	Macrobenthic Invertebrate Rank	Land Use Rank	Overall Rank
Fresh Pond	1	3	1	5
Northwest Creek	3	1	2	6
Ligonee Creek	4	4	4	12
Alewife Creek	3	3	4	10
Meetinghouse Creek	5	5	5	15
West Creek	2	2	4	7
Goose Creek	3	4	4	11
Bass Creek	1	2	1	4
West Neck Creek	3	5	4	12
Little Bay Tributary	2	4	3	7

The overall rank of the ten creeks is a sum of the 3 parameters used in this evaluation (water quality, macrobenthic invertebrates and land use). The overall rank represents a sliding gradient, with a rank of 1-5 indicating a relatively "good" creek, a rank of 6-10 representing a relatively "fair" creek, and a rank of 11-15 representing a relatively "poor" creek.

VI. RESULTS OF TEN TIDAL CREEKS

A. Fresh Pond

Fresh Pond is located along the southwest corner of Napeague Bay within the Town of East Hampton. Fresh Pond is a relatively small (approximately 18 acres) impoundment attached to Napeague Bay by a long (approximately 300 foot east/west), narrow (20 to 25 foot north/south) stream channel. Both areas are extremely shallow, with an average depth of 0.5 to 1.5 feet. The inlet to Fresh Pond is open and has been dredged yearly by the town to facilitate tidal flushing. The entire area of Fresh Pond is uncertified year-round. The stream channel consists primarily of medium coarse sand, while the pond is dominated by fine grain silts. No sub-aquatic vegetation was present in the stream channel. The pond was completely dominated by widgeongrass (*Ruppia maritima*). Salinities within the fresh pond system averaged 24.8 parts per thousand (ppt) with a range of 21.9 to 27.6 ppt. In general, the pond was surrounded by a mixed deciduous evergreen forest with a mixture of oaks and pitch pines (*Pinus rigida*). The shoreline was fringed with emergent vegetation, mostly saltmarsh cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*Spartina patens*), common reed (*Phragmites australis*) and groundsel tree (*Baccharis halimifolia*).

Fresh pond was surveyed from September 30, 1997 to November 14, 1997 for the hydrodynamic survey; on December 4, 1997 and July 14, 1998 for macrobenthic invertebrates; June 9, July 30th and September 21, 1998 for water quality analysis; April 25, 1998 for bathymetry; and in July of 1998 for physical chemistry (P-chem) analysis. The following sections report the results of each discipline.

1. Water Quality

Fresh Pond has a restricted outlet, which closes naturally during significant storm events. This outlet is re-opened via an excavator. The NYSDEC has classified Fresh Pond as uncertified for shellfishing year-round. The discharge from Fresh Pond is an actual, direct pollution source to Napeague Bay. The water quality analysis of Fresh Pond for this study show relatively low levels of ammonia, nitrogen, total chlorophyll-a, and phosphorus. The water quality analysis of Fresh Pond did indicate relatively high levels of total and fecal coliforms in the sampling conducted in June of 1998.

The physical chemistry data analysis of Fresh Pond indicate relatively high salinity levels (over 30 ppm), which was expected given the tidal flushing of this creek. The physical chemistry field data analysis is presented below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
9/10/97	Mouth	18.00			30.00	
7/14/98	Head	2.00	6.60	6.60	37.20	37.20

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
9/10/97	Mouth	21.80		43.47		8.00
7/14/98	Head	23.10	23.10	37.20	37.20	7.80

2. Bathymetric Survey

Fresh Pond is a uniformly shallow body of water connected to Napeague Bay by a narrow stream channel. The average water depth is 0.3 to 1.8 feet at mean low water.

3. Hydrodynamic Survey

Based on the results of the hydrodynamic survey conducted by EEA and numerous tidal studies conducted by the East Hampton Town Natural Resources Department, the tidal cycle is relatively normal with two ebb tides and two flood tides a day. The only anomaly is a slight interruption in the ebb tide as the flood tide begins to come in and backs it up (EHTNRD 1998).

The current meter was deployed at the northeast corner of the pond. The current pattern within the pond appears to be variable and more influenced by the wind direction than the tidal cycle. Velocity with the pond are fairly weak with a maximum of 21.8 cm/sec observed on September 31, 1997. The average direction was 155 degrees, south south-east, the average velocity was 3.11 cm/sec. The current dropped to near zero on the slack water, as expected.

4. Land Use

Fresh Pond is in the Town of East Hampton, approximately 1.25 miles north of Montauk Highway. Fresh Pond Road runs along the southern portion of the pond. There are several houses across the road from the woods bordering this secluded and nearly pristine pond. At the end of Fresh Pond Road, approximately 20 yards from the shoreline, there is a rest facility, with a one-acre hard surface parking lot, a phone, and two restrooms. There are low density, single-family residential communities to the south, west and north.

Fresh Pond has a surface area of approximately 20 acres, and a length, from tidal creek mouth to the pond's westernmost point, of ½ mile. It is almost completely surrounded by vegetation, including common reed, deciduous and evergreen trees, and shrubs. In certain areas along the creek's edge near the mouth, the reeds are fifteen feet deep.

This tidal creek flows east into Napeague Bay. An estimated 150 yards east of the creek's mouth, approximately fifteen houses line the bay, some with docks. Approximately .75 mile north of the creek's mouth, there are a few houses and docks among the open space, dunes, and bluffs that border Napeague Bay. Napeague State Park is located approximately six miles southeast of Fresh Pond. Approximately 1 mile southwest of the pond is the South Fork Country Club.

The area surrounding Fresh Pond is best described as a forested residential area. A small town park, with restroom facilities and what appeared to be a septic system, can be found along the south side of the mouth. The park appears to receive limited usage by small family groups. The interior of the system is surrounded by forest with no road ends or other potential stormwater runoff sources available. Therefore, it would appear that there is little contributed to Fresh Pond from land use activities.

5. Wildlife

Various species of finfish, in particular bait species such as Atlantic silverside (*Menida menida*), sand lance (*Ammodytes americana*), killifishes (*Fundulus heteroclitus, F. majalis, F. Diaphanus* and *Cyprinodon variegatus*) and white mullet (*Mugel curema*) appeared to be extremely abundant at times. Associated with the bait fish, in particular during September and October, were large schools of juvenile "snapper" bluefish (*Pomatomus saltatrix*). Also evident in the system were numbers of young-of-year (YOY) winter flounder (*Pleuronectes americanus*).

Large numbers of water-related avian species, such as the osprey (*Pandion haliaetus*), belted kingfisher (*Megaceryle alcyon*), great blue heron (*Ardea herodias*), green heron *(Butorides striatus*), great egret (*Casmerodius albus*), and snowy egret (*Egretta thula*) were commonly seen.

Many passerine species were often heard calling from the adjacent shoreline or forest.

Some of the more common species included, but not limited to, the bluejay (*Cyanocitta cristata*), black capped chickadee (*Parus atricapillus*), gray catbird (*Dumetella carolinensis*), American goldfinch (*Garduelis tristis*), common flicker (*Colaptes auratus*), and American crow (*Corvus brachyrhynchos*).

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed two distinctly different communities. Those present at the head of the creek reflected a community most typically associated with silty fine grain sediments, while those at the mouth were clearly different, indicating a coarser grained sand.

In July, there was a total of 61 benthic organisms observed at the mouth of Fresh Pond. Annelids comprised over 95% of these organisms. In December, there was a total of 34 benthic organisms observed at the mouth of Fresh Pond. Nemertean worms comprised over 40% of this grab sample.

In July, there was a total of 345 benthic organisms observed at the head of Fresh Pond. Annelids comprised almost 80% of these organisms, and Mollusks comprised approximately 15%. In December, there was a total of 73 benthic organisms observed at the head of Fresh Pond. Annelids comprised over 65% of these organisms.

The benthic community found at the head of the creek in December was dominated by both Annelids (*Streblospio benedicti*) and a grouping of miscellaneous organisms, which have been defined in this report as "Other" (*Molgula manhattensis*). At the head of the Fresh Pond in July, Annelids were dominant with *Hypaniola grayi*, and to a lesser extent, oligochaeta.

The benthic community found at the mouth of Fresh Pond in December was dominated by Nemertean worms, and in July, the mouth community was dominated by Annelids (*Streblospio benedicti*).

B. Northwest Creek

Northwest Creek is immediately adjacent to Northwest Harbor which drains into Gardiners Bay. Northwest Creek is solely located within the Town of East Hampton. Northwest Creek is a relatively long (approximately 1.3 miles) and narrow (an average 1,250 feet) estuary occupying approximately 140 acres. The inlet connecting Northwest Creek to Northwest Harbor is extremely narrow (less than 100 feet across). Northwest Creek is fed tidally by this inlet which is maintained by the county, but has not been dredged since 1971.

The environment associated with the head of Northwest Creek was much shallower than the mouth, with a mean depth of 8.0 feet compared to areas of less than 1 foot. There was no apparent SAV observed while sampling in Northwest Creek. The vast majority of the shoreline is fringed by an expansive intertidal marsh dominated by saltmarsh cordgrass. Beyond the marsh is an oak/pine forest. The remaining portion of the creek shoreline contains a small stretch of beach (approximately 240 l.f.). Salinities within the creek system averaged 26.5 ppt, ranging from 24.1 to 28.8 ppt with little variation between the mouth and head.

In general, the entire system is extremely shallow, with an average depth of 3.0 to 4.0 feet. The deepest areas are at the mouth and northeast corner where a mooring field is located. The depths in the northeast corner of the creek exceed 10 feet in some areas. The vast majority of the Northwest Creek substrate consisted of silty fine grain material with the exception of the mouth and mooring area which is mostly medium sands.

Northwest Creek was surveyed from September 9, 1998 to September 16, 1998 for the hydrodynamic survey, on December 4, 1997 and July 14, 1998 for marcrobenthic invertebrates, June 9, July 30th, and September 21, 1998 for water quality, April 24, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

The shellfish resource of Northwest Creek is considered moderate to large, according to NYSDEC. NYSDEC has classified Northwest Creek as uncertified for shellfishing. Northwest Harbor has numerous freshwater feeds in addition to sizeable underflow and shore seep contributions. Tests by the NYSDEC of the waters of Northwest Creek for coliforms after storms suggest that it may develop water quality problems if steps are not taken to abate coliform sources. The coliform sources are presumed to be from septics situated in the water table approximate to creek waters. The water quality analysis of Northwest Creek for this study indicate relatively low levels of phosphorus and nitrogen for the samples taken during this study. The headwaters of Northwest Creek indicate relatively high levels of total and fecal coliforms. The water quality of Northwest Creek indicated that it may be a stressed system. This is believed to be a function of flushing coupled with meteorological conditions.

The physical chemistry field data analysis appears below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
7/14/98	Head	36	7.4	7.8	22.9	24.7
7/14/98	Mouth	24	6.9	7	26.6	26.6

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
7/14/98	Head	25.6	25.3	38	39.1	6.7
7/14/98	Mouth	24.7	24.8	41.3	41.3	7.8

2. Bathymetric Survey

Northwest Creek is uniformly shallow throughout with an average depth of 3.0 to 4.0 feet. The only exceptions are the narrow inlet and body mooring area where the water depth averages 8.0 feet deep. The creek channel is maintained by dredging conducted by Suffolk County Department of Public Works (SCDPW). However, SCDPW files indicate that this creek has not been dredged for over ten years.

3. Hydrodynamic Survey

Based on the results of the hydrodynamic survey, as well as regular observations conducted by EEA and numerous tidal studies conducted by the East Hampton Town Natural Resources Department, the tidal cycle is relatively normal with two ebb tides and two flood tides in a twenty-four hour period. The tidal height in Northwest Creek on average is 3.0 feet above mean low water. This is reported by the computer program "Tides and Currents for Windows 1995" and confirmed by field sampling conducted by EHTNRD.

The current meter was deployed at the end of Northwest Landing Road. The current pattern within the creek appears to be variable, possibly more influenced by the wind direction than a predictable ebb and flood current pattern. The average direction of the current was recorded as 130 degrees, east south-east. Velocities within the creek were fairly weak with a maximum velocity of 9.9 cm/sec. The average velocity was 2.42 cm/sec. As expected, velocities dropped out to near zero on the slack water. The hydrodynamic survey was studied from a first quarter moon to a full moon.

4. Land Use

Northwest Creek is located in East Hampton, approximately 2.25 miles from the Village of Sag Harbor. It is approximately 1.5 miles long, with an estimated surface area of 183 acres. Northwest Harbor Park (County) surrounds the majority of Northwest Creek. The creek's natural surroundings consist of vegetation, including wetlands, deciduous and evergreen trees, and some sandy beach. The mouth of the creek meets Northwest Harbor. Northwest Landing Road runs east of the creek and ends approximately 1/8 mile from the creek mouth. A boat rental house and a bulkhead/parking lot with approximately 20 boat moorings border the creek at the end of Northwest Landing Road. Single-family residential dwellings line this road. Northeast of the creek is a New York State Environmental Conservation Area encompassing 1,100 sf. Sag Harbor Golf Club is approximately 1,000 feet west of the creek.

Approximately 80 percent of the shoreline associated with Northwest Creek was intertidal saltmarsh. Only a very small portion of the northeast shoreline was bulkheaded, approximately 840 linear feet in front of nine houses, with 11 shorefront lots. Also associated with the northeast corner of the creek was a small mooring field which is maintained by Town Trustees. Northwest Creek is completely surrounded by the Northwest Harbor Co. Park. Immediately adjacent to the west of the park and the creek is the Barcelona Neck/Sag Harbor Golf Club.

5. Wildlife

Observation of fish, given the large size of the system, was somewhat difficult, although the presence of schools of baitfish, in particular the Atlantic silverside and Atlantic menhaden (*Brevoortia tyrannus*) and large schools of juvenile bluefish were present during September and October.

As with Fresh Pond, shore birds or water dependent birds were abundant in the Northwest Creek. This includes the belted kingfisher, great egret, and snowy egret, as well as passerines such as the northern mockingbird (*Mimus polyglottos*), mourning dove (*Zenaida macroura*) and house sparrow *(Passer domesticus)* as well as others based on the available habitat.

Larger megabenthic invertebrates such as fiddler crabs (*Uca* Sp.), green crabs (*Carcinus maenas*) and ribbed mussels (*Geukensia demissus*) were present along the shoreline.

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed two distinctly different communities. Those present at the head of the creek reflected a community most typically associated with silty fine grain sediment, while those at the mouth were clearly different indicating a medium/coarse grained sand.

In July, there was a total of 53 benthic organisms observed at the mouth of Northwest Creek. Nemertean worms comprised nearly 60% of these grabs, and Annelids comprised over 30% of these organisms. In December, there was a total of 126 benthic organisms observed at the mouth of Northwest Creek. Annelids comprised over 40% of these organisms, and Arthropods comprised approximately 30%.

In July, there was a total of 409 benthic organisms observed at the head of Northwest

Creek. Annelids comprised over 65% of these organisms, and Arthropods comprised approximately 25%. In December, there was a total of 382 benthic organisms observed at the head of Northwest Creek. Annelids comprised over 50% of these organisms, Arthropods comprised approximately 40%. The benthic community found at the head of the creek in July was dominated by Annelids (with significant abundance of *Neanthes succinea* and *Mediomastus ambieseta*). In December, the head of the creek was also dominated by Annelids (again with an abundance of *Neanthes succinea*, and also *Scolecolepides viridis* and *Hypaniola grayi*). In the mouth in July, the benthic community was dominated by Nemertean worms, and to a lesser extent, the Annelids (abundances of *Polygordius triestinus* were observed). The mouth in December was again dominated by Annelids, with abundances of *Paraonis fulgens* and *Haploscopoplos rubustus*.

C. Ligonee Creek

Ligonee Creek is located in the southwest corner of the upper Sag Harbor Cove entirely located within the Town of Southampton. Ligonee Creek is a long (2,800 feet) east to west and narrow (average width approximately 200 feet) north to south body of water approximately 13 acres in size. The sediments associated with the bottom of the creek uniformly consists of a silty fine grain material from the mouth to the head. No sub-aquatic vegetation was evident throughout the study period. In general, salinities were somewhat higher at the mouth (average 26.7 ppt) and lower at the head (average 17.3 ppt). This can be attributed to a six inch layer of freshwater (0.6 ppt) on the surface at the head of the creek during low tide. Bottom salinities were more uniform. The shoreline of Ligonee Creek was mostly developed or channelized. A narrow band of intertidal and high marsh can be found on the north and south shores, primarily at the mouth, with saltmarsh cordgrass and the groundsel tree compromising the bulk of the vegetation. Ligonee Creek was chosen for this study, in part, due to the substantial plume of organic contaminants from the former Rowe Industries site which discharges into the creek.

Ligonee Creek was surveyed for the hydrodynamic study from August 25, 1998 to August 26, 1998, for macrobenthic invertebrates on December 4, 1997 and July 6, 1998, for water quality analysis on June 9, July 30, and September 21, 1998, on July 28, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each analysis.

1. Water Quality

There is the potential for freshwater input from a few small ponds located in Ligonee Brook. The waters of Ligonee Creek have been closed to shellfishing by the NYSDEC. The water quality analysis of Ligonee Creek indicate relatively high levels of ammonia, total chlorophyll-a, phosphorus, and nitrogen.

The physical chemistry of Ligonee Creek indicate relatively low levels of salinity. The physical chemistry field data analysis appears below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
7/6/98	Head	32.4	5.1	3.3	17.8	19.7
7/6/98	Mouth	42	5.5	6.7	22	23.5

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
7/6/98	Head	21.6	24.9	28.4	34.5	6
7/6/98	Mouth	25.5	26	30.8	38.5	6.5

2. Bathymetric Survey

Ligonee Creek, unlike the previously discussed creeks, is deeper with a central channel. There is no recent record of dredging occurring in the creek. The station located at the mouth of the creek is considerably deeper than the head of the creek with a depth of 2.5 feet. The head of the creek is a dead end cul de sac and extremely shallow, with a depth of 0 to 1.0 feet. No boat traffic or piers exist in the upper 300 feet of the creek.

3. Hydrodynamic Study

The current meter was deployed at the end of East Cove Road. The results of the hydrodynamic study indicate that a nearly normal ebb and current exist within Ligonee Creek, although currents remain fairly weak, peaking at 5.5 cm/second and dropping out to near zero during slack water periods. Based on the field observation in conjunction with the tides and current program, it does appear the typical ebb and flood tide pattern exists within the creek. The average mean high tide in the Ligonee Creek is 3.0 feet above mean low water. The average direction of the current was 266 degrees west south-west. The average velocity was 3.1 cm/sec. The hydrodynamic study ended on a new moon.

4. Land Use

Ligonee Creek is located in Southampton, approximately ½ mile from the Village of Sag Harbor. It is approximately 20-25 acres in surface area. An estimated 55 percent of this 3/4 mile long creek is lined with single family residences, docks, and moorings. A majority of the residences have maintained lawns. The rest of the creek is vegetated with reeds, wetlands, and trees. The creek spills into Sag Harbor Cove to the north, and to the east through The Little Narrows passageway to Morris Cove and Upper Sag Harbor Cove. These embayments also have houses and docks along their borders.

There are several ponds south of Ligonee Creek. They are Round Pond, Long Pond, and Crooked Pond. They are set back from the main roads that run parallel to them. The majority of the land surrounding these ponds is vegetated with deciduous woods and shrubs.

Ligonee Creek has one of the more developed shorelines of the tidal creeks surveyed. The entire shoreline is lined with 34 residential dwellings on the south shore, and four on Long Point. Most of the houses have a small dock and pier complex with a small to medium sized power boat. A very small percentage of the shoreline is bulkheaded.

5. Wildlife

The presence of finfish utilizing Ligonee Creek was not overly evident. The surface activity of feeding fish appeared within the creek. Avian species, mostly evident within the creek, were the mallard duck (*Anas platyrhynchos*), along with the great egret, belted kingfisher, and passerine species (e.g., gray catbird and white-throated sparrow) which utilize the shoreline.

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program indicate that there is little difference between the benthic community found at the head and mouth of the creek. This is, in part, due to the similarity in grain size between the two stations. Grain size at the mouth was 93 percent sand, and 80 percent sand at the head.

In July, there was a total of three benthic organisms observed at the mouth of Ligonee Creek. These three organisms were all Annelids. In December, there was a total of 335 benthic organisms observed at the mouth of Ligonee Creek. Annelids comprised over 40% of these organisms, and Arthropods comprised approximately 30%.

In July, there was a total of 53 benthic organisms observed at the head of Ligonee Creek. Annelids comprised over 75% of these organisms, and Arthropods comprised approximately 15%. In December, there was a total of 211 benthic organisms observed at the head of Ligonee Creek. Annelids comprised over 90% of these organisms.

At the head of the creek in July, Annelids (with a significant abundance of *Haploscopoplos rubustus*) were the dominant organism. In December at the head, the Annelids were again the dominant organism, with an abundance of *Capitella capitata* and *Streblospio benedicti* (to a lesser extent). At the mouth of the creek, Annelids were the dominant organism discovered in both December and July. In December, significant abundances of *Capitella capitata* and *Streblospio benedicti* were again observed. Mollusks were represented by a significant abundance of *Hydrobia minuta*.

The shallow water shellfish survey (April 1998) conducted by the Cornell Cooperative Extension, had a sampling location in close proximity to EEA's benthic station at the mouth of the creek. The results of this survey indicated that a substantial population of hard clam (*Mercenaria mercenaria*) was present, with numbers of 8.67 clams/9.29 m^2 found at this location.

D. Alewife Creek

Alewife Creek is located at the southern end of North Sea Harbor and is connected to Big Fish Pond to the south and is totally located within the Town of Southampton. Alewife Creek is one of the smallest tidal creeks surveyed, approximately six acres in size. The portion of the creek that was studied for this project is long, approximately 2,600 feet (north to south) and narrow (east to west), with an average width of approximately 100 feet. The shoreline of Alewife Creek is heavily developed with both residential housing, private power boats and docks and two large-scale public marinas. Small patches of intertidal and high marsh (mostly saltmarsh cordgrass and groundsel tree) are present along the east and west shores. The sediments associated with Alewife Creek are almost entirely comprised of fine grain silts with no sub-aquatic vegetation present. Salinities varied greatly at Alewife Creek with an overall average of 20.7 ppt. Salinities at the mouth were the highest, averaging 26.5 ppt and lowest at the head, averaging 14.9 ppt. A narrow six-inch layer of freshwater (0.4 ppt) could be found floating above higher salinity levels at low tide.

Alewife Creek was surveyed from August 24, 1998 to August 25, 1998 for the hydrodynamic survey, on December 4, 1997 and July 6, 1998 for macrobenthic invertebrates, June 9, July 30 and September 21, 1998 for water quality analysis, April 24,1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report on the results of each discipline.

1. Water Quality

Water quality at Alewife Creek has been identified as a problem by the NYSDEC, and the creek is closed to shellfishing on a year-round basis. Tidal flushing of the creek is poor, and the creek itself can actually be considered a pollution source. NYSDEC tests have shown high coliform counts, which may be due to freshwater input from Big Fresh Pond. The water quality analysis of Alewife Creek for this study indicated relatively high levels of nitrogen, total and fecal coliforms, and phosphorus.

The physical chemistry field data analysis appears below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
7/14/98	Mouth	120	8.43	7	25.1	26
7/14/98	Head	24	7.97	6.5	18.3	24.2

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
7/14/98	Mouth	25.8	25.3	40.12	40.92	8.1
7/14/98	Head	25.2	25.3	34.6	37.84	6.9

2. Bathymetric Survey

Alewife Creek is deepest at the mouth with a central channel running most of the creek. This channel appears to be maintained to permit the passage of vessels up and down the creek. The Department of Public Works has never dredged this creek. This channel has an average depth of approximately 5 feet. Only the upper 200 feet of the creek are not maintained, very shallow and mostly silted in. The depth of this portion of the creek are approximately 1 to 3 feet deep, with small depressions of up to 8 feet deep.

3. Hydrodynamic Survey

The current meter was deployed in Alewife Creek, across the street from the intersection of North Sea Road and Conscience Point Road. Based upon the results of the hydrodynamic survey, there appears to be a consistent ebb/flood pattern. This is in part based on the long narrow dimensions of the creek. The currents have an average velocity of 2.67 cm/second, with a maximum of 4.27 cm/sec and travel in an east northeast (66 degrees) direction. The hydrodynamic survey ended six days before a first quarter moon.

4. Land Use

Alewife Creek is located in Southampton, approximately 3.5 miles north of the Village of Southampton. It is estimated to be 15 acres in surface area. Alewife Creek is a tributary of North Sea Harbor, a bay on the north shore of the south fork of Long Island that has a connection to Little Peconic Bay. North of the creek, on the northwest side of North Sea Harbor, is Conscience Point National Wildlife Refuge. An estimated 65 percent of the creek's narrow, ½ mile long waterfront is developed, mostly with single-family residences, docks, bulkheads, and two marinas.

Single-family residences dot the eastern shore of North Sea Harbor. Towd Point Road runs along the northeast section of North Sea Harbor. A bridge on this road crosses over another tributary called Davis Creek. Wetland vegetation covers 95 percent of this creek. There is a bulkhead on the harbor side near the end of Towd Point Road. Conscience Point National Wildlife Refuge borders 25 percent of the western side of North Sea Harbor.

Alewife Creek is one of the most highly utilized waterways surveyed during this study. Located on the creek are two marinas with more than one hundred powerboats and assorted recreational vessels. With the exception of a small portion of the head of Alewife Creek, the entire shoreline is bordered by residential homes (24 on the eastern shore, 7 on the western shore), bulkheaded or two large public marinas.

5. Wildlife

The headwaters of Alewife Creek were noted to contain large schools of bait fish, in particular, Atlantic silversides, several killifish species, and juvenile bluefish during September and October. Numbers of bluefish did not appear as high in Alewife Creek as other creeks. Alewife Creek is noted for historically supporting a migratory run of Alewife herring (*Alosa pseudoharengus*), and anadromous species that would spawn in the waters of Big Fish Pond. Spawning typically occurs when the water temperature reaches 55 to 60° F, sometime during April or May of each year.

Avian fauna observed utilizing the waters of Alewife Creek included the kingfisher, egrets, herons, and mallard ducks, in addition to the common tern (*Sterna hirundo*), herring gull (*Larus argentatus*) and double-crested cormorant (*Phalocrocorax auritus*).

Although the amount of shoreline vegetation is extremely limited, species such as saltmarsh cordgrass, common reed, and the groundsel tree are present along with black locust

(*Robinia pseudo-acacia*), black cherry (*Prunus serotina*), and common three-square (*Scirpus pungens*) present at the head of the creek.

6. Macrobenthic Invertebrates

The results of the marcrobenthic sampling program revealed two distinctly different communities. Those present at the head of the creek reflected a community most typically associated with silty fine grain materials. Conditions at the head of the creek also were represented by extremely shallow water at low tide (0.5 feet) and widely fluctuating salinities (0.4. ppt on the surface and 16.0 ppt on the bottom at low tide to 26.4 ppt on the surface and 27.6 ppt on the bottom at high tide).

In July, there was a total of 259 benthic organisms observed at the mouth of Alewife Creek. Annelids comprised over 80% of these grabs. In December, there was a total of 229 benthic organisms observed at the mouth of Alewife Creek. Annelids comprised over 60% of these organisms, and Arthropods comprised approximately 35%.

In July, no benthic organisms were observed at the head of Alewife Creek. In December, there was a total of 89 benthic organisms observed at the head of Alewife Creek. Annelids comprised over 60% of these organisms, and Mollusks comprised over 30%.

The benthic community found at the head of the creek was dominated by polychaete worms. Also observed was the Mollusk, *Nassarius obsoletus*. Conditions at the mouth of the creek were considerably more stable in terms of both depth and salinity. The sediments contained a higher percentage of medium sands along with the silty fines. At the mouth of the creek in July, the Annelids were the dominant organism (with a large amount of *Streblospio benedicti* observed). To a lesser extent, Mollusks were observed (represented by *Nassarius obsoletus*). In December, *Streblospio benedicti* were again abundant, as was *Capitella capitata*, and the Arthropod *Leptocheirus plumolosus*.

E. Meetinghouse Creek

Meetinghouse Creek is the western-most creek surveyed, located in the northwest corner of Flanders Bay within the Town of Riverhead. Meetinghouse Creek is a medium sized creek of approximately 30+ acres, and is the most developed of all the tidal creeks surveyed. The Creek is approximately 3,400 feet long north to south and 375 feet wide east to west on average. The east side of the creek is the most heavily developed, while the west side still contains a significant amount of intertidal and high marsh. The species composition is similar to the other creeks surveyed with salt marsh cordgrass and groundsel tree.

Salinities varied from the head of the creek with an overall salinity of 21.1 ppt. Salinities at the head averaged 18.3 ppt and 23.8 ppt at the mouth. The headwaters of Meetinghouse Creek, a formerly connected tidal wetlands, drain through an active Long Island duck farm. A noticeable freshwater layer was observed floating on top of the saltier water. Water depths throughout the creek are maintained at a uniform depth of 6 to 8 feet. Meetinghouse Creek has been cited by SCDHS as contributing a significant nutrient load to the Peconic Estuary system, and is under further investigation.

Meetinghouse Creek was surveyed from August 17, 1998 to August 18, 1998 for the hydrodynamic study, on December 5, 1997 and July 6, 1998 for macrobenthic invertebrates, June 11, July 30, and September 21, 1998 for water quality analysis, April 21, 1998 for bathymetric data and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

The NYSDEC reports that total coliform counts reached 2501 mpn/100 ml on August 12, 1994. Fecal coliforms reached 460 mpn/100ml on the same day. The water quality analysis of Meetinghouse Creek for this study indicate that these waters are the most nutrient rich of all the mpn/100ml on August 12, eport. Relatively extremely high levels of nitrogen, ammonia, phosphorus, and total chlorophyll-a were discovered. Total and fecal coliform levels were relatively average or slightly higher than the other creeks sampled in this study.

The physical chemistry analysis indicated relatively high levels of dissolved oxygen, at the surface waters and relatively low levels of dissolved oxygen at the bottom waters. The physical chemistry field data analysis appears below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
7/16/98	Head	24	12.5	3.5	15	21.6
7/16/98	Mouth	108	13.9	4.1	20.8	23.8

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
7/16/98	Head	22.8	24	28.5	33.5	6.8
7/16/98	Mouth	25.9	24.9	33.5	36.9	8.6

2. Bathymetric Survey

The depth of Meetinghouse Creek is maintained by regular dredging to provide access to the creek for recreational and commercial vessels. The Department of Public Works last dredged this creek in the Spring of 1998. The average depth for the main channel is 8.5 feet. The very head of the creek in the vicinity of the macrobenthic station is only approximately two feet at mean low water. This station is north of the marinas and boat traffic.

3. Hydrodynamic Survey

The current meter was deployed north of the end of Harbor Road (along Beach Ave.) Based upon the results of EEA's current meter deployment and hydrological studies conducted by the Suffolk County Department of Health Services, it was apparent that Meetinghouse Creek is receiving fresh water influx from a large drainage area. This was confirmed by low salinity readings collected during various surveys. Given the larger size and narrow corridor associated with Meetinghouse Creek, the likelihood of a wind driven system is unlikely. This is evident by the data collected. It appears that, based on the data collected, regular tidal regime consists of two floods and two ebbs over a twenty-four hour period. The average velocity was recorded as 4.34 cm/sec, with a maximum of 12.2 cm/sec. The average direction of the current was determined to be 90.8 degrees, east southeast. The hydrodynamic survey ended three days before a new moon.

4. Land Use

Meetinghouse Creek is located in Riverhead. It's approximate 51- acre surface area makes it one of the largest of the ten creeks. Approximately 1.25 miles long, Meetinghouse Creek's banks are lined with single-family residences and docks, a marina, and a restaurant. Crescent Duck Farm (a.k.a. Corwin's Duck Farm) is on Edgar Avenue northwest of the creek; several commercial facilities, including two auto body shops, are within 1/8-1/4 mile of the creek. Meetinghouse Creek Park is located near the headwaters of the creek. Voss Docking and Storage facility is northeast of the head of the creek. The remainder of Edgar Avenue property between Hubbard Avenue and Main Road consists of houses, approximately 1/2-1 acre each. An elementary school is on the northwest corner of Main Avenue and Edgar Avenue. The LIRR train tracks are perpendicular to the creek. A sheet metal workshop is on Hubbard Avenue across from the tracks.

Meetinghouse Creek Road runs along the east side of the creek. Larry's Lighthouse Marina and Meetinghouse Creek Inn Restaurant are on the creek side of this road. This road is lined with houses to the end, where the creek meets Flanders Bay. Indian Island County Park is southwest of the creek mouth, so there is no development in that area. The creek is approximately 30 percent vegetated with trees, reeds, and wetlands. Overlook Drive runs along the west side of the creek. This is a narrow dirt road, which has no sign and is approximately ½ mile long. It is more secluded than the roads on the creek's east side. There is swamp and wooded land on the west side of this road for the northern half of its length, and houses line the east side along the creek. The southern half has houses on both sides.

Aquebogue Cemetery and woodlands are on Main Road near the creek's headwaters. Crystal Pine Estates is a new community being developed north of the creek. Swamps and vacant wooded land along Main Road engulf the head of the creek.

The shoreline of Meetinghouse Creek is highly developed by two large marinas and numerous residential development with bulkheaded shore and private docks. In excess of 200 power boats were observed utilizing the waters of Meetinghouse Creek. The headwaters and associated drainage basins of Meetinghouse Creek are heavily utilized by agriculture.

5. Wildlife

Although not readily visible, it must be assumed that large schools of bait fish are present in Meetinghouse Creek. This is based on the large schools of juvenile bluefish observed feeding in the creek during September and October. Also, based on anecdotal information, a harvestable number of oyster toadfish (*Opsanus tau*) exist within the creek.

Large numbers of waterfowl were observed utilizing the creek during the various surveys. These would include mallard, black duck, bufflehead (*Bucephala albeola*), mute swan (*Cygnus olor*), as well as gulls and terns, such as the herring gull, greater black-backed (*Larus marinus*), common tern and least tern (*Sterna albifrons*), belted kingfisher and numerous barn swallows (*Hirundo rustica*) and a small nesting colony of purple martins (*Progne subis*). Numerous hybrid duck (e.g., mallard, white domestic), were present in the creek at all observation periods.

Passerine species appeared to be limited to those typically found in urban environments (e.g., house sparrow and starlings).

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed that both the benthic communities, those at the head and mouth, were extremely similar. The sediment grain size analysis indicated that both areas were similar, containing mostly a muddy fine sand substrate.

In July, there was a total of 470 benthic organisms observed at the mouth of Meetinghouse Creek. Annelids comprised over 50% of these grabs, and Arthropods comprised over 40%. In December, there was a total of 1679 benthic organisms observed at the mouth of Meetinghouse Creek. Arthropods comprised almost 80% of these organisms, and Annelids comprised approximately 20%.

In July, there was a total of 518 benthic organisms observed at the head of Meetinghouse

Creek. Arthropods comprised almost 75% of these grabs, and Annelids comprised almost 25%. In December, there was a total of 148 benthic organisms observed at the head of Meetinghouse Creek. Annelids comprised almost 80% of these organisms, and Arthropods comprised over 20%.

At both locations, the most abundant organisms was the amphipod *Ampelisca abdita*. This made the arthropods the dominant group. The polychaete worm were the next most abundant group, with a large abundance of *Mediomastus ambieseta* observed.

F. West Creek

West Creek is located on the south side of the north fork and drains into the Great Peconic Bay, and is solely located within the Town of Southold. West Creek is fairly small at approximately 55 acres and resembles a pond rather than a creek. The inlet connecting West Creek to Great Peconic Bay is long and narrow, approximately 1,200 feet by 150 feet.

The entire shoreline is buffered by an intertidal marsh system. Along the east side, the marsh is mostly common reed which separates the creek and Grathwohl Road by approximately 50 feet. To the west, a saltmarsh cordgrass marsh separates the creek from the North Fork Country Club. The headwaters of the creek flow through an intertidal marsh dominated by the common reed. Salinities vary very little within the creek. The average salinity at the head station was 26.1 ppt and 27.1 ppt at the mouth. No evidence of freshwater flow was observed within the creek. West Creek is extremely shallow with an average depth of 1-1.5 feet at MLW.

West Creek was surveyed from August 10 to August 11, 1998 for the hydrodynamic study, and December 5, 1997 and July 15, 1998 for macrobenthic invertebrates, June 10, July 30, and September 21, 1998 for water quality analysis, April 20, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

The waters of West Creek are open (certified) to shellfish harvesting. The NYSDEC have reported high levels of coliforms in these waters (total coliform levels of 2501 mpn/100 ml on October 22, 1996 and again on December 15, 1992, and fecal coliform levels of 120 on October 22, 1996).The water quality analysis of West Creek for this study indicate relatively low levels of nitrogen, phosphorus, and ammonia. Total and fecal coliform levels of West Creek were relatively higher than the other creeks sampled in this study.

The physical chemistry field data table appears below.

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
4/20/98	Flow meter	30			24.4	24.4
5/15/98	Flow meter	48			24.9	25
7/15/98	Mouth	72	7.6	7.5	25.9	25.9

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
4/20/98	Flow meter	12.4	12.4	38.42	38.41	8
5/15/98	Flow meter	16.6	16.5	32.76	32.7	8.1
7/15/98	Mouth	26.2	26.3	41.5	41.5	8.1

2. Bathymetric Survey

These results indicate that West Creek is a uniformly shallow body of water. The average depth of the main creek is 1.0 to 1.5 feet at mean low tide. The channelized inlet leading to Great Peconic Bay has an average depth of approximately 1 foot. The SCDPW has dredged this creek in 1982, 1994, and 1996.

3. Hydrodynamic Survey

The current meter was deployed on the north side of the New Suffolk Avenue Overpass, about 5-10 feet from the east bank. The results of the hydrodynamic survey conducted by EEA show that a clear ebb/flood current pattern exists at the mouth of West Creek where the meter was deployed. The average velocity of the current was 23.2 cm/sec, with a maximum velocity of 61.5 cm/sec. The average direction was 313 degrees, west northwest. Given the circular shape of the main body of the creek, it is likely that current patterns might not be as clearly defined and are probably wind drive. Currents would be expected to be weak. The hydrodynamic survey concluded four days prior to a 3rd quarter moon.

4. Land Use

West Creek is located in Southold. It has approximately 153 acres of surface area, and is one mile long. Almost 85 percent of the creek's borders are vegetated with wetlands, common reed, and deciduous and evergreen trees. Other than the 2000 feet of golf course and less than 10 houses that are on the creek's edges, the land bordering this creek is undeveloped. Four houses are on a bulkhead with moorings at mouth of creek. North Fork Country Club is located on the west side of the creek. Grathwohl Road runs along the east side of the creek. No houses line the creek on this road, but houses are on the east side of Grathwohl. There are no paved boat launches. New Suffolk Avenue is perpendicular to the creek and has a bridge, approximately 200-300 feet from the creek mouth, that crosses over the creek.

West Creek is buffered on all shores from direct contact, although this buffer is extremely narrow, (less than 50 feet in some locations). Grathwohl Road to the east and New Suffolk Avenue to the south border the creek. Residential houses can be found to the east, southwest, and northwest, and a golf course (North Fork Country Club) to the west. Although a launch ramp was available, it does not appear that boat traffic was significant in the creek. One of the primary uses of the ramp would appear to be access to the waterfowl hunters whose blinds were observed on the creek.

5. Wildlife

The majority of West Creek did not appear to support large numbers of finfish. This could be contributed to the very shallow depths and extreme temperatures encountered within the creek. Temperatures in excess of 31.6°C (89°F) were recorded on July 30, 1998. Numbers of bait fish and juvenile bluefish were observed at the mouth of the creek by the New Suffolk Avenue Bridge.

Large numbers of avian species were noted to utilize the surrounding intertidal marsh and the open waters of the creek. This would include the American and snowy egret, great blue heron, herring gull, greater blackback gull, least and common tern, mallard and black duck and the red-winged blackbird (*Agelaius phoeniceus*). It is extremely likely that West Creek is utilized by more water fowl, shorebird and passerine species than our observations indicated.

The edge of the creek was also utilized by the ribbed mussel and fiddler crab which appeared to be numerous.

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed two distinctly different benthic communities. The benthic community found at the mouth is one associated with a high energy system. This is confirmed by the grain size analysis which reports a dominance of gravels and coarse sand. The benthic community found at the head of the creek is that of a silty fine grain environment, also supported by the grain size analysis which reports 83% silt.

In July, there was a total of 178 benthic organisms observed at the mouth of West Creek. Mollusks comprised over 60% of these grabs, and Annelids comprised over 30%. In December, there was a total of 296 benthic organisms observed at the mouth of West Creek. Annelids comprised almost 50% of these organisms, and Mollusks comprised nearly 30%.

In July, there was a total of 136 benthic organisms observed at the head of West Creek. Mollusks comprised almost 75% of these grabs, and Annelids comprised approximately 25%. In December, there was a total of 67 benthic organisms observed at the head of West Creek. Mollusks comprised almost 80% of these organisms, and Annelids comprised almost 20%.

The samples collected at the mouth in July were dominated with Mollusks (*Nassarius obsoletus* was the most dominant), and in December Annelids were dominate (oligochaetes, *Nepthy incisa* and *Nucula proxima* were each abundant).

The samples collected at the head in both December and July were dominated by the Mollusks (*Nassarius obsoletus* was again the most dominant).

G. Goose Creek

Goose Creek is located along the south side of the North Fork and drains into Southold Bay. Goose Creek is entirely located in the Town of Southold and is one of the largest creeks surveyed, approximately 120 acres in size. Goose Creek is fairly long, approximately 4,350 feet east to west and approximately 1,250 feet wide north to south on average. Like many of the other creeks, it has a very narrow inlet connecting the creek to Southold Bay.

In general, Goose Creek is highly variable in depth, sediment type, SAV and shoreline development. Goose Creek is fairly shallow with an average depth of 1 to 4 feet, but contains deep holes, channels, sand bars, and small islands. The sediment ranges from very silty fine grain at the head to coarse gravel at the mouth. Wigeon grass is present at the head, as well as an intertidal marsh complex. Salinities show very little variation between the head and mouth, averaging 27.8 ppt at the head and 28.1 ppt at the mouth. The Town of Southold has adopted Goose Creek and enlisted voluntary assistance with water quality monitoring of this creek. This was done as a pilot project within the Town.

Goose Creek was surveyed from April 13, 1998 to April 20, 1998 for the hydrodynamic study, on December 5, 1997, and July 15, 1998 for macrobenthic invertebrates, June 10, July 30th and September 21, 1998 for water quality analysis, April 20, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

Preliminary screening of the water quality analysis of Goose Creek did not indicate significantly elevated nutrient levels. The physical chemistry field data analysis appears in the table below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
4/13/98	Flow meter		10.04	9.82	26.4	26.5
4/20/98		36			25.7	25.7
7/15/98	Head	24	6.6	6.6	26.7	26.8
7/15/98	Mouth	72	6.9	6.9	27.1	27.2

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
4/13/98	Flow meter	10.1	10	29.55	29.64	8.2
4/20/98		11.3	11.4	40.3	40.33	8
7/15/98	Head	25.8	25.9	42.2	42.5	8
7/15/98	Mouth	24.1	23.9	41.4	41.3	8

2. Bathymetric Survey

The depths associated with Goose Creek are extremely variable, but average out as shallow, with an average water depth of 1 to 4 feet at mean low water. The average tidal fluctuation in Goose Creek is approximately 2.3 feet as determined from the Window '95 Tides and Current Program. An extensive sand bar/shoal occupies the east/central portion of the creek, along with two small islands. The deepest portion of the creek can be found at the mouth leading into Southold Bay. Goose Creek was last dredged in 1995.

3. Hydrodynamic Survey

The current meter was deployed on the south side of the Bayview Rd. Overpass, about 5-10 feet from the western bank. The results of the hydrodynamic survey conducted by EEA show that a clear ebb/flood current pattern exists at the mouth of Goose Creek, where the meter was deployed. The average velocity of the current was 14.1 cm/sec, with a maximum of 42.3 cm/sec, the average direction was 76.4 degrees, east northeast. Given the circular shape of the main body of the creek, it is likely that current patterns might not be as clearly defined, and are probably wind driven. Currents would be expected to be weak. There was a 3rd Quarter moon (on April 19) during the hydrodynamic study.

4. Land Use

Goose Creek, located in Southold, is approximately 163 acres in surface area and 1.25 miles long. An estimated 65 percent of the creek's waterfront is developed with houses, docks, bulkheads and moorings; some powerboats are moored. The creek is approximately 35 percent vegetated with wetlands and deciduous trees. Goose Bay Estates is on Cedar Road, a dead end road with the creek at the end. There is a private beach for Goose Bay Estates residents only. Southold Yacht Club is at the mouth of the creek. A bridge on the east side of the creek, on North Bayview Road, runs over the creek close to its mouth. The creek opens into Southold Bay. North of the creek on Pine Neck Road, the land is wooded with trees and shrubs. The remainder of this road is lined with residences. Waterview Road, located on the south side of the creek, is lined with houses; the ones on the creek have docks. Williams Drive and Glenn Road, on the northwest side of the creek, are dead end at the creek. A cemetery is on Main Road northwest of the creek.

The shoreline surrounding Goose Creek consists primarily of single unit residential developments. Most have a small finger pier on pilings; a few have a hardened shoreline consisting of bulkheading and docking facilities. Nearly all the homes have a small power boat. A few jet skies were also present and some boats were moored in the bay. A small intertidal marsh surrounds the head of the bay station.

5. Wildlife

The presence of large schools of bait fish, mostly Atlantic silversides and Atlantic menhaden, were evident during most of the site surveys. As would be expected, given the presence of bait fish, large schools of juvenile bluefish were also present during September and October. Given the larger size and somewhat deeper water, it is safe to assume many different finfish species (e.g., striped bass [*Morone saxatilis*], white perch [*M. americana*], summer flounder [*Paralichthys dentatus*], winter flounder [*Pleuronectes americanus*], etc.) are likely to utilize the creek.

Avian species observed on or around the creek included the various species of egrets, herons, ducks, and gulls mentioned at the other creeks. In addition, Canada goose (*Branta canadensis*), greater yellowlegs (*Tringa melanoleuca*), osprey (*Pandion haliaetus*), common loon (*Gavia immer*), and common grackle (*Quiscalus quiscula*) were also observed. Raccoons (*Procyon lotor*) were also determined to utilize the creek.

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed two distinctly different benthic communities. The benthic community found at the mouth is one associated with a high energy system. This is confirmed by the grain size analysis which reports a dominance of gravels and coarse sand (96% sand). The benthic community found at the head of the creek is that of a silty fine grain environment, also supported by the grain size analysis which reports 75% silt.

In July, there was a total of 202 benthic organisms observed at the mouth of Goose Creek. Annelids comprised almost 90% of these grabs. In December, there was a total of 43 benthic organisms observed at the mouth of Goose Creek. Aschelminthes comprised over 65% of these organisms, and Arthropods comprised over 15%.

In July, there was a total of 371 benthic organisms observed at the head of Goose Creek. Arthropods comprised almost 40% of these grabs, and Mollusca comprised approximately 30%. In December, there was a total of 32 benthic organisms observed at the head of Goose Creek. Annelids and Aschelminthes each comprised approximately 50%.

At the head of Goose Creek in July, the benthic community was very diverse; *Tellina agilis* and *Ampelisca abdita* were two dominant organisms. In December at the head of the creek, there was a diverse Annelid community and also an abundance of *Aschelminthes*. At the mouth of the creek in July, the Annelids, particularly *Capitella capitata* were the dominant organism. The mouth in December was dominated by *Aschelminthes*.

H. Bass Creek

Bass Creek is located on the southeast peninsula of Shelter Island within the Mashomack Preserve (The Nature Conservancy). The creek falls within the Town of Shelter Island. Bass Creek is relatively small (approximately 14 acres) and is connected to Shelter Island Sound by a narrow (approximately 25 feet) inlet which is approximately 200 feet long. Swift currents are encountered in the inlet. Bass Creek is relatively more pond-like and irregularly shaped, and is one of the shallowest areas surveyed in this study, with an average depth of 0.2 to 1.0 feet at MLW. The upper section of Bass Creek has a nearly complete coverage of widgeon grass on the bottom, while the lower section and inlet are near void of SAV. Salinities were nearly identical at the head and mouth. Average salinity at the mouth was 27.5 ppt and 27.6 ppt at the head.

Bass Creek was surrounded by an intertidal marsh dominated by saltmarsh cordgrass and high marsh which was represented by groundsel tree, marsh elder (*Iva frutescens*), glasswort (*Salicornia* sp.) and salt grass (*Distichlis spicata*), blending into an uplands of northern bayberry (*Myrica pensylvanica*) and switchgrass ((*Panicum virgatum*). The salt marsh is surrounded by a deciduous forest dominated by black oak (*Quercus velutina*).

Bass Creek was surveyed from July 27, 1998 to July 28, 1998 for the hydrological survey, on December 15, 1997 and July 12, 1998 for macrobenthic invertebrates, June 10, August 3, and September 22, 1998 for water quality analysis, July 28, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

The NYSDEC found the water quality acceptable at Bass Creek. However, since Bass Creek is known to harbor large numbers of birds, the water quality must be carefully monitored to detect impacts the waterfowl may have on the water quality. Preliminary screening of the water quality analysis of Bass Creek for this study did not indicate significantly elevated nutrient levels. The headwaters of Bass Creek indicate high levels of total suspended solids (480 mg/l) for one sample taken in July of 1998. This may be a laboratory anomaly, as the head waters at Bass Creek appeared relatively clear, and other TSS levels were relatively average for this same sampling station during other sampling periods.

Dissolved oxygen levels were observed to be lower relative to the other creeks studied. The physical chemistry field data table appears below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
7/28/98	Flow meter		4.6	4.77	27.7	27.8

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
7/28/98	Flow meter	23.6	23.6	43.01	43.1	7.8

2. Bathymetric Survey

In general, Bass Creek is an extremely shallow body of water with an average depth of 0.2 to 1.0 feet at mean low water. The two most notable exceptions are a deep hole centrally located within the narrow corridor that connects the two main bodies of the creek and the channel that has been cut through the inlet and enters the Shelter Island Sound. The water in these two areas average approximately 2.2 feet and 1-foot deep at MLW, respectively.

The channel by the inlet has been obviously cut by the swift currents that pass through the inlet. The other deep hole is unexplained.

3. Hydrodynamic Survey

The current meter was deployed at the mouth of the creek inlet, south of the wood bridge. The results of the hydrodynamic survey conducted by EEA show that a clear ebb/flood current pattern exists at the mouth of Bass Creek, where the meter was deployed. The average velocity of Bass Creek was 22.2 cm/sec, with a maximum of 51.9 cm/sec. The average direction was 123.8 degrees, east south-east. Given the circular and somewhat irregular shape of the main body of the creek, it is likely that current patterns might not be as clearly defined, and are probably wind driven. Currents would be expected to be weak. The Department of Public Works (DPW) has never dredged this creek. The hydrodynamic survey concluded three days prior to a 1st quarter moon.

4. Land Use

Bass Creek is located on Shelter Island. This creek is approximately 3/5 mile long, with a surface area estimated at 61 acres. Bass Creek is located in Mashomack Preserve, owned by the Nature Conservancy; therefore, no development exists on the creeks borders. Prior to preservation, the property was the estate of a private residence and was excluded from public usage. With the exception of whatever may come in on the flood tide from Shelter Island Sound, the waters of Bass Creek appear to be as pristine as possible.

5. Wildlife

Bass Creek, like all the other creeks surveyed, contained a population of bait fish, mostly Atlantic silversides, which attract large schools of juvenile bluefish in September and October. At Bass Creek, the presence of bait fish and feeding activity associated with the bluefish appeared to be restricted to the inlet area, at least during our surveys. Large adult blue crabs (*Callinectes sapidus*) were observed in the lower portion of the creek.

Avian species observed in and around Bass Creek were a mixture of passerine and aquatic species. Common species included the greater black-backed gull, herring gull, greater yellowlegs, song sparrow (*Melospiza melodia*), rufus-sided towhee (*Pipilo erythrophthalmus*), and barn swallow. Additional wildlife observed included the raccoon, white-tailed deer (*Odocoileus virginianus*), and fowler's toad (*Bufo woodhousii fowleri*).

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed two distinctly different benthic communities. The benthic community found at the mouth is one associated with a high energy system. This is confirmed by the grain size analysis which reports a dominance of gravels and coarse sand, while the benthic community found at the head of the creek is that of a silty fine grain environment, also supported by the grain size analysis, which reports 77% silt.

In July, there was a total of 305 benthic organisms observed at the mouth of Bass Creek. Annelids comprised almost 50% of these organisms, and Mollusks comprised approximately 40%. The dominant Mollusk at the mouth of Bass Creek in July was *Hydrobia minuta*, and the dominant Annelids were *Oligochaetes* and *Haploscopoplos rubustus*. In December, there was a total of 163 benthic organisms observed at the mouth of Bass Creek. Arthropods comprised over 50% of these organisms, and Aschelminthes comprised approximately 25%. The Arthropod *Caprellidae* was the most dominant at the mouth in December.

In July, there was a total of 846 benthic organisms observed at the head of Bass Creek. Annelids comprised almost 65% of these organisms, and Aschelminthes comprised approximately 35%. The Annelid *Capitella capitata* was discovered in a large abundance (over 500 organisms) at the head of the creek in July, and almost 300 Aschelminthes were discovered here also. In December, there was a total of 11 benthic organisms observed at the head of Bass Creek. Arthropods comprised over 35% of these organisms, Aschelminthes and Annelids each comprised approximately 25%.

I. West Neck Creek

West Neck Creek is located in the southwest quadrant of Shelter Island. West Neck Creek is fairly large, approximately 100 acres in size. The creek is nearly 7,000 feet north to south and has an average width of 625 feet east to west and is located completely within the Town of Shelter Island. The creek is fed by West Neck Bay to the north and drains into West Neck Harbor to the south. It is heavily utilized by recreational boaters. The sediments associated with West Neck Creek consisted of muddy fine sands throughout the system. No sub-aquatic vegetation was observed during the study period. Salinities averaged only slightly higher at the mouth of the creek than at the head. The salinity at the mouth averaged 27.8 ppt and 26.9 ppt at the head. Bottom salinities were only slightly higher than the surface.

The shoreline of West Neck Creek consists predominantly of residential dwellings. In many cases, development extends to the water's edge. Most properties have small docks and piers for boats; shores are bulkheaded or stabilized in some fashion to prevent erosion.

Narrow strips of intertidal marsh and high marsh can also be found between areas of development. Steep sloping shores prevent the spread of these marshes. The undeveloped upland portions of the shore are predominantly a mixed deciduous forest.

West Neck Creek was surveyed from to August 3, 1998 to August 4, 1998 for the hydrodynamic survey, on December 15, 1997 and July 12, 1998 for macrobenthic invertebrates, June 11, August 3, and September 22, 1998 for water quality analysis, April 22, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

The water quality of West Neck Creek is influenced by nutrient flow from the groundwater. This nutrient flow is most likely due to the presence of a capped landfill and an area that was once a poultry farm in close proximity to the creek. Though neither area is still being utilized as a landfill or poultry farm, the nutrient flow in the groundwater could be a concern for the next 20 to 30 years. The water quality data analysis indicate slightly higher nutrient levels than the other creeks studied, and both the waters at the head and mouth of the creek indicated extremely high levels of total coliform, relative to the other creeks studied. In June through late July, a short, but relatively intensive brown tide (Aureococcus anophagefferens) bloom occuredin West Neck Bay, which is fed by West Neck Creek. This bloom peaked at approximately 600,000 cells/per milliliter. The rest of the tidal creeks studied were relatively free from brown tide blooms during this study, according to New York Sea Grant's "Brown Tide Research Initiative".

The physical chemistry field data table appears below:

Date	Location	Depth (inches)	Secchi (feet)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
8/3/98	Flow meter	30		7.82	6.81	27.9	27.8
8/4/98	Flow meter	30		6.15	7.43	27.7	27.8
8/10/98	Flow meter	30		5.63	5.47	28	27.9

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
8/3/98	Flow meter	27.3	26.4	45.36	44.5	8.2
8/4/98	Flow meter	27.1	26.4	44.82	44.39	8
8/10/98	Flow meter	26	26	44.19	44.18	8

2. Bathymetric Survey

West Neck Creek is uniformly deep throughout with an average depth of approximately 8 feet at MLW. The depth of West Neck Creek is maintained through periodic dredging to permit boat access. The DPW last dredged this creek in the fall of 1998.

3. Hydrodynamic Survey

The current meter was deployed at the end of Montclair Ave, at the mouth of West Neck Creek.The results of the hydrodynamic survey conducted by EEA show that a clear ebb/flood current pattern exists at the mouth of West Creek where the meter was deployed. The average velocity of the current was 3.67 cm/sec, with a maximum of 7.4 cm/sec. The average direction was 305.5 degrees, west north-west. Given the circular shape of the main body of the creek, it is likely that current patterns might not be as clearly defined, an`d are probably wind driven. Currents would expect to be weak. The hydrodynamic study concluded four days prior to a full moon.

4. Land Use

West Neck Creek, approximately 183 acres in surface area, is located on Shelter Island. This is one of the largest creeks, at an estimated 1 1/8 miles in length. The waterfront is dotted with single-family residences with docks-some have powerboats. Undeveloped land, making-up approximately 40 percent of the creek's borders, consists of wetlands, open space, and vegetation.

Island Boat Yard and Marina are east of the creek on Menantic Road. A paved boat launch is at end of Simpson Road. The end of Montclair Road has three docks and 25-30 slips. This is a low density residential area. The end of Daniel Road meets the creek, where there are approximately 10 slips, a dock across the creek has a power boat, three more are anchored in the water, along with one sailboat and one rowboat. Silver Beach Residential Community is on Bayshore Drive. A boat launch is at the end of this road.

The primary use of the land surrounding West Neck Creek is residential housing, followed closely by recreational boating. Not all of the houses along the creek are connected to the island sewer system. Many still have septic systems that have potential to leach into the creek. The creek also received stormwater runoff from the many roads that abut the creek.

5. Wildlife

The greater average depth and size did not permit the observation of bait fish or predatory species as in the smaller and shallower creeks. It can be safety assumed that the previously mentioned species (i.e., Atlantic silversides, killifish, bluefish, Atlantic menhaden, and winter flounder are likely to utilize the creek. Additionally, fish species likely to be found in West Neck Creek would include the striped bass, weakfish (*Cynoscion regalis*), scup (*Stenotomus chrysops*), bay anchovies (*Anchoa mitchilli*), and several herring (*Alosa* spp.) species.

Similarly, the avian species were represented by most of the water fowl and wading bird species (i.e., duck, heron and egrets) previously discussed. It is extremely likely that other waterfowl species, such as lesser and greater scup (*Aythya affinis* and *A. marila*), common goldeneye (*Bucephala clangula*), red-breasted merganser (*Mergus servator*), and hooded merganser (*Lophodytes cucullatus*) are likely to utilize the creek. It should also be noted that two large birds of prey were seen on the creek, the osprey (*Pandion haliaetus*) and the red-tailed hawk (*Buteo jamaicensis*).

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed that both the benthic communities, those at the head and mouth were extremely similar. The sediment grain size analysis indicated that both areas were similar, containing mostly a muddy fine sand substrate.

In July, there was a total of 627 benthic organisms observed at the mouth of West Neck Creek. Annelids comprised over 40% of these organisms, and Aschelminthes comprised over 30%. Of the Annelids, oligochaetas were the most abundant. In December, there was a total of 2382 benthic organisms observed at the mouth of West Neck Creek. Arthropods comprised over 75% of these organisms, and Annelids comprised approximately 25%. The Annelids were dominated by *Capitella capitata*, while the Arthropods were dominated by a very large abundance of *Ampelisca abdita* (over 1700 organisms). The Annelids were dominated by class *oligochaetes*, with almost 250 organisms observed.

In July, there was a total of 1080 benthic organisms observed at the head of West Neck Creek. Arthropods comprised almost 80% of these organisms, and Annelids comprised approximately 15%. In December, there was a total of 1341 benthic organisms observed at the head of West Neck Creek. Arthropods comprised over 65% of these organisms, Annelids comprised approximately 25%. In December at the head of the creek, the Arthropods were represented by over 600 *Ampelisca abdita*. There was also a significant abundance of *Paraphoxus epistomus* and *Corophium* sp.

J. Little Bay

Little Bay is located at the extreme eastern end of the North Fork at Orient Point, within the Town of Southold, bordered to the south by Orient Beach State Park and open undeveloped land to the north, and directly connected to Long Beach Bay which empties into Orient Harbor and ultimately into Gardiners Bay. Little Bay is approximately 5,625 feet long (east to west) and averages 625 feet wide (north to south) for a total of approximately 80 acres in size.

The shoreline of Little Bay is bordered by an expansive intertidal marsh to the north and a barrier beach-size back dune community to the south. Some development exists along the small man-made channels in the northeast corner.

The sediment associated with Little Bay varies greatly between the mouth and the head. Grain size at the mouth is medium sand with gravel and pebbles mixed in, while the head consists mostly of fine silty/grain material.

Salinities showed little difference between the mouth and the head. Average salinity at the mouth was 28.5 ppt and 27.6 ppt at the head. No evidence of freshwater influx was evident.

Little Bay was surveyed from March 27, 1998 to April 2, 1998 for the hydrodynamic study, on December 15, 1997 and July 12, 1998 for macrobenthic invertebrates, June 10, August 3, and September 22, 1998 for water quality analysis, April 21, 1998 for bathymetry, and in July of 1998 for physical chemistry analysis. The following sections report the results of each discipline.

1. Water Quality

Preliminary screening of the water quality of Little Bay creek did not indicate significantly elevated nutrient levels, and average to low chlorophyll-a, TOC, and coliform levels. The physical chemistry field data analysis table appears below:

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
4/3/98	Flow meter	22	10.4	10.1	26.2	26.5

Date	Location	Depth (inches)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (ppm)	Bottom Salinity (ppm)
4/13/98	Flow meter	24	9.27	9.02	25.9	26
7/12/98	Head	30	6	4.2	26.7	27
7/12/98	Mouth	60	7.9	7.1	27.2	27.2

Date	Location	Surface Temperature (C)	Bottom Temperature (C)	Surface Conductivity (ms)	Bottom Conductivity (ms)	pH
4/3/98	Flow meter	12.7	12.3	31.31	31.18	8
4/13/98	Flow meter	9.7	9.6	40.8	40.8	8.1
7/12/98	Head	27.5	27.2	43.8	43.3	7.5
7/12/98	Mouth	28.4	26.2	45.1	43.8	7.9

2. Bathymetric Survey

The results of the bathymetric survey are presented on Figure 3-10. Little Bay is uniformly deep throughout the system with an average depth of approximately 6 feet at MLW. The DPW has never dredged this tributary.

3. Hydrodynamic Survey

The current meter was deployed at the mouth of Little Bay, at the eastern-most part of Orient Beach.The results of the hydrodynamic survey conducted by EEA show that a clear ebb/flood current pattern exists at the mouth of Little Bay Tributary where the meter was deployed. The average velocity of the current was 19.77 cm/sec, with a maximum of 50.19 cm/sec. The average direction was 179 degrees, south south-east. The hydrodynamic survey began on a new moon and concluded 1 day prior to a 1st quarter moon.

4. Land Use

Little Bay Tributary, located in Orient Point, is approximately 1.25 miles long and 184 acres in surface area. A restaurant, marina and the Orient Point ferry are the commercial developments in the area. Almost 95 percent of the land bordering the creek is undeveloped.

Wetlands and woody vegetation engulf the edges. Little Bay is nestled between open space, salt marshes, and Orient Beach State Park. The park office, a playground, and rest facility with a hard top parking lot, are the only developments in the Park. No developments are visible along creek. A few farms are northwest of the creek. Orient By The Sea is a low density residential community north of the creek on Route 25. A cemetery is located on Rt 25 approximately 1/8 mile from the park's entrance. Cedar Birch Lane, an unpaved road approximately ½ mile long, borders the bay with approximately 10 houses. Narrow River Road, an estimated 1.75 miles from Little Bay, runs parallel to Hallocks Bay; this and Little Bay flow into Long Beach Bay. Narrow River Road has a town ramp with 27 slips and a marina with approximately 50 berths/slips. A few small residential dwellings are located in the northeast quadrant of the creek along with what appeared to be man-made channels. This was based upon the dredge materials along the banks. These homes support a limited number of power boats along with small piers and dock systems.

5. Wildlife

No direct evidence of bait fish or predatory fish was noted during the field surveys. This can possibly be attributed to the time of day, stage of tide or larger size of the creek. It is anticipated that most of the species previously discussed (i.e., Atlantic silversides, killifish, sand lance, bluefish, striped bass, weakfish, summer and winter flounder) along with many other estuarine species, are likely to be found in the creek.

Avian species were abundant during each survey period. All of the previously discussed waterfowl and wading bird species were present. Additionally, several pairs of osprey were observed nesting on platforms along the creek. Several pair of piping plovers (*Charadrius melodus*) were observed on the adjacent beach along Gardiners Bay. Additional passerine species, in particular various wood warbler (family *Parulidae*) were observed in the autumn olives (*Elaeagnus umbellata*) along the north shore. This occurred during the fall migration in September.

During the September 22, 1998 water quality survey, numerous northern diamondback terrapin (*Malaclemys terrapin*) were observed in Little Bay. A single red fox (*Vulpes fulva*) was sighted on the beach during the spring 1998 hydrological survey.

6. Macrobenthic Invertebrates

The results of the macrobenthic sampling program revealed that both the benthic communities, those at the head and mouth were extremely similar. The sediment grain size analysis indicated that both areas were similar, containing mostly a muddy fine sand substrate.

In July, there was a total of 402 benthic organisms observed at the mouth of Little Bay tributary. Annelids comprised over 65% of these organisms, and Aschelminthes comprised over 20%. The Annelids were dominated by *Syllis* sp., *Scolecolepides viridis*, and *Streblospio benedicti* in relatively equal abundances (approximately 45 organisms were collected from each of these species). In December, there was a total of 210 benthic organisms observed at the mouth of Little Bay tributary. Annelids comprised almost 90% of these organisms. These Annelids were dominated by class *Oligochaetes*, with over 120 organisms collected.

In July, there was a total of 2 benthic organisms observed at the head of Little Bay tributary. There was one Aschelminthe and one Annelid observed. In December, there was a total of 24 benthic organisms observed at the head of Little Bay tributary. Arthropods comprised almost 65% of these organisms, Annelids comprised approximately 25%.

VII. ANALYSIS AND RECOMMENDATIONS

A. Fresh Pond

The results of the various field programs clearly indicate that, as expected, Fresh Pond functions as a typical coastal estuarine tidal pond. The pond itself is surrounded by a good buffer of upland forest and fringed by a well developed intertidal and high marsh ecosystem. Abundances and types of macrobenthic organisms, although somewhat lower in density than originally anticipated, do not indicate a significant problem. The mouth of Fresh Pond is clearly a high energy environment, swept on a regular basis by swift currents during the tidal exchange. The soft fine grain sediment found at the head of the pond would be expected to support a sizable benthic community. The fact that it does not, may not reflect any anthropogenic effect; benthos may be controlled more by the dense growth of widgeon grass which may sufficiently shade the bottom, limiting faunal development. A similar situation was also observed occurring in the Bass Creek system found in the Mashomack Preserve on Shelter Island. Both creeks/ponds are extremely similar in size and shape; both isolated from development; and both dense with widgeon grass and low benthic diversity and abundances at the head. It is believed that the dense growths of widgeon grass is not a result of nutrient loading and is a natural phenomenon that is controlling the benthic community. Therefore, it is recommended by EEA that Fresh Pond should not require additional survey work, unless the surrounding environment is altered significantly.

B. Northwest Creek

The benthic communities associated with the head and mouth of Northwest Creek are distinctly different. This is directly attributed to sediment types, silts at the head, and sand at the mouth. The benthic community present at the head is extremely well developed, and comprised of numerous species, some of which are large and considered to be long lived, e.g. sandworms (*Neanthes succinea*). The sand worms are replaced by the *Orbinnid* worm (*Haploscoloplos rubustus*) at the head of the creek. The species difference is more a function of grain size and possible salinity than anything else.

Northwest Creek does have potential to be impacted given the presence of residential dwellings, high coliform levels reported by NYSDEC, bulkheading, moored vessels, and the adjacent Barcelona Neck Golf course. The surrounding salt marsh and forest habitat may provide an adequate buffer against runoff from all directions. The total lack of eelgrass in Northwest Creek is still unexplained, given the historical evidence that the creek was nearly completely covered by eelgrass at one time.

The change in the position of the inlet may have a strong bearing on the flushing and circulation patterns in the creek. The bathymetric survey clearly shows a very shallow system. It is unclear if this sedimentation is the result of shifted circulation patterns or natural, or if this sedimentation has covered existing eelgrass beds preventing them from redeveloping.

In any event, the present benthic community is clearly well developed and strongly suggests a system which is not impacted. Further surrounding land use changes, if any, may require a re-evaluation of the benthos.

C. Ligonee Creek

Based on the study findings, Ligonee Creek is considered to be moderately disturbed (the creek has been altered from its original shape). Numerous residential dwellings are present along the creek's banks. In many cases, the native vegetation has been cleared, and a small dock and boat are in its place. Although some intertidal salt marsh does exit containing salt marsh cordgrass, the dominant vegetation is the common reed. The banks of the creek have become straight and the corners sharp, apparently the result of past dredging and widening. The head of the creek is a dead-end. The area in which the head water tributary would have originated from is a developed lot with a residential home. Additionally, Ligonee Creek is part of the Sag Harbor watershed. This area has been identified by the Suffolk County Department of Health Services as having above average nitrogen levels at their sampling station located nearby. A significant potential contributor of this nitrogen load has been the Sag Harbor Sewage Treatment Plant

At both the head and mouth of the creek, the benthic community is dominated by the *polychaete* worms *Streblospio benedicti, Polydora ligni, Haploscoloplus rubustus*, and the *amphipod Ampelisca abdita*. The worms identified were dominant during both sampling events, while the *amphipod* represented only 1.5 percent of the catch during December and escalated to 30 percent in the winter.

The *polychaetes* that dominated the Ligonee Creek samples are predominantly sedentary species that thrive in nutrient-rich organic sediments. Additionally, they can be considered pioneer species, exploiting under-utilized habitat and reproducing in great numbers. All of the dominant species present are the same as those that dominate highly eutrophic systems, such as

Jamaica Bay, New York, and the Hudson and East Rivers of New York Harbor. Ligonee Creek appears to be a stagnating system with a poor flushing rate and acting as a nutrient sink.

The high densities of the species discussed indicate that the creek is receiving high nutrient levels. A positive aspect of this is that organisms present have been documented as providing a substantial food source for many finfish species, in particular the young-of-year winter flounder.

D. Alewife Creek

As with the previously discussed Ligonee Cree, Alewife Creek represents a tidal system with a well developed shoreline. At least 50 percent of the western shoreline is occupied by a commercial marina providing slips for numerous power and sail boats. The remaining shoreline, with the exception of the head which is extremely shallow and not navigable, is occupied by residential homes, bulkhead and private docks. Some intertidal vegetation was present, but was almost completely dominated by the common reed, clearly a sign of nutrient loading. Both the head and mouth are predominantly sand, with a slight increase of silts at the head. The benthic community structure is similar at both locations.

Polychaetes dominate the benthic community in both abundance and diversity. Species present are similar to those in Ligonee Creek (*Streblospio benedicti, Polydora ligne, Haploscoloplus robustus, Capitella capitata,* and *Tharyx occutus).* All of these are considered sedentary *polychaetes.* The *amphipod Ampelisca abdita* is present, but in low numbers. The *amphipod Leptocheirus plumolosus* is present in extremely high densities, approximately 20,803/m^2 or 83 percent of all the organisms collected. The change between *Ampelisca* and *Leptocheirus* is most likely a function of grain size preference. Clearly, the presence of large numbers of *Leptocheirus* indicate a species exploiting available habitat to its fullest. An adequate food source and nutrient rich sediments must be present to support such high densities.

The benthic community structure of Alewife Creek is similar to Ligonee Creek. In both cases, the species present are short-lived, highly prolific species, capable of colonizing available habitat. All of the species present have been identified occurring in degraded habitat found in New York Harbor. The dredging of the mouth of Alewife Creek, adjacent to the marina, most likely disrupts the establishment of a well developed benthic community at that location, but sufficient nutrient must also be present to support the encountered densities of organisms.

Alewife Creek is at least impacted directly and indirectly by the well developed shoreline facilities and is receiving adequate nutrients to support the benthic community.

E. Meetinghouse Creek

By all accounts, Meetinghouse Creek receives the highest loading of nitrogen of all the tidal creeks surveyed, as reported by the Suffolk County Department of Health Services. This is not unexpected, given the upstream location of the Corwin Duck Farm. The creek additionally supports the largest commercial marina associated with the tidal creek survey. The remainder of the creek on the eastern shore is mostly residential dwellings, bulkheaded, with dock and private vessels. The western shoreline has some development, but is mostly intertidal marsh dominated by saltmarsh cordgrass. No rooted SAV was observed. However, there was an abundance of the macroalgae *Ulva lactuca* (sea lettuce)

The benthic community found in the creek is one that is anticipated to occur in a nutrient rich, muddy-sand environment. The benthic community associated with Meetinghouse Creek is dominated by the Amphipod *Ampelisca abdita* (73 and 57 percent of all organisms during the winter and summer sampling season, respectively). The remainder of the dominant organisms consisted of sedentary *polychaetes* (i.e., *Streblospio benedicti, Mediomastus ambiseta*, and *Polydora ligni*). As previously discussed, these organisms are all typically associated with nutrient rich, organic sediment, usually classified as impacted. This is not unexpected, given the previous history of the creek and the known nutrient loadings of the creek.

The large numbers of Amphipods (up to 36,000/m$^{2)}$ will provide an excellent food source for juvenile finfish species, in particular, young-of-year winter flounder which have been known to selectively feed on *Ampelisca abdita*. Therefore, the benthic sampling program only confirms the water quality data identifying the creek as nutrient rich and correlates with the existing biota.

F. West Creek

West Creek had been chosen for study based on the variety of potential impacted sources located nearby (a large golf course, to the west and northwest, a farm and orchard to the north [upgradient], and a road with residential development to the east). All have potential to increase the nutrient load of the creek. With the exception of the stormwater runoff from the roadway, the creek is buffered by saltmarsh on three sides. Most of the saltmarsh is typical intertidal marsh, dominated by saltmarsh cordgrass. The wetland to the north was dominated by common reed.

A review of the existing water quality data from the Suffolk County Department of Health services and the NYSDEC Shellfish Bureau did not indicate nutrient loading. The creek is certified as open to shellfishing by NYSDEC. Although the benthic communities are extremely different at the head and mouth, it would appear that this is purely a function of grain size (the mouth is sandy and silty).

The benthic organisms present represent a stable, well developed community. The organisms are best represented by the mud dog whelk (*Nassarius obsoletus*), the common slipper shell (*Crepidula fornicata*), and the dwarf tellina (*Tellina agilis*). All are *mollusca* species typically not found in impacted environments. The remaining abundant organisms include the worms: *Nephtys incisa, Tharxy accitus,* and *Scolecolepides viridis*. The dominant arthropod was the amphipod *Leptocherirus plumolosus*. Based on this benthic community, there does not appear to be any significant ecological stresses on the creek. It would also appear that the wetland buffer is sufficiently large enough to remove the anticipated nutrients coming from the golf course and farmland, and that the stormwater runoff is relatively free from nutrients.

G. Goose Creek

Goose Creek represents one of the largest creeks surveyed during the tidal creek program. The dominant land use surrounding the creek was residential homes, many of which had finger piers, docks and boats, and a few bulkheads. The creek was extremely shallow, almost non-navigable at low tide, with the exception of a narrow channel along the south side. Some intertidal marsh is present and contains patches dominated by saltmarsh cordgrass and patches dominated by common reed. The result of EEA's water quality analysis, Suffolk County Water Survey, or NYSDEC indicated that the creek was overloaded by nutrients.

The benthic community present differs between the head and mouth, but this can be explained by the grain size differences (96 percent sand at the mouth and 75 percent silts at the head). The species composition at both locations more closely resembles a stressed system. The samples collected at the head during July were dominated by *Ampelisca abdita*, 36 percent, and the clam *Tellina agilis,* 23 percent, followed by the sedentary worms, *Mediomastus ambiseta* and *Polydora ligni*. The mouth was similar, dominated by *Oligochaete* worm (43 percent) along with the *polychaete* worms (*Mediomastus ambiesta* and *Capitella capitata*. The December samples were dominated by nemotod worms and the spionid worm *Streblospio benedicti*. In both cases, abundance was relatively low, with December significantly lower than July.

The benthic community appears to be in transition, between a well developed one, indicative by the high number of *Tellina agilis* and one dominated by stress-related species (e.g., *Mediomastus* and *Capitella*). The low density numbers would appear to indicate that the nutrient load is sufficiently low to limit the abundance of the organisms present. Continued monitoring of this creek would be required to determine the direction that Goose Creek is heading.

H. Bass Creek

Bass Creek is the most isolated creek from human activities of all the tidal creeks surveyed. The creek is located within the Mashomack Preserve on Shelter Island. The pond is fringed with varying amounts of intertidal marsh with an adjacent mature oak forest. The upper sections of Bass Creek support a dense growth of widgeon grass. There appears to be no evidence of dredging, and the mouth appears to be scoured open by swift currents that pass through the narrow inlet.

Differences in the benthic community between the head and the mouth can be explained in part by the sediment types. The head of creek consisted of 77 percent silt, while the mouth was 92 percent sand.

The benthic community found at the head of Bass Creek was extremely limited in terms of both density and diversity. The most abundant organisms during both sampling events was the Nematod worm (33 percent in December and 35 percent in July). During July, Oligochaete worms made up the remaining 62 percent. The balance of the density was distributed among a relatively small group of organisms. Samples collected at the mouth were dominated by the Caprellid amphipod (57 percent) in December, but more evenly distributed in July between the gastropod *Hydrobia minuta*, the clam *Gemma gemma*, several *polychaetes* (i.e., *Haploscoloplus rubustus* and *Neanthos succinea*), as well as *Oligochaete* worms.

The lack of benthic organisms at the head of Bass Creek is hard to explain as the water quality parameters were good, and there is no evidence of disturbances from around the creek. One possible explanation may be the abundant widgeon grass. The nearly complete coverage of the bottom may prevent the potential for a benthic community to develop. The vegetation appears to be present year-round, as it was observed during each survey event. The swift current and coarse sediment types at the mouth create a limited environmental, only suitable for certain species.

I. West Neck Creek

West Neck Creek connects West Neck to West Neck Harbor. A sizeable fleet of pleasure boats can be found moored at various locations along the creek. A few areas of intertidal marsh can be found along the creek, but the shoreline is mostly occupied by residential homes with properties developed to the water's edge. Most homes have a dock and boat.

Water quality sampling by EEA and the Suffolk County Department of Health Services has identified the West Neck system as being nutrient rich. The West Neck System has been known to have isolated brown tide events when no brown tide was reported elsewhere in the Peconics.

The benthic community reflects the high nutrient levels. The benthic community of West Neck Creek closely resembles that of Meetinghouse Creek (almost completely dominated by the amphipod *Ampelisca abdita*). *Ampelisca* was found at both the head and mouth of the creek in December, making up 75 and 52 percent of the total number of organisms collected, respectively. During July, *Ampelisca* made up 69 percent of all organisms at the head and only 10 percent at the mouth. This is somewhat surprising since the sediments found at the head of West Neck Creek were 87 percent sand and only 48 percent sand at the mouth. *Ampelisca* typically favor a muddy-sand mix, not pure sand.

Other benthic species dominating the benthic community were the Oligochaete worms, Nematod worms, and *Capitella capitata*, all commonly found in organic rich disturbed environments. The remainder of the community is evenly distributed between species such as the Amphipods *Leptocheirus plumolosus,* and *Parphoxus epistomus*, and the clam *Nucula proxima*. Those three species are typically found in well developed benthic communities in undisturbed environments.

Densities of *Ampelisca abdita* are exceptionally high, averaging between 20,000 and 30,000 *Ampelisca*/m^2 in most samples (similar densities to Meetinghouse Creek).

Given the presence of benthic organisms found in undisturbed systems and given the limited sampling period, it is unclear in which state of flux the benthic community is in. Possibly pioneer species are taking advantage of degrading conditions, or the stable environment organisms taking advantage of improving water quality conditions. Additionally, West Neck Creek is periodically dredged to maintain the boat channels. This may contribute to constant presence of species, such as *Ampelisca,* while retarding the establishment of species such as *Paraphoxus* and *Nucula.* In either case, the organisms present provide an excellent food source for juvenile finfish species and will be readily utilized.

J. Little Bay

Little Bay is located at the extreme eastern tip of the North Fork of Long Island. It is buffered on all sides by an expansive saltmarsh. The south shore of the bay consists entirely of Orient Beach State Park; to the shore is almost completely saltmarsh (both intertidal and high). A few residential homes exist along the north shore located along a narrow tributary to the bay. The tributary appears to be channelized, based on the dredge spoil piles along the shoreline. The extreme head of Little Bay also appears to have been dredged at some time in the past.

As expected, the sediments found at the dead end head of Little Bay consist of 88 percent silts, while the mouth is 83 percent sand.

The benthic community found at the head was very low in terms of both abundance and diversity. Densities at the head ranged from 34 to 408 organisms/m^2, while at the mouth, they ranged from 3,349 to 6,834 organisms/m^2. Dominant benthic organisms at the mouth were oligochaete worms, nematod worms, the polychaete worms *Capitella capitata,* and *Scolecolepides viridis*, the clams *Gemma gemma* and *Lyonsia hyalina*, and the arthropods *Hippolyte zostericola, Corophium* sp. and *Ampelisca abdita.* In general, this represents a good diversity.

Additionally, the samples collected at the head station contained large amounts of organic material, mostly what appeared to be decomposing widgeon grass which was abundant in shallow water near, but not at the head of the bay. No SAV was present at the mouth, but eelgrass was abundant immediately west of that station in Hallock Bay.

It is believed that the benthic community associated with the mouth of Little Bay represents a typical, well developed community, while those present at the head do not. It would appear that the condition at the head station support only a limited stressed benthic community. EEA does not anticipate that these conditions are indicative of the entire habitat associated with the head of Little Bay, rather they only represent a very small area with poor circulation where organic material collects and decomposes, restricting the benthic development in a localized area.

The Little Bay benthic community structure is not representative of a stressed waterway with a nutrient loading problem, nor is there any evidence to suggest a nutrient rich system.

VIII. CONCLUSIONS

EEA evaluated ten tidal creeks throughout the Peconic Estuary representing a wide range of watershed variables. Of potential impacts, nutrient loading appeared to be primary. Of those ten, four clearly had a benthic community structure which was more representative of a nutrient rich environment closely resembling communities found in water bodies such as Jamaica Bay, New York and the New York Harbor: Meetinghouse, West Neck, Ligonee, and Alewife. This is not totally unexpected, as the drainages these creeks are associated with have been previously identified by the Suffolk County Department of Health Service as areas with above normal levels of nitrogen. In all cases, the source of nitrogen has been identified as a municipal sewage treatment plant, or in the case of Meetinghouse Creek, an active duck farm. In most cases, the diversity in each creek was low, and the density of a single species extremely high. The amphipod *Ampelisca abdita* was the dominant identified species. In some cases, *Ampelisca* abundances exceeded $30{,}000/m^{2}$.

These species and densities indicate a stressed environment, which is most likely the result of nutrient loading. On a system-wide basis, the primary sources of nitrogen which causes most of this nutrient loading is due to on-site disposal systems and residential and agricultural fertilizers. The organisms present are not necessarily detrimental to the environment, as they provide an excellent food source for many juvenile finfish species.

The remaining six creeks (Fresh Pond, Northwest Creek, West Creek, Goose Creek, Bass Creek, and Little Bay) all appear to support well established benthic communities. This determination is based on the presence of a diverse benthic community that is not dominated by large numbers of pioneering organisms, such as the ampeliscids, spionid worms, and oligochaetes. In general, as one would expect, these six creeks are the more underdeveloped systems, with predominantly open space (i.e., intertidal marsh) surrounding them. Goose Creek is the most developed of the six. It would appear that the presence of extensive intertidal marsh is extremely beneficial in maintaining the equilibrium in the creek, even though it would appear that most of the nutrients are coming through the groundwater. Based on EEA's previous studies in Jamaica Bay, it is clear that *Spartina alterniflora* is a sink for nutrients and capable of removing a significant amount from the surrounding waterbody.

It is recommended that further studies be concluded on a more in-depth, longer term analysis, with fewer creeks. This tidal creek study can be used to choose a smaller number of creeks, which would represent a highly impacted system, a relatively low-impacted system, and possibly one in between. With a smaller set of variables, it would be possible to further study these creeks, to determine to what extent the land use practices have on the overall health of the system. The benthic studies that were concluded for this project will prove even more valuable if compared to data sets in the future. Also, a continued analysis of the water quality parameters of these creeks is necessary, and possibly a more in-depth study would reveal trends which may parallel certain land use practices.

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APPENDIX A

WATER QUALITY AND PHYSICAL CHEMISTRY

PEP Tidal Creek Study

Water Quality Laboratory Data from Samples Collected in June of 1998 by Suffolk County Department of Health Services Office of Ecology

Date	Time	Name	Loc	Depth	Secchi	Temp	D.O.	Salinity	T. Coliform	F. Coliform	NH3	NOx
				(ft)	(ft)	(C)	(mg/l)	(o/oo)	(mpn/100 ml)		(mg/l)	(mg/l)
6/9/98	9:35	Fresh Pond - mouth		1.0	> 1	16.6	7.8	27.05	4	4	0.034	< 0.005
6/9/98	10:36	Fresh Pond - head		2.0	> 2	18.2	6.9	16.69	170	170	0.016	0.009
6/9/98	11:48	Northwest Creek - mouth		9.0	7.0	18.1	7.1	26.08	17	17	0.018	< 0.005
6/9/98	11:49	Northwest Creek - mouth	B			17.5	7.0					
6/9/98	12:01	Northwest Creek - head		2.0	> 2	18.0	6.1	6.84	900	500	0.025	< 0.005
6/9/98	12:02	Northwest Creek - head	B			18.8	6.1					
6/9/98	13:36	Ligonee Creek - mouth		5.0	5.0	19.7	7.6	19.40	22	17	0.024	0.010
6/9/98	13:37	Ligonee Creek - mouth	B			19.2	6.5					
6/9/98	13:52	Ligonee Creek - head		2.5	2.5	19.0	8.3	16.19	23	13	0.106	0.011
6/9/98	13:53	Ligonee Creek - head	B			19.1	8.6					
6/9/98	14:48	Alewife Creek - mouth		6.5	5.0	18.8	8.1	19.67	170	50	0.033	< 0.005
6/9/98	14:49	Alewife Creek - mouth	B			18.8	8.5					
6/9/98	15:02	Alewife Creek - head		1.0	> 1	19.6	7.9	4.45	300	170	0.042	0.048
6/10/98	8:33	Goose Creek - mouth		8.5	5.0	17.9	6.8	26.40	13	13	0.035	< 0.005
6/10/98	8:34	Goose Creek - mouth	B			17.9	6.7					
6/10/98	8:54	Goose Creek - head		2.0	> 2	18.7	5.7	26.03	23	23	0.027	< 0.005
6/10/98	10:03	West Creek - mouth		3.5	> 3.5	18.5	7.2	25.35	50	11	0.023	< 0.005
6/10/98	10:04	West Creek - mouth	B			18.5	7.3					
6/10/98	10:31	West Creek - head		1.0	> 1	20.4	8.2	15.16	500	80	0.021	0.088
6/10/98	12:02	Bass Creek - mouth		2.5	> 2.5	19.0	8.2	26.99	2	2	0.023	< 0.005
6/10/98	12:03	Bass Creek - mouth	B			19.2	8.0					
6/10/98	12:18	Bass Creek - head		2.0	> 2	22.3	5.5	25.37	2	2	0.022	< 0.005
6/10/98	13:30	Little Bay - mouth		5.5	> 5.5	20.6	7.6	27.17	8	8	0.028	< 0.005
6/10/98	13:31	Little Bay - mouth	B			19.7	8.5					
6/10/98	13:43	Little Bay - head		13.5	5.5	20.7	8.2	26.32	2	2	0.036	< 0.005
6/10/98	13:44	Little Bay - head	B			19.0	6.0					
6/11/98	6:46	Meetinghouse Creek - mouth		10.5	6.0	20.5	8.4	21.12	30	30	0.081	0.057
6/11/98	6:47	Meetinghouse Creek - mouth	B			20.2	5.4					
6/11/98	7:16	Meetinghouse Creek - head		5.5	5.5	17.7	4.6	18.24	300	130	0.860	0.492
6/11/98	7:17	Meetinghouse Creek - head	B			19.0	3.2					
6/11/98	7:20	West Neck Creek - mouth		7.0	4.5	19.6	7.0	26.02	2	2	0.032	< 0.005
6/11/98	7:21	West Neck Creek - mouth	B			19.6	6.8					
6/11/98	7:33	West Neck Creek - head		8.9	4.0	20.0	7.1	25.46	17	17	0.028	< 0.005
6/11/98	7:34	West Neck Creek - head	B			20.0	6.9					

PEP Tidal Creek Study

Water Quality Laboratory Data from Samples Collected in June of 1998 by Suffolk County Department of Health Services Office of Ecology

Date	Time	Name	Urea (mg/l)	TKN (mg/l)	TDKN (mg/l)	TPO4 (mg/l)	TDPO4 (mg/l)	o-PO4 (mg/l)	SiO3 (mg/l)	TOC (mg/l)	TSS (mg/l)	Chl-T (ug/l)	Aureo (cells/ml)
6/9/98	9:35	Fresh Pond - mouth	0.012	0.22	0.24	0.056	0.055	0.011	0.192	1.920		2.0	136
6/9/98	10:36	Fresh Pond - head	0.017	0.67	0.22	0.047	0.032	0.009	1.130	4.260		3.0	0
6/9/98	11:48	Northwest Creek - mouth	0.016	0.42	0.25	0.055	0.043	0.008	0.280	2.180		1.8	136
6/9/98	11:49	Northwest Creek - mouth											
6/9/98	12:01	Northwest Creek - head	0.020	0.43	0.44	0.034	0.030	0.005	1.630	8.560		7.3	0
6/9/98	12:02	Northwest Creek - head											
6/9/98	13:36	Ligonee Creek - mouth	0.009	0.32	0.22	0.051	0.050	0.005	1.200	2.870		9.1	0
6/9/98	13:37	Ligonee Creek - mouth											
6/9/98	13:52	Ligonee Creek - head	0.008	0.54	0.53	0.049	0.023	0.005	1.070	2.190		2.2	0
6/9/98	13:53	Ligonee Creek - head											
6/9/98	14:48	Alewife Creek - mouth	0.015	0.38	0.27	0.042	0.023	0.006	0.656	2.630		3.2	68
6/9/98	14:49	Alewife Creek - mouth											
6/9/98	15:02	Alewife Creek - head	0.009	0.58	0.39	0.045	0.022	< 0.005	0.395	4.100		8.2	0
6/10/98	8:33	Goose Creek - mouth	0.020	0.33	0.38	0.042	0.040	0.011	0.189	1.950		2.9	68
6/10/98	8:34	Goose Creek - mouth											
6/10/98	8:54	Goose Creek - head	0.010	0.33	0.36	0.053	0.047	0.005	0.294	2.310		8.6	0
6/10/98	10:03	West Creek - mouth	0.011	0.31	0.36	0.037	0.044	0.007	0.151	2.380		1.8	0
6/10/98	10:04	West Creek - mouth											
6/10/98	10:31	West Creek - head	0.009	0.62	0.51	0.036	0.027	< 0.005	0.334	6.100		11.0	0
6/10/98	12:02	Bass Creek - mouth	0.007	0.33	0.24	0.048	0.045	0.008	0.097	1.750		2.0	136
6/10/98	12:03	Bass Creek - mouth											
6/10/98	12:18	Bass Creek - head	0.011	0.61	0.53	0.051	0.044	< 0.005	0.407	3.940		9.9	34
6/10/98	13:30	Little Bay - mouth	0.017	0.60	0.37	0.094	0.036	0.010	0.172	2.490		2.5	579
6/10/98	13:31	Little Bay - mouth											
6/10/98	13:43	Little Bay - head	0.013	0.56	0.52	0.059	0.047	0.014	0.239	3.030		3.5	238
6/10/98	13:44	Little Bay - head											
6/11/98	6:46	Meetinghouse Creek - mouth	0.023	0.49	0.49	0.079	0.070	0.024	0.698	2.780		4.1	0
6/11/98	6:47	Meetinghouse Creek - mouth											
6/11/98	7:16	Meetinghouse Creek - head	0.026	2.30	1.79	0.389	0.277	0.139	1.310	3.410		6.0	0
6/11/98	7:17	Meetinghouse Creek - head											
6/11/98	7:20	West Neck Creek - mouth	0.013	0.46	0.43	0.100	0.051	0.006	0.695	3.060		4.1	42024
6/11/98	7:21	West Neck Creek - mouth											
6/11/98	7:33	West Neck Creek - head	0.015	0.55	0.41	0.065	0.056	0.006	0.901	3.660		6.5	28560
6/11/98	7:34	West Neck Creek - head											

PEP Tidal Creek Study
Water Quality Laboratory Data from Samples Collected in July of 1998

	Sample Collected	Total Coliforms mpn/100ml	Fecal Coliforms mpn/100ml	Total Organic Carbon mg/L	Total Kjeldahl Nitrogen mg/L	Dissolved Kjeldahl Nitrogen mg/L	Dissolved Total Organic Carbon mg/L	Total Chlorophyll-a ug/l	NH4 mg N/L	NO2 mg N/L	NO2 + NO3 mg N/L	PO4 mg P/L	Total Suspended Solids mg/L	Total Phosphorus mg P/L	TDP mg P/L
Fresh Pond Head	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10	3.4	0.006	0.0006	0.0041	0.0279	9.3	0.05	0.0364
Fresh Pond Mouth	7/30/98	<1	ND	<10.0	<1.0	<1.0	<10.0	1.9	0.013	0.0012	0.0075	0.023	7.1	0.04	0.0401
Northwest Creek Head	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	3.9	0.018	0.0011	0.0147	0.024	15.2	0.0526	0.0323
Northwest Creek Mouth	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	2.3	0.006	0.0001	0.003	0.0212	10.8	0.0303	0.0318
Ligonee Creek Head	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	46	0.288	0.0036	0.0467	0.0033	19.6	0.1081	0.0222
Ligonee Creek Mouth	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	5	0.005	0.0002	0.0036	0.0082	16.2	0.0422	0.0185
Alewife Creek Head	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	1.8	0.087	0.0038	0.232	0.0117	2.8	0.0207	0.0142
Alewife Creek Mouth	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	7.7	0.009	0	0.0036	0.0275	19	0.1276	0.0426
Meetinghouse Creek Head	7/30/98	1	ND	<10.0	<1.0	<1.0	<10.0	16.1	4.015	0.0903	2.77	0.854	9.6	0.8848	0.8386
Meetinghouse Creek Mouth	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	49.7	0.524	0.0344	0.453	0.0949	19	0.1878	0.0491
West Creek Head	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	12	0.004	0.0003	0.0032	0.0083	23.5	0.0622	0.0259
West Creek Mouth	7/30/98	<1	ND	<10.0	<1.0	<1.0	<10.0	4.4	0.008	0.0002	0.0031	0.0269	13.4	0.0456	0.0376
Goose Creek Head	7/30/98	<1	ND	<10.0	<1.0	<1.0	<10.0	10.4	0.008	0.0006	0.0024	0.0205	17.8	0.0587	0.0435
Goose Creek Mouth	7/30/98	ND	ND	<10.0	<1.0	<1.0	<10.0	4.2	0.004	0.0002	0.0024	0.0225	21.4	0.0323	0.0341
Bass Creek Head	7/31/98	ND	ND	<10.0	<1.0	<1.0	<10.0	9	0.008	0.002	0.0038	0.0108	180.6	0.0403	0.0414
Bass Creek Mouth	7/31/98	2	ND	<10.0	<1.0	<1.0	<10.0	3.5	0.018	0.0008	0.0199	0.0281	18.6	0.1173	0.0389
West Neck Creek Head	8/3/98	500	8	<10.0	<1.0	<1.0	<10.0	8	0.004	0.0003	0.0041	0.032	23.3	0.0475	0.0431
West Neck Creek Mouth	8/3/98	1600	13	<10.0	<1.0	<1.0	<10.0	3.3	0.017	0.0012	0.0139	0.037	26.3	0.0671	0.0512
Little Bay Tributary Head	8/3/98	130	8	<10.0	<1.0	<1.0	<10.0	7.3	0.01	0.0008	0.0111	0.0384	19.8	0.076	0.0542
Little Bay Tributary Mouth	8/3/98	4	<2	<10.0	<1.0	<1.0	<10.0	6.6	0.003	0.0005	0.004	0.0421	12.4	0.0749	0.0589

ND = Not Detected

Source: Water samples collected by EEA, Inc.
Laboratory analysis conducted by Chesapeake Biological Laboratory, Environmental Testing Laboratory, and Suffolk County Department of Health Services

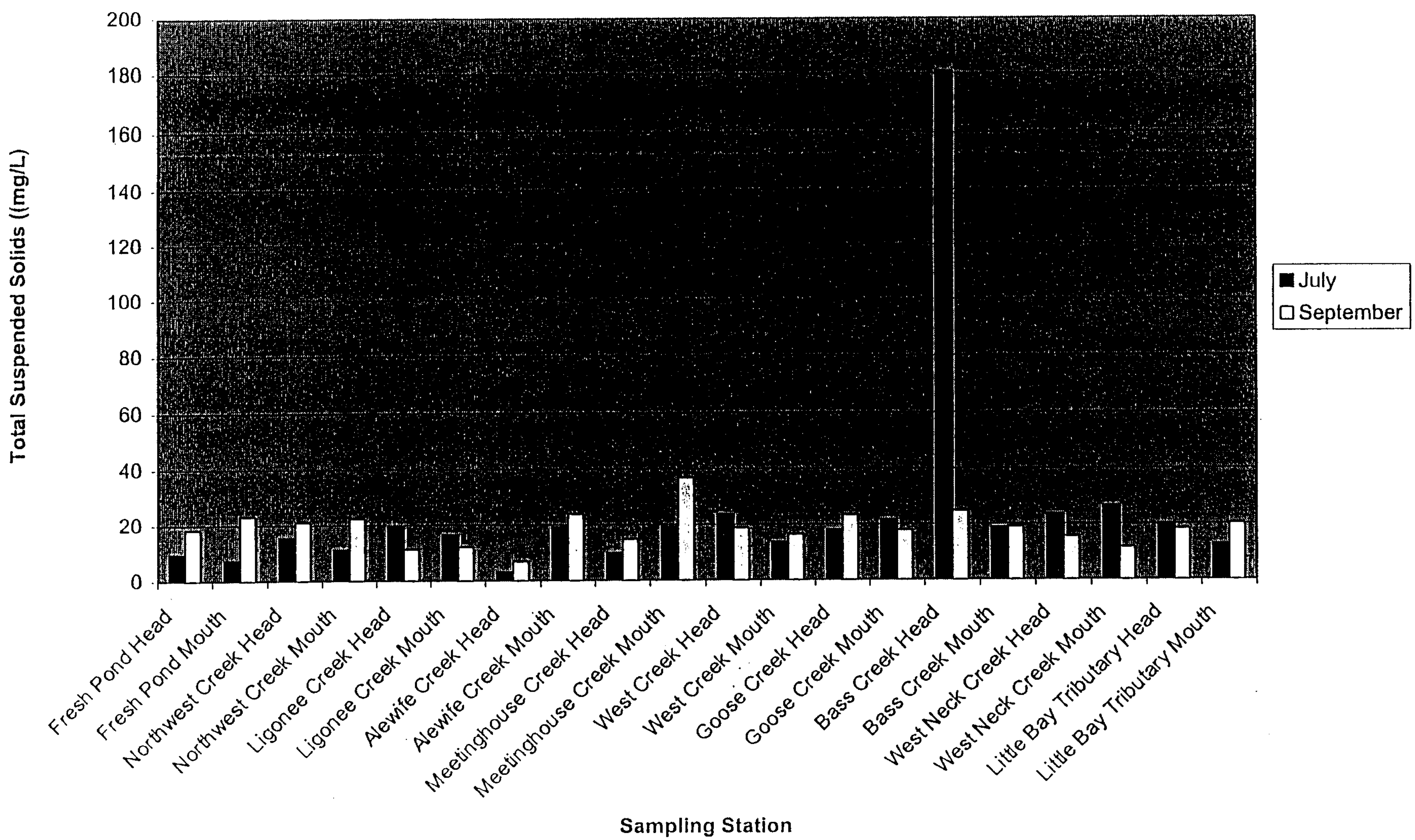
PEP Tidal Creek Study

1998 Water Quality Laboratory Data from Samples Collected in September of 1998

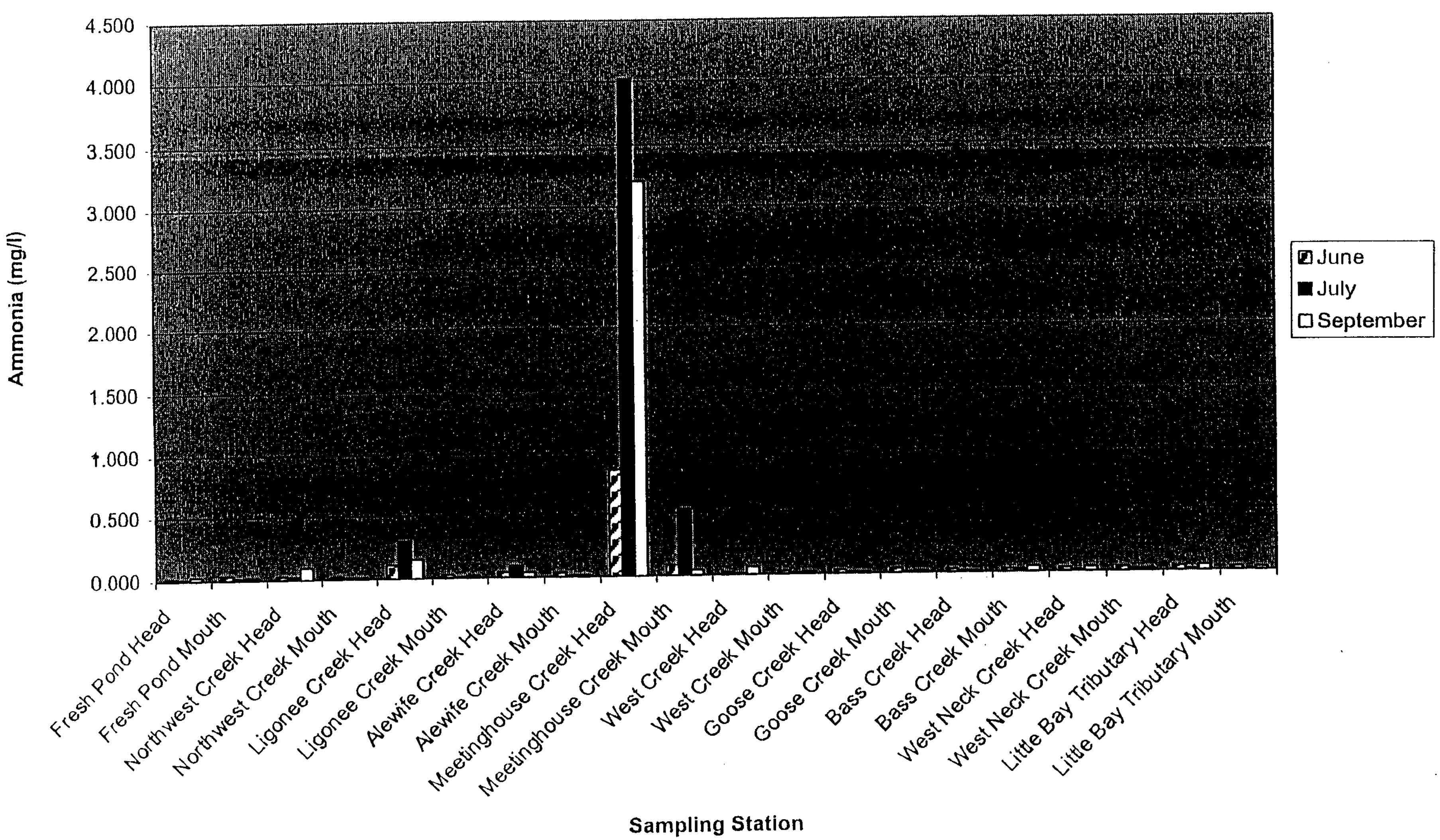
	Sample Collected	Total Coliforms cfu/mL	Fecal Coliforms cfu/100 mL	Total Organic Carbon mg/L	Total Kjeldahl Nitrogen mg/L	Dissolved Kjeldahl Nitrogen MG/L	Dissolved Total Organic Carbon MG/L	Total Chlorophyll-a ug/l	NH4 mg N/L	NO2 mg N/L	NO3 mg N/L	PO4 mg P/L	Total Suspended Solids mg/L	Total Phosphorus mg P/L	TDP mg P/L
Fresh Pond Head	Sep-98	<1	0	26.1	<1.0	<1.0	22.5	3.9	0.026	0.0005	0.0082	0.0246	18.2	0.0467	0.0408
Fresh Pond Mouth	Sep-98	0	0	24.4	<1.0	<1.0	21.7	3.4	0.019	0.0006	0.0113	0.0305	23.1	0.0546	0.0431
Northwest Creek Head	Sep-98	0	0	23.9	<1.0	<1.0	19.8	2.4	0.093	0.0006	0.0257	0.0233	21	0.0489	0.0356
Northwest Creek Mouth	Sep-98	0	0	24.1	<1.0	<1.0	21.1	2.3	0.011	0.0003	0.0093	0.0279	22.4	0.034	0.0406
Ligonee Creek Head	Sep-98	0	0	15.3	<1.0	<1.0	13.6	6.6	0.148	0.0041	0.122	0.0018	11.2	0.0215	0.0106
Ligonee Creek Mouth	Sep-98	0	0	23.8	<1.0	<1.0	19.1	2.6	0.018	0.0008	0.027	0.0146	12	0.1099	0.0296
Alewife Creek Head	Sep-98	<1	0	<10	<1.0	<1.0	<10	4.6	0.038	0.0024	0.145	0.0072	6.8	0.0191	0.0148
Alewife Creek Mouth	Sep-98	3	0	23.3	<1.0	<1.0	19.3	2.2	0.013	0.0005	0.0184	0.0252	23.8	0.0524	0.0377
Meetinghouse Creek Head	Sep-98	<1	0	25.1	<1.0	<1.0	21.1	7.8	3.205	0.0903	2.68	0.7685	14.7	1.0074	0.8466
Meetinghouse Creek Mouth	Sep-98	<1	0	21.3	<1.0	<1.0	16.9	18	0.04	0.0051	0.068	0.0183	36.9	0.0803	0.0436
West Creek Head	Sep-98	0	0	25	<1.0	<1.0	18.6	5.1	0.061	0.0032	0.0336	0.0161	18.8	0.0572	0.0341
West Creek Mouth	Sep-98	1	0	22	<1.0	<1.0	16.8	2.1	0.016	0.0004	0.0063	0.0264	16.3	0.0527	0.0442
Goose Creek Head	Sep-98	0	0	25.6	<1.0	<1.0	19.6	12.6	0.011	0.0004	0.0063	0.0269	23.3	0.0567	0.0512
Goose Creek Mouth	Sep-98	<1	0	23.1	<1.0	<1.0	17.8	3.1	0.014	0.0005	0.0082	0.0284	17.8	0.0521	0.0471
Bass Creek Head	Sep-98	0	0	27.5	<1.0	<1.0	23.6	18.5	0.006	0.0009	0.0063	0.0153	24.8	0.0931	0.0394
Bass Creek Mouth	Sep-98	0	0	24.4	<1.0	<1.0	20.5	2.5	0.043	0.0011	0.0134	0.0335	19	0.0558	0.0575
West Neck Creek Head	Sep-98	1	0	22.3	<1.0	<1.0	19.2	7.2	0.034	0.0015	0.0314	0.0643	15.4	0.0434	0.0456
West Neck Creek Mouth	Sep-98	<1	0	22.1	<1.0	<1.0	19.1	3.2	0.018	0.0004	0.011	0.0299	11.5	0.0427	0.0493
Little Bay Tributary Head	Sep-98	0	0	22	<1.0	<1.0	17.7	9.9	0.043	0.002	0.0727	0.0237	18.2	0.0627	0.0473
Little Bay Tributary Mouth	Sep-98	0	0	21.8	<1.0	<1.0	17.8	4.6	0.022	0.0016	0.0294	0.0243	20.2	0.0502	0.042

Source: Water samples collected by EEA, Inc.
Laboratory analysis conducted by Chesapeake Biological Laboratory, Environmental Testing Laboratory, and Suffolk County Department of Health Services

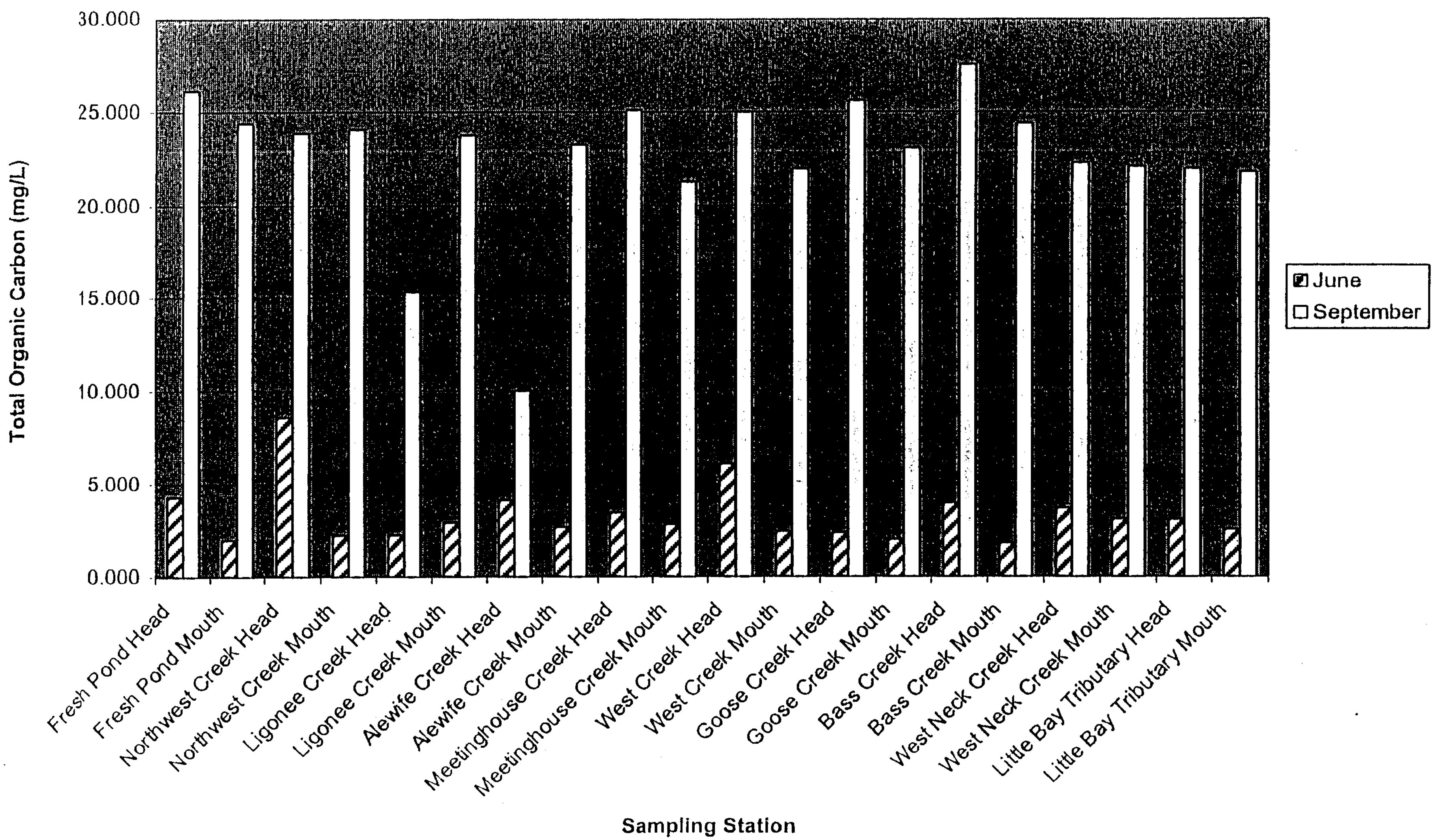
Total Suspended Soilds Values for Headwaters and Mouthwaters of Ten Tidal Creeks



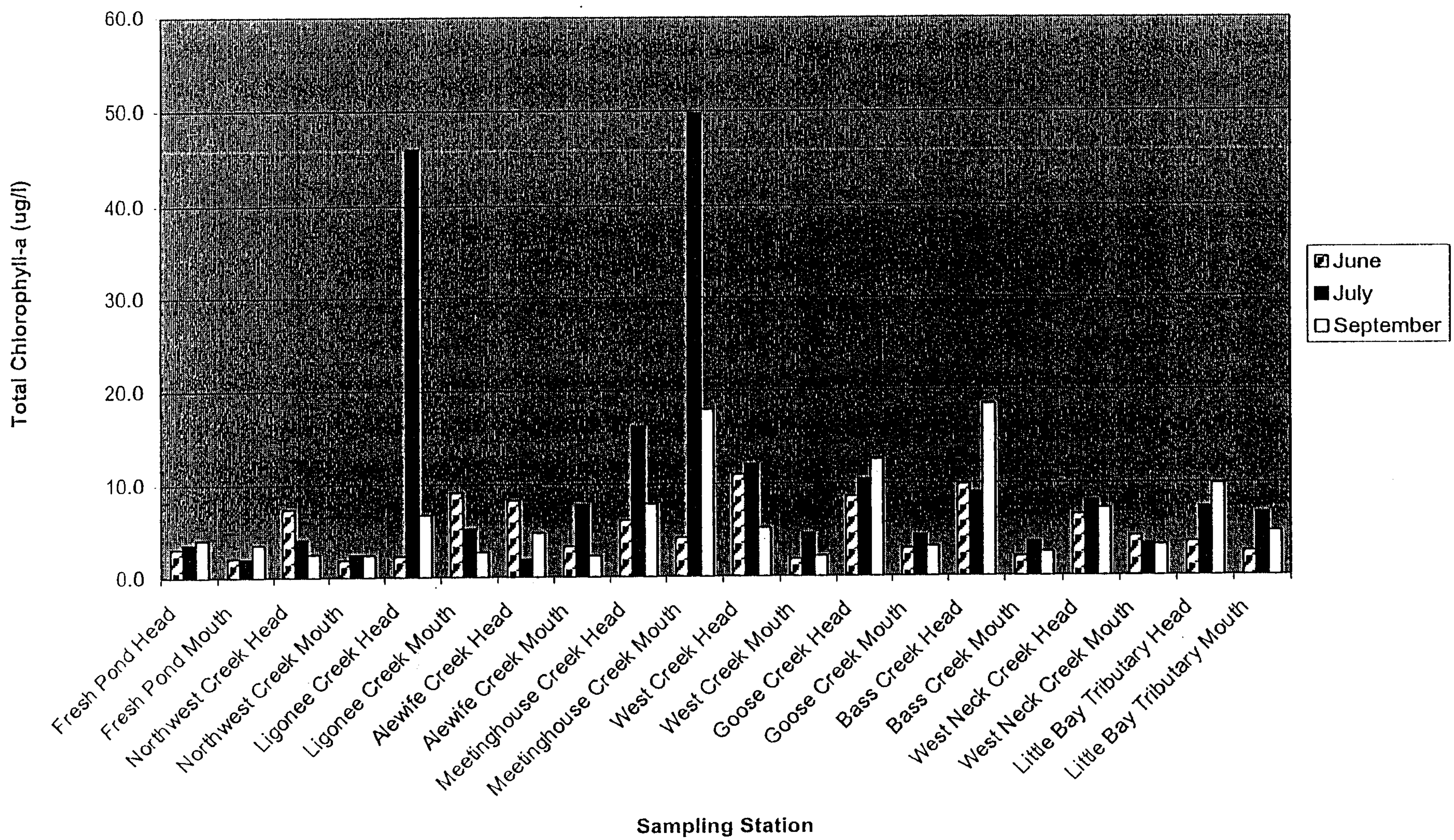
Ammonia Values for Headwaters and Mouthwaters of Ten Tidal Creeks



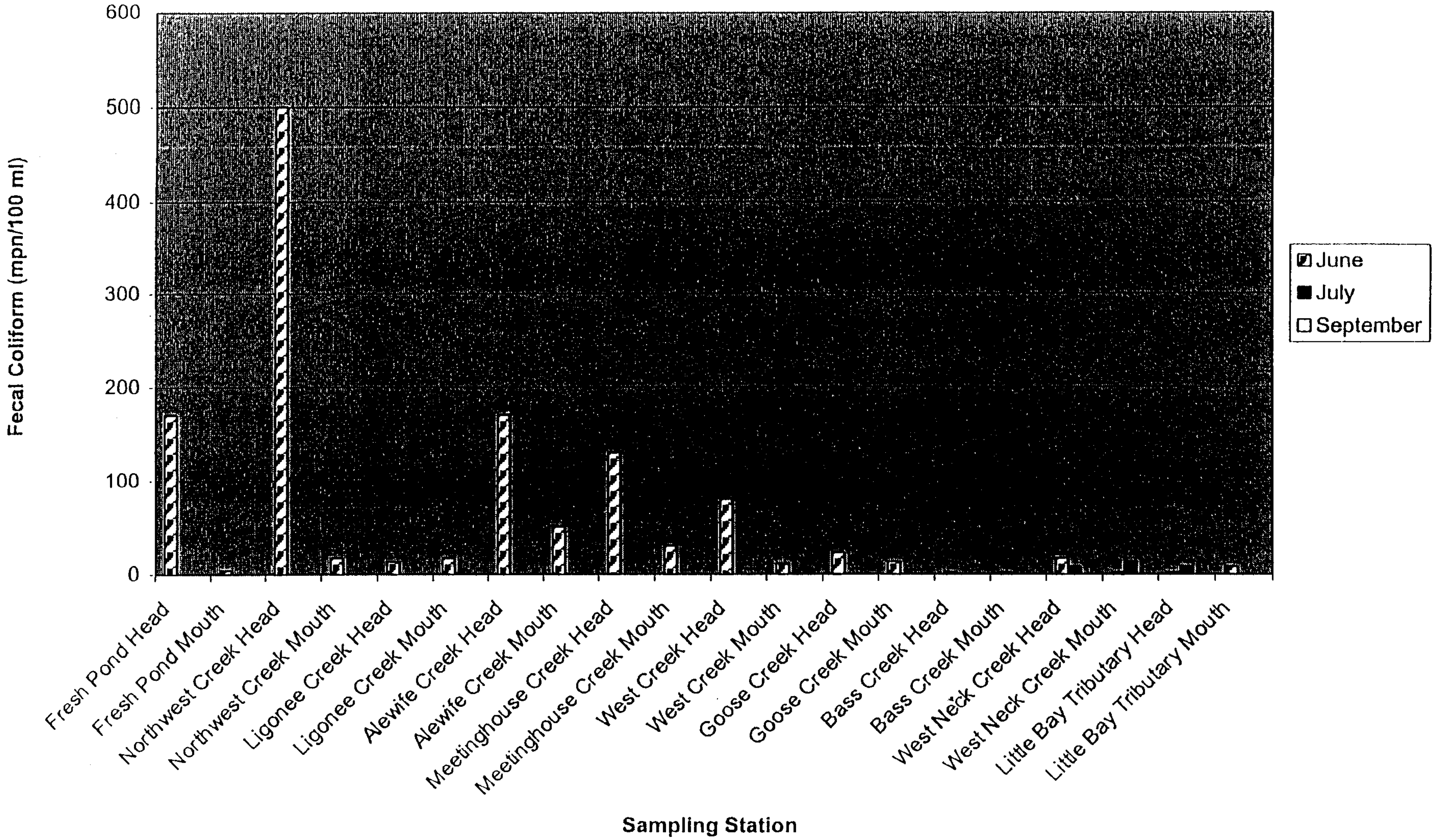
Total Organic Carbon Values for Headwaters and Mouthwaters of Ten Tidal Creeks



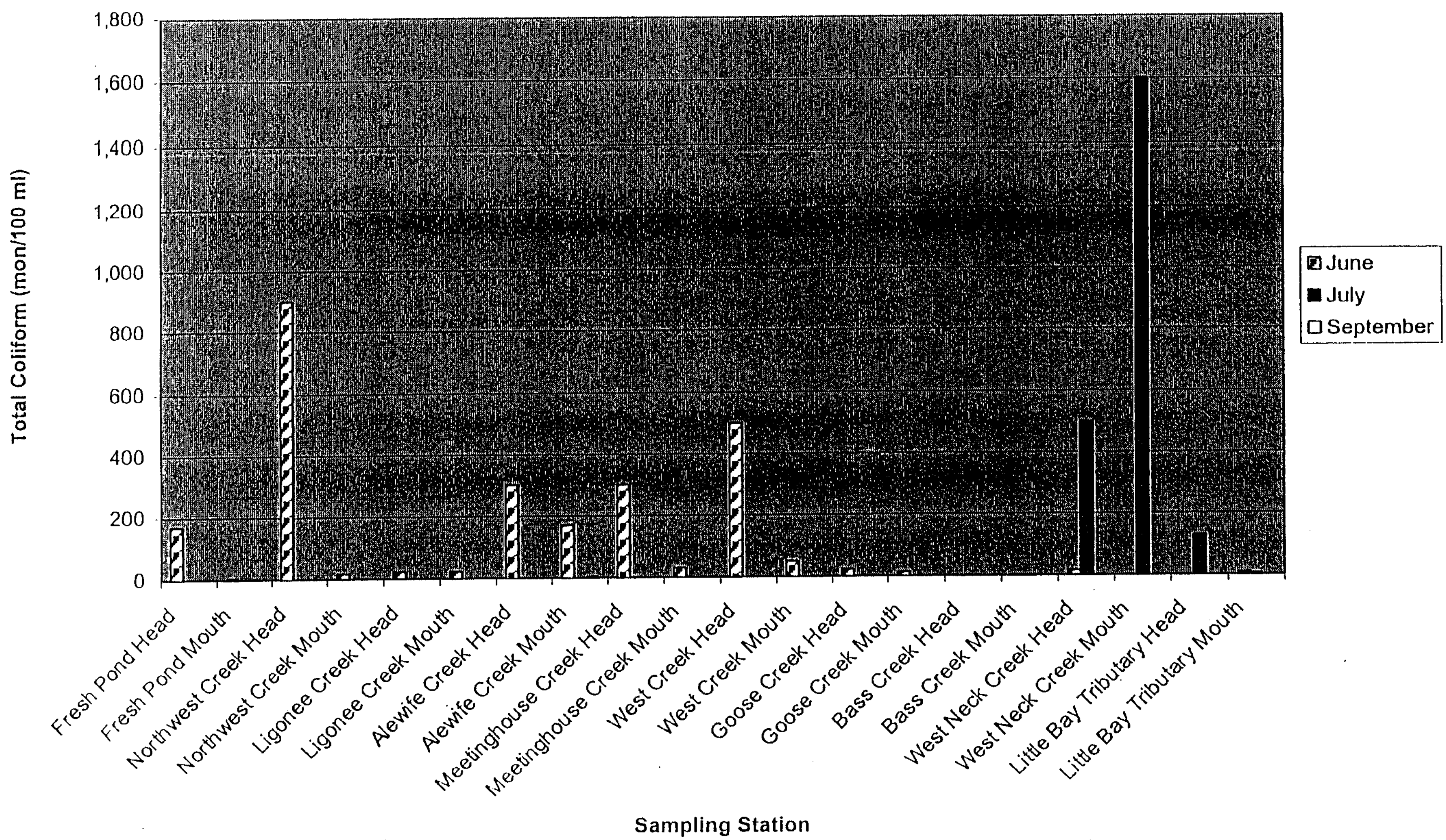
Total Chlorophyll-a Values for Headwaters and Mouthwaters of Ten Tidal Creeks



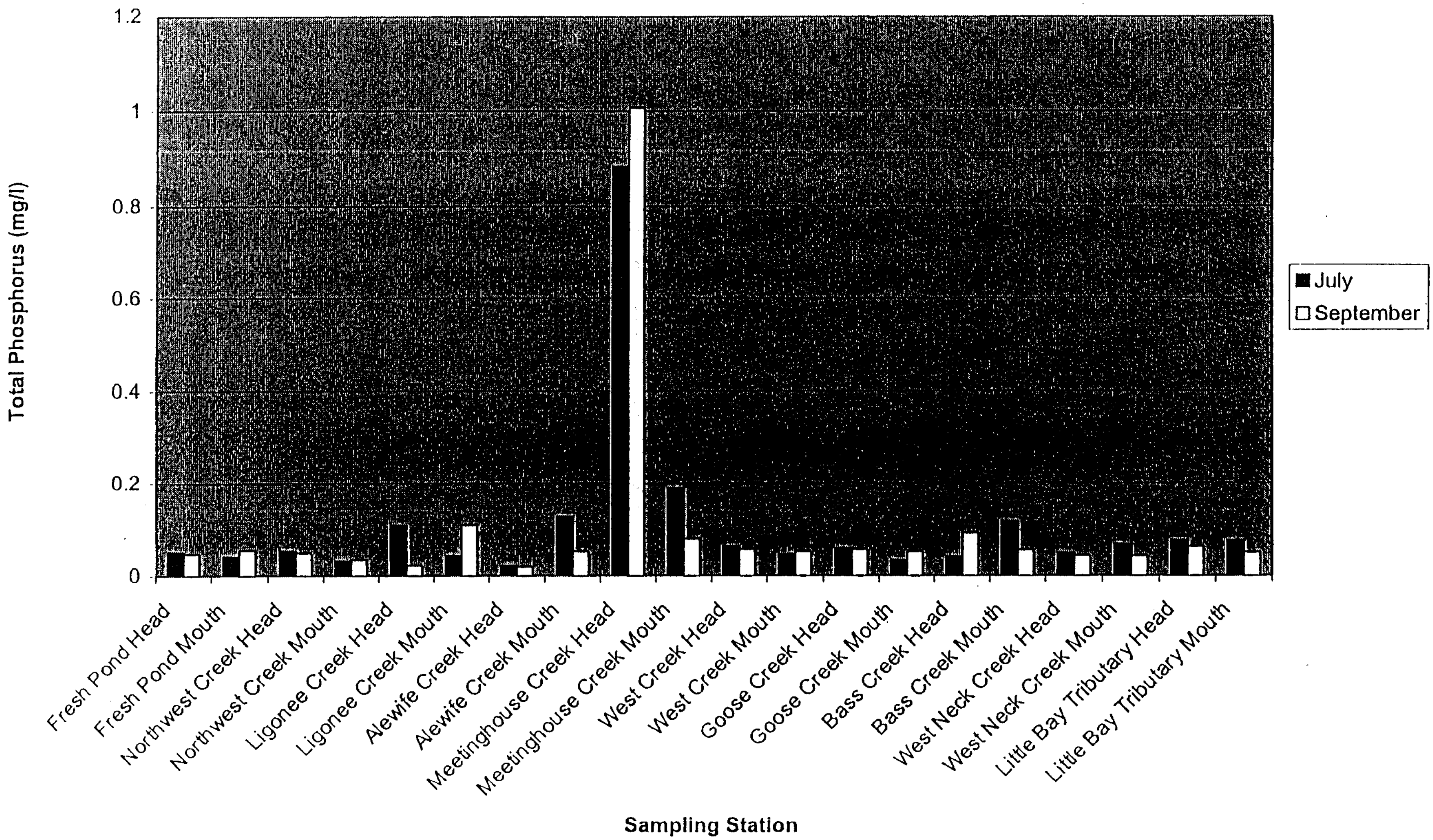
Fecal Coliform Values for Headwaters and Mouthwaters of Ten Tidal Creeks



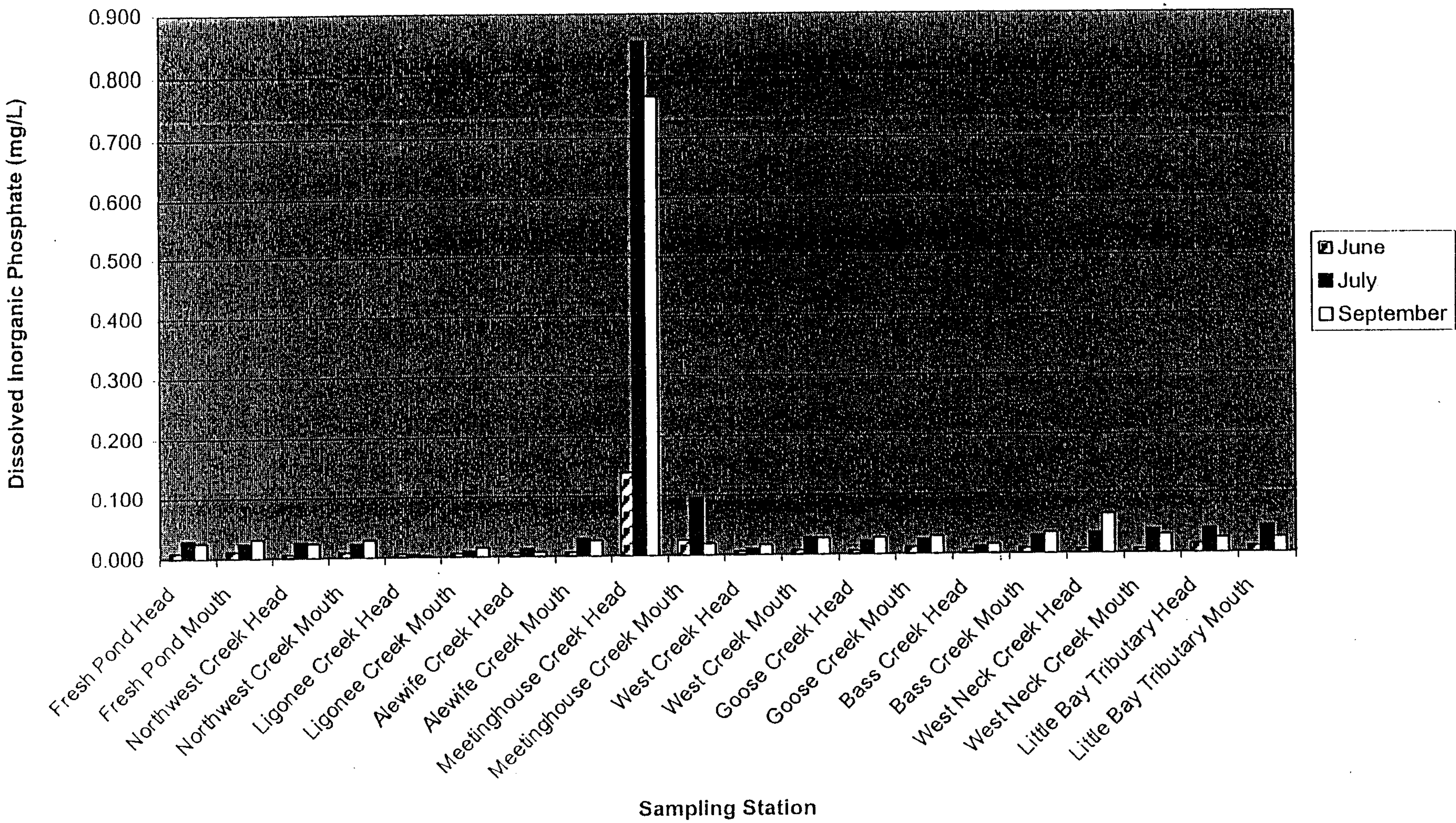
Total Coliform Values for Headwaters and Mouthwaters of Ten Tidal Creeks



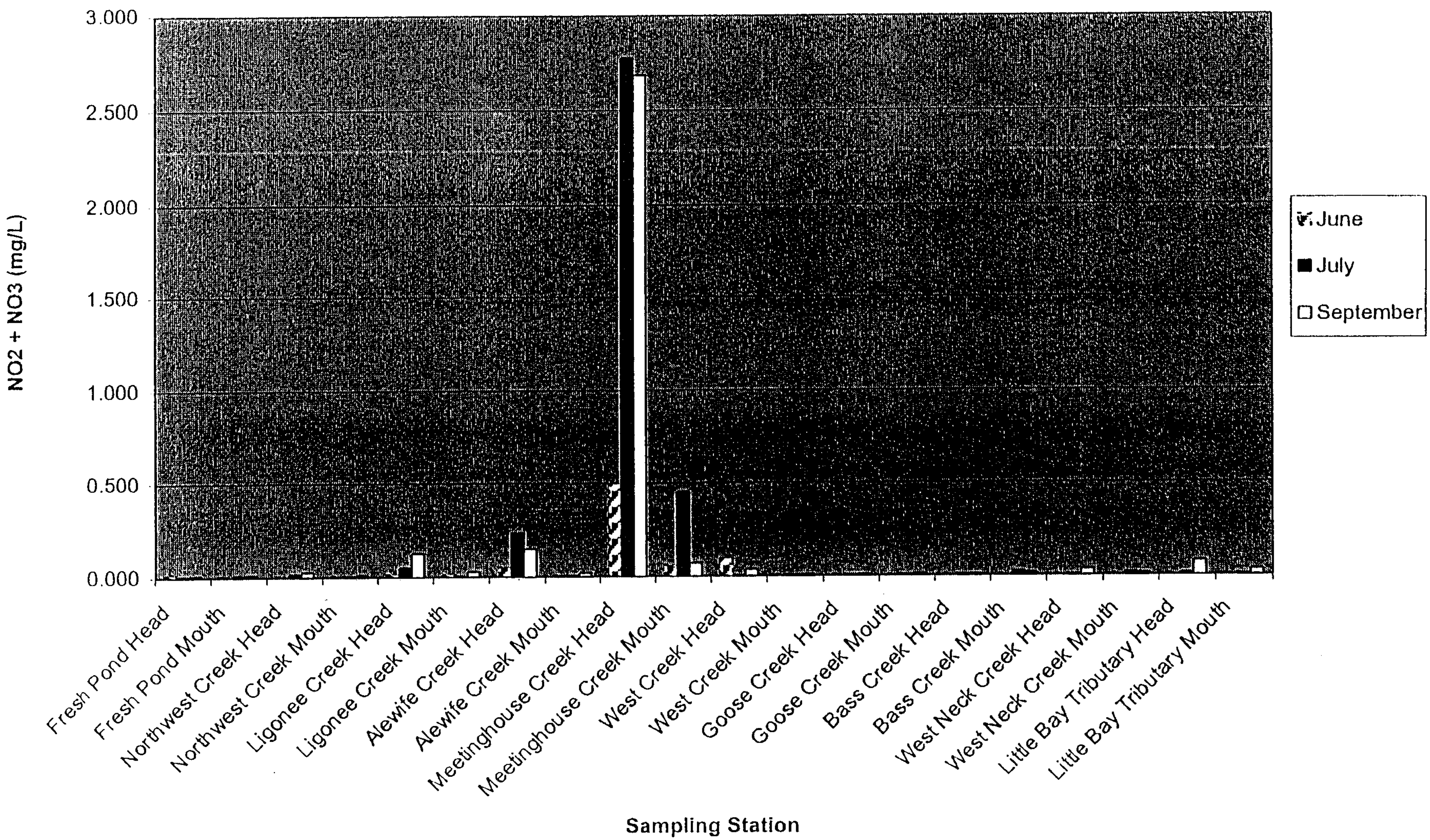
Total Phosphorus Values for Headwaters and Mouthwaters of Ten Tidal Creeks



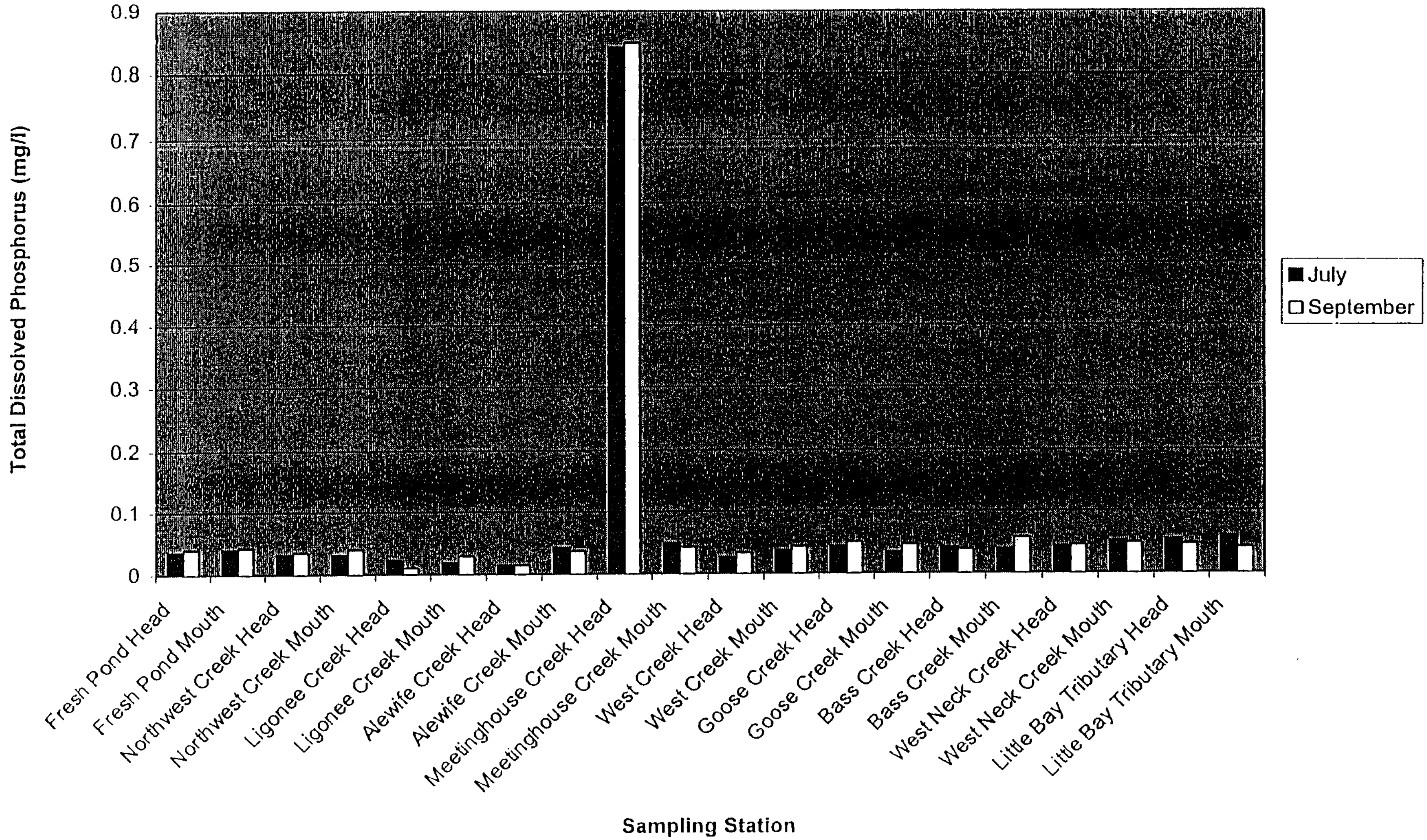
Dissolved Inorganic Phosphate (PO4) Values for Headwaters and Mouthwaters of Ten Tidal Creeks



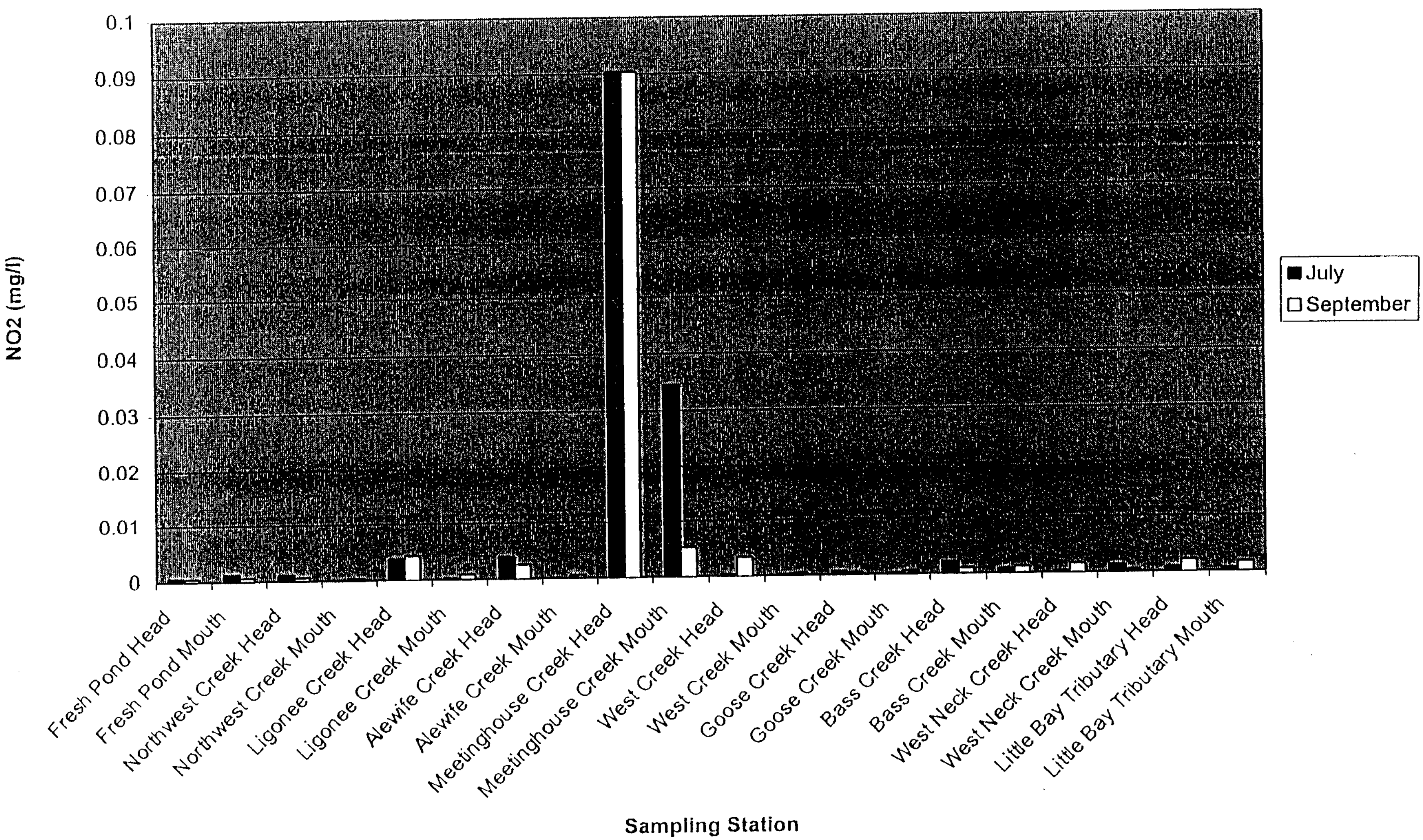
NO2 + NO3 Values for Headwaters and Mouthwaters of Ten Tidal Creeks



Total Dissolved Phosphorus Values for Headwaters and Mouthwaters of Ten Tidal Creeks



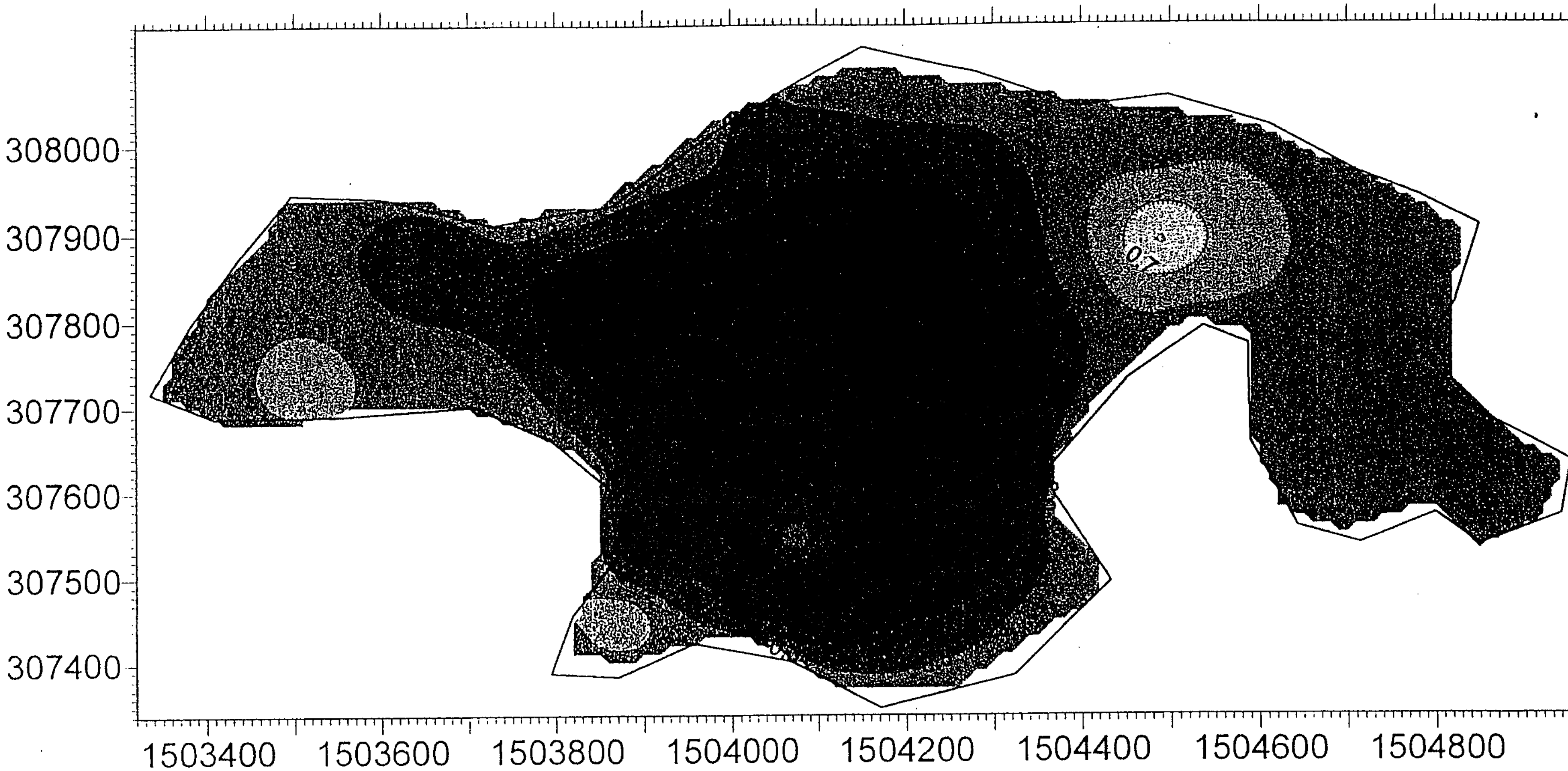
NO2 Values for Headwaters and Mouthwaters of Ten Tidal Creeks



APPENDIX B

BATHYMETRY

FRESH POND BATHYMETRY



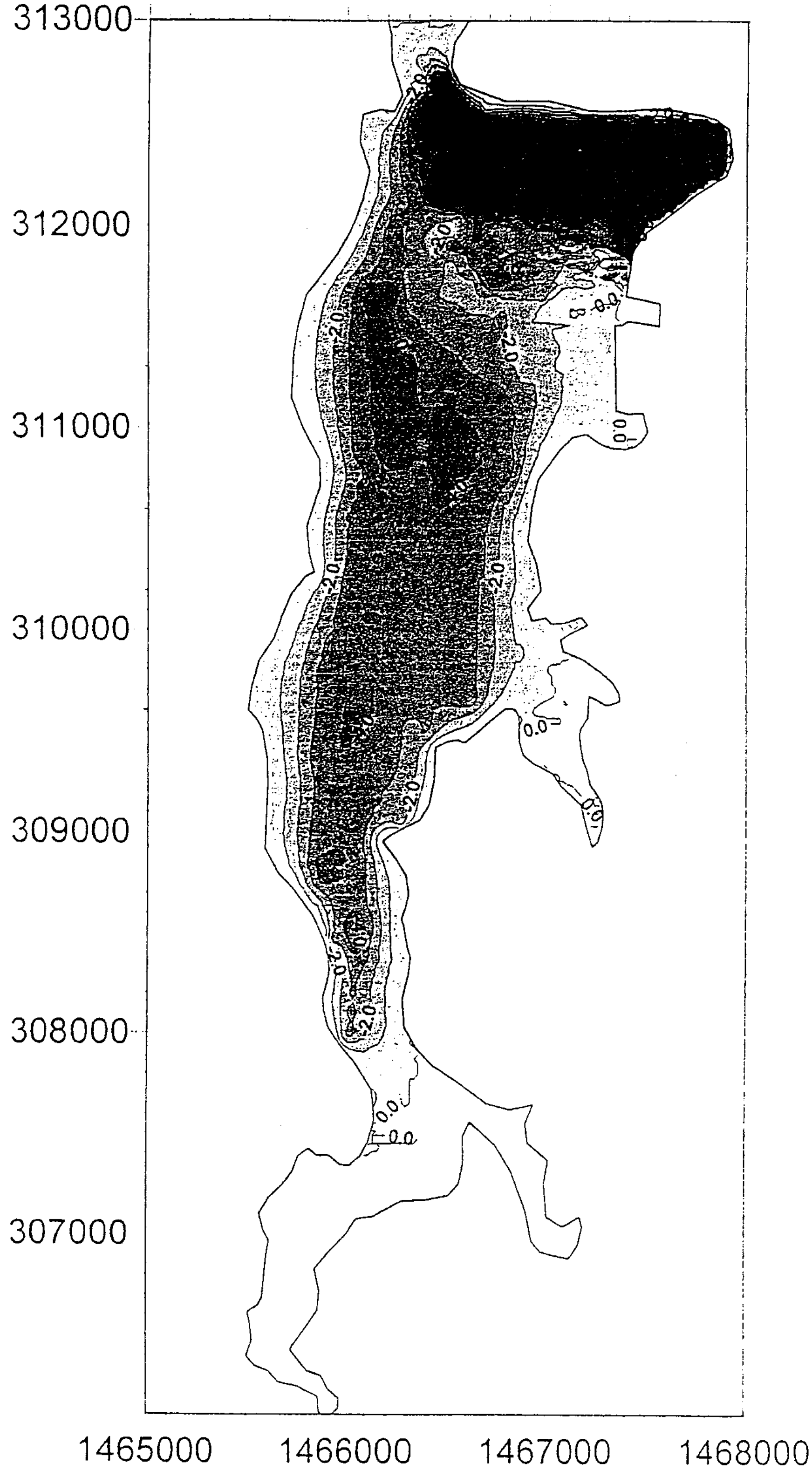
CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 25, 1998	Horizontal Coordinates: NAD 83, NY State Plane, L.I. (feet) Vertical Reference: Mean Low Water
Survey Vessel: Spartina	Contour Interval: 0.5 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLW.
Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan.

NORTHWEST CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 24, 1998

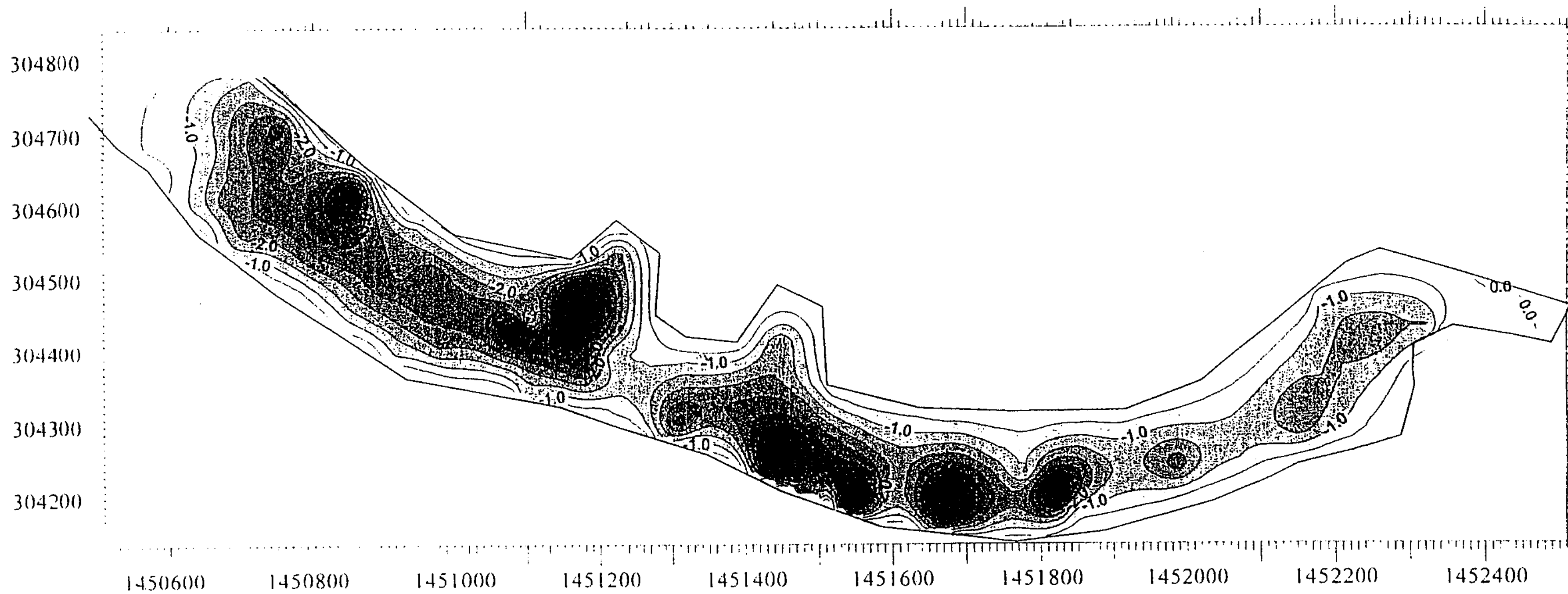
Horizontal Coordinates: NAD 83 NY State Plane L I (feet)
Vertical Reference: Mean Lower Low Water

Survey Vessel: Spartina

Contour Interval: 1 foot

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW
Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan

LIGONEE CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: July 28, 1998

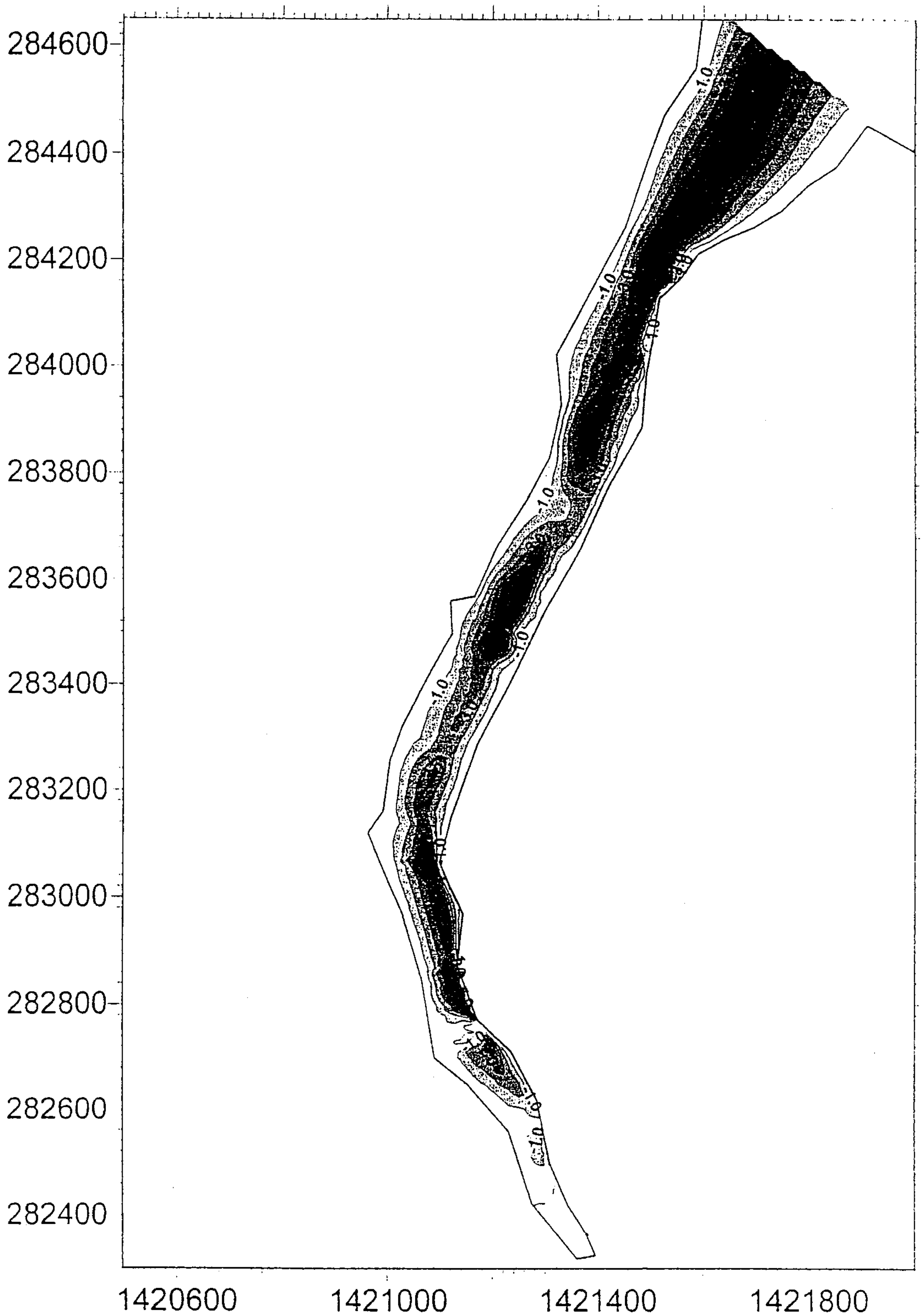
Horizontal Coordinates: NAD 83, NY State Plane, L I (feet)
Vertical Reference: Mean Lower Low Water

Survey Vessel: Spartina

Contour Interval: 0.5 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW. Soundings collected outside of the digital shoreline file provided by FEA, Inc. are not depicted on this plan.

ALEWIFE CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 24, 1998

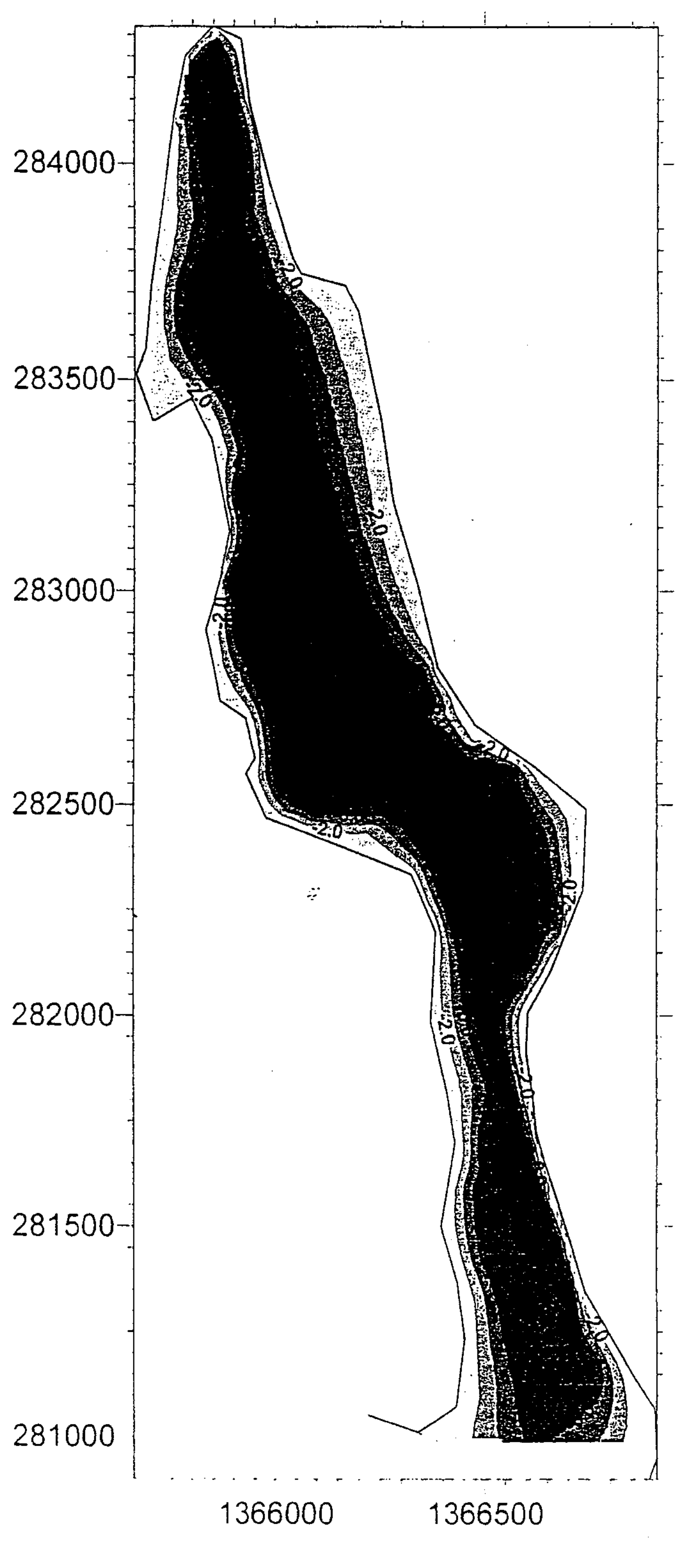
Horizontal Coordinates: NAD 83, NY State Plane, L I (feet)
Vertical Reference: Mean Lower Low Water

Survey Vessel: Spartina

Contour Interval: 1 foot

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW
Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan.

MEETINGHOUSE CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date April 21, 1998

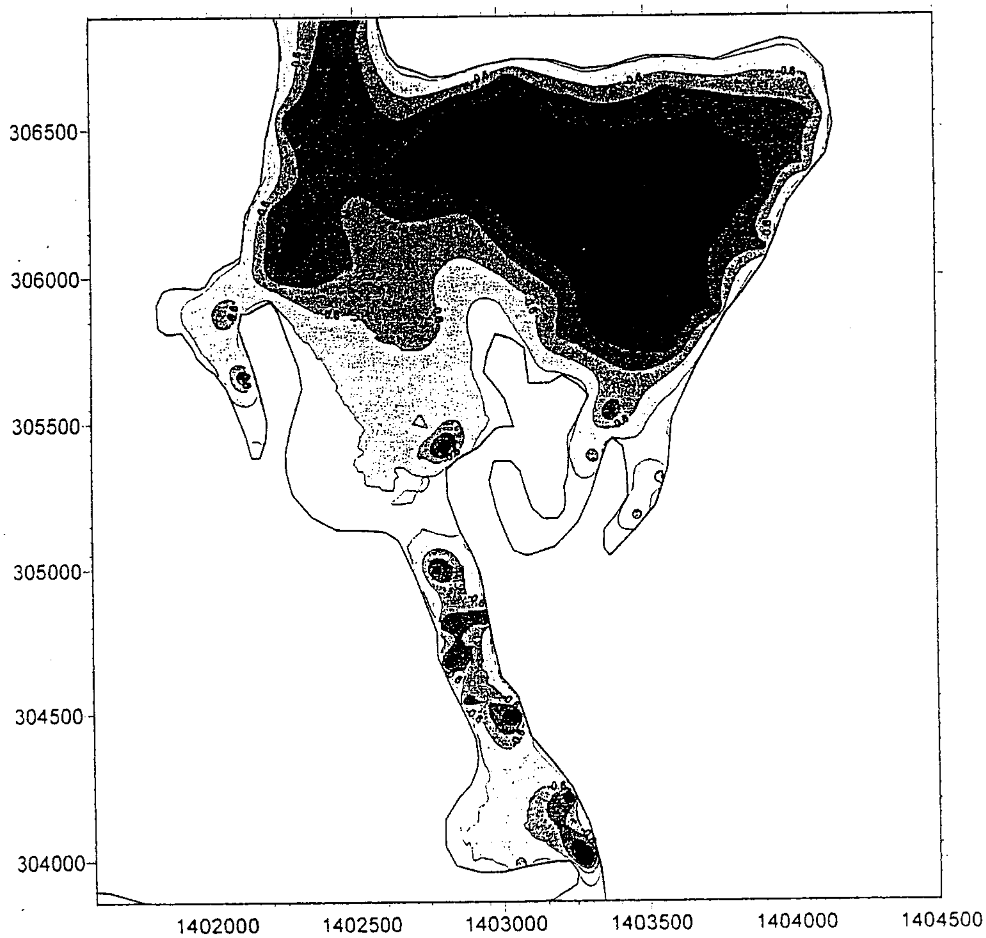
Horizontal Coordinates NAD 83 NY State Plane LI (feet)
Vertical Reference Mean Lower Low Water

Survey Vessel Spartina

Contour Interval 2 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW
Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan

WEST CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 20, 1998

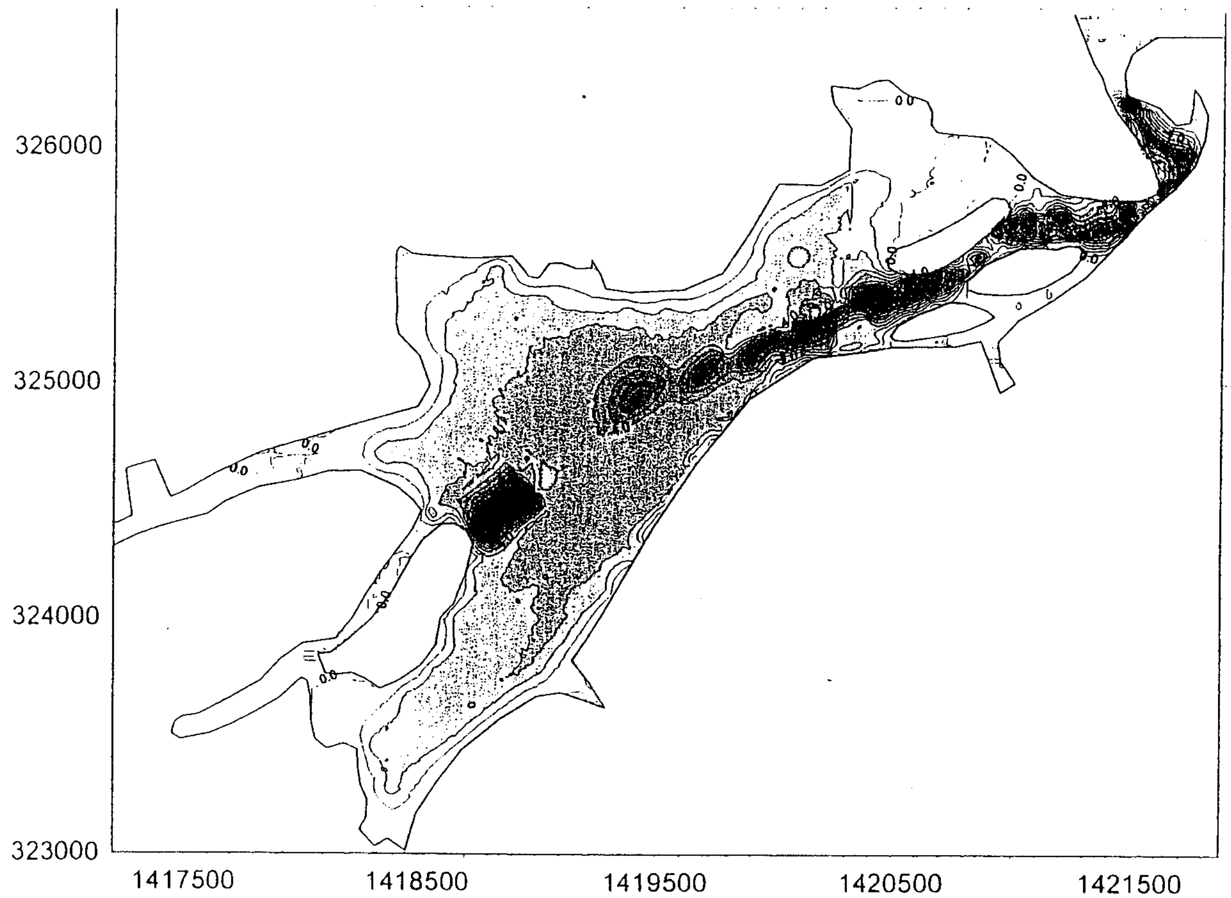
Horizontal Coordinates: NAD 83, NY State Plane, L.I (feet)
Vertical Reference: Mean Lower Low Water

Survey Vessel: Spartina

Contour Interval: 0.5 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW
Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan.

GOOSE CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 20, 1998

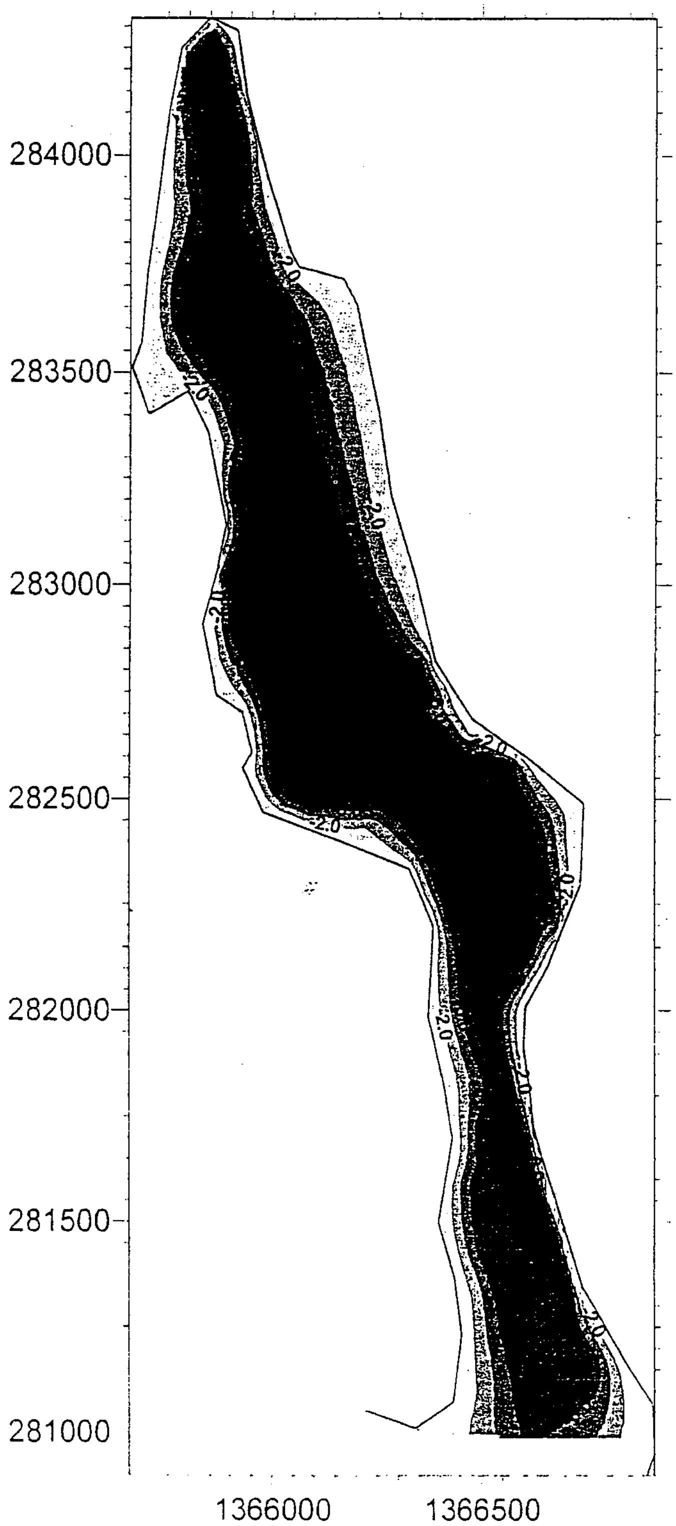
Horizontal Coordinates: NAD 83, NY State Plane, LI (feet)
Vertical Reference: Mean Low Water

Survey Vessel: Spartina

Contour Interval: 1 foot

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLW. Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan.

MEETINGHOUSE CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date April 21 1998

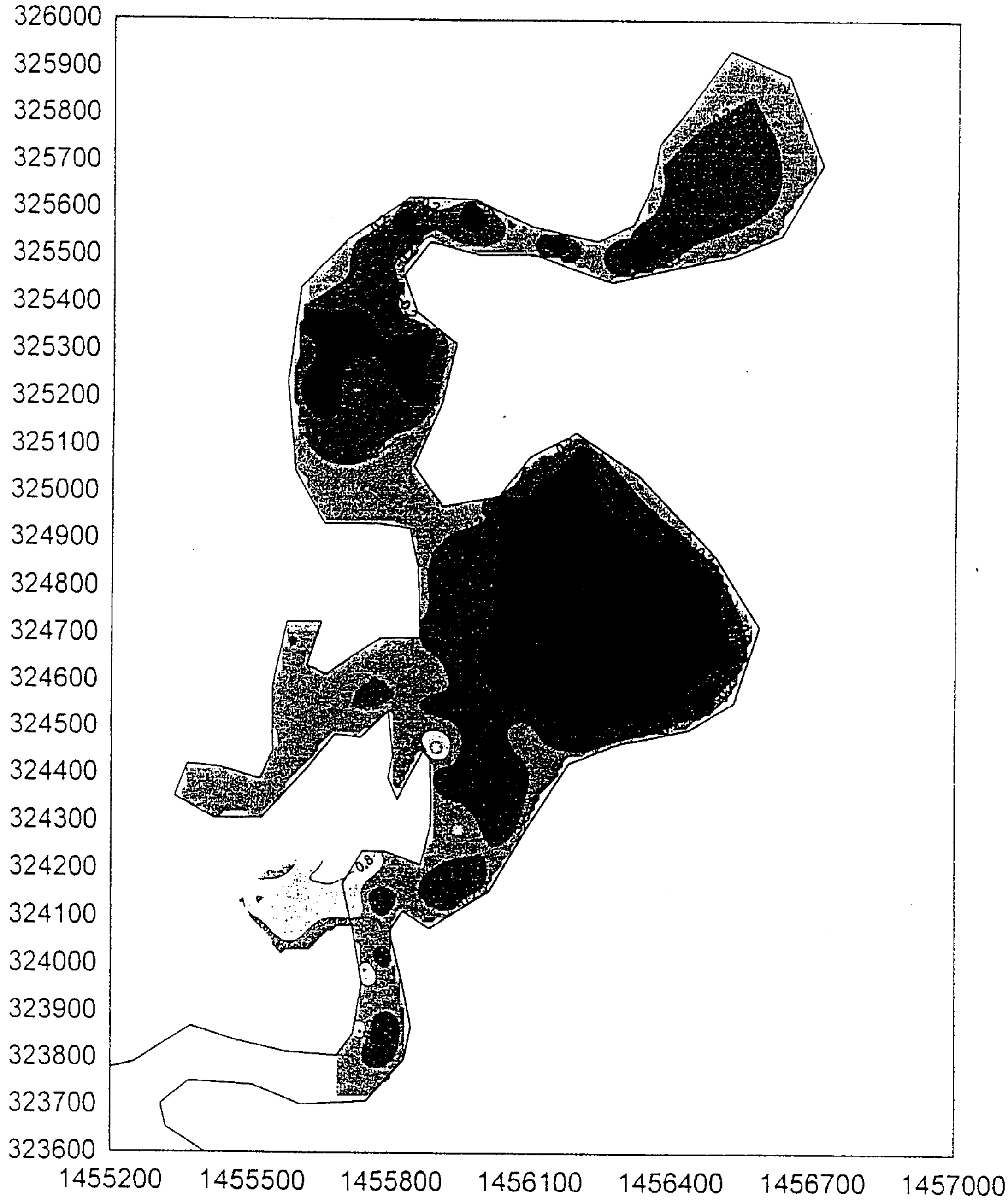
Horizontal Coordinates NAD 83 NY State Plane (feet)
Vertical Reference Mean Lower Low Water

Survey Vessel Spartina

Contour Interval 2 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW
Soundings collected outside of the digital shoreline file provided by EEA, Inc are not depicted on this plan

BASS CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date. July 28, 1998

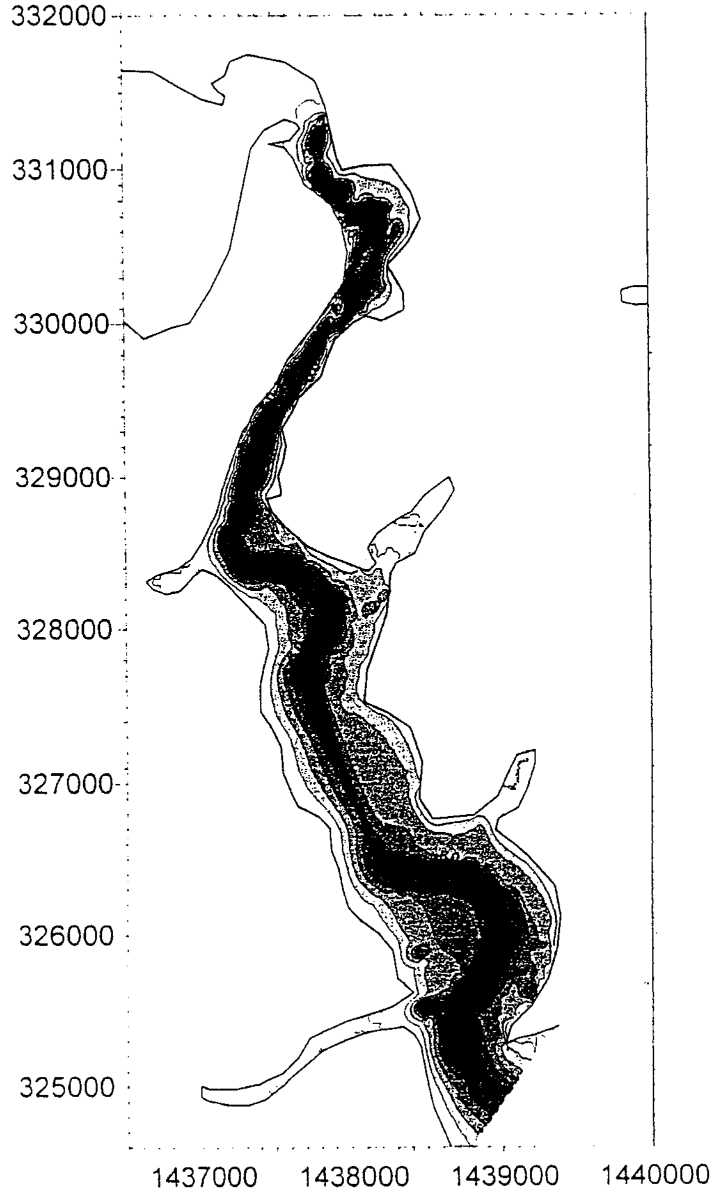
Horizontal Coordinates: NAD 83, NY State Plane, LI (feet)
Vertical Reference: Mean Lower Low Water

Survey Vessel: R/V Cyprinodon

Contour Interval: 0.5 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW
Some soundings collected outside of the digital shoreline file provided by EEA, Inc. are depicted on this plan.

WEST NECK CREEK BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 22, 1998

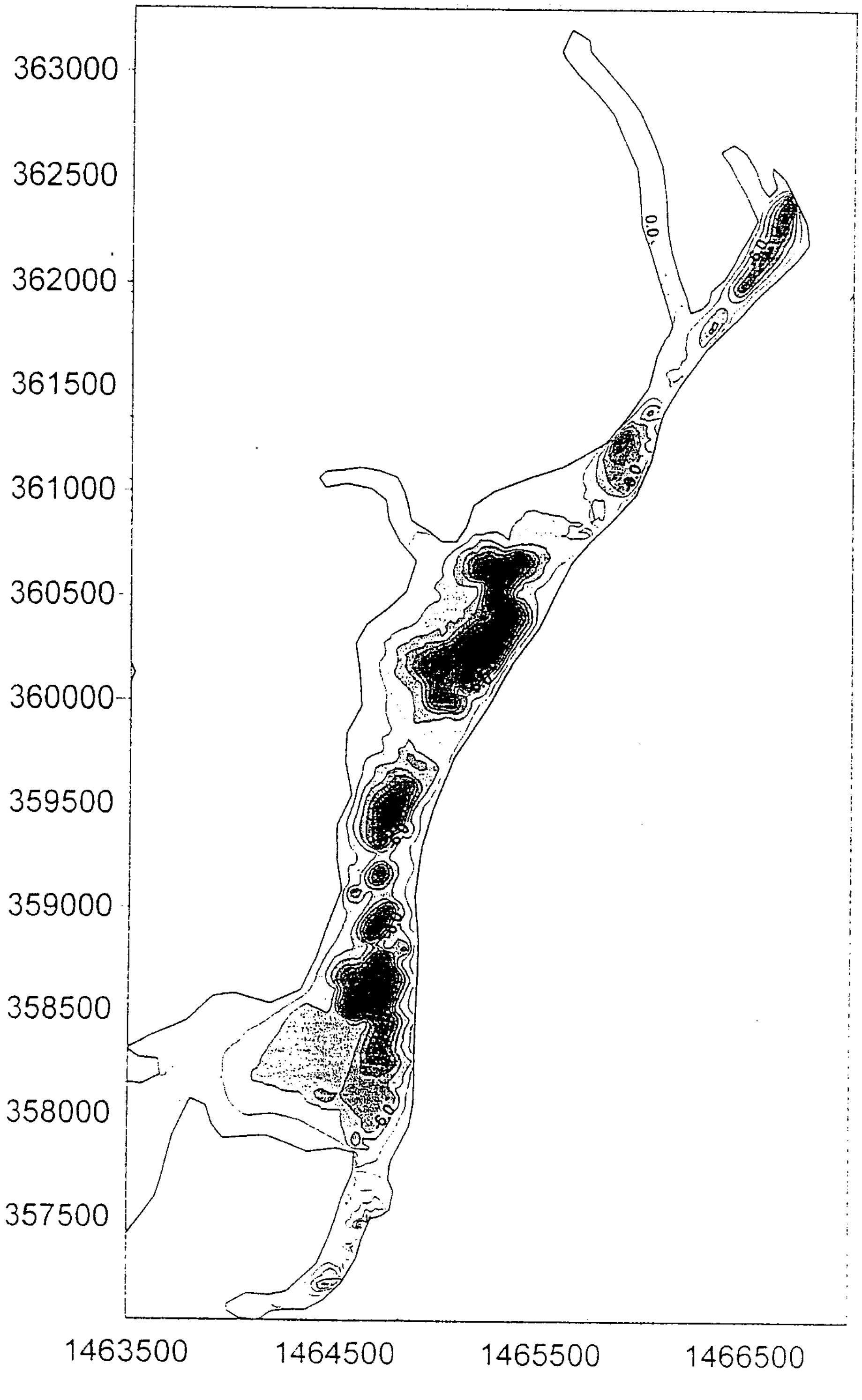
Horizontal Coordinates: NAD 83, NY State Plane, L I (feet)
Vertical Reference: Mean Low Water

Survey Vessel: Spartina

Contour Interval: 2 feet

For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLW
Soundings collected outside of the digital shoreline file provided by EEA, Inc are not depicted on this plan

LITTLE BAY, ORIENT POINT
BATHYMETRY



CR Environmental, Inc.

639 Boxberry Hill Road
East Falmouth, Massachusetts 02536

Survey Date: April 21, 1998	Horizontal Coordinates: NAD 83 NY State Plane LI (feet) Vertical Reference: Mean Lower Low Water
Survey Vessel: Spartina	Contour Interval: 2 feet

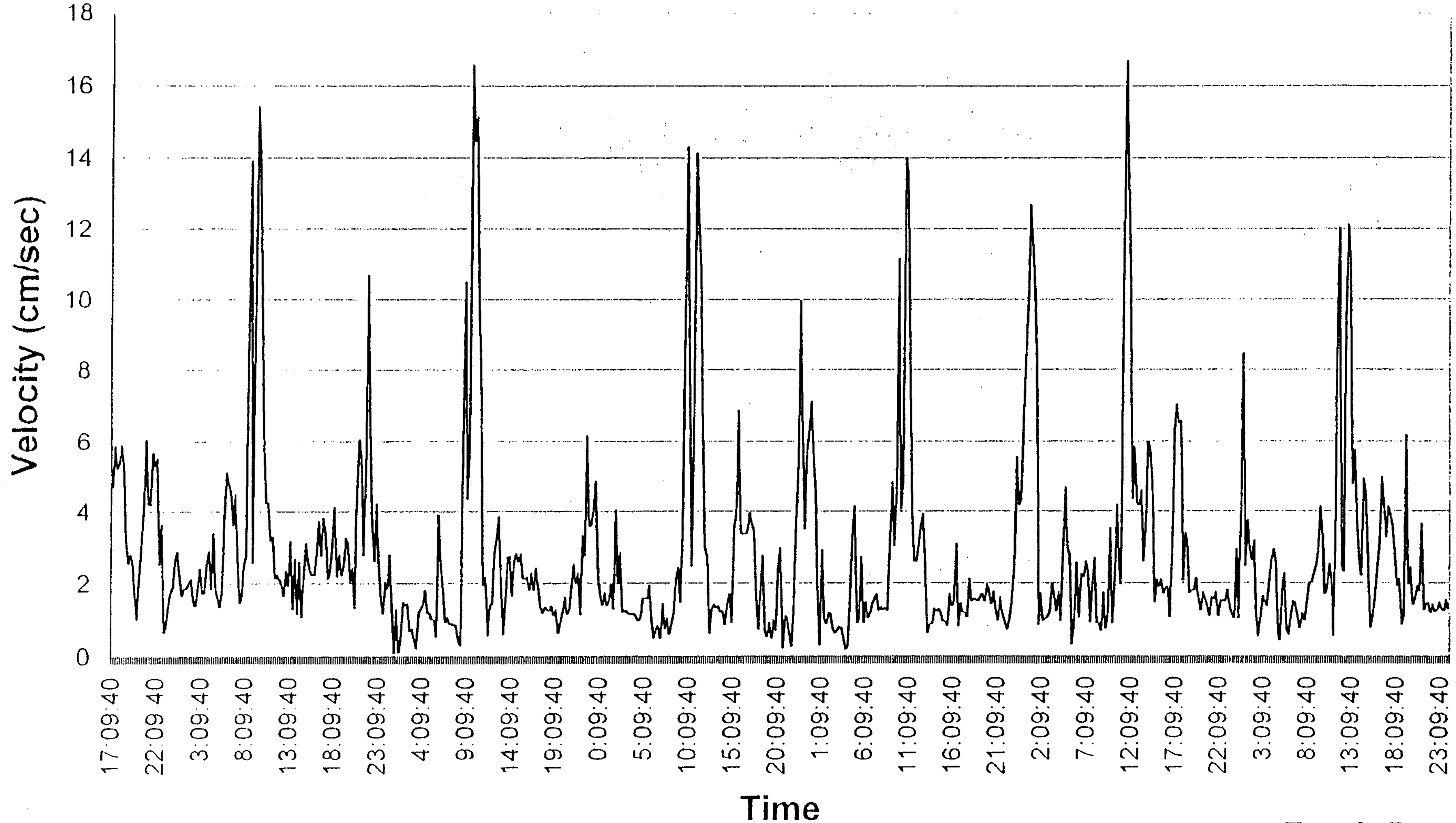
For the purposes of preparing this contour map, the shoreline elevation was assumed to equal zero feet MLLW.
Soundings collected outside of the digital shoreline file provided by EEA, Inc. are not depicted on this plan.

APPENDIX C

HYDROGRAPHIC CHARTS

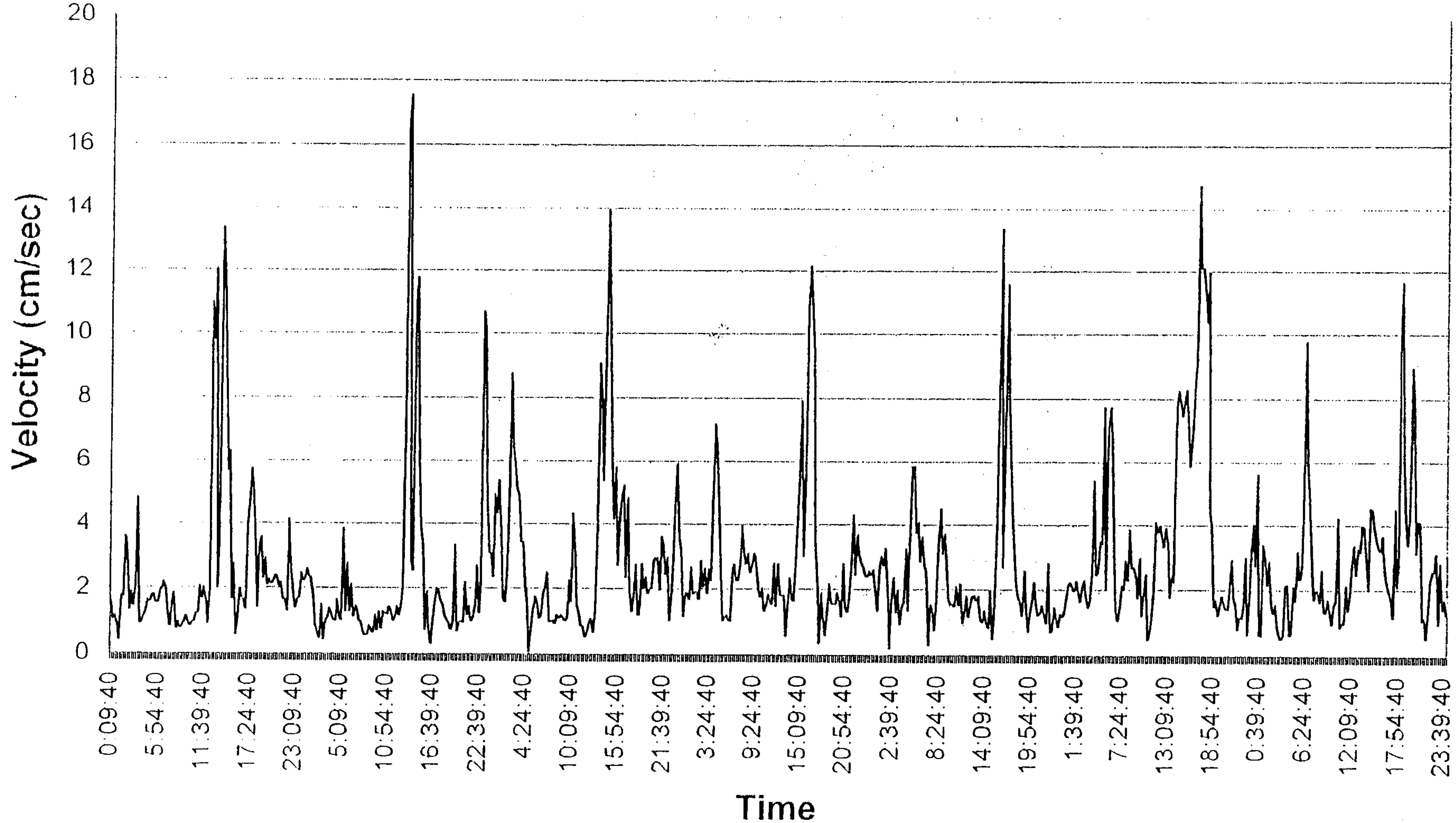
Fresh Pond Creek

Fresh Pond from 9/30/97 to 10/6/97

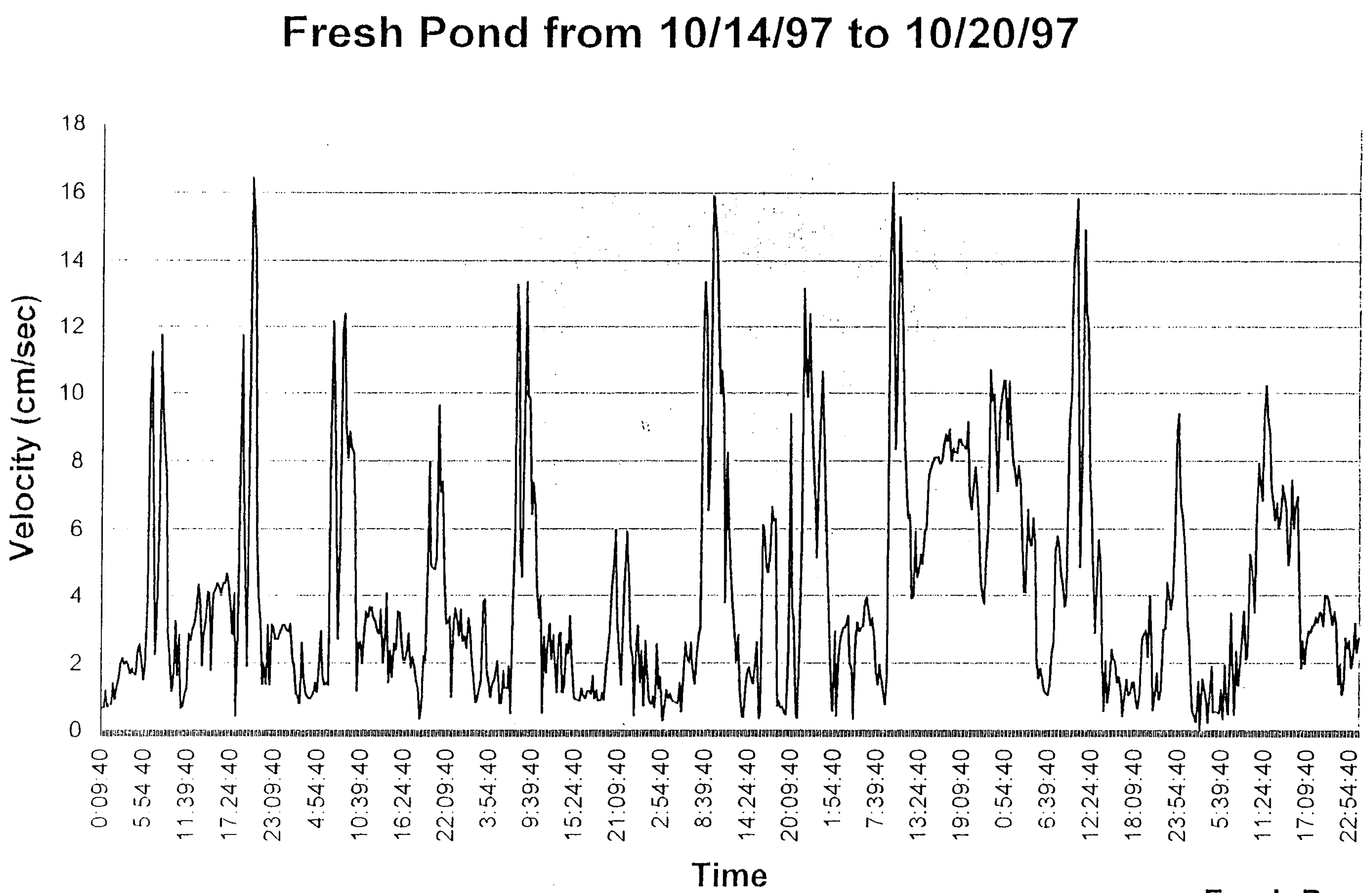


Fresh Pond
9/30/97 - 10/6/97
Velocity

Fresh Pond from 10/7/97 to 10/13/97

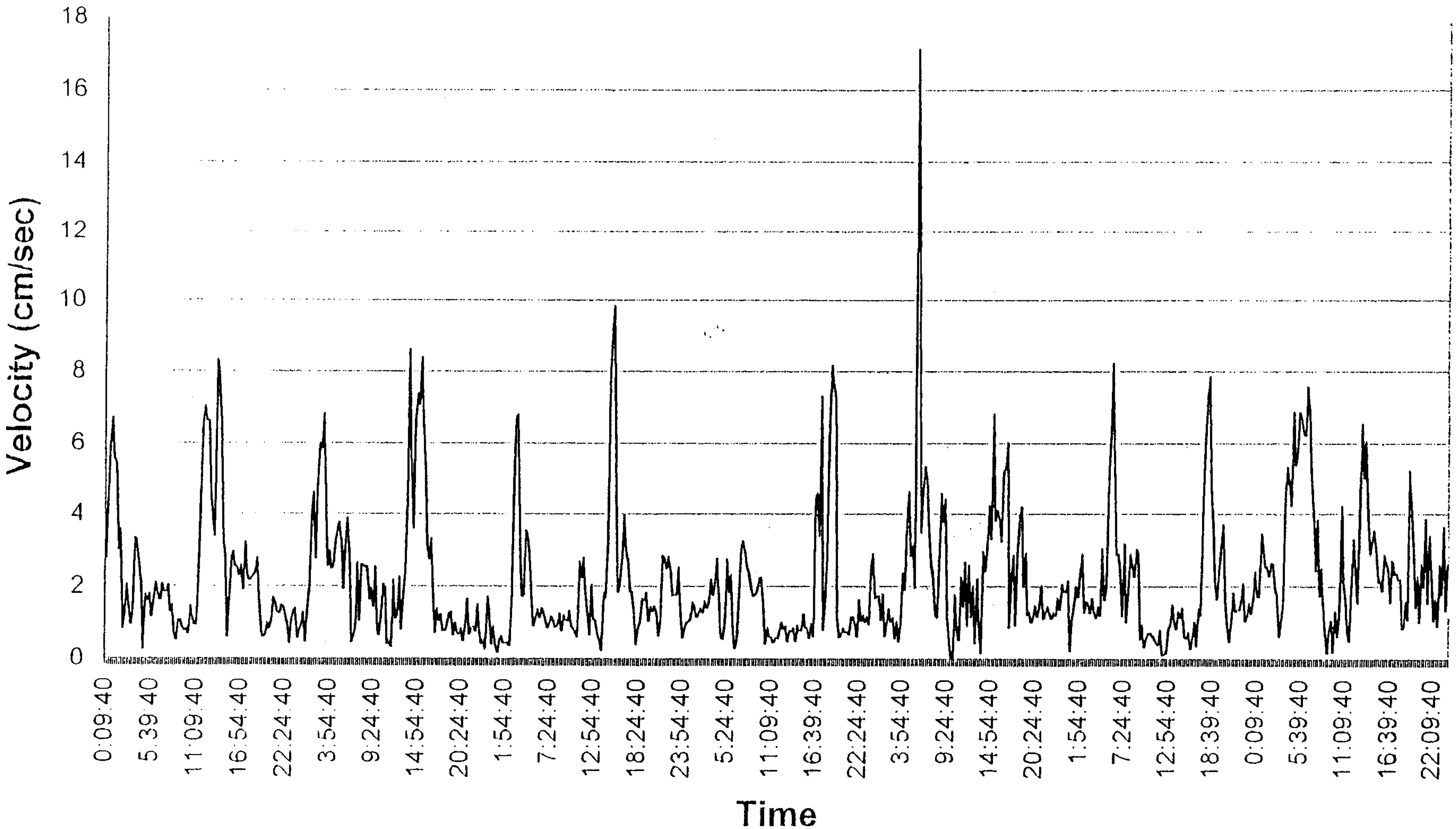


Fresh Pond
10/7/97 - 10/13/97
Velocity



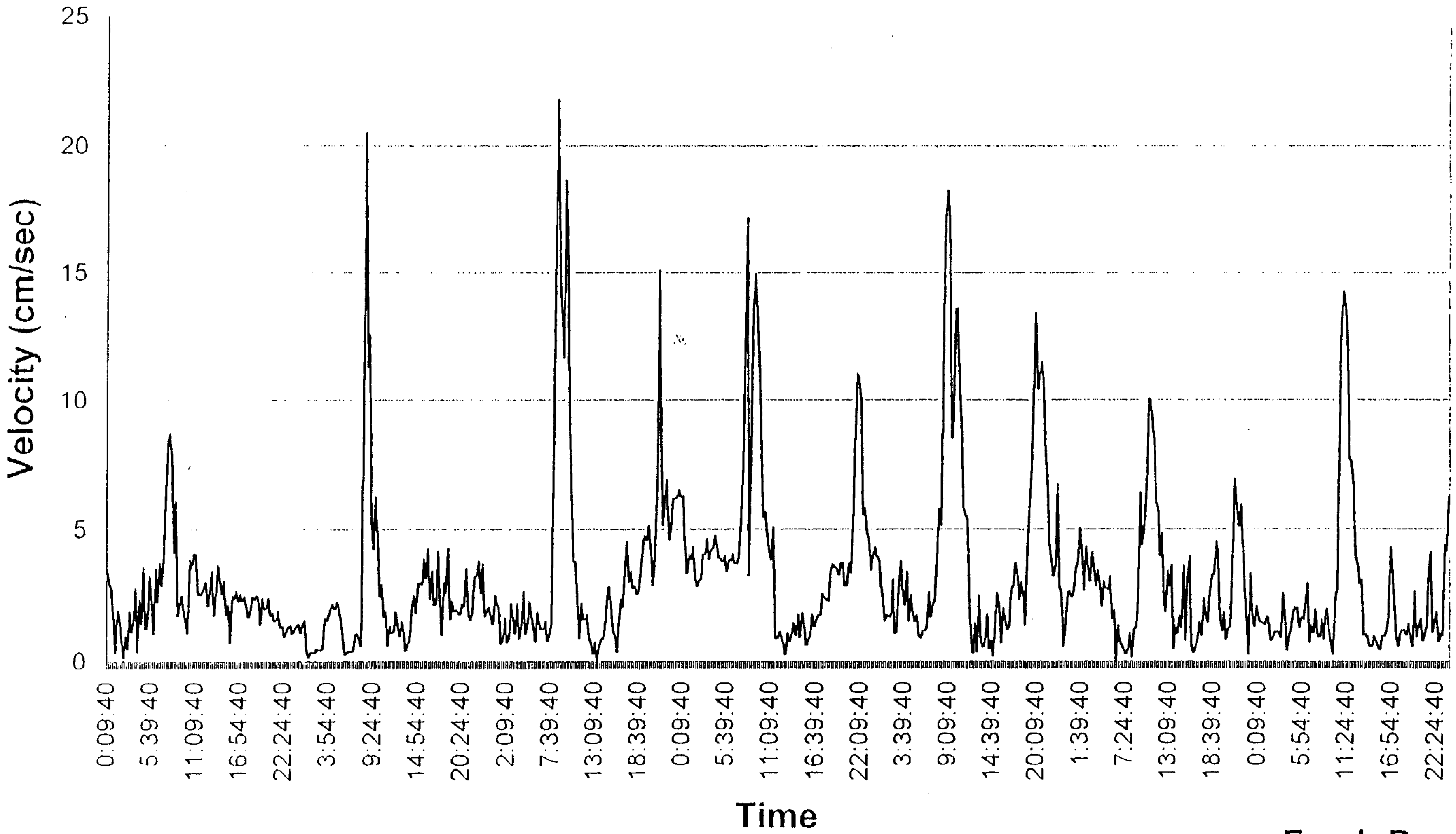
Fresh Pond
10/14/97 - 10/20/97
Velocity

Fresh Pond from 10/21/97 to 10/27/97



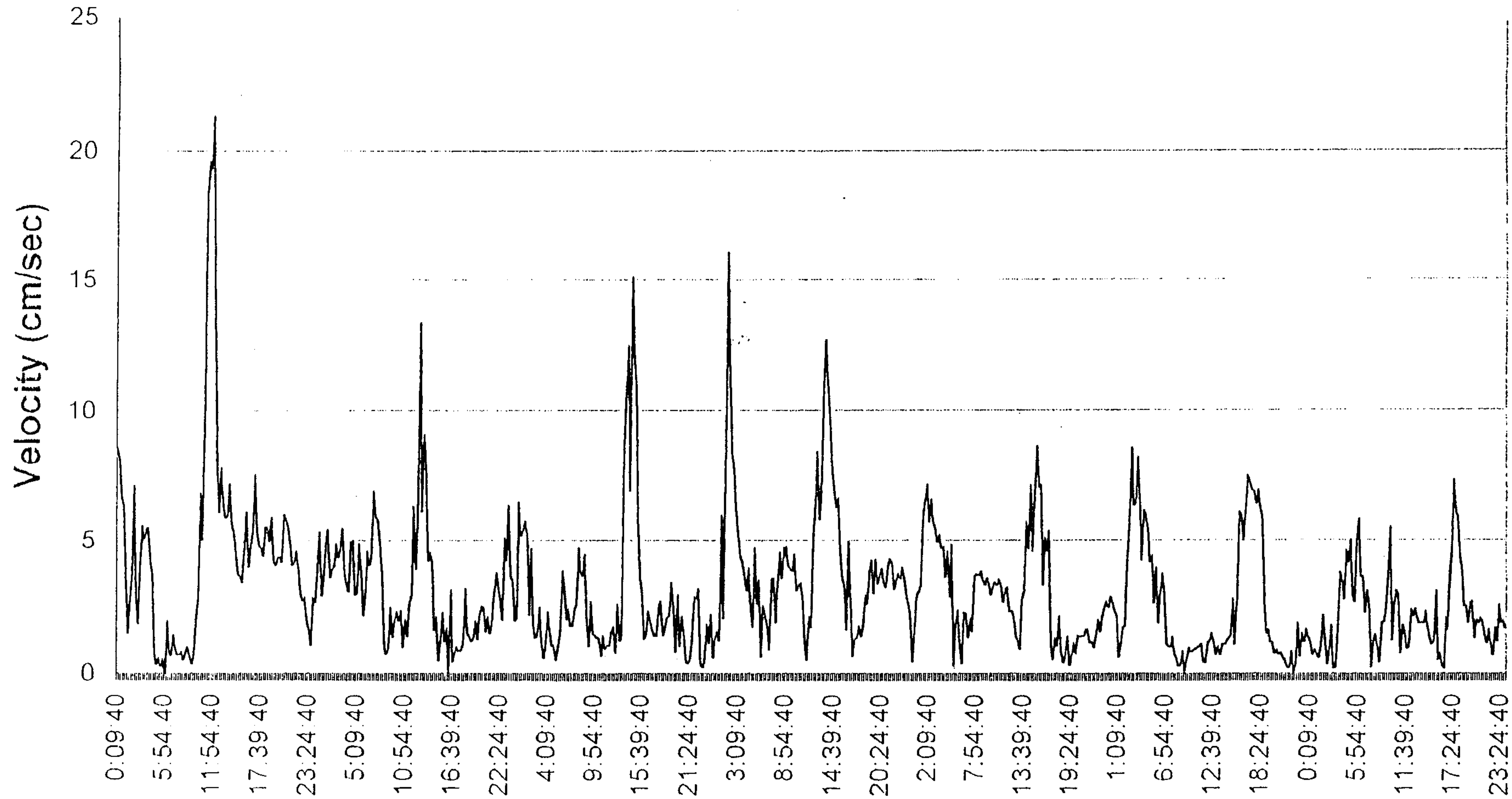
Fresh Pond
10/21/97 - 10/27/97
Velocity

Fresh Pond from 10/28/97 to 11/3/97



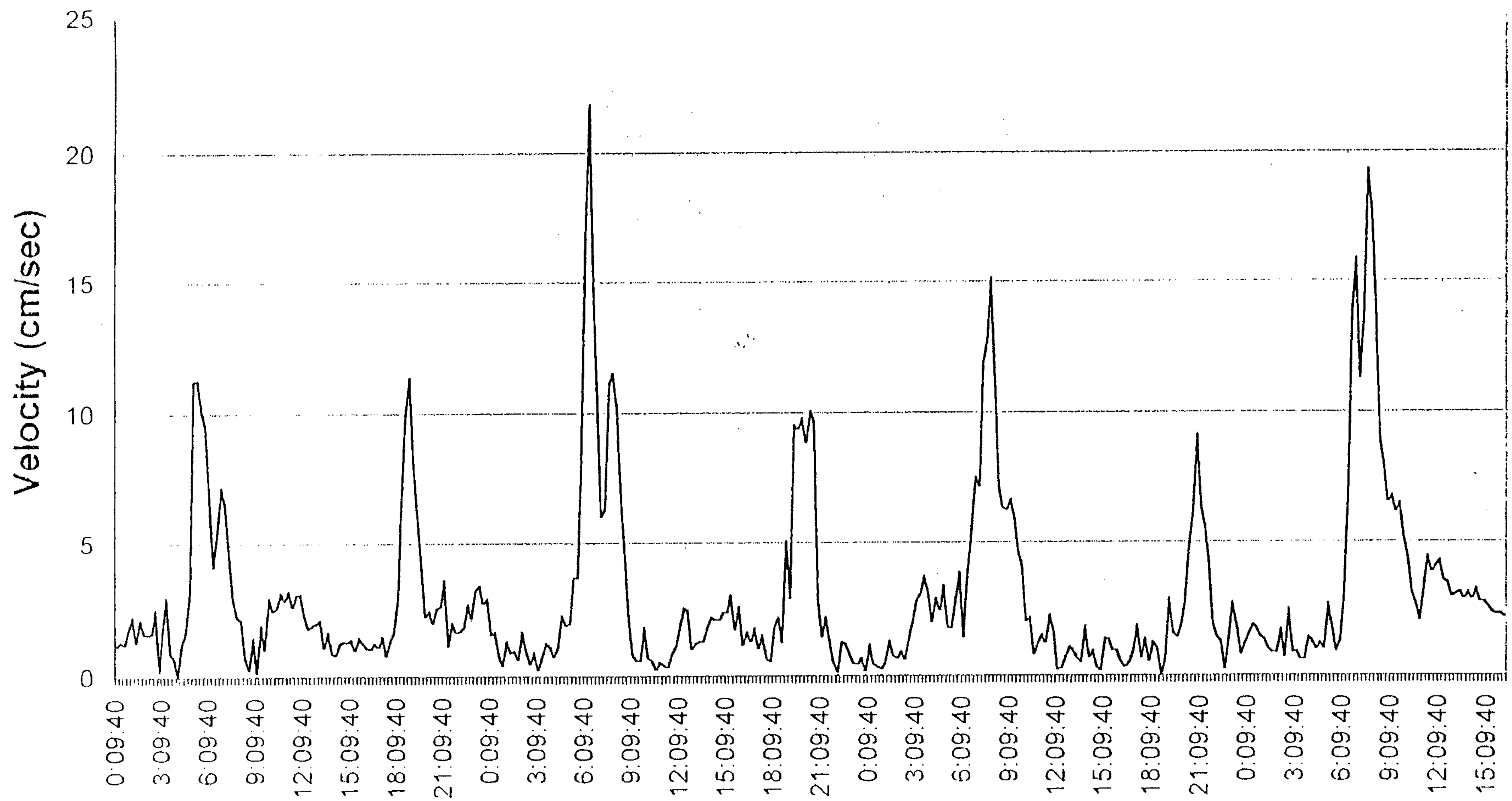
Fresh Pond
10/28/97 - 11/3/97
Velocity

Fresh Pond from 11/4/97 to 11/10/97



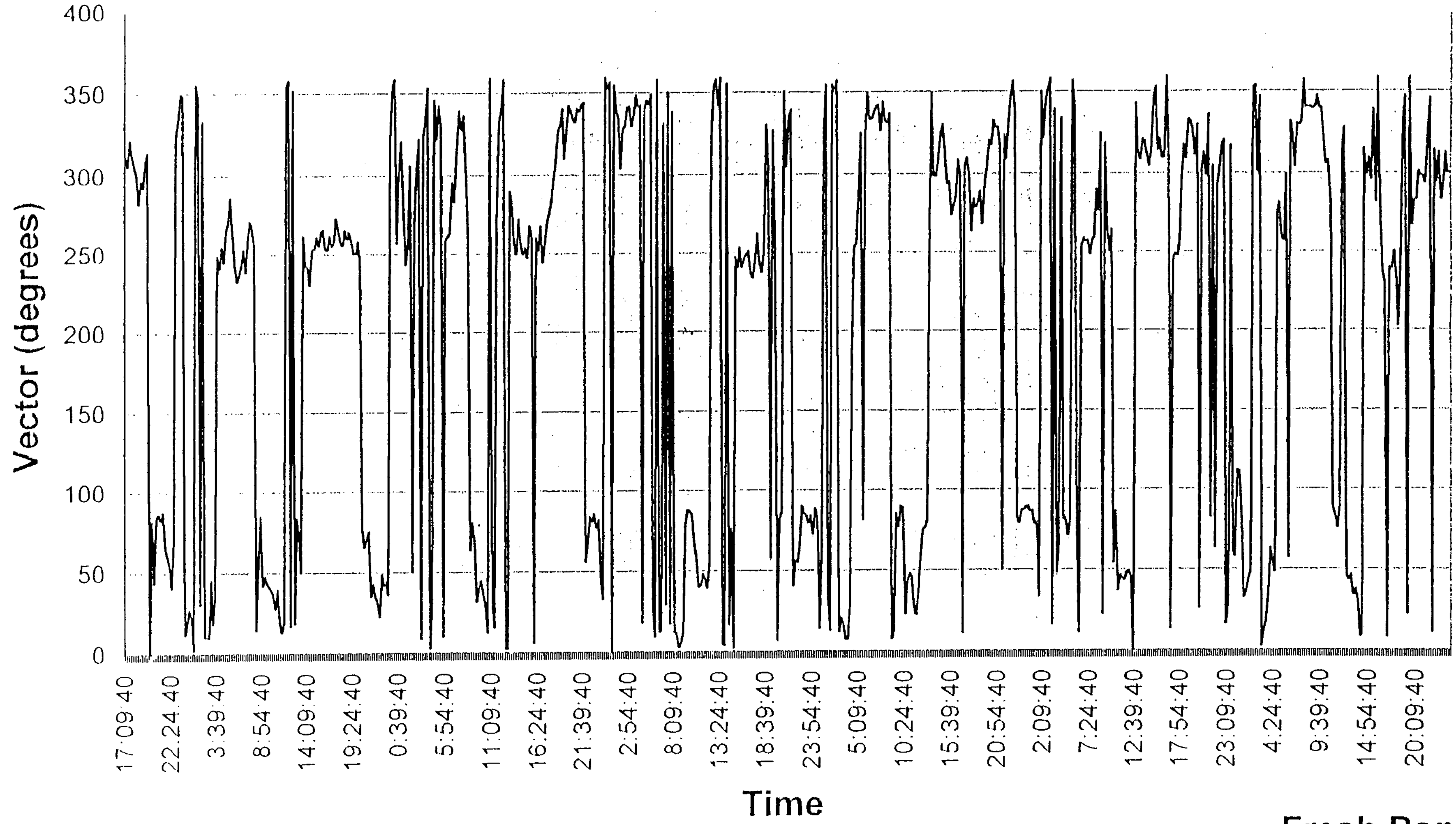
Fresh Pond
11/4/97 to 11/10/97
Velocity

Fresh Pond from 11/11/97 to 11/14/97



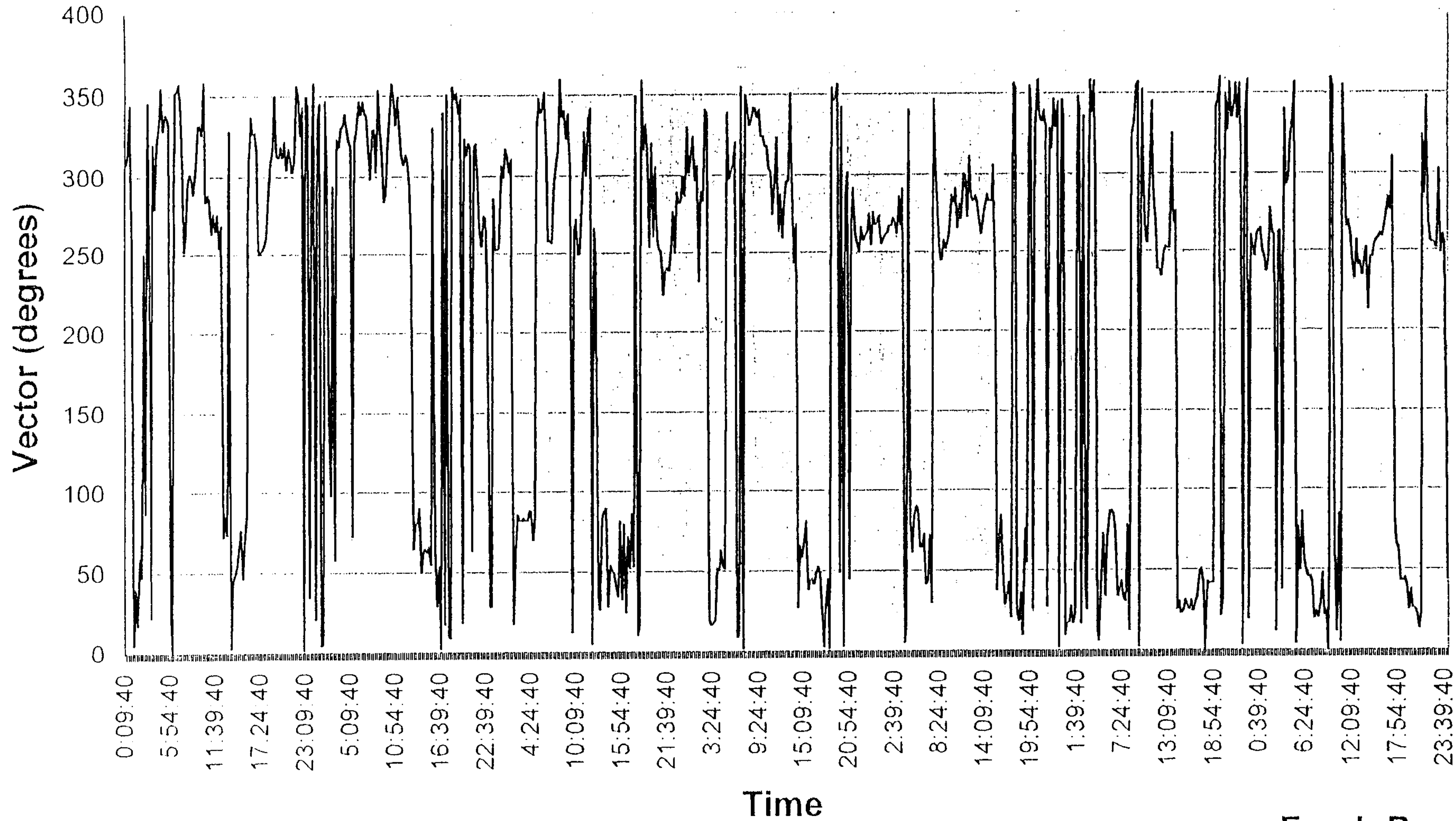
Fresh Pond
11/11/97 - 11/14/97
Velocity

Fresh Pond from 9/30/97 to 10/6/97



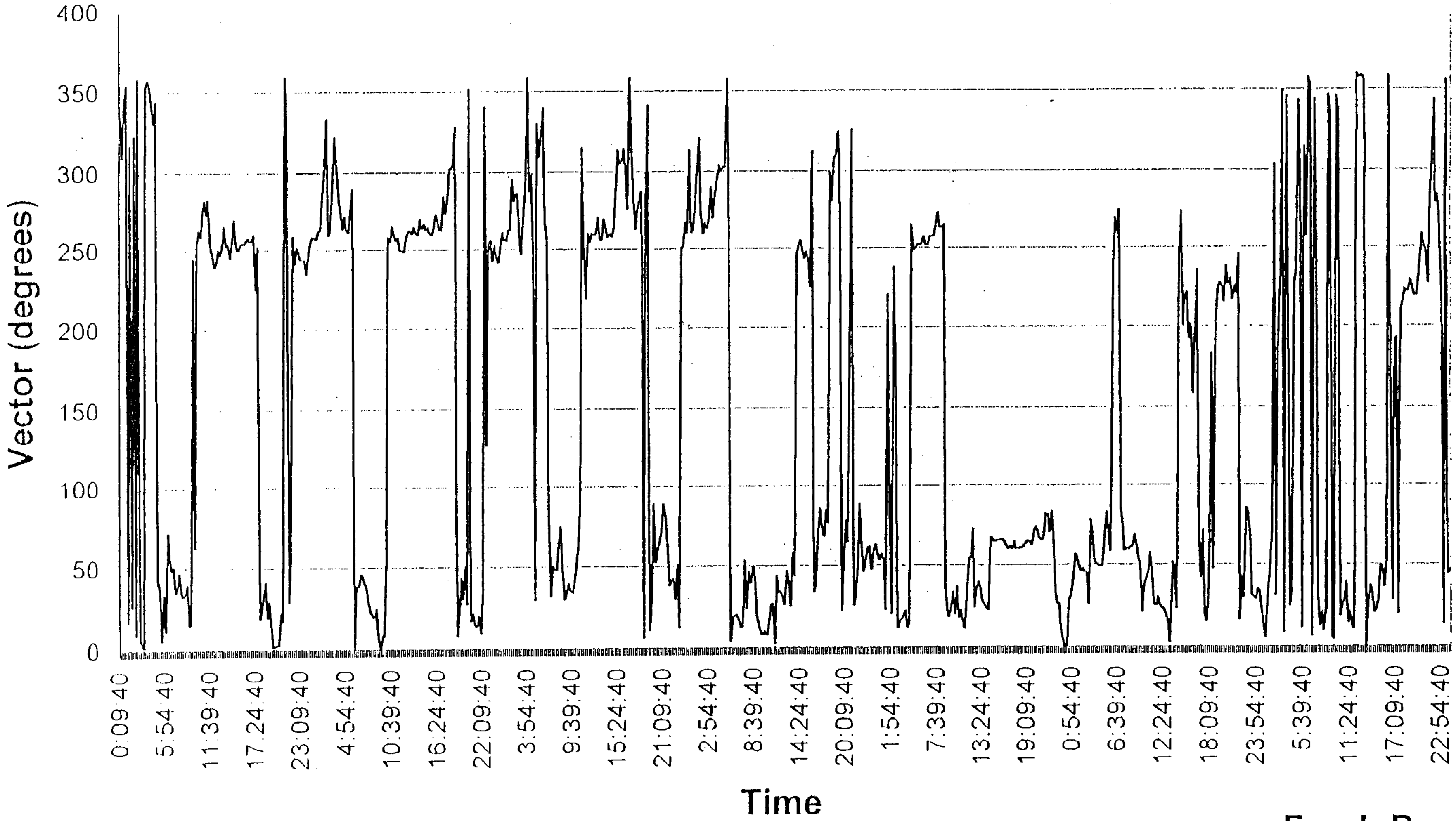
Fresh Pond
9/30/97 - 10/6/97
Vector

Fresh Pond from 10/7/97 to 10/13/97



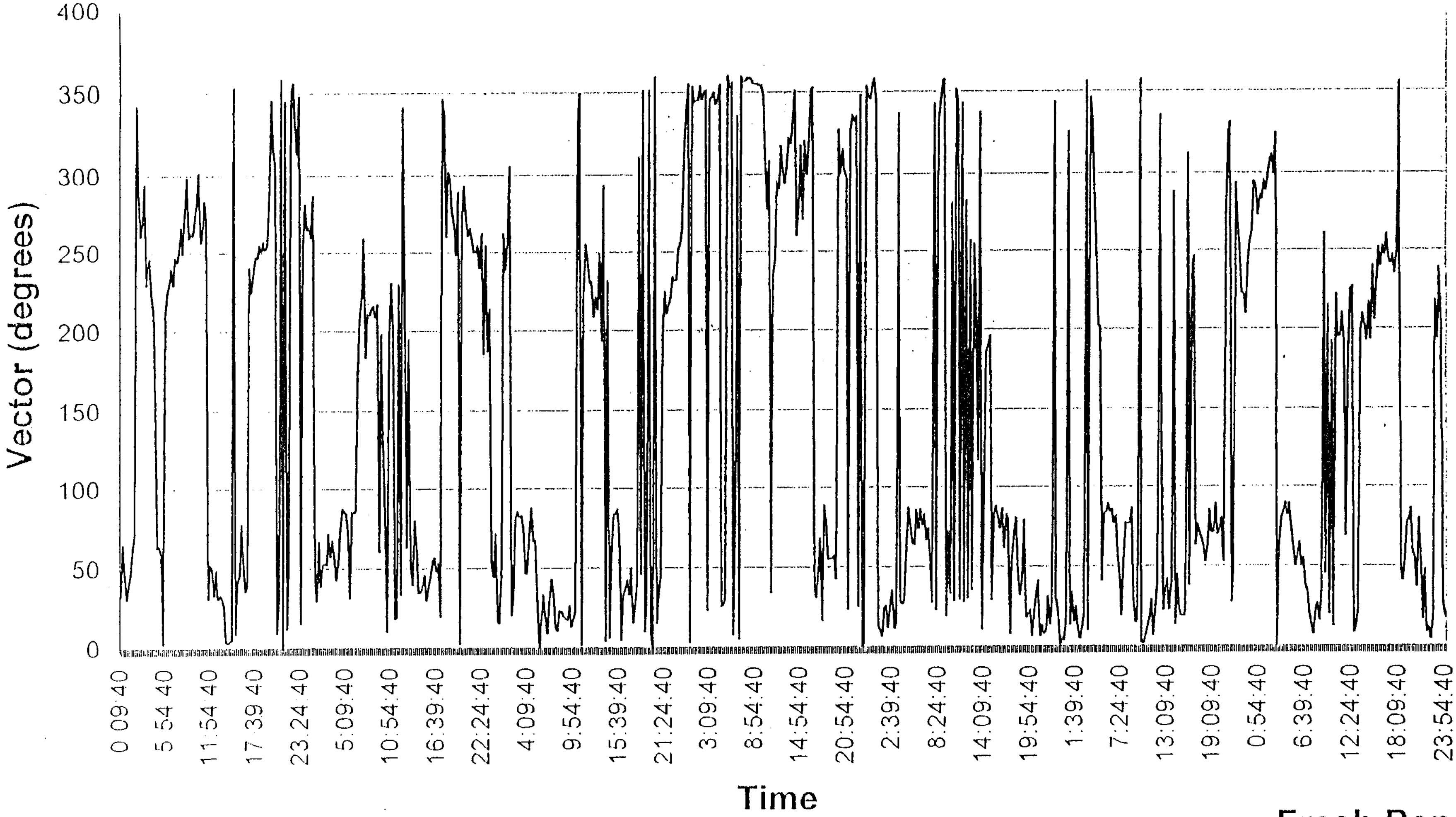
Fresh Pond
10/7/97 - 10/13/97
Vector

Fresh Pond from 10/14/97 to 10/20/97



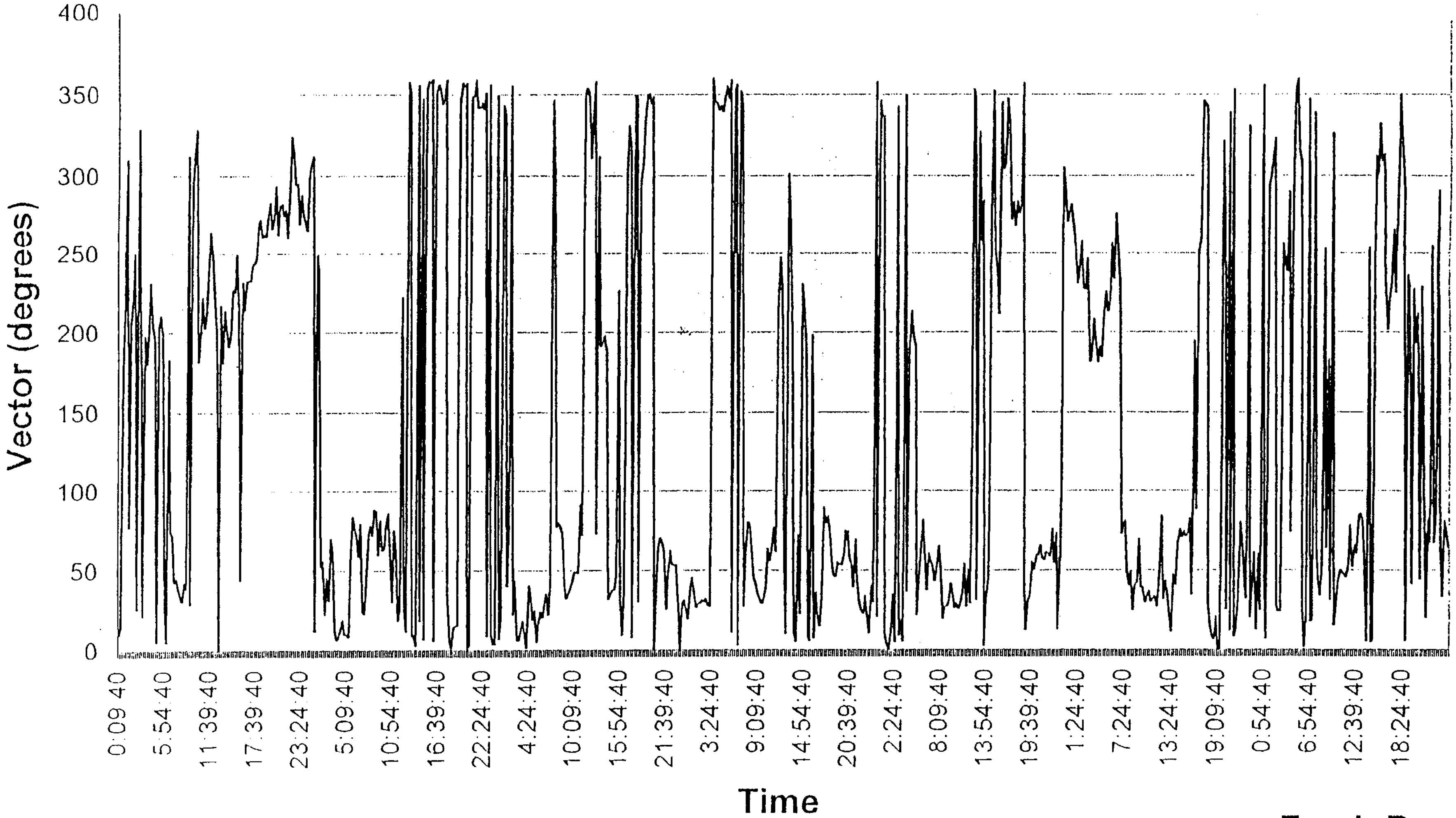
Fresh Pond
10/14/97 - 10/20/97
Vector

Fresh Pond from 10/21/97 to 10/27/97



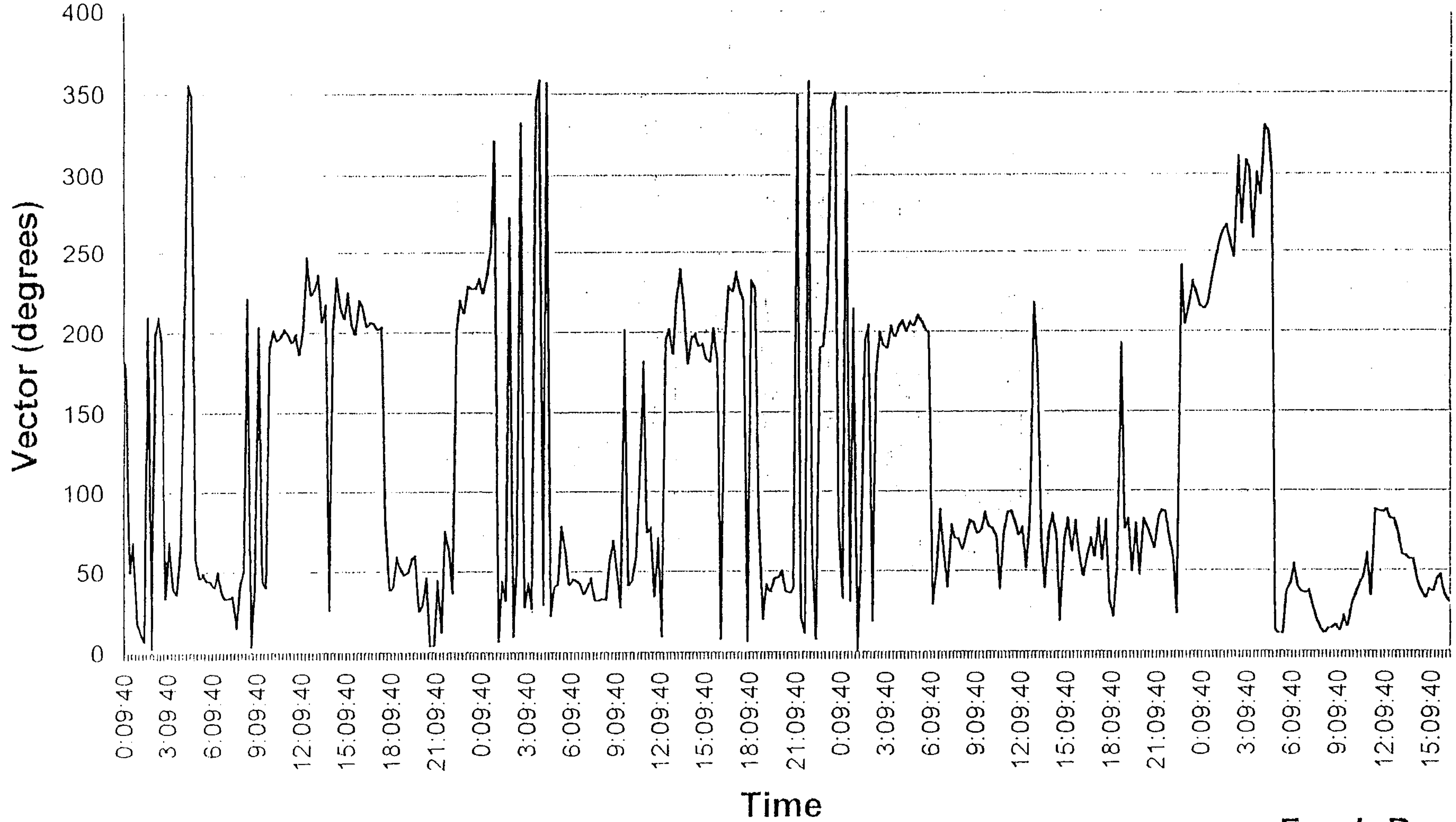
Fresh Pond
10/21/97 - 10/27/97
Vector

Fresh Pond from 10/28/97 to 11/3/97



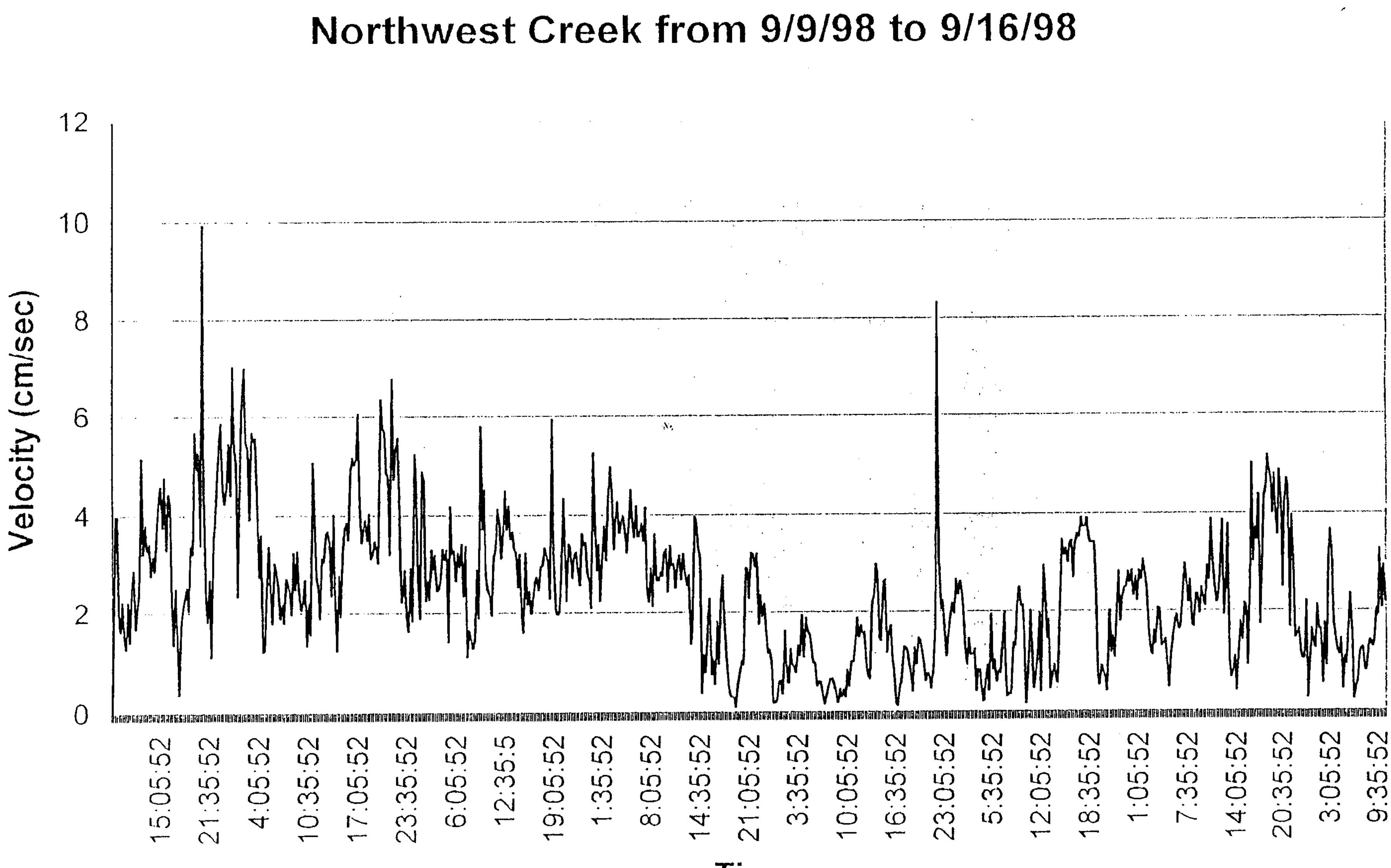
Fresh Pond
10/28/97 - 11/3/97
Vector

Fresh Pond from 11/11/97 to 11/14/97

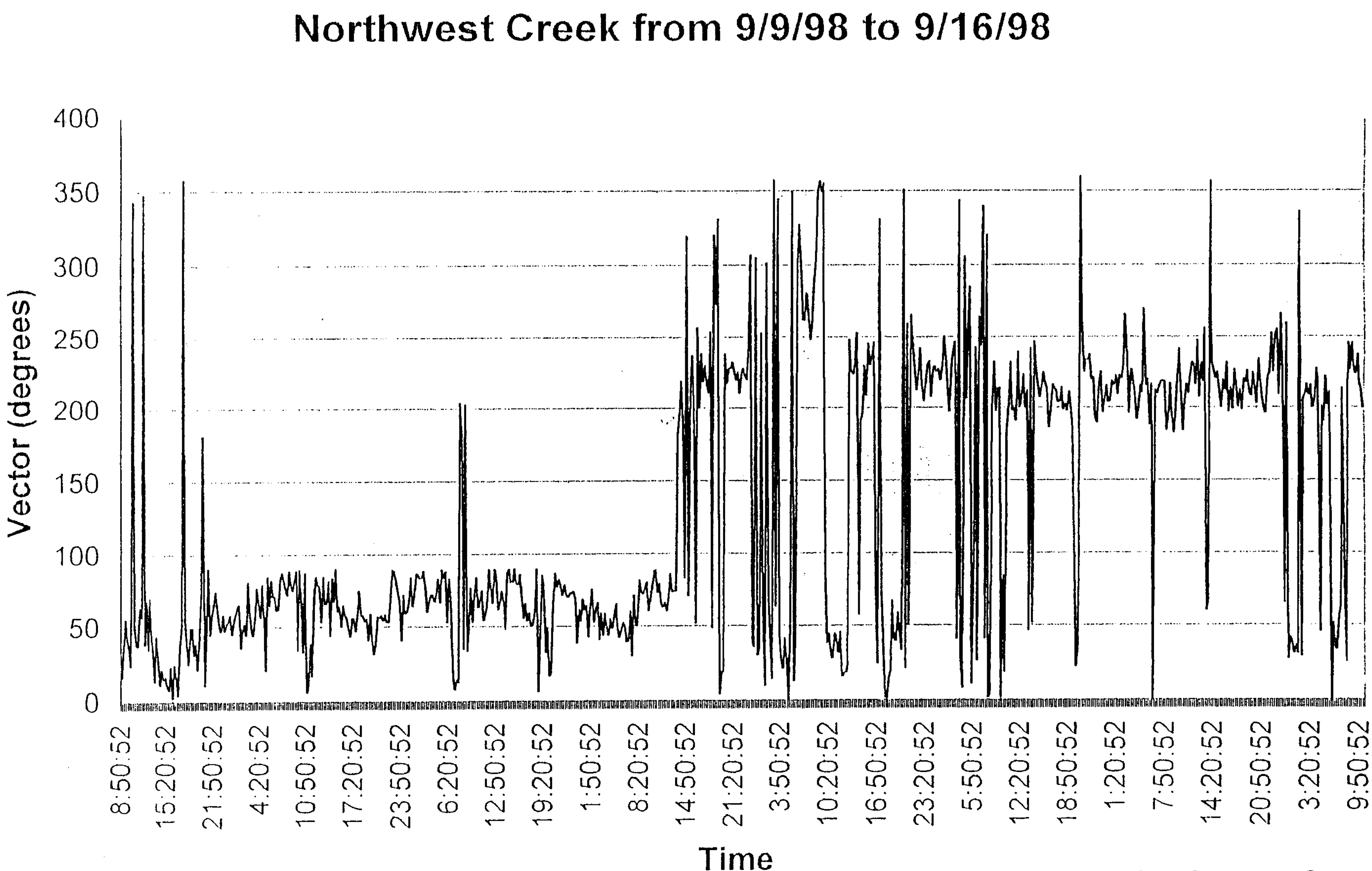


Fresh Pond
11/11/97 - 11/14/97
Vector

Northwest Creek

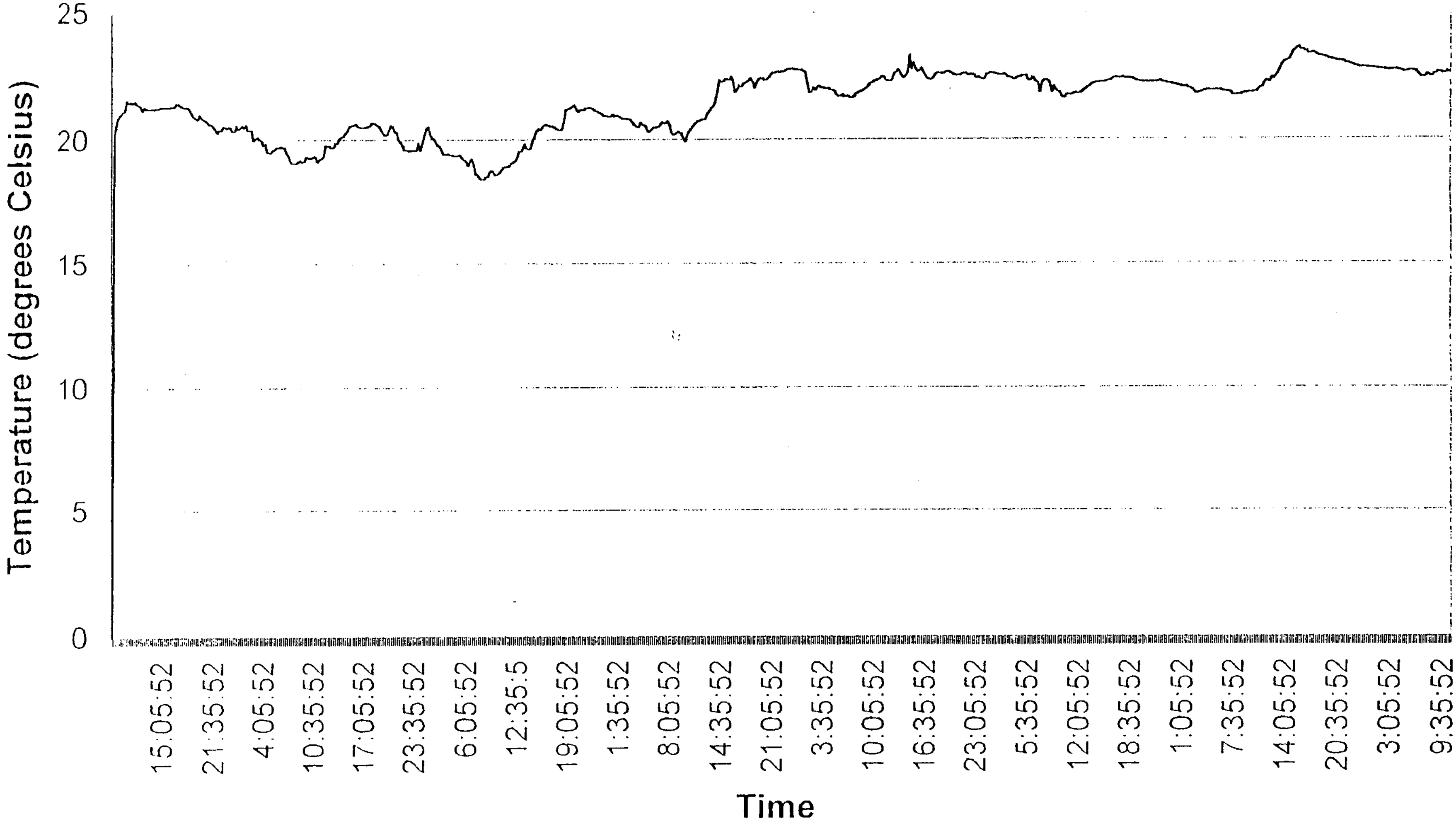


Northwest Creek
9/9/98 - 9/16/98
Velocity

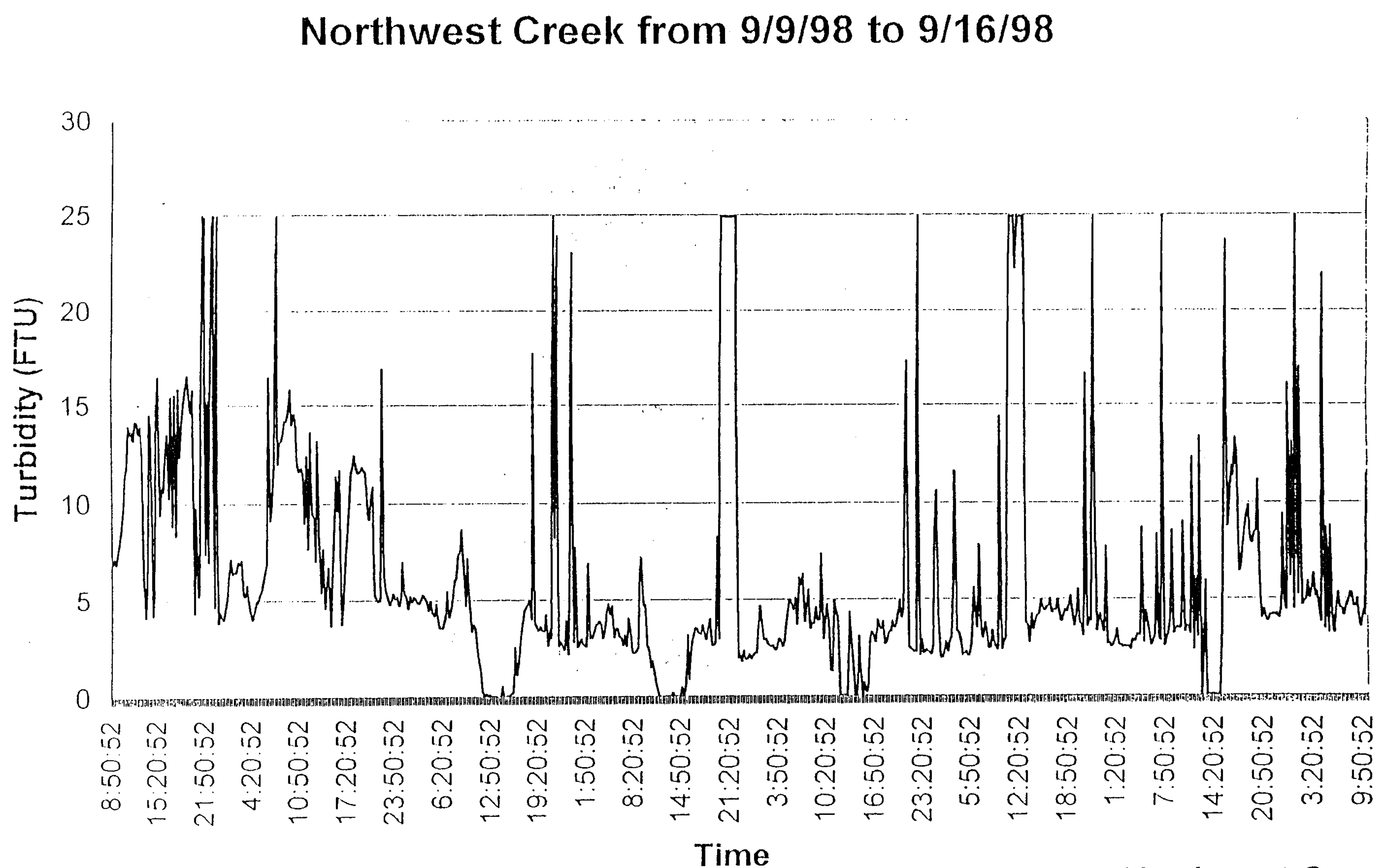


Northwest Creek
9/9/98 - 9/16/98
Vector

Northwest Creek from 9/9/98 to 9/16/98

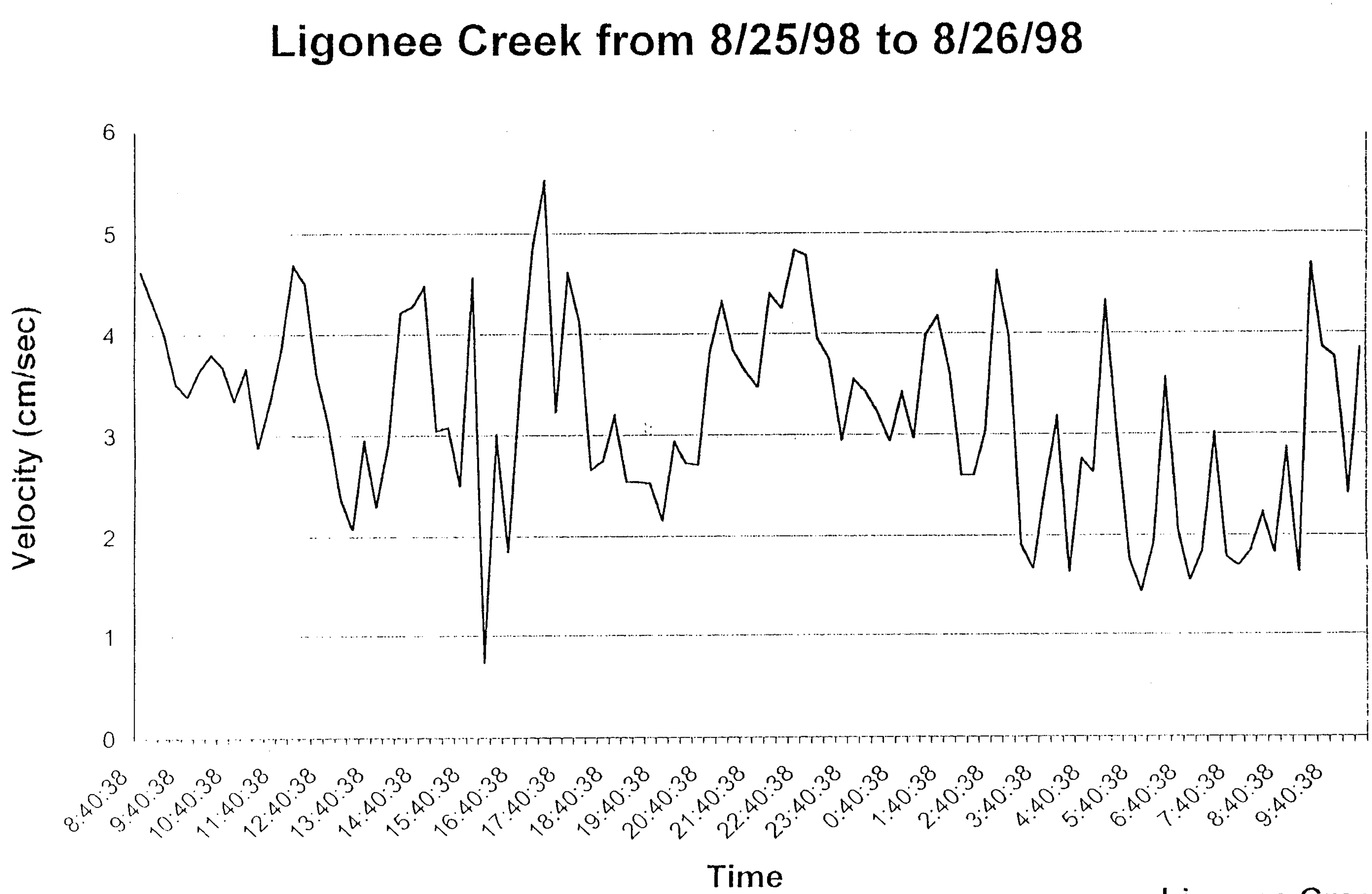


Northwest Creek
9/9/98 - 9/16/98
Temperature



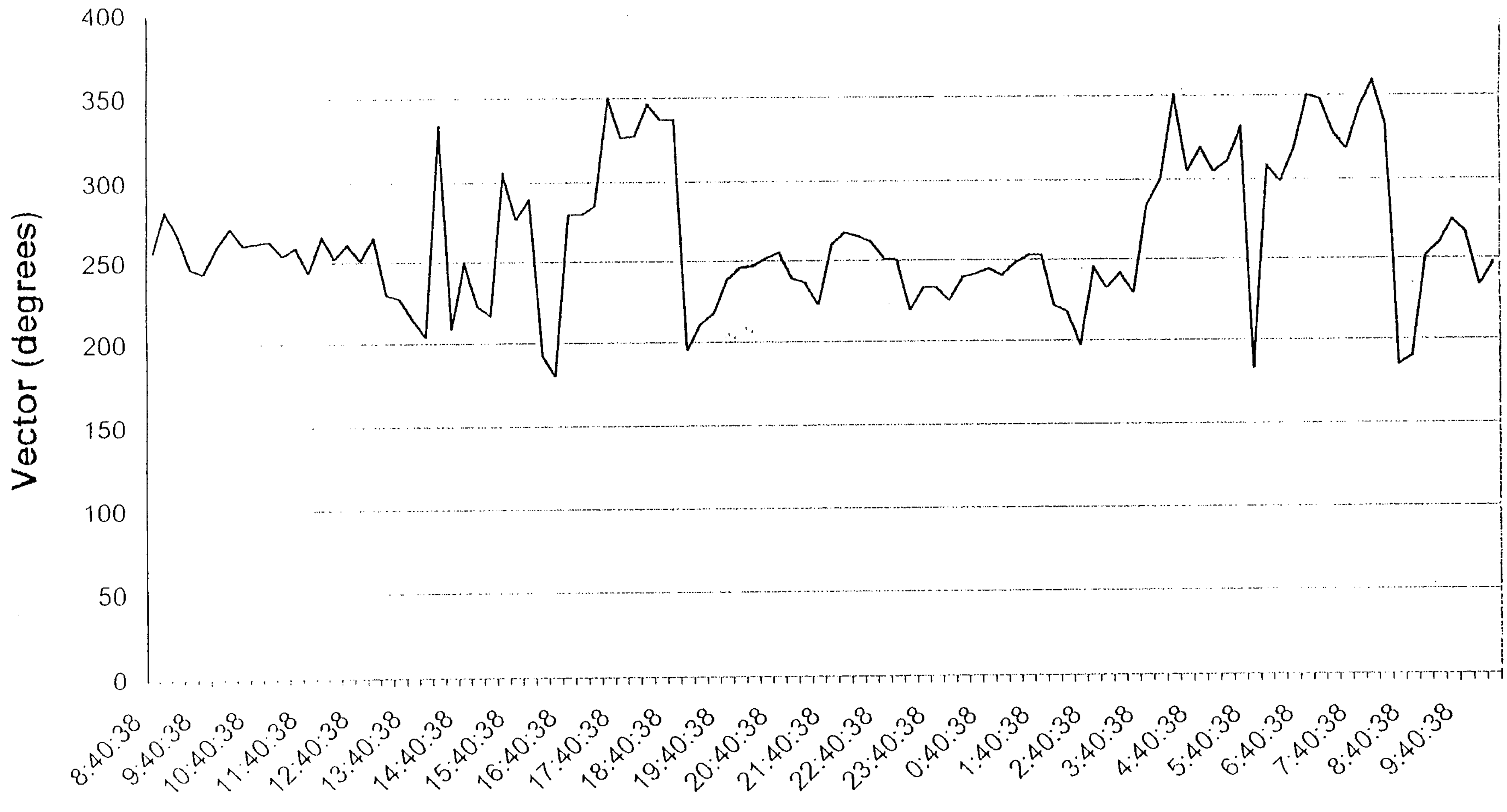
Northwest Creek
9/9/98 - 9/16/98
Turbidity

Ligonee Creek

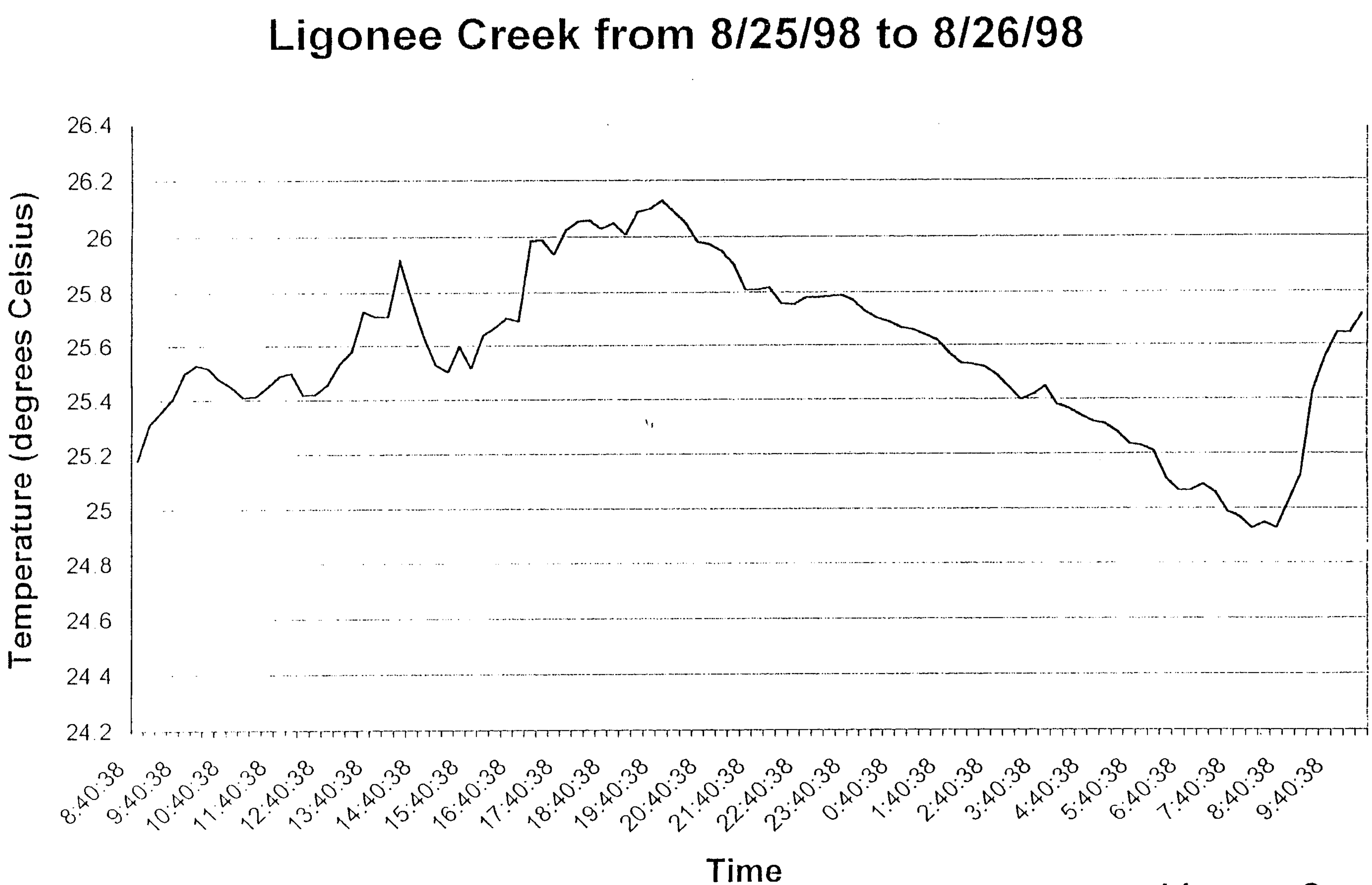


Ligonee Creek
8/25/98 - 8/26/98
Velocity

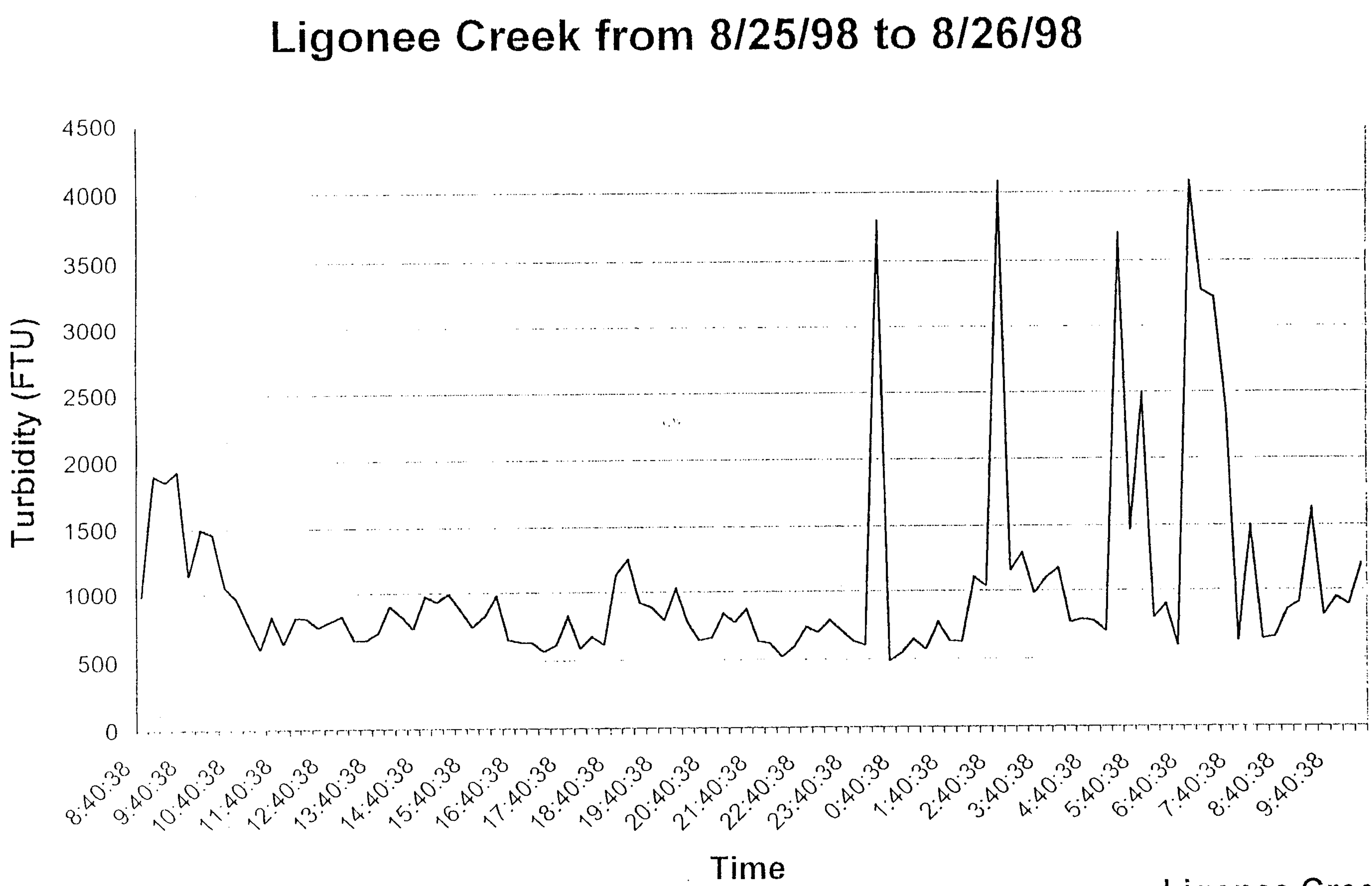
Ligonee Creek from 8/25/98 to 8/26/98



Ligonee Creek
8/25/98 - 8/26/98
Vector



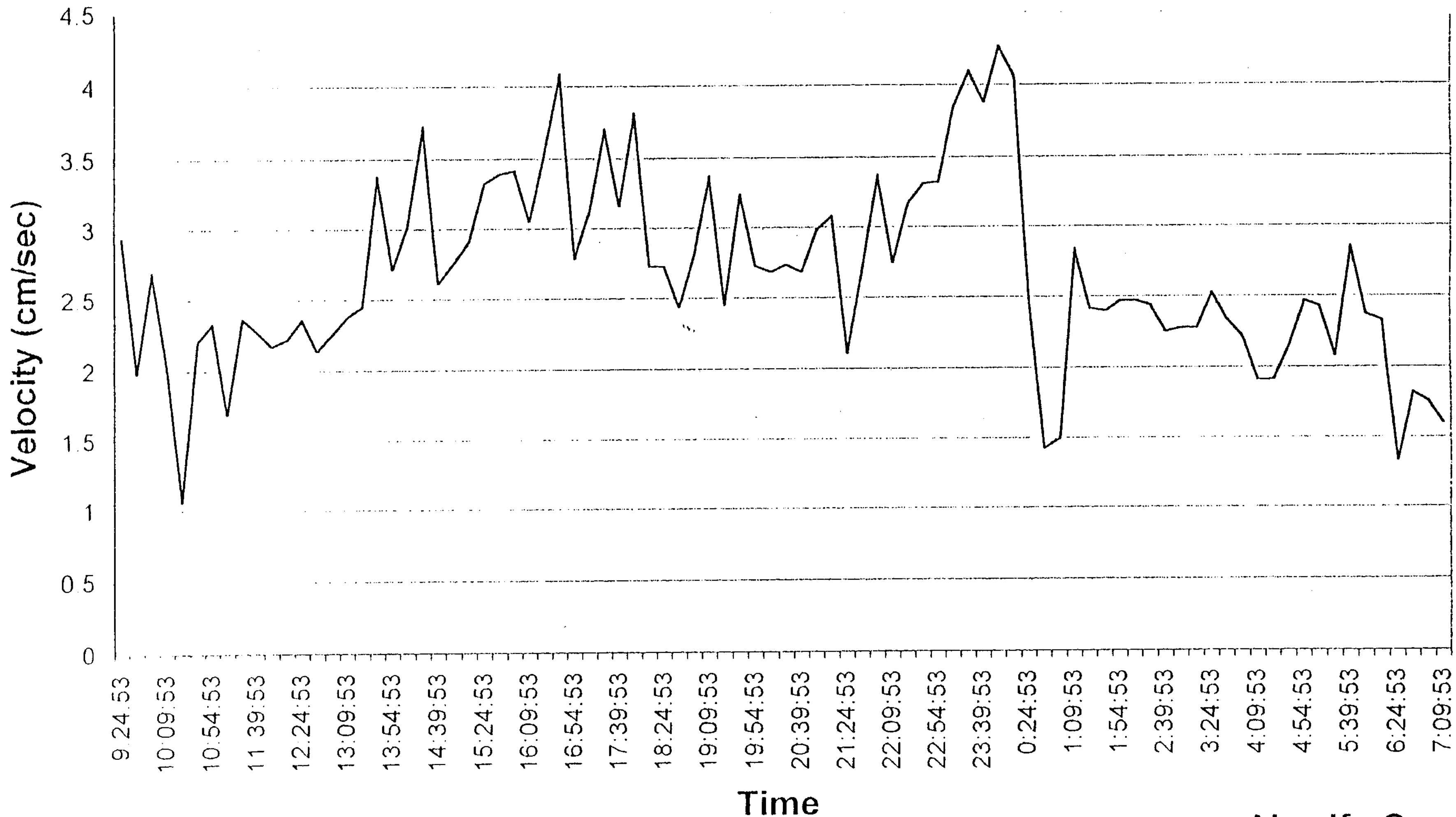
Ligonee Creek
8/25/98 - 8/26/98
Temperature



Ligonee Creek
8/25/98 - 8/26/98
Turbidity

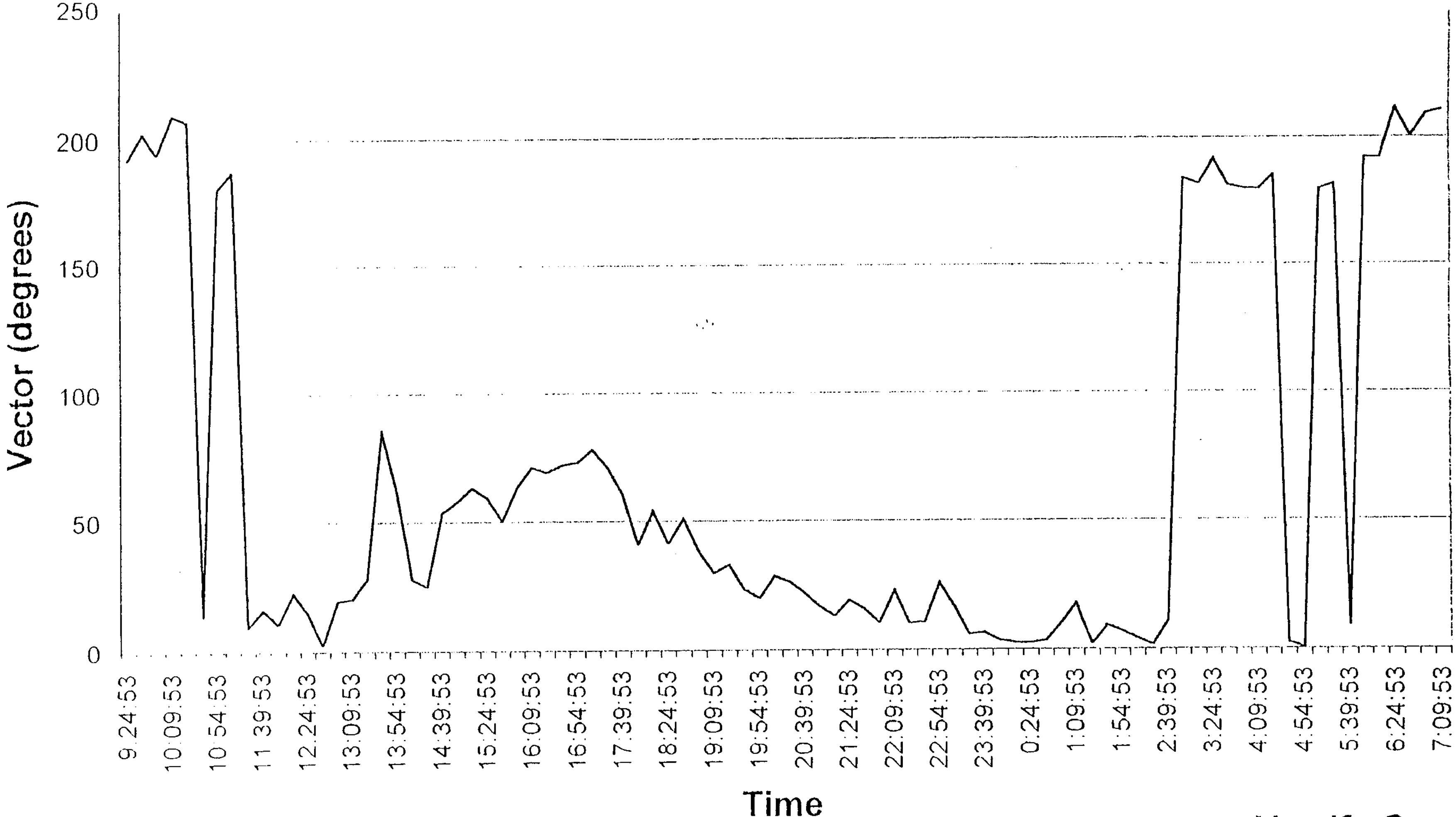
Alewife Creek

Alewife Creek from 8/24/98 to 8/25/98

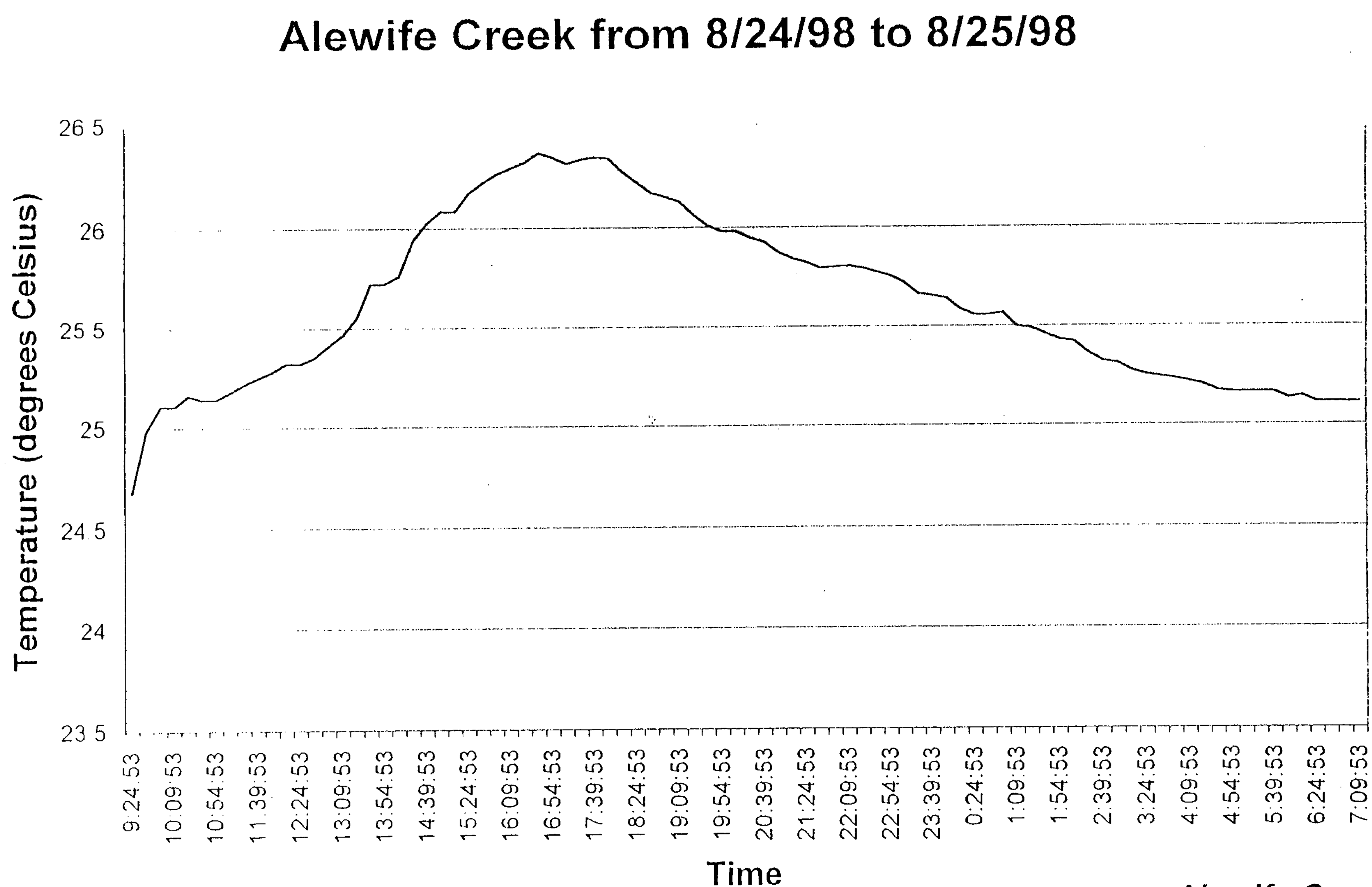


Alewife Creek
8/24/98 - 8/25/98
Velocity

Alewife Creek from 8/24/98 to 8/25/98

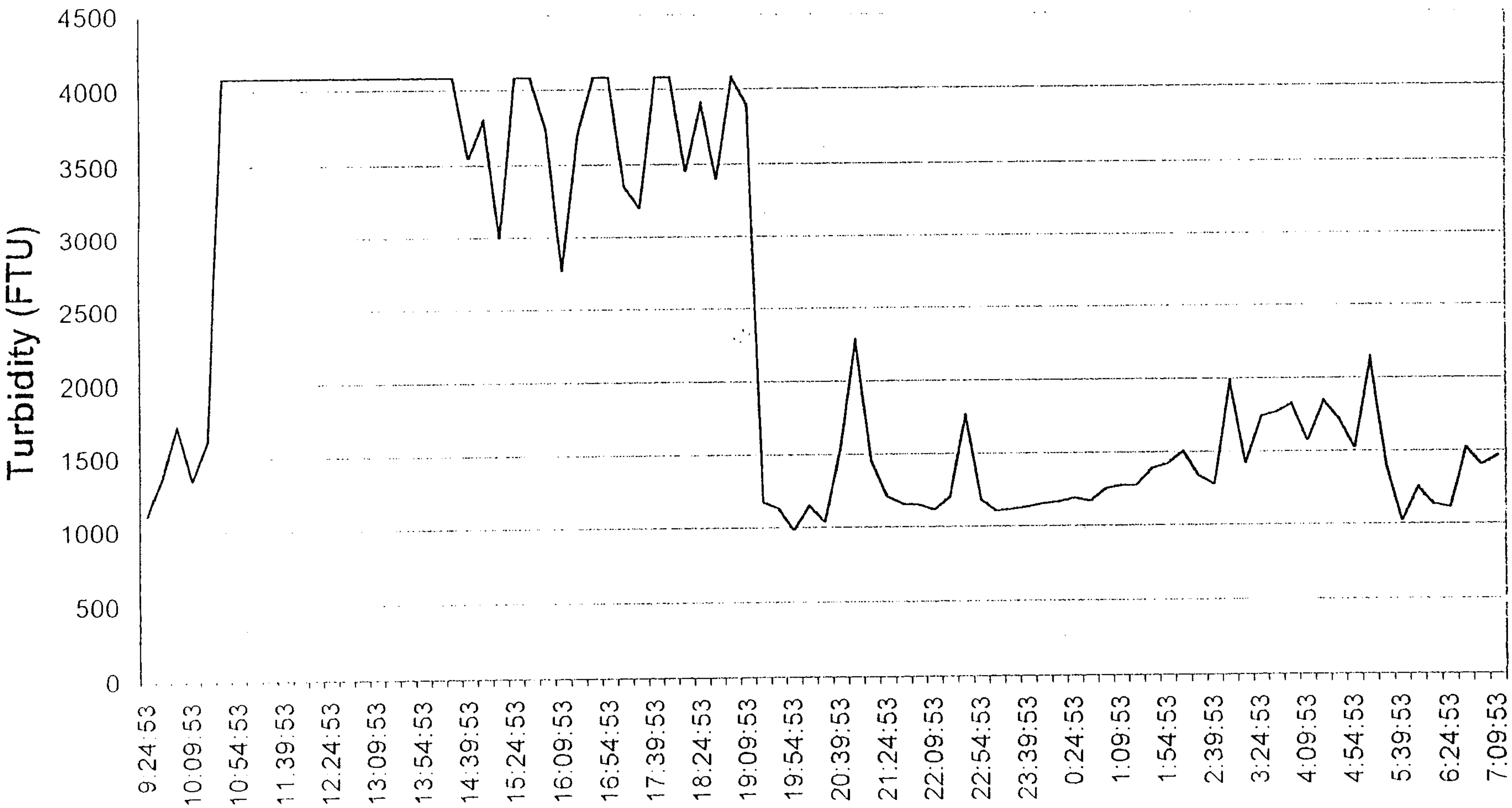


Alewife Creek
8/24/98 - 8/25/98
Vector



Alewife Creek
8/24/98 - 8/25/98
Temperature

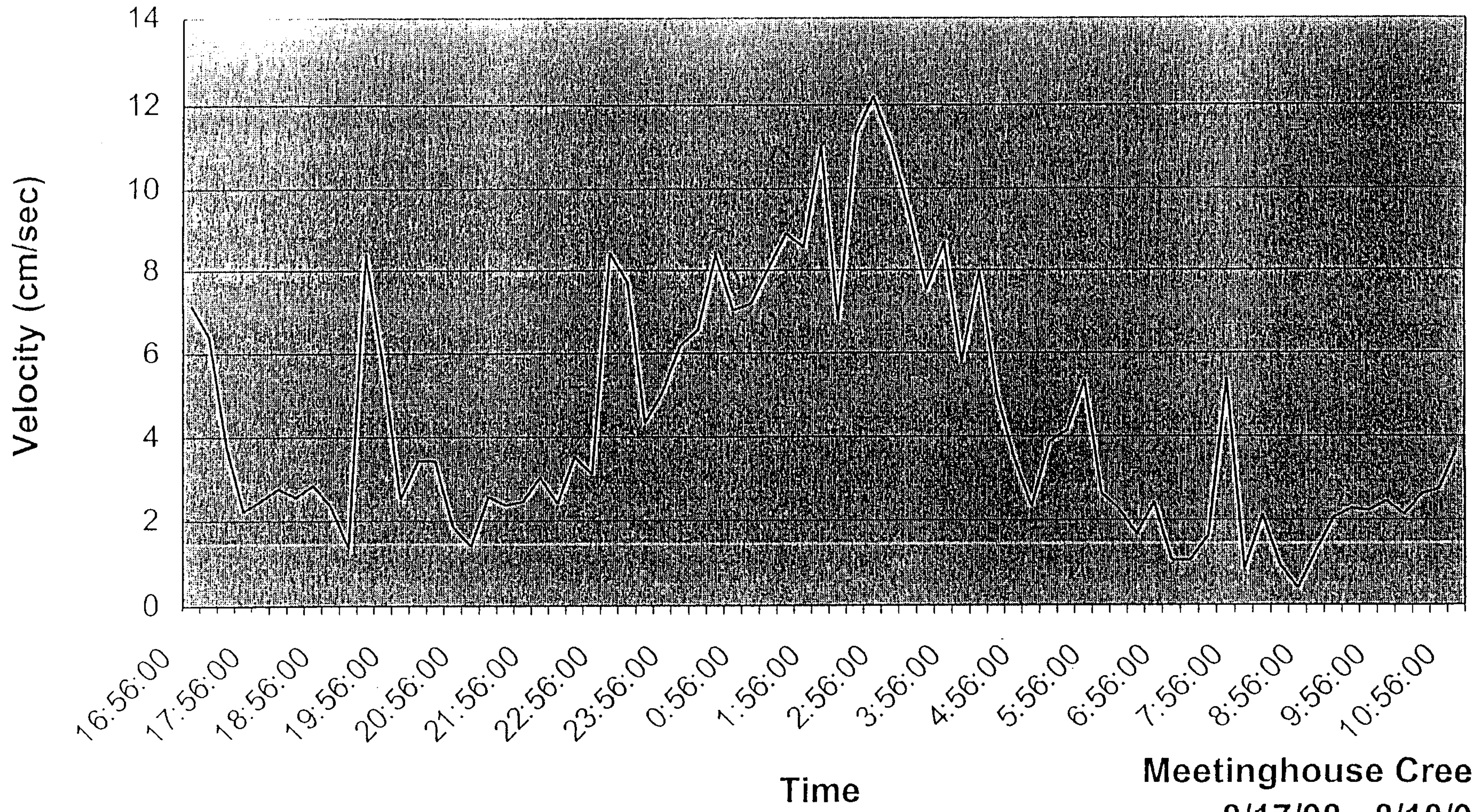
Alewife Creek from 8/24/98 to 8/25/98



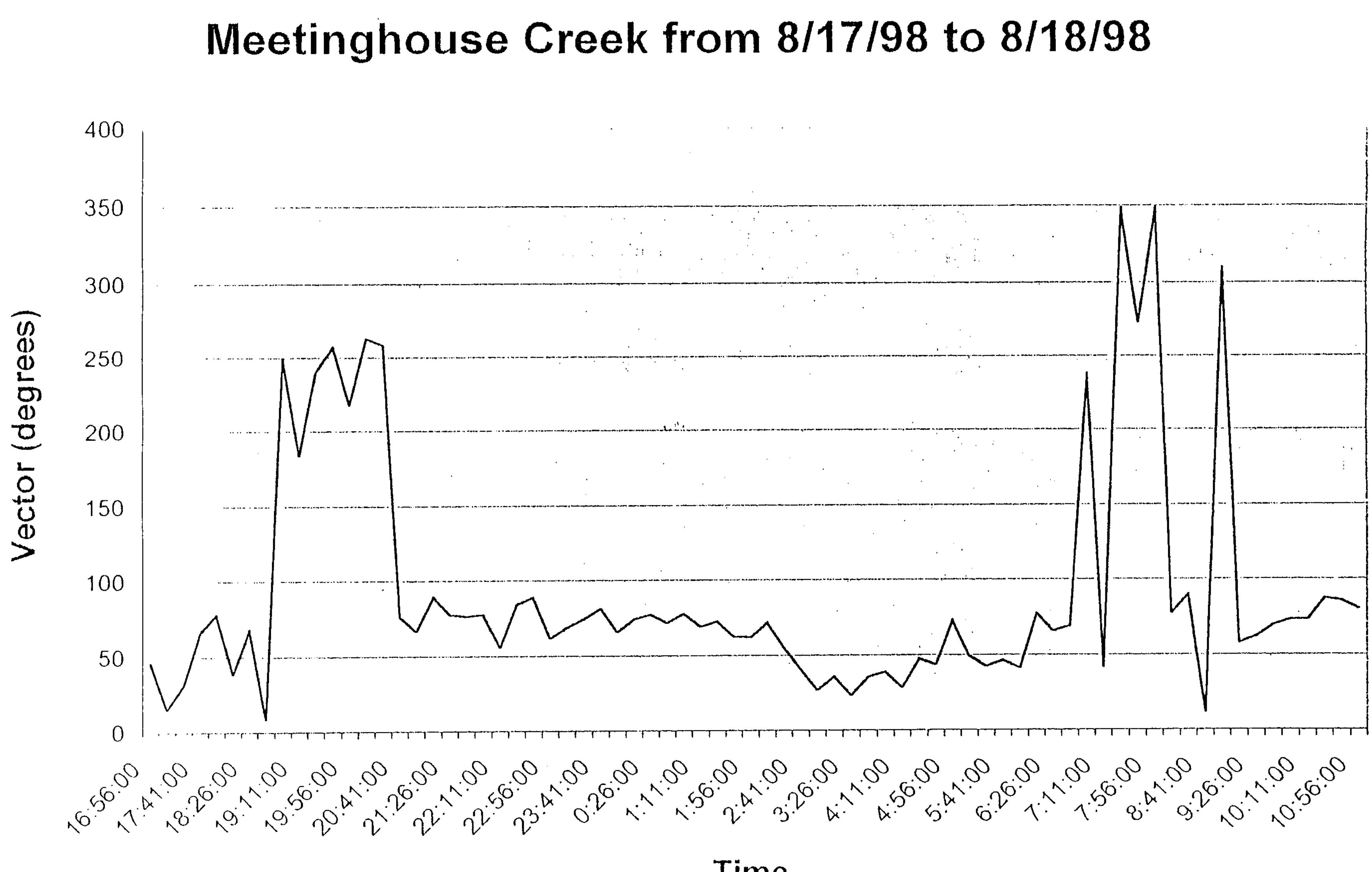
Alewife Creek
8/24/98 - 8/25/98
Turbidity

Meetinghouse Creek

Meetinghouse Creek from 8/17/98 to 8/18/98

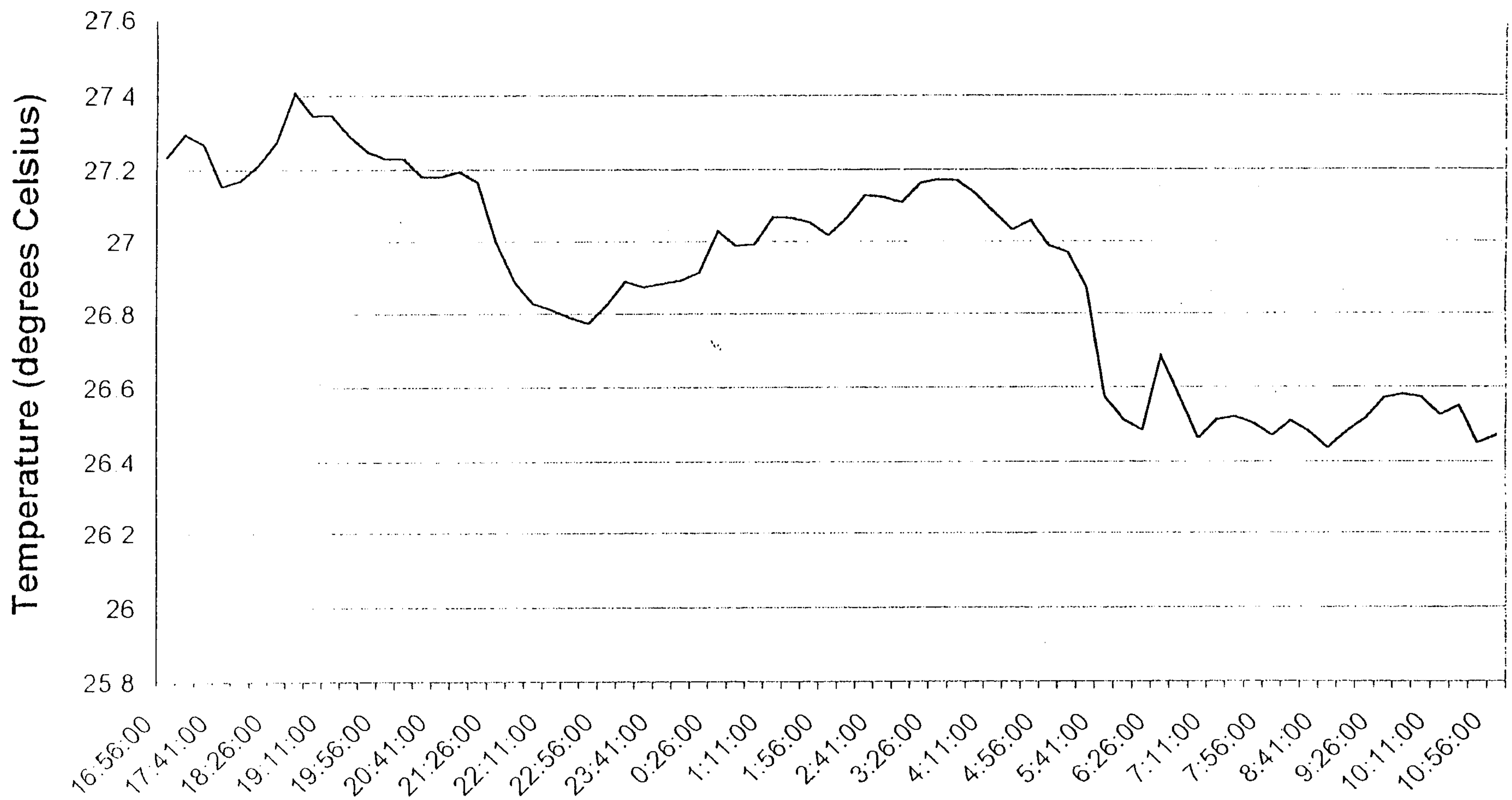


Meetinghouse Creek
8/17/98 - 8/18/98
Velocity



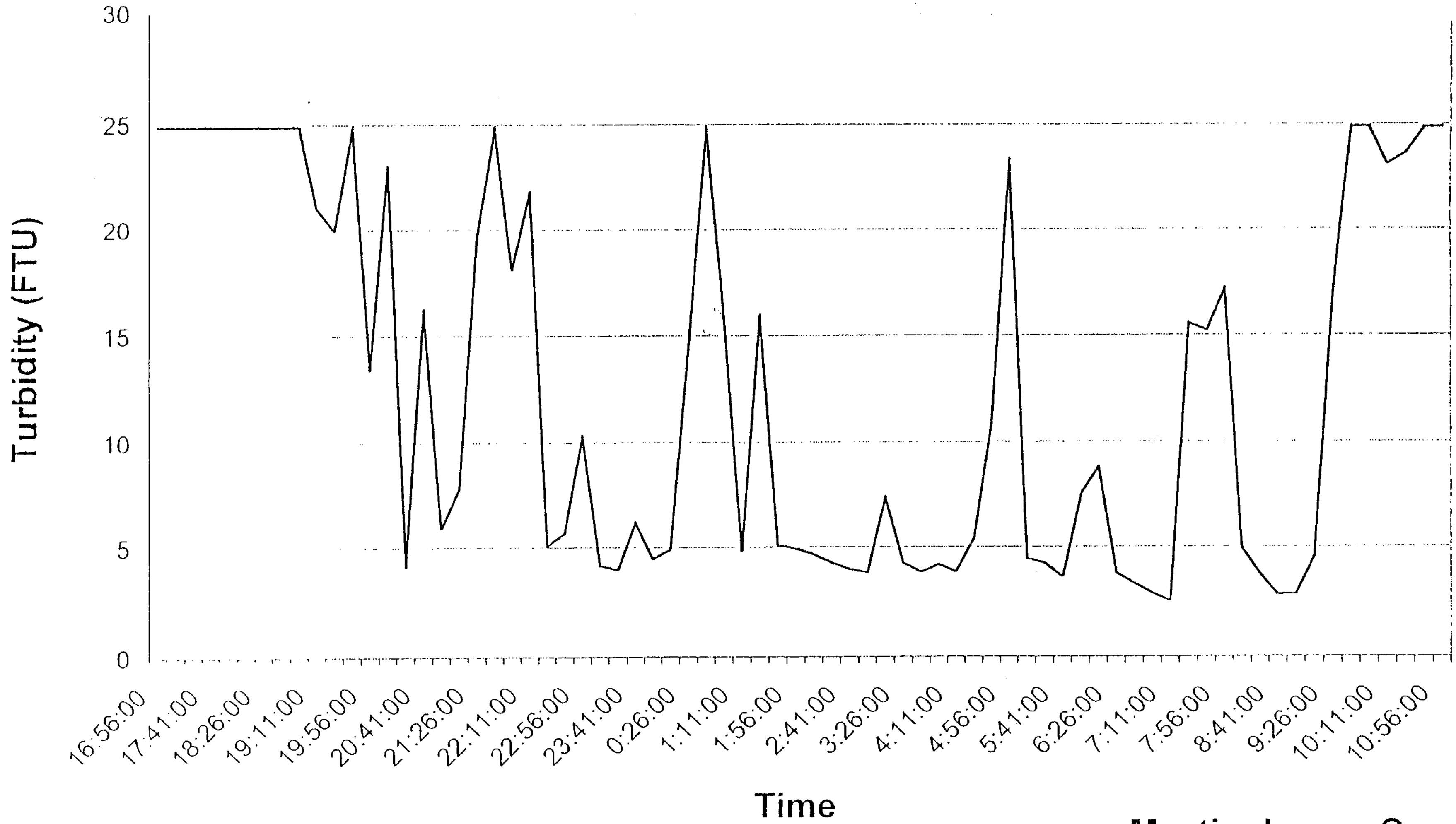
Meetinghouse Creek
8/17/98 - 8/18/98
Vector

Meetinghouse Creek from 8/17/98 to 8/18/98



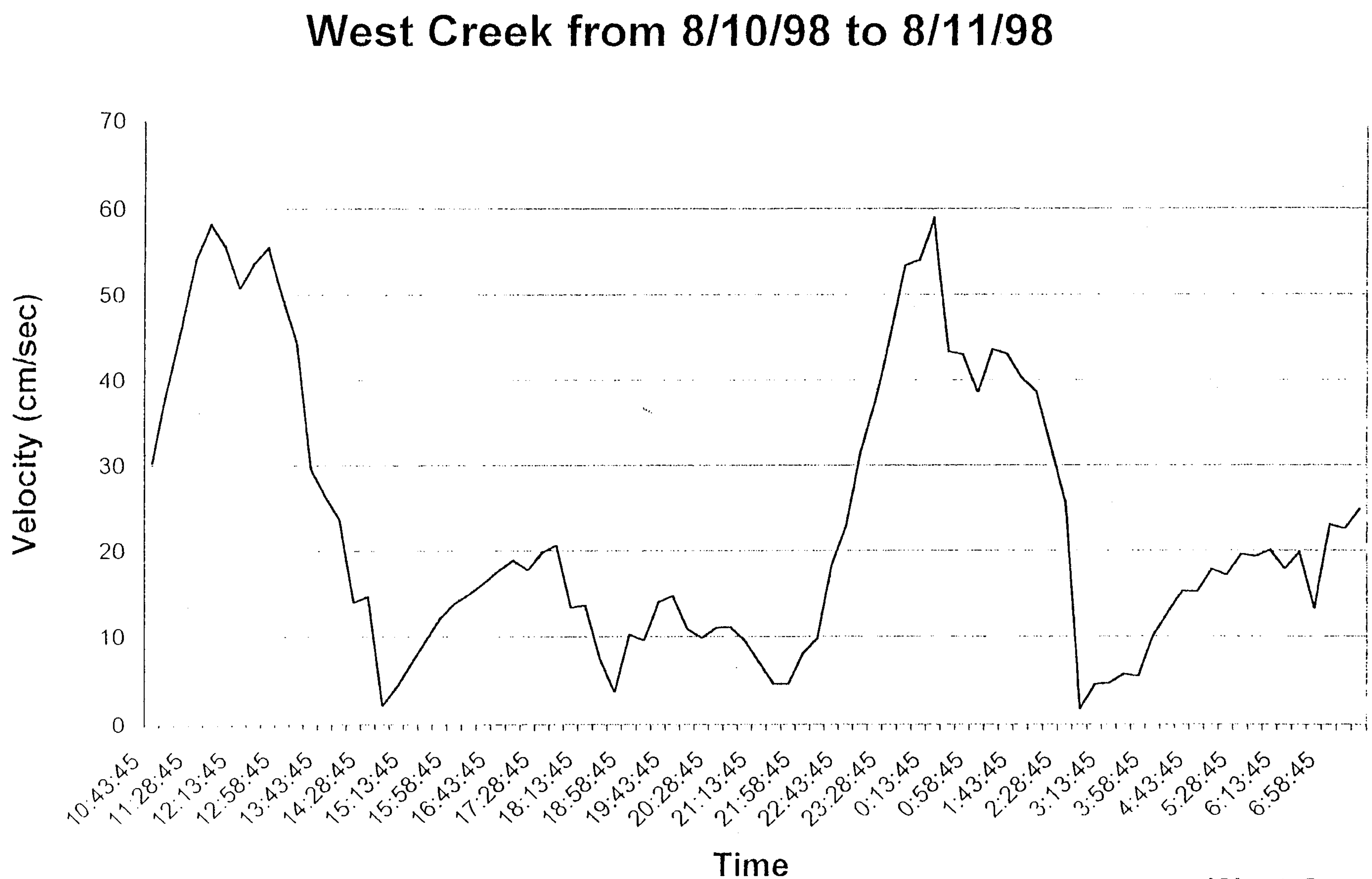
Meetinghouse Creek
8/17/98 - 8/18/98
Temperature

Meetinghouse Creek from 8/17/98 to 8/18/98



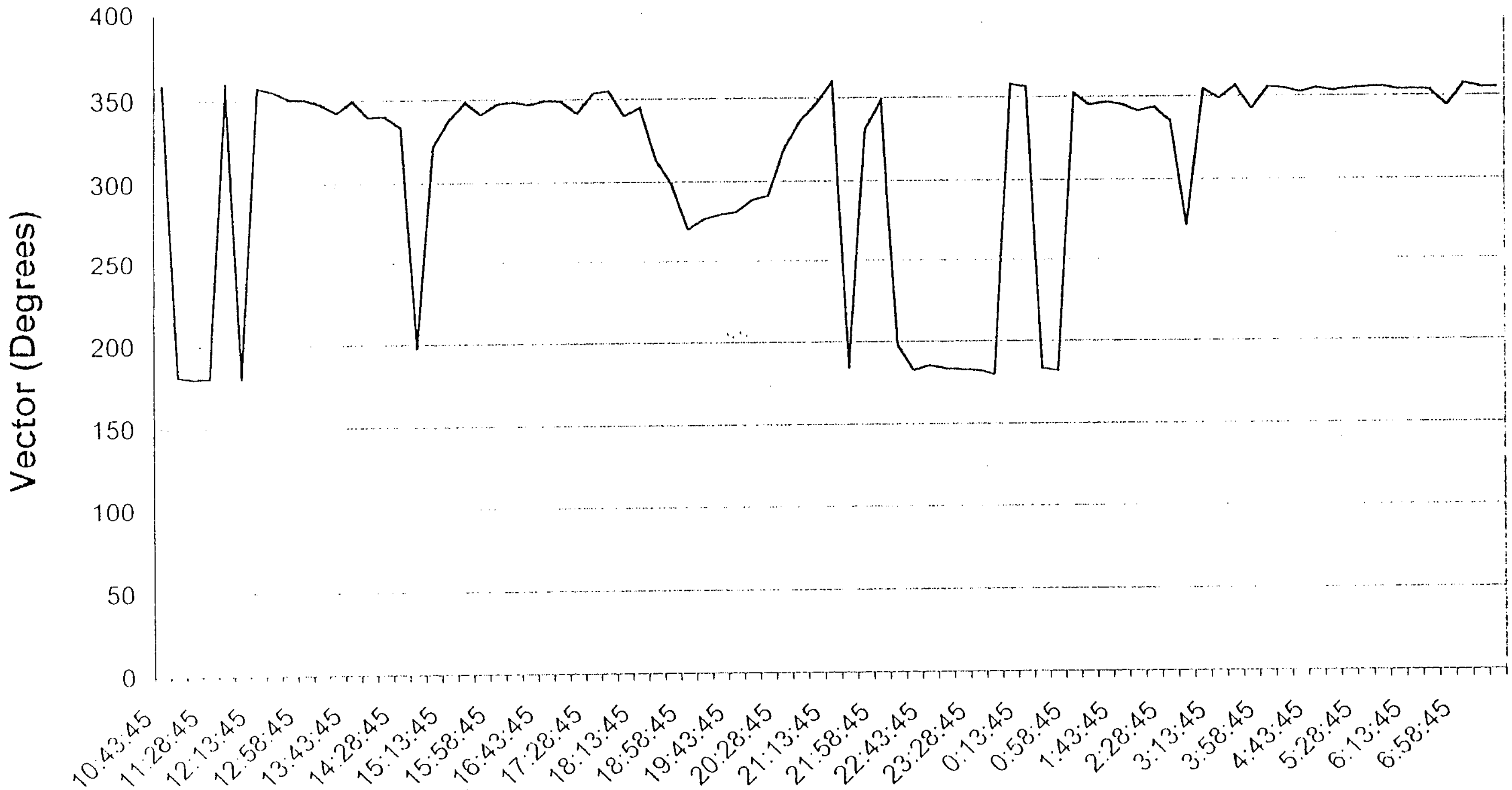
Meetinghouse Creek
8/17/98 - 8/18/98
Turbidity

West Creek



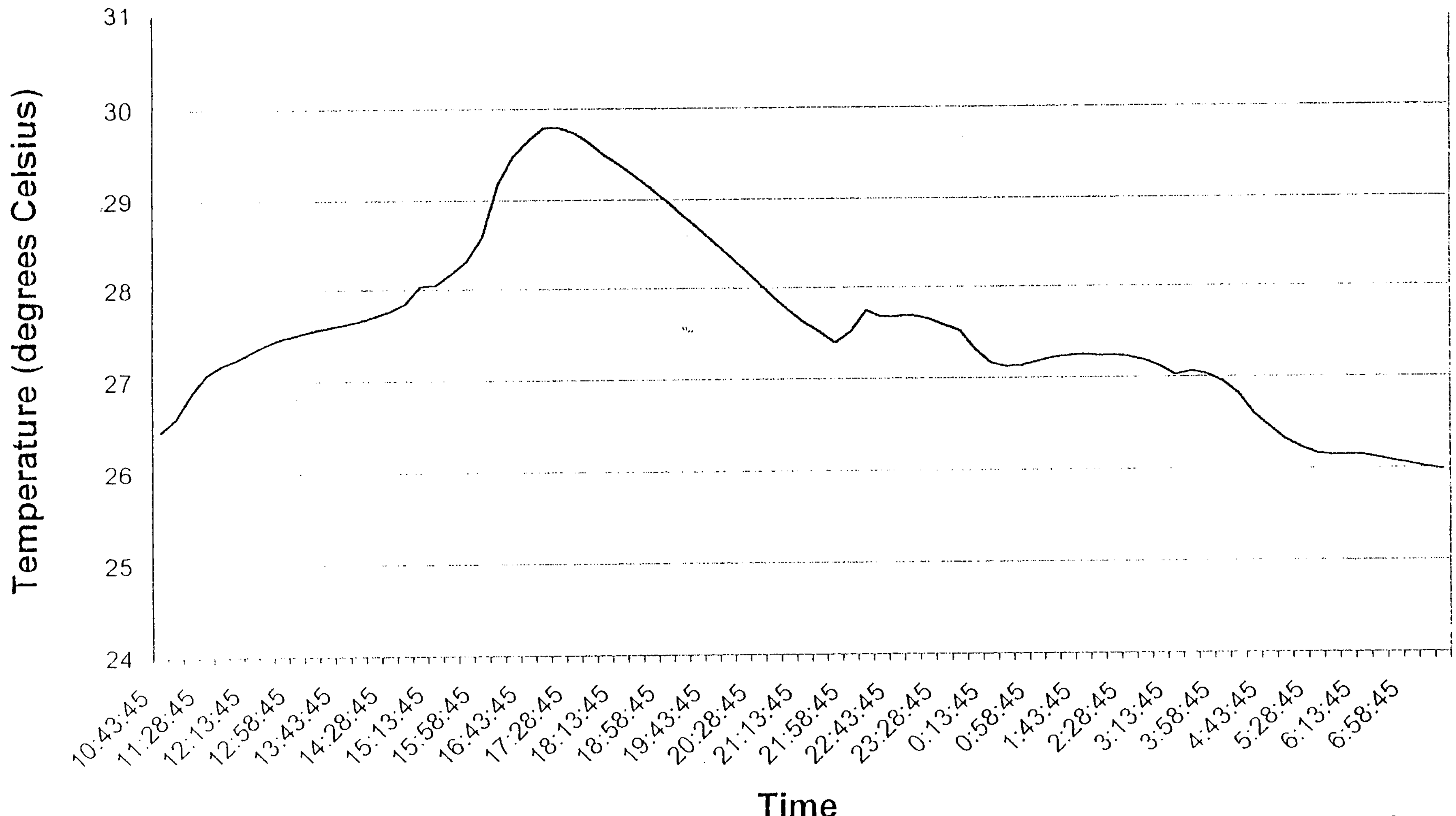
West Creek
8/10/98 - 8/11/98
Velocity

West Creek from 8/10/98 - 8/11/98



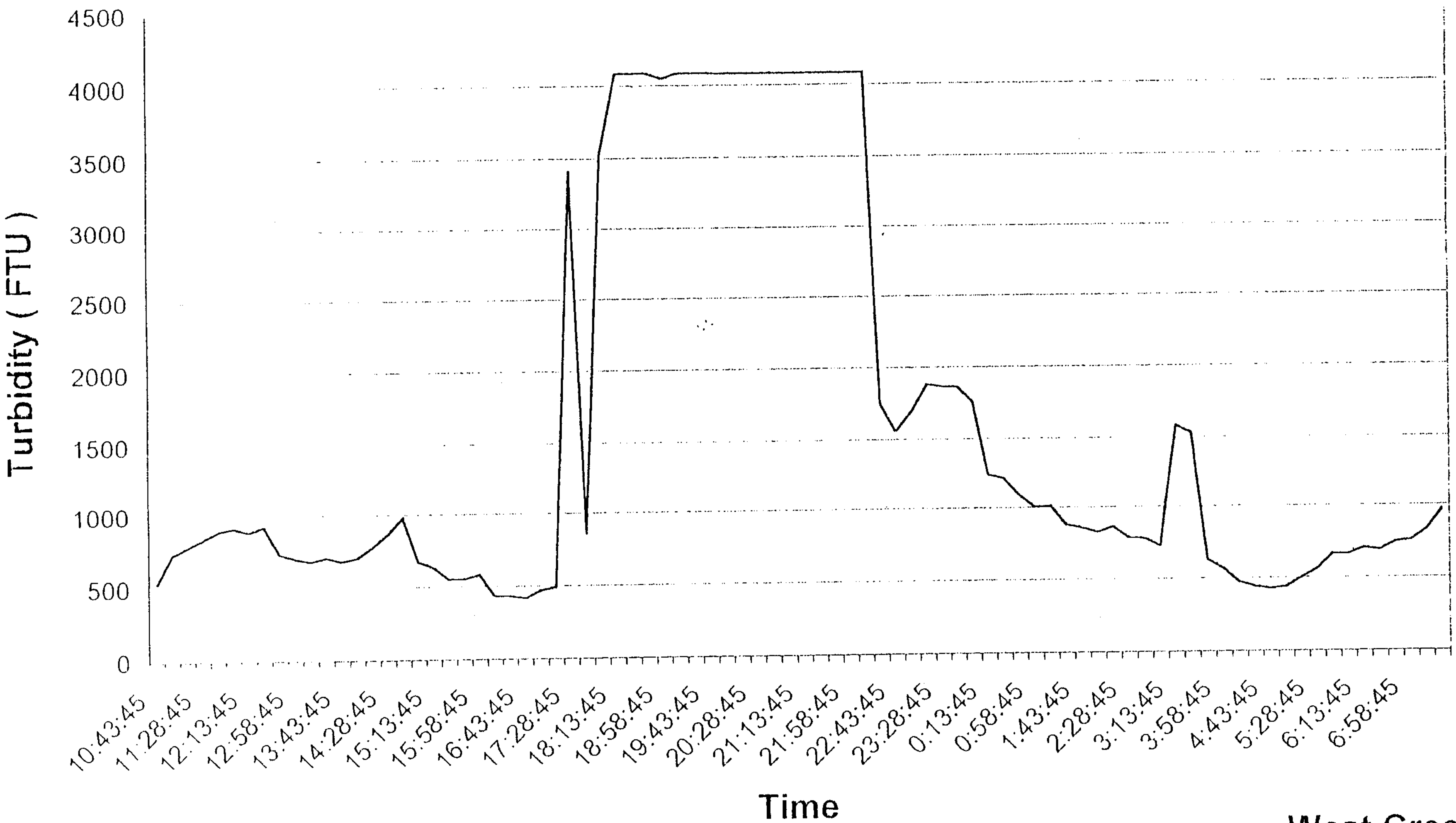
West Creek
8/10/98 - 8/11/98
Vector

West Creek from 8/10/98 to 8/11/98



West Creek
8/10/98 - 8/11/98
Temperature

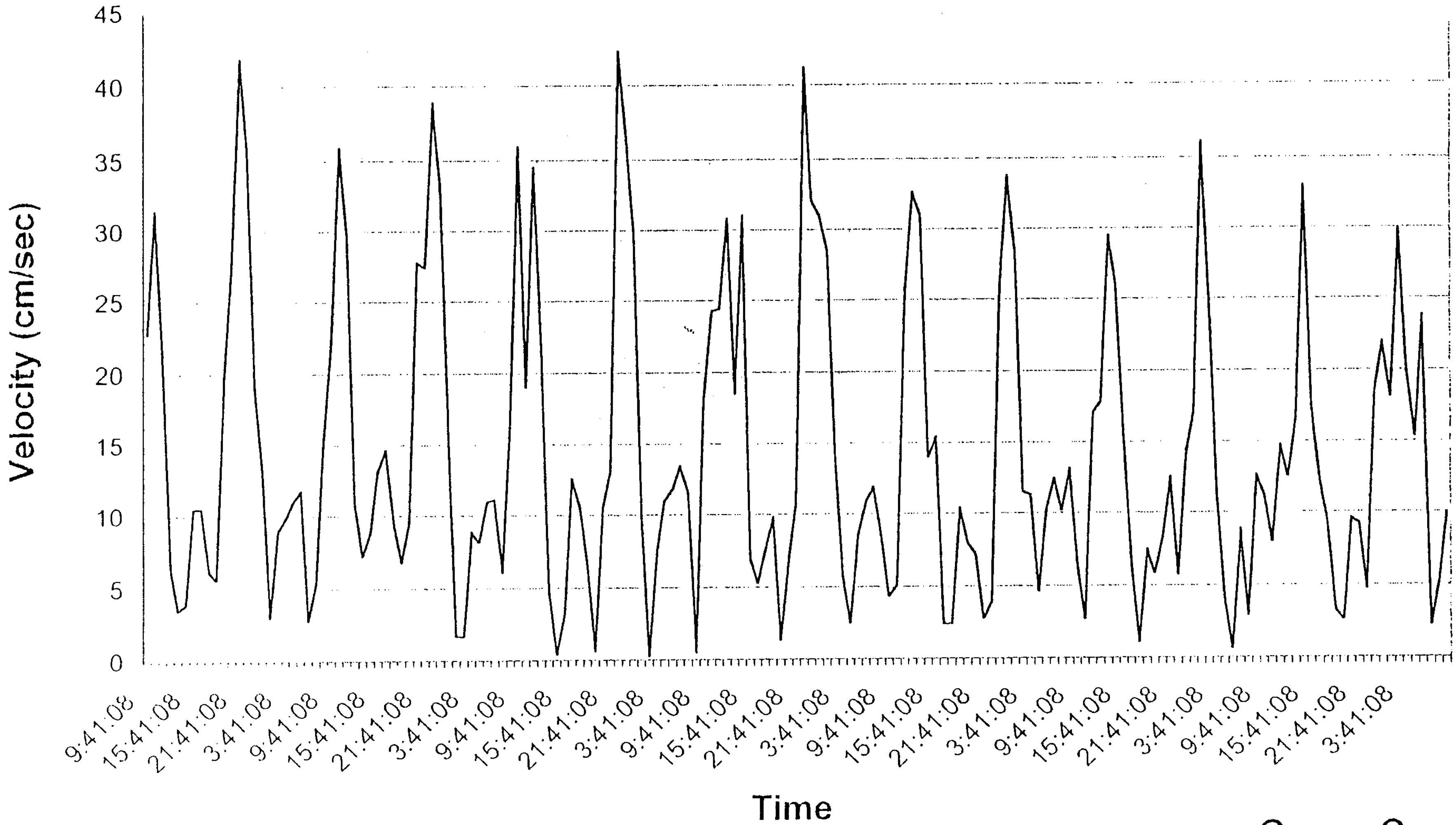
West Creek from 8/10/98 to 8/11/98



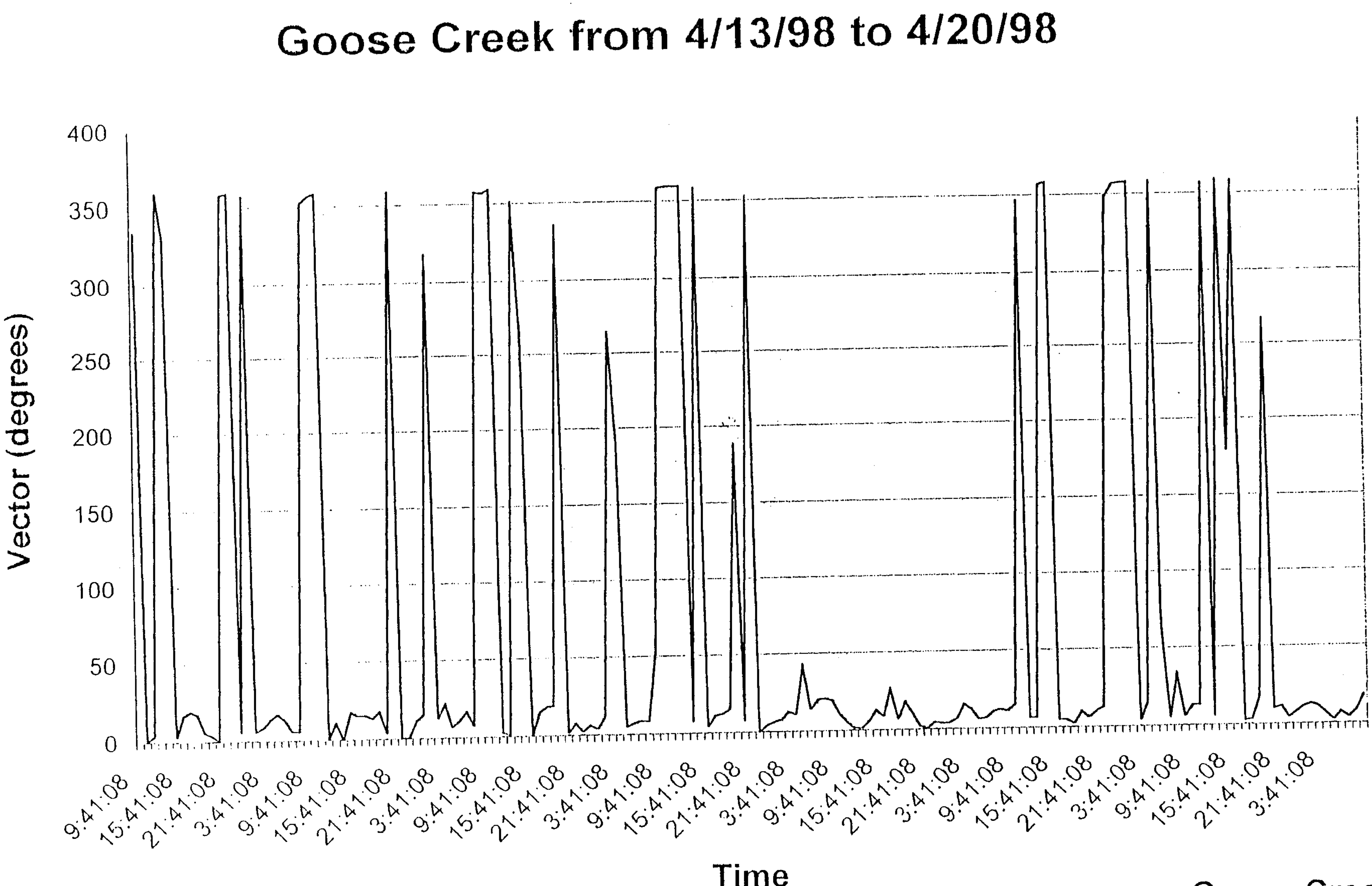
West Creek
8/10/98 - 8/11/98
Turbidity

Goose Creek

Goose Creek from 4/13/98 to 4/20/98

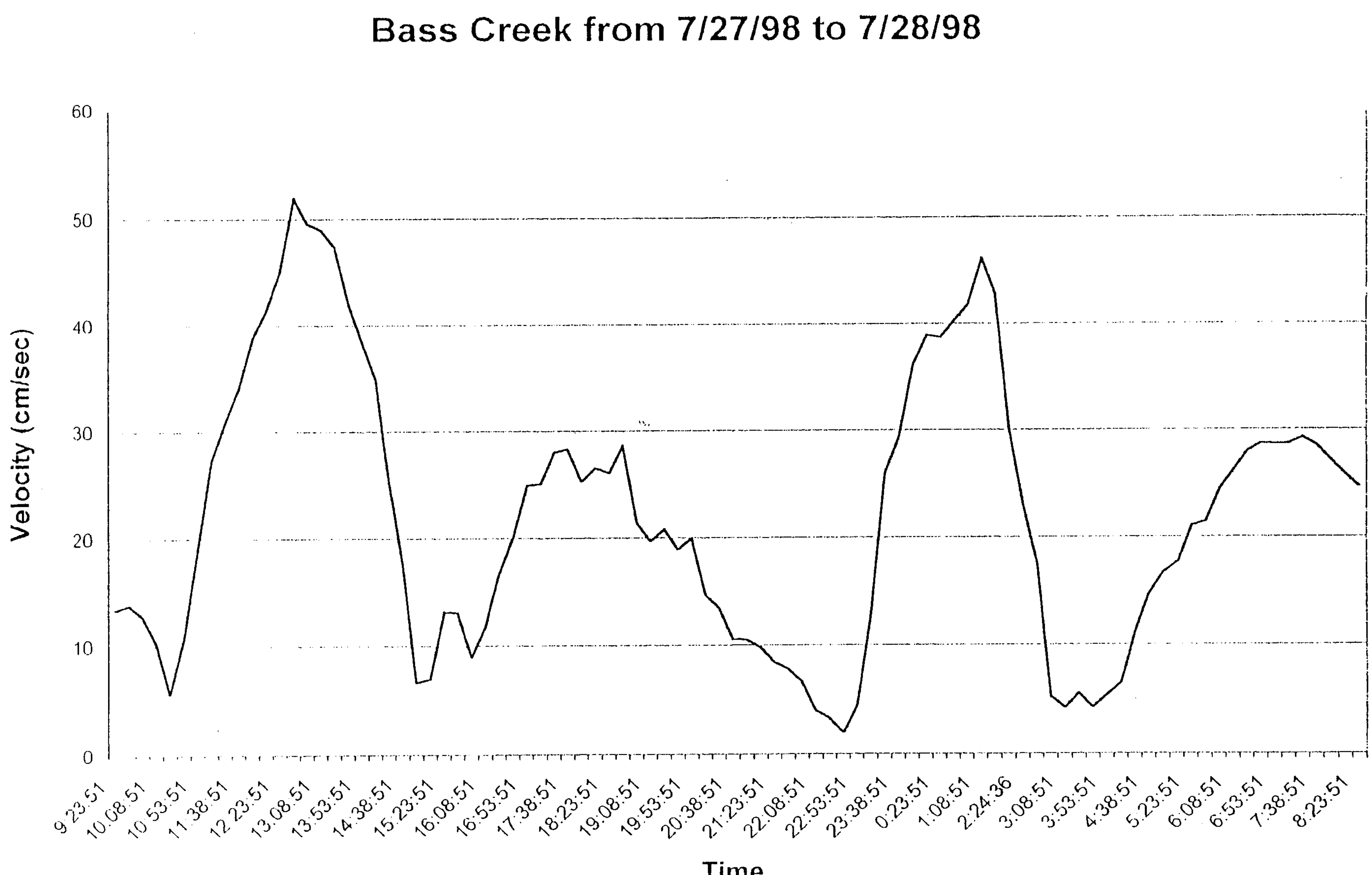


Goose Creek
4/13/98 - 4/20/98
Velocity



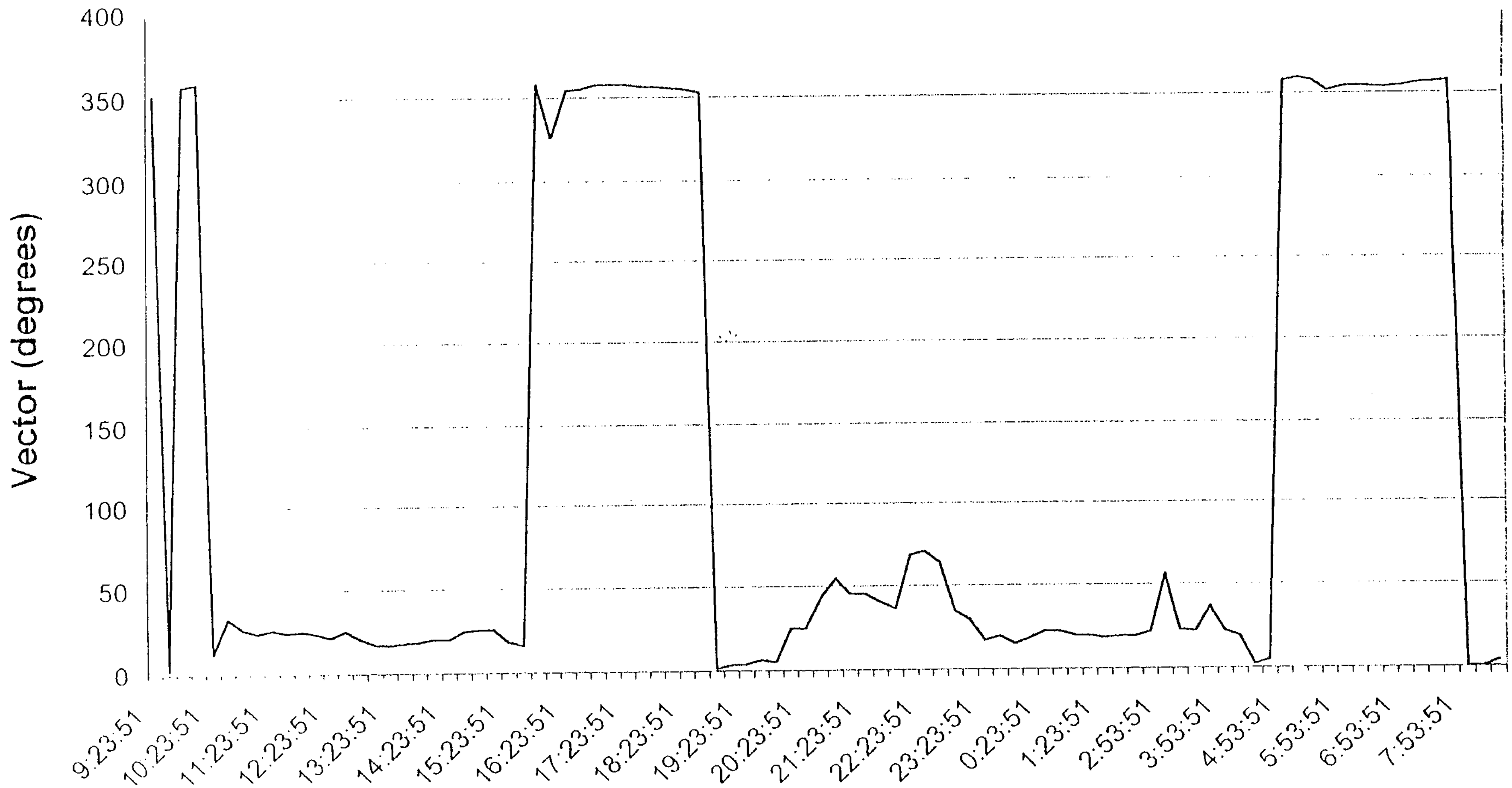
Goose Creek
4/13/98 - 4/20/98
Vector

Bass Creek



Bass Creek
7/27/98 - 7/28/98
Velocity

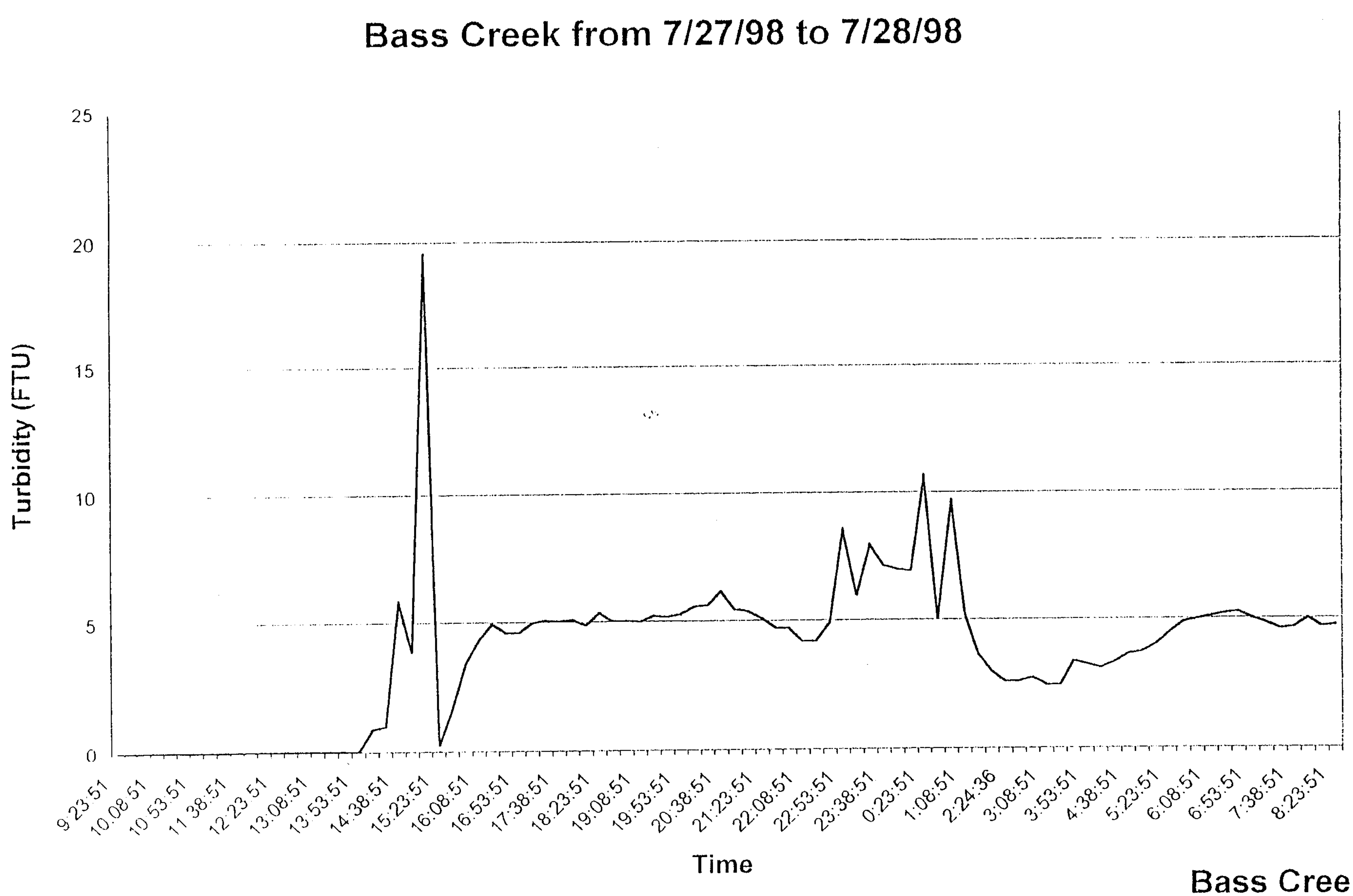
Bass Creek from 7/27/98 to 7/28/98



Bass Creek
7/27/98 - 7/28/98
Vector

Bass Creek from 7/27/98 to 7/28/98

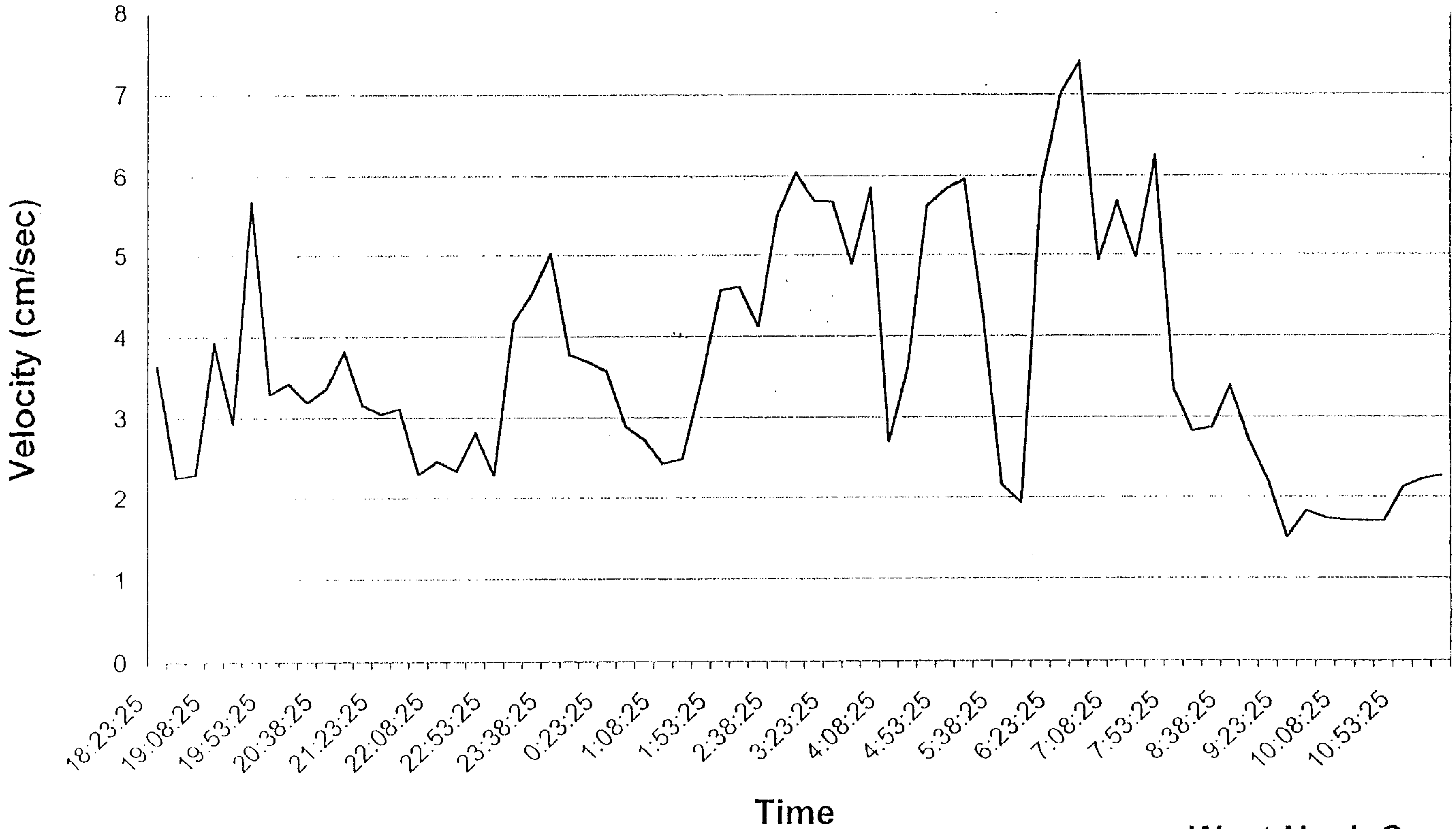
Bass Creek
7/27/98 - 7/28/98
Temperature



Bass Creek
7/27/98 - 7/28/98
Turbidity

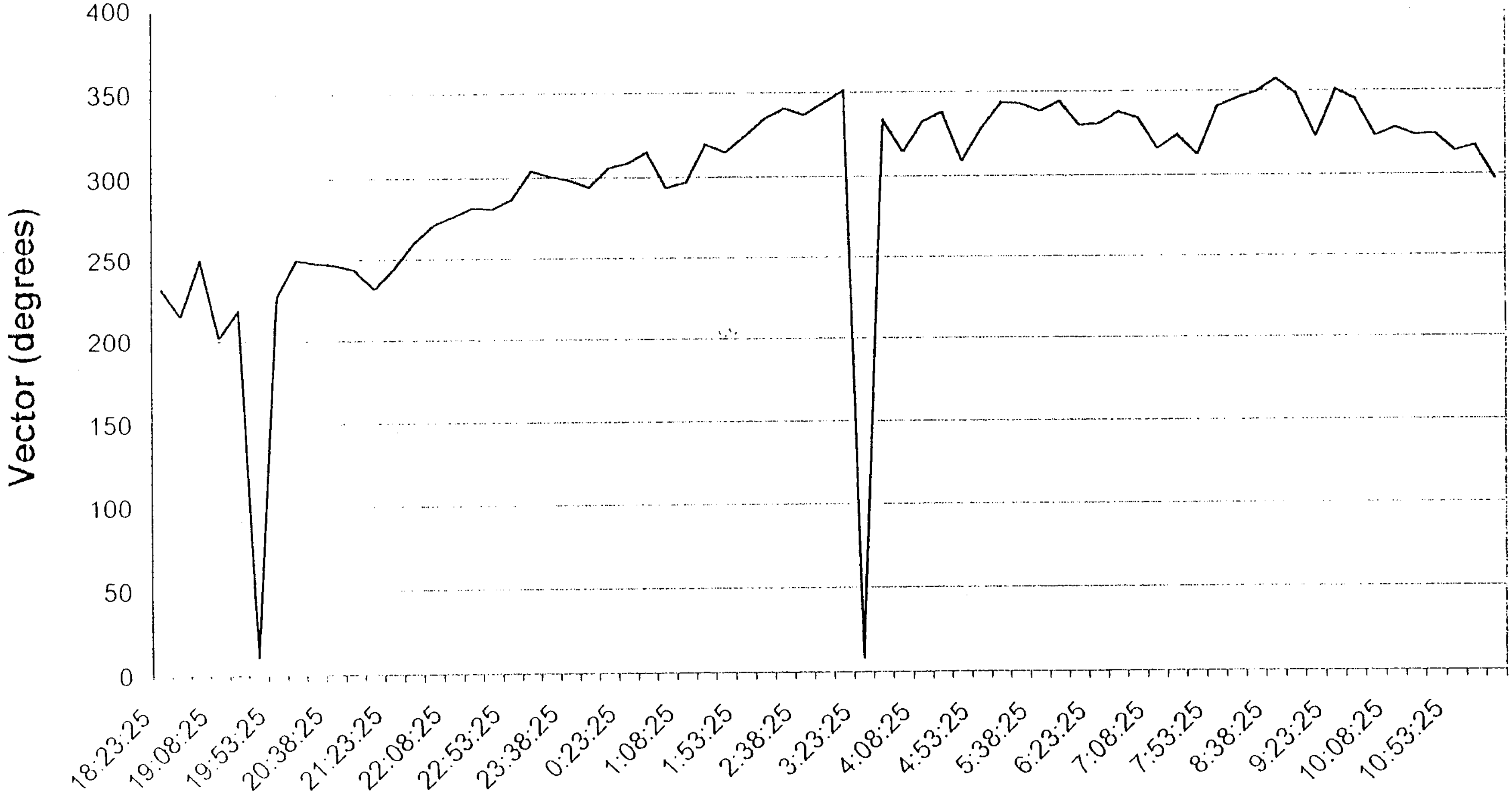
West Neck Creek

West Neck Creek from 8/3/98 to 8/4/98

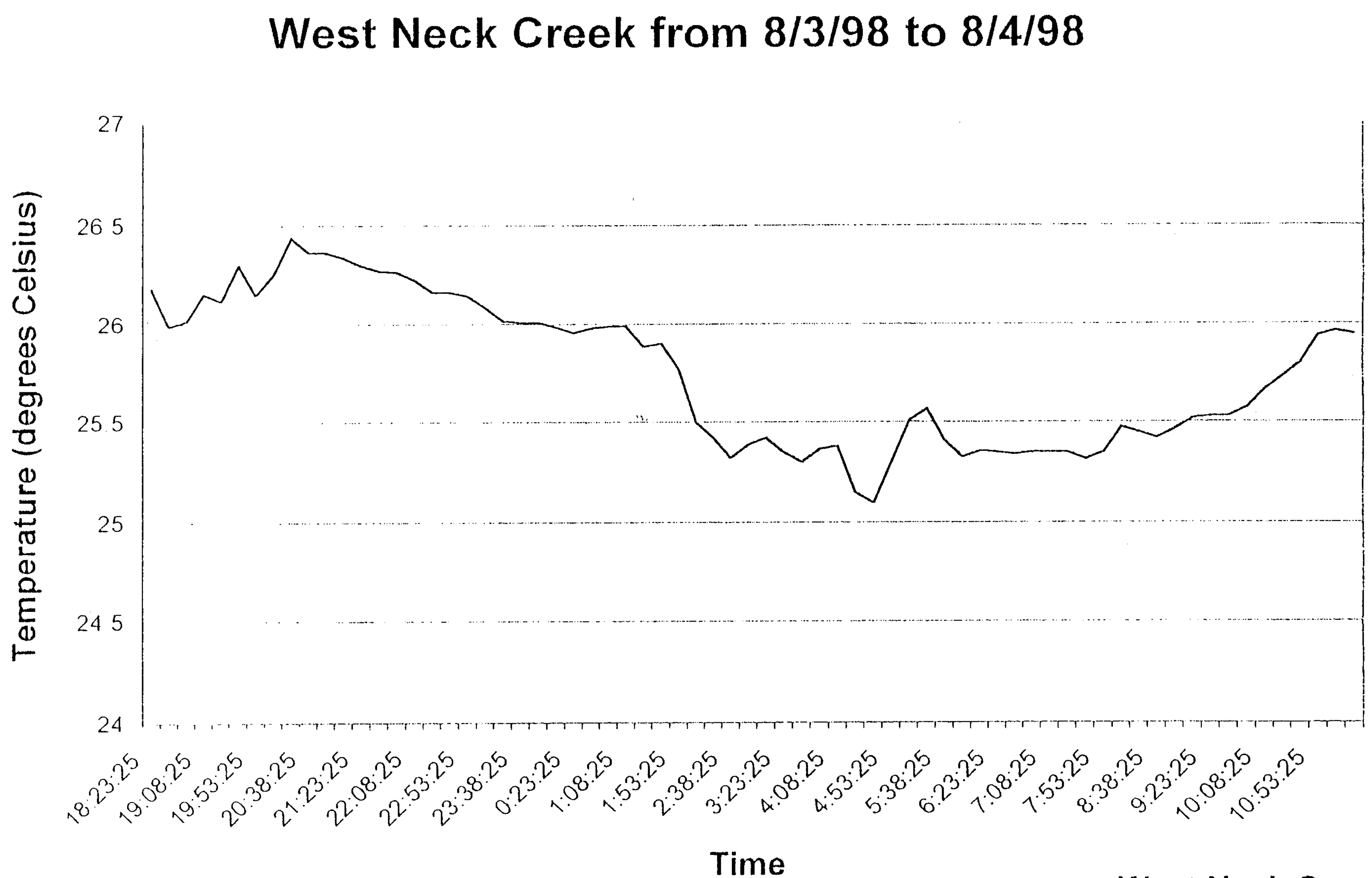


West Neck Creek
8/3/98 - 8/4/98
Velocity

West Neck Creek from 8/3/98 to 8/4/98

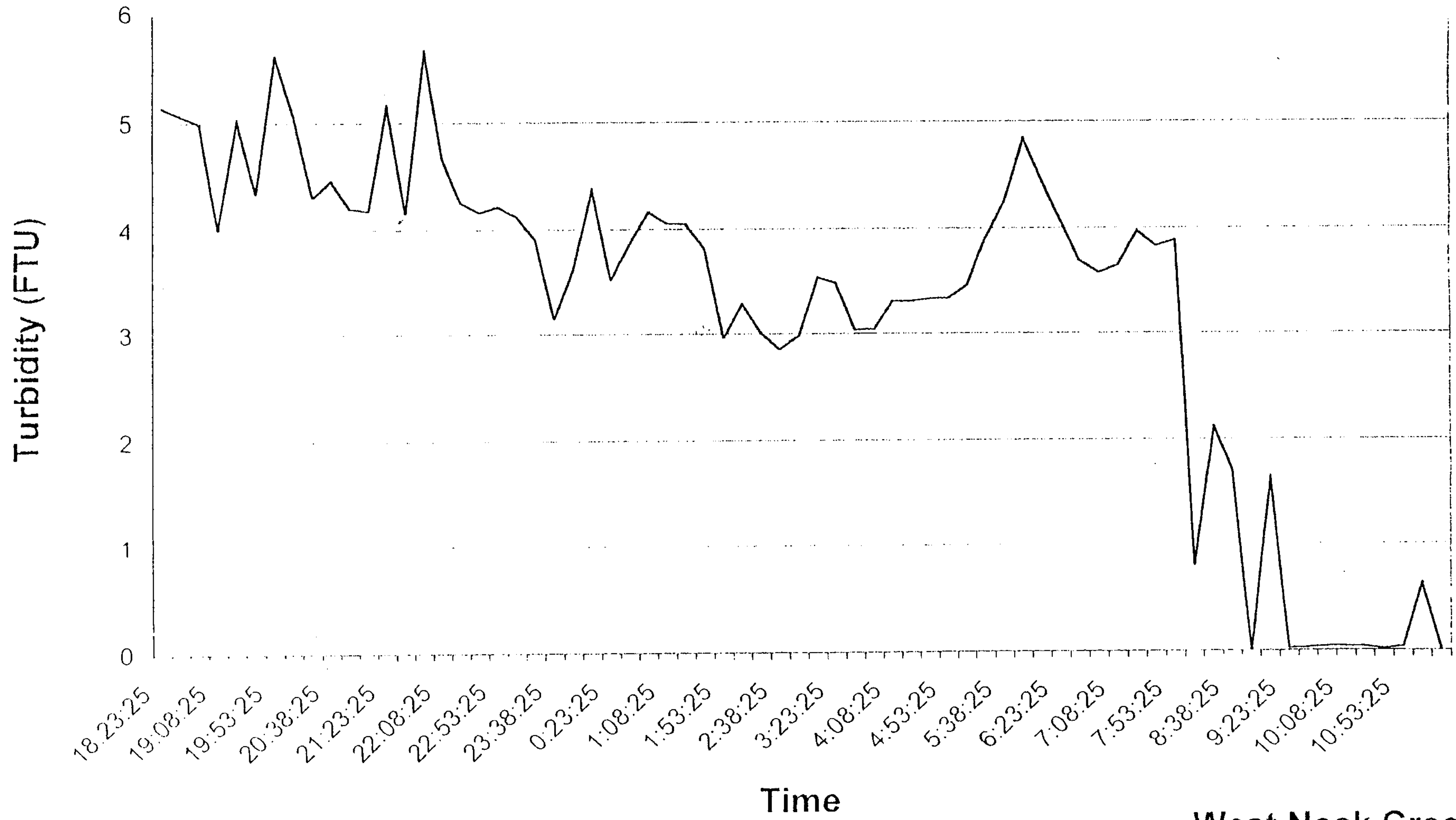


West Neck Creek
8/3/98 - 8/4/98
Vector



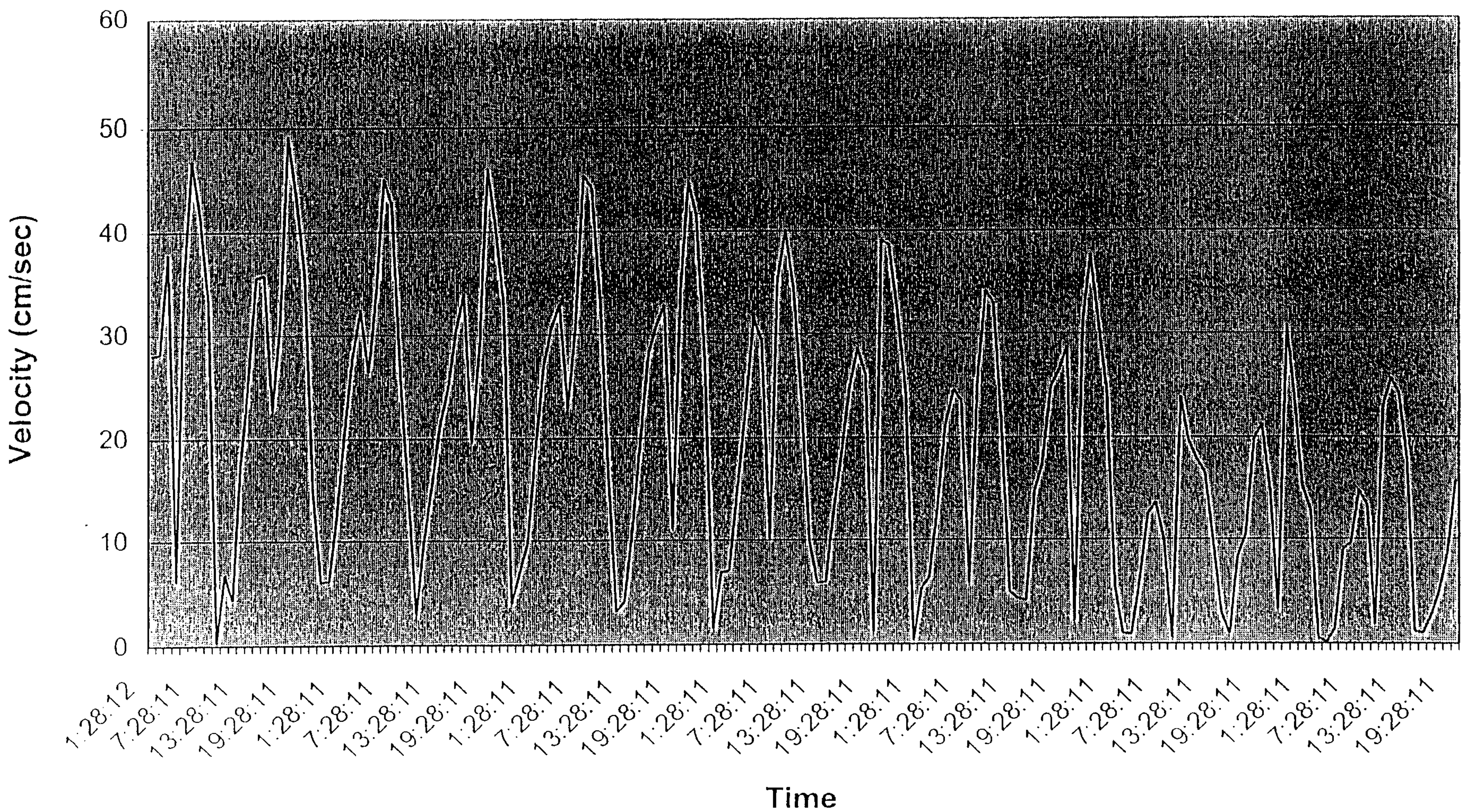
West Neck Creek
8/3/98 - 8/4/98
Temperature

West Neck Creek from 8/3/98 to 8/4/98



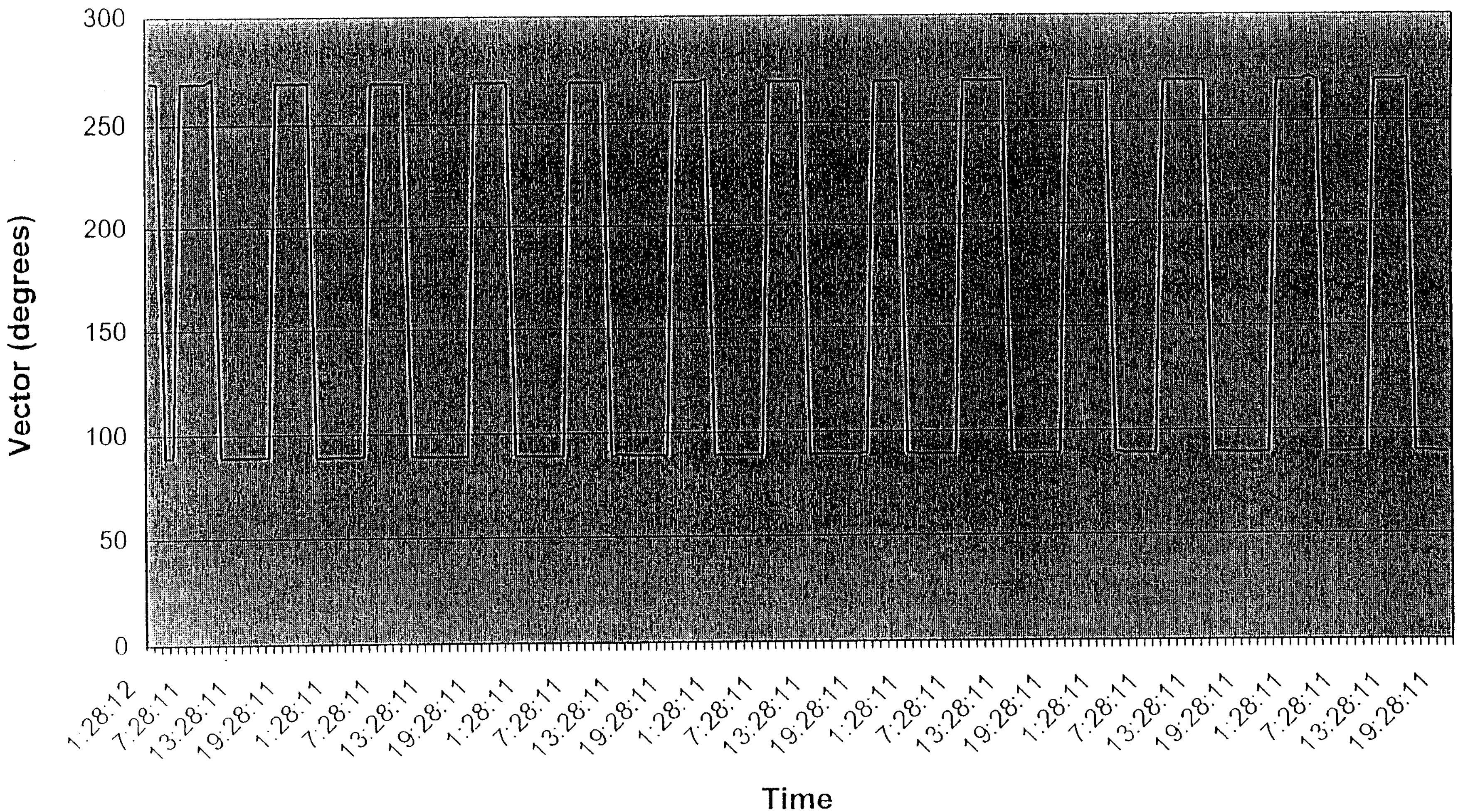
West Neck Creek
8/3/98 - 8/4/98
Turbidity

Little Bay Tributary from 3/27/98 to 4/2/98



Little Bay Tributary
3/27/98 - 4/2/98
Velocity

Little Bay Tributary from 3/27/98 to 4/2/98



Little Bay Tributary
3/27/98 - 4/2/98
Vector

APPENDIX D

LAND USE

PEP Tidal Creeks Study
Watershed and In-water Uses

Creek	Municipality Town / Village	Watershed Uses	Waterfront and Water Uses
Fresh Pond	East Hampton	Recreational / Park, Alberts Landing (1/4 mile north of creek)	
Northwest Creek	East Hampton / Sag Harbor	Residential, Northwest Harbor Park (County)	Road End (Ramp / Parking Lot) 1 Bulkhead 20 Moorings 2 Sailboats
Alewife Creek Mouth North Sea Harbor	Southampton	Residential (moderate), Commercial, Marina, Recreational / Park - Conscience Point National Wildlife Refuge (at creek mouth)	Cement Boat Ramp, Maintained Lawn, Boat Discharges 36 Houses (5 W, 31 E) 18 Docks (5 W, 13 E) 11 Bulkheads (4 W, 7 E) 1 Barge (1 W) 2 Marinas (2 W) 1 Houseboat (1 W) 116 Slips (116 W) 1 Jet Ski (1 W) 3 Dinghies (3 E) 97 Powerboats (80 W, 17 E) 14 Sailboats (12 W, 2 E)
Ligonee Creek	Southampton / Sag Harbor	Residential (low)	Maintained Lawn, Boat Discharges, Road End 18 Houses 13 Docks 5 Dinghies 8 Powerboats
Meetinghouse Creek	Riverhead / Aquebogue	Residential, Commercial, Marina (E)	Culvert 32 Houses 28 Docks 10 Bulkheads 1 Marina 1 Restaurant 182 Slips 29 Powerboats 23 Sailboats
West Creek	Southold / Cutchogue	North Fork Country Club (W), Fair to good creek used for shellfish seeding	7-9 Private Docks/Bulkheads 2 Houses (E) 1 Marina and Yacht Club 1/4-1/2 mile east of creek Town sm. boat launch (Grathwohl Road)

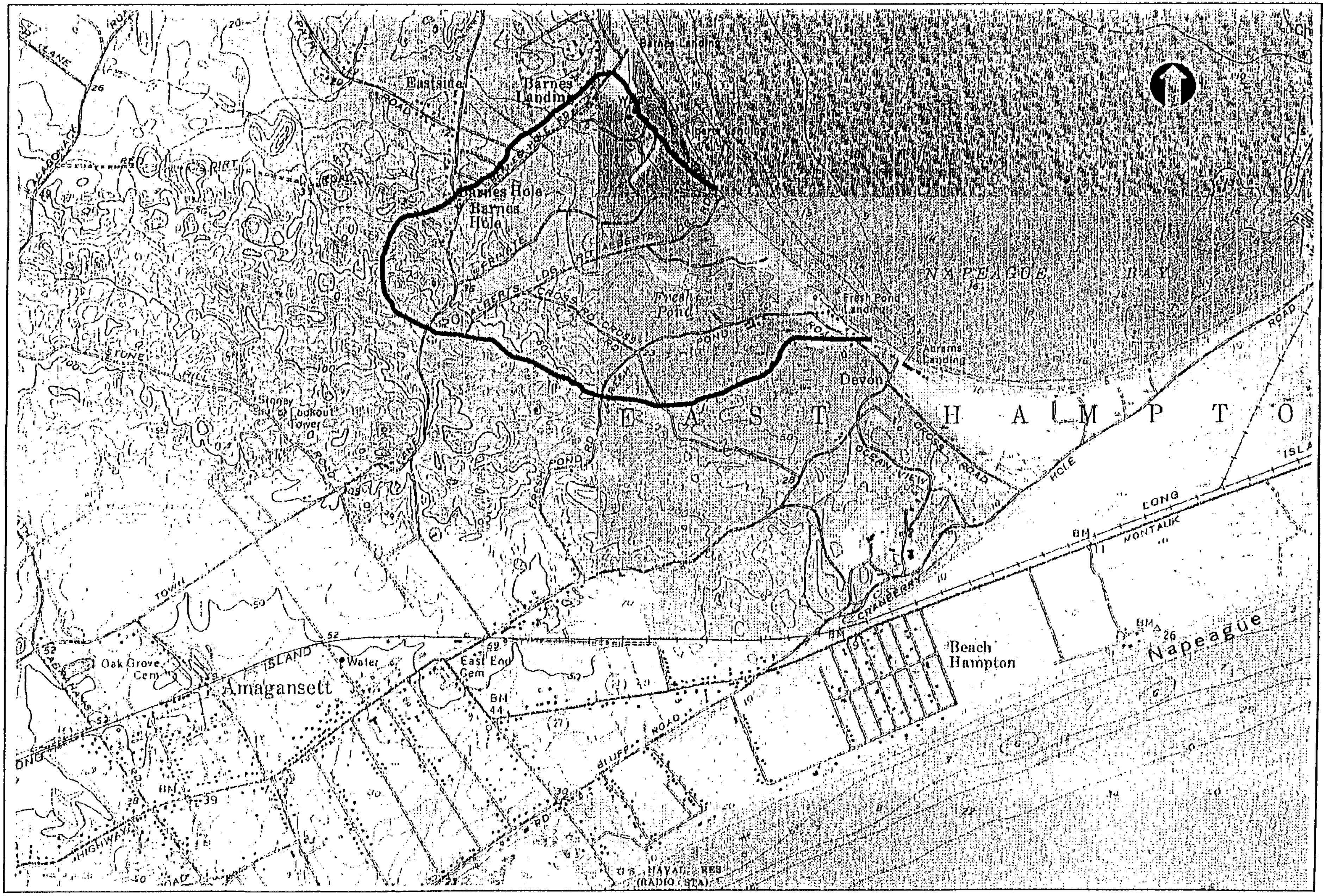
PEP Tidal Creeks Study
Watershed and In-water Uses

Creek	Municipality Town / Village	Watershed Uses	Waterfront and Water Uses
Goose Creek	Southold	Residential, Aquaculture (most productive creek - used for shelfish seeding), Goose Creek Bay Beach (private for residents of Goose Bay Estates)	Maintained Lawn, Boat Discharges 92 Houses 51 Docks 23 Bulkheads 1 Canoe 2 Jet Skis 6 Dinghies 50 Powerboats 2 Sailboats *31 Moorings 1 Town Ramp (Gaden's Landing Road) 1 Yacht Club (Southold)
West Neck Creek	Shelter Island / Shelter Island Heights	Island Boat Yard and Marina	2 Boat Launches 45 slips 20-25 Docks 4 Powerboats 1 Sailboat 1 Rowboat
Bass Creek	Shelter Island	Recreational / Park - Mashomack Preserve, Nature Conservancy	Undeveloped - In Preserve
Little Bay Tributary	Southold / Orient	Recreational / Park - Orient Beach State Park	1 Powerboat Long Beach Bay (at the mouth of Little Bay) has: 65 Slips/Berths *15 Moorings 1 Dock/bulkhead 1 Marina (Narrow River Road)

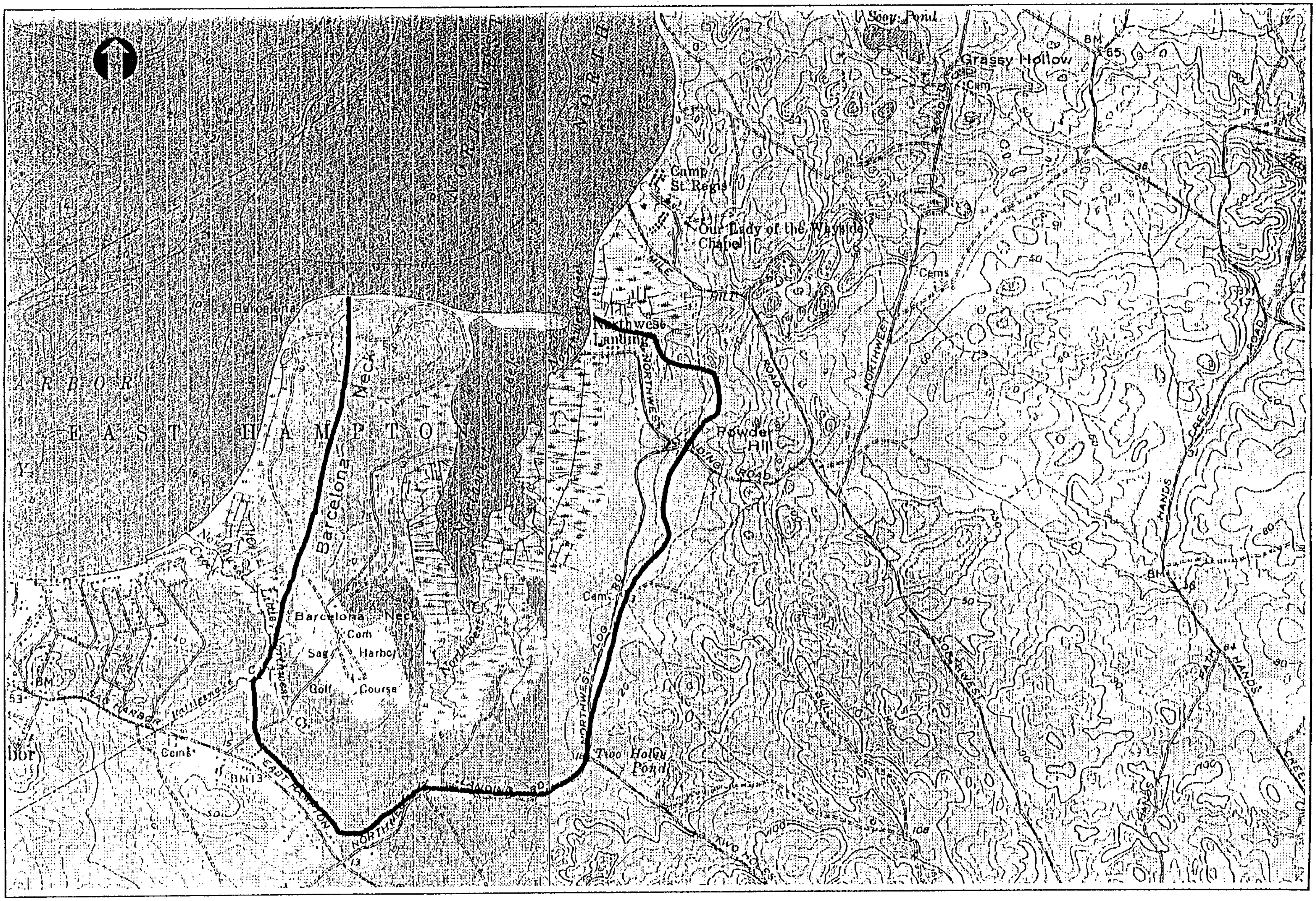
Key:

W - West
E - East
* - Mooring Capacity

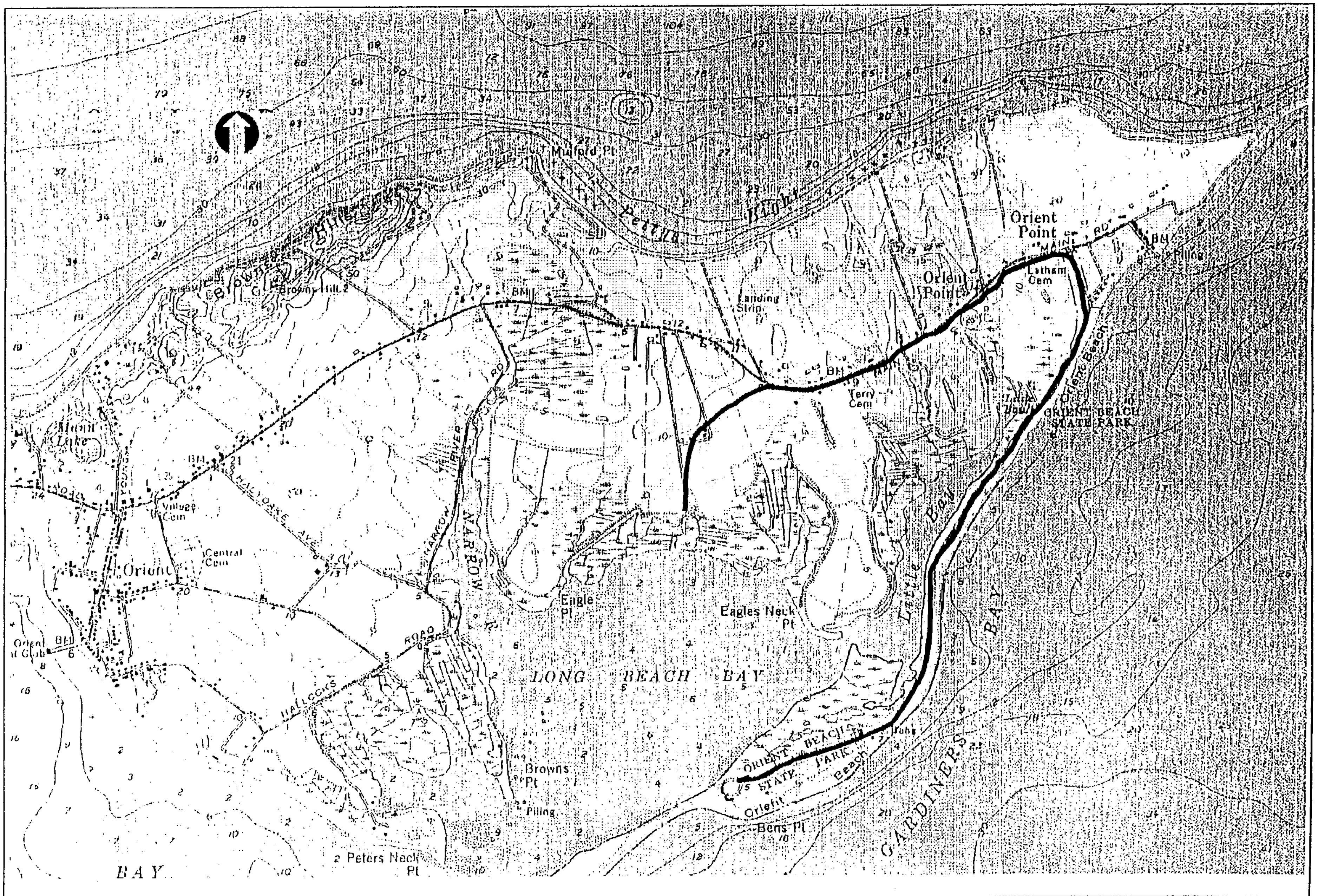
F:\PEP97521AKRFPeconicTable.wpd



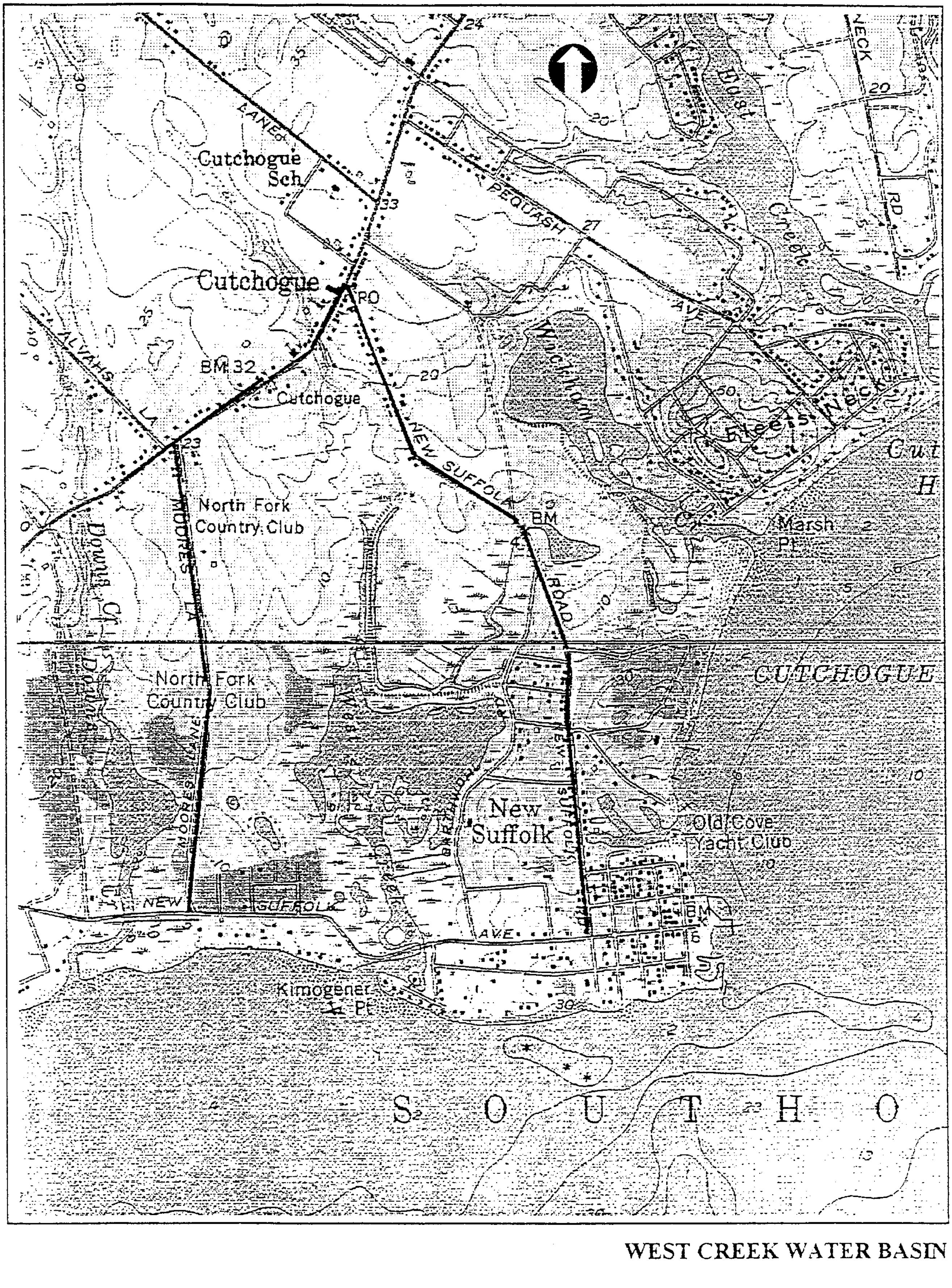
FRESH POND WATER BASIN



NORTHWEST CREEK WATER BASIN



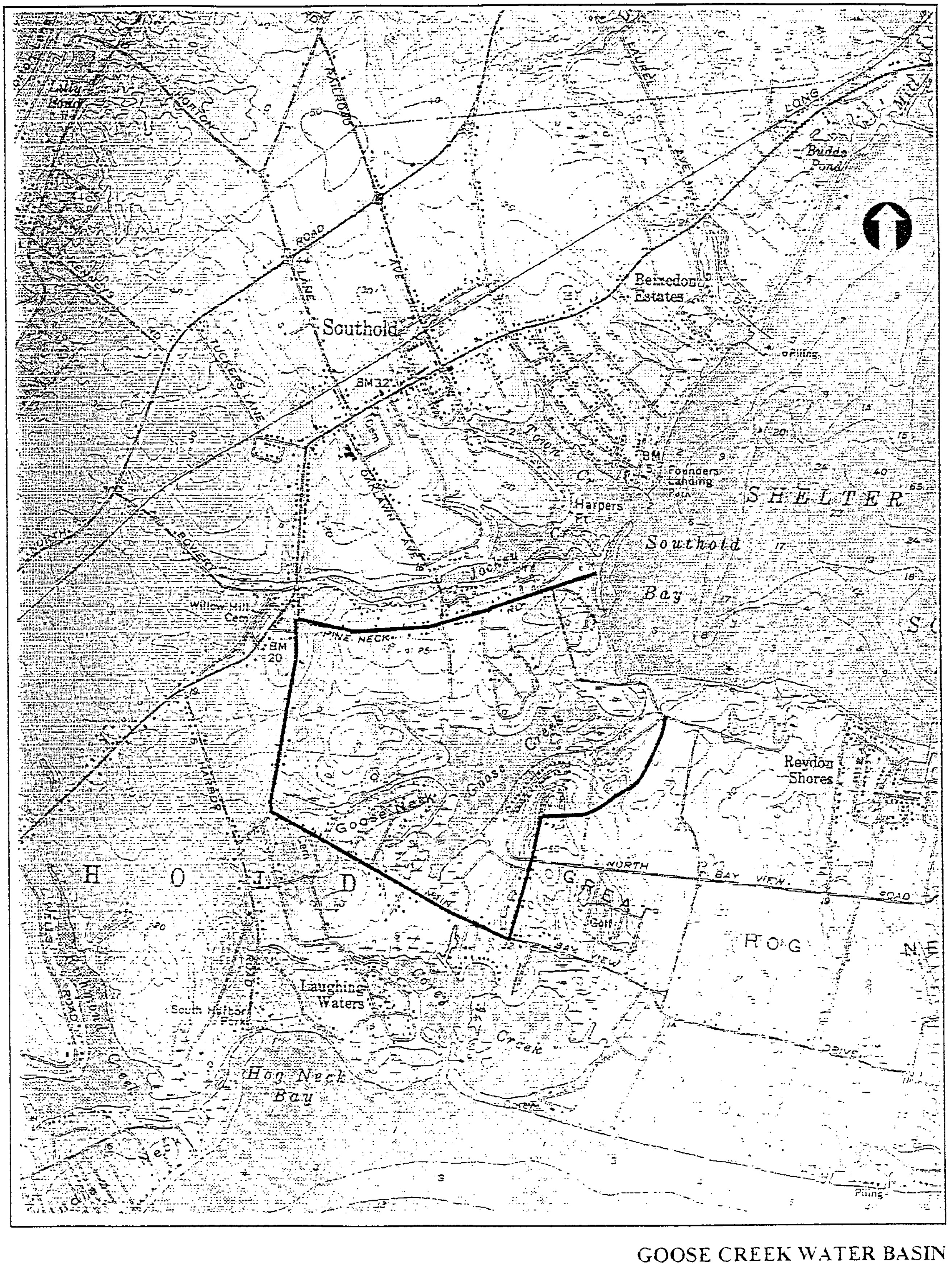
LITTLE BAY WATER BASIN



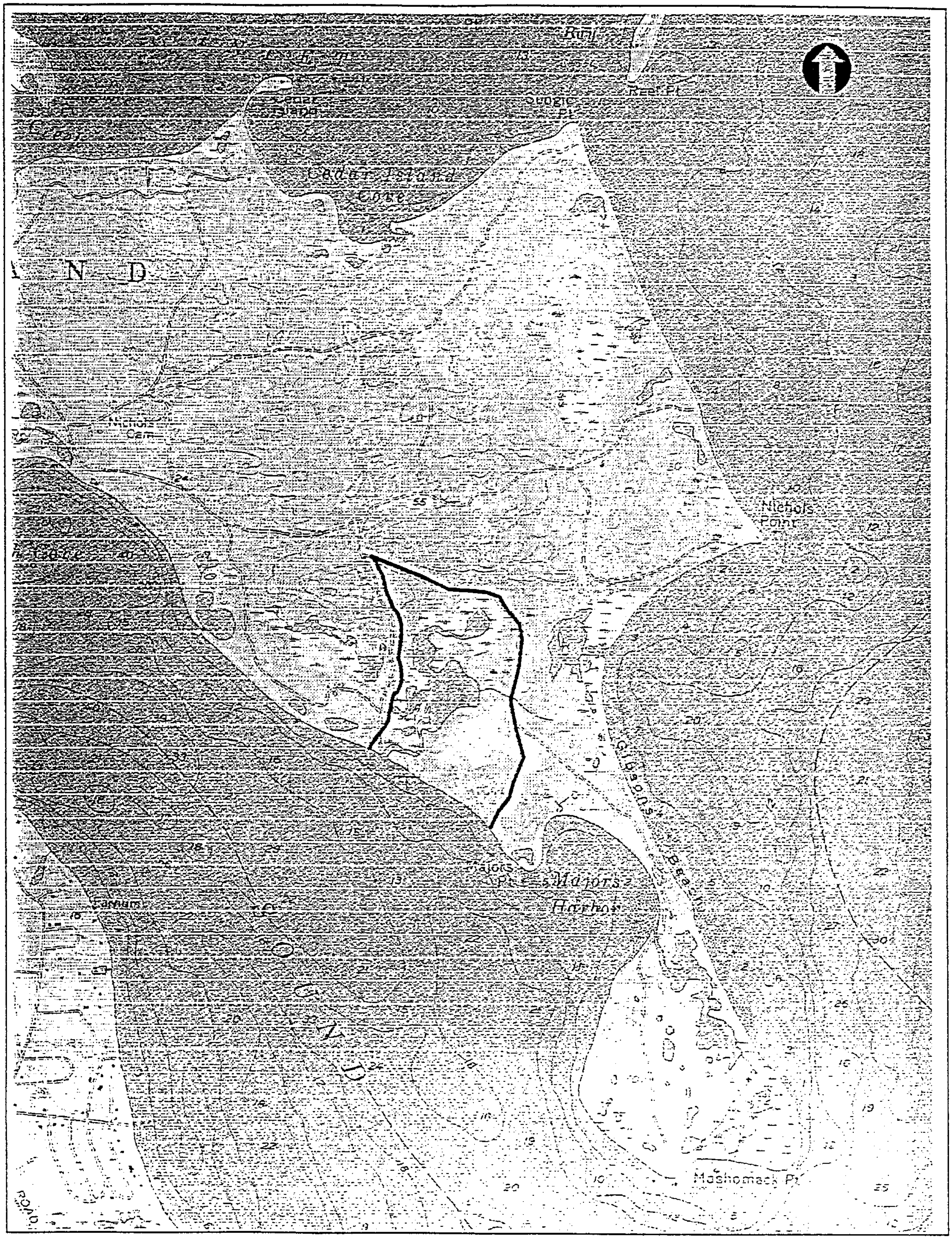
WEST CREEK WATER BASIN

MEETINGHOUSE CREEK WATER BASIN

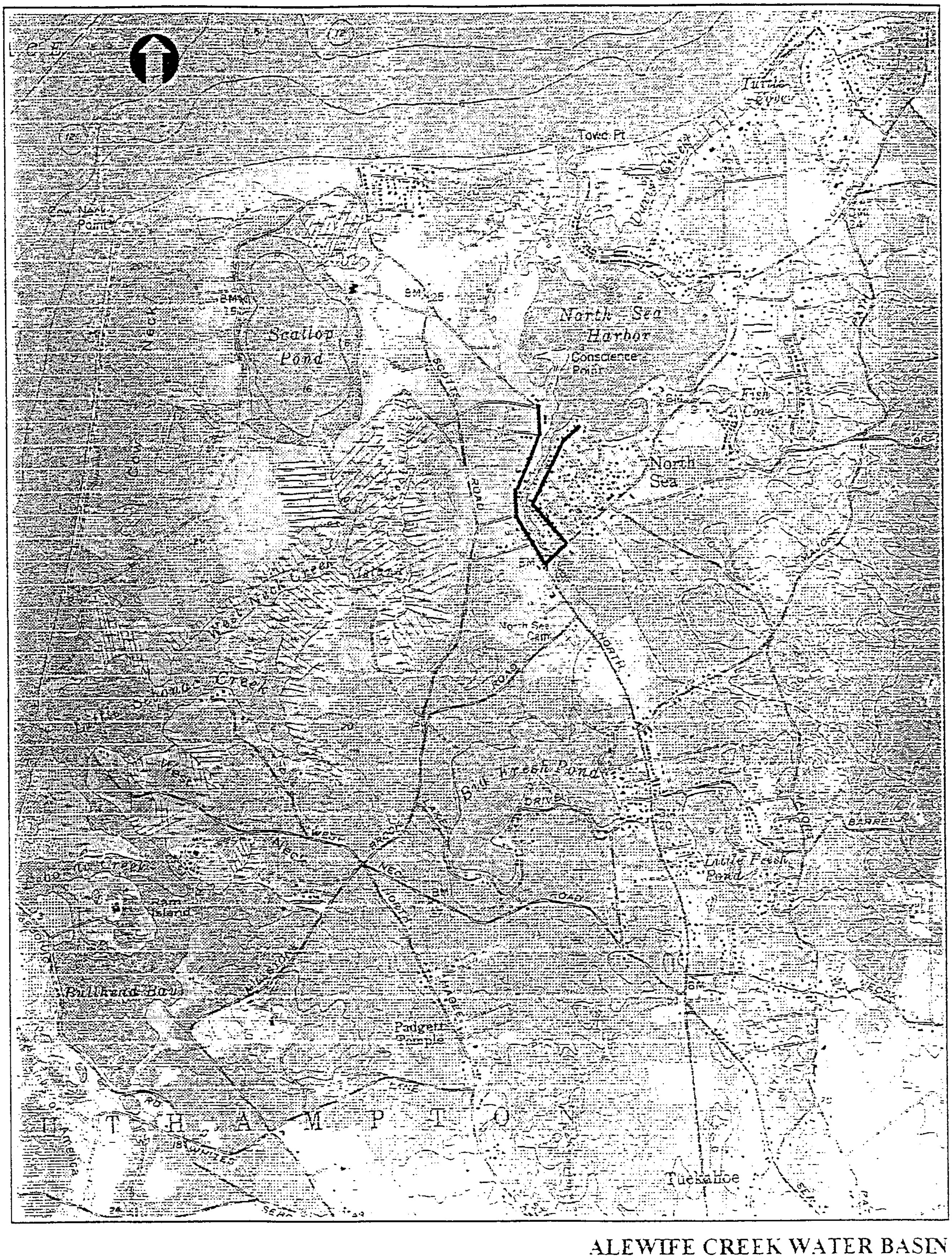
LIGONEE CREEK WATER BASIN



GOOSE CREEK WATER BASIN



BASS CREEK WATER BASIN



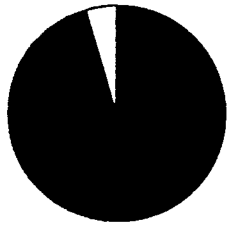
ALEWIFE CREEK WATER BASIN

APPENDIX E

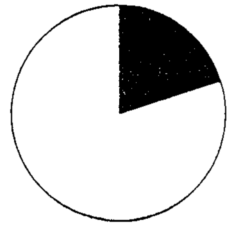
GRAIN SIZE & MACROBENTHIC COMMUNITIES

PEP Tidal Creek Study
Grain Size Analysis
August 1998

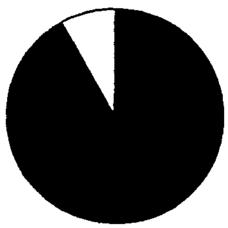
Fresh Pond Mouth Grain Size



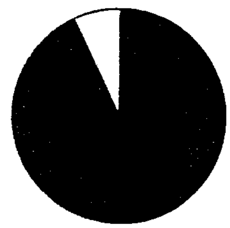
Fresh Pond Head Grain Size



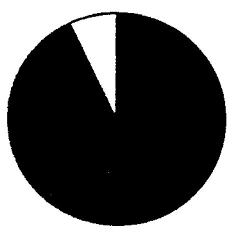
Northwest Creek Mouth Grain Size



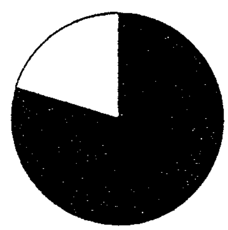
Northwest Creek Head Grain Size



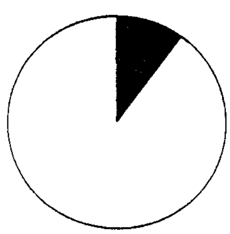
Ligonee Creek Mouth Grain Size



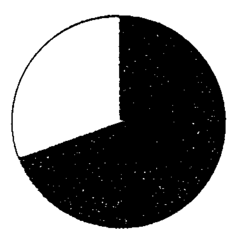
Ligonee Creek Head Grain Size



Alewife Creek Mouth Grain Size



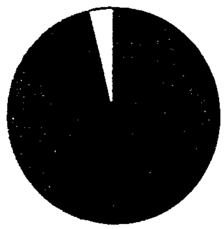
Alewife Creek Head Grain Size



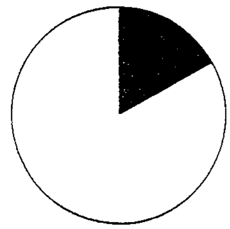
■ Sand (< 2.0mm and > .038 mm)
□ Silt (<.038 mm)

PEP Tidal Creek Study
Grain Size Analysis
August 1998

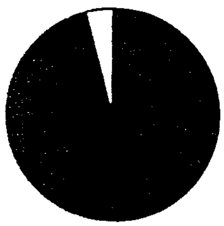
West Creek Mouth Grain Size



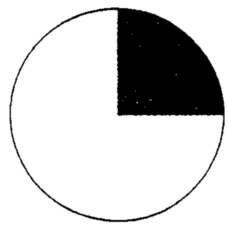
West Creek Head Grain Size



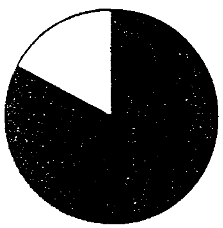
Goose Creek Mouth Grain Size



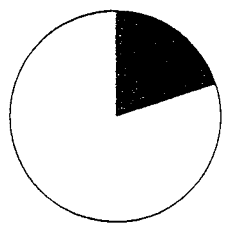
Goose Creek Head Grain Size



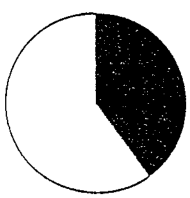
Little Bay Mouth Grain Size



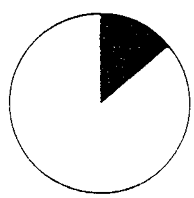
Little Bay Head Grain Size



Meetinghouse Creek Mouth Grain Size

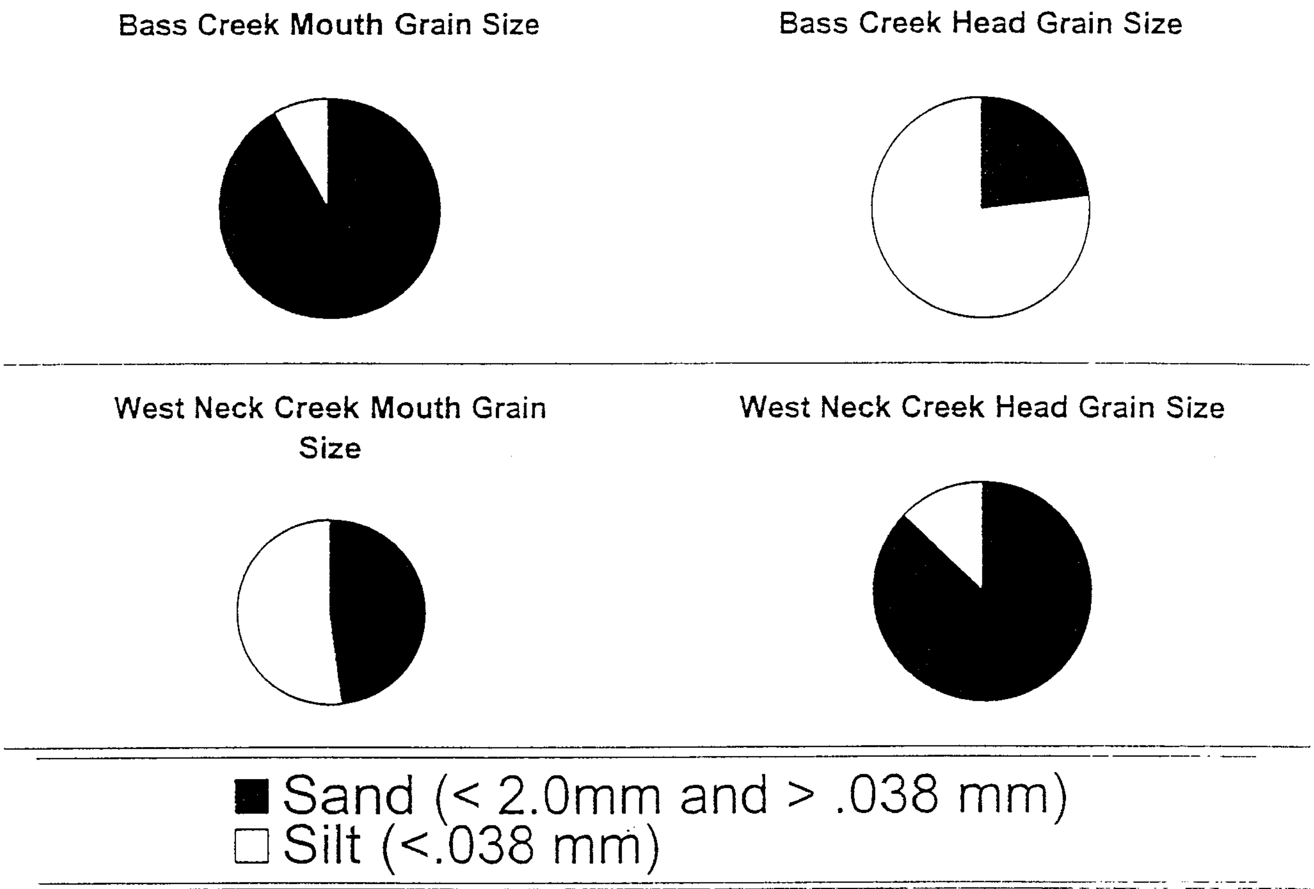


Meetinghouse Creek Head Grain Size



■ Sand (< 2.0mm and > .038 mm)
□ Silt (<.038 mm)

PEP Tidal Creek Study
Grain Size Analysis
August 1998



Peconic Estuary Program
Tidal Creek Study
Grain Size Distribution

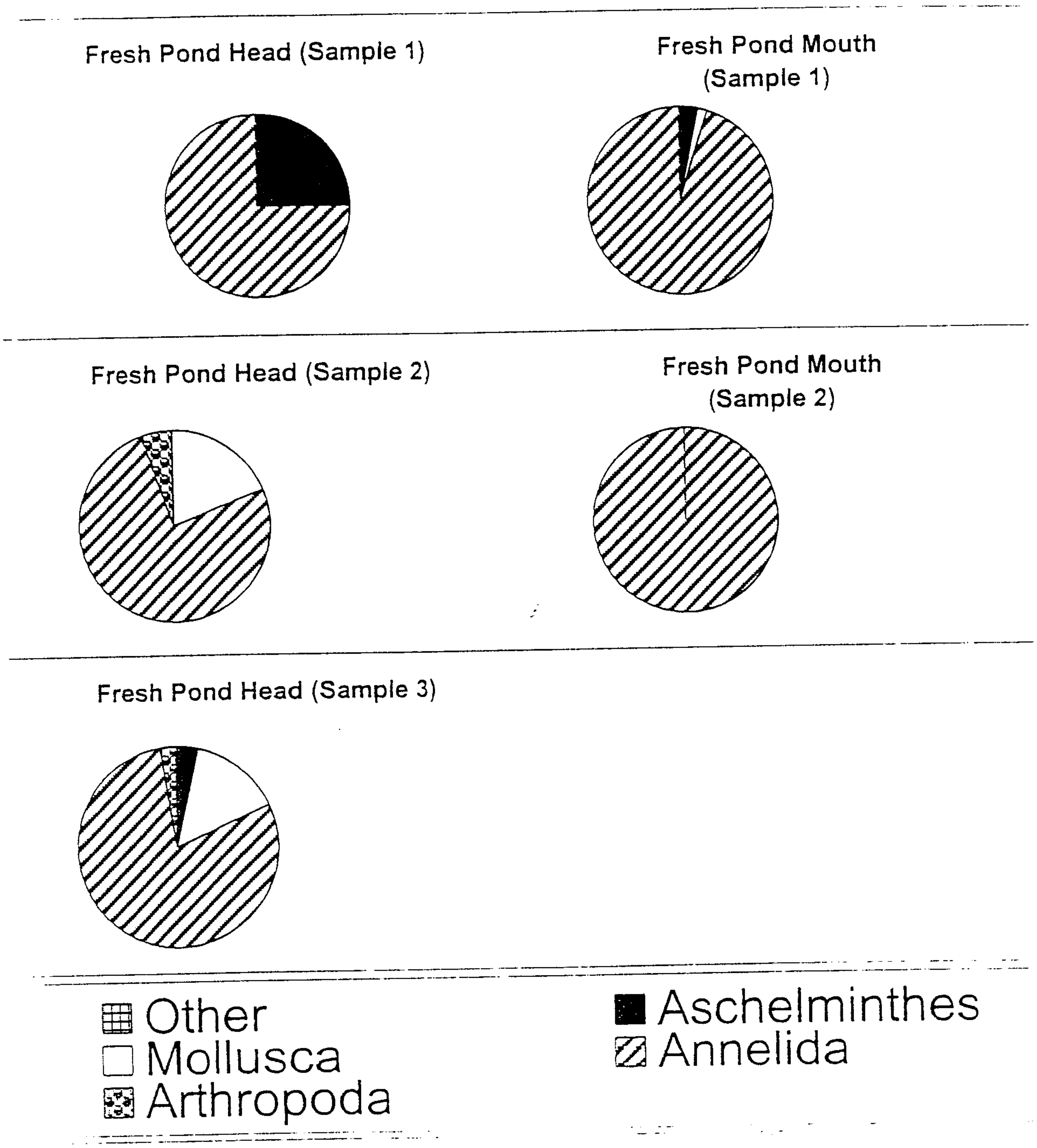
Station	Percent Sand*	Percent Silt**
West Creek HEAD	17%	83%
West Creek MOUTH	96%	4%
Goose Creek MOUTH	96%	4%
Goose Creek HEAD	25%	75%
Little Bay MOUTH	83%	17%
Little Bay HEAD	22%	88%
Meetinghouse Creek MOUTH	40%	60%
Meetinghouse Creek HEAD	14%	86%
Fresh Pond HEAD	20%	80%
Fresh Pond MOUTH	96%	4%
Northwest Creek HEAD	93%	7%
Northwest Creek MOUTH	92%	8%
Ligonee Creek HEAD	80%	20%
Ligonee Creek MOUTH	93%	7%
Alewife Creek HEAD	69%	31%
Alewife Creek MOUTH	10%	90%
Bass Creek HEAD	23%	77%
Bass Creek MOUTH	92%	8%
West Neck Creek HEAD	87%	13%
West Neck Creek MOUTH	48%	52%

* = Sand represents grain sizes between 2.0 mm and .038 mm

** = Silt represents grain sizes less than .038 mm

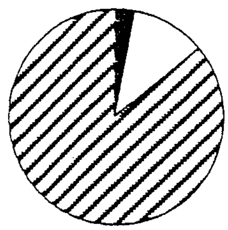
Sampling Date: August 2, 1998

Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Fresh Pond, July 1998

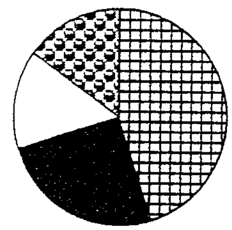


Macrobenthic Invertebrate Densities
Fresh Pond, December 1998

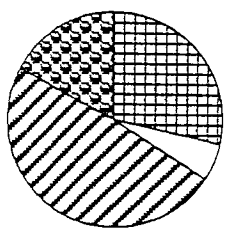
Fresh Pond Head (Sample 1)



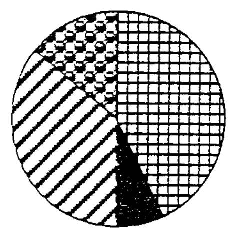
Fresh Pond Mouth (Sample 1)



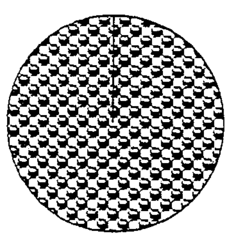
Fresh Pond Head (Sample 2)



Fresh Pond Mouth (Sample 2)

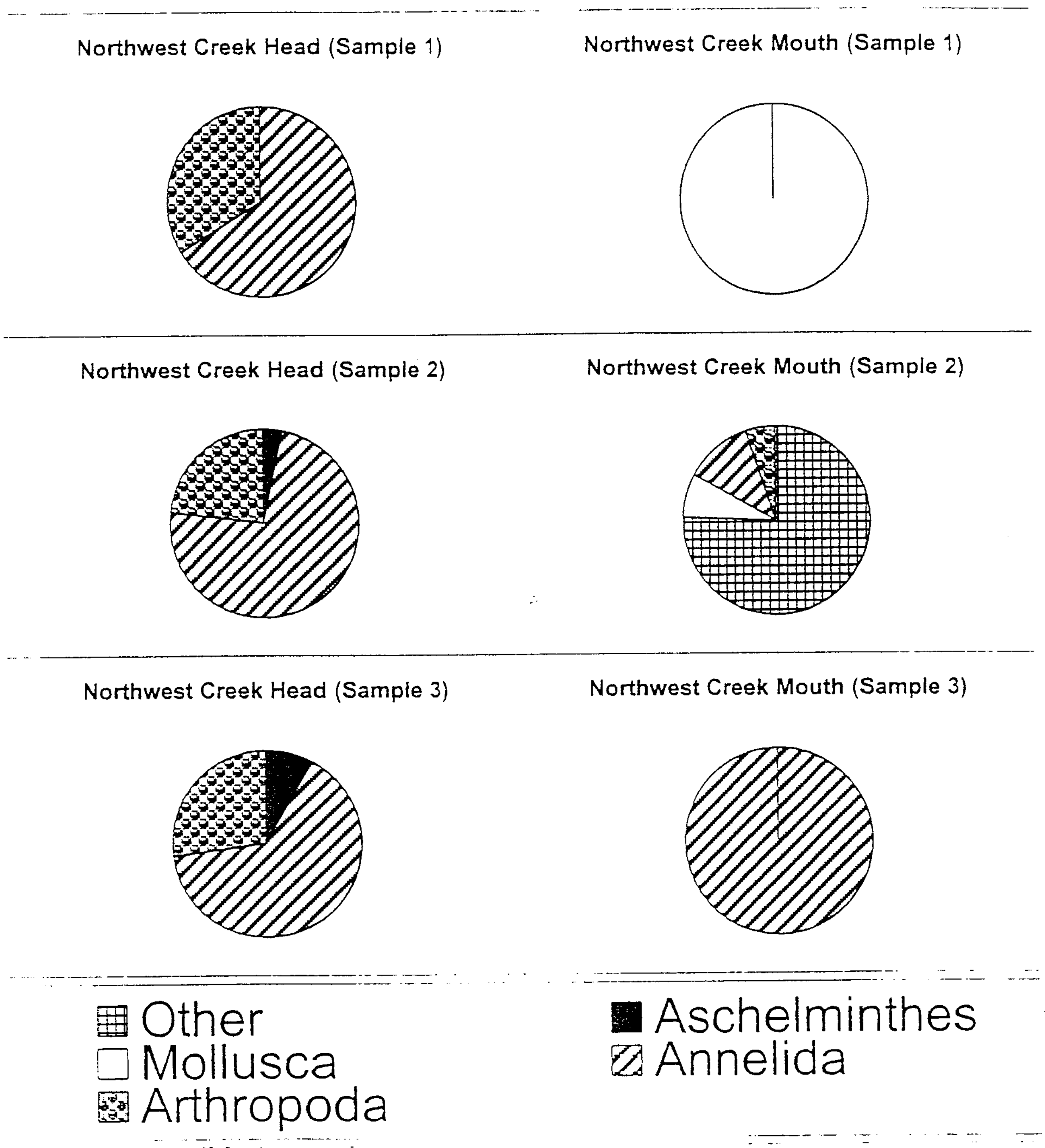


Fresh Pond Head (Sample 3)



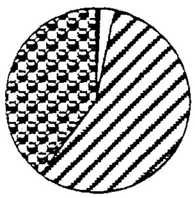
- Other
- Mollusca
- Arthropoda
- Aschelminthes
- Annelida

Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Northwest Creek, July 1998

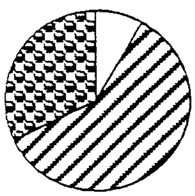


Macrobenthic Invertebrate Densities
Northwest Creek, December 1998

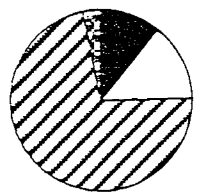
Northwest Creek Head
(Sample 1)



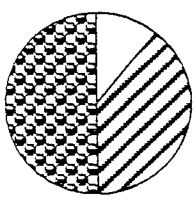
Northwest Creek Head
(Sample 2)



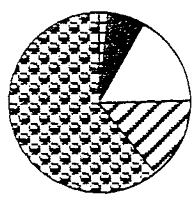
Northwest CreekMouth
(Sample 2)

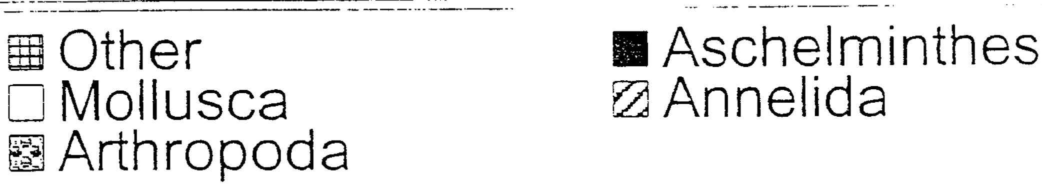


Northwest Creek Head
(Sample 3)



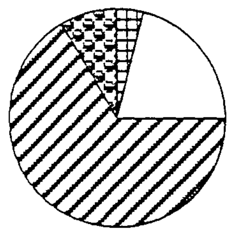
Northwest Creek Mouth
(Sample 3)



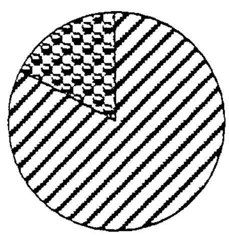


Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Ligonee Creek, July 1998

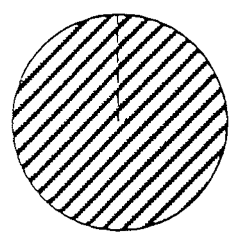
Ligonee Creek Head (Sample 1)



Ligonee Creek Head (Sample 2)

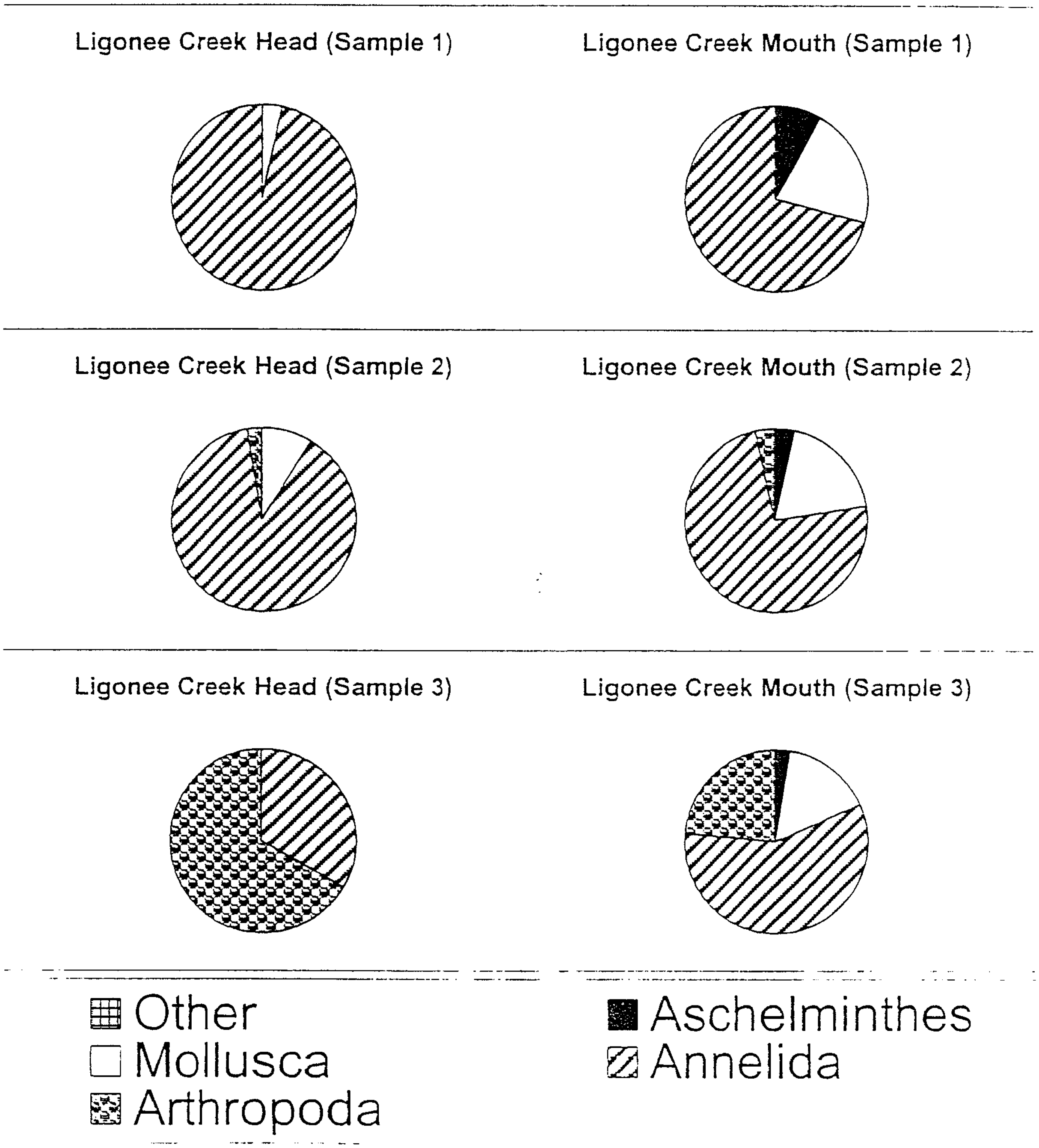


Ligonee Creek Mouth (Sample 3)

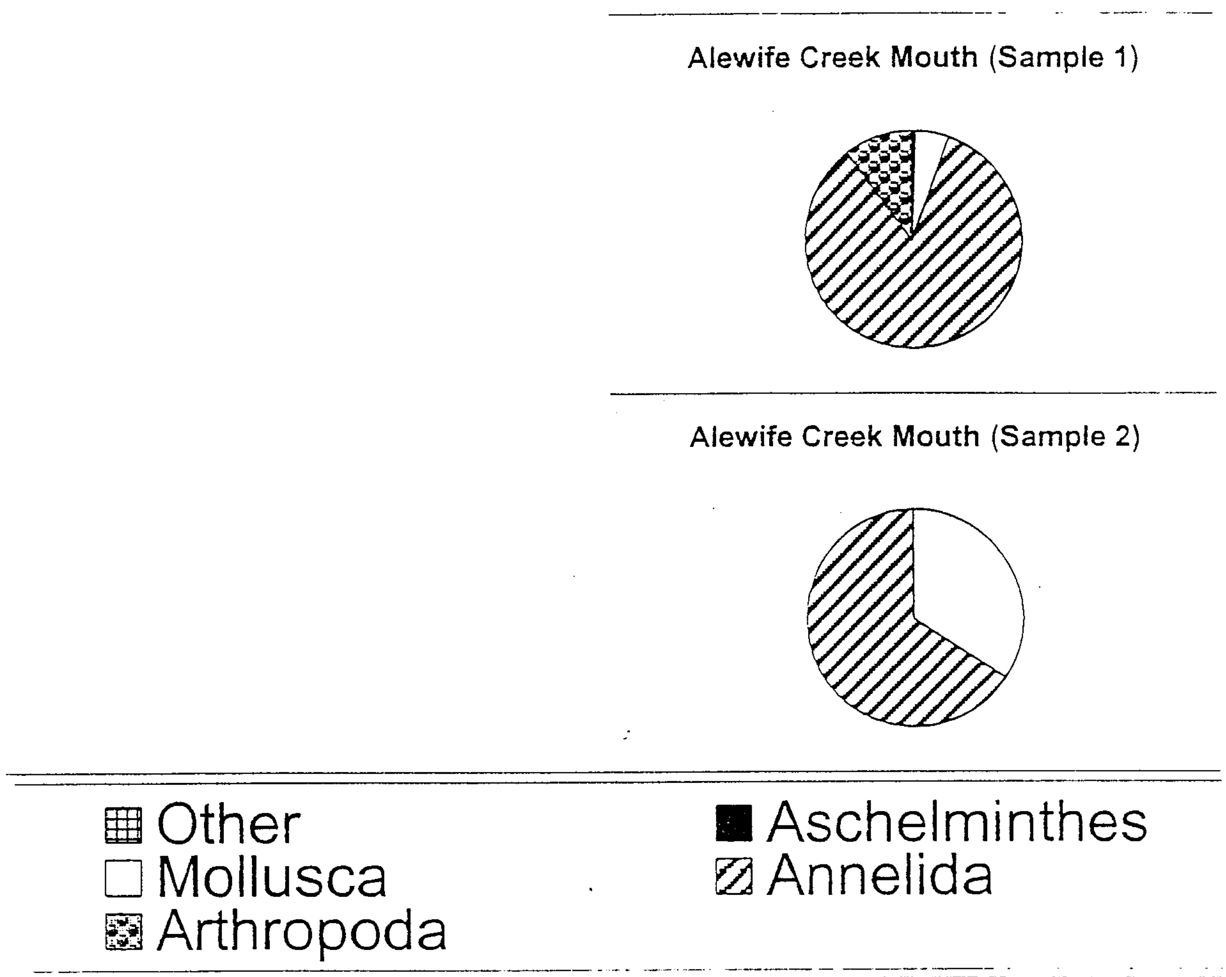


- Other
- Mollusca
- Arthropoda
- Aschelminthes
- Annelida

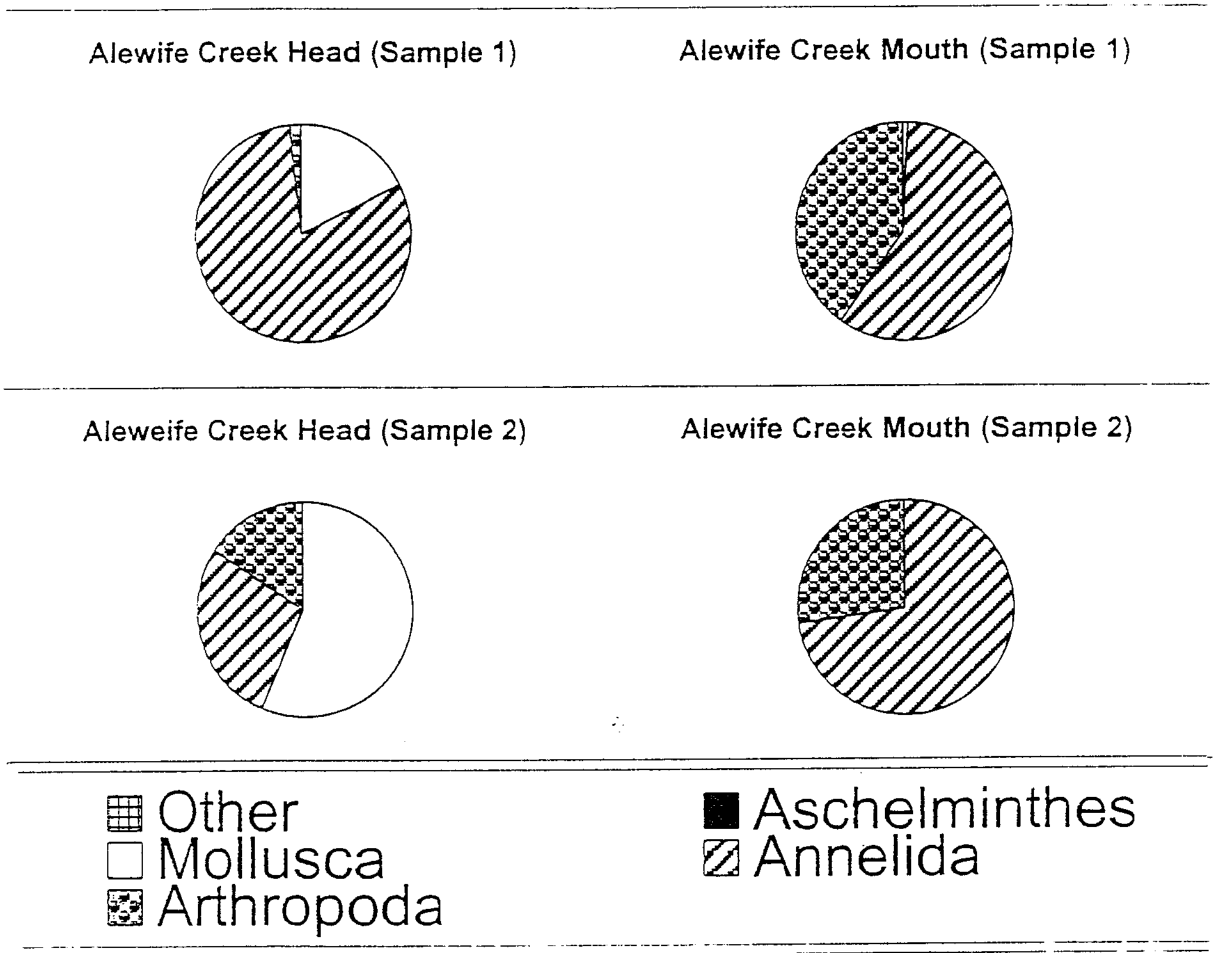
Macrobenthic Invertebrate Densities
Ligonee Creek, December 1998



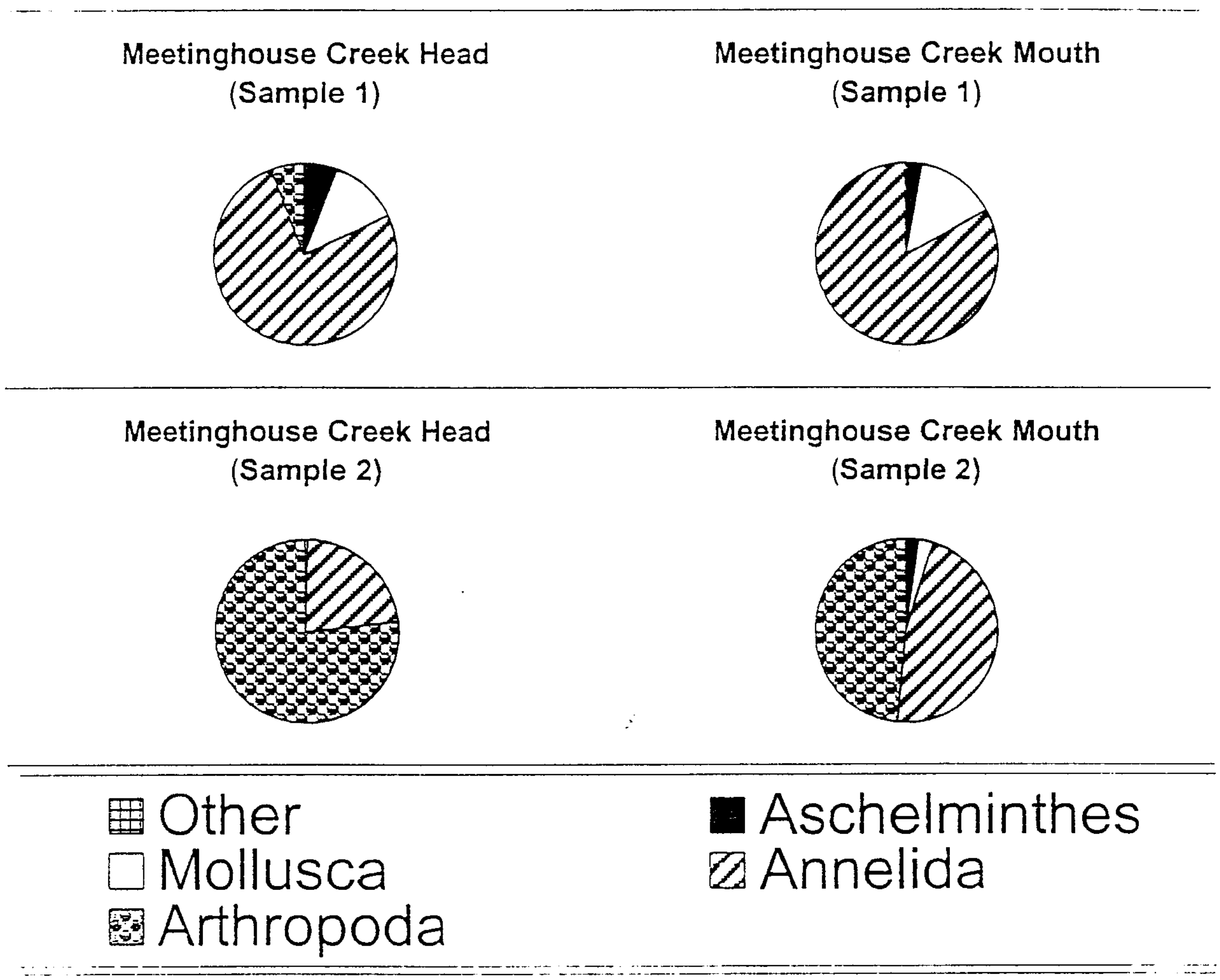
Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Alewife Creek, July 1998



Macrobenthic Invertebrate Densities
Alewife Creek, December 1998

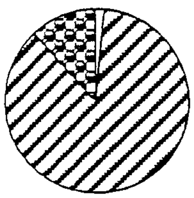


Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Meetinghouse Creek, July 1998

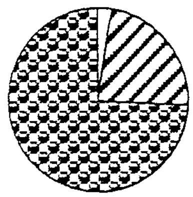


Macrobenthic Invertebrate Densities
Meetinghouse Creek, December 1998

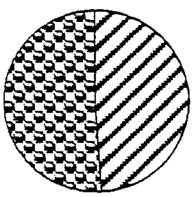
Meetinghouse Creek Head
(Sample 1)



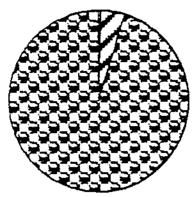
Meetinghouse Creek Mouth
(Sample 1)



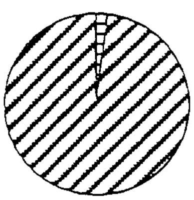
Meetinghouse Creek Head
(Sample 2)



Meetinghouse Creek Mouth
(Sample 2)

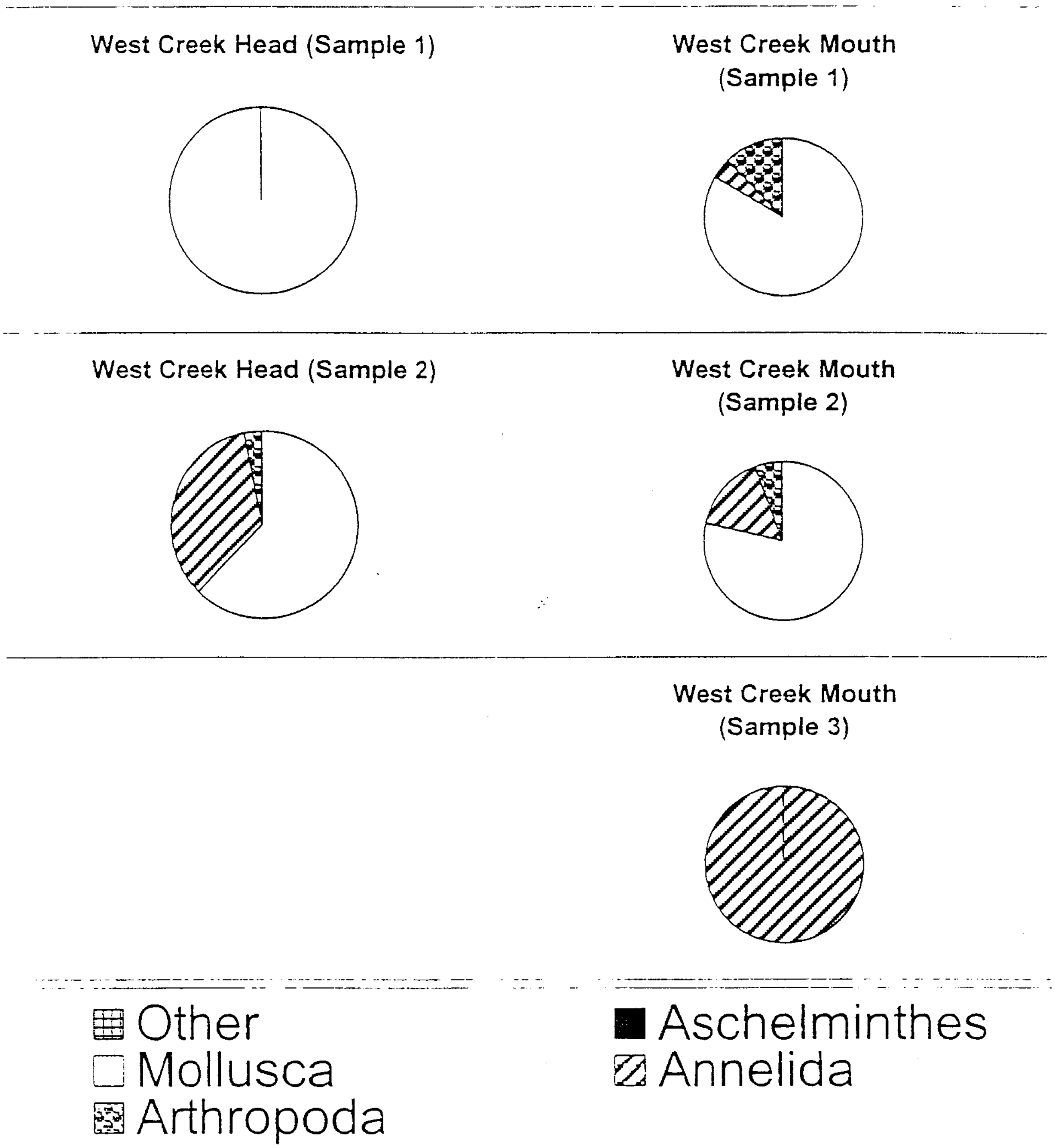


Meetinghouse Creek Head
(Sample 3)

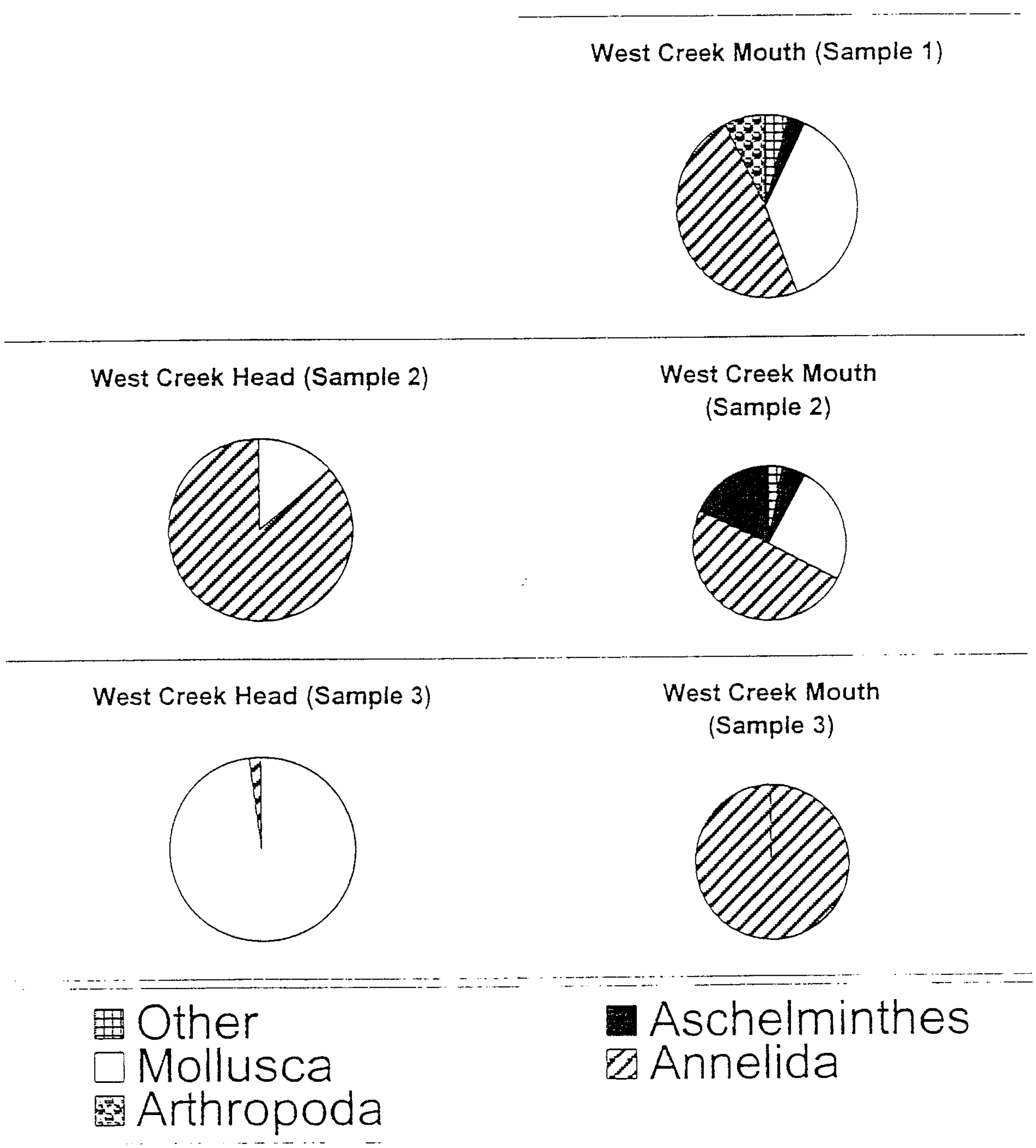


Other
Mollusca
Arthropoda
Aschelminthes
Annelida

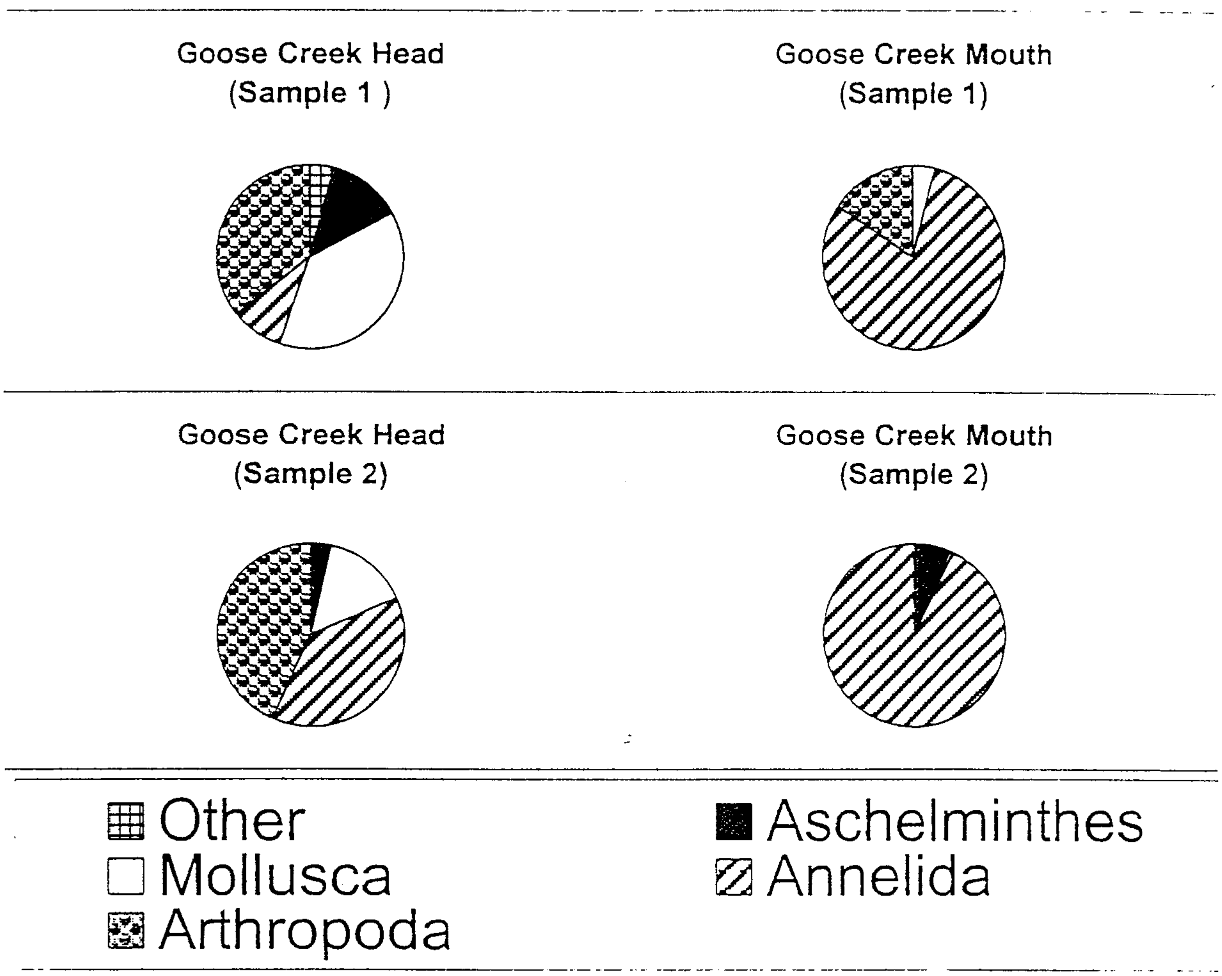
Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
West Creek, July 1998



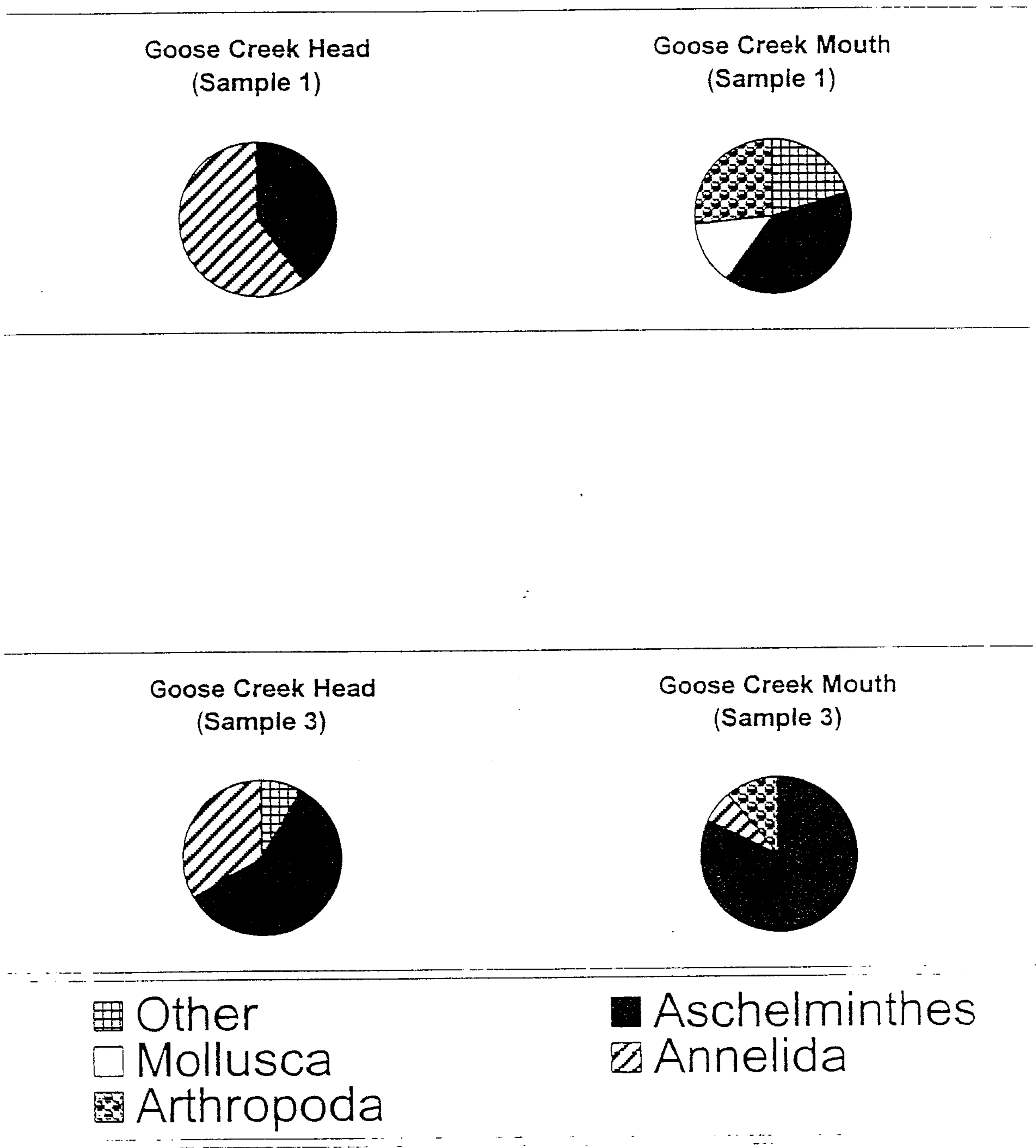
Macrobenthic Invertebrate Densities
West Creek, December 1998



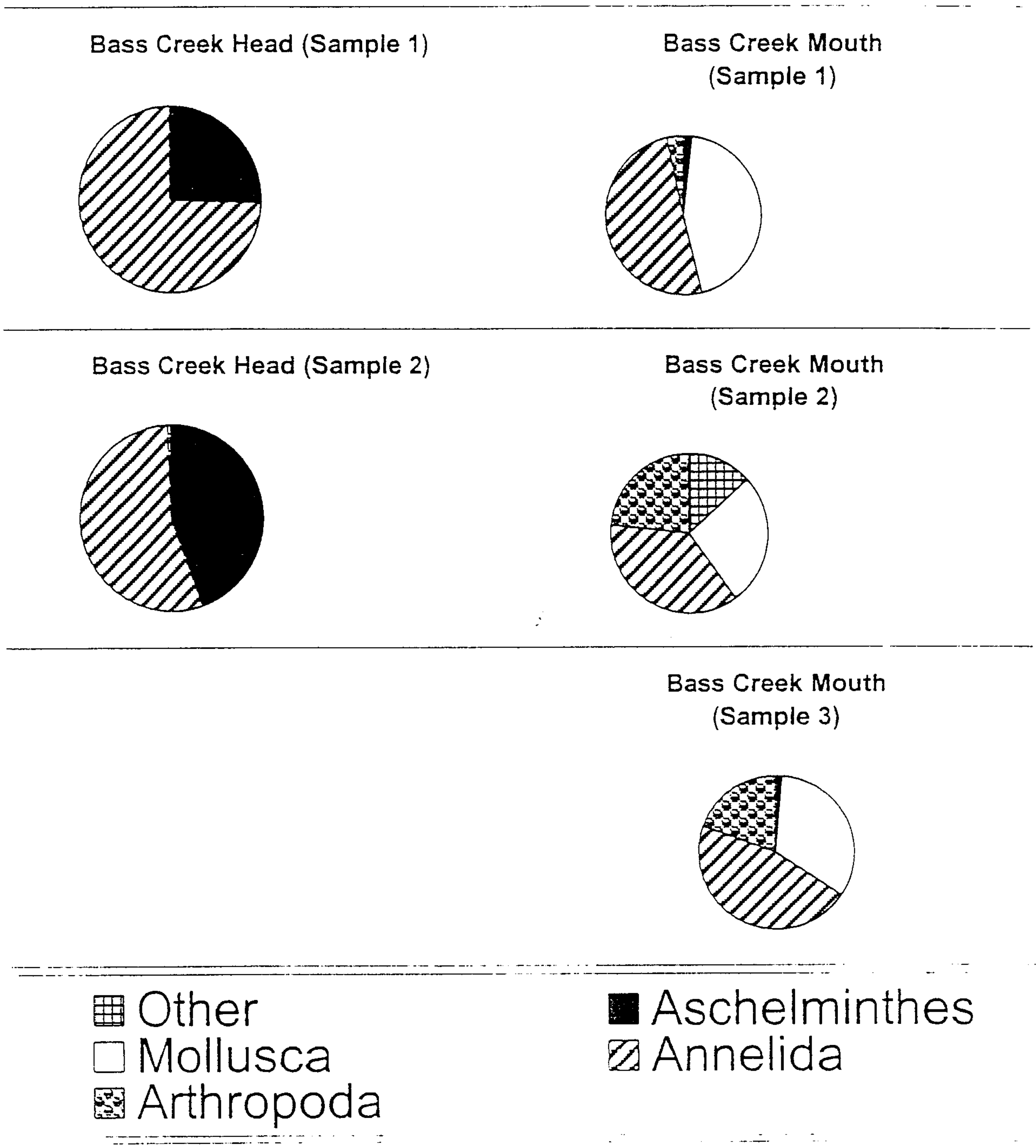
Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Goose Creek, July 1998



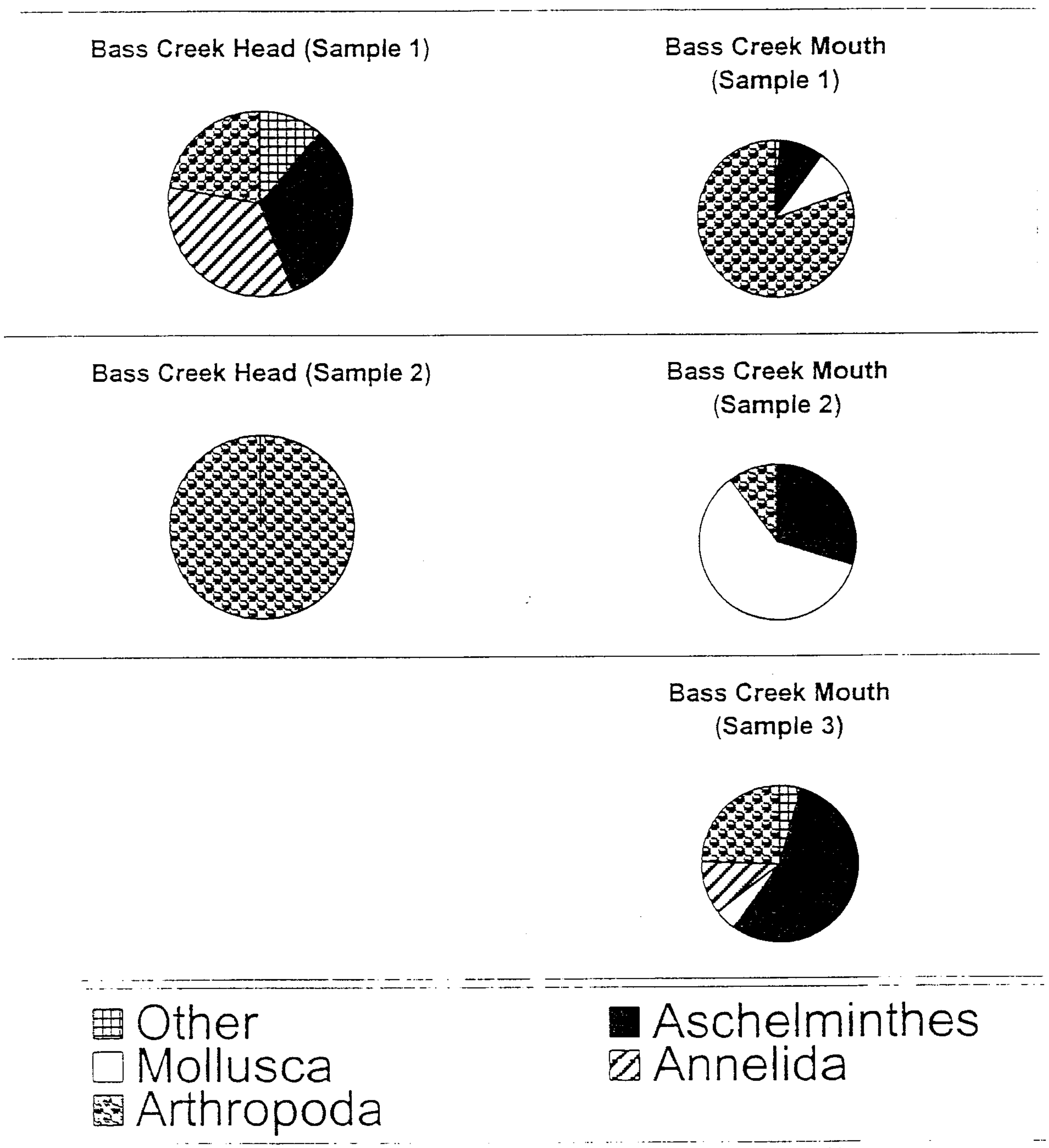
Macrobenthic Invertebrate Densities
Goose Creek, December 1998



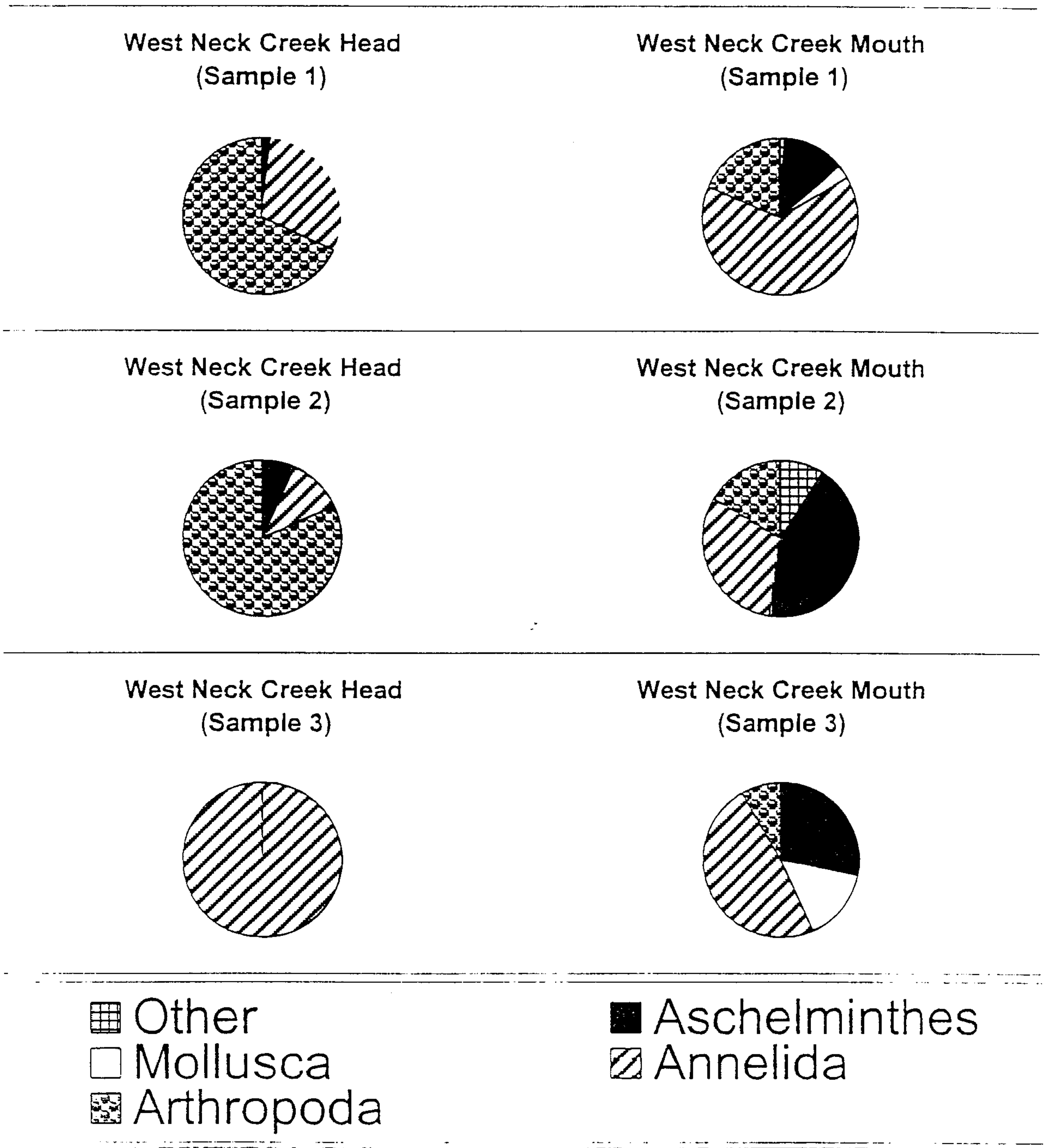
Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Bass Creek, July 1998



Macrobenthic Invertebrate Densities
Bass Creek, December 1998

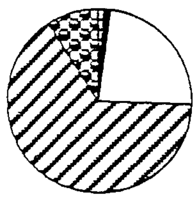


Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
West Neck Creek, July 1998

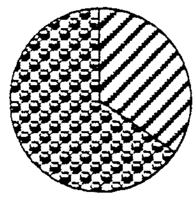


Macrobenthic Invertebrate Densities
West Neck Creek, December 1998

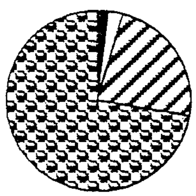
West Neck Creek Head
(Sample 1)



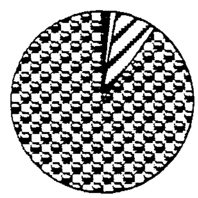
West Neck Creek Mouth
(Sample 1)



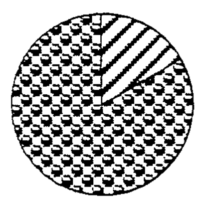
West Neck Creek Head
(Sample 2)



West Neck Creek Mouth
(Sample 2)

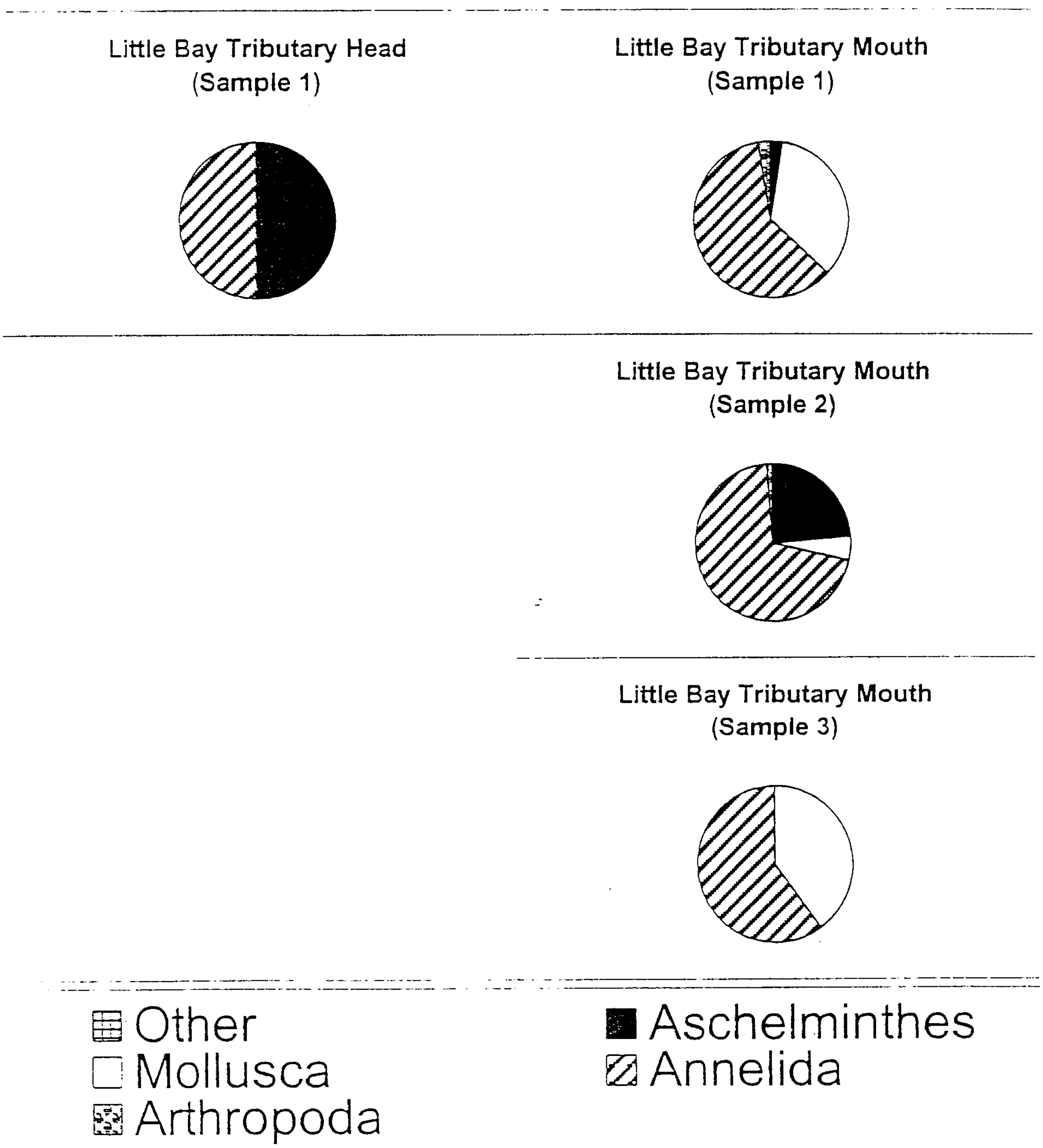


West Neck Creek Mouth
(Sample 3)

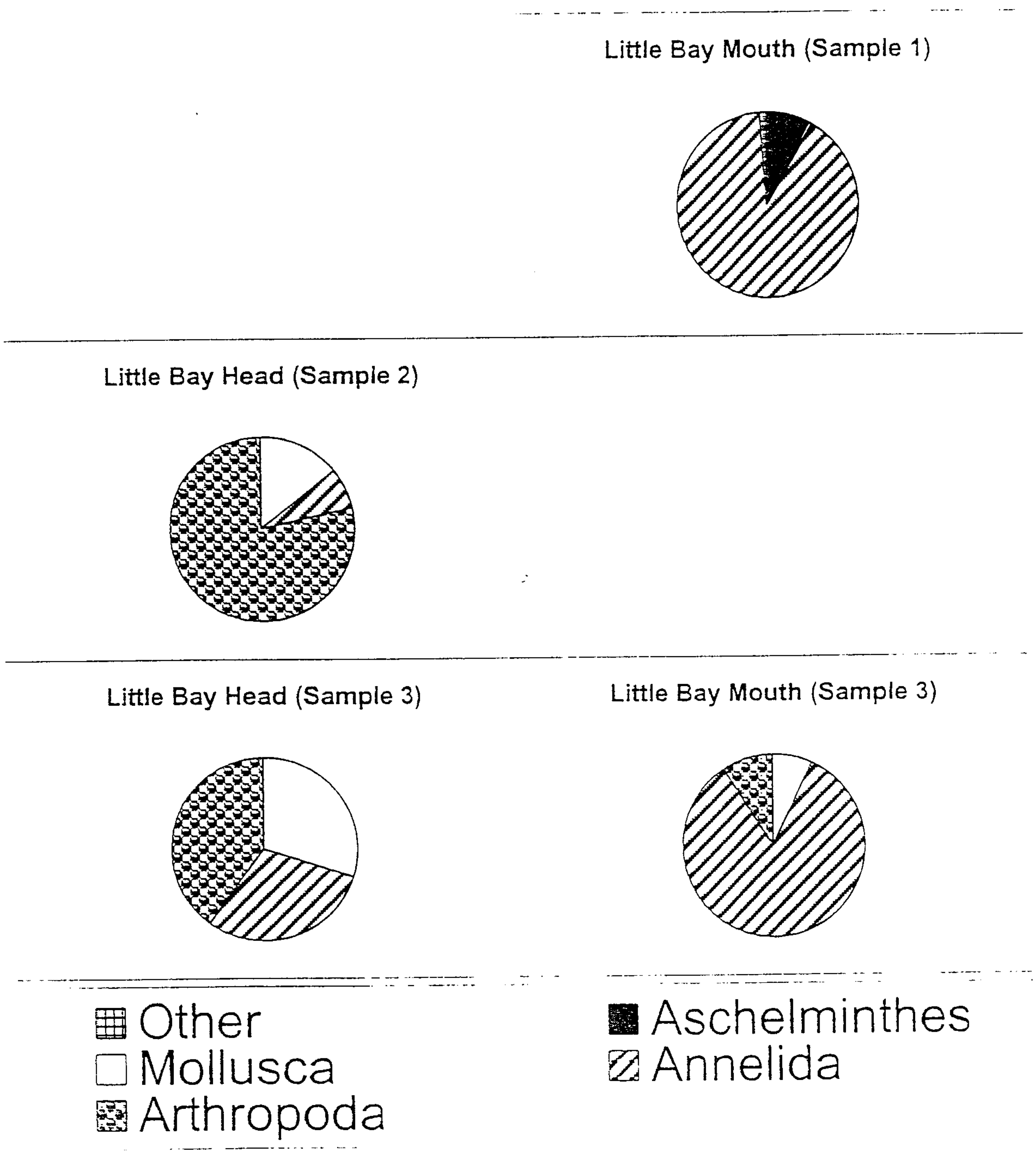


- Other
- Mollusca
- Arthropoda
- Aschelminthes
- Annelida

Macrobenthic Invertebrate Densities for the PEP Tidal Creek Study
Little Bay Creek, July 1998



Macrobenthic Invertebrate Densities
Little Bay Creek, December 1998



PEP Tidal Creeks Study
July 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Platyhelminthes:																														
Platyhelminthes flatworms													1																	
Rhynchocaela:																														
Nemertean worms			1								31											1								
Aschelminthes:																														
Aschelminthes	1	0	10	2	0	0	0	3	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	9	0
Mollusca:																														
Crepidula fornicata																														
Crepidula convexa																														
Gastropoda sp																														
Thais lapillus																														
Nassarius obsoletus																						7	15		1	3		8	8	
Nassarius trivittatus																						4								
Hydrobia minuta		1	31	1							1		3																	
Unidentified Bivalvia		6	3																						1					
Mytilus edulis													1																	
Mya arenaria										1																				
Mercenaria mercenaria																														
Macoma tenta			2																											
Petricola pholadiformis																														
Nucula proxima																														
Tellina agilis																												2	2	
Gemma gemma			9								2		1																	
Solemya velum																														
Annelida:																														
Unidentified Polychaeta																														
Polygordius triestinus											2	9																		
Eumida sanguinea																														
Notocirrus spiniferus																														
Lumbrineris tenuis		1						1																						
Goniadella sp.																														
Aricidea catherinae																														
Asabellides oculata																														
Platynereis dumerilii																														
Arabellidae																														
Microphthalmus aberrans				1																										
Elasmopus levis																														
Phyllodocidae																														
Phascolion strombi																														
Eteone heteropoda			3						1				1																2	
Glycera sp																						5								
Syllis sp																														
Podarke obscura									2		3															1		1		
Neanthes succinea		1	9				29	31	58																					

PEP Tidal Creeks Study
July 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Noanthes sp																														
Mediomastus ambiesota							16	20	50					1									11			87			3	
Capitella capita			3					4					1									8			13				2	
Maldonidae																														
Clymenella torqueta																														
Spionidae sp																														
Streblospio benedicti		9		51				4	8			2		5								124	6			17		58	179	
Polydora ligni		1	18										5	2								27	1			3				
Scolelepis squamata	3																													
Scolecolepides viridis				1			1	1	6				1																	
Haploscopoplos rubustus			8	3									8	10								7	3			4				
Hypaniola grayi		15	157	1			10	6	18																					
Tharyx acutus																						5	8							
Pectinaria gouldi																														
Pista cristata																														
Class oligochaeta			42		1		7							6								5				1				
Unid polychaete																														
Polychaete (larvae)		1																												
Arthropoda:																														
Salamae cocina																														
Edotea triloba		2	6																											
Sphaeromoma quadridentatum																														
Amphipod sp																						1								
Ampelisca vadorum											1																			
Ampelisca verrilli																														
Erichthonius sp.																														
Paraphoxus epistomus																														
Listerella sp.																														
Ampelisca abdita																						9				385			193	
Gammarus mucronatus														4																
Gammarus sp																														
Microdeutopus gryllotalpa																														
Corophium sp																														
Lysianopsis alba								1														3								
Leptocheirus plumolosus			2				33	20	57													9								
Leucon americana											1		1	1																
Crangon septemspinosa																													1	
Palaemonetes sp																														
Palaemonetes pugio																														
Hippolyte zostericola																														
Neomysis americana																														

PEP Tidal Creeks Study
July 1998 Macrobenthic Invertebrate Densities

Species	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Platyhelminthes:																														
Platyhelminthes flatworms											1					1														
Rhynchocaela:																														
Nemertean worms							10										4					2	35							
Aschelminthes:																														
Aschelminthes	0	0	0	0	0	0	30	5	0	0	9	0	106	192	0	3	0	1	4	51	0	22	167	17	1	0	0	1	80	0
Mollusca:																														
Crepidula fornicata		8		6	9					1						1	5	2												4
Crepidula convexa							3																							
Gastropoda sp	1			8	1									1																
Thais lapillus					6																									
Nassarius obsoletus	36	24		16	31			6								4	2	3						3				12		6
Nassarius trivittatus				1																										
Hydrobia minuta	1	8			8											51		10						1						
Unidentified Bivalvia		2					17																							
Mytilus edulis																														
Mya arenana																	1	3												
Mercenaria mercenaria				2	1																									
Macoma tenta																														
Petricola pholadiformis																10														
Nucula proxima																				1										
Tellina agilis		19		8	13		70	14		1	1					1				1								1		
Gemma gemma					1											25		4				3	1	4					17	
Solemya velum																			1	3		2	1	1						
Annelida:																														
Unidentified Polychaeta																														
Polygordius triestinus																														
Eumida sanguinea																													1	1
Notocirrus spiniferus																			1				12							1
Lumbrineris tenuis																			2			6	4	6					12	
Goniadella sp.																						1								
Aricidea catherinae																													1	
Asabellides oculata																												1		
Platynereis dumerilii																							1	1						
Arabellidae																						9								
Microphthalmus aberrans																2						2	1	8					16	
Elasmopus levis					1																									
Phyllodocidae																				1										
Phascolion strombi																												1		
Eteone heteropoda																1			3			1							1	2
Glycera sp		1					1													1			1							1
Syllis sp																	2		1	6		12	27	2					52	
Podarke obscura											1								3											
Neanthes succinea																10		6	3	3									1	
Neanthes sp											28																			
Mediomastus ambiseta							16	20		5	19					1						3	1	1				1	8	1
Capitella capitata		3			2					17	78		303	226		1		1				1							1	

PEP Tidal Creeks Study
July 1998 Macrobenthic Invertebrate Densities

	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Maldonidae		1																												
Clymenella torquata		1									2								15	10		5	2	3					1	1
Spionidae sp		2			2																									
Streblospio benedicti		3		1	7		4	32		2			4	7					2			16						1	43	1
Polydora ligni				1		19								5		2		1	1	1		6	2						3	
Scolelepis squamata																								1					11	1
Scolecolepides viridis																			2			8	10						53	
Haploscopoplos robustus		3														31	5	7	18	7		5	4	5				1	8	2
Hypaniola grayi																				2				1	1					
Tharyx aculus		12			1	17					10											15	1	1				6	13	1
Pectinaria gouldi		1			1	1																								
Pista cristata										17							3													
Class oligochaeta																57		16	24	63		25	56					10	13	1
Unid polychaete		6															1											1		2
Polychaete (larvae)		1																												
Arthropoda:																														
Salamae cocina																		1												
Edotea triloba		1		1	1					1						2		2											1	
Sphaeromoma quadridentatum																1														
Amphipod sp				1	1																									
Ampelisca vadorum																														
Ampelisca vemilli																						1								
Erichthonius sp.																						4	30							
Paraphoxus epistomus																			5	10			1							
Listerella sp.																				2			1	1						
Ampelisca abdita		1					82	52											156	585		27	29	4					3	
Gammarus mucronatus				1				1																						
Gammarus sp														1																
Microdeutopus gryllotalpa								6																						
Corophium sp							1			3						2		5					3							
Lysianopsis alba														1				4		2										
Leptocheirus plumolosus				3												1	2			65		1								
Leucon americana							1			4									8	10										
Crangon septemspinosa					2															2										
Palaemonetes sp																														
Palaemonetes pugio																														
Hippolyte zostericola																		1												
Neomysis americana																1			2											
Caprellidae																	1													
Limulus polyphemus (larvae)		1			1																							1		
Pagurus longicarpus																	3													
Cancer irrorata																	1													
Insecta:																														
Chironomis																														
Anurida maritima																														
Total Invertebrates	39	100	3	50	91	40	236	138	3	52	151	3	414	435	3	209	33	70	252	828	3	178	392	63	3	2	3	38	341	28

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Anthozoa:																														
Platyhelminthes flatworms																											1			
Rhynchocaela:																														
Nemertean worms				9	6																									
Ascidiacea:																														
Molgula manhattensis		10																												
Bryozoa:																														
Schizoporella unicornis																														
Stomachetosella sinuosa																														
Membranipora tenuis												1																		
Aschelminthes:																														
Aschelminthes:	1			5	1		1				7	4				10	6	1										1		
Mollusca:																														
Crepidula fornicata											2	9																		
Crepidula plana																														
Crepidula convexa																														
Gastropoda sp	1																		1	1										
Lunatia heros																														
Thais lapillus																														
Nassarius obsoletus																			8	13								29	3	
Urosalpinx cinerea																														
Hydrobia minuta				1			2	10	12				3	3		22	31	6		4										
Utriculastra canaliculata																														
Riclaxis punctostriatus								1																						
Bivalvia:				2																										
Mytilus edulis							1																							
Mercenaria mercenaria																														

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Pitar morrhuana								1																						
Tellina agilis	3	2									6	1	1	4					1			1			1					
Petricola pholadiformus																														
Lyonsia hyalina																4	2													
Gemma gemma									1																					
Nucula proxima																														
Ensis directus											1																			
Pranartis speciosa (?)																														
Mya arenaria																														
Annelida:																														
Polychaeta	1	1						1										1	1						1	1				
Polygordius triestinus												9																		
Eulalia viridis	7	1																												
Phyllodocidae																														
Phyllodoce arenae																	1		1											
Eteone heteropoda		1																										4		
Eumida sanguinea																														
Harmothoe extenuata																														
Glycera americana																	1													
Goniadella sp																11	11													
Hydroides dianthus																														
Nephtys picta																														
Syllidae																														
Syllis sp											1					1														
Nephthy incisa																														
Podarke obscura											2		1	7				1							1		13			
Micropntha sp																														
Nereimyra punctata																									5		1			

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Neanthes succinea	2	3						47	18							11		1							3		2			
Neanthes sp													1									2	2							
Mediomastus ambieseta	1																	3	3				10		25		22	47		
Capitella capitta	1	4							1		4		80	20		5	39	3	7			43	32			1				
Maldonidae																														
Clymenella torqueta																												4		
Owenia fusiformis																														
Travisia carnea																														
Spionidae sp																														
Streblospio benedicti	18	6											29	21		14	56	7	9	5		33	23		1	11		172		
Paraonis sp																														
Spio sp																														
Polydara (JUV)					1									1																
Polydora ligni	1														2	2	4		1						15	7	4	5	15	
Polydora socialis																														
Scolelepis squamata											2																			
Scolecolepides viridis							31	14	11					1		18	14	3												
Paraonis fulgens											20																			
Sabellaria vulgaris																														
Arabella iriculor																														
Lumbrineris tenuis																1														
Haploscopoplos rubustus	1	1									16		8	23		14	1	3	13							2				
Cirratulidae																														
Cirratulus grandis																													4	
Tharyx acutus											2					11	1		11	4					1			31		
Pectinaria gouldi																														
Ampharate arctica																														
Amphitrite sp																														

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Hypaniola grayi							16	22	12																					
Terebellidae																														
Pista cristata																														
Sabellidae																						3								
Class oligochaeta					4		20	1	5																			23		
Arthropoda:																														
Balanus amphitrite																														
Cymothoidae																														
Philoscia vittata				1																										
Leptochelia savignyi																						1								
Cyathura polita							16	6	14								1	3												
Edotea triloba																														
Erichsonella attenuata		2																												
Sphaeroma quadridentatum								1				1																		
Salamae cocina									6			5																		
Erichthonius sp								2	12														2							
Amphipod sp											1																			
Leptocheirus plumolosus							5	19	12			13					1		1			47	22					1		
Unciola irrorata											1						1													
Gammarus sp																						1								
Gammarus mucronatus																														
Gammarus annulatus																														
Microdentopus gryllotalpa		4					3																			2				
Paraphoxus epistomus												1																		
Corophium sp																										1		7		
Lysianopsis alba				1																						19		5		
Caprellidae																														
Leucon americana								2	11			10					1	1				6	1							

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	Fresh Pond						Northwest Creek						Ligonee Creek						Alewife Creek						Meetinghouse Creek					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Ampelisca abdita																	2	3		2								894	431	
Chironomis				1	2		23	16	6					2	4													1		
Crangon septemspinosa																				1										
Palaemonetes sp			1									7																		
Palaemonetes pugio																				2					1					
Hippolyte zostericola																														
Neomysis americana																		2							6	1		2		
Anurida maritima																														
Neopanopcus sayi																														
Melita nitida																														
Listriella sp																														
Carcinus																														
Pagurus longicarpus																														
Total Invertebrates	37	35	1	18	14	0	118	144	121	0	65	61	123	82	6	124	173	38	57	32	0	137	92	0	60	45	43	1226	453	0

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Anthozoa:																														
Platyhelminthes flatworms																		1		2										
Rhynchocaela:																														
Nemertean worms									1				1			1		1	1											
Ascidiacea:																														
Molgula manhattensis																														
Bryozoa:																														
Schizoporella unicornis				2	1					2																				
Stomachetosella sinuosa				1	4																									
Membranipora tenuis				1	1					1																				
Aschelminthes:																														
Aschelminthes:				3	10		8		7	6		23	3			9	6	25	1	24		1	17					13		
Mollusca:																														
Crepidula fornicata				28												1	11	2												
Crepidula plana				1																										
Crepidula convexa					1														1											
Gastropoda sp																														
Lunatia heros																														
Thais lapillus																														
Nassarius obsoletus		1	51	5	8																						1	1		2
Urosalpinx cinerea																3	1													
Hydrobia minuta																2			1											
Utriculastra canaliculata																			1											
Rictaxis punctostriatus																														
Bivalvia:																														
Mytilus edulis																														
Mercenaria mercenaria					2					1										2			2							
Pitar morrhuana																														
Tellina agilis		1		2																1			2							

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Petricola pholadiformus																														
Lyonsia hyalina																				1						2	2			
Gemma gemma					1					1						2														1
Nucula proxima					37														18	26			7							
Ensis directus																														
Pranartis speciosa (?)																														
Mya arenaria																1														
Annelida:																														
Polychaeta																														
Polygordius triestinus				5								2						1												
Eulalia viridis																														
Phyllodocidae																														
Phyllodoce arenae																														
Eteone heteropoda																		1				4					1	1		
Eumida sanguinea				1									2					2		2		5								
Harmothoe extenuata																														
Glycera americana																							2							
Goniadella sp																							2							
Hydroides dianthus																														
Nephtys picta																														
Syllidae																														
Syllis sp																														
Nephthy incisa				1	47													1		31			12					1		
Podarke obscura		1		2	2														8											
Micropntha sp																														
Nereimyra punctata																														
Neanthes succinea		2					1																							
Neanthes sp				1	1				1																					
Mediomastus amblosota							1		1																		1	16		
Capitella capitta							4												23			413	1							

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Maldonidae																														
Clymenella torqueta																							38					2		
Owenia fusiformis																														
Travisia carnea																												1		
Spionidae sp																														1
Streblospio benedicti		6					6		2																					1
Paraonis sp																														
Spio sp																														
Polydara (JUV)																														
Polydora ligni		3				1														1		3	1							
Polydora socialis													1																	
Scolelepis squamata																														
Scolecolepides viridis					24																									1
Paraonis fulgens																														
Sabellaria vulgaris																			1											
Arabella iricular					1																		2					1		
Lumbrineris tenuis																														
Haploscopoplos rubustus		1	1	1	4														2	3		3	1					2		3
Cirratulidae																														
Cirratulus grandis																			4											
Tharyx acutus					1														20	6								2		
Pectinaria gouldi																				1				1						1
Ampharate arctica																							4							
Amphitrite sp																														
Hypaniola grayi																														
Terebellidae																														6
Pista cristata																							2							
Sabellidae																						50				1		1		
Class oligochaeta				36	17														1	246			7				1	124		23

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Arthropoda:																														
Balanus amphitrite				2																										
Cymothoidae																														
Philoscia vittata																														
Leptochelia savignyi																							1							
Cyathura polita																4														
Edotea triloba																1				1										
Erichsonella attenuata																														
Sphaeroma quadridentatum												1																		
Salamae cocina										2																				
Erichthonius sp																		1		5										
Amphipod sp																														
Leptocheirus plumolosus				3	17							1				2		2		50		6	15							
Unciola irrorata																			2							2				
Gammarus sp																4														
Gammarus mucronatus																2			1											
Gammarus annulatus																														
Microdentopus gryllotalpa																														
Paraphoxus epistomus					6					1								2		86			2							
Corophium sp				1	3													1		75						1	1			
Lysianopsis alba					4							1				1			2	4		5	1				1			
Caprellidae					2											65	2	3		1										
Leucon americana																							2							2
Ampelisca abdita					2								2						3	682		885	878			1	1			2
Chironomis										1				1				2												
Crangon septemspinosa																														
Palaemonetes sp																														
Palaemonetes pugio																														
Hippolyte zostericola																										7	1			
Neomysis americana					1																	2								
Anurida maritima				1																										

PEP Tidal Creeks Study
December 1998 Macrobenthic Invertebrate Densities

	West Creek						Goose Creek						Bass Creek						West Neck Creek						Little Bay					
	Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth			Head			Mouth		
Species	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Neopanopeus sayi																								3						
Melita nitida																								2						
Listriella sp																												2		
Carcinus														1						1										
Pagurus longicarpus					1																									
Total Invertebrates	0	15	52	97	198	1	20	0	12	15	0	28	9	2	0	98	20	45	90	1251	0	1377	999	6	0	14	10	167	0	43

APPENDIX F

FIELD DATA SHEETS

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Fresh Pond (106)

Field Crew: MPB/TWY

Tributary To: Gardiners Bay

Weather: warm, (21.7 C) wind gusting to 20 mph from west

Last Rainfall Event: July 4 1998

Date: July 14, 1998

Position:	**HEAD**	**MOUTH**
LAT:	N40.59.715'	N40.59.728'
LONG:	W072.07.046'	W072.06.707'

Time: 08:04

Low Tide: 08:04, 20:33

Last Dredged:

High Tide: 01:35, 14:16

Moon: 3rd quarter in 2 days

Restricted Outlet: YES, closes naturally during significant storm events, re-opened via excavator.

Surrounding Land/Water Uses

Residential   Commercial   Recreational/Park X   Marina

Open Space   Agricultural

Notes:
Inlet to Fresh Pond closed on   And was re-opened on   By use of an excavator.

Land/Water Use Impacts

Storm Drain   Size   Type   Location   Culvert

Discharge   Color   Apparent Source

Road End   Maintained Lawn   Failed Septic Systems

STP Outfall   Boat Discharges   Other

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding X (south bank)

Vegetated

Hardened, Bulkhead

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	WEST	EAST
Houses		
Docks		
Bulkheads		
Barges		
Marinas		
Houseboats		
Slips		
Jet Skis		
Dingies		
Powerboats		
Sailboats		

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	6.6		6.6	
Conductivity (MS)	37.2		37.2	
Salinity (ppm)	24.5		24.5	
Temperature (C)	23.1		23.1	
pH	7.8			
Depth			2.0- inches	

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
widgeon grass	*Ruppia maritima*	only in ponded area near head
blue claw crab		
soft-shelled clam	*Mya arenaria*	
slipper shell	*Crepidula fornicata*	
beach grass	*Ammophila breviligulata*	
dusty miller	*Artemesia stelleriana*	
yellow rocket	*Barberea vulgaris*	
seaside goldenrod	*Solidago semprevirens*	
rugose rose	*Rosa rugosa*	on path near bath house
pin oak	*Quercus palustris*	
post oak	*Quercus stellata*	
common reed	*Phragmites australis*	
poplar	*Populus deltoides*	
salt marsh cordgrass	*Spartina alterniflora*	
marsh elder	*Iva frutescens*	
groundsel tree	*Baccharis halimifolia*	
high marsh cordgrass	*Sparina patens*	
kingbird	*Tyrannus tyrannus*	three dozen on wires near parking lot
grackle	*Quiscalus quiscula*	
red-winged blackbird	*Agelius phoeniceus*	
osprey	*Pandion haliaetus*	
song sparrow	*Melospiza melodia*	
muskrat	*Ondatra zibenthicus*	
lion's mane jellyfish	*Cyanea capillata*	

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Northwest Creek

Field Crew: MPB/TWY

Tributary To: Northwest Harbor

Weather: wind from southwest 10 mph, gusts 15-20 mph.

Last Rainfall Event: July 4, 1998

Date: July 14, 1998

Position:	**HEAD**	**MOUTH**
LAT.	N41.00.856'	N41.00.703'
LONG.	W072.02.442'	W072.15.138'

Time: 14:00 (head), 14:57 (mouth)

Low Tide: 08:50, 21:19

Last Dredged:

High Tide: 02:13, 14:54

Moon: 3rd quarter moon in 2 days

Restricted Outlet: NO, may shoal near mouth naturally

Surrounding Land/Water Uses

Residential X   Commercial   Recreational/Park   Marina

Open Space   Agricultural

Notes: Town Permit required for boat launching. State designated recreational area. Closed for shell fishing.
Local person indicated that the inlet has been changed since . Originally located

Land/Water Use Impacts

Storm Drain   Size   Type   Location   Culvert

Discharge   Color   Apparent Source

Road End X (ramp/parking lot)   Maintained Lawn   Failed Septic Systems

STP Outfall   Boat Discharges   Other

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding

Vegetated

Hardened, Bulkhead

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	WEST	EAST
Houses		
Docks		
Bulkheads		
Barges		
Marinas		
Houseboats		
Slips		
Jet Skis		
Dingies		
Powerboats		
Sailboats		

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	7.4	6.9	7.8	7.0
Conductivity (MS)	38.0	41.3	39.1	41.3
Salinity (ppm)	22.9	26.6	24.7	26.6
Temperature (C)	25.6	24.7	25.3	24.8
pH	6.7	7.8		
Depth			3.0 feet	2.0 feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
rockweed	*Fucus vesiculosis*	
spider crab	*Libinia dubia*	
blue claw crab	*Callinectes sapidus*	
bay scallop	*Aequipecten irradians*	
slipper shell	*Crepidula fornicata*	
horse shoe crab	*Limulus polyphemus*	
osprey	*Pandion haliaetus*	
American crow	*Corvus brachyrhynchos*	
red-winged blackbird	*Agelaius phoeniceus*	
herring gull	*Larus argentatus*	
great egret	*Casmerodius albus*	
barn swallow	*Hirundo rustica*	
double-breasted cormorant	*Phalacrocorax auritus*	
common reed	*Phragmites australis*	
groundsel tree	*Baccharis halimifolia*	
salt marsh cordgrass	*Spartina alterniflora*	
high marsh cordgrass	*Spartina patens*	
spike grass	*Distichlis spicata*	
marsh elder	*Iva frutescens*	
bayberry	*Myrica pensylvanica*	
beach plum	*Prunus maritima*	
black chery	*Prunus serotina*	
red cedar	*Juniperus virginiana*	
pin oak	*Quercus palustris*	
black locust	*Robinia pseudoacacia*	

COMMON NAME	*LATIN NAME*	COMMENTS
beach grass	*Ammophila breviligulata*	
seaside goldenrod	*Solidago semprevirens*	
	Crugularia	
sea rocket		
seaside spurge		
jingle shell		
	Hudsonia tomentosa	

Additional Notes

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Ligonee Creek

Field Crew: MPB/TWY

Tributary To: Noyack Bay

Weather: Sunny, calm

Last Rainfall Event: July 4, 1998

Date: July 6, 1998

Position:	**HEAD**	**MOUTH**
LAT.	N40.59.385'	No Record
LONG.	W072.18.221'	

Time: 10:15 (head), 10:40 (mouth)

Low Tide: 02:52, 14:51

Last Dredged:

High Tide: 08:50, 21:02

Moon: full moon in 3 days

Restricted Outlet: NO

Surrounding Land/Water Uses

Residential X (low) Commercial Recreational/Park Marina

Open Space Agricultural

Notes: Surrounding vegetation is mostly maintained lawns and *Phragmites australis*.

Land/Water Use Impacts

Storm Drain Size Type Location Culvert

Discharge Color Apparent Source

Road End X Maintained Lawn X Failed Septic Systems

STP Outfall Boat Discharges X Other

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding X Considerable

Vegetated

Hardened, Bulkhead

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	QUANTITY
Houses	18
Docks	13
Bulkheads	0
Barges	0
Marinas	0
Houseboats	0
Slips	0
Jet Skis	0
Dingies	5
Powerboats	8
Sailboats	0

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	5.1	5.5	3.3	6.7
Conductivity (MS)	28.4	30.8	34.5	38.5
Salinity (ppm)	17.8	22.0	19.7	23.5
Temperature (C)	21.6	25.5	24.9	26.0
pH	6.0	6.5		
Depth			2.7 feet	3.5 feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
sea lettuce	*Ulva lactuca*	
rockweed	*Fucus vesiculosa*	
hard clam	*Mercenaria mercenaria*	
groundsel tree	*Baccharis halimifolia*	
red cherry	*Prunus serotina*	
black locust	*Robinia psuedoacacia*	
red cedar	*Juniperus virginiana*	
pin oak	*Quercus palustris*	
tree of heaven	*Ailanthus altissima*	
Canada goose	*Branta canadensis*	
great egret	*Casmerodius albus*	
brown-headed cowbird	*Molothrus ater*	
herring gull	*Larus argentatus*	
barn swallow	*Hirundo rustica*	
mallard duck	*Anas platyrhynchos*	
domestic dog		

Additional Notes

Benthic invertebrate samples collected today. Sample at head consisted of a very organic fine silt with many tube worms.

Considerable erosion on both the western and eastern banks.

Poor GPS reading message on GPS screen.

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Alewife Creek Mouth (104)

Field Crew: MPB/TWY

Tributary To: North Sea Harbor

Weather: warm, partly sunny, wind gusts to 25 mph from west.

Last Rainfall Event: July 4, 1998

Date: July 14, 1998

Position:	**MOUTH**	**HEAD**
LAT:	N40.56.235'	N40.00.700'
LONG:	W072.24.968'	W072.15.141'

Time: 17:59

Low Tide: 08:50, 21:19

Last Dredged:

High Tide: 02:13, 14:54

Moon: 3rd quarter moon in 2 days

Restricted Outlet: No

Surrounding Land/Water Uses

Residential X   Commercial X   Recreational/Park X   Marina X

Open Space   Agricultural

Notes: Moderately residential, 2 moderately sized Marina's located on western shoreline. Conscience Point National Wildlife Refuge at mouth of creek. Head waters of creek enter under Noyack Road through a 24-inch culvert.

Land/Water Use Impacts

Storm Drain   Size   Type   Location   Culvert

Discharge   Color   Apparent Source   Cement Boat Ramp X

Road End   Maintained Lawn X   Failed Septic Systems

STP Outfall   Boat Discharges X   Other

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding

Vegetated X

Hardened, Bulkhead X

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	TOTAL	WEST	EAST
Houses	36	5	31
Docks	18	5	13
Bulkheads	11	4	7
Barges	1	1	0
Marinas	2	2	0
Houseboats	1	1	0
Slips	116	116	0
Jet Skis	1	1	0
Dingies	3	0	3
Powerboats	97	80	17
Sailboats	14	12	2

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	7.8	8.4	6.5	7.0
Conductivity (MS)	34.6	40.1	37.8	40.9
Salinity (ppm)	18.3	25.1	24.2	26.0
Temperature (C)	25.2	25.8	25.3	25.3
pH	6.9	8.2		
Depth			2.0 feet	10.0 feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
banded killifish		
red-winged blackbird		in *Phragmites*
mallard duck		2 male, 2 female
common reed	*Phragmites australis*	
black locust	*Robinia psuedoacacia*	
groundsel tree	*Baccharis halimifolia*	
salt marsh cordgrass	*Spartina alterniflora*	
black cherry	*Prunus serotina*	

Additional Notes

Benthic Invertebrate samples collected today.

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Meetinghouse Creek

Field Crew: TWY/MJB

Tributary To: Flanders Bay

Weather:

Last Rainfall Event: July 4, 1998:

Date: July 16, 1998

Position:	**HEAD**	**MOUTH**
LAT.	N40.56.338'	N40.55.747'
LONG.	W072.37.145'	W072.36.942'

Time: 09:50 (head), (Mouth)

Low Tide: 00:12, 12:30

Last Dredged:

High Tide: 05:45, 18:25 (extreme)

Moon: 3rd quarter moon today

Restricted Outlet: NO

Surrounding Land/Water Uses

Residential X Commercial X Recreational/Park Marina X

Open Space Agricultural

Notes: Toadfish traps in Creek for commercial sale

Land/Water Use Impacts

Storm Drain Size Type Location Culvert X

Discharge Color Apparent Source

Road End Maintained Lawn Failed Septic Systems

STP Outfall Boat Discharges Other

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding

Vegetated

Hardened, Bulkhead

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	QUANTITY
Houses	32
Docks	28
Bulkheads	10
Barges	0
Marinas	1
Houseboats	0
Slips	182
Jet Skis	0
Dingies	0
Powerboats	29
Sailboats	23

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	12.5	13.9	3.5	4.1
Conductivity (MS)	28.5	33.5	33.5	36.9
Salinity (ppm)	15.0	20.8	21.6	23.8
Temperature (C)	22.8	25.9	24.0	24.9
pH	6.8	8.6		
Depth			2.0 Feet	9.0 Feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
ribbed mussel	*Modiolus demissus*	
least tern	*Sterna albifrons*	
common tern	*Sterna hirundo*	
mute swan	*Cygnus olor*	
herring gull	*Larus argentatus*	
hybrid ducks		with ducklings
double-crested cormorant	*Phalacrocorax auritus*	
starling	*Sturnus vulgaris*	
house sparrow	*Passer domesticus*	
greater black-backed gull	*Larus marinus*	
tree of heaven	*Ailanthus altissima*	

Additional Notes

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: West Creek

Field Crew: TWY/MJB

Tributary To:

Weather:

Last Rainfall Event: July 4, 1998

Date: July 15, 1998

Position:	**HEAD**	**MOUTH**
LAT:		N40.59.514'
LONG:		W072.28.940'

Time: 15:05 (mouth)

Low Tide:

Last Dredged:

High Tide:

Moon:

Restricted Outlet: NO

Surrounding Land/Water Uses

Residential   Commercial   Recreational/Park   Marina

Open Space   Agricultural

Notes:

Land/Water Use Impacts

Storm Drain   Size   Type   Location   Culvert

Discharge   Color   Apparent Source

Road End   Maintained Lawn   Failed Septic Systems

STP Outfall   Boat Discharges   Other

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding

Vegetated

Hardened, Bulkhead

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	WEST	EAST
Houses		2
Docks		
Bulkheads		
Barges		
Marinas		
Houseboats		
Slips		
Jet Skis		
Dingies		
Powerboats		
Sailboats		

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)		7.6		7.5
Conductivity (MS)		41.5		41.5
Salinity (ppm)		25.9		25.9
Temperature (C)		26.2		26.3
pH		8.1		
Depth				6.0 feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS

Additional Notes

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Goose Creek

Field Crew: MJB/TWY

Tributary To: Southold Bay

Weather:

Last Rainfall Event: July 4, 1998

Date: July 15, 1998

Time: 12:20 (head), 12:50 (mouth)

Position:	**HEAD**	**MOUTH**
LAT.	N40.55.810'	N41.03.084
LONG.	W072.36.955'	W072.24.883'

Low Tide: 10:28, 23:05

Last Dredged:

High Tide: 03:54, 16:35

Moon: 3rd quarter moon tomorrow

Restricted Outlet: NO

Surrounding Land/Water Uses

Residential X	Commercial	Recreational/Park	Marina
Open Space	Agricultural	Aquaculture X	

Notes:
Town's scallop shellfish program near mouth.

Land/Water Use Impacts

Storm Drain	Size	Type	Location	Culvert
Discharge	Color	Apparent Source		
Road End	Maintained Lawn X	Failed Septic Systems		
STP Outfall	Boat Discharges X	Other		

Shoreline Condition

Bare, Non-Eroding

Bare, Eroding

Vegetated X

Hardened, Bulkhead X

Hardened, Sea Wall

Other

Surrounding Land Use

STRUCTURES/BOATS	QUANTITY
Houses	92
Docks	51
Bulkheads	23
Barges	0
Marinas	0
Houseboats	0
Canoes	1
Jet Skis	2
Dingies	6
Powerboats	50
Sailboats	2

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	6.6	6.9	6.6	6.9
Conductivity (MS)	42.2	41.4	42.5	41.3
Salinity (ppm)	26.7	27.1	26.8	27.2
Temperature (C)	25.8	24.1	25.9	23.9
pH	8.0	8.0		
Depth			2.0 feet	6.0 feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
bluefish		snapper
green heron	Butorides striatus	immature
osprey	Pandion haliaetus	nesting
least tern		
red-winged blackbird	Agelaius phoeniceus	
common grackle	Quascalus quiscula	
mute swan	Cygnus olor	
herring gull	Larus argentatus	
Canada goose	Branta canadensis	
red cedar		
common reed	Phragmites australis	
black cherry	Prunus serotina	
spike grass	Distichlis spicata	
groundsel tree	Baccharis halimifolia	
salt marsh cordgrass	Spartina alterniflora	
pin oak	Quercus palustris	
black locust	Robinia pseudoacacia	
tree of heaven	Ailanthus altissima	
sea lettuce	Ulva lactuca	

Additional Notes

Private canal not surveyed.
Flow meter deployed on   and retrieved on

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Bass Creek

Field Crew: MPB/TWY

Tributary To: Shelter Island Sound

Weather: Sunny, 85 F

Last Rainfall Event: July 4, 1998

Date: July 12, 1998

Position:

	HEAD	MOUTH
LAT.		
LONG.		

Time: 09:10 (head)
10.00 (mouth)

Low Tide: 07:12, 19:24 (extreme)

Last Dredged:

High Tide: 12:31, 13:10

Moon: 3rd quarter moon in 4 days

Restricted Outlet: moderate, neatural restriction due to shoaling.

Surrounding Land/Water Uses

Residential Commercial Recreational/Park X_ Marina

Open Space Agricultural

Notes: Mashomack Preserve, Nature Conservancy

Land/Water Use Impacts

Storm Drain Size Type Location Culvert

Discharge Color Apparent Source

Road End Maintained Lawn Failed Septic Systems

STP Outfall Boat Discharges Other

Shoreline Condition

Bare, Non-Eroding	Bare, Eroding X
Vegetated	Hardened, Bulkhead
Hardened, Sea Wall	Other

Surrounding Land Use

STRUCTURES/BOATS	WEST	EAST
Houses		
Docks		
Bulkheads		
Barges		
Marinas		
Houseboats		
Slips		
Jet Skis		
Dingies		
Powerboats		
Sailboats		

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)				
Conductivity (MS)				
Salinity (ppm)				
Temperature (C)				
pH				
Depth				

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
lady Crab	*Ovalipes ocellatus*	
bay scallop	*Aequipecten irradians*	predated
soft-shelled clam	*Mya arenaria*	
hard clam	*Mercenaria mercenaria*	
common periwinkle	*Littorina littorea*	
green crab	*Carcinus maenas*	
hermit crab	*Pagurus sp.*	
Slipper shell	*Crepidula fornicata*	dominant
razor clam	*Ensis directus*	
ribbed mussels	*Modiolus demissus*	
winter flounder		YOY
striped bass		YOY
bamboo worm	*Clymenella*	
red beard sponge	*Microciona prolifera*	common near foot bridge
mummichog	*Fundulus majalis*	
Fowler's toad	*Bufo woodhousii fowlerii*	
great egret	*Casmerodius albus*	resting/feeding
double-crested cormorant	*Phalacrocorax auritus*	
herring gull	*Larus argentatus*	
great blue heron	*Ardea herodius*	
roseate tern	*Sterna dougallii*	
mute swan	*Cygnus olor*	foraging
black-backed gull	*Larus marinus*	immature/resting
common tern	*Sterna-hirundo*	

COMMON NAME	LATIN NAME	COMMENTS
brown thrasher	*Toxostoma rutum*	
grey squirrel		
raccoon		
white-tailed deer		male, feeding
chipmunk		
salt marsh cordgrass	*Spartina alterniflora*	
common rockweed	*Fucus vesiculosis*	
Green hollow weed	*Enteromorpha intestinalis*	
widgeon grass	*Ruppia maritima*	dominant near head
green fleece	*Codium fragilis*	
beach grass	*Ammophila breviligulata*	
bayberry	*Myrica pensylvanica*	
groundsel tree	*Baccharis halimifolia*	
red cedar	*Juniperus virginiana*	
switchgrass	*Panicum virgatum*	
common milkweed	*Asclepias syriaca*	
marsh elder	*Iva frutescens*	
common reed	*Phragmites australis*	
spike grass	*Distichlis spicata*	
glasswort	*Salicornia europa*	
post oak	*Quercus stellata*	
pin oak	*Quercus palustris*	
Tupelo	*Nyssa sylvatica*	

Additional Notes

Small footbridge near mouth does not contribute to erosion. Osprey platform was not occupied during this visit.

Area near mouth has some areas devoid of vegetation on the western bank.

Northwestern banks of Bass Creek are dominated by *Spartina alterniflora* with moderately dense ribbed mussel beds. An area on the northwestern high marsh is presently being encroached by *Phragmites australis*.

Eastern shoreline is not experiencing erosion.

Flow meter deployed July 27, 1998 at 08:24:06. Flow meter was retreived on July 28, 1998 at 08:24:36.

Benthic invertebrate samples were collected today. Samples from the mouth were coarse-grained material and hard-packed sand. Samples collected from the head was very organic, fine silty material with sub-aquatic vegetation included.

FIELD DATA SHEET
PECONIC ESTUARY PROGRAM
TIDAL CREEK SURVEY - PROJECT 97521

Station: Little Bay Tributary

Field Crew: MPB/TWY

Tributary To: Hallocks Bay

Weather: sunny, 85 F

Last Rainfall Event: July 4, 1998

Date: July 12, 1998

Position:	**HEAD**	**MOUTH**
LAT.	N41.08.900'	N41.08.908'
LONG.	W072.14.843'	W072.14.830'

Time: 17:28 (head), 17:54 (mouth)

Low Tide: 07:00, 12:47

Last Dredged:

High Tide: 00:08, 12:47

Moon: 3rd quarter moon in 4 days

Restricted Outlet: NO, mouth sometimes shoals naturally with coarse grained material.

Surrounding Land/Water Uses

Residential   Commercial   Recreational/Park X   Marina

Open Space   Agricultural

Notes: Orient Point State Park

Land/Water Use Impacts

Storm Drain   Size   Type   Location   Culvert

Discharge   Color   Apparent Source

Road End   Maintained Lawn   Failed Septic Systems

STP Outfall   Boat Discharges   Other

Shoreline Condition

Bare, Non-Eroding X   Bare, Eroding

Vegetated   Hardened, Bulkhead

Hardened, Sea Wall Other

Surrounding Land Use

STRUCTURES/BOATS	HEAD	MOUTH
Houses		
Docks		
Bulkheads		
Barges		
Marinas		
Houseboats		
Slips		
Jet Skis		
Dingies		
Powerboats	1	
Sailboats		

Physical Water Chemistry

PARAMETER	SURFACE (head)	SURFACE (mouth)	BOTTOM (head)	BOTTOM (mouth)
Dissolved Oxygen (mg/l)	6.0	7.9	4.2	7.1
Conductivity (MS)	43.8	45.1	43.3	43.8
Salinity (ppm)	26.7	27.2	27.0	27.2
Temperature (C)	27.5	28.4	27.2	26.2
pH	7.5	7.9		
Depth			2.5 feet	5.0 feet

Incidental Occurrences of Natural Resources

COMMON NAME	LATIN NAME	COMMENTS
green fleece	*Codium fragile*	floating
rockweed	*Fucus vesiculosis*	
ribbed mussel	*Modiolus demissus*	at base of *Spartina*
common reed	*Phragmites australis*	
salt marsh cordgrass	*Spartina alterniflora*	
poison ivy	*Rhus radicans*	
groundsel tree	*Baccharis halimifolia*	
black cherry	*Prunus serotina*	
Catalpa		
high marsh cordgrass	*Spartina patens*	
red cedar	*Juniperus virginiana*	
black pine		
bay berry	*Myrica pensylvanica*	
barn swallow	*Hirundo rustica*	
American oystercatcher	*Haematopus palliatus*	

Additional Notes

Western shoreline is eroding slightly, eastern shoreline erosion is less and patchy.

APPENDIX G

LABORATORY PROTOCOLS

Specifications

Power Requirements:	7-20VDC, 3.5mA avg, 6mA pk
Output:	0-5.0 VDC
Output Time Constant:	0.1 sec
RMS Noise:	<1 mV
Power-up Transient Period:	<1 sec
Light Source Wavelength:	880 nm
Scatterance Angles:	15 - 150 degrees
Linearity:	<2% deviation 0-750 FTU

Sensitivity/Range:

100x gain:	200 mV/FTU	25 FTU
20x gain:	40 mV/FTU	125 FTU
5x gain:	10 mV/FTU	500 FTU
1x gain:	2 mV/FTU (<750 FTU)	*

Temperature Coefficient:	<0.05 %/°C
Operating Temperature:	0°C to 65°C
Depth Capability:	6000 m (19,700 ft)
Overall Length:	12 cm (4.7 in)
Sensor Weight (dry):	86 g (3.0 oz)
Body Diameter:	2.5 cm (1.0 in)

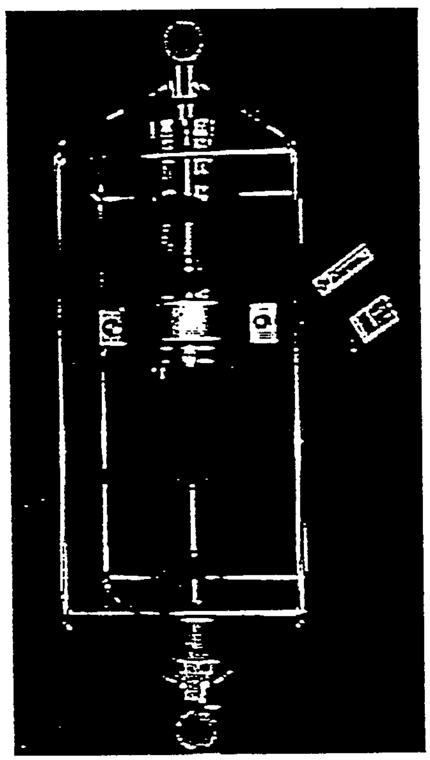
* Response to turbidity levels greater than 750 FTU is non-linear

FALMOUTH SCIENTIFIC, INC.

3-D ACOUSTIC CURRENT METER (3D-ACM)

VERSION 7.0
FIRMWARE VERSION 2.79
P/N A800-010

Operating Instructions



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velocity. Hence the pulse type sensor requires two wide band receivers and very fast circuitry to measure extremely small time differences. Williams [3] in his BASS design eliminated this particular problem by reversing the receivers and transducers to determine any differences in time delays.

The continuous wave type sensor described by Brown [4] eliminated the need for very high speed circuits by heterodyning the two received 1.6 MHz carrier frequency signals to obtain a beat frequency of 34 Hz and by measuring the phase difference at 34 Hz with low power CMOS logic circuits. However this circuitry required a second oscillator phase locked to the first at a frequency difference of 34 hz. The requirement of two receivers, the 2nd oscillator and the phase locked loop required a substantial amount of electronics, with a corresponding contribution to overall size, cost, and power consumption.

The direction sensors in previous designs used either gimballed compass cards with optical readout or gimballed 2 axis fluxgate magnetometers. The compass card design was fragile, expensive and did not have good dynamic response due to inertia of the card and the low magnetic torque inherent in compass cards. Similarly, the gimballed fluxgate designs required jewel bearings to minimize errors due imperfect leveling caused by bearing stickiness, and this in turn required enclosure in an oil filled chamber to provide mechanical damping.

THE 3D-ACM DESIGN

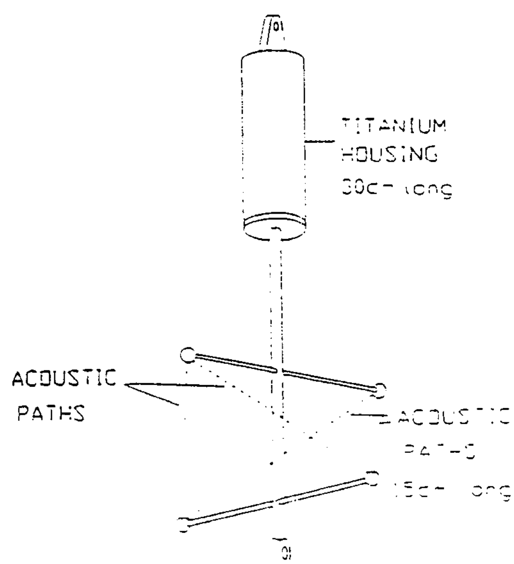

Figure 1 (right) illustrates the location of the acoustic paths used by the 3D-ACM. The 3D-ACM has a total of 4 axes (see fig. 1). Each axis is 13 cm in length and has a vertical separation of 10.5 cm. It can be shown that only one of the four paths will be significantly contaminated by the wake from the center support strut. The microprocessor is used to determine which axis is contaminated by flow interaction with the center support strut, and will reject the data from this axis. This is done by simply determining from which quadrant, in the X-Y plane, the current is flowing. Only three axes are required for a complete solution of the X, Y, and Z components of velocity thus permitting the accurate determination of current flow essentially uncontaminated by flow interaction with the center strut.

The 3D-ACM includes a "no moving parts" direction sensor described below. It

$$\therefore \quad \Theta_{ab} - \Theta_{ba} = \Theta_{tab} - \Theta_{tba} \qquad (1)$$

$$= \frac{\omega d}{c - v} - \frac{\omega d}{c + v}$$

Where
ω = Angular frequency (rads per sec)
d = Distance between transducers A and B (cm)
c = Velocity of sound (cm per sec)
v = Component of velocity along path A $\rightarrow$ B

$$\therefore \quad \Theta_{ab} - \Theta_{ba} = \frac{2\omega v d}{c^2 + v^2}$$

$$\therefore \quad v = c^2 \left[\frac{\Theta_{ab} - \Theta_{ba}}{2\omega d}\right] \qquad (c>>>v)$$

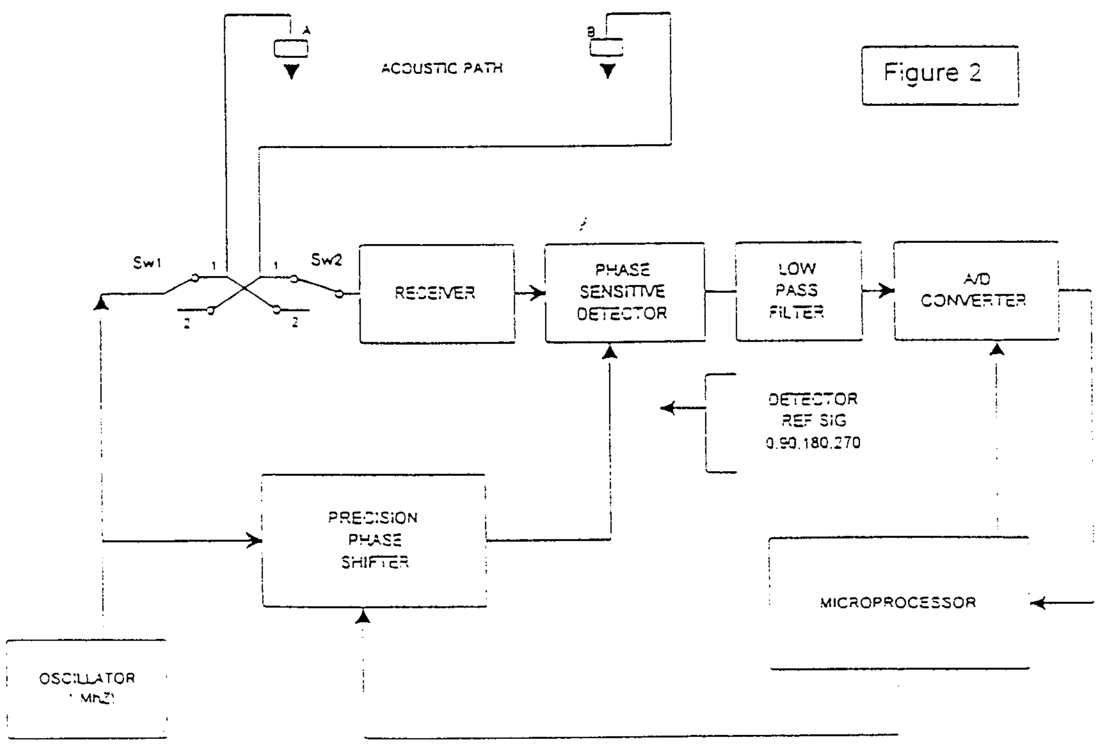

Figure 2

PHASE MEASURING CIRCUIT

The phase sensitive detector shown in figures 4 ideally can be treated as an analog multiplier whose output is the instantaneous product of the two inputs.

$$E_s = K_s \; SIN(\varpi\tau + \Theta_s)$$

$$E_r = K_r \; SIN(\varpi\tau + \Theta_r)$$

Where Ks, Kr are constants

$$\therefore \quad E_{out} = E_s \times E_r$$

$$= \frac{K_s K_r}{2} [\cos(\Theta_s - \Theta_r) - (2\varpi\tau + \Theta_r)]$$

Low pass filtering E_{out} gives E_{dc}

$$\therefore \quad E_{dc} = K \cos(\Theta_s - \Theta_r) + E_{os}$$

Where $K = \frac{K_s K_r}{2}$

and E_{os} = Zero offset of the detector

If $\Theta_r = 0$, then $E_0 = E_{dc} = K \cos(\Theta_s) + E_{os}$

If $\Theta_r = 90$, then $E_{90} = E_{dc} = -K \cos(\Theta_s) + E_{os}$

If $\Theta_r = 180$, then $E_{180} = E_{dc} = -K \cos(\Theta_s) + E_{os}$

If $\Theta_r = 270$, then $E_{270} = E_{dc} = K \cos(\Theta_s) + E_{os}$

$$E_0 - E_{180} = 2K \cos(\Theta_s)$$

$$E_{270} - E_{90} = 2K \sin(\Theta_s)$$

$$\Theta_s = \arctan\left[\frac{(E270 - E90)}{(E0 - E180)}\right]$$

Hence Θ_s is independent of the gain or any d.c. offsets in the phase sensitive detector. The only requirement is that there be a linear relationship between the detector output and the cosine of the phase angle between the signal and reference input.

output from the integrator is fed back to the sense coil. The complete circuit is a negative feedback system which balances the earth's field with an equal and opposite field in the sense coil. The field generated by the sense coil is proportional to the product of the number of turns and the feedback current I_{fb}. To minimize power consumption the maximum value of required feedback current was minimized by winding the sense coil with a large number of turns. The output voltage E_{out} is given by

$$E_{out} = I_{fb} \cdot R_1$$

Hence E_{out} is directly proportional to the component of magnetic field (H) parallel to the axis of the sense coil. The advantage of this negative feedback scheme is that the calibration of the magnetometer is essentially insensitive to changes in the magnetic properties of the core.

MICROPROCESSOR

The instrument uses an 8052 derivative 87C528 processor. All code is written in object oriented "C" in an IBM/PC environment cross complied for the target.

The final design utilizes a 82C55 24 programmable input/output port operating under the 87C528 control to sequence the velocity measurement through the various acoustic paths and reference phases and the measurement of the outputs of the 3 magnetometers and the 2 tilt sensors. The numerically intensive computations to process the raw data require the powerful 87C528. At 2 scans per second the microprocessors operating as described will consume 25 mw average.

SUMMARY

The 3D-ACM is based on a simple, small design with a power consumption of 50 mw. Similarly the complete direction sensor (magnetometer and accelerometer) consumes 5 mw, is small and extremely rugged and clearly meets the accuracy requirements for a good current meter. It has been shown through tow tank testing that the directional response will be substantially free from flow perturbation effects.

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Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[1]

This standard is issued under the fixed designation D 421; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

ε1 Note—Editorial changes were made throughout in September 1993.

1. Scope

1.1 This practice covers the dry preparation of soil samples as received from the field for particle-size analysis and the determination of the soil constants.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2217 Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

3. Significance and Use

3.1 This practice can be used to prepare samples for particle-size and plasticity tests where it is desired to determine test values on air-dried samples, or where it is known that air drying does not have an effect on test results relative to samples prepared in accordance with Practice D 2217.

4. Apparatus

4.1 *Balance*, sensitive to 0.1 g.

4.2 *Mortar and Rubber-Covered Pestle*, suitable for breaking up the aggregations of soil particles.

4.3 *Sieves*—A series of sieves, of square mesh woven wire cloth, conforming to Specification E 11. The sieves required are as follows:

No. 4 (4.75-mm)
No. 10 (2.00-mm)
No. 40 (425-μm)

4.4 *Sampler*—A riffle sampler or sample splitter, for quartering the samples.

5. Sampling

5.1 Expose the soil sample as received from the field to the air at room temperature until dried thoroughly. Break up the aggregations thoroughly in the mortar with a rubber-covered pestle. Select a representative sample of the amount required to perform the desired tests by the method of quartering or by the use of a sampler. The amounts of material required to perform the individual tests are as follows:

5.1.1 *Particle-Size Analysis*—For the particle-size analysis, material passing a No. 10 (2.00-mm) sieve is required in amounts equal to 115 g of sandy soils and 65 g of either silt or clay soils.

5.1.2 *Tests for Soil Constants*—For the tests for soil constants, material passing the No. 40 (425-μm) sieve is required in total amount of 220 g, allocated as follows:

Test	Grams
Liquid limit	100
Plastic limit	15
Centrifuge moisture equivalent	10
Volumetric shrinkage	30
Check tests	65

6. Preparation of Test Sample

6.1 Select that portion of the air-dried sample selected for purpose of tests and record the mass as the mass of the total test sample uncorrected for hygroscopic moisture. Separate the test sample by sieving with a No. 10 (2.00-mm) sieve. Grind that fraction retained on the No. 10 sieve in a mortar with a rubber-covered pestle until the aggregations of soil particles are broken up into the separate grains. Then separate the ground soil into two fractions by sieving with a No. 10 sieve.

6.2 Wash that fraction retained after the second sieving free of all fine material, dry, and weigh. Record this mass as the mass of coarse material. Sieve the coarse material, after being washed and dried, on the No. 4 (4.75-mm) sieve and record the mass retained on the No. 4 sieve.

7. Test Sample for Particle-Size Analysis

7.1 Thoroughly mix together the fractions passing the No. 10 (2.00-mm) sieve in both sieving operations, and by the method of quartering or the use of a sampler, select a portion

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

Current edition approved July 26, 1985. Published September 1985. Originally published as D 421 – 35 T. Last previous edition D 421 – 58 (1978)ε1.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

weighing approximately 115 g for sandy soils and approximately 65 g for silt and clay soil for particle-size analysis.

8. Test Sample for Soil Constants

8.1 Separate the remaining portion of the material passing the No. 10 (2.00-mm) sieve into two parts by means of a No. 40 (425-μm) sieve. Discard the fraction retained on the No. 40 sieve. Use the fraction passing the No. 40 sieve for the determination of the soil constants.

9. Keywords

9.1 dry preparation; particle-size analysis; soil

Standard Test Method for Particle-Size Analysis of Soils[1]

This standard is issued under the fixed designation D 422; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε1 Note—Section 19 was added editorially in September 1990

1. Scope

1.1 This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 µm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 µm is determined by a sedimentation process, using a hydrometer to secure the necessary data (Notes 1 and 2).

Note 1—Separation may be made on the No. 4 (4.75-mm), No. 40 (425-µm), or No. 200 (75-µm) sieve instead of the No. 10. For whatever sieve used, the size shall be indicated in the report.

Note 2—Two types of dispersion devices are provided: (*1*) a high-speed mechanical stirrer, and (*2*) air dispersion. Extensive investigations indicate that air-dispersion devices produce a more positive dispersion of plastic soils below the 20-µm size and appreciably less degradation on all sizes when used with sandy soils. Because of the definite advantages favoring air dispersion, its use is recommended. The results from the two types of devices differ in magnitude, depending upon soil type, leading to marked differences in particle size distribution, especially for sizes finer than 20 µm.

2. Referenced Documents

2.1 *ASTM Standards:*

D 421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants[2]

E 11 Specification for Wire-Cloth Sieves for Testing Purposes[3]

E 100 Specification for ASTM Hydrometers[4]

3. Apparatus

3.1 *Balances*—A balance sensitive to 0.01 g for weighing the material passing a No. 10 (2.00-mm) sieve, and a balance sensitive to 0.1 % of the mass of the sample to be weighed for weighing the material retained on a No. 10 sieve.

3.2 *Stirring Apparatus*—Either apparatus A or B may be used.

3.2.1 Apparatus A shall consist of a mechanically operated stirring device in which a suitably mounted electric motor turns a vertical shaft at a speed of not less than 10 000 rpm without load. The shaft shall be equipped with a replaceable stirring paddle made of metal, plastic, or hard rubber, as shown in Fig. 1. The shaft shall be of such length that the stirring paddle will operate not less than ¾ in. (19.0 mm) nor more than 1½ in. (38.1 mm) above the bottom of the dispersion cup. A special dispersion cup conforming to either of the designs shown in Fig. 2 shall be provided to hold the sample while it is being dispersed.

3.2.2 Apparatus B shall consist of an air-jet dispersion cup[5] (Note 3) conforming to the general details shown in Fig. 3 (Notes 4 and 5).

Note 3—The amount of air required by an air-jet dispersion cup is of the order of 2 ft^3/min; some small air compressors are not capable of supplying sufficient air to operate a cup.

Note 4—Another air-type dispersion device, known as a dispersion tube, developed by Chu and Davidson at Iowa State College, has been shown to give results equivalent to those secured by the air-jet dispersion cups. When it is used, soaking of the sample can be done in the sedimentation cylinder, thus eliminating the need for transferring the slurry. When the air-dispersion tube is used, it shall be so indicated in the report.

Note 5—Water may condense in air lines when not in use. This water must be removed, either by using a water trap on the air line, or by blowing the water out of the line before using any of the air for dispersion purposes.

3.3 *Hydrometer*—An ASTM hydrometer, graduated to read in either specific gravity of the suspension or grams per litre of suspension, and conforming to the requirements for hydrometers 151H or 152H in Specifications E 100. Dimensions of both hydrometers are the same, the scale being the only item of difference.

3.4 *Sedimentation Cylinder*—A glass cylinder essentially 18 in. (457 mm) in height and 2½ in. (63.5 mm) in diameter, and marked for a volume of 1000 mL. The inside diameter shall be such that the 1000-mL mark is 36 ± 2 cm from the bottom on the inside.

3.5 *Thermometer*—A thermometer accurate to 1°F (0.5°C).

3.6 *Sieves*—A series of sieves, of square-mesh woven-wire cloth, conforming to the requirements of Specification E 11. A full set of sieves includes the following (Note 6):

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.03 on Texture, Plasticity, and Density Characteristics of Soils.

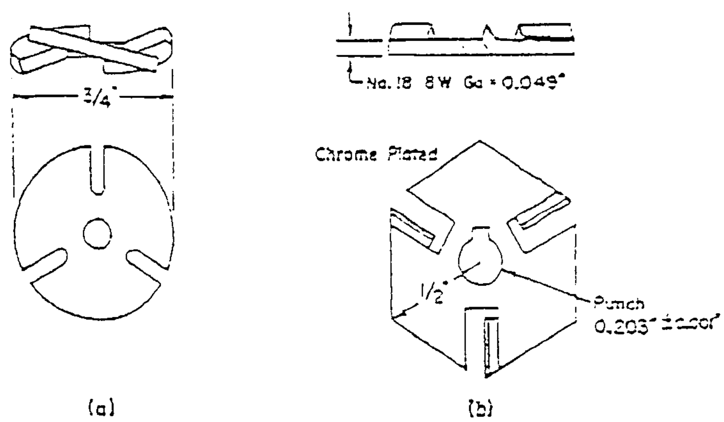
Current edition approved Nov. 21, 1963. Originally published 1935. Replaces D 422 – 62.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 14.03.

[5] Detailed working drawings for this cup are available at a nominal cost from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103. Order Adjunct No. 12-404220-00.



Metric Equivalents

in.	0.001	0.049	0.203	½	¾
mm	0.03	1.24	5.16	12.7	19.0

FIG. 1 Detail of Stirring Paddles

3-in. (75-mm)	No. 10 (2.00-mm)
2-in. (50-mm)	No. 20 (850-μm)
1½-in. (37.5-mm)	No. 40 (425-μm)
1-in. (25.0-mm)	No. 60 (250-μm)
¾-in. (19.0-mm)	No. 140 (106-μm)
⅜-in. (9.5-mm)	No. 200 (75-μm)
No. 4 (4.75-mm)	

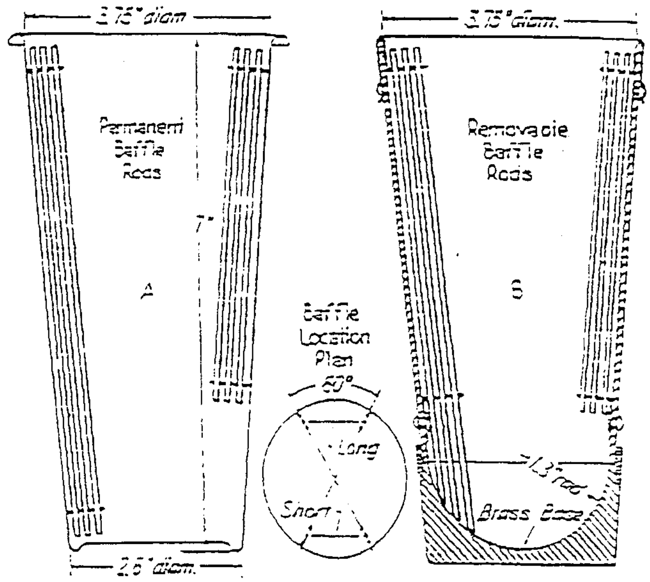
NOTE 6—A set of sieves giving uniform spacing of points for the graph, as required in Section 17, may be used if desired. This set consists of the following sieves:

3-in. (75-mm)	No. 16 (1.18-mm)
1½-in. (37.5-mm)	No. 30 (600-μm)
¾-in. (19.0-mm)	No. 50 (300-μm)
⅜-in. (9.5-mm)	No. 100 (150-μm)
No. 4 (4.75-mm)	No. 200 (75-μm)
No. 8 (2.36-mm)	

3.7 *Water Bath or Constant-Temperature Room*—A water bath or constant-temperature room for maintaining the soil suspension at a constant temperature during the hydrometer analysis. A satisfactory water tank is an insulated tank that maintains the temperature of the suspension at a convenient constant temperature at or near 68°F (20°C). Such a device is illustrated in Fig. 4. In cases where the work is performed in a room at an automatically controlled constant temperature, the water bath is not necessary.

3.8 *Beaker*—A beaker of 250-mL capacity.

3.9 *Timing Device*—A watch or clock with a second hand.



Metric Equivalents

in.	1.3	2.5	3.75
mm	33	63	95.2

FIG. 2 Dispersion Cups of Apparatus

4. Dispersing Agent

4.1 A solution of sodium hexametaphosphate (sometimes called sodium metaphosphate) shall be used in distilled or demineralized water, at the rate of 40 g of sodium hexametaphosphate/litre of solution (Note 7).

NOTE 7—Solutions of this salt, if acidic, slowly revert or hydrolyze back to the orthophosphate form with a resultant decrease in dispersive action. Solutions should be prepared frequently (at least once a month) or adjusted to pH of 8 or 9 by means of sodium carbonate. Bottles containing solutions should have the date of preparation marked on them.

4.2 All water used shall be either distilled or demineralized water. The water for a hydrometer test shall be brought to the temperature that is expected to prevail during the hydrometer test. For example, if the sedimentation cylinder is to be placed in the water bath, the distilled or demineralized water to be used shall be brought to the temperature of the controlled water bath; or, if the sedimentation cylinder is used in a room with controlled temperature, the water for the test shall be at the temperature of the room. The basic temperature for the hydrometer test is 68°F (20°C). Small variations of temperature do not introduce differences that are of practical significance and do not prevent the use of corrections derived as prescribed.

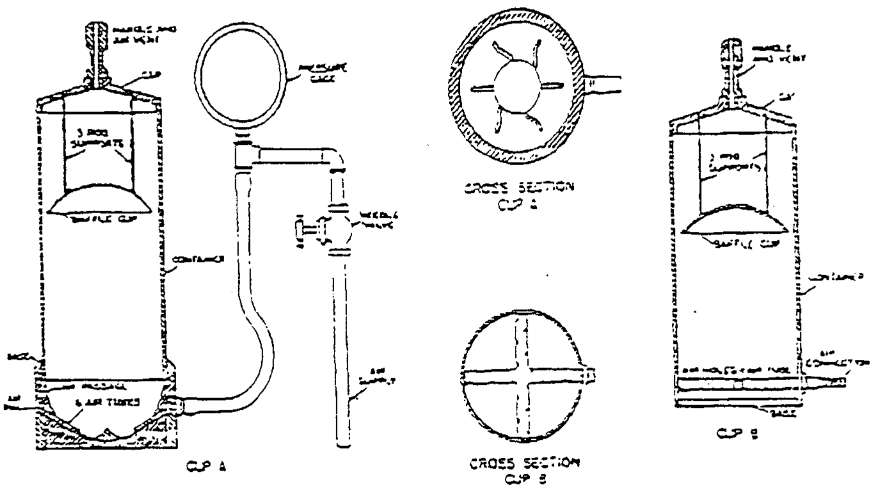


FIG. 3 Air-Jet Dispersion Cups of Apparatus B

5. Test Sample

5.1 Prepare the test sample for mechanical analysis as outlined in Practice D 421. During the preparation procedure the sample is divided into two portions. One portion contains only particles retained on the No. 10 (2.00-mm) sieve while the other portion contains only particles passing the No. 10 sieve. The mass of air-dried soil selected for purpose of tests, as prescribed in Practice D 421, shall be sufficient to yield quantities for mechanical analysis as follows:

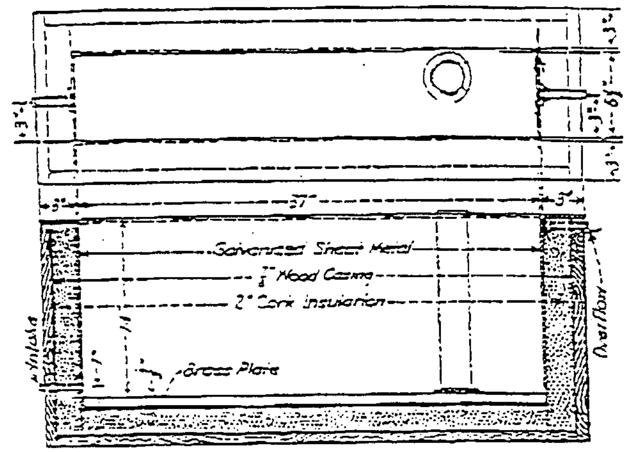
5.1.1 The size of the portion retained on the No. 10 sieve shall depend on the maximum size of particle, according to the following schedule:

Nominal Diameter of Largest Particles, in. (mm)	Approximate Minimum Mass of Portion, g
3/8 (9.5)	500
3/4 (19.0)	1000
1 (25.4)	2000
1½ (38.1)	3000
2 (50.8)	4000
3 (76.2)	5000

5.1.2 The size of the portion passing the No. 10 sieve shall be approximately 115 g for sandy soils and approximately 65 g for silt and clay soils.

5.2 Provision is made in Section 5 of Practice D 421 for weighing of the air-dry soil selected for purpose of tests, the separation of the soil on the No. 10 sieve by dry-sieving and washing, and the weighing of the washed and dried fraction retained on the No. 10 sieve. From these two masses the percentages retained and passing the No. 10 sieve can be calculated in accordance with 12.1.

NOTE 3—A check on the mass values and the thoroughness of pulverization of the clods may be secured by weighing the portion passing the No. 10 sieve and adding this value to the mass of the washed and oven-dried portion retained on the No. 10 sieve.



Metric Equivalents

in.	7/8	1	3	6¼	14	37
mm	22.2	25.4	76.2	158.2	356	940

FIG. 4 Insulated Water Bath

SIEVE ANALYSIS OF PORTION RETAINED ON NO. 10 (2.00-mm) SIEVE

6. Procedure

6.1 Separate the portion retained on the No. 10 (2.00-mm) sieve into a series of fractions using the 3-in. (75-mm), 2-in. (50-mm), 1½-in. (37.5-mm), 1-in. (25.0-mm), ¾-in. (19.0-mm), ⅜-in. (9.5-mm), No. 4 (4.75-mm), and No. 10 sieves, or as many as may be needed depending on the sample, or upon the specifications for the material under test.

6.2 Conduct the sieving operation by means of a lateral and vertical motion of the sieve, accompanied by a jarring action in order to keep the sample moving continuously over the surface of the sieve. In no case turn or manipulate fragments in the sample through the sieve by hand. Continue sieving until not more than 1 mass % of the residue on a sieve passes that sieve during 1 min of sieving. When mechanical sieving is used, test the thoroughness of sieving by using the hand method of sieving as described above.

6.3 Determine the mass of each fraction on a balance conforming to the requirements of 3.1. At the end of weighing, the sum of the masses retained on all the sieves used should equal closely the original mass of the quantity sieved.

HYDROMETER AND SIEVE ANALYSIS OF PORTION PASSING THE NO. 10 (2.00-mm) SIEVE

7. Determination of Composite Correction for Hydrometer Reading

7.1 Equations for percentages of soil remaining in suspension, as given in 14.3, are based on the use of distilled or demineralized water. A dispersing agent is used in the water, however, and the specific gravity of the resulting liquid is appreciably greater than that of distilled or demineralized water.

7.1.1 Both soil hydrometers are calibrated at 68°F (20°C), and variations in temperature from this standard temperature produce inaccuracies in the actual hydrometer readings. The amount of the inaccuracy increases as the variation from the standard temperature increases.

7.1.2 Hydrometers are graduated by the manufacturer to be read at the bottom of the meniscus formed by the liquid on the stem. Since it is not possible to secure readings of soil suspensions at the bottom of the meniscus, readings must be taken at the top and a correction applied.

7.1.3 The net amount of the corrections for the three items enumerated is designated as the composite correction, and may be determined experimentally.

7.2 For convenience, a graph or table of composite corrections for a series of 1° temperature differences for the range of expected test temperatures may be prepared and used as needed. Measurement of the composite corrections may be made at two temperatures spanning the range of expected test temperatures, and corrections for the intermediate temperatures calculated assuming a straight-line relationship between the two observed values.

7.3 Prepare 1000 mL of liquid composed of distilled or demineralized water and dispersing agent in the same proportion as will prevail in the sedimentation (hydrometer) test. Place the liquid in a sedimentation cylinder and the cylinder in the constant-temperature water bath, set for one of the two temperatures to be used. When the temperature of the liquid becomes constant, insert the hydrometer, and, after a short interval to permit the hydrometer to come to the temperature of the liquid, read the hydrometer at the top of the meniscus formed on the stem. For hydrometer 151H the composite correction is the difference between this reading and one; for hydrometer 152H it is the difference between the reading and zero. Bring the liquid and the hydrometer to the other temperature to be used, and secure the composite correction as before.

8. Hygroscopic Moisture

8.1 When the sample is weighed for the hydrometer test, weigh out an auxiliary portion of from 10 to 15 g in a small metal or glass container, dry the sample to a constant mass in an oven at 230 ± 9°F (110 ± 5°C), and weigh again. Record the masses.

9. Dispersion of Soil Sample

9.1 When the soil is mostly of the clay and silt sizes, weigh out a sample of air-dry soil of approximately 50 g. When the soil is mostly sand the sample should be approximately 100 g.

9.2 Place the sample in the 250-mL beaker and cover with 125 mL of sodium hexametaphosphate solution (40 g/L). Stir until the soil is thoroughly wetted. Allow to soak for at least 16 h.

9.3 At the end of the soaking period, disperse the sample further, using either stirring apparatus A or B. If stirring apparatus A is used, transfer the soil - water slurry from the beaker into the special dispersion cup shown in Fig. 2, washing any residue from the beaker into the cup with distilled or demineralized water (Note 9). Add distilled or demineralized water, if necessary, so that the cup is more than half full. Stir for a period of 1 min.

NOTE 9—A large size syringe is a convenient device for handling the water in the washing operation. Other devices include the wash-water bottle and a hose with nozzle connected to a pressurized distilled water tank.

9.4 If stirring apparatus B (Fig. 3) is used, remove the cover cap and connect the cup to a compressed air supply by means of a rubber hose. A air gage must be on the line between the cup and the control valve. Open the control valve so that the gage indicates 1 psi (7 kPa) pressure (Note 10). Transfer the soil - water slurry from the beaker to the air-jet dispersion cup by washing with distilled or demineralized water. Add distilled or demineralized water, if necessary, so that the total volume in the cup is 250 mL, but no more.

NOTE 10—The initial air pressure of 1 psi is required to prevent the soil - water mixture from entering the air-jet chamber when the mixture is transferred to the dispersion cup.

9.5 Place the cover cap on the cup and open the air control valve until the gage pressure is 20 psi (140 kPa). Disperse the soil according to the following schedule:

Plasticity Index	Dispersion Period, min
Under 5	5
6 to 20	10
Over 20	15

Soils containing large percentages of mica need be dispersed for only 1 min. After the dispersion period, reduce the gage pressure to 1 psi preparatory to transfer of soil - water slurry to the sedimentation cylinder.

10. Hydrometer Test

10.1 Immediately after dispersion, transfer the soil - water slurry to the glass sedimentation cylinder, and add distilled or demineralized water until the total volume is 1000 mL.

10.2 Using the palm of the hand over the open end of the cylinder (or a rubber stopper in the open end), turn the cylinder upside down and back for a period of 1 min to complete the agitation of the slurry (Note 11). At the end of 1 min set the cylinder in a convenient location and take hydrometer readings at the following intervals of time (measured from the beginning of sedimentation), or as many as may be needed, depending on the sample or the specification for the material under test: 2, 5, 15, 30, 60, 250, and 1440 min. If the controlled water bath is used, the sedimentation cylinder should be placed in the bath between the 2- and 5-min readings.

NOTE 11—The number of turns during this minute should be approximately 60, counting the turn upside down and back as two turns.

Any soil remaining in the bottom of the cylinder during the first few turns should be loosened by vigorous shaking of the cylinder while it is in the inverted position.

10.3 When it is desired to take a hydrometer reading, carefully insert the hydrometer about 20 to 25 s before the reading is due to approximately the depth it will have when the reading is taken. As soon as the reading is taken, carefully remove the hydrometer and place it with a spinning motion in a graduate of clean distilled or demineralized water.

NOTE 12—It is important to remove the hydrometer immediately after each reading. Readings shall be taken at the top of the meniscus formed by the suspension around the stem, since it is not possible to secure readings at the bottom of the meniscus.

10.4 After each reading, take the temperature of the suspension by inserting the thermometer into the suspension.

11. Sieve Analysis

11.1 After taking the final hydrometer reading, transfer the suspension to a No. 200 (75-μm) sieve and wash with tap water until the wash water is clear. Transfer the material on the No. 200 sieve to a suitable container, dry in an oven at 230 ± 9°F (110 ± 5°C) and make a sieve analysis of the portion retained, using as many sieves as desired, or required for the material, or upon the specification of the material under test.

CALCULATIONS AND REPORT

12. Sieve Analysis Values for the Portion Coarser than the No. 10 (2.00-mm) Sieve

12.1 Calculate the percentage passing the No. 10 sieve by dividing the mass passing the No. 10 sieve by the mass of soil originally split on the No. 10 sieve, and multiplying the result by 100. To obtain the mass passing the No. 10 sieve, subtract the mass retained on the No. 10 sieve from the original mass.

12.2 To secure the total mass of soil passing the No. 4 (4.75-mm) sieve, add to the mass of the material passing the No. 10 sieve the mass of the fraction passing the No. 4 sieve and retained on the No. 10 sieve. To secure the total mass of soil passing the ⅜-in. (9.5-mm) sieve, add to the total mass of soil passing the No. 4 sieve, the mass of the fraction passing the ⅜-in. sieve and retained on the No. 4 sieve. For the remaining sieves, continue the calculations in the same manner.

12.3 To determine the total percentage passing for each sieve, divide the total mass passing (see 12.2) by the total mass of sample and multiply the result by 100.

13. Hygroscopic Moisture Correction Factor

13.1 The hydroscopic moisture correction factor is the ratio between the mass of the oven-dried sample and the air-dry mass before drying. It is a number less than one, except when there is no hygroscopic moisture.

14. Percentages of Soil in Suspension

14.1 Calculate the oven-dry mass of soil used in the hydrometer analysis by multiplying the air-dry mass by the hygroscopic moisture correction factor.

14.2 Calculate the mass of a total sample represented by the mass of soil used in the hydrometer test, by dividing the oven-dry mass used by the percentage passing the No. 10 (2.00-mm) sieve, and multiplying the result by 100. This value is the weight W in the equation for percentage remaining in suspension.

TABLE 1 Values of Correction Factor, a, for Different Specific Gravities of Soil Particles[A]

Specific Gravity	Correction Factor[A]
2.95	0.94
2.90	0.95
2.85	0.96
2.80	0.97
2.75	0.98
2.70	0.99
2.65	1.00
2.60	1.01
2.55	1.02
2.50	1.03
2.45	1.05

[A] For use in equation for percentage of soil remaining in suspension when using Hydrometer 152H.

14.3 The percentage of soil remaining in suspension at the level at which the hydrometer is measuring the density of the suspension may be calculated as follows (Note 13): For hydrometer 151H:

$$P = [(100\,000/W) \times G/(G - G_1)](R - G_1)$$

NOTE 13—The bracketed portion of the equation for hydrometer 151H is constant for a series of readings and may be calculated first and then multiplied by the portion in the parentheses.

For hydrometer 152H:

$$P = (Ra/W) \times 100$$

where:

a = correction faction to be applied to the reading of hydrometer 152H. (Values shown on the scale are computed using a specific gravity of 2.65. Correction factors are given in Table 1),
P = percentage of soil remaining in suspension at the level at which the hydrometer measures the density of the suspension,
R = hydrometer reading with composite correction applied (Section 7),
W = oven-dry mass of soil in a total test sample represented by mass of soil dispersed (see 14.2), g,
G = specific gravity of the soil particles, and
G_1 = specific gravity of the liquid in which soil particles are suspended. Use numerical value of one in both instances in the equation. In the first instance any possible variation produces no significant effect, and in the second instance, the composite correction for R is based on a value of one for G_1.

15. Diameter of Soil Particles

15.1 The diameter of a particle corresponding to the percentage indicated by a given hydrometer reading shall be calculated according to Stokes' law (Note 14), on the basis that a particle of this diameter was at the surface of the suspension at the beginning of sedimentation and had settled to the level at which the hydrometer is measuring the density of the suspension. According to Stokes' law:

$$D = \sqrt{[30n/980(G - G_1)] \times L/T}$$

where:

D = diameter of particle, mm,

η = coefficient of viscosity of the suspending medium (in this case water) in poises (varies with changes in temperature of the suspending medium),
L = distance from the surface of the suspension to the level at which the density of the suspension is being measured, cm. (For a given hydrometer and sedimentation cylinder, values vary according to the hydrometer readings. This distance is known as effective depth (Table 2)),
T = interval of time from beginning of sedimentation to the taking of the reading, min.
G = specific gravity of soil particles, and
G_1 = specific gravity (relative density) of suspending medium (value may be used as 1.000 for all practical purposes).

NOTE 14—Since Stokes' law considers the terminal velocity of a single sphere falling in an infinity of liquid, the sizes calculated represent the diameter of spheres that would fall at the same rate as the soil particles.

15.2 For convenience in calculations the above equation may be written as follows:

$$D = K\sqrt{L/T}$$

where:
K = constant depending on the temperature of the suspension and the specific gravity of the soil particles. Values of K for a range of temperatures and specific gravities are given in Table 3. The value of K does not change for a series of readings constituting a test, while values of L and T do vary.

15.3 Values of D may be computed with sufficient accuracy, using an ordinary 10-in. slide rule.

NOTE 15—The value of L is divided by T using the A- and B-scales, the square root being indicated on the D-scale. Without ascertaining the value of the square root it may be multiplied by K, using either the C- or CI-scale.

16. Sieve Analysis Values for Portion Finer than No. 10 (2.00-mm) Sieve

16.1 Calculation of percentages passing the various sieves used in sieving the portion of the sample from the hydrometer test involves several steps. The first step is to calculate the mass of the fraction that would have been retained on the No. 10 sieve had it not been removed. This mass is equal to the total percentage retained on the No. 10 sieve (100 minus total percentage passing) times the mass of the total sample represented by the mass of soil used (as calculated in 14.2), and the result divided by 100.

16.2 Calculate next the total mass passing the No. 200 sieve. Add together the fractional masses retained on all the sieves, including the No. 10 sieve, and subtract this sum from the mass of the total sample (as calculated in 14.2).

16.3 Calculate next the total masses passing each of the other sieves, in a manner similar to that given in 12.2.

16.4 Calculate last the total percentages passing by dividing the total mass passing (as calculated in 16.3) by the total mass of sample (as calculated in 14.2), and multiply the result by 100.

17. Graph

17.1 When the hydrometer analysis is performed, a graph of the test results shall be made, plotting the diameters of the particles on a logarithmic scale as the abscissa and the percentages smaller than the corresponding diameters to an

TABLE 2 Values of Effective Depth Based on Hydrometer and Sedimentation Cylinder of Specified Sizes[A]

Hydrometer 151H		Hydrometer 152H			
Actual Hydrometer Reading	Effective Depth, L, cm	Actual Hydrometer Reading	Effective Depth, L, cm	Actual Hydrometer Reading	Effective Depth, L, cm
1.000	16.3	0	16.3	31	11.2
1.001	16.0	1	16.1	32	11.1
1.002	15.8	2	16.0	33	10.9
1.003	15.5	3	15.8	34	10.7
1.004	15.2	4	15.6	35	10.6
1.005	15.0	5	15.5		
1.006	14.7	6	15.3	36	10.4
1.007	14.4	7	15.2	37	10.2
1.008	14.2	8	15.0	38	10.1
1.009	13.9	9	14.8	39	9.9
1.010	13.7	10	14.7	40	9.7
1.011	13.4	11	14.5	41	9.6
1.012	13.1	12	14.3	42	9.4
1.013	12.9	13	14.2	43	9.2
1.014	12.6	14	14.0	44	9.1
1.015	12.3	15	13.8	45	8.9
1.016	12.1	16	13.7	46	8.8
1.017	11.8	17	13.5	47	8.6
1.018	11.5	18	13.3	48	8.4
1.019	11.3	19	13.2	49	8.3
1.020	11.0	20	13.0	50	8.1
1.021	10.7	21	12.9	51	7.9
1.022	10.5	22	12.7	52	7.8
1.023	10.2	23	12.5	53	7.6
1.024	10.0	24	12.4	54	7.4
1.025	9.7	25	12.2	55	7.3
1.026	9.4	26	12.0	56	7.1
1.027	9.2	27	11.9	57	7.0
1.028	8.9	28	11.7	58	6.8
1.029	8.6	29	11.5	59	6.6
1.030	8.4	30	11.4	60	6.5
1.031	8.1				
1.032	7.8				
1.033	7.6				
1.034	7.3				
1.035	7.0				
1.036	6.8				
1.037	6.5				
1.038	6.2				

[A] Values of effective depth are calculated from the equation:

$$L = L_1 + \tfrac{1}{2}\left[L_2 - (V_B/A)\right]$$

where:
L = effective depth, cm,
L_1 = distance along the stem of the hydrometer from the top of the bulb to the mark for a hydrometer reading, cm,
L_2 = overall length of the hydrometer bulb, cm,
V_B = volume of hydrometer bulb, cm³, and
A = cross-sectional area of sedimentation cylinder, cm²
Values used in calculating the values in Table 2 are as follows:
For both hydrometers, 151H and 152H:
L_2 = 14.0 cm
V_B = 67.0 cm³
A = 27.8 cm²
For hydrometer 151H:
L_1 = 10.5 cm for a reading of 1.000
= 2.3 cm for a reading of 1.031
For hydrometer 152H:
L_1 = 10.5 cm for a reading of 0 g/litre
= 2.3 cm for a reading of 50 g/litre

TABLE 3 Values of K for Use in Equation for Computing Diameter of Particle in Hydrometer Analysis

Temperature, °C	Specific Gravity of Soil Particles								
	2.45	2.50	2.55	2.60	2.65	2.70	2.75	2.80	2.85
16	0.01510	0.01505	0.01481	0.01457	0.01435	0.01414	0.01394	0.01374	0.01356
17	0.01511	0.01486	0.01462	0.01439	0.01417	0.01396	0.01376	0.01356	0.01338
18	0.01492	0.01467	0.01443	0.01421	0.01399	0.01378	0.01359	0.01339	0.01321
19	0.01474	0.01449	0.01425	0.01403	0.01382	0.01361	0.01342	0.01323	0.01305
20	0.01456	0.01431	0.01408	0.01386	0.01365	0.01344	0.01325	0.01307	0.01289
21	0.01438	0.01414	0.01391	0.01369	0.01348	0.01328	0.01309	0.01291	0.01273
22	0.01421	0.01397	0.01374	0.01353	0.01332	0.01312	0.01294	0.01276	0.01258
23	0.01404	0.01381	0.01358	0.01337	0.01317	0.01297	0.01279	0.01261	0.01243
24	0.01388	0.01385	0.01342	0.01321	0.01301	0.01282	0.01264	0.01246	0.01229
25	0.01372	0.01349	0.01327	0.01306	0.01288	0.01257	0.01249	0.01232	0.01215
26	0.01357	0.01334	0.01312	0.01291	0.01272	0.01253	0.01235	0.01218	0.01201
27	0.01342	0.01319	0.01297	0.01277	0.01258	0.01239	0.01221	0.01204	0.01188
28	0.01327	0.01304	0.01283	0.01264	0.01244	0.01255	0.01208	0.01191	0.01175
29	0.01312	0.01290	0.01269	0.01249	0.01230	0.01212	0.01195	0.01178	0.01162
30	0.01298	0.01276	0.01256	0.01236	0.01217	0.01199	0.01182	0.01165	0.01149

arithmetic scale as the ordinate. When the hydrometer analysis is not made on a portion of the soil, the preparation of the graph is optional, since values may be secured directly from tabulated data.

18. Report

18.1 The report shall include the following:

18.1.1 Maximum size of particles,

18.1.2 Percentage passing (or retained on) each sieve, which may be tabulated or presented by plotting on a graph (Note 16),

18.1.3 Description of sand and gravel particles:

18.1.3.1 Shape—rounded or angular,

18.1.3.2 Hardness—hard and durable, soft, or weathered and friable,

18.1.4 Specific gravity, if unusually high or low,

18.1.5 Any difficulty in dispersing the fraction passing the No. 10 (2.00-mm) sieve, indicating any change in type and amount of dispersing agent, and

18.1.6 The dispersion device used and the length of the dispersion period.

NOTE 16—This tabulation of graph represents the gradation of the sample tested. If particles larger than those contained in the sample were removed before testing, the report shall so state giving the amount and maximum size.

18.2 For materials tested for compliance with definite specifications, the fractions called for in such specifications shall be reported. The fractions smaller than the No. 10 sieve shall be read from the graph.

18.3 For materials for which compliance with definite specifications is not indicated and when the soil is composed almost entirely of particles passing the No. 4 (4.75-mm) sieve, the results read from the graph may be reported as follows:

(1) Gravel, passing 3-in. and retained on No. 4 sieve ... %
(2) Sand, passing No. 4 sieve and retained on No. 200 sieve ... %
(a) Coarse sand, passing No. 4 sieve and retained on No. 10 sieve ... %
(b) Medium sand, passing No. 10 sieve and retained on No. 40 sieve ... %
(c) Fine sand, passing No. 40 sieve and retained on No. 200 sieve ... %
(3) Silt size, 0.074 to 0.005 mm ... %
(4) Clay size, smaller than 0.005 mm ... %
Colloids, smaller than 0.001 mm ... %

18.4 For materials for which compliance with definite specifications is not indicated and when the soil contains material retained on the No. 4 sieve sufficient to require a sieve analysis on that portion, the results may be reported as follows (Note 17):

SIEVE ANALYSIS

Sieve Size	Percentage Passing
3-in.	
2-in.	
1½-in.	
1-in.	
¾-in.	
⅜-in.	
No. 4 (4.75-mm)	
No. 10 (2.00-mm)	
No. 40 (425-μm)	
No. 200 (75-μm)	

HYDROMETER ANALYSIS

0.074 mm	
0.005 mm	
0.001 mm	

NOTE 17—No. 8 (2.36-mm) and No. 50 (300-μm) sieves may be substituted for No. 10 and No. 40 sieves.

19. Keywords

19.1 grain-size; hydrometer analysis; hygroscopic moisture; particle-size; sieve analysis

Chesapeake Biological Laboratory · Solomons

Nutrient Analytical Services Laboratory

Standard Operating Procedures

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INTRODUCTION

The following pages document the analytical methodologies performed by the Nutrient Analytical Services Laboratory at the University of Maryland Chesapeake Biological Laboratory (CBL). This manual includes sections on dissolved inorganic nutrients, dissolved organic nutrients and particulate nutrients. Within each of these sections, sample collection, storage, preparation and analysis are discussed. A final section addresses data management and quality assurance/quality control (QA/QC).

Many of the procedures discussed are used for the Maryland Mainstem portion of the Chesapeake Bay Program.

Instrumentation includes:

- Technicon AutoAnalyzer II,
- Two channel Technicon TrAAcs-800 Nutrient Analyzer,
- OI Analytical Model 700 TOC Analyzer,
- Shimadzu TOC-5000 Total Organic Carbon Analyzer,
- Turner Designs TD-700 Fluorometer,
- Sequoia Turner Fluorometer Model 112,
- Shimadzu UV-120-02 Spectrophotometer,
- Exeter Analytical, Inc. CE-440 Elemental Analyzer, and
- Rainin Co. Inc./Dionex hybrid Ion Chromatograph.

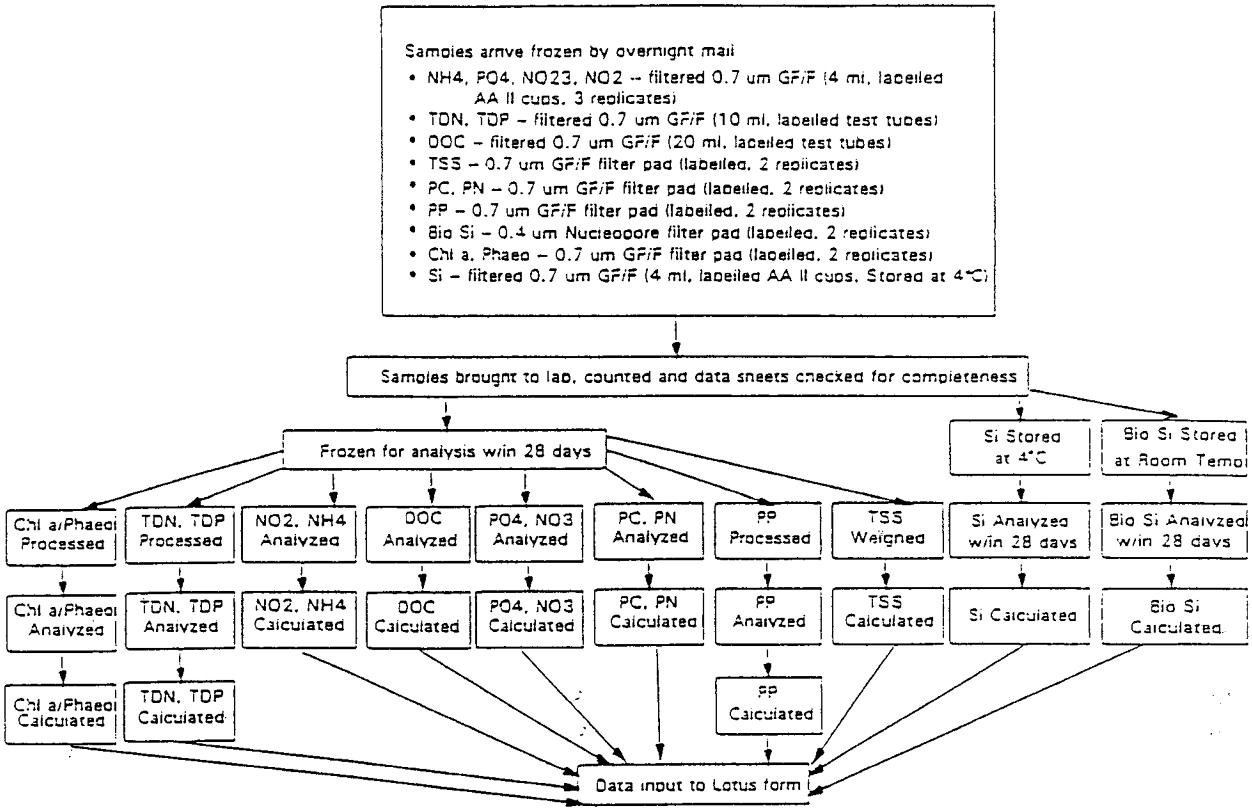
Gateway 2000 Pentium microcomputers with complete spreadsheet packages are used heavily in data reduction and management.

High quality (18.3 megohm-cm) water is provided via a Barnstead NANOpure II system. The Barnstead system produces Type 1 Reagent Grade water equal to or exceeding standards established by the American Society for Testing and Materials. First, water is filtered through a reverse osmosis membrane. Final product water then passes through a series of five filters: one organic colloid, two mixed bed, one organic free, and one final 0.2 µm filter. Throughout this report, the term "deionized water" refers to 18.3 megohm-cm water and "frozen" refers to temperature < -20°C.

Table 1. Parameters routinely analyzed at the Nutrient Analytical Services Laboratory at CBL

DISSOLVED INORGANIC	ORGANIC	PARTICULATE
Ammonium-Nitrogen	Acid Persulfate Phosphorus	Carbon
Nitrite-Nitrogen	Persulfate Nitrogen	Nitrogen
Nitrite–Nitrate-Nitrogen	Persulfate Phosphorus	Phosphorus
Phosphate-Phosphorus	Dissolved Carbon	Total Suspended Solids
Silicate		Biogenic Silica
Sulfate		Chlorophyll *a*
Chloride		Phaeopigments
Nitrate-Nitrogen		

Sample Data Reduction Process



DISSOLVED INORGANIC ANALYTES

Instrumentation

All of the dissolved inorganic nutrient procedures, particulate phosphorus and biogenic silica procedures require the use of a segmented continuous flow analyzer such as the Technicon AutoAnalyzer II where samples and reagents are continuously added in a specific sequence along a path of glass tubing and mixing coils. Within the system of tubes, air bubbles injected at precise intervals sweep the walls of the tubing and prevent diffusion between successive samples. Reactions in the AutoAnalyzer do not develop to completion as in manual methods, but reach identical stages of development within each sample since every sample follows the same path, timing and exposure to specific reagents.

The basic function of each component of the segmented continuous flow analyzer is discussed briefly below. This explanation is similar to that of Sanborn and Larrance (1972).

Automatic Sampler

At a timed interval, the sampler probe alternately draws fluid from a tray of discrete samples and a wash fluid receptacle. After each sample is drawn, the sample tray advances to the next sample position. A bubble of air, which acts as a diffusion barrier, is aspirated into the sample stream between sample and wash. The ratio of sample-to-wash time and the number of samples analyzed per hour are controlled by a cam located in the top well of the sampler assembly. Cams are changed easily and are available for various sampling rates.

The wash solution separates successive samples in the sample stream as indicated on the graphical record by alternating minima (wash) and maxima (sample). The sample probe is connected to a stream divider that delivers identical samples simultaneously to each manifold via the pump.

Proportioning Pump

The proportioning pump is a peristaltic-type pump that continuously delivers air, reagents and samples to the manifold. Plastic pump tubes of various diameters are pressed between a series of moving rollers and a platen. The motion of the rollers along the tubes delivers a continuous flow of samples and reagents. The delivery rate is determined by the inside diameter of the tubes since the rollers move at a constant rate. These pump tubes are available in a large assortment of delivery rates. The pump holds a maximum of 28 tubes and has an air bar that mechanically measures and injects identically sized air bubbles into the analytical stream. The pump tubes delivering reagents, air and samples are connected to appropriate manifolds.

Manifold

Each analysis requires a manifold specifically designed for the chemical determination employed. The manifolds are composed of a series of horizontal glass coils, injection fittings and heating baths arranged for the proper sequence of reactions leading to color development. The glass coils permit mixing of the sample and the reagents; as two solutions with different densities travel around each turn of the mixing coil, the denser solution falls through the less dense one, causing mixing and creation of a homogenous mixture of the two solutions. The length of the coil determines the amount of time allowed for chemical reaction between the addition of successive reagents. Injection fittings for each of the reagents are placed between mixing coils: thus, a sample enters one end of the manifold, a reagent is added, and then another reagent is added and mixed. After the addition of all reagents, and an adequate reaction time, the solution flows into a colorimeter.

Colorimeter

The colorimeter measures the absorption of monochromatic light by the solution in the flow cell. Light from a single source passes through two separate but identical interference filters that pass light within a narrow spectral band. The light then passes through the appropriate flow cell and is projected onto a phototube. The phototube generates an electrical signal in response to the intensity of the impinging light. The output from each phototube is a measure of transmittance and is converted electronically by the colorimeter to a signal proportional to absorbance. The relationship between transmittance and absorbance is given by the equation $A = \log 1/T$; where A = absorbance and T = transmittance. The resulting signal is linear in absorbance and directly proportional to concentration. As each sample passes through the flow cell, the signals are sent to a recorder.

Recorder

Results of the analyses are continuously recorded by strip chart recorders or by computer using an IBM compatible DP500 software system by Labtronics Inc. Each recorder can simultaneously monitor two separate analyses and the DP500 system can collect and analyze data from up to four different detectors simultaneously. The output of the colorimeter is proportional to absorbance and standards of known concentration must be analyzed to relate absorbance to concentration. The analog signals can be converted to absorbance values by referring to the Technicon reference curve and the standard calibration control.

Sampling and Storage

Collected water samples are filtered through Whatman GF/F filters (nominal pore size 0.7 µm), placed in either polypropylene bottles or directly into 4 ml AutoAnalyzer cups and frozen. Samples for silicate are treated in the same manner but are refrigerated at 4°C. All samples are analyzed within 28 days.

Operating Procedures

The following describes step-by-step operating procedures for the AutoAnalyzer II system.

1. *Colorimeter* - Turn power on and allow 10 minutes for warm-up. Set standard calibration setting for desired determination.

2. *Recorder (or Computer)* - Turn power on and allow 10 minutes for recorder warm-up. Check recorder paper supply. If using computer for data collection, load software and select appropriate sample method and sample table. Refer to Labtronics Inc DP500 users manual for a description of system operation.

3. *Sampler Water Reservoirs* - Check and fill the deionized water reservoirs.

4. *Pump* - Connect pump tubes and attach platen to pump. Start pump with deionized water flowing through the system. Check for leaks in tubes at connections and for a regular bubble pattern in the manifold.

5. *Recorder* - Start recorder. Paper should begin to move.

6. *Colorimeter* - Check ZERO and FULL SCALE knob. ZERO simulates a zero output so that ZERO adjustment (screwdriver) of the recorder can be made. Set knob to NORMAL and establish a baseline with deionized water using the BASELINE CONTROL adjustment knob and a standard calibration (STD CAL) setting of 1.0.

7. Allow reagents to pump through the system and note any rise in baseline and readjust the baseline to zero. Refer to this rise as the REAGENT BLANK (at a STD CAL of 1.0).

8. An extremely wide range of nutrient concentrations found in Chesapeake Bay waters, both temporally and spatially, requires use of a standard curve covering a large range and that covers a few STD CAL control settings.

9. Reset zero baseline at the STD CAL control setting normally used for that determination (e.g., particulate phosphorus STD CAL of 4.0). Next, switch the STD CAL setting to 1.0. There should be no deflection of the pen at zero baseline. Note peak heights of standards at the various STD CAL settings along with the STD CAL settings. This allows the operator to use STD CAL settings in the range of 1 to 4 (for this example) in analyzing standards and samples that otherwise would have gone off scale. Intersperse standards in the run after approximately every 20 samples, including a standard analyzed at each STD CAL setting employed during the preceding 40 samples. A visual comparison with the day's initial standard curve should indicate no greater variance than 5% of the peak height (e.g., initial standard peak height 60.0; subsequent standards acceptable in the range of 57.0 to 63.0). If the variance exceeds 5%, identify the source of the problem, correct and re-analyze affected samples. Adjust baseline after approximately every 20 samples. If an adjustment of more than 1 unit is required, identify the source of the problem, correct and re-analyze affected samples.

10. At completion of the run, remove lines from reagents and place tubes in deionized water.

11. *Shut-down* - Turn off recorder. Wash system with 1 N hydrochloric acid for 15 minutes, followed by a 15 minute wash with deionized water. Turn off pump, release proportioning platen and loosen pump tubes. Turn off colorimeter.

Glassware

Glassware for all determinations are acid-washed with 10% hydrochloric acid followed by numerous rinses with deionized water.

Calibration and Standardization

Please refer to each specific determination for the appropriate STD CAL control setting and for the standard concentrations used.

The STD CAL control setting located on the colorimeter allows the operator to adjust the electrical output to the concentration range of the samples. Extremely low values (µg/l) require high STD CAL settings (high sensitivity) whereas high values (mg/l) require lower STD CAL settings (lower sensitivity).

Concentrations of nutrients are calculated from the linear regression of the standard concentration (independent variable) against the corresponding peak height (dependent variable). All standards analyzed at a particular STD CAL setting are included in the regression for that set of calculations. Only samples whose peak heights were measured at that individual STD CAL setting are calculated from that regression. If a broad range of sample concentrations requires that more than one STD CAL setting be used throughout the course of a run, then a separate regression must be employed for each STD CAL setting. For example, peak heights obtained from standards read at STD CAL 9.0 are used to obtain the linear regression for calculating only the concentrations of samples whose peak heights were read at STD CAL 9.0. Likewise, peak heights obtained from standards read at STD CAL 2.0 are used to obtain the linear regression for calculating only the concentrations of samples whose peak heights were read at STD CAL 2.0.

Peak heights are read manually from the strip chart or automatically by the DP500 software system, depending on the AutoAnalyzer II system used. Operator vigilance is necessary throughout the run to ensure that all peaks indicate steady state conditions for the reaction for each sample. If steady state conditions are not obtained, the samples are re-analyzed.

Stock standards are prepared with primary standard grade chemicals of each nutrient in deionized water. As a general rule, stock solutions should be made every 6 months and the preparation date logged. Secondary standards, where appropriate, are prepared with deionized water. Working standards are prepared daily with deionized water or the appropriate matrix as described by the specific determination method and should encompass the range of the samples.

All analysis documents are kept in bound notebooks and the carbon copy is given to the investigator or granting agency. Information provided includes:

- name of the method;
- collection date;
- source of samples;
- analyst;
- analysis date;
- sample number;
- sample concentration;
- results of duplicate analyses; and
- results of spike analyses.

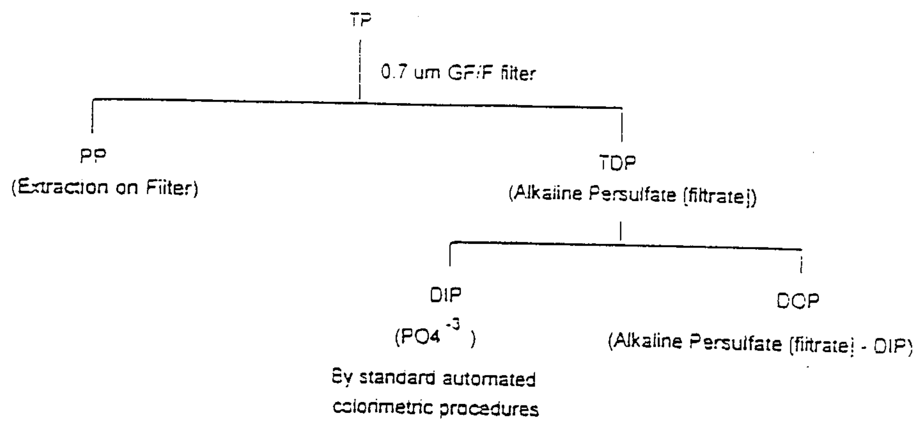


Figure 8. Flow diagram of phosphorus analysis (TP = total phosphorus, PP = particulate phosphorus, TDP = total dissolved phosphorus, DIP = dissolved inorganic phosphorus, DOP = dissolved organic phosphorus).

PARTICULATE ANALYTES

Rationale

The direct measurement of particulate carbon, particulate nitrogen and particulate phosphorus is the preferred method used by the Nutrient Analytical Services Laboratory. A large volume can be filtered onto the pad, yielding a representative sample. The alternative, subtraction of the dissolved concentrations from the total sample concentration to determine the particulate carbon concentration, often yields negative values. Direct measurement is rapid, sensitive and more precise.

Instrumentation

Particulate phosphorus and biogenic silica procedures require the use of a segmented continuous flow analyzer such as the AutoAnalyzer II, previously described in the section Dissolved Inorganic Analytes. Particulate carbon and particulate nitrogen procedures require the use of an elemental analyzer.

Sampling and Storage

A known volume of the collected water is filtered through Whatman GF/F filters (25 mm for particulate carbon and nitrogen, and 47mm for particulate phosphorus, nominal pore size 0.7 µm). The filter is folded, placed in an aluminum foil pouch and frozen until analysis. For biogenic silica, water is filtered through a 0.4 µm Nuclepore polycarbonate filter. The filter is placed in a 50 ml plastic centrifuge tube and stored at room temperature.

Sediment samples are collected, dried and ground with a mortar and pestle to thoroughly blend the sample.