COASTAL
NONPOINT SOURCE CONTROL
DEMONSTRATION PROJECT

DRAFT
NONPOINT SOURCE MANAGEMENT PLAN
FOR THE WATERSHED OF
SNELL CREEK
WESTPORT, MASSACHUSETTS

Prepared for the

Massachusetts Department of Environmental Protection

Division of Water Pollution Control

by

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CHAPTER 1
INTRODUCTION

Nonpoint Source Pollution

Nonpoint source pollution has become recognized as a primary obstacle to the achievement of water quality standards and is now becoming a major focus of pollution control efforts. Nonpoint source pollution is defined as pollution derived from diffuse or widespread sources as opposed to point sources such as discharges from municipal wastewater treatment plants which usually flow from the end of a pipe. Typical nonpoint pollutants and sources include:

- **Bacteria** from stormwater, on-site wastewater disposal systems, feedlot runoff, domestic and wild animals, and boat discharges
- **Nutrients** from cultivated areas, on-site wastewater disposal systems, fertilizer application, and decaying grass clippings and vegetation
- **Sediment** from stormwater runoff, land cultivation, construction sites, cleared land, and stream bank erosion
- **Oil and Grease** from parking lot runoff, road surfaces, and illegal disposal of waste oil
- **Heavy Metals** from parking lots and road runoff, industrial areas, pesticides, herbicides and fungicides

Legislative Background

From the 1970's to the present, water pollution control regulations have been directed primarily at point source control. With most point discharges addressed under the National Pollutant Discharge Elimination System (NPDES), the U.S. Environmental Protection Agency (EPA) and state regulatory agencies such as the Massachusetts Department of Environmental Protection (DEP), Division of Water Pollution Control (DWPC) have begun to focus on controlling nonpoint sources of pollution. Unlike point sources, however, there are no well established institutional or regulatory frameworks to deal with nonpoint sources.

As a first step in developing this framework, with Section 319 of the 1987 amendments to the Clean Water Act, Congress provided local, state and federal agencies with a new mandate to restore the beneficial uses of streams, lakes, wetlands and estuaries impaired by nonpoint source pollution. The states are currently in the process of developing nonpoint source control strategies through the preparation of Nonpoint Source Assessment Reports and Nonpoint Source Management Plans. Through these plans, the states are identifying nonpoint source pollution impaired water bodies, developing nonpoint source management plans to address the most impaired water bodies, and applying for federal nonpoint source control funds.

Project Objectives and Approach

In order to develop approaches and effective means for the assessment and control of nonpoint source pollution problems for use by municipal officials in Massachusetts coastal areas, especially in areas where nonpoint sources have resulted in shellfish closures, the Division of Water Pollution Control selected two test case or demonstration areas for study. These areas included the watershed of Phinneys Harbor and Back River in Bourne, and part of the watershed of the East Branch of the Westport River (EBWR) in Westport. Both of these areas are experiencing shellfish closures due to bacterial contamination. There are, however, no significant point source discharges in either area, indicating that the loss of resources is occurring as a result of nonpoint source pollution.

In order to demonstrate both technical and organizational means to control nonpoint sources, nonpoint source management plans were developed for both study areas. This report contains a nonpoint source management plan for the watershed of Snell Creek, a tributary of the East Branch of the Westport River. Harbor and Back River, Bourne, Massachusetts. The objective of the development and implementation of the nonpoint source management plan is to achieve a visible, perceptible or tangible improvement in water quality in an area where nonpoint sources were having detrimental effects. In the case of the Westport demonstration area, established goals include:

- Achievement of Massachusetts water quality standards
- Reduction of nonpoint pollutant loadings, and
- Restoration of the recreational and economic value of shellfish beds in the East Branch of the Westport River.

It should be noted that it is not the objective of this project to address all sources of bacterial pollution to the entire East Branch of the Westport River (EBWR) or to restore the river as an area approved unconditionally for shellfishing. Bacterial pollution in the EBWR comes from sources located over a wide geographical area. Rather, this project should be considered an important step toward addressing the overall water quality problems of the Westport River area by developing the planning and implementation procedures necessary for NPS control in a test case area. These procedures can then be implemented for the remainder of the EBWR.

The major tasks conducted and outlined in this report include:

1. Review of past studies and sanitary surveys, shellfish closure records, previous efforts at pollution control, and existing environmental quality data including data on land use, geology and soils, hydrography, water quality, sediment quality, and biological resources (Chapter 2).

2. Selection and delineation of specific study/demonstration area boundaries and demonstration area description (Chapter 3).

3. Identification and ranking of nonpoint pollution sources within the demonstration area (Chapter 4).

4. Identification, evaluation, and screening of best management practices (BMPs) for each category or particular source of pollution identified. Screening criteria include technical feasibility, economics, public support, demonstration value and anticipated water quality improvements (Chapter 5).

5. Development of a nonpoint source management plan for the demonstration area including recommended BMPs, cost estimates, funding sources, implementation responsibilities, regulatory requirements, scheduling, a water quality monitoring plan, and a description of anticipated water quality benefits (Chapter 6).

As there is no existing institutional/regulatory framework for nonpoint source control, much of the effort must come from state and local governments and civic groups. There is a critical need for networking, coalition building, and sharing of responsibilities among federal, state, regional, municipal and local groups. Further, enthusiastic individuals from such groups must be identified, educated and supported by the state's lead nonpoint source agency.

In order to assist state and local municipal officials in developing local strategies to control nonpoint sources, procedures used in the development of nonpoint source management plans for the demonstration areas in Westport and Bourne are outlined in a concurrently prepared report entitled: Nonpoint Source Control: A Guidance Document for Local Officials, 1989. This document, available from the Division of Water Pollution Control, guides users, step-by-step, through a basic approach to nonpoint source control as outlined in Figure 1-1 and will be disseminated in an educational/technical assistance format to municipal officials from communities experiencing persistent water quality problems derived from nonpoint sources.

Project Participants

This technical report has been prepared by Metcalf & Eddy, Inc. under contract to the Massachusetts Department of Environmental Protection. The conduct of the study was facilitated by a large number of other participants. Continuous guidance and technical review was provided by the Massachusetts Division of Water Pollution Control. In order to obtain input from groups involved in nonpoint source control, a project advisory group (PAG) was formed. This group consisted of 27 primary members from federal, state and local government; local environmental groups; local agricultural and fisheries groups; and the academic community. The PAG met for two working sessions during the development of the management plans and guidance document. The role of the group was to:

- Identify pertinent environmental assessment information and pollution sources
- Provide input form various perspectives during project development

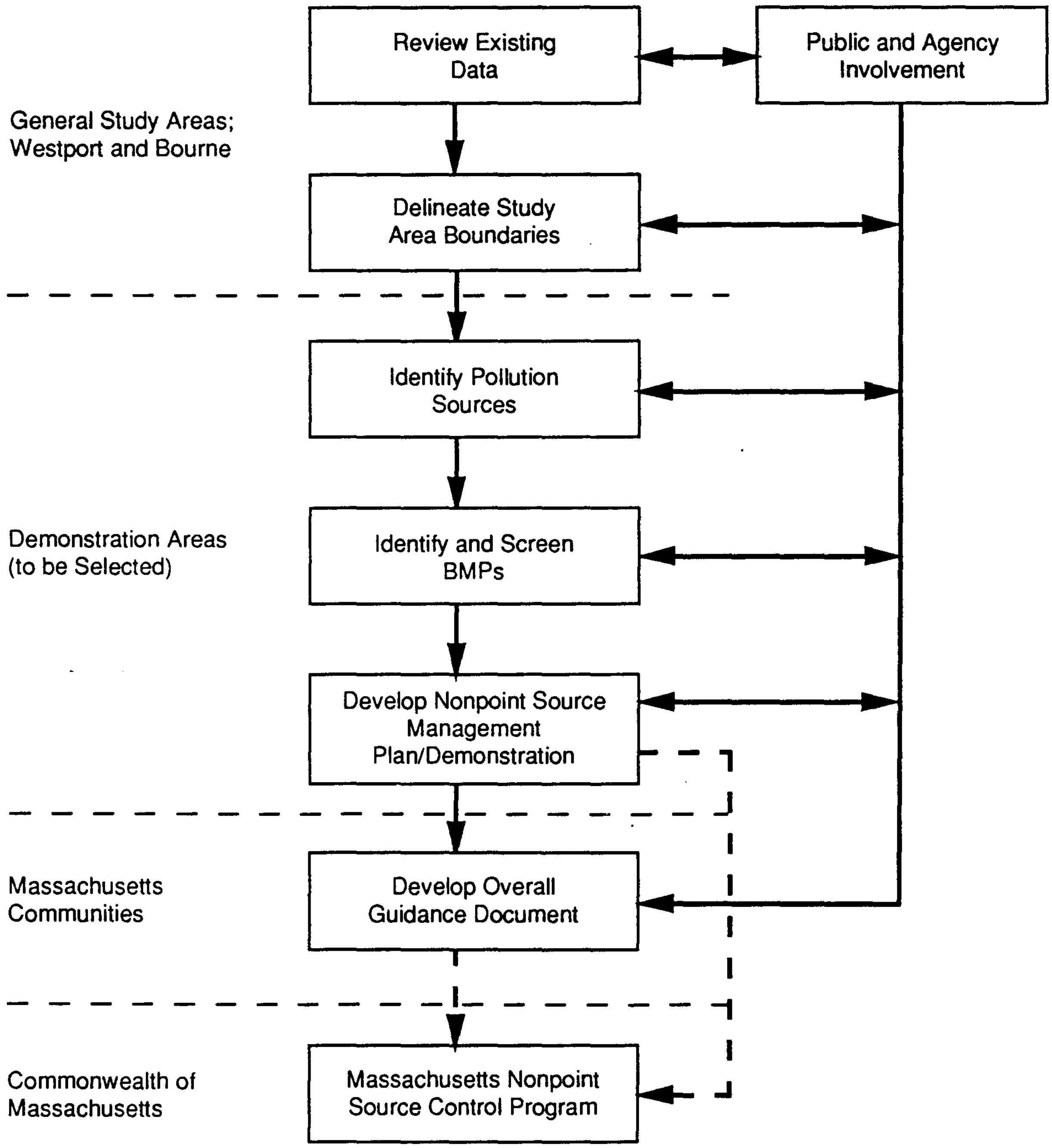

FIGURE 1-1. NONPOINT SOURCE DEMONSTRATION PROJECT TECHNICAL APPROACH

- [redacted]
- Provide a communication link to larger groups and auxiliary project advisory group members
- Develop consensus and support within the represented organizations.

Each PAG member contributed by providing pertinent data and reports, assisting with field investigations, and sharing site-specific knowledge and organizational information. The membership of the PAG is given in Appendix A.

Numerous individuals from local communities and agencies, as well as state and federal agencies, provided input and assistance. This assistance is noted in the report where applicable. A public participation program consisting of two public meetings in each demonstration area was also held to obtain further local input to the project.

CHAPTER 2
STUDY AREA BACKGROUND AND EXISTING ENVIRONMENT

This chapter provides a discussion of the project study area - the East Branch of the Westport River. Initially, the history of nonpoint source pollution impacts and control efforts is provided and applicable water quality and shellfishing standards and criteria are outlined. Finally, an environmental baseline description including land use, geology and soils, hydrography, water and sediment quality and biological resources is provided.

The EBWR is an estuary located in the Town of Westport, Massachusetts, in the southern coastal area of the state. The estuary (Figure 2-1) is about eight miles long, and has a drainage area of about 53 square miles. There are several major tributaries and drainage sub-areas which drain a largely rural forested area, in addition to residential and agricultural land uses.

Nonpoint Source Pollution Impacts

Nonpoint source pollution in the EBWR is symptomatic of widespread pollution problems in the Buzzards Bay system of which it is a part. According to the Massachusetts Nonpoint Source Assessment Report (MDEQE, 1988a) nonpoint source pollution is pervasive in Buzzards Bay and includes pollution from such sources as surface runoff, boat discharges, storm sewers, septic systems, waterfowl, feedlot runoff and pasture runoff. Bacteria, nutrients and solids contamination from these sources has resulted in shellfishing bans, eutrophication and depressed dissolved oxygen levels in various areas of the bay. In response, organizations ranging from the U.S. Environmental Protection Agency to local environmental groups are participating in the EPA-sponsored Buzzards Bay project. This project involves a comprehensive multidisciplinary study of the bay, its watershed, and potential solutions to widespread pollution problems caused by both point source and nonpoint sources. In turn, the DEP Division of Water Pollution Control has identified Buzzards Bay as an area that has been significantly degraded by nonpoint

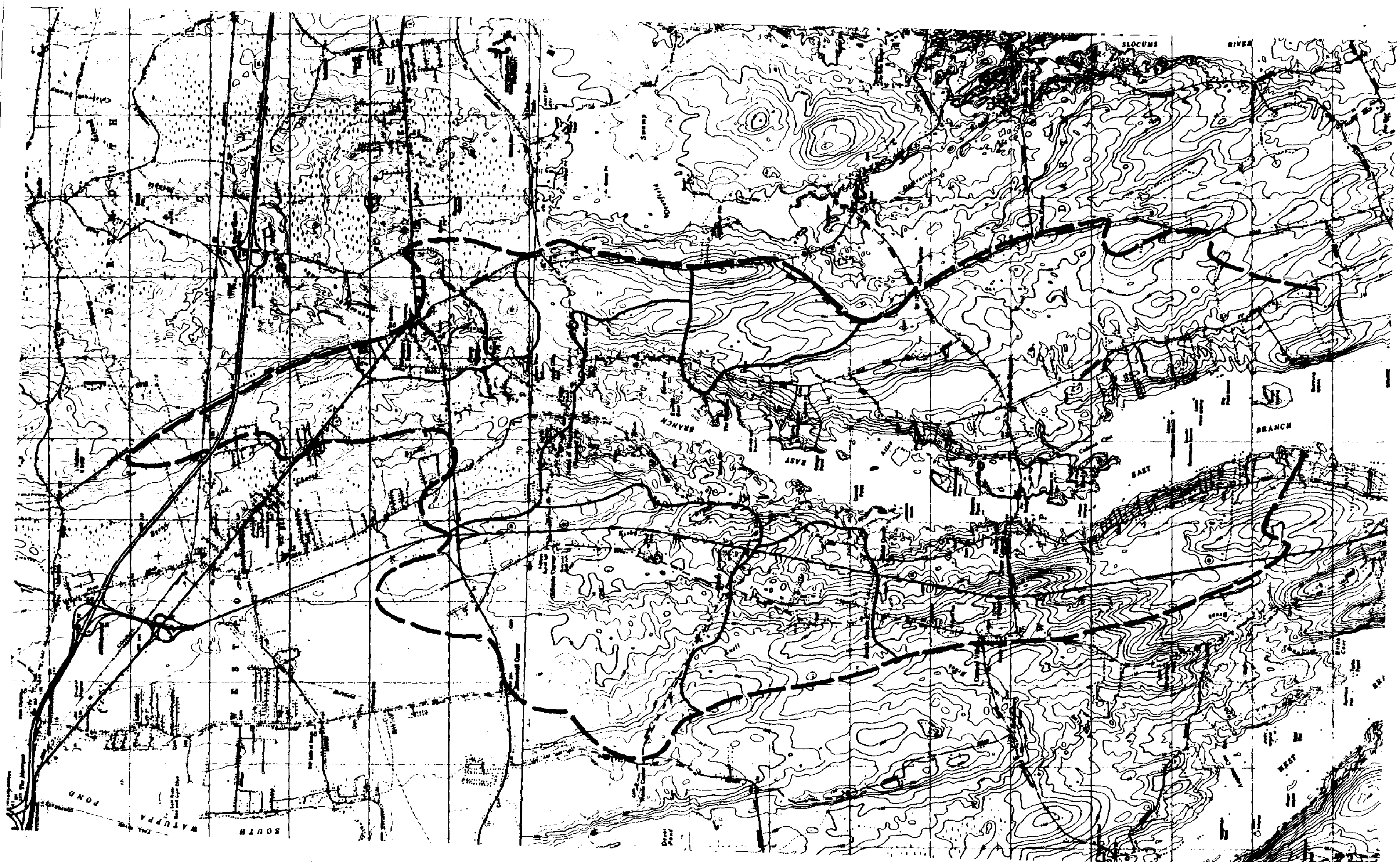

FIGURE 2-1. WESTPORT PROJECT AREA AND DRAINAGE BASINS

source pollution and has incorporated a management plan for Buzzards Bay into its Nonpoint Source Management Plan (MDEQE, 1988b).

The impacts of nonpoint sources of bacteria on Buzzards Bay have been significant. The bay contains approximately 20,000 acres of shellfish beds where thousands of bushels of hardshell clams, bay scallops, and oysters are harvested annually by commercial and recreational fishermen, accounting for more than $10 million in annual commercial landings. Yet, the number of shellfish beds closed to harvesting as result of coliform contamination has increased dramatically during the past decade such that as of January of 1989, 11,600 of productive shellfish beds were closed. According to the Environmental Protection Agency (EPA, 1989), the increase in acreage of closed shellfish beds is closely correlated with the increase in the number of building permits issued throughout the watershed.

The impact of nonpoint sources on shellfish bed closures in the East Branch of the Westport River has been perhaps even more dramatic than in Buzzards Bay as a whole. During the past ten years, a total of 960 acres of shellfish beds including soft-shelled clams, quahog and oyster beds in the EBWR have been impacted by nonpoint sources and have been either permanently or intermittently closed to shellfishing due to violations of Class SA water quality criteria. A chronology of changes in the status of shellfish beds in the EBWR is provided below.

On October 2, 1979, the Division of Water Pollution Control conducted a sanitary survey of the shellfish growing areas of the East Branch of the Westport River and determined that 960 acres of shellfishing areas north of Cadman's Neck did not meet the criterion of an "approved" harvesting area. In a letter to the Westport Board of Selectmen, the Division of Marine Fisheries (1979) reclassified the area as "prohibited" to the direct harvest of shellfish for human consumption under the provisions of MGL, Chapter 130, Section 74. This closure of 960 acres comprised over 75 percent of the total of 1270 acres of shellfish producing acreage in the estuary.

In 1983, this classification was revised to provide a conditional closure of 750 acres of shellfish beds between Hixbridge Road and Cadman's Neck. This area was closed for a minimum of eight days following rainfall of one inch or more. The area north of Hixbridge Road remained permanently closed. During July of 1984, the river classification was again revised to be permanently closed to shellfishing from Old County Road to the northern end of Gunning Island, extending the closed area to approximately 960 acres.

In 1984 and 1985, the Town of Westport sponsored a study to determine whether growing areas in the EBWR could be managed for conditional closure. This study (GHR, 1987) resulted in another reclassification of the closed area. Fifty-eight percent or 557 of the 960 acres that had been permanently closed was changed to conditionally closed. DEQE determined in 1988, based on extensive bacteria data (GHR, 1987) that the area between Gunning Island and Cadman's Neck should be closed for a minimum of eight days following rainfall of 0.1 inches. After rainfall events of two inches or more, the beds would be reopened only after testing by DEQE showed that bacteria had declined to acceptable levels. Bacteria levels north of Cadman's Neck did not meet shellfishing standards for at least 10 to 16 days after rainfall (GHR, 1987) and this area remains permanently closed. Figure 2-2 depicts the location and the status of shellfish growing areas in the EBWR as well as the major drainage basins. Since the conditional closure was reinstituted, shellfish beds between Cadman's Neck and Gunning Island have been intermittently opened to harvesting. Shellfish beds were opened on approximately 90 days in 1988 and over 40 days to date in 1989.

Shellfish bed closures have resulted in economic hardship to local diggers and to the local economy in Westport. It is estimated that annual losses in commercial shellfishing exceed $1 million and that losses to recreational diggers are considerable. The severity of nonpoint pollution and lost natural resources and economic hardship prompted the DEP Division of Water Pollution Control to select the EBWR as a general study area for the development of a nonpoint source management plan under this demonstration project.

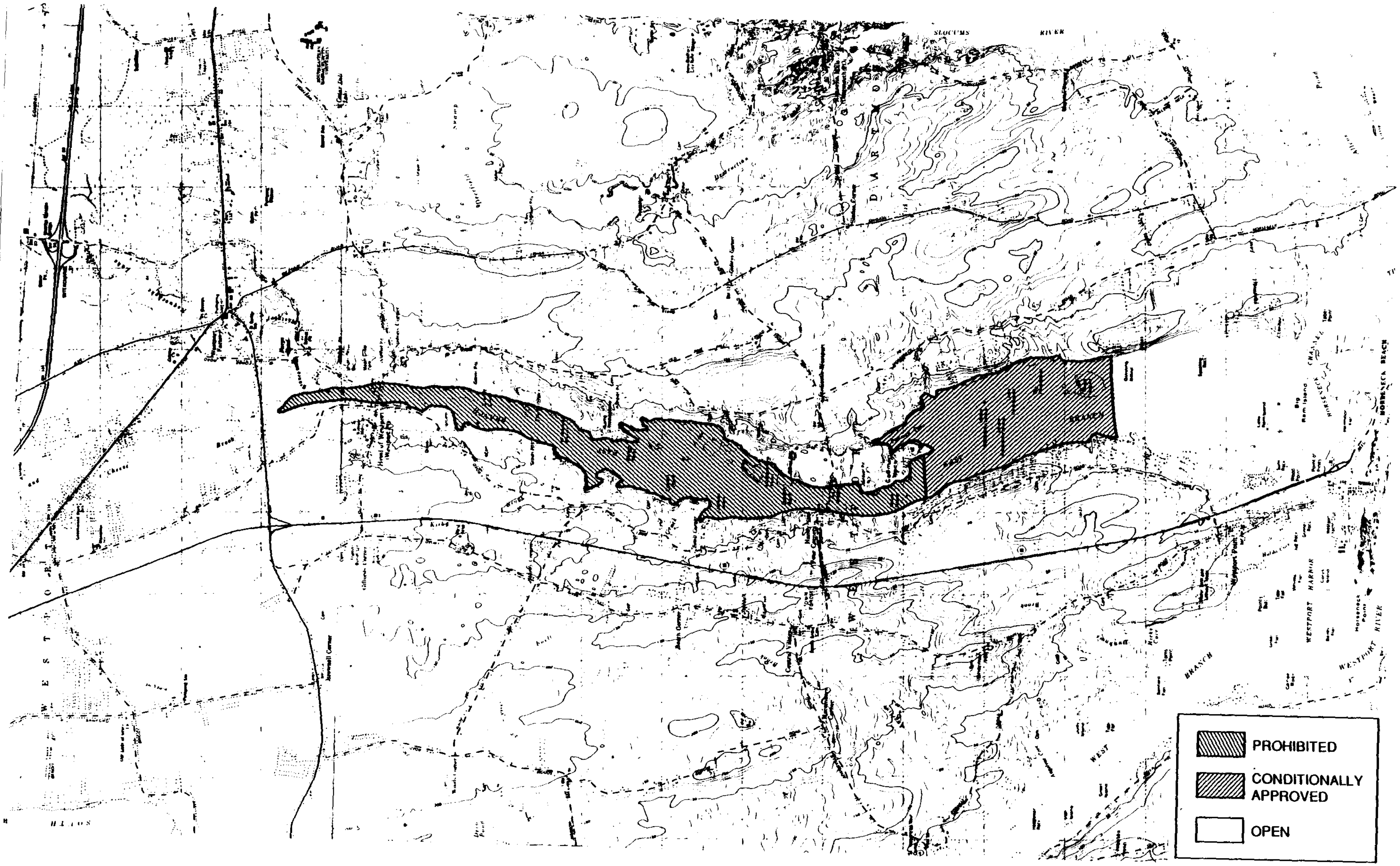

FIGURE 2-2. STATUS OF SHELLFISH GROWING AREAS IN EBWR

Local Pollution Control Measures

In developing a nonpoint source management plan, it is critical to be aware of past local efforts to control nonpoint sources. This section describes nonpoint source control efforts in Westport conducted during the last ten years by the U.S. Department of Agriculture, the Town of Westport and the Westport River Watershed Alliance.

In response to widespread shellfish closures in the EBWR, the USDA Agricultural Stabilization and Conservation Service, with technical assistance from the Soil Conservation Service, initiated a [redacted]. The USDA initiated 21 Rural Clean Water Projects across the United States to address water quality problems and to develop information on agricultural best management practices, means to implement them, their effectiveness and their sociological implications. The program started in 1981 and was designed to assist farmers within established critical areas with water quality problems resulting from agricultural activities. Federal funds in the amount of [redacted] were made available for the construction of SCS-designed agricultural BMPs aimed at reducing bacterial pollution in runoff. The original plan for Westport included installation of fifteen [redacted] for feedlots and animal holding areas; conservation tillage, strip cropping systems and permanent vegetative cover on 1715 acres of agricultural land; [redacted]; and [redacted] (USDA, 1984). It was hoped that shellfishing would be restored, and that farmers would also benefit from more efficient operations.

Through a prioritization process, a "critical area" was established by USDA at the outset of the program and targeted for implementation. Through educational activities such as educational tours, fact sheets, newspaper articles and personal contacts, Westport farmers were encouraged to sign up with the Soil Conservation Service for the development of water quality plans. Over the course of the program, [redacted] to implement the water quality plans developed by the Soil Conservation Service. During [redacted]. During this period, many local farmers were uncertain of their futures in the dairy business. Between 1984 and 1986, several more farms cancelled contracts and more farms in the Westport area went out of business. The critical area was redefined by SCS in 1986 based on changes in the status of farms and BMPs implemented and includes 8 farms, not all of which are under contract with USDA. Since the start of the program, one contract has been completed and seven remain active but incomplete.

After a slow start, progress has been made toward accomplishing project goals. Major components of animal waste control systems have been installed for four of the originally proposed fifteen systems. These components include a paved feedlot, two roofed feedlots, and a manure storage structure. Other measures have included a terrace system, a lined waterway, a grassed waterway and other erosion control practices. Through the implementation of these controls, the critical area has recently been redefined to a smaller area with seven farms.

Overall, the success of the [redacted]

- [redacted] ior to program initiation and during the program that agricultural sources of bacteria were causing water quality problems and shellfish closures
- [redacted] of the dairy business
- [redacted]
- poor manure handling practices which made pollution control infeasible
- impact of other programs such as the Dairy Termination Program and the Milk Diversion Program, which encouraged farmers to reduce their herd size or go out of business
- [redacted]
- frequent turnover of SCS personnel working with the farmers on-site

The Town of Westport has taken several steps to reduce bacterial runoff from agricultural sources. The Board of Health contracted with Dr. Jeffrey Erickson to analyze the status of agricultural pollution sources in the town and to visit with the farmers to discuss methods to reduce bacterial contamination. Between April and June of 1988, Dr. Erickson visited a number of farms and his suggestions regarding waste storage, fencing, and erosion control were well received at several farms. Dr. Erickson's contract, however, was cancelled due to lack of funds and he was not able to follow up on his suggestions. The town has recently hired a Health Director to continue some of the work initiated by Dr. Erickson.

In addition to the efforts of USDA and the Town, the Westport River Watershed Alliance helped to raise public awareness through public education and distribution of a newsletter. They are currently conducting a Massachusetts Department of Environmental Management sponsored Adopt-a-Stream program on Snell Creek in Westport, which involves the collection of qualitative land use, water quality and biological data, recommendations for better land use practices, and press releases. The Westport River Watershed Alliance is also participating in a program involving the posting of signs on the roads in Town where they intersect the tributaries of the EBWR to increase public awareness of these resources and the vulnerability of the river.

Applicable Standards and Criteria

Objectives of this demonstration project include improvement of water quality in the study area through the control of nonpoint sources, and achieving an improvement in water quality in shellfish beds which are permanently or intermittently closed due to bacteria violations. This section outlines the water quality standards, criteria and regulations that apply to the East Branch of the Westport River and its tributaries which affect the desired uses of this water body. These standards and criteria are used later in the report in an assessment of existing water quality and to define specific water quality objectives for this project.

As required by the Federal Clean Water Act, the Commonwealth of Massachusetts has set [redacted]nd its tributaries. Table 2-1 lists the minimum water quality criteria that must be met by all waters of the Commonwealth, except when the criteria specified for individual classes are more stringent. According to the Massachusetts Surface Water Quality Standards (314 CMR 4.03), the East Branch of the Westport River is [redacted] The water quality criteria for Class SA waters are presented in Table 2-2. Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting without depuration in approved areas. According to the Massachusetts Water Quality Standards, all the fresh water tributaries of the EBWR are Class B. The water quality criteria for Class B waters are presented in Table 2-3. Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for primary and secondary contact recreation. In addition, in order to further protect the public from health risks related to the ingestion of contaminated seafood, Massachusetts has adopted the guidelines established by the U.S. Department of Public Health, Shellfish Sanitation Branch, as set forth in the National Shellfish Sanitation Program Manual (U.S. Department of Health and Human Services, 1986). Compliance requirements from the National Shellfish Sanitation Program Manual are listed in Table 2-4, and Table 2-5 describes the state-mandated criteria on which shellfish beds are classified.

Environmental Description

In order to understand the extent and nature of [redacted]nd to select a subwatershed as a demonstration area for this project, it is important to understand the characteristics of the contributing watershed. Accordingly, this section contains an environmental description of the EBWR. This description includes a review of existing environmental assessment information on the community and land use, geology and soils, hydrography, water and sediment quality, and biological resources. This baseline is used in this report to identify water quality problems and pollution sources, to select a demonstration area, and to evaluate potential best management practices.

TABLE 2-1. MASSACHUSETTS MINIMUM WATER QUALITY CRITERIA FOR ALL WATERS OF THE COMMONWEALTH

Parameter	Criteria
1. Aesthetics	All waters shall be free from pollutants in concentrations or combinations that: a) Settle to form objectionable deposits; b) Float as debris, scum or other matter to form nuisances; c) Produce objectionable odor, color, taste or turbidity; or d) Result in the dominance of nuisance species.
2. Radioactive Substances	Shall not exceed the recommended limits of the United States Environmental Protection Agency's National Drinking Water Regulations.
3. Tainting Substances	Shall not be in concentrations or combinations that produce undesirable flavors in the edible portions of aquatic organisms.
4. Color, Turbidity, Total Suspended Solids	Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.
5. Oil and Grease	The water surface shall be free from floating oils, grease and petrochemicals and any concentrations or combinations in the water column or sediments that are aesthetically objectionable or deleterious to the biota are prohibited. For oil and grease of petroleum origin the maximum allowable discharge concentration is 15 mg/l.
6. Nutrients	Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.
7. Other Constituents	Waters shall be free from pollutants in concentrations or combinations that: a) Exceed the recommended limits on the most sensitive receiving water use; b) Injure, are toxic to, or produce adverse physiological or behavioral responses in humans or aquatic life; or c) Exceed site-specific safe exposure levels determined by bioassay using sensitive resident species

TABLE 2-2. WATER QUALITY CRITERIA FOR CLASS SA WATERS

Parameter	Criteria
1. Dissolved Oxygen	Shall be a minimum of 85 percent of SATURATION.
2. Temperature	None except where the increase will not exceed the recommended limits on the most sensitive water use.
3. pH	Shall be in the range of 6.5-8.5 standard units and not more than 0.2 units outside of the naturally occurring range.
4. Total Coliform Bacteria	Shall not exceed a median value of 70 MPN per 100 ml and not more than 10 percent of the samples shall exceed 230 MPN per 100 ml in any monthly sampling period.

TABLE 2-3. WATER QUALITY CRITERIA FOR CLASS B WATERS

Parameter	Criteria
1. Dissolved Oxygen	Shall be a minimum of 5.0 mg/l in warm water fisheries and a minimum of 6.0 mg/l in cold water fisheries.
2. Temperature	Shall not exceed 83°F (28.3°C) in warm water fisheries or 68°F (20°C) in cold water fisheries, nor shall the rise resulting from artificial origin exceed 4.0°F (2.2°C).
3. pH	Shall be in the range of 6.5-8.0 standard units and not more than 0.2 units outside of the naturally occurring range.
4. Fecal Coliform Bacteria	Shall not exceed a log mean for a set of samples of 200 per 100 ml, nor shall more than 10 percent of the total samples exceed 400 per 100 ml during any monthly sampling period, except as provided in 310 CMR 4.02(1).

TABLE 2-4. SATISFACTORY COMPLIANCE CRITERIA FOR GROWING AREAS APPROVED FOR SHELLFISHING WITHOUT DEPURATION (U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, 1986)

A. The area is not contaminated with fecal material, pathogenic organisms, poisonous or deleterious substances, or marine biotoxins.

B. The bacteriological quality of every sampling station in those portions of the area exposed to fecal contamination shall met one of the following standards:

i. The total coliform median or geometric mean MPN of the water does not exceed 70 per 100 ml and not more than 10 percent of the samples exceed an MPN of 230 per 100 ml for a 5-tube decimal dilution test (or an MPN of 330 per 100 ml for a 3-tube decimal dilution test).

The total coliform standard need not be applied if it can be shown by detailed study verified by laboratory findings that the coliforms are not of direct fecal origin and do not indicate a public health hazard. In addition, the standard may not be applicable in a situation where an abnormally large number of pathogens might be present. Consideration must be given to the possible presence of industrial or agricultural wastes containing a typical coliform to pathogen ratio. The standard in (b)(i) is based upon typical coliform to pathogen ratios associated with discharge of domestic sewage after some dilution and die-off in coastal waters.

ii. The fecal coliform median or geometric mean MPN of the water does not exceed 14 per 100 ml and not more than 10 percent of the samples exceed an MPN of 43 for a 5-tube dilution test (or an MPN of 49 per 100 ml for a 3-tube decimal dilution test).

C. The determination that the approved area classification standards are met shall be based upon a minimum of fifteen (15) samples collected from each station in the approved area. These stations shall be located adjacent to actual or potential sources of pollution. Sample collection shall be timed to represent the worst pollution conditions.

TABLE 2-5. SHELLFISH BED CLASSIFICATIONS
(U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, 1986)

APPROVED AREA: any shellfish growing area that does not contain pathogenic bacteria, fecal material or poisonous substances in dangerous concentrations and was approved by state authorities for growing or harvesting shellfish for direct marketing.

CONDITIONALLY APPROVED AREA: any shellfish growing area that is subject to intermittent microbiological pollution and was determined by state authorities to meet approved area criteria for a predictable period. The period is conditional upon established performance standards specified in a management plan.

RESTRICTED AREA: any shellfish growing area that is subject to a limited degree of pollution and was classified by state authorities as an area from which shellfish may be harvested only by licensed diggers and subjected to a suitable and effective purification process.

CLOSED AREA: any shellfish growing area where the harvesting of shellfish is temporarily or permanently not permitted.

PROHIBITED AREA: any shellfish growing area that is closed to the harvesting of shellfish at all times.

Community Description and Land Use. The Town of Westport, Massachusetts is located in the southern portion of Bristol County in southeastern Massachusetts, approximately 54 miles south of Boston and 26 miles southeast of Providence. The Town encompasses an area of 53.01 square miles, and 2.23 square miles of water. Westport is primarily a rural community that has recently experienced a high rate of population growth. According to the 1975 state census, the town had a [redacted] The Town experienced a population increase of 25 percent from 9,791 between 1970 and 1975. It is estimated that the population will grow an additional 13 percent by 1990 [redacted]

Fishing and agriculture are important to the local economy and the Town is also a coastal resort area. Coastal development consists of both year-round and seasonal homes, mobile homes, and commercial establishments. Horseneck Beach Reservation is part of the Horseneck barrier beach, which extends across the mouth of the Westport River. Past hurricanes have destroyed development on this beach.

Residential and commercial development along both the East Branch and West Branch is sparse as depicted in Figure 2-1. The upper portions of the rivers watershed have scattered farms and residences located along the shores. The rivers converge at Westport Point, which is characterized by older homes and commercial facilities that serve the local fishing industry. There are extensive marshlands along the shores of the rivers.

[redacted]

Evaluations of aerial photographs documents that farmland or pastureland occupies much of the eastern shore of the EBWR from below Gunning Island to Cadman Cove. This extends along the shore in a band ranging from 300 to 450 yards from the shore, without significant woodland vegetation as a buffer. There are three clusters of housing along the eastern shore of the river. The western side of the EBWR has much less open cultivated land bordering the water, with most of the land used for residential purposes. There is some cultivated land along Drift Road between Hix Bridge and Westport Point. From Drift Road west to the drainage divide is mostly forested land.

Much of the land from Cadman Cove to about 600 yards north of Hix Bridge is open cultivated land. Some trees are present along a narrow band along the shore. The western shore in the same area is primarily residential. There is a significant amount of open cultivated land along the west shore from below Snell Creek to above Kirby Brook, between Drift Road and the water.

These land use patterns indicate that there is a definite potential for soil erosion due to the location of the cultivated farmland, bare fields or pastures next to the river. Rainsplash can more easily dislodge and subsequently transport soil particles to the tributaries or estuary given the proximity of the bare fields (Kelly et. al., 1986).

In the past 35 years, significant land use changes have occurred within the southeastern Massachusetts area. From 1951 to 1971, developed land within Westport increased by 96 percent, while open, forested, and agricultural land decreased by 19 percent. The conversion of undeveloped land is continuing, with residential land use increasing by 1,500 acres and commercial land increasing by 110 acres between 1971 and 1981.

There have also been important changes in the use of the remaining farmland. Tilled land increased from 2,550 acres to 4,557 acres, between 1951 and 1981 while pasture land decreased from 3,750 acres to 740 acres. Since dairy farming remains the predominant agricultural activity in Westport, the net effect of these land use changes has been to increase the number of cows per acre (Thomas, 1985). This shift in feeding methods away from open pasture grazing to a more intensive feedlot operation may be an important factor in the deterioration in water quality in the EBWR.

More recent land use data have been developed by the Soil Conservation Service (1984) and the Environmental Protection Agency (1989) as part of the Buzzards Bay project. [redacted] The Environmental Protection Agency recently prepared detailed color land use maps through an agreement with the Resource Mapping Group at the University of Massachusetts at Amherst. The results of these surveys are listed in Table 2-6. The land use categories used are not consistent and the study areas were slightly different which are the main reasons for differences between the two studies. These results, however provide a reasonable representation of contemporary land use characteristics in the watershed of the EBWR.

TABLE 2-6. LAND USE DATA IN 1983 AND 1988

(Soil Conservation Service, 1984 and Environmental Protection Agency, 1989)

Land Use Type	Quantity (Acres) 1983(1)	1988(2)
Agricultural		
Cropland	1845	2704
Pasture	665	361
Orchard/Nursery	25	-
Subtotal	2535	3065
Forest	13455	12344
Woody Perennial		44
Subtotal	13455	12388
Residential	1910	
Residential (R1)		19
Residential (R2)		879
Residential (R3)		1164
Subtotal	1910	2062
Urban		
Other Urban	520	
Urban Open		107
Transportation		217
Industrial		13
Commercial		163
Waste Disposal		54
Mining		125
Subtotal	520	679
Open	1125	
Open Land		288
Recreation		52
Subtotal	1125	340
Wetland	260	274
Water		15
Salt Wetland		512
Subtotal	260	801
TOTAL	19805	19335

(1) Soil Conservation Service, 1984
(2) Environmental Protection Agency, 1989

[redacted]. The coastal region adjacent to Westport was formed by glacial outwash plains and channels, giving the area an irregular outline of bays, coves, and promontories. Inland from the coast, the topography rises to low hills with elevations ranging to 230 feet. The northwestern portion of the Town is characterized by emergent wetlands, and the southern area is dominated by the open waters of the East and West Branches of the Westport River, formed by rising sea level drowning the glacial outwash valleys.

The glacial deposits in the East Branch watershed are of two types. The lowland regions are underlain by moderately to highly permeable deposits of sand and gravel. These materials occur in the valley of the East Branch and some of its tributaries. Glacial till overlies most of the bedrock in the upland area. In contrast to the stratified deposits of the valleys, the till is compact, clay-rich, and poorly drained.

Within the drainage basin of the East Branch, the soils are of the Paxton-Woodbridge-Whitman soil association. Paxton soils have developed on the glacial tills in the upland areas. These soils develop on nearly level to moderately steep slopes and are deep and well-drained. However, there is a very firm sub-stratum (hard-pan) at a depth of about 0.5 meter that restricts the movement of water. Consequently, runoff is heavy during storms. The Woodbridge soils form on nearly level and gently sloping terrain. Found adjacent to Paxton soils on the hills and ridges, they are also developed from the compact till. The Woodbridge soils are deep and moderately well drained, but have a very hard substratum at a depth of 0.7 meters that restricts the downward percolation of water. The Whitman soils are nearly level, having developed from the till in depressions and low-lying areas adjacent to the waterways. These soils are very poorly drained, have a firm substratum at a depth of 0.4 meters, and a seasonal high water table. Consequently, runoff is high and the Whitman soils pose severe problems with regard to septic tank leaching fields (Roffinoli and Fletcher, 1981).

In contrast, the soils that have developed on the stratified sands and gravels of the outwash plains and kame deltas are deep and excessively drained. These soils (Merrimac and Hinkley) are very permeable and thus may not adequately filter septic system effluent and other groundwater discharges. As well, run-off is low so the overland transport of contaminants into streams is substantially less in areas where these soils are present.

In wetland areas, the major soil types are very poorly drained organic soils and peats of the Freetown, Swansea, Pawtucket, and Ipswich series. Because of their low permeability, all these soils create severe problems with regard to the proper functioning of septic tank absorption fields.

[redacted]

The Westport River is a drowned river valley which is presently a shallow estuary. [redacted] Accelerated shoaling has taken place at the mouth of the estuary leading to Westport Harbor. In the mid-nineteenth century, large vessels up to one hundred tons drawing 8 to 12 feet of water moved freely into Westport Point. Since 1938, only small fishing and recreational boats could navigate the area. Fiske et al. (1968) calculated morphometric data for the EBWR as shown in Table 2-7.

The East Branch of the Westport River drains an area of low to moderate relief characterized by north-south trending ridges and valleys. The EBWR begins at the outlet of Lake Noquochoke, flowing southward through Forge Pond to the head of tide at the Head of Westport. The headwaters of the East Branch include the Shingle Island and Copicut Rivers and Bread and Cheese Brook. The streams drain a hilly area with extensive forested wetlands in Fall River, Freetown, and Dartmouth. Elevations range to over 300 ft.

South of the Head of Westport, the river flows between till-mantled, bedrock ridges with relatively steep gradients. Parallel tributary streams from the ridges join the East Branch at nearly right angles. The combination of the

TABLE 2-7. MORPHOMETRIC DATA FOR THE EAST BRANCH OF THE WESTPORT RIVER (Fiske et al, 1968)

Length:	7.89 miles
Width:	
Max:	1.00 miles
Mean:	0.39 miles (at MHW)
Surface Area:	1,987 acres (at MHW) 1,909 acres (at MLW)
Salt Marsh:	775 acres
Shoreline Length:	36.23 miles (at MHW)
Depth:	
Max:	22 ft (at MHW)
Mean:	6.1 ft (at MHW)
Volume:	357,568,000 cubic feet (at MHW) 128,414,000 cubic feet (at MLW)

Note: These measurements based on northern limits of "north of Hix Bridge" in the East Branch

moderately steep slopes, high drainage density, and soils that allow little infiltration produces streams that are characterized by high flood peaks. Consequently, sediment production is high and contaminant transport is rapid (Kelly et al., 1986).

The major drainage basins of the EBWR were shown in Figure 2-1. A summary of the areas of these basins, adapted from Pivetz et. al. (1986), is given in Table 2-8. Also shown are the average annual freshwater flow rates, developed from the following regression equation of USGS stream flow data:

$$Q_{MA} = 1.94 \; A_d^{0.96}$$

Where: Q_{MA} = average annual flow (cfs)

A_d = drainage area (square miles)

TABLE 2-8. EAST BRANCH OF THE WESTPORT RIVER DRAINAGE AREAS AND AVERAGE FLOWS (Pivetz et. al., 1986)

Tributary	Drainage Area (square miles)	Average Annual Flow (cfs)
East Branch	21.5	39.9
Bread and Cheese Brook	10.4	19.8
Minor Tributaries	0.7	1.4
Sub-total: to Head of Westport	32.6	61.1
Kirby Brook	3.7	7.1
Snell Creek	1.7	3.2
Minor tributaries	2.4	4.9
Coastal direct drainage areas	3.6	7.1
Sub-total: to Hix Bridge	44.0	83.4
Minor tributaries	5.8	11.7
Coastal direct drainage areas	3.6	7.1
Total: To Westport Point	53.4	102

About 46 percent of this streamflow is contributed by groundwater baseflow (Pivetz et. al., 1986).

The climate of the Town is typical of southeastern coastal Massachusetts, characterized by frequent, but usually short periods of precipitation. Thunderstorms are common during the summer, while tropical and extratropical storms occur during the early fall and winter, respectively. The average annual precipitation is approximately 43 inches. Of this average annual amount, about 24 inches becomes runoff and 19 inches is evapotranspirated (Pivetz et. al., 1986).

[redacted]. Extensive water quality data have been collected in the EBWR by a number of organizations between 1983 and 1989. These data collection programs are described in this section and are summarized in Table 2-9. Earlier data collected in the 1970's are limited and sporadic and have not been included in this discussion. The following discussion of water quality data includes both watershed stream quality as well as the EBWR. This discussion is also intended to be of an introductory and descriptive nature.

TABLE 2-9. EXISTING WATER QUALITY DATA SOURCES
EAST BRANCH OF THE WESTPORT RIVER

Agency	Report Title	No. of Stations in Study Area	Dates and Frequency of Sampling	Parameters	Scope
Mass. DEQE Division of Water Pollution Control (DWPC, 1986)	Buzzards Bay 1986 Water Quality Survey Data	5-EBWR 5-tributary	6/24-25/86 two per day	Nutrients, solids, bacteria	General water quality survey of Buzzards Bay.
Mass. DEQE Division of Water Pollution Control (DWPC, 1987)	Buzzards Bay Research Bacteriological Data Report 1986	69-mostly in EBWR	6 sampling runs about every two weeks - 7/14 to 10/2/86	Nutrients, solids, bacteria	Microbial indicator study of Buzzards Bay.
Mass. DEQE Division of Water Pollution Control (DWPC, 1988)	A Report on Bacteriological Sampling in the Tributaries of the Westport River	23	4 sampling times - 6, 7, 8 and 11/87	Nutrients, solids, bacteria	Microbial indicator study of Snell Creek and Kirby Brook.
U.S. Department of Agriculture (USDA, 1983-1988)	Rural Clean Water Program, Annual Reports	2-EBWR 9-tributary	Several sampling runs per year, 1983-1988	Nutrients, solids, bacteria	Evaluation of the effectiveness of Soil Conservation Service designed BMPs in agricultural areas in Westport.
U.S. Department Health and Human Services (FDA, 1986)	Sanitary Survey of the Westport River Estuary	13-EBWR 9-tributary	9/29-10/8/86 one per day	Bacteria	Assess bacterial impacts of nonpoint sources
Town of Westport Boston University (Kelly et.al., 1986)	A Study of Determine the Causes, Types and Locations of Pollutants Contaminating the Westport River Estuary, Westport, Massachusetts	130-both in EBWR and tributaries	14 sampling runs between 8/7/84 and 9/10/85	Bacteria	Identify and sample non-point sources in the EBWR.
Town of Westport (GHR, 1987)	Bacterial Water Quality Survey of the East Branch of the Westport River Estuary	13-EBWR 9-tributary	38 sampling runs between 8/84 and 11/85	Bacteria	Determine whether conditional opening of shellfish beds is justifiable.

A more detailed evaluation of water quality data, particularly for the demonstration area, is presented in Chapter 3.

Bacteria - The Massachusetts Division of Water Pollution Control conducts periodic water quality monitoring to assess progress toward achieving water quality goals. DWPC (1986) conducted a recent intensive survey of the EBWR and its tributaries. Samples were collected on June 24 and 25, 1986 at five receiving water stations from Lake Noquochoke to Gunning Island and six tributary stations including Bread and Cheese Brook, Snell Creek and Kirby Brook. Although this sampling effort was not designed to document the effects of rainfall on water quality, these samples were collected during 0.2 inches of rainfall as recorded at New Bedford. Table 2-10 shows the concentrations of total and fecal coliform at Kirby Brook, Snell Creek, and the Westport River at County Road bridge on June 24 and 25, 1986. These data show a dramatic increase in bacteria levels on June 24 followed by a steady decline on June 25. Receiving water fecal coliform concentrations between Hix Bridge and Gunning Island ranged from 29 to 88 colonies/100 ml during the same period.

During 1986, in response to previously measured bacteria levels and widespread shellfish closures, the Division of Water Pollution Control (1987), also conducted a microbial indicator study with samples collected on six occasions in the East Branch of the Westport River between July 14 and October 2, 1986. The study compiled information aimed at describing the relative impacts of nonpoint sources on bacteriological water quality. Areas sampled in Westport included housing areas thought to be in compliance with Title V (310 CMR 15.00) west of the EBWR, housing areas thought to be in violation of Title V on the east side of the river, and agricultural areas north of Hix Bridge.

Discussions and analyses of these data were not presented in the DEP report, however, review of the information gives an indication of certain patterns of bacterial pollution in the EBWR. Many of the six sampling events were conducted during or after rainfall events. As shown in Table 2-11, fecal coliform concentrations tend to be in the thousands in the upper EBWR (above

TABLE 2-10. TOTAL AND FECAL COLIFORM DATA (MPN/100 ML) FROM THE EAST BRANCH OF THE WESTPORT RIVER ON 6/24-25/86

Station	Parameter	6/24/86 A.M.	6/24/86 P.M.	6/25/86 A.M.	6/25/86 P.M.
Kirby Brook	Total Coliform	60	6,000	3,500	400
	Fecal Coliform	<5	2,500	450	140
Snell Creek	Total Coliform	1,000	3,000	1,400	900
	Fecal Coliform	200	680	600	320
County Rd. Bridge	Total Coliform	800	1,900	9,000	1,000
	Fecal Coliform	120	170	600	320

TABLE 2-11. SUMMARY OF FECAL COLIFORM DATA (DEQE, 1987)

Date of Sampling Run (1986)	Rainfall (inches) on days prior to sampling				Range of Fecal Coliform Counts (MPN/100 ml)			
	0	1	2	3	Upper EBWR	Hix Bridge	Lower EBWR[(a)]	Tributaries
7/14	0.71	0.93	0.74	0	1,600-2,400	2,200-2,400	-	2,100-80,000
7/28	0	0.09	0.02	0	10-120	5-15	<5-5	-
8/4	0	0.64	0	0	2,100-4,200	-	<20-40	2,400-34,000
8/19	0.10	1.16	0.01	0	-	1,000	45-1,100	-
9/17	0	0.73	0	0	60-2,100	-	-	90-2,900
10/2	0.39	0	0	0	500-20,000	-	-	4,000-25,000

(a) Below Hix Bridge.

Hix Bridge) whenever rainfall occurs on the day of or prior to sample collection. The one sampling event (7/28/89) with nearly dry conditions demonstrates substantially lower fecal coliform counts. The counts in tributaries sampled are generally higher than the counts in the EBWR, indicating that tributaries are a source of bacteria. Bread and Cheese Brook, the EBWR at County Road, Kirby Brook and Snell Creek are all contributors of bacterial contamination. These patterns are consistent with findings of other studies of the EBWR.

One objective of the DWPC (1987) study was to identify impacts of specific nonpoint sources. The data were so influenced by rainfall that it is difficult to separate impacts of different sources. For example, sampling areas offshore of homes in compliance with Title V had substantially higher bacterial concentrations than areas offshore of homes not in compliance. This was most likely caused by high rainfall-related bacteria loads and the large dilution of any septic system effluents.

During summer 1987, the Division of Water Pollution Control (1988) conducted an investigation to isolate the sources of fecal coliform contamination in Snell Creek and Kirby Brook. PSE media were used to differentiate among fecal streptococci from humans, livestock, birds, insects, and vegetation. Because the summer of 1987 was extremely dry and sampling stations often were not flowing, successful surveys of Snell Creek were conducted on only three days: June 8, July 13, and November 17. Several species of fecal bacteria including *S. faecalis var liquefaciens* and *S. faecalis var zymogenes*, were isolated, and elevated bacterial levels were found in a tributary emanating from Booth Corner. However, differentiation between human and livestock sources was not possible.

The Town of Westport, through a contract with Boston University conducted an extensive water quality study on the East Branch of the Westport River. During 1984 and 1985, Boston University (Kelly et al., 1986) collected over 800 water samples at over 100 receiving water and tributary stations on 14 dates. Areas identified as sources of domestic and/or agricultural bacterial pollution included Kirby Brook, Snell Creek, the Lincoln Park Sewage Treatment Plant, various dairy farms, and the area along the west side of Bread and Cheese Brook upstream of Route 6. These sources are all located north of Hix Bridge with the exception of a dairy farm on Horseneck Rd.

The pattern of rainfall-related bacterial contamination shown during this study is demonstrated in Figure 2-3. These data were taken the day after 0.67 inches of rain fell in New Bedford, and represent a rainfall-impacted condition. The fecal coliform bacteria decrease proceeding in a southerly direction away from the Head of Westport, demonstrating that most of the bacterial contamination occurs in the upstream reach of the EBWR, where most of the large tributaries enter.

Another study sponsored by the Town of Westport (GHR, 1987), assessed the possibility of conditionally reopening closed shellfish areas in the EBWR based on the relationship between rainfall events and bacteria levels in the estuary. The project focussed on storm event sampling in addition to monitoring seasonal trends. In addition, shellfish meats were tested for bacterial contamination following storm events to determine the time required for the shellfish to "cleanse" themselves of bacteria to the point where they are acceptable for human consumption. Thirty-eight sampling surveys were conducted, twenty-seven of which were routine surveys and eleven of which were episodic surveys. During routine sampling surveys, samples were collected from thirteen locations in the estuary. During episodic surveys, nine additional stations were sampled. A total of twenty shellfish samples were also analyzed for total and fecal coliform.

The results of the water quality survey showed a predictable pattern of fecal coliform contamination following rainfall events. During dry weather, bacteria levels in the EBWR were generally very low, and were for the most part in compliance with the shellfishing standards from at least Hix Bridge southward. The relationship between bacteria levels and rainfall from this study is shown in Figure 2-4. These data indicate clearly that after several days of dry weather, the estuary south of Hix Bridge was in compliance with the fecal coliform criterion for shellfishing. At Hix Bridge (and northward), it took a large number of rain free days to bring the estuary into compliance, thus indicating the large impact of sources and slower flushing rate in this reach.

The GHR study determined that the area of Gunning Island north to Cadman's Neck meets acceptable shellfish water quality standards within two to three rain-free days following a rain event, while the area north of Cadman's Neck had to remain

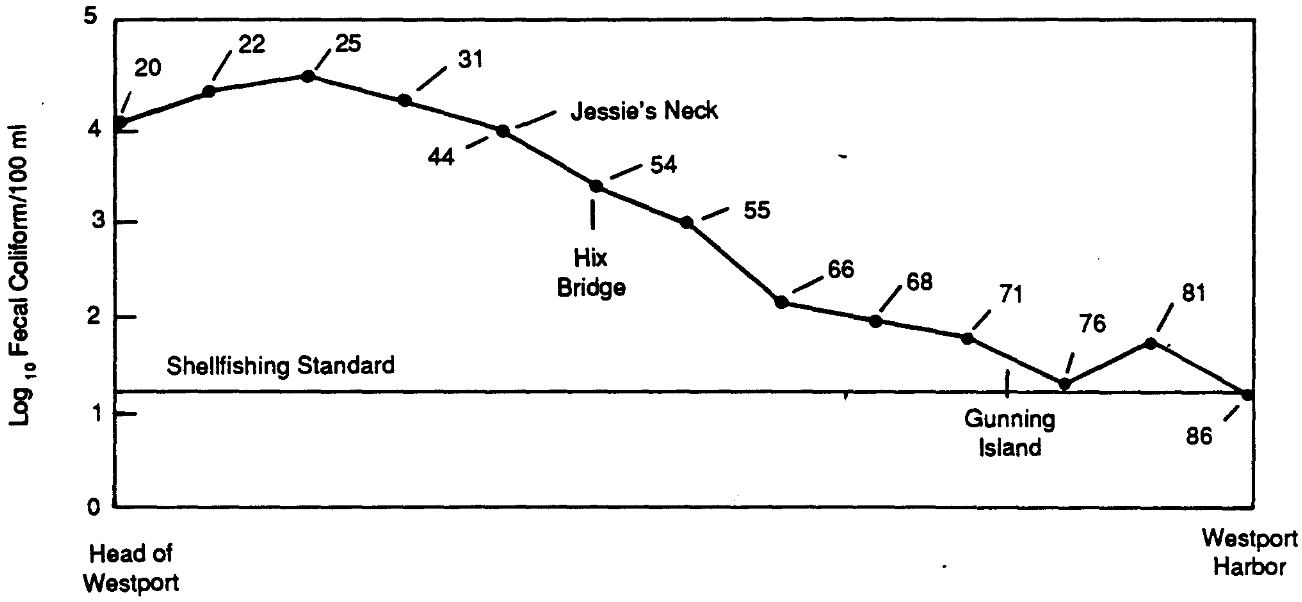

FIGURE 2-3. FECAL COLIFORM COUNTS AT SELECTED SITES IN THE EAST BRANCH OF THE WESTPORT RIVER ESTUARY' (SEPTEMBER 10, 1985) (KELLY ET. AL. 1986)

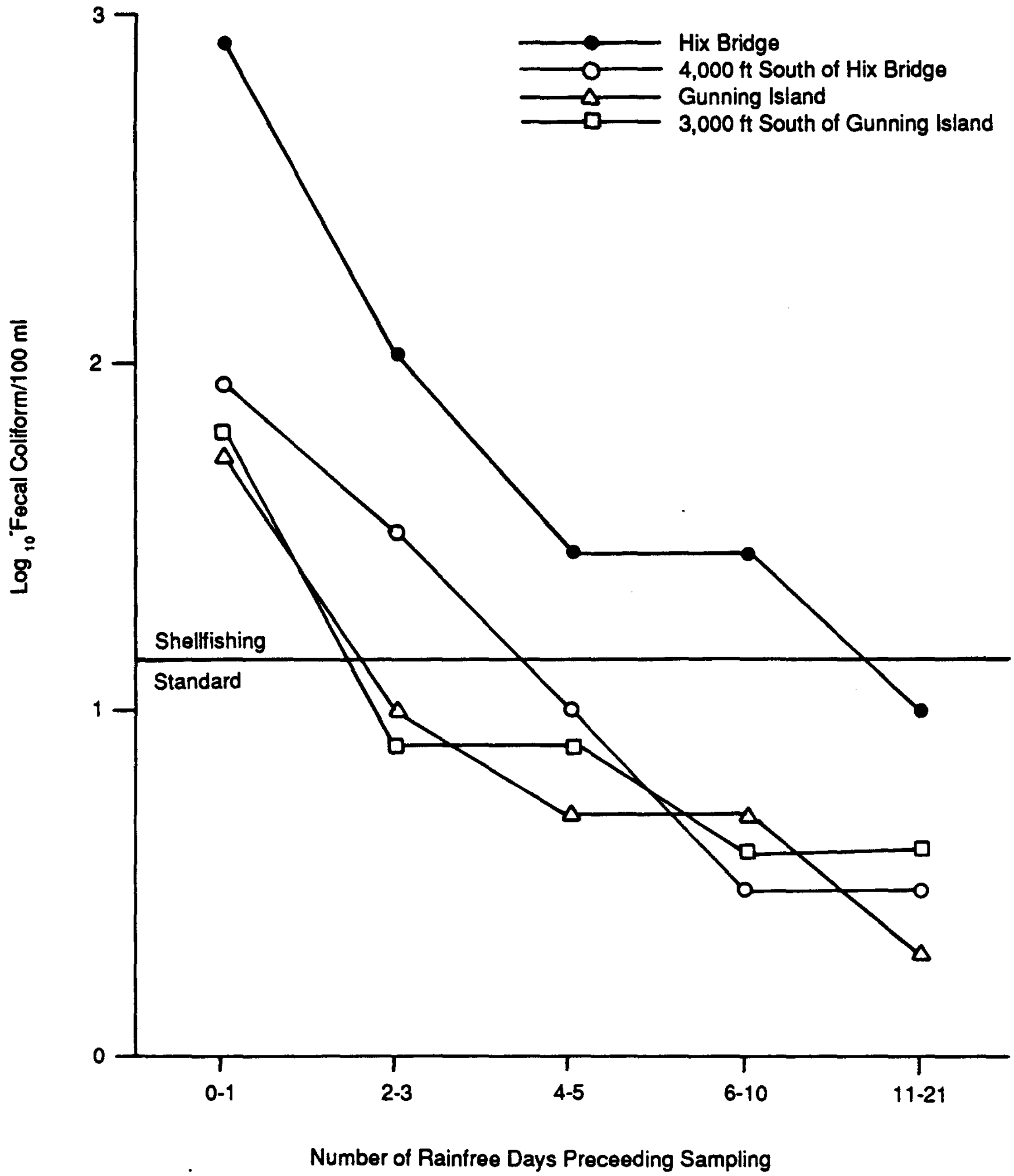

FIGURE 2-4. MEAN FECAL COLIFORM COUNTS VS. NUMBER OF RAINFREE DAYS AT VARIOUS POINTS IN THE EBWR (ADAPTED FROM GHR, 1987)

permanently closed. An additional four day depuration period was added as a conservative measure to protect the public health. Based on this sampling effort, the DEQE revised the status of the river to allow conditional opening of approximately 555 acres of shellfishing beds on the EBWR. The area runs north of Gunning Island to Cadman's Neck and includes Cadman's Cove. The area is closed for seven days after any rainfall of 0.1 inch or greater.

As part of the USDA Rural Clean Water Program, the Soil Conservation Service implemented an extensive water quality sampling program in the EBWR. Sampling was conducted from 1983 to 1989 at eleven stations including receiving water stations above Hix Bridge Road and three tributaries including Bread and Cheese Brook, Kirby Brook and Snell Creek. The purpose of this sampling program was to evaluate the effectiveness of agricultural best management practices designed and installed by the Soil Conservation Service in the watershed of the EBWR. In general, no long-term trends of improving water quality have been observed in the bacteria data.

In 1986, the USDA Soil Conservation Service monitoring program described above was temporarily suspended and an intensive interagency survey, overseen by the U.S. Food and Drug Administration, was conducted during September and October, 1986. This survey reoccupied the nine fresh water tributary stations sampled by SCS in the Rural Clean Water Program plus an additional 13 receiving water stations. Sampling for fecal coliform and fecal streptococcus was conducted in both wet and dry weather over approximately a one week period from September 30 to October 8, 1986. The first samples were taken during a three day period of dry weather and then during subsequent rainfall on October 2, 4 and 5. These samples showed violations of Class B water quality standards, and the dramatic impact of wet weather on bacteria levels in the EBWR and freshwater tributaries. An example of this impact is shown in Figure 2-5. The highest levels of bacterial contamination were recorded at the mouth of Snell Creek and ranged from 540 MPN/100 ml during dry weather to 88,000 MPN/100 ml during wet weather.

Nutrients - As was shown in Table 2-9, a number of sampling studies provided nutrient data in the EBWR and its tributaries. The only numerical nutrient criterion involves ammonia, and is related to ammonia toxicity. The draft Commonwealth of Massachusetts

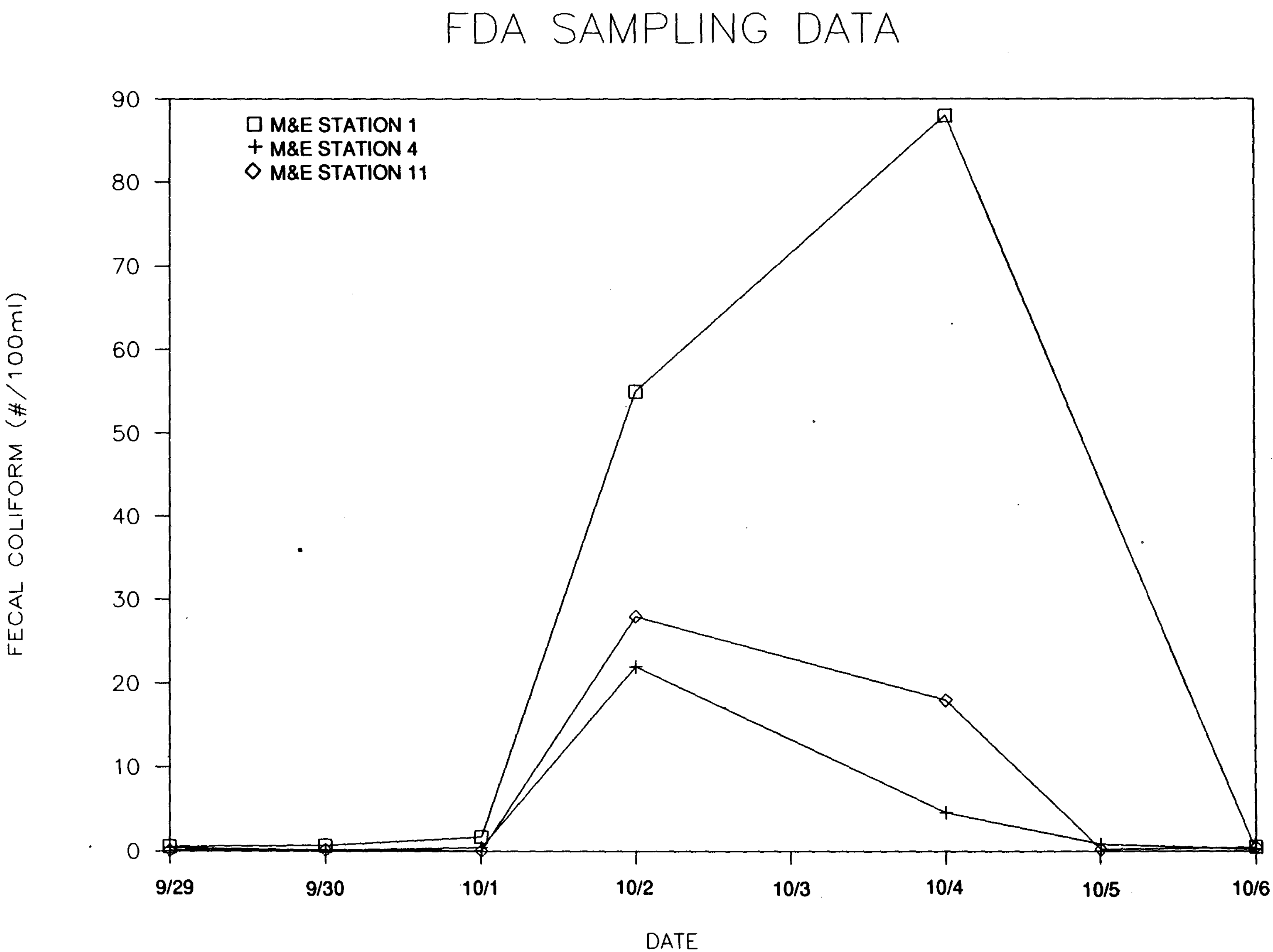

FIGURE 2-5. FECAL COLIFORM COUNTS AT VARIOUS POINTS IN SNELL CREEK

"toxic policy" limits ammonia nitrogen in both fresh and marine waters to a maximum of 0.5 mg/l. The ammonia data available on both the EBWR and tributaries are typically on the order of 0.1 to 0.2 mg/l, and rarely exceed 0.3 mg/l, thus there appears to be no ammonia toxicity concerns for these waterways.

Regarding eutrophication, there has been no evidence found in any of the studies which would indicate that a eutrophication problem is occurring in the EBWR. This situation is difficult to assess, however, given that there are no available phytoplankton data. Dissolved oxygen data in the EBWR, although limited, indicate levels either slightly below or slightly above saturation. No substantial DO depletion or diurnal variations have been observed.

Nutrient levels in the EBWR at Hix Bridge are shown in Figures 2-6 through 2-9. These data have been compiled from the sources listed in Table 2-9 in which nutrient measurements were conducted. The growth of phytoplankton in estuarine and marine systems is usually limited by the availability of the plant nutrient nitrogen. This is in contrast to freshwater systems, where phosphorus is normally the growth-limiting nutrient.

The dichotomy in nutrient limitation between freshwater and marine systems can be explained based on theoretical considerations of the elemental nitrogen and phosphorus content, and thus nutritional requirements, of plant cells. The well known Redfield ratio (Redfield, 1934) states that the ratio by weight of elemental carbon, nitrogen and phosphorus in both marine phytoplankton and seawater are approximately 53:8:1 (N:P ratio equals 6.6). Other researchers, such as Cooper (1938) and Fleming (1940) have developed a similar ratio for marine systems, suggesting that when the nitrogen to phosphorus weight ratio in seawater is much less than 7, as is usually the case, phytoplankton growth is primarily nitrogen limited. Similarly, at ratios close to 7, both nitrogen and phosphorus may limit phytoplankton growth by similar degrees.

Based on the available data, the typical ratio is about 12, assuming total N equals 1.2 and total P equals 0.1. This would indicate nitrogen limitation, although the ratio is low enough that phosphorus may also play some role. This is supported by the fairly low concentration of ammonia, nitrate and total phosphorus which occur in the

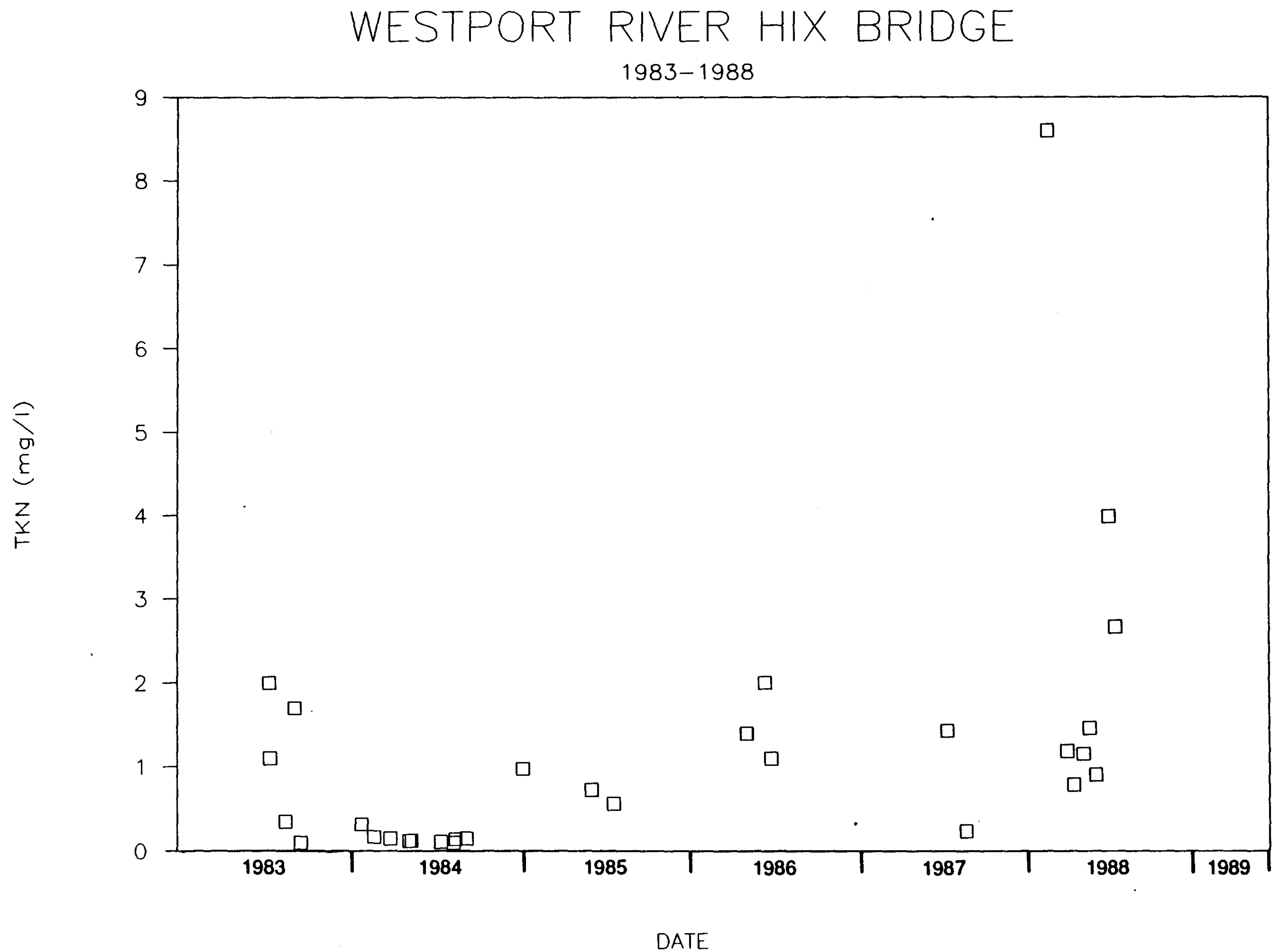

FIGURE 2-6. TOTAL KJELDAHL NITORGEN CONCENTRATIONS AT HIX BRIDGE STATION

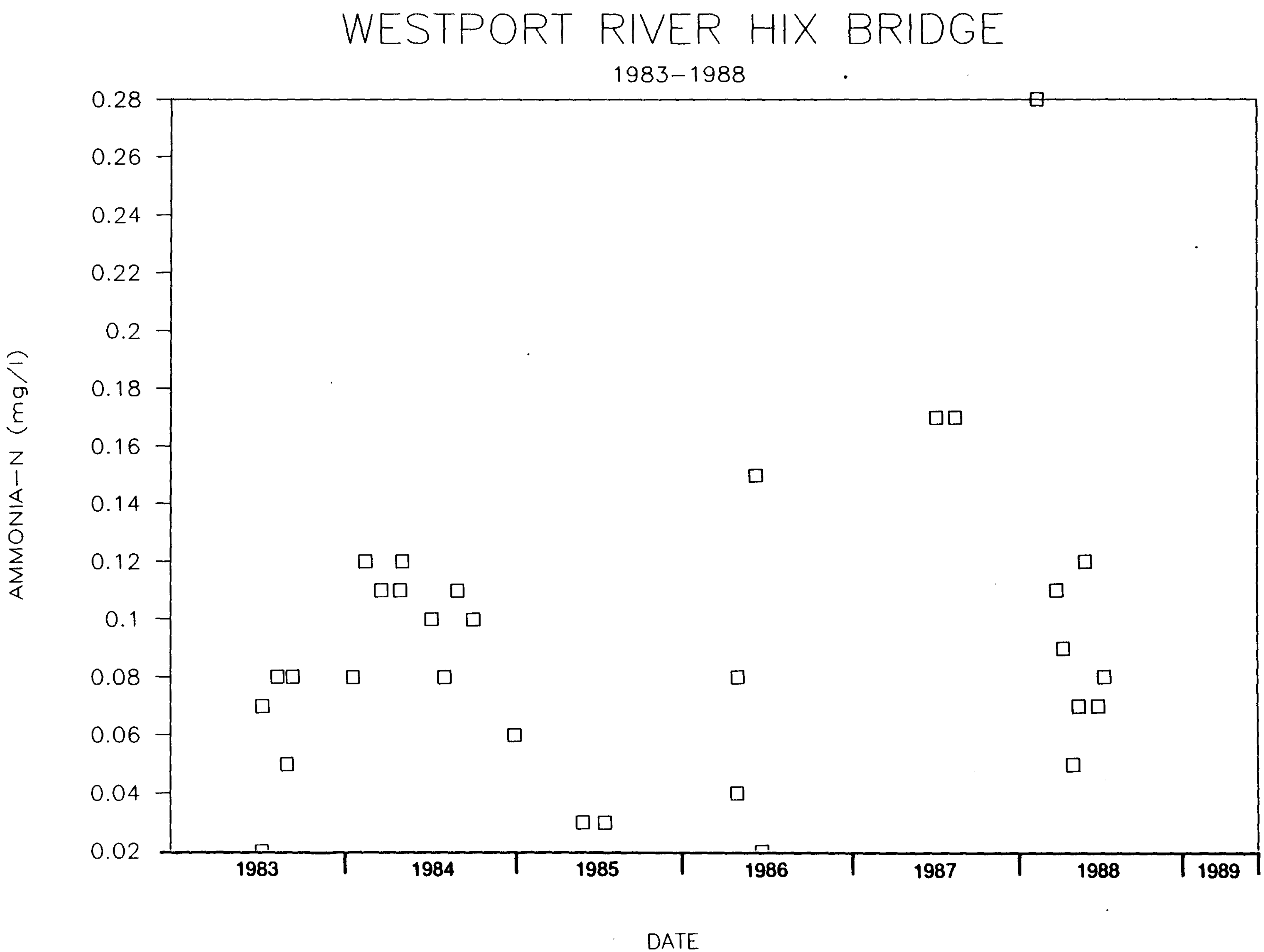

FIGURE 2-7. AMMONIA CONCENTRATIONS AT HIX BRIDGE STATION

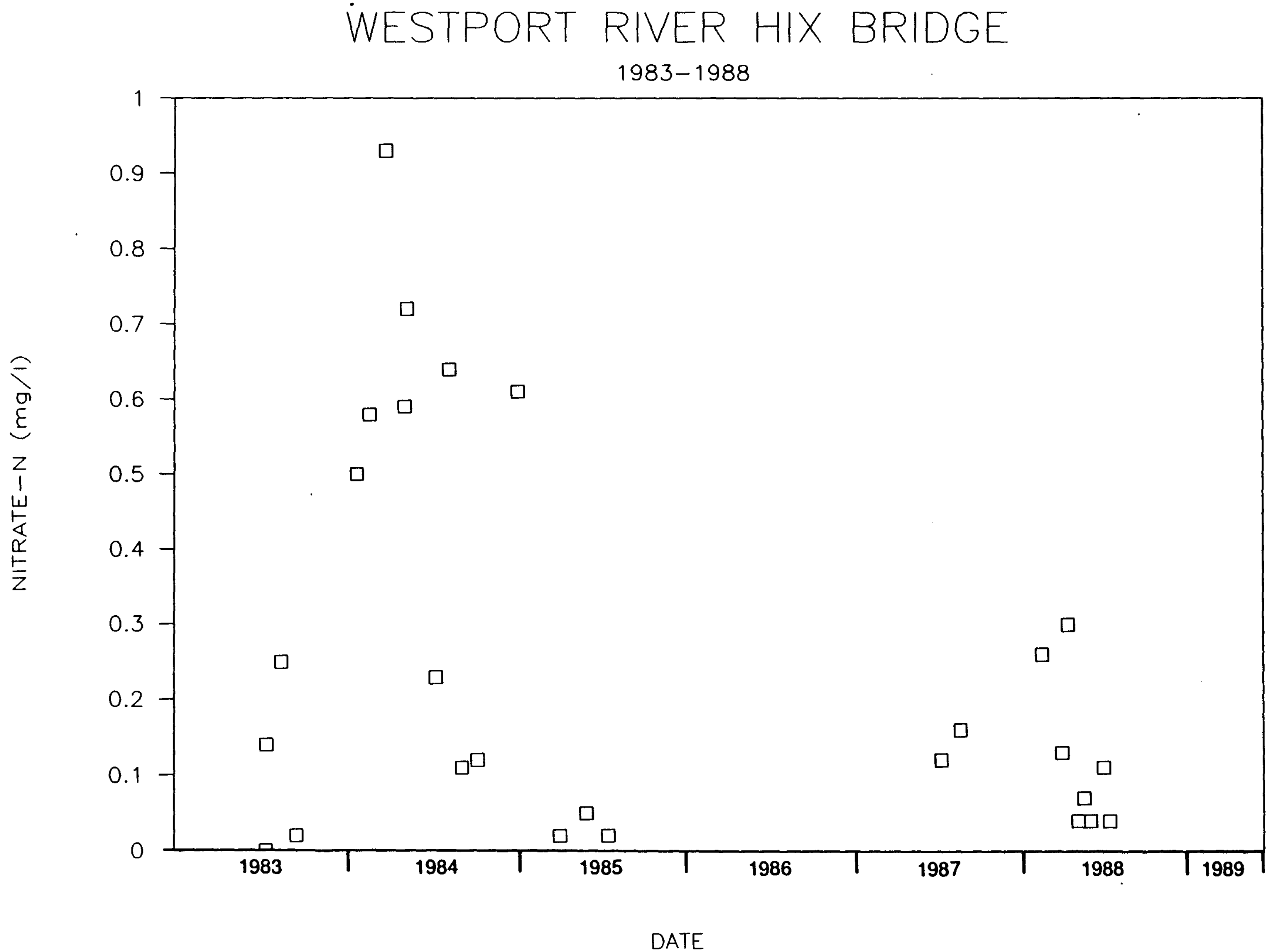

FIGURE 2-8. NITRATE CONCENTRATIONS AT HIX BRIDGE STATION

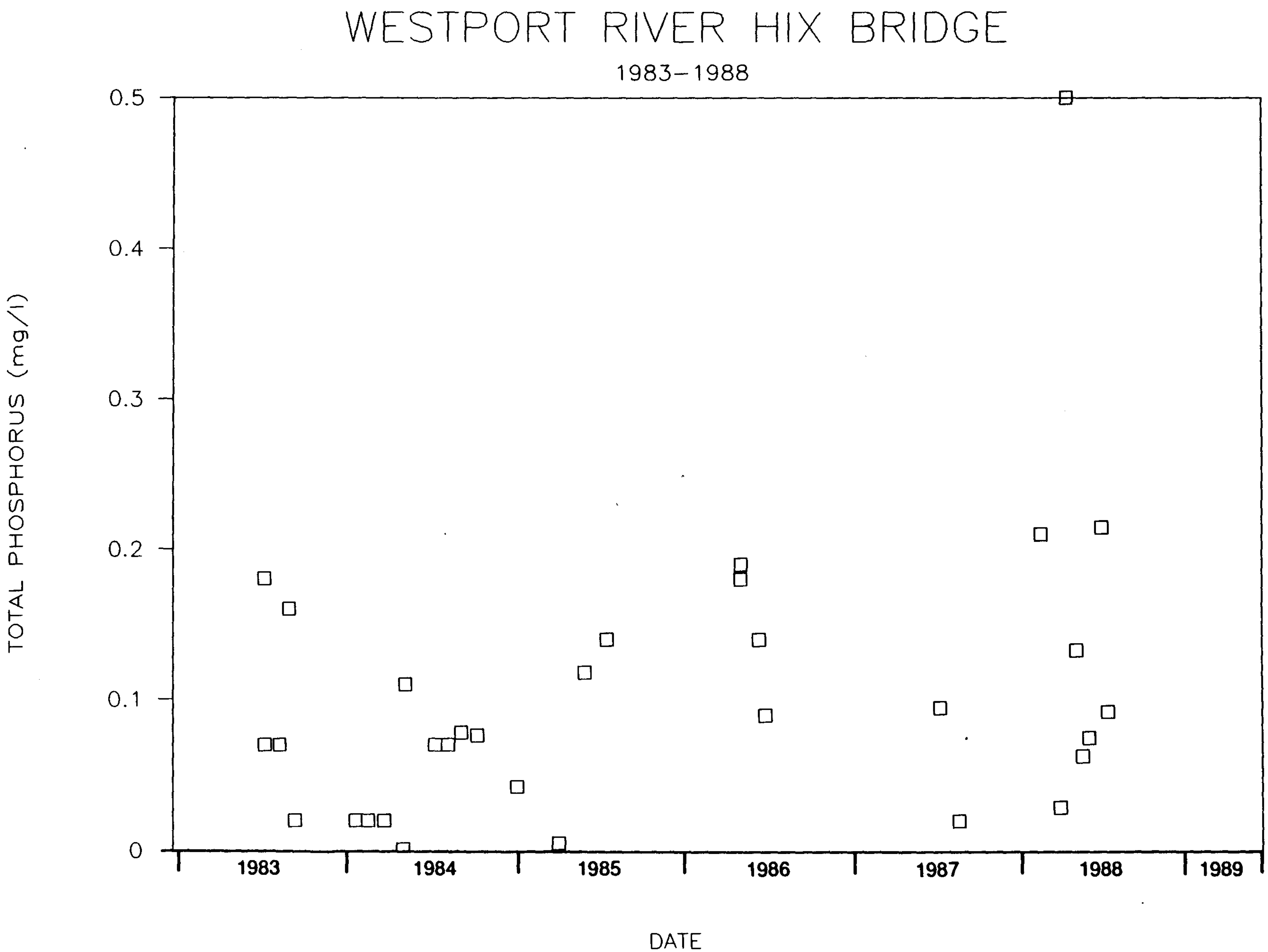

FIGURE 2-9. TOTAL PHOSPHOROUS CONCENTRATIONS AT HIX BRIDGE STATION

EBWR. The fact that ammonia and nitrate levels are low (near the typical values of half-saturation constants for these parameters), and that these are the forms of nitrogen which are preferred by phytoplankton, indicates that they are currently likely to be limiting growth.

Typical nutrient levels in the tributaries of the EBWR are at about the same level as within the EBWR itself, except for nitrate. Typical nitrate levels are about 1 mg/l in the tributaries, which indicates that nonpoint sources are contributing nitrate, and some level of control may thus be desireable. However, there is no current problem with respect to eutrophication and any nutrient control measure would thus be aimed at future potential problems, and would not take as high a priority as bacteria, which have been shown clearly to be impacting an existing resource.

Solids - There are no numerical solids criteria in the state or federal water quality standards. As was shown in Table 2-1, however, there are aesthetic criteria. The transport of suspended sediment and its relationship to bacteria in the EBWR was studied in detail (Pivetz et. al., 1986). It was found that transport of suspended marine sediment was a much greater source than riverine sediment. This is demonstrated by water quality data which show much higher sediment concentrations in the EBWR than in tributaries. Despite this, it is good practice to control areas of excessive erosion such as gulleys which can be created by such activities as construction and agriculture. Other than sensible best management practices to control excessive erosion, there does not seem to be a need for solids reduction.

Metals - Data on metals in the water column of the EBWR and its tributaries are extremely limited. A grab sample collected during 1983 (Anderson, 1983) indicated no violations of U.S. EPA marine criteria for lead, cadmium, copper, chromium, aluminum and nickel. However, data are insufficient to draw conclusions. Sediment metals data are discussed later in this chapter.

[redacted]Since 1979, portions of the East Branch of the Westport River have been periodically closed to shellfishing due to fecal coliform levels which exceed the criterion of 14 colonies/100 ml. All of the surveys conducted from 1975 to the present show that fecal coliform contamination rises during rainfall and then falls to baseline conditions in dry weather. This indicates that the contamination originates largely from nonpoint source runoff from dairy farms, roadways, and developed areas. Each of the studies conducted has also shown that the freshwater tributaries to the Westport River including Bread and Cheese Brook, Kirby Brook and Snell Creek are major sources of bacteria to the EBWR.

Sediment Quality

Sediment chemistry data were collected in the EBWR by DWPC (1987). In order to assess the quality of these sediments, heavy metals, PCB, PAH and solids data were compared with sediment classification criteria from three sources including:

1. Massachusetts dredge material disposal classification (314 CMR 9.00 1986).
2. Massachusetts regulations for land application of sludge (310 CMR 29.00, 1983)
3. Great Lakes sediment rating criteria (MDEQE, 1982).

Table 2-12 compares sediment data collected at Hix Bridge and in Westport Harbor with the cleanest criteria in the regulations and guidelines outlined above. This comparison shows that sediments from the EBWR meet the cleanest criteria with the exception of one cadmium measurement in Category II for 310 CMR 29.00. These data indicate no major sources of metals pollution, and no apparent need for metals control.

Biological Resources

There is a paucity of data and reports on the biological resources of the EBWR. Fiske et al. (1968) conducted a qualitative biological survey of the Westport River. The information collected is summarized below.

Shellfisheries - In 1968, the Westport River was one of the most productive shellfisheries on the south shore of Massachusetts. There were significant commercial fisheries for quahogs, scallops and oysters, with some soft-shelled clams. Five oyster grant permits, 365 family shellfishing permits and 134 family scalloping

TABLE 2-12. SEDIMENT DATA FROM THE EAST BRANCH OF THE WESTPORT RIVER (DWPC, 1987) (MG/KG)

Parameter	10WPE13 Hix Bridge	13WPH16 Westport Harbor	Dredge and Fill Class (a)	Sludge Classification (b)	Great Lakes Rating
Cd	2.0	1.0	1 (<5)	II (2-25)	* (<6)
Cr	10	6.5	1 (<100)	I (<1,000)	* (<25)
Cu	8.0	21	1 (<200)	I (<1,000)	* (<25)
Pb	9.0	24	1 (<100)	I (<300)	* (<40)
Hg	0.095	0.070	1 (<0.5)	I (<10)	* (<1)
Na	12	7.5	1 (<50)	I (<200)	* (<20)
PCB's	ND	ND	1 (<0.5)	I (<2)	
PAH	ND	ND			
% fines (silt & clay)	79	89	Type B - (60-90)		

a. 1 = cleanest
b. I = cleanest
c. * = nonpolluted

permits were issued in 1966. While 1966 had a large scallop harvest, they were scarce in 1961-64 and 1967. The quahog fishery had declined from 1956 (8,500 bushels harvested) to 1967 (1,804 bushels harvested). This decrease was attributed to eelgrass encroachment and liberal fishing regulations, resulting in over harvesting. From 1956 to 1967 the oyster harvest fluctuated, but showed a general decline.

Finfish - A total of 39 estuarine fish species were captured in the east and west branches. The species in most abundance were Atlantic silverside, mummichog, American sand lance, and Striped killifish. The Westport River serves as a nursery area for the juvenile forms of important economic species such as the winter flounder, alewife, smelt, tautog, pollock and white hake. Flounder appear to spawn within the river. Sportfishing is noted in the estuary for striped bass, bluefish, winter flounder, tomcod, tautog and mackerel.

Saltmarshes - There are 775 acres of saltmarsh on the EBWR. Marsh flora identified on the East Branch of the Westport River includes saltwater cord grass (*Spartina alterniflora*) extending from the water's edge to the middle of the marsh where it is replaced by saltmeadow grass (*Spartina patens*). Spike grass (*Distichlis spicata*) is the uppermost species of the marsh, growing just below the beach grass (*Ammonphila breviligulata*) of the upland border.

Within the area of spike grass were found scattered specimens of sea blite (*Suaeda maritima*), orach (*Atriplex patula*), sand spurry (*Spergularia canadensis*) and marsh elder (*Iva frutescens*). Marsh rosemary (*Limonium carolinianum*) and Glasswort (*Salicornia europaea*) are found scattered within the marsh grasses. Below mean low water, eel grass (*Zostera marina*) is the most prevalent vascular plant growing in the Westport River. In the late 1960's it had been spreading rapidly.

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CHAPTER 3

DEMONSTRATION AREA SELECTION AND DESCRIPTION

Demonstration Area Selection Process

The watershed of the EBWR (Figure 2-1) covers about 53 square miles over several municipalities and is composed of numerous subwatersheds, each of various sizes and land use characteristics. Since the scope of this project is to demonstrate the development of effective nonpoint source control strategies rather than to address pollution sources throughout the entire watershed, one subwatershed was selected for the development of a nonpoint source management plan. To be an appropriate demonstration area, the selected subwatershed had to include all the locally dominant categories of nonpoint sources of pollution. This would insure that the management plan addresses the planning needs of the entire Westport River area, as well as serves as a model for the development of a guidance document for municipal officials. Additional selection criteria for the demonstration area included:

- availability and quality of environmental assessment information
- location with respect to shellfish resources
- willingness of landowners to participate
- local hydrography
- representative land use for the study area
- ease of monitoring program design and implementation
- opportunity to illustrate BMP effectiveness, and
- absence of confounding influences

These selection criteria were reviewed and ranked during a working session of the Project Advisory Group (see Appendix A) on November 9, 1988. Several important issues discussed included the benefits of selecting an area with extensive existing environmental assessment information - primarily water quality data that had been collected over a number of years, at geographically well distributed stations, and during a wide range of meteorological conditions. The importance of adequate quality assurance/quality control was also emphasized. Preliminary review of such data would assure the selection of a demonstration tributary with documented water quality standard violations and would address the need to collect baseline data for a "before-and-after" water quality analysis. The selected area should also discharge within reasonable proximity upstream of shellfish growing areas, in order to maximize opportunities for water quality improvements in the vicinity of shellfish resources and to contribute to future reductions in shellfish closures in the area. Further, landowners in the project area who may be asked for construction or maintenance easements must be willing to cooperate, land use within the selected area should reasonably reflect that of the rest of the EBWR watershed, and the area must provide an opportunity to illustrate BMP effectiveness through a monitoring plan that is not compromised by confounding influences and allows access to monitoring stations.

Project advisory group members were presented with a worksheet to assist in ranking selection criteria. Figure 3-1 shows that it was the consensus of the project advisory group that the most highly rated selection criteria related to the presence of locally dominant nonpoint sources, the willingness of landowners to cooperate, and opportunity to illustrate BMP effectiveness. Project advisory group members were also asked to indicate subwatersheds that they would rate highly as candidate demonstration areas. Highly rated candidate areas and votes received included Snell Creek (14), Kirby Brook (8), and Head of Westport (4). Other nominated areas included Bread and Cheese Brook, Noquochoke River, Everett Cove and the Ferry Farm.

Based on the high ranking of Snell Creek by the project advisory group and a preliminary favorable rating of Snell Creek based on technical criteria, it was decided to investigate the willingness of landowners in the watershed to cooperate. Specifically, it was felt that the cooperation of Mr. Jose Pimental, a dairy farm owner near the mouth of Snell Creek, was critical to the selection of Snell Creek as the demonstration area. On December 16, 1988, Metcalf & Eddy and a representative of the USDA Agricultural Stabilization and Conservation Service (ASCS), met with Mr. Pimental to discuss opportunities to implement agricultural BMPs on his farm as part of the demonstration project. The ASCS had recently worked with Mr. Pimental through the USDA Rural Clean Water Program, under which Mr. Pimental entered a contract to

WORKSHEET FOR SELECTION OF DEMONSTRATION AREAS

The purpose of this worksheet is to obtain input from the project advisory group for the selection of demonstration areas. Please check the criteria that you consider highly important for the selection process. Then rank the rest as moderate or minor. Also, please identify sites you feel would rate highly as demonstration candidates and the reasons why. Thanks for your cooperation.

Potential Selection Criteria	Ranking Importance		
	High	Moderate	Minor
Sufficiency of Existing Water Quality Data	9	12	1
Contribution of Locally Dominant Types of Nonpoint Sources	18	3	1
Location with Respect to Shellfish Resources	7	15	
Willingness of Owners to Participate	17	2	2
Local Hydrography	7	14	
Representative Land Use for Study Area	5	16	
Ease of Monitoring Program Design & Implementation	13	6	2
Opportunity to Illustrate BMP Effectiveness (Soil Type, Drainage etc.)	19	3	
Absence of Confounding Influences	2	16	2

Potentially Suitable Demonstration Areas

1. Snell Creek 14
2. Kirby Brook 8
3. Head of Westport 4

FIGURE 3-1. DEMONSTRATION AREA SELECTION CRITERIA RANKING RESULTS implement a water quality management plan. After an extensive discussion in which past difficulties of the Rural Clean Water Program, as well as the scope of the DEP demonstration project were discussed, Mr. Pimental agreed, in principal, to participate.

Following this discussion with Mr. Pimental, an evaluation of Snell Creek based on its technical merit for selection of the demonstration area was conducted. Subsequently, [redacted]

[redacted] Fecal coliform criteria violations had been documented by numerous water quality sampling programs conducted by state and federal agencies, the Town of Westport and private groups.

[redacted] The range of locally dominant nonpoint sources are present including stormwater runoff from the state highway and local roads, existing and proposed housing developments, commercial areas, and the Costa and Pimental farms.

[redacted] Snell Creek discharges directly into an area of the EBWR with abundant shellfish growing areas.

[redacted] Mr. Pimental expressed willingness to explore implementation of additional pollution control measures on his farm, and publicly owned land is available in other areas of the watershed to control other sources.

[redacted] Land use in the watershed of Snell Creek is reasonably representative of that of the greater Westport River area.

[redacted] Critical sampling stations are accessible.

[redacted] Controls can be selectively monitored from residential and commercial areas, Route 88 and Main Road, and agricultural areas of the Pimental farm.

[redacted] Due to the small size of its watershed, Snell Creek will have a short response time to any pollution control measures implemented, providing the opportunity to illustrate BMP effectiveness in a short period of time.

[redacted] There are no known confounding influences such as hazardous waste sites, landfills or intermittent pollutant sources such as industrial areas.

Demonstration Area Description

Snell Creek (Figure 3-2) is located on the west side of the EBWR and discharges into a small cove at Jessie's Neck. The northern branch, running from west to east, toward the EBWR, originates at a small pond just south of Charlotte White Road, half way between Sodom and Main Roads. It then runs east, crossing Main Road and continuing southeast to cross Route 88 between Charlotte White Road and Hix bridge Road. At this point, it travels across to Drift Road just south of 658 Drift Road, and finally enters the EBWR at Jessie's Neck.

The south branch of Snell Creek originates at a small pond off Main Road behind Brookwood Drive. It then crosses Main Road between the new bank in Central Village and Brookwood Drive. It continues east to Route 88, about a quarter of a mile south of the north branch, then continues east, crossing Drift Road again near Snell Corner. At that point, it connects with the north branch and enters the EBWR. There is also a short middle branch which originates just west of Route 88, crosses under Route 88, and intersects the north branch in the vicinity of Drift Road.

In order to assist in the identification of pollutant sources in the watershed of Snell Creek and to enable future evaluation of the effectiveness of BMPs implemented under this demonstration project, this section presents an environmental baseline description of Snell Creek and its watershed. The baseline includes a land use description, soils data, a summary of sampling program results and an analysis of Snell Creek water quality based on a database of recently collected data established for this project.

Land Use. Several recent studies of land use in the watershed of Snell Creek have been conducted by the Soil Conservation Service (1984) and the Environmental Protection Agency (1989). The data collected by EPA are shown in Figure 3-3. Although the land use categories used in these two studies were different, the data are compared in Table 3-1 and provide a reasonably accurate description of recent land use in this area.

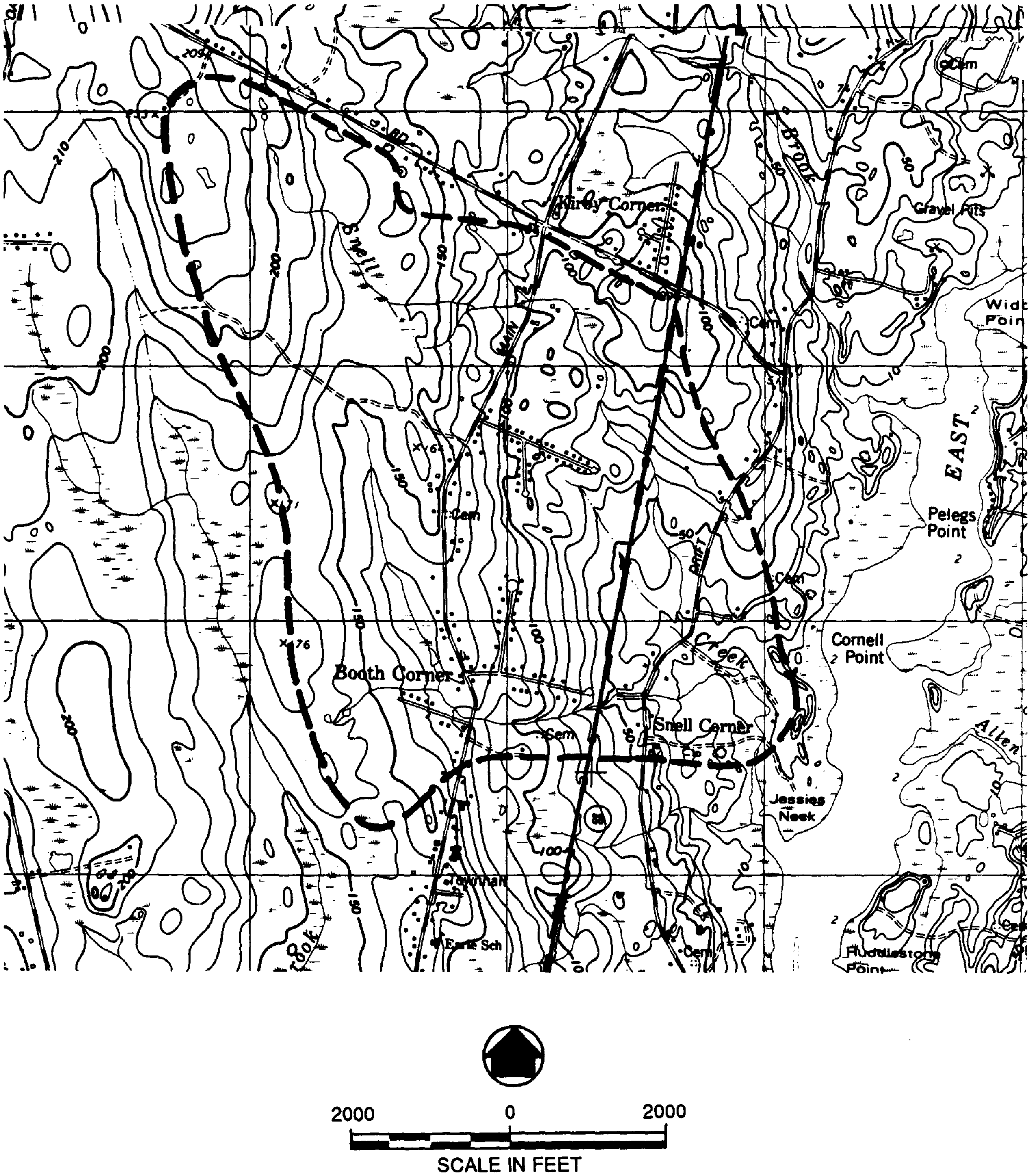
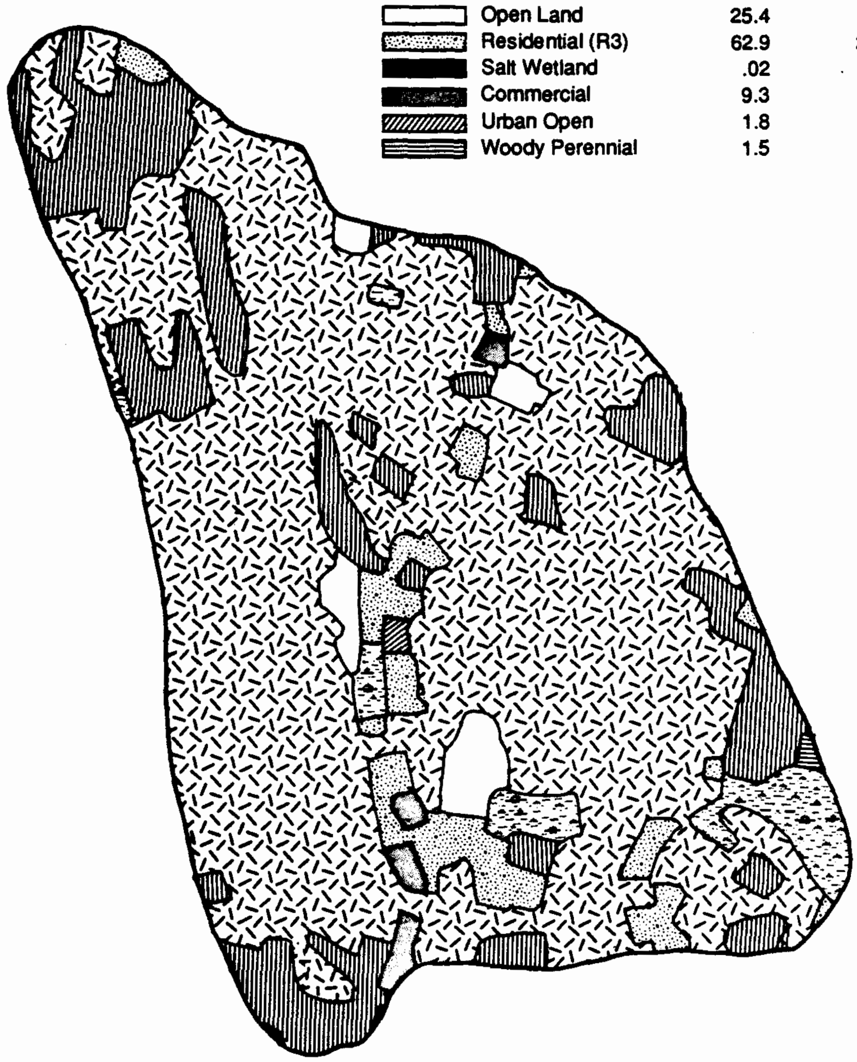


FIGURE 3-2. SNELL CREEK LOCATION

Land Use	Acres	Sq. Feet
Cropland	175.7	7655134.0
Pasture	37.3	1625177.0
Forest	711.8	31006660.0
Open Land	25.4	1105460.0
Residential (R3)	62.9	2740116.0
Salt Wetland	.02	889.4
Commercial	9.3	406487.4
Urban Open	1.8	79760.9
Woody Perennial	1.5	63314.3



Landuse data automated by resource mapping group, UMASS amherst.
Processing by MassGIS Project.
EOEA-HWFSSC/USGS-WRD

FIGURE 3-3. LAND USE IN THE SNELL CREEK WATERSHED

TABLE 3-1. LAND USE DATA FOR THE WATERSHED OF SNELL CREEK

	Quantity (Acres) 1983 (1)	1988 (2)
Agriculture	205	
Cropland		176
Pasture		37
Subtotal	205	213
Developed	95	
Commercial		9
Residential (R3)		63
Urban Open		2
Subtotal	95	74
Forest	665	712
Woody Perennial		2
Subtotal	665	714
Open	45	25
Total	1,010	1,026

(1) Soil Conservation Service, 1984
(2) Environmental Protection Agency, 1989

Soils. The soils within the watershed of the Snell Creek watershed are comparable to the regional description. The locations of soil types within the watershed are depicted in Figure 3-4 and the soil types present are listed in Table 3-2. It is dominated by Paxton-Woodbridge-Whitman soils which are typically less than one meter deep overlying impermeable glacial tills. Surface runoff tends to be high, while slow percolation, wetness, and ponding result in severe conditions for septic systems. Minor amounts of other soil types in the watershed, such as the Gloucester-Hinkley and the Ridgebury loams also overly tills. These soils tend to promote runoff rather than percolation, and may not be suitable for septic tanks due to low percolation and wetness (Roffinoli and Fletcher, 1981).

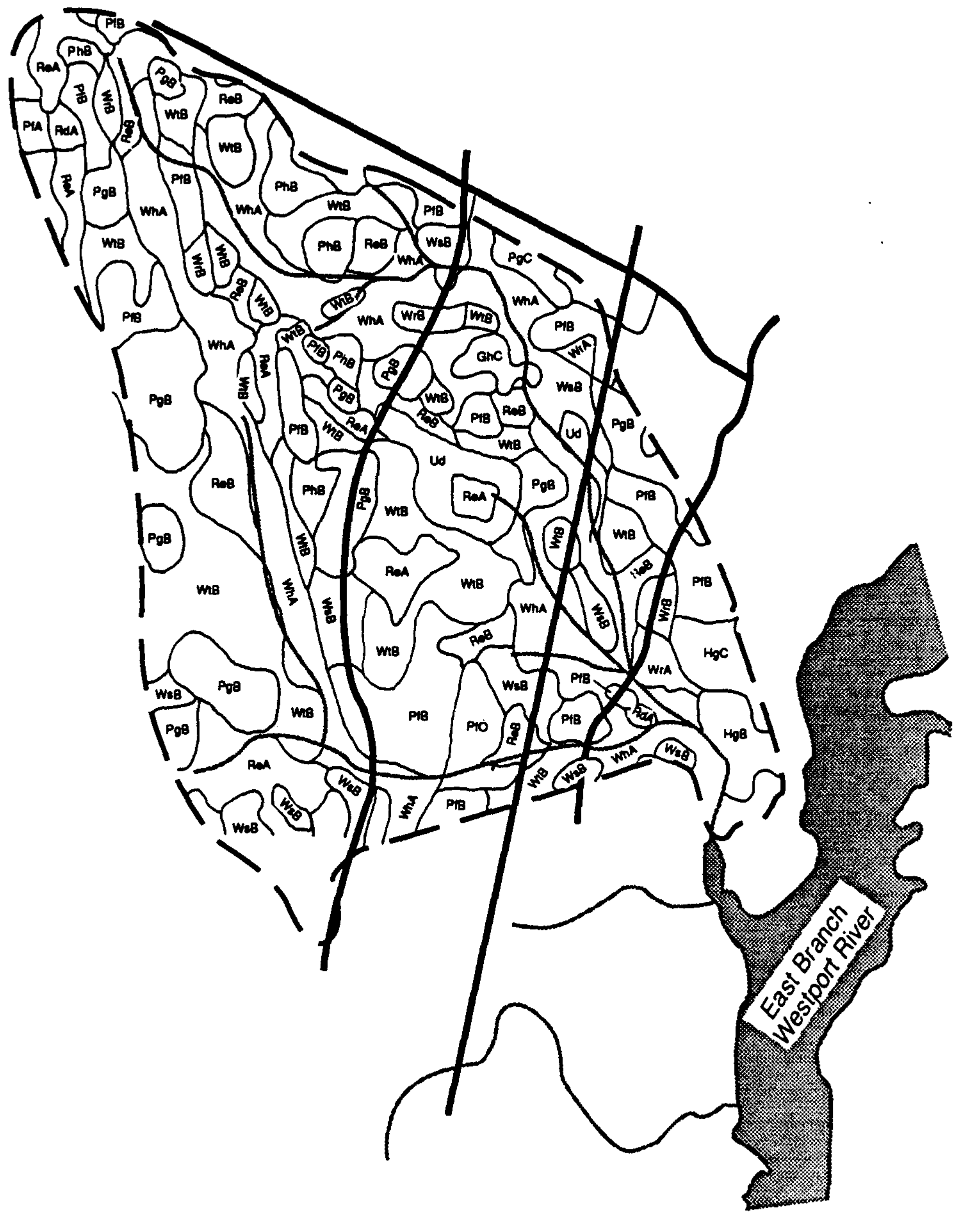


FIGURE 3-4. SOILS MAP OF SNELL CREEK

TABLE 3-2. SNELL CREEK WATERSHED SOIL TYPES (ROFFINOLI AND FLETCHER, 1981)

Symbol	Description	Slope (Percent)	Septic Tank Suitability
GhC	Gloucester, Hinckley complex very stony	rolling	Severe: poor filter
HgC	Hinkley gravelly fine sandy loam	8-15	Severe: poor filter
PfB	Paxton fine sandy loam	3-8	Severe: percs slowly
PgB	Paxton very stony fine sandy loam	0-8	Severe: percs slowly
PgC	Paxton very stony fine sandy loam	8-15	Severe: percs slowly
PhB	Paxton extremely stony fine sandy loam	0-8	Severe: percs slowly
ReA	Ridgebury extremely stony fine sandy loam	0-3	Severe: percs slowly
ReB	Ridgebury extremely stony fine sandy loam	3-8	Severe: percs slowly
WhA	Whitman extremely stony fine sandy loam	0-3	Severe: percs slowly
WrA	Woodbridge fine sandy loam	0-3	Severe: percs slowly
WrB	Woodbridge fine sandy loam	3-8	Severe: percs slowly
WsB	Woodbridge very stony fine sandy loam	0-8	Severe: percs slowly
WtB	Woodbridge extremely stony fine sandy loam	0-8	Severe: percs slowly

Water Quality. As described in Chapter 2, water quality data have been collected in the EBWR and its tributaries by state and federal agencies, the town of Westport, and the Westport River Watershed Alliance. This section contains a summary of these programs focusing on bacteria data collected in Snell Creek, and the EBWR at Hix Bridge.

In order to assist in assessing water quality, a database was established by extracting data collected in Snell Creek from existing studies. In addition, in order to assess the impact of Snell Creek on water quality in the EBWR, a similar database was established for the Hix Bridge station, located just downstream of the mouth of Snell Creek. The data were coded and entered in a Lotus spreadsheet, thus allowing sorting and plotting of the data from individual data collection programs or of aggregate data. The database established for Snell Creek and Hix Bridge is included in Appendix B. The data were sorted by station and parameter and were then sorted chronologically to enable plots of concentration over time.

In order to allow sorting by geographical sampling location, stations that were sampled frequently during different sampling programs were grouped and assigned a single station number. These station numbers, listed as "M&E station #" in the data file (Appendix B) are shown in Figure 3-5. In the database, the original sample number and station number assigned by the collector was recorded. In order to provide a chronological reference and evaluate the time elapsed between rainfall events and sample collection, the sampling date was recorded with the time (if available), as well as rainfall amounts on the day of sampling and the previous day. Parameter analyzed, measured concentration, measured flow, sponsoring agency, year published, and reference number were assigned individual fields in the data file. Units of concentration are milligrams per liter for chemical parameters, colonies per 100 milliliters for bacterial parameters and cubic feet per second for flow. Definitions of the file contents and associated codes and abbreviations are presented in Appendix B. The data file assembled for Snell Creek contains over 900 records and includes total coliform, fecal coliform, fecal streptococcus, e. coli, ammonia, total Kjeldahl nitrogen, nitrate, total phosphorus, and total suspended solids.

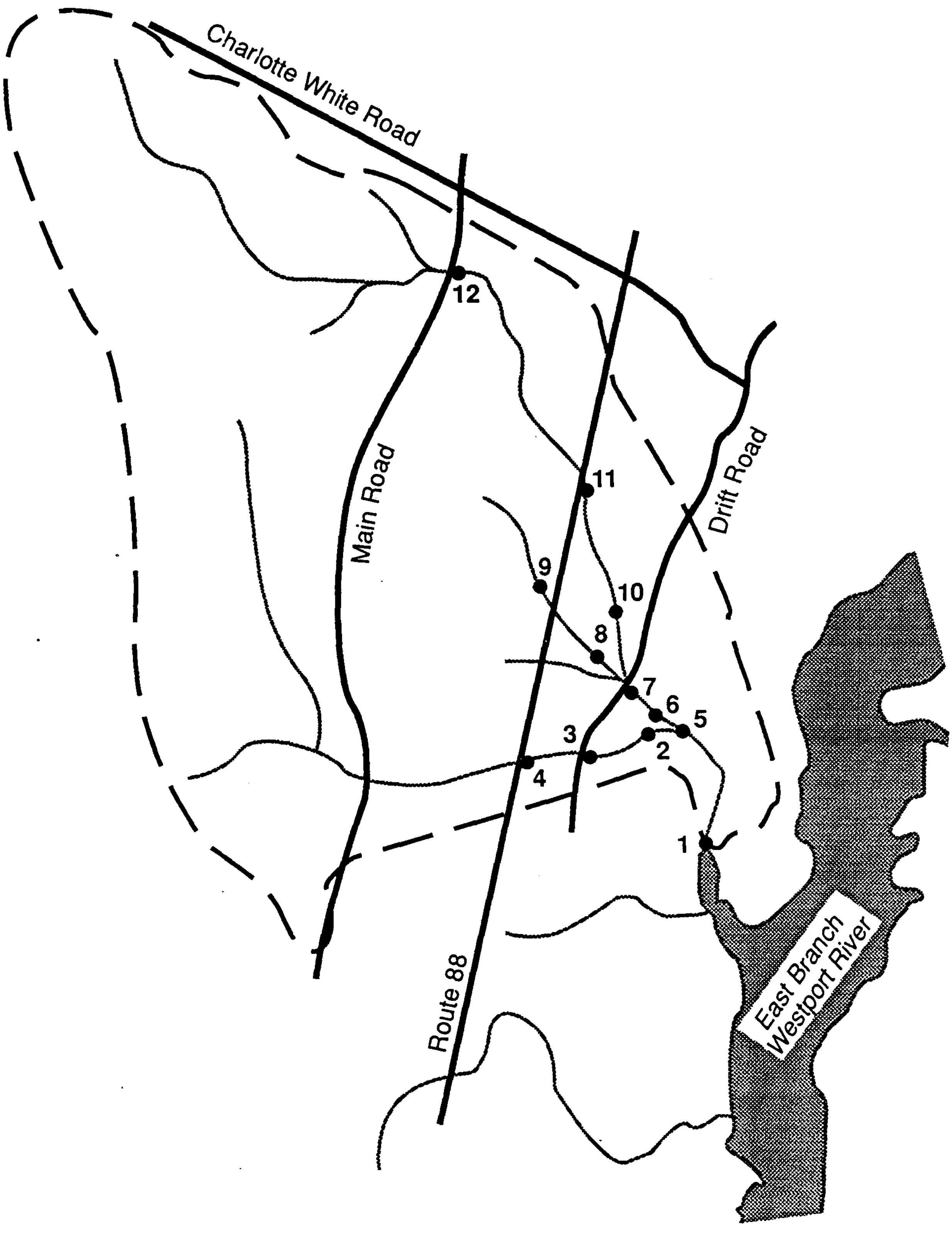


FIGURE 3-5. METCALF & EDDY FIELD PROGRAM DATA
SUMMARY STATIONS SNELL CREEK

In Chapter 2, a summary table (Table 2-9) of information on the major sampling efforts in the EBWR was given. Table 3-3 is a similar summary, but focuses on sampling programs during which data in the Snell Creek watershed area have been collected. Data from these sampling programs which have been installed on the project database are utilized to assess water quality in Snell Creek.

Using the data base, plots of fecal coliform bacteria levels were generated covering the period of 1983 to 1989. Figure 3-6 shows fecal coliform counts at Station 1 at the mouth of Snell Creek between 1984 and 1989. The fecal coliform counts during this period frequently exceed Class B standards (200 per 100 ml). Plots of fecal coliform levels at stations upstream (Stations 4, 7, and 11) show less frequent violations. Figure 3-7 shows log mean fecal coliform values at five stations along the north branch of Snell Creek, based on data collected between 1983 and 1989. These data show nearly an order of magnitude increase in fecal coliform counts between Station 7 at Drift Road and Station 1 at the mouth of the creek. This increase is attributed to the Pimental farm which discharges into this reach and is a significant source of bacteria. This plot of longitudinal variation of bacteria also indicates that most of Snell Creek is in compliance with the Class B criterion on an average basis, although frequent violations still occur.

The U.S. Department of Health and Human Services (1987) conducted a sanitary survey of the Westport River between September 29 and October 8 of 1986 with six fecal coliform, fecal strep tococcus and e. coli samples collected in Snell Creek at three stations. Figure 3-8 shows fecal coliform concentrations at the three locations between September 29 and October 6, 1989. During this time period, rain fell on October 2, 4 and 5, and the data clearly demonstrate large rain-induced inputs of bacteria to the EBWR. The higher bacteria counts at the station downstream of the Pimental Farm (ME1) are also shown. This is consistent with the previous patterns discussed, in which most of Snell Creek is at or near the Class B criterion of 200 org/100 ml prior to rainfall (except the most downstream station), but substantially above the criterion during and after rainfall events.

TABLE 3-3. EXISTING WATER QUALITY DATA SOURCES
SNELL CREEK

Agency	Report Title	No. of Stations in Snell Creek	Dates and Frequency of Sampling	Parameters	Scope
Mass. DEQE Division of Water Pollution Control (DWPC, 1987)	Buzzards Bay Research Bacteriological Data Report 1986	5-1701, 1707 and 1710 - 1712	1 day - 10/2/86	Nutrients, solids, bacteria	Microbial indicator study of Buzzards Bay.
Mass. DEQE Division of Water Pollution Control (DWPC, 1988)	A Report on Bacteriological Sampling in the Tributaries of the Westport River	9-010 to 0109 plus selected sources	4 sampling times - 6, 7, 8 and 11/87	Nutrients, solids, bacteria	Microbial indicator study of Snell Creek and Kirby Brook.
U.S. Department of Agriculture (USDA, 1983-1988)	Rural Clean Water Program, Annual Reports	3-5,10 and 11	Several sampling runs per year, 1983-1988	Nutrients, solids, bacteria	Evaluation of the effectiveness of Soil Conservation Service designed BMPs in agricultural areas in Westport.
U.S. Department Health and Human Services (1986)	Sanitary Survey of the Westport River Estuary	3-5,10 and 11	9/29-10/8/86 one per day	Bacteria	Assess bacterial impacts of nonpoint sources
Town of Westport Boston University (Kelly et.al., 1986)	A Study of Determine the Causes, Types and Locations of Pollutants Contaminating the Westport River Estuary, Westport, Massachusetts	8-34, 41-42	14 sampling runs between 8/7/84 and 9/10/85	Bacteria	Identify and sample nonpoint sources in the EBWR.
Town of Westport (GHR, 1987)	Bacterial Water Quality Survey of the East Branch of the Westport River Estuary	1-A6	38 sampling runs between 8/84 and 11/85	Bacteria	Determine whether conditional opening of shellfish beds is justifiable.
Mr. Edmire Bibeau Westport High School	Unpublished	3-1, 4 and 7	Weekly (approx.) ongoing	Bacteria	Monitor nonpoint source effects
Mass. DEQE Division of Water Pollution Control (DWPC, 1986)	Buzzards Bay 1986 Water Quality Survey Data	1-SNC04	6/24-25/86 two per day	Nutrients, solids, bacteria	General water quality survey of Buzzards Bay.

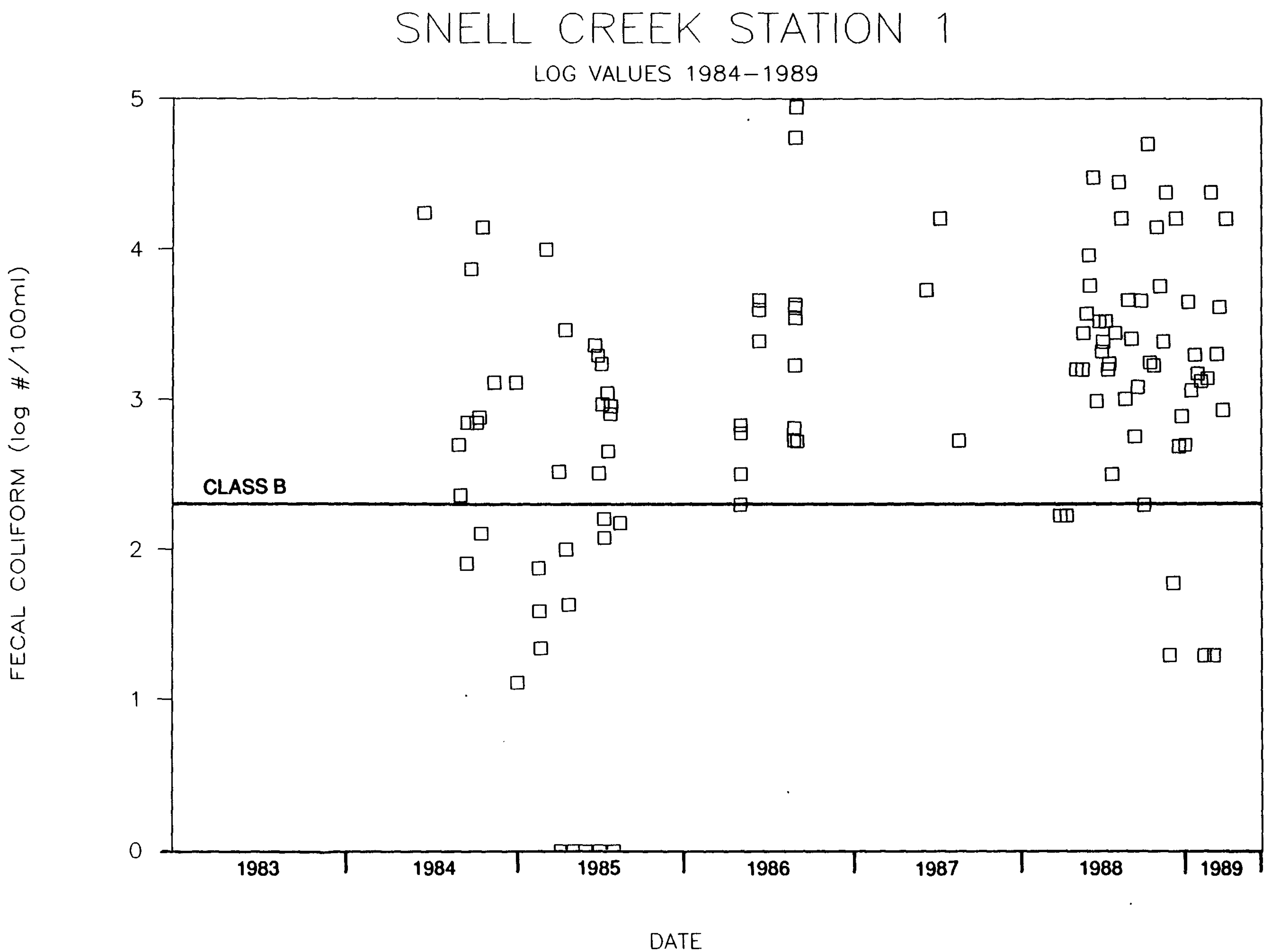


FIGURE 3-6. FECAL COLIFORM, MOUTH OF SNELL CREEK, 1984-1989

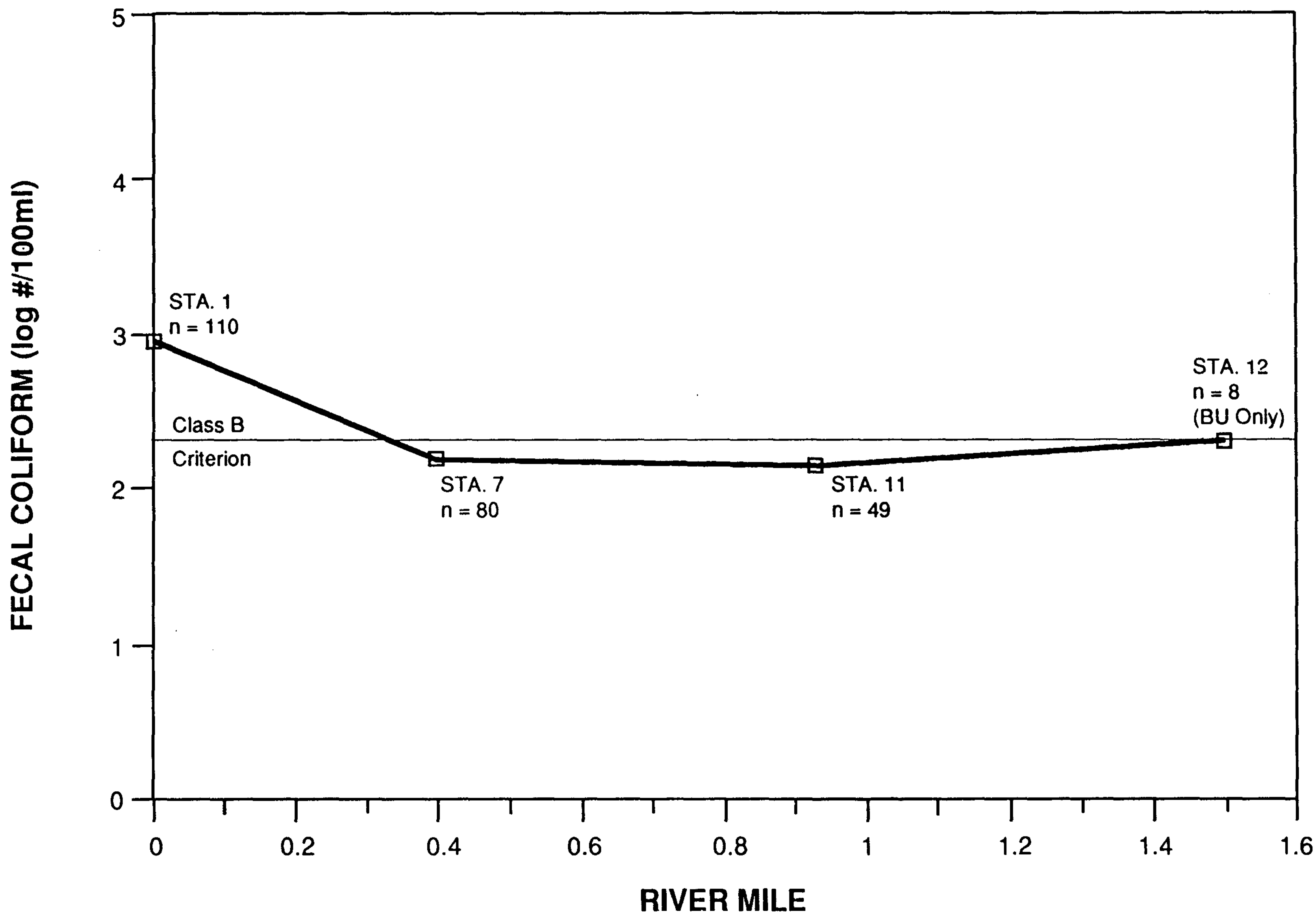


FIGURE 3-7. LOG MEAN FECAL COLIFORM VALUES, SNELL CREEK NORTH BRANCH, 1983 - 1989

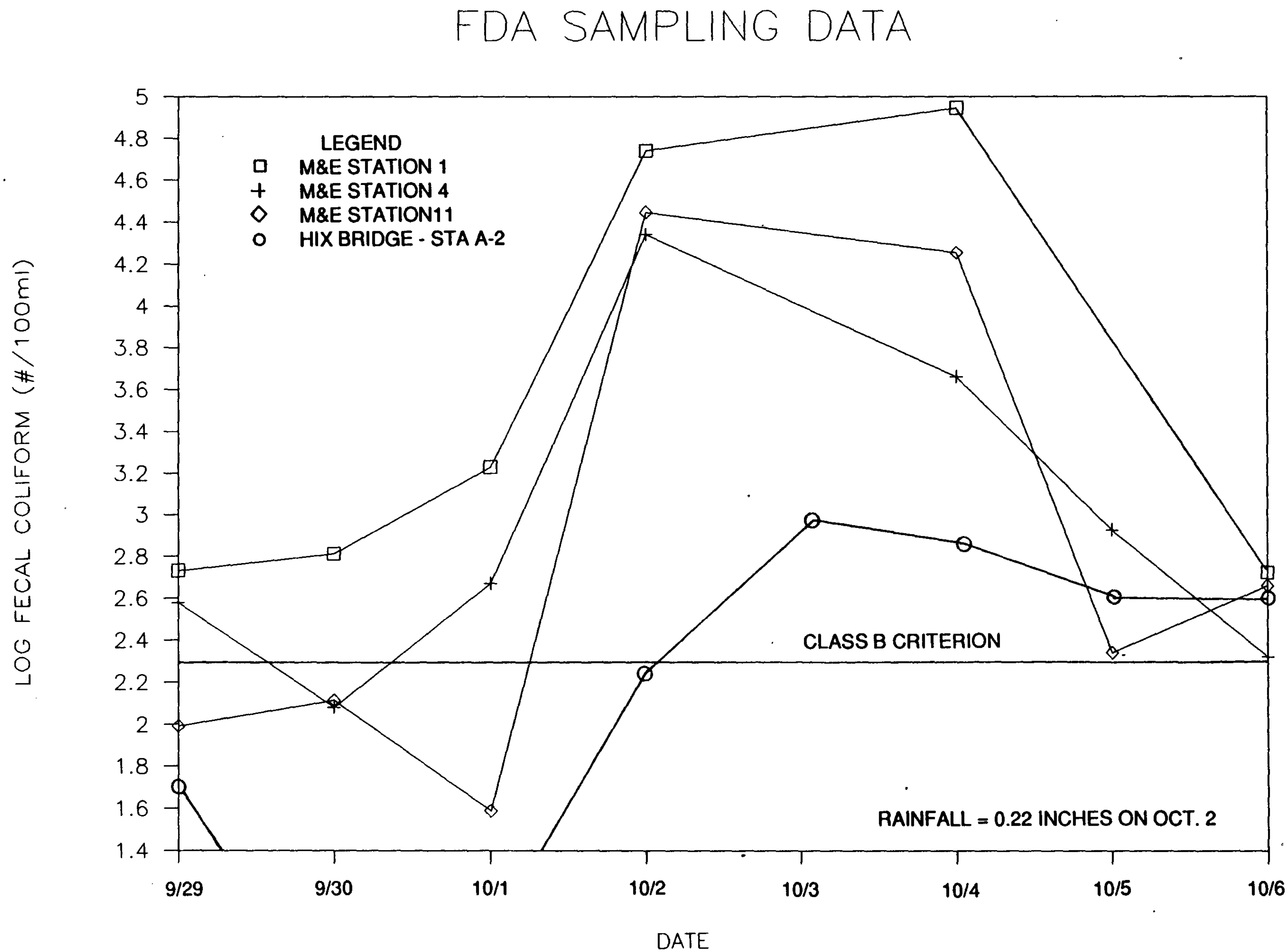


FIGURE 3-8. FECAL COLIFORM, FECAL STREPTOCOCCUS AND E. COLI, MOUTH OF SNELL CREEK, SEPTEMBER 29 TO OCTOBER 6, 1989

Also shown on Figure 3-8 are the fecal coliform counts at the Hix Bridge station in the EBWR during the same survey. The response to the rainfall event at this location is clear, although not as dramatic as in Snell Creek. This is as anticipated due to several factors including 1) the dilution in the larger water body, 2) the tendency of more rapid bacterial die-off in saline water, and 3) the travel time required for the bacteria to move from sources such as Snell Creek to the receiving water stations in the EBWR.

In 1987, the DWPC (1988) conducted intensive bacteriological sampling in both branches of Snell Creek as well as the intermittent tributary just west of Drift Road. During the previous year, the DWPC also collected samples in Snell Creek. Data from the former program collected on July 13, 1987 during a dry period are shown in Figure 3-9. Data from the latter program, collected on October 2, 1986 when 0.39 inches of rainfall were recorded in New Bedford, are shown in Figure 3-10. On July 13, 1987, it should be noted that 0.01 inches of rainfall were recorded at New Bedford. It is possible that some small volume of runoff may have occurred from this trace rainfall on that day.

The dry weather bacteria data indicate that violations of the Class B criterion for fecal coliform can still occur. The data (Figure 3-9) show a significant increase in fecal coliform levels between Stations 0105 and 0106, indicating a source between these stations. Further investigation has indicated the likely source of this bacteria increase to be storm drains from the Route 88 state highway drainage system. These drains can flow during fairly dry weather, although the amount of increase in fecal coliform counts on July 13, 1987 indicated that some runoff may have occurred. The only other source in this reach could be animal feces in the actual stream segment, however there are no agricultural sources in this reach. A nearly three-fold increase in chloride concentration (15 to 41 mg/l) indicates a highway runoff contribution. Other data at these stations have shown a similar increase in bacteria and chloride between these two stations.

Data on the wet day (10/2/86) indicate fecal coliform counts an order of magnitude higher than on the dry day. This is consistent with the data in other studies, and stresses the need for wet weather bacteria control.

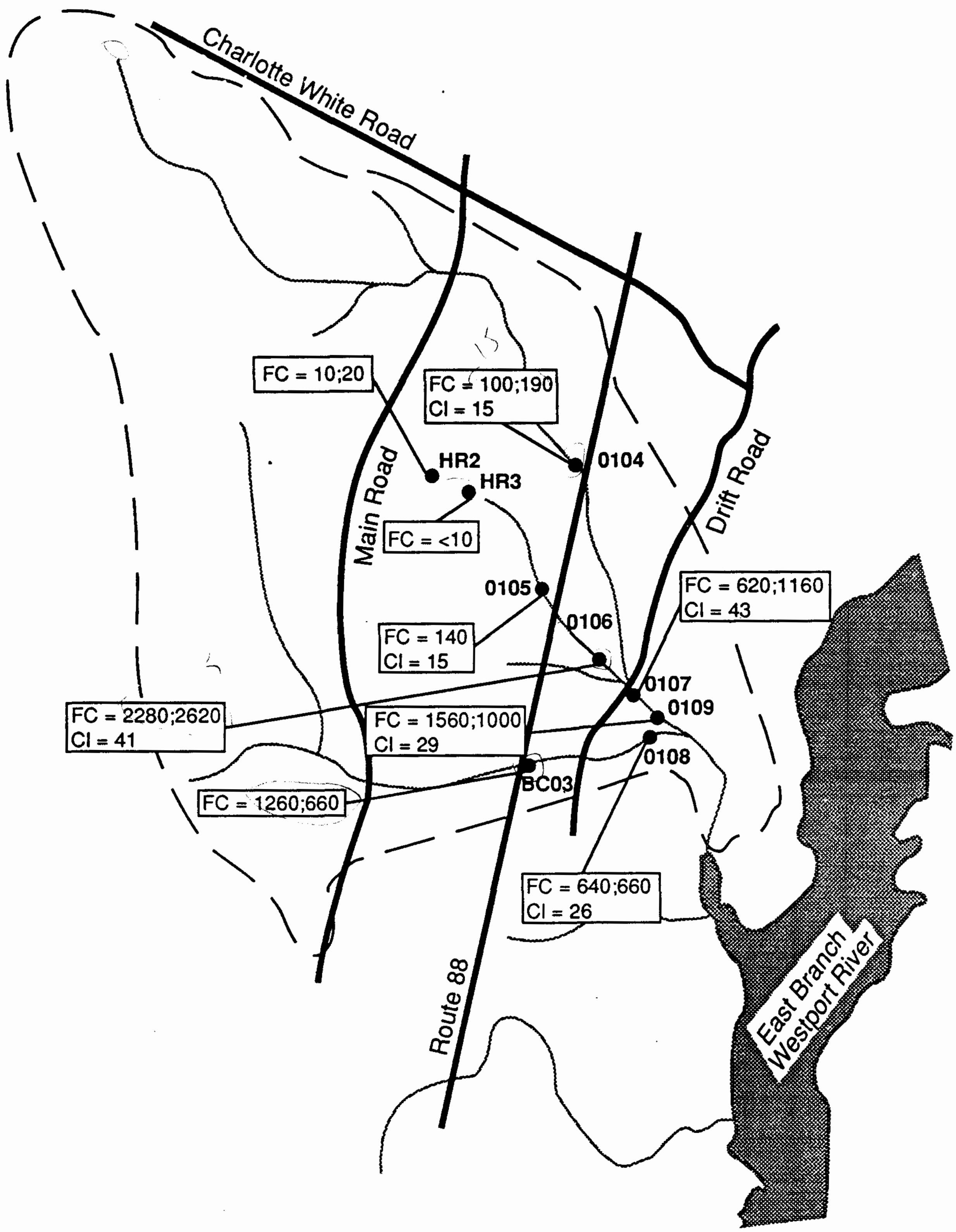


FIGURE 3-9. SNELL CREEK DRY WEATHER WATER QUALITY – 7/13/87 SAMPLING STATIONS (BESKINIS, 1986)

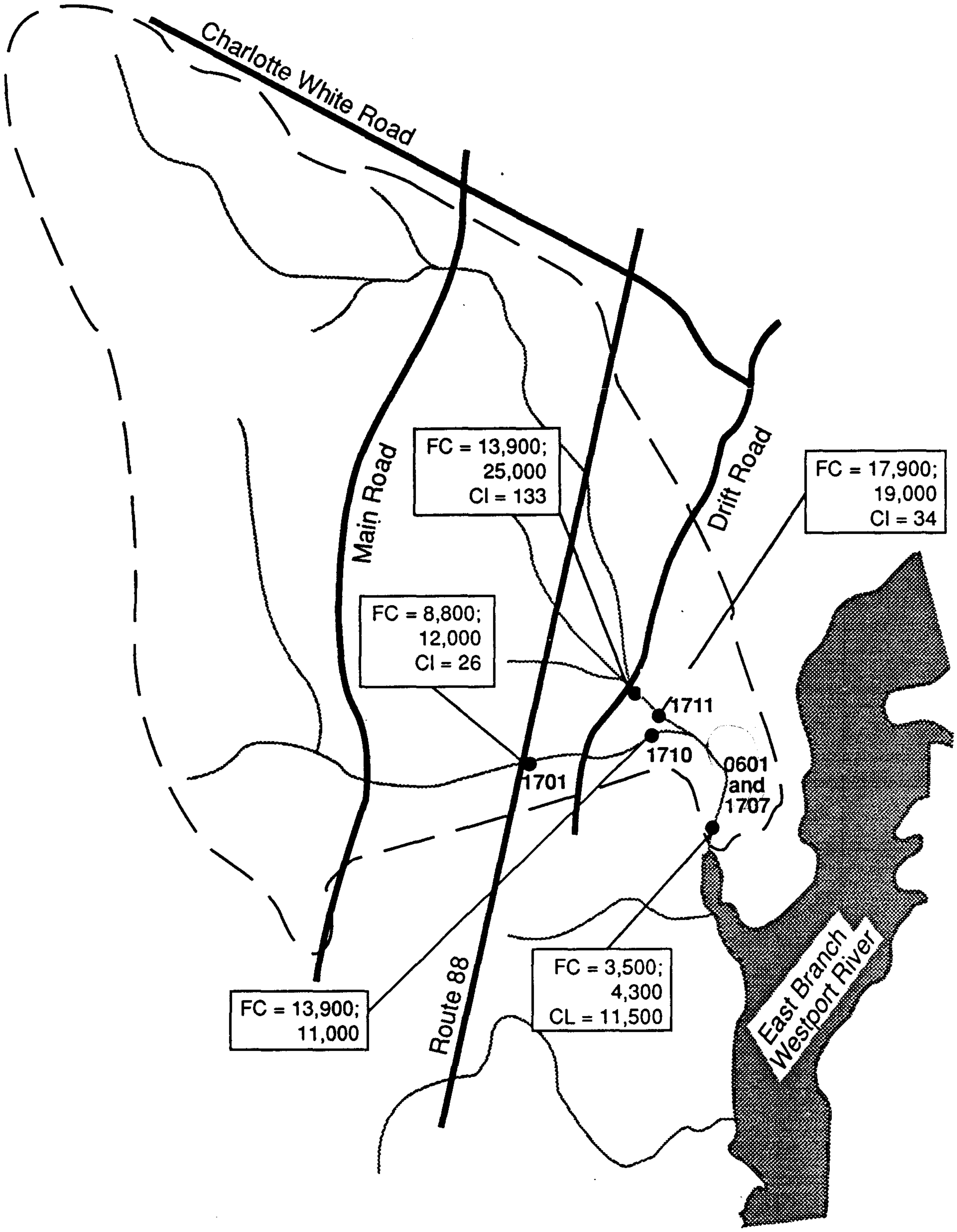


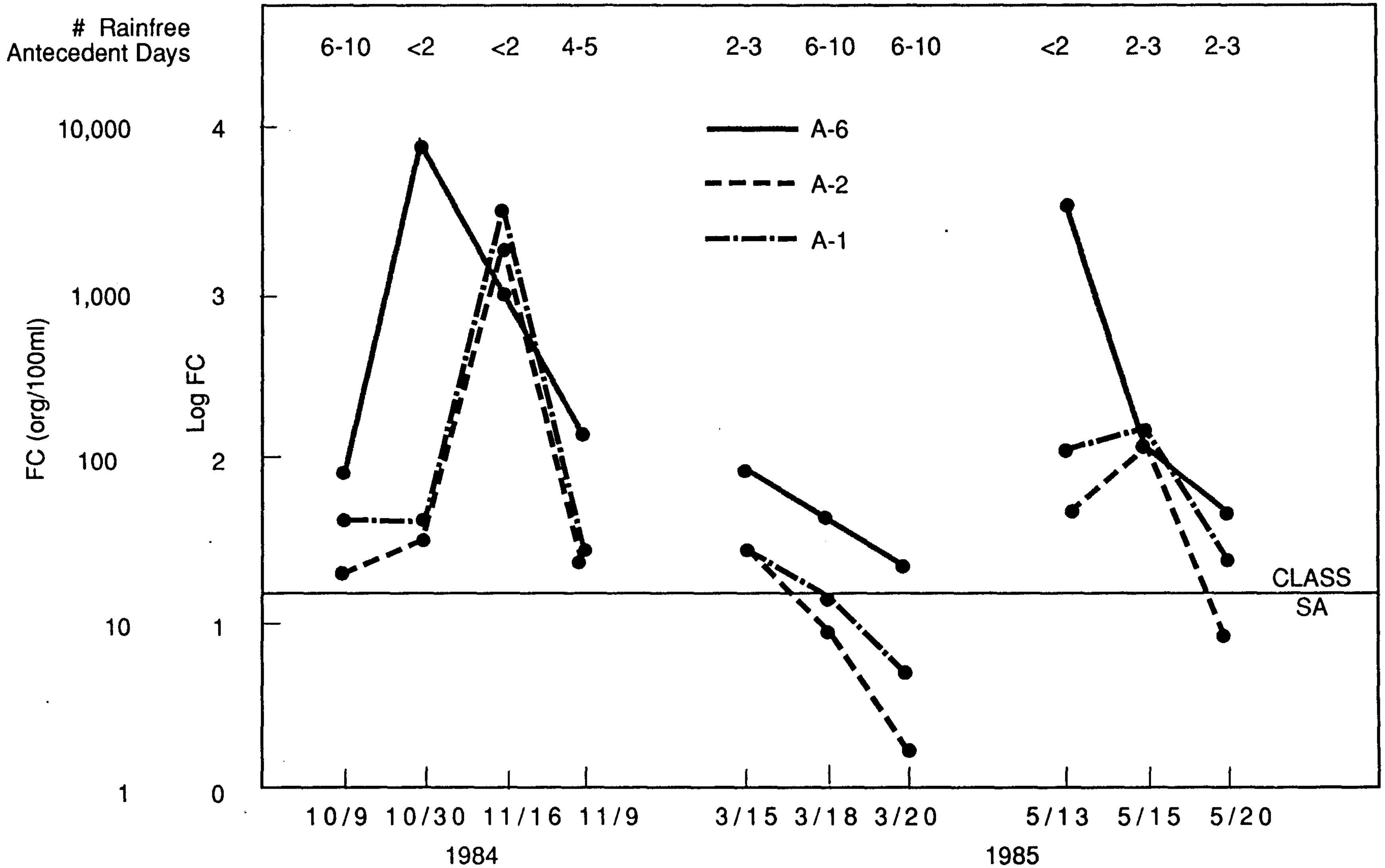
FIGURE 3-10. SNELL CREEK WET WEATHER WATER QUALITY – 10/2/86 SAMPLING STATIONS (BESKINIS, 1986)

Although dry weather bacteria violations may occur in Snell Creek and other EBWR tributaries, they are not substantial enough to result in shellfish closures in the conditionally open segments of the EBWR. They do, however, contribute to consistent contamination problems in upper reaches.

In a bacterial survey of the EBWR Westport (GHR, 1987), the mouth of Snell Creek was sampled ten times between August 1984 and November 1985. This study established a direct correlation between fecal coliform standard violations in the EBWR and rainfall events. Figure 3-11 shows fecal coliform concentrations at the mouth of Snell Creek and at two receiving water stations in the EBWR, one upstream and one downstream of Snell Creek. Fecal coliform counts at Hix Bridge respond to inputs from Snell Creek as well as sources further upstream, significantly exceeding Class SA standards after rainfall and subsiding after several days of dry weather.

The impact of Snell Creek is indicated in Figure 3-11 by the higher bacteria counts which occur at the mouth of the creek than in the EBWR. However, the specific effect of Snell Creek is masked by other sources of bacteria entering the EBWR, as well as other factors which contribute to the observed EBWR bacteria counts, such as travel time, mixing, dilution and bacterial die-off. To fully represent all these processes, a mathematical model of the entire EBWR system would need to be developed, calibrated and verified. This type of effort is beyond the scope of this study, and for that matter, is beyond the scope of what is reasonable to implement during most nonpoint source control projects. Rather, approximate but reasonable estimates can be made which will provide assurance that control of bacteria in Snell Creek will have a positive impact on the conditionally closed reach of the EBWR.

The major contributing drainage areas of the EBWR are listed in Table 3-4, along with their average flow contribution estimated using the relationships developed by Pivetz et. al. (1986). An estimate of the distance from Hix Bridge, along with a travel time and a bacteria die-off rate can be used to estimate a loading contribution as follows:



A-1 East Branch, Upstream of Snell Creek
A-2 East Branch, Downstream of Snell Creek at Hix Bridge
A-6 Snell Creek, Mouth

FIGURE 3-11. FECAL COLIFORM, MOUTH OF SNELL CREEK AND EAST BRANCH OF THE WESTPORT RIVER

$$C = C_o e^{-kt}$$

where C = Concentration (or load) at Hix Bridge
C_o = Concentration (or load) at source
k = Bacterial die-off rate (assumed = 1/day)
t = Travel time (range from 2.6 to 5.2 days)

This calculation assumes constant bacteria concentration of all sources, a fairly conservative (low) bacterial die-off rate, and a range of travel times based on Pivetz et. al. (1986). This type of rough estimate demonstrates that sources close to the area of impact, such as Snell Creek and Kirby Brook,

TABLE 3-4. IMPACT OF FECAL COLIFORM BACTERIA AT HIX BRIDGE

Name	Area (Acres)	Avg. Flow (cfs)	Avg. Flow (% Total)	Distance Upstream of Hix Bridge (Feet)	Fecal Coliform (Percent of Load)
Snell Creek	1,090	3.2	3.8	5,000	20-50
Kirby Brook	2,360	7.1	8.5	12,000	20-30
Everett Cove	570	1.7	2.0	15,000	3-4
Sisson's Cove	425	1.4	1.7	22,000	1-2
Bread & Cheese Brook	6,690	20.0	24.0	24,000	5-15
East Branch	13,780	40.0	48.0	24,000	10-30
Minor Tribs	940	3.2	3.8	6,000	5-20
Direct Drainage	2,330	7.1	8.5	12,000	<1
Total		83.7	100		

can have a more significant effect than those further away, even if those more distant sources are larger. These estimates are not intended as a substitute for more detailed mathematical modeling, but only to show that since Snell Creek accounts for 20 to 50 percent of the bacteria load at Hix Bridge, reduction in bacteria export from Snell Creek should have a positive impact on the conditional closure area in the EBWR. It also should be stressed that ultimately, control of all nonpoint sources into the EBWR, not just those in Snell Creek, is desired.

The fecal coliform data at the Hix Bridge station on a long-term basis are shown in Figure 3-12. These data show a high frequency of shellfishing criteria violations. Reduction in Snell Creek bacteria loading should contribute to lowering the frequency of these violations, thus allowing conditional openings to be more frequent.

The water quality assessment has focused on bacteria based on the discussion in Chapter 2 which showed it to be the main water quality problem. Data in Snell Creek at station ME1 on nutrients and solids are shown in Figures 3-13 through 3-17 for TKN, ammonia, nitrate, total phosphorus and total suspended solids. These data are summarized and compared to data in the EBWR at Hix Bridge in Table 3-5. It is clear from this comparison that bacteria are significantly higher in Snell Creek than in the EBWR. Regarding nutrients, nitrate is the only parameter which is higher in Snell Creek than in the EBWR. Although data from other tributaries in the EBWR were not analyzed in detail, similar patterns are expected.

TABLE 3-5. COMPARISON OF SNELL CREEK AND HIX BRIDGE WATER QUALITY

Parameter	Unit	Snell Creek @ Mouth	Hix Bridge	Note
Fecal Coliform	MPN/100 ml	900	100	log mean
Fecal Strep	MPN/100 ml	1,100	25	log mean
NH_3	mg/l	0.1	0.1	
TKN	mg/l	1.0	1.0	
NO_3	mg/l	1.5	0.3	
TP	mg/l	0.1	0.1	
TSS	mg/l	4	10	

Summary. Based on the data discussed in this chapter, as well as in Chapter 2, the main goal of the nonpoint source management plan will be to reduce the bacterial impact of Snell Creek on the EBWR. Achieving the Class B criterion of 200 organisms/100 ml in Snell Creek will be sought. This will require a bacteria reduction in wet weather of at least one order of magnitude. Some control during dry weather will also be sought, although this will not likely have a significant effect on the EBWR. A secondary goal having much less priority will be control of nutrients.

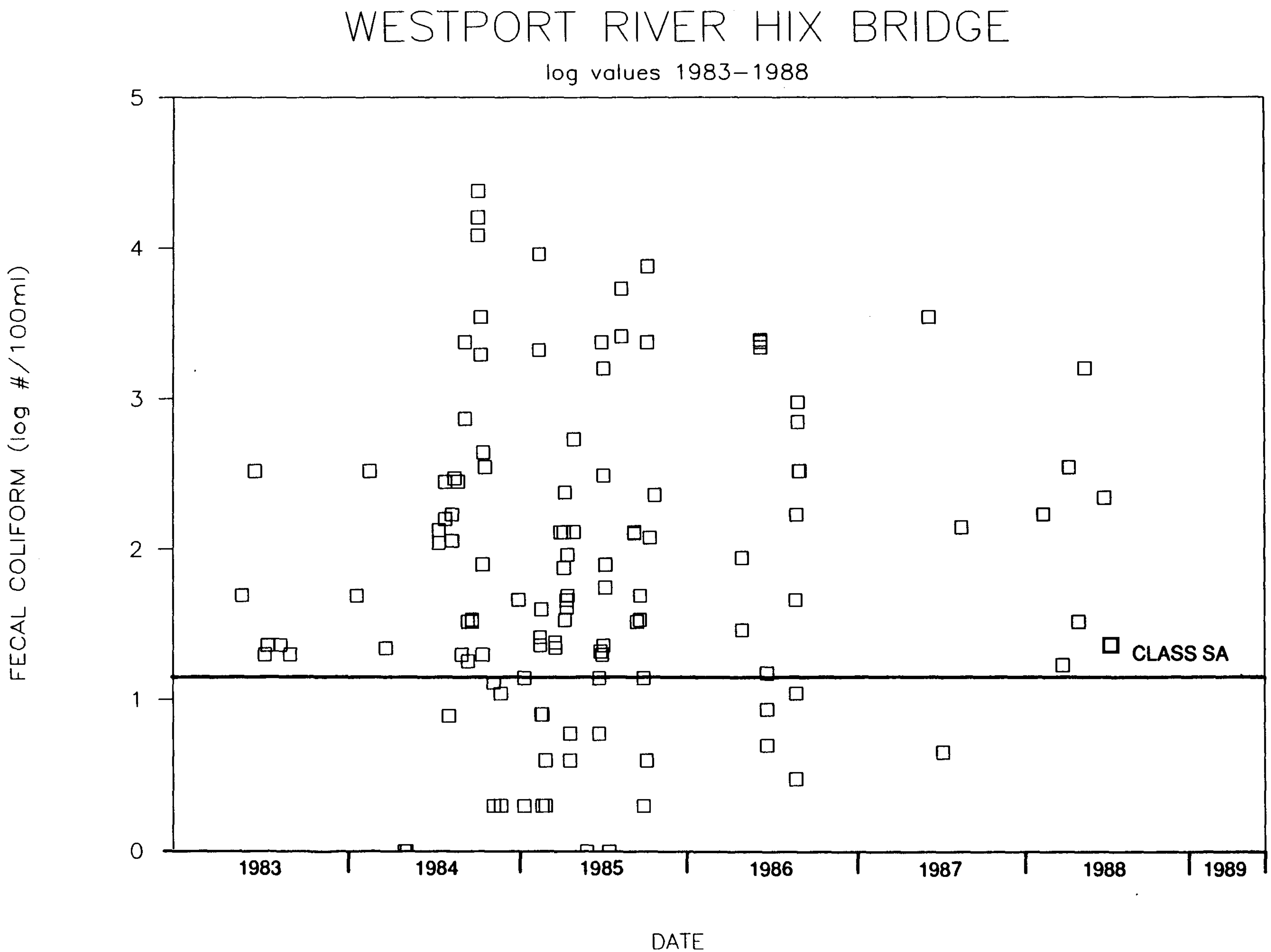


FIGURE 3-12. FECAL COLIFORM DATA, HIX BRIDGE STATION

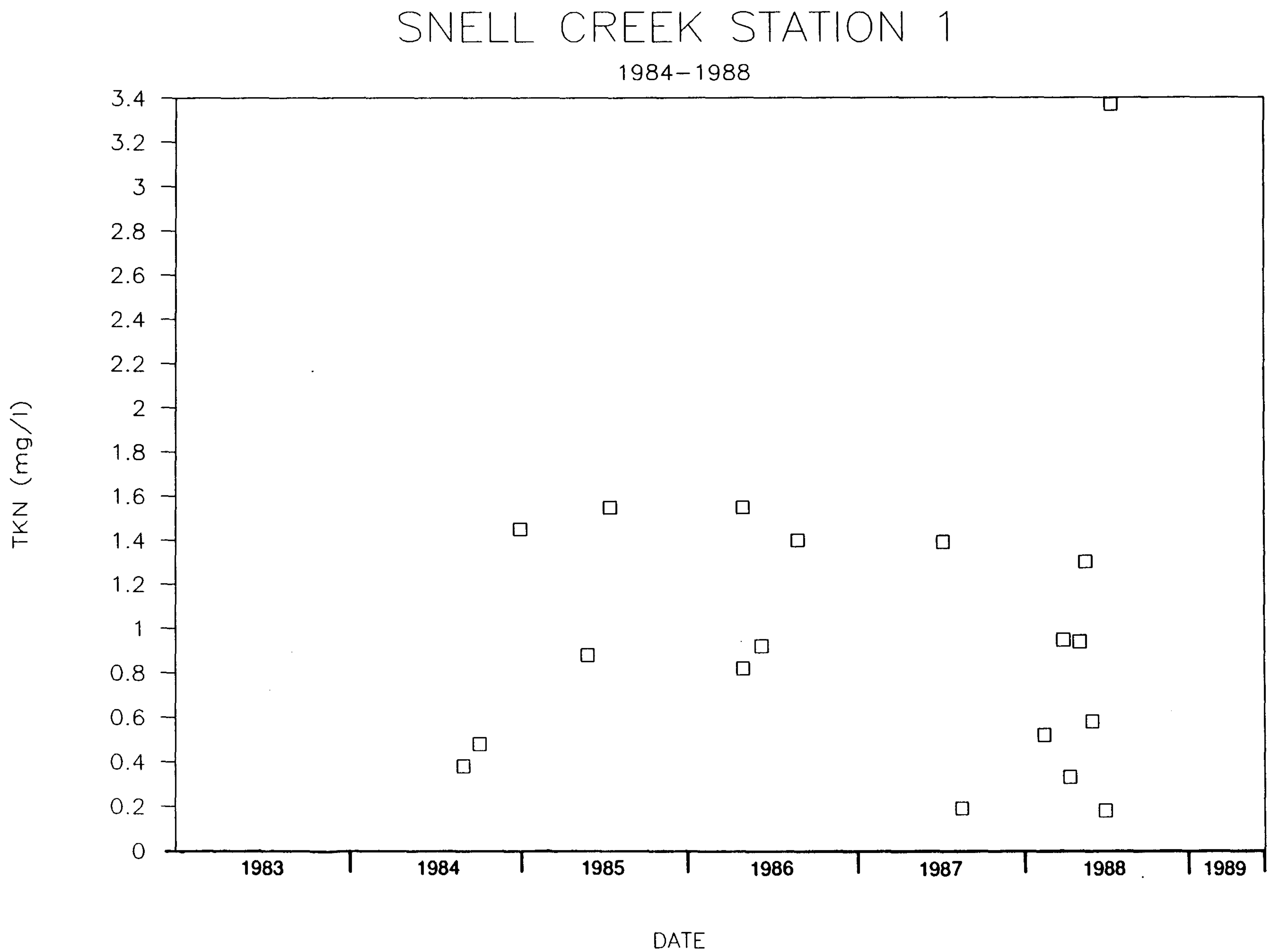


FIGURE 3-13. TOTAL KJELDAHL NITROGEN CONCENTRATIONS, SNELL CREEK STATION 1

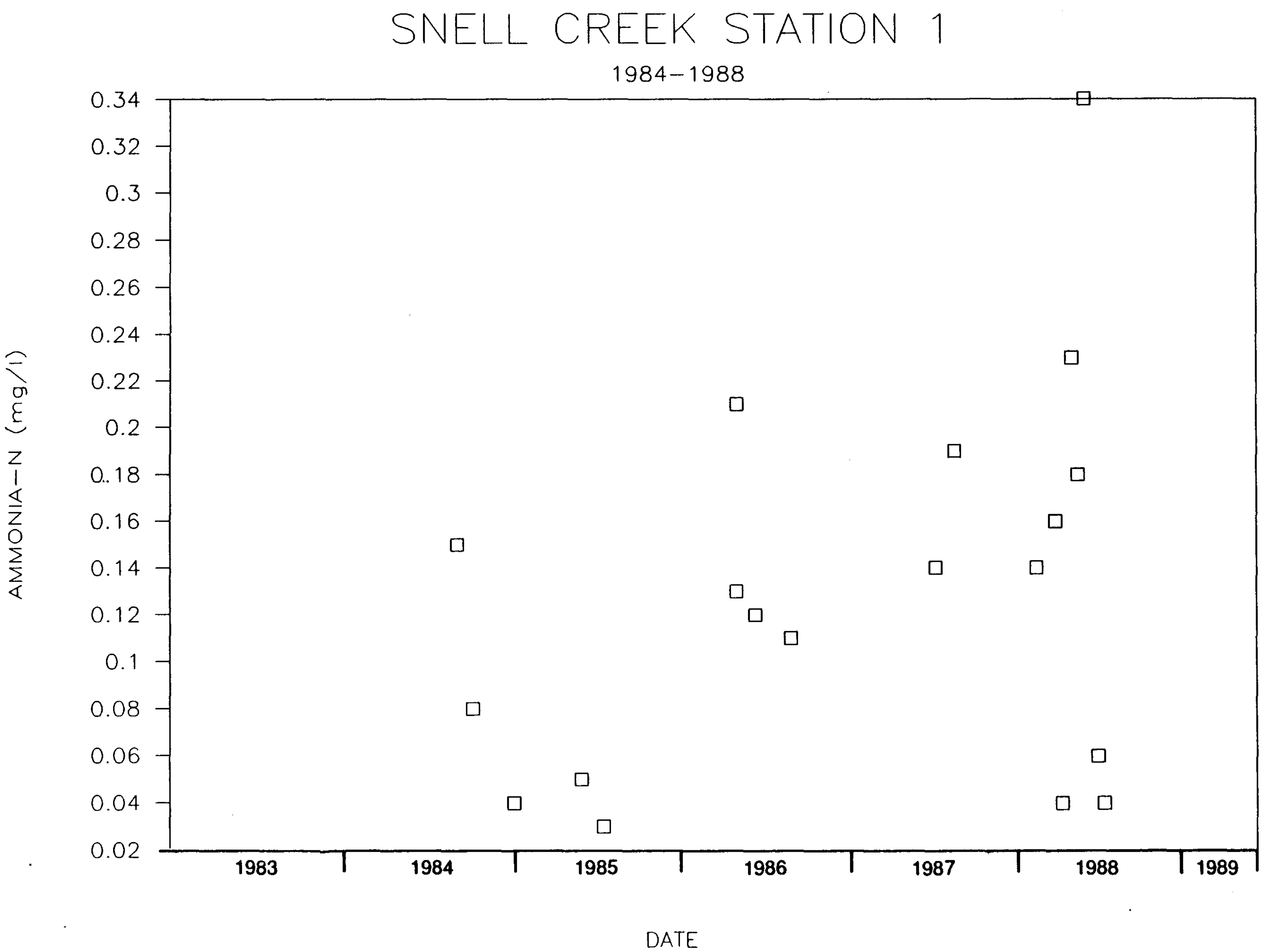


FIGURE 3-14. AMMONIA CONCENTRATIONS, SNELL CREEK STATION 1

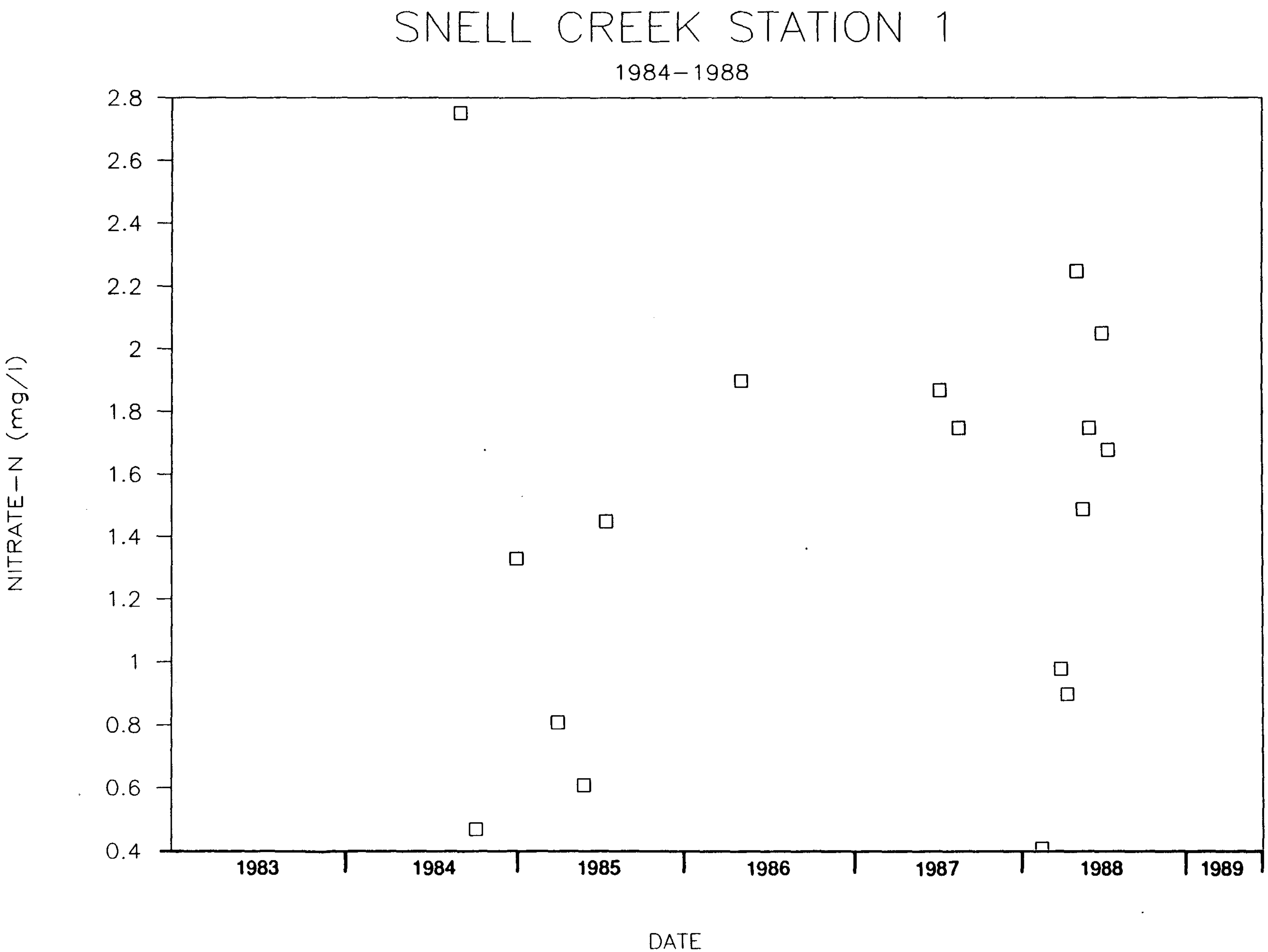


FIGURE 3-15. NITRATE CONCENTRATIONS, SNELL CREEK STATION 1

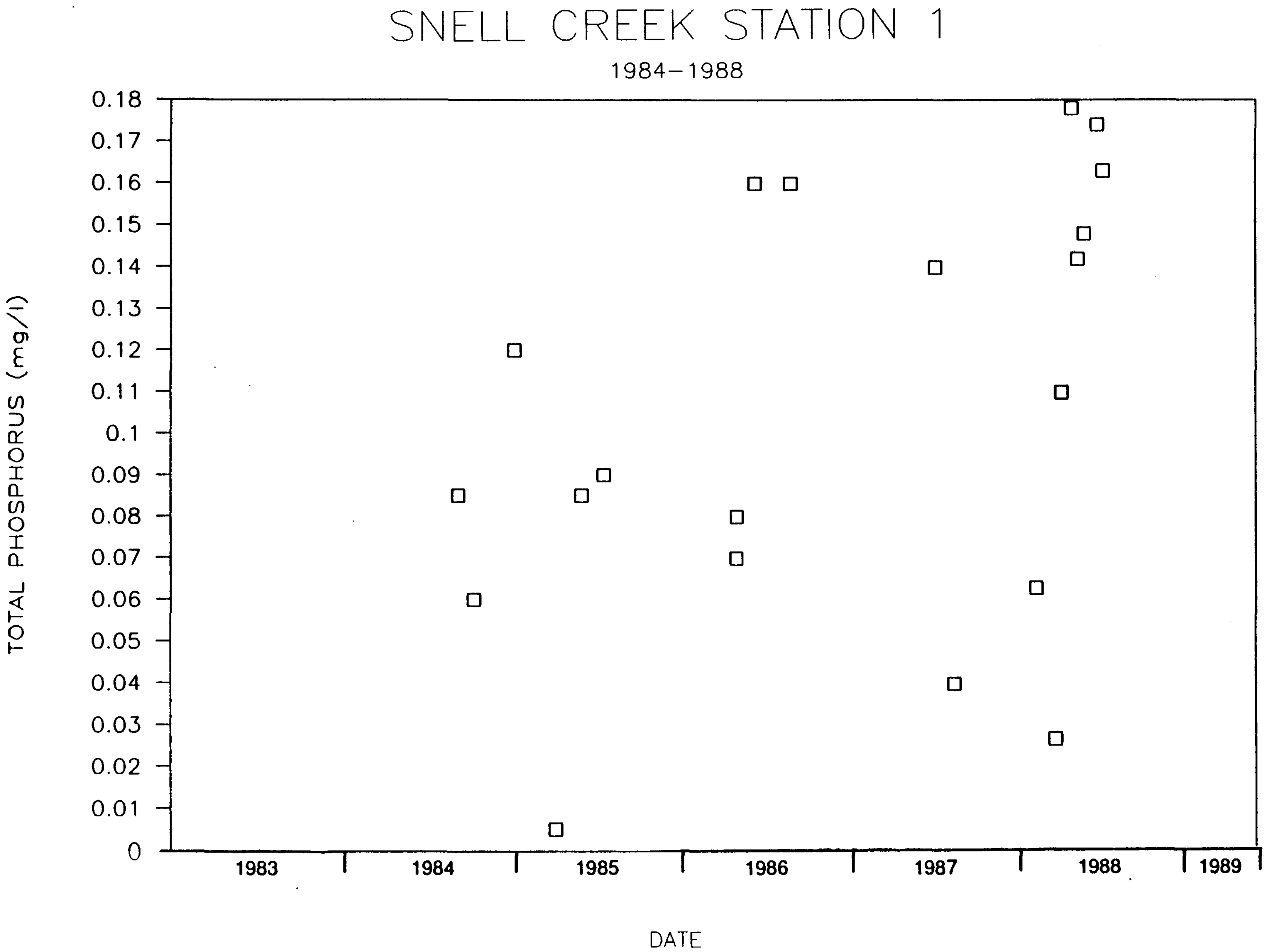


FIGURE 3-16. TOTAL PHOSPHOROUS CONCENTRATIONS, SNELL CREEK STATION 1

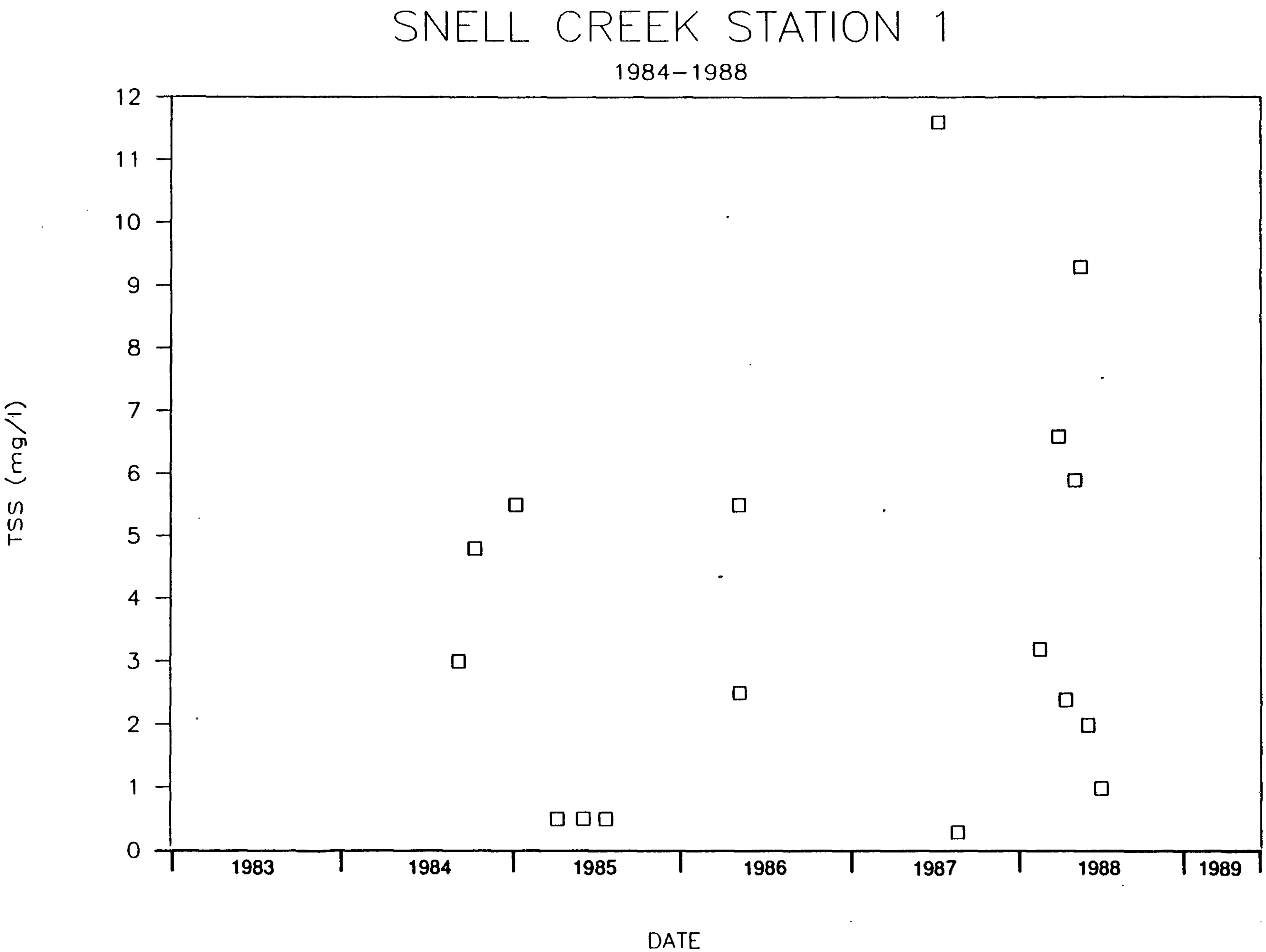


FIGURE 3-17. TOTAL SUSPENDED SOLIDS CONCENTRATIONS, SNELL CREEK STATION 1

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CHAPTER 4

IDENTIFICATION AND PRIORITIZATION OF POLLUTION SOURCES

This chapter describes the identification of nonpoint sources within the watershed of Snell Creek, and the process used to prioritize sources recommended for control.

Source Identification and Description

Morehouse (1988) Region I developed a list of nonpoint sources of pollution commonly found throughout New England. This list was used as the basis for the development of a list of pollution sources or watershed profile for the Snell Creek watershed. This Snell Creek watershed profile shown in Table 4-1 was developed through:

- Interviews with local and state officials, members of the project advisory group, local environmental groups, representatives of USDA, and private citizens;
- Review of previous studies;
- Review of recently developed land use maps and aerial photographs; and
- Field visits during February, 1989 with local representatives.

The underlined categories were those thought to be present in the watershed. In order to identify specific sources, detailed field reconnaissance was conducted during the summer of 1989. Field activities included visual observations, drainage system inspections, and photodocumentation. The specific sources identified through field inspection are listed and described with respect to location and pollutant type in Table 4-2. The locations of these sources are shown in Figure 4-1. Detailed descriptions of the sources are provided below by category.

Agriculture. According to the Association of State and Interstate Water Pollution Control Administration and EPA (1985), every region of the United States listed agricultural sources of pollution as the most pervasive nonpoint

TABLE 4-1
NPS POLLUTION CATEGORIES AND SUBCATERGORIES SCREENING FOR WESTPORT

10 Agriculture
- 11: Non-Irrigated Crop Production
- 12: Irrigated Crop Production
- 13: Specialty Crop Production
- 14: Pasture Land
- 15: Hayland
- 16: Animal Holding Areas
- 17: Wash and Process Water
- 18: Waste Application Areas

20 Silviculture
- 21: Harvesting
- 22: Reforestation
- 23: Residue Management

30 Construction
- 31: Highway/Road/Bridge
- 32: Land Development

40 Urban Runoff
- 41: Storm Sewers
- 42: Combined Sewers
- 43: Surface Runoff
- 44: Infiltration Wells and Basins

50 Resource Extraction/Exploration/Development
- 51: Surface Extraction Areas
- 52: Processing Facilities

60 Land Disposal (Runoff/Leachate from Permitted Areas)
- 61: Sludge/Septage
- 62: Landfills
- 63: On-Site Wastewater Systems
- 64: Hazardous Waste

70 Hydrologic/Habitat Modification
- 71: Channelization
- 72: Dredging
- 73: Dam Construction
- 74: Earth Fill

80 Other
- 81: Atmospheric Deposition
- 82: Waste Storage/Storage Tank Leaks
- 83: Highway and Bridge Maintenance
- 84: Spills/Illegal Disposal
- 85: In-Place Contaminants
- 86: Natural Vegetation
- 87: Auto Salvage Facilities
- 88: Washing and Processing Areas
- 89: Snow Dumping Areas
- 90: Utility Rights-of-Way
- 91: Domestic and Wild Animals
- 92: Sewer System Leaks
- 93: Boats and Marinas

TABLE 4-2. SNELL CREEK NONPOINT POLLUTION SOURCE DESCRIPTIONS

Pollution Sources	Description	Conventional Pollutant Types
1. Pimental Farm	Dairy farm on Drift Road near the mouth of Snell Creek with 375 cattle and associated feedlots, barnyards, animal holding areas, and manure handling areas	Bacteria, nutrients, solids
2. Costa Farm	Dairy farm on Charlotte White Road adjacent to the headwaters of Snell Creek with 50 cattle and associated facilities	Bacteria, nutrients, solids
3. Brookwood Road Development	Cleared land on Brookwood Road for construction of new homes	Nutrients, solids
4. Charlotte White Road	Cleared land on Charlotte White Road for construction of new homes	Nutrients, solids
5. Route 88	Two lane state highway drained by concrete waterways and piped drainage system discharging to Snell Creek at three locations	Bacteria, nutrients, solids
6. Main Road	Drainage from Main Road enters Snell Creek in two locations by overland runoff	Bacteria, nutrients, solids
7. Drift Road	Drainage from Drift Road enters Snell Creek in two locations by overland runoff	Bacteria, nutrients, solids
8. Pratt Avenue	A portion of Pratt Avenue is drained by a catchbasin connected to an open trench discharging to Snell Creek	Bacteria, nutrients, solids
9. Septic Systems	Watershed-wide and suspected specific problems along Pratt Avenue and Brookwood Road	Bacteria, nutrients
10. Charlotte White Road Auto Salvage	Auto salvage yard near intersection of Charlotte White Road and Main Road	Bacteria, nutrients, solids, metals
11. Domestic and Wild Animals	Domestic animals watershed-wide. Waterfowl concentrated in wetland west of Main Road	Bacteria
12. Parking Lots	Runoff from parking areas on Main Road with no drainage systems	Bacteria, nutrients, solids

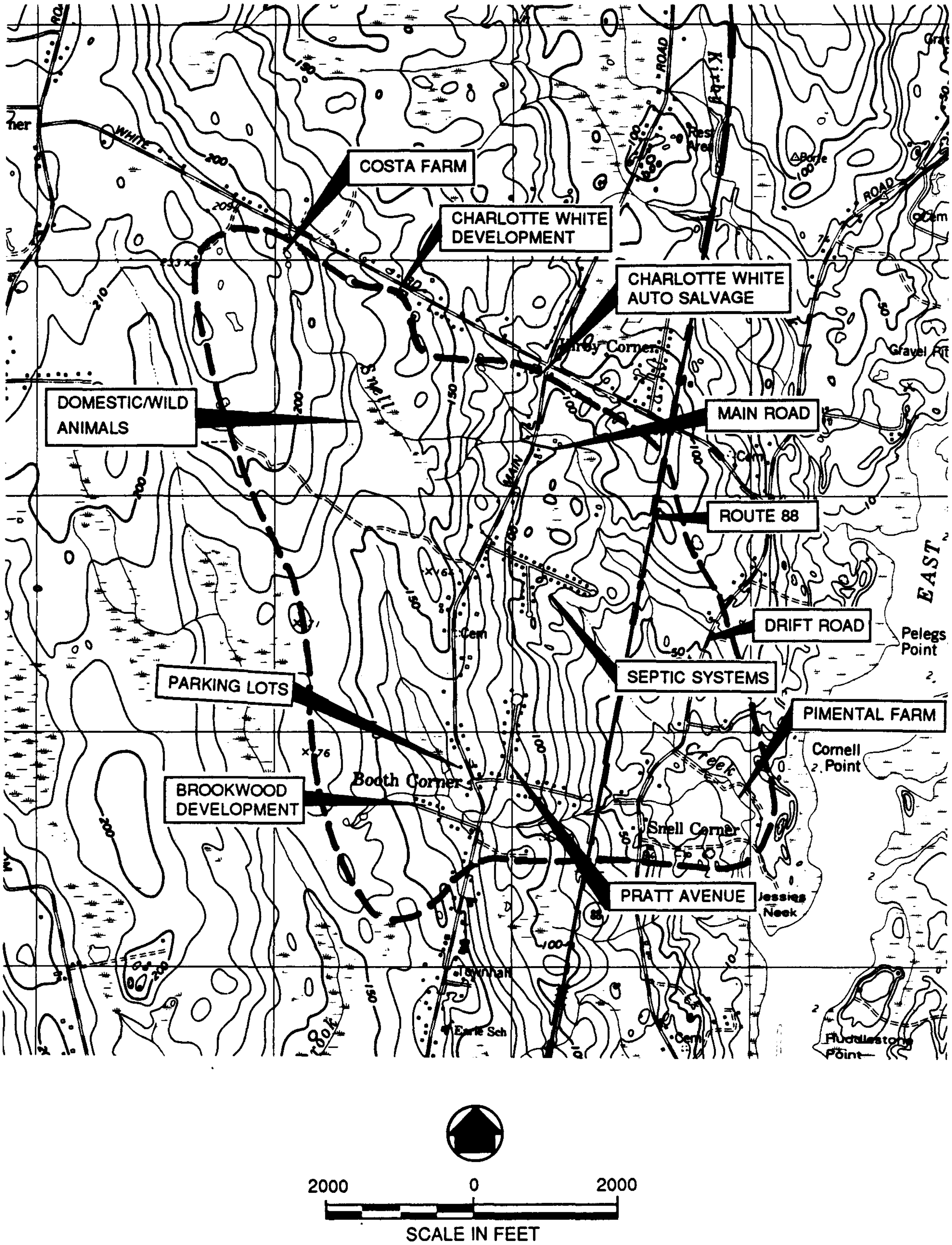

FIGURE 4-1. SNELL CREEK NONPOINT SOURCE LOCATIONS

pollution source. Within the Snell Creek watershed, agricultural sources of pollution include two dairy farms located along the waterway. Both of these farms have overgrazed pasture land and have failed to maintain sufficient pastureland ground cover. This lack of ground cover, combined with concentrated animal holding areas has resulted in soil erosion, wash-off of fecal matter, and development of drainage gullies that flow directly to Snell Creek. Fecal matter from cattle has been shown experimentally to be a source of significant fecal coliform bacteria with runoff from fresh cow manure deposits having significantly higher bacteria counts than did old deposits. However, even fecal deposits 100 days old produced bacterial counts in surface runoff to nearby waters in excess of recreational water quality standards (Kress and Gifford, 1984). Detailed descriptions of agricultural sources follow.

Pimental Farm - The Pimental farm is a large dairy farm of approximately 375 cattle which covers 30 acres and borders on 1500 linear feet of the creek. A schematic of the farm is provided in Figure 4-2 to illustrate the location of the grazing fields and farm buildings with respect to Snell Creek and the EBWR. The four grazing fields depicted in Figure 4-2 are largely unvegetated due to overgrazing, with the exception of weeds and brush which provide little filtration and retention of water. During several site visits and an extensive tour of the farm on August 17, 1989, the effects of overgrazing were evident. As indicated in Figure 4-2, runoff from erosion-prone overgrazed areas and from roof runoff has caused formation of eroded gullies or erosion ditches which provide a direct hydrologic connection between livestock grazing, feeding and holding areas and Snell Creek. Based on the large number of livestock currently on the farm and the large structures present which generate considerable runoff, overgrazed fields and uncontrolled runoff are felt to be the principle causes of fecal coliform export from this farm. During 1982, Mr. Pimental entered into a water quality contract with the USDA Soil Conservation Service and Agricultural Stabilization and Conservation Service. As part of this contract, the Soil Conservation Service developed a water quality management plan with recommendations to protect water quality including the installation of a roofed feedlot, a manure pit, roof runoff control, fencing, and seeding of the

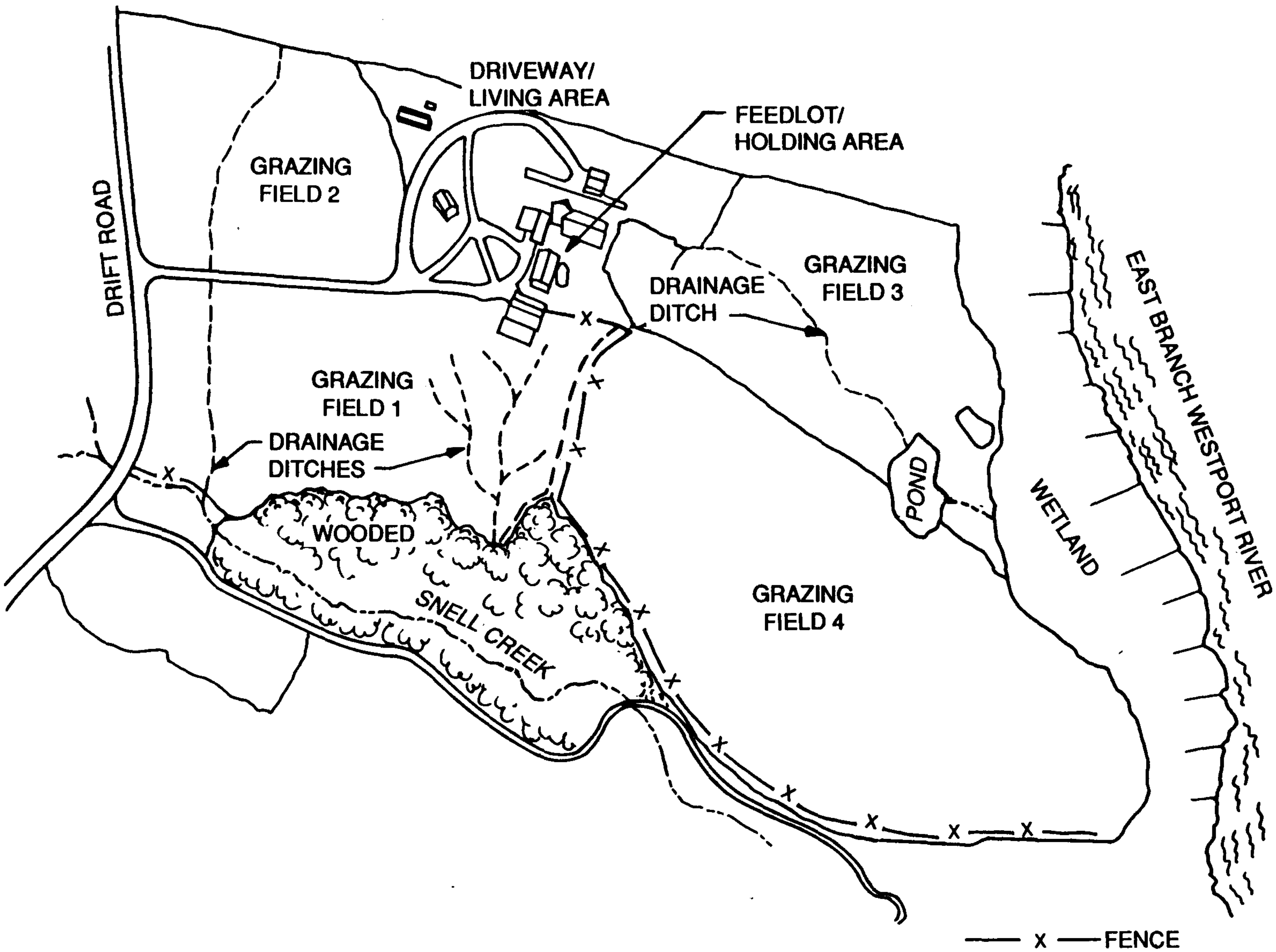

FIGURE 4-2. PIMENTAL FARM SCHEMATIC. EXISTING CONDITIONS

grazing land. Due to difficulties with administration of this contract, only the roofed feedlot has been constructed. Therefore, the Pimental farm is still a potential significant source of bacteria and sediment to Snell Creek and the East Branch of the Westport River.

Costa Farm - The Costa farm is located west of Main Road at the headwaters of the north branch of Snell Creek. This farm is significantly smaller than the Pimental farm with only 40 to 50 cattle and several pigs. Based on a site visit and review of USGS topographic maps, an approximate 2 acre area abuts a small pond which is the headwaters of Snell Creek. This farm is not suspected as a significant source of fecal bacteria to Snell Creek, although manure handling practices at this farm may contribute to the elevated coliform counts found in this reach of the creek on several sampling events. The Soil Conservation Service has not developed a water quality management plan for the Costa farm.

Construction. Construction activities result in erosion and deposition of sediment in nearby waterways. Within the watershed of Snell Creek, there are areas at Brookwood Road and Charlotte White Road where land has been cleared for development but construction has not yet begun. These areas are identified on Figure 4-1. Brookwood Road is an existing development off Main Road near the southern-most tributary of Snell Creek with approximately 25 homes. It is being extended westward to accommodate approximately an equal number of new homes. In addition, land along the south side of Charlotte White Road east of the Costa Farm is being cleared for development. Approximately ten lots have been cleared in the densely wooded area at the northern section of the Snell Creek watershed.

Urban Runoff. On a national level, stormwater runoff is seen as the most pervasive nonpoint pollution problem after agriculture. In developed areas and major roadways, drainage systems cause urban runoff to bypass natural vegetation which promotes infiltration and filtering of solids. Therefore, the pollutants which build-up along the road sides during dry weather are washed off directly into adjacent waterways during wet weather. These pollutants include bacteria, nutrients, sediments, and heavy metals.

Route 88, a major state highway running north/south from Route 6 to Horseneck Beach, has an extensive drainage system within the Snell Creek watershed. This drainage system consists of a series of concrete channels which convey water down the road embankment from the road surface to a series of catch basins which direct the flow into Snell Creek. The existing system provides no opportunity for solids to settle or for infiltration to remove nutrients and bacteria. As discussed in Chapter 3, the middle branch of Snell Creek showed a significant increase in fecal coliform levels downstream of Route 88.

As shown in Figure 4-3, there are three separate branches of Snell Creek which receive runoff from Route 88. The northern crossing receives runoff from approximately 2,000 linear feet of roadway beginning at Charlotte White Road. The central crossing is at the low point of Route 88 and receives runoff from approximately 1,000 linear feet of roadway. The southern crossing receives runoff from approximately 1,000 linear feet of Route 88 as well as two catchbasins at the end of Kirby Road. In addition, the current system includes perforated sub-drains to direct high groundwater away from the roadway fill. During field investigations, many of these sub-drains were flowing, indicating high groundwater elevations.

Other sources of urban runoff near Snell Creek are identified on Figure 4-1 and include surface runoff from Main Road, Drift Road, Pratt Road, and a parking lot off Main Road. Snell Creek crosses Main Road two times, both in light residential areas, and Drift Road is crossed twice in undeveloped areas. These roadways do not have drainage systems, thus runoff enters Snell Creek by overland flow. Pratt Avenue is a small roadway off Kirby Road which has a catch basin directing flow into a wooded area. This flow, which is collected from the length of Pratt Avenue, then travels over land to Snell Creek. Finally, along Main Road near its intersection with Kirby Road, there is a bank parking lot less than two acres in size. These areas, however, are not drained by piped drainage systems and pollutant runoff from these areas may be attenuated through infiltration, and filtration by roadside vegetation.

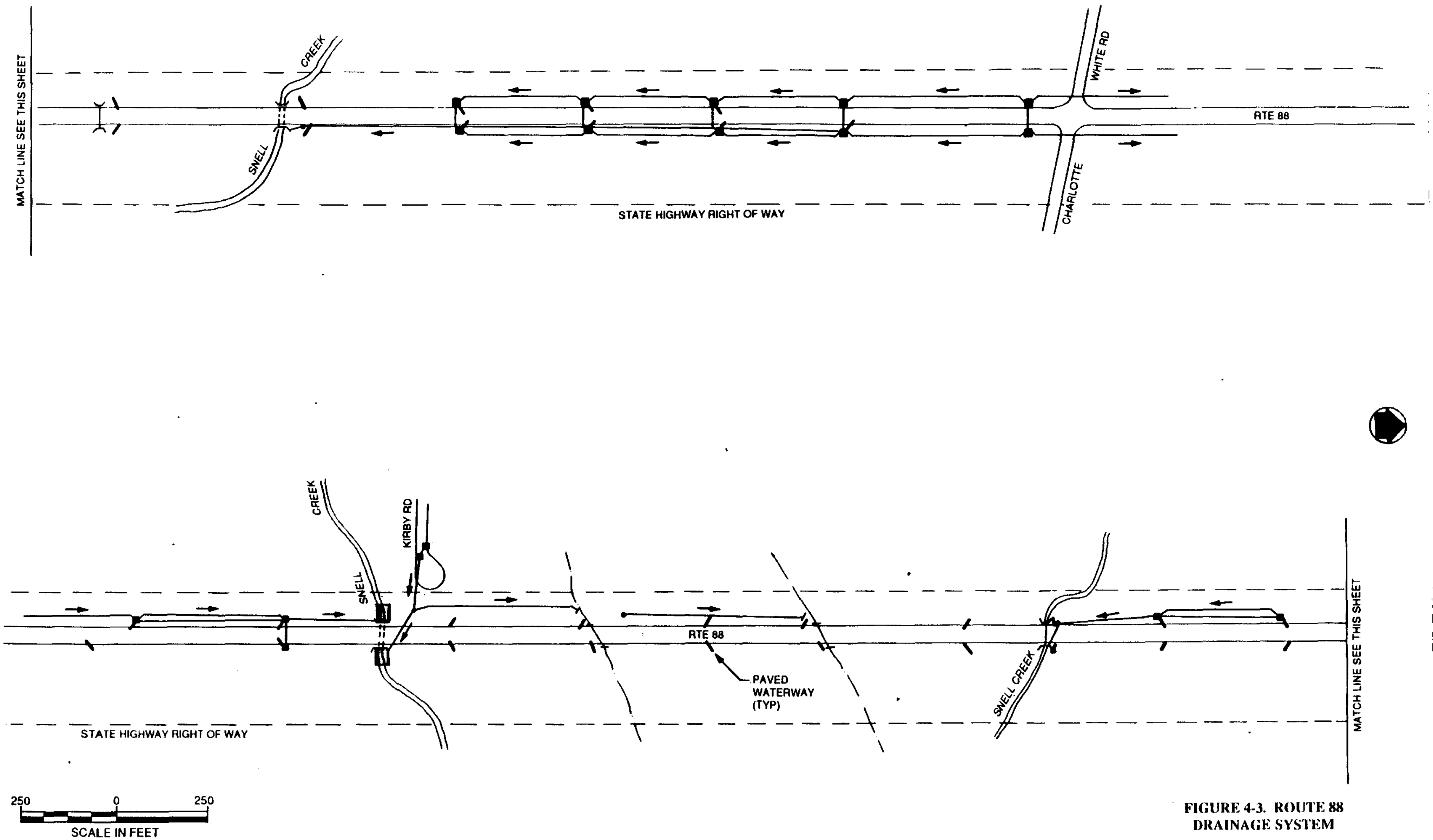

FIGURE 4-3. ROUTE 88 DRAINAGE SYSTEM

Land Disposal. Land disposal sources include on-site wastewater disposal systems. Since the watershed of Snell Creek is not sewered, each home has a septic tank. Septic tanks may contribute nutrients and bacteria to groundwater which flows to Snell Creek. If systems are properly operated, solids are removed periodically during maintenance. Bacteria and nutrient loading from septic systems, however, is substantially reduced by filtration and contact with soils. In recent studies of the impact of septic tank effluent on groundwater quality at Buttermilk Bay (Weiskel, et. al, 1989), horizontal transport of fecal coliform with flowing groundwater was observed to be extremely limited. Previously, DEQE (1987) was not able to isolate sources of fecal contamination through differentiation of coliform bacteria in samples collected in areas thought to have widespread Title V violations and areas thought to be in compliance. Septic tanks are among the most difficult nonpoint sources to identify due to their location (largely on private property) and the fact that they discharge underground. Within the Snell Creek watershed, there are approximately 200 homes with septic systems. Many of these are greater than 300 feet from the waterway.

Other nonpoint sources identified include an auto salvage facility on Charlotte White Road near the intersection of Main Road and areas where domestic animals and waterfowl congregate such as the large forested wetland area west of Main Road which directly feeds Snell Creek.

Source Prioritization

The U.S. Environmental Protection Agency has published several nonpoint source guidance documents setting forth a pollution source identification and prioritization process. This process is outlined in Figure 4-4 and is designed to isolate the sources of pollution in a target area and determine which of these sources should have priority for control. EPA (1987) recommends, in the nonpoint source guidance document Setting Priorities, that pollution control efforts be concentrated on limited areas causing substantial degradation or loss of resources. Through this targeting approach, water quality improvements can be optimized given limited financial resources.

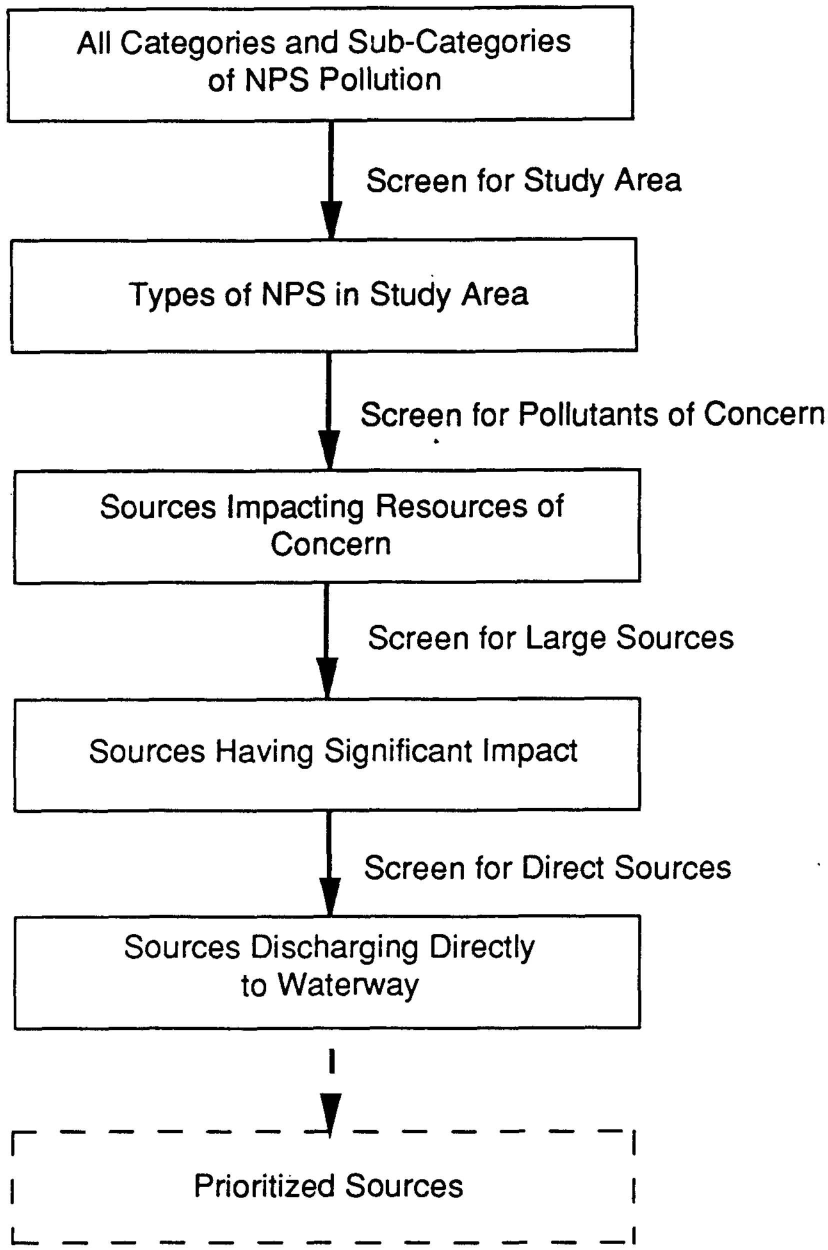

FIGURE 4-4. IDENTIFICATION AND PRIORITIZATION PROCEDURE

The process begins with review of a list of all possible categories and subcategories of nonpoint pollution sources. The list is then screened to establish a watershed profile or a list of all the sources occurring in the study area. This list is then ranked to develop a priority list of those sources which should be addressed to optimize water quality improvements. The ranking process seperates significant sources from those that do not contribute pollutants of concern, sources of relatively small magnitude and sources that do not discharge directly and whose pollutant load may be attenuated by vegetation or infiltration. This section describes the application of this process to the watershed of Snell Creek.

In order to optimize water quality improvements in Snell Creek, a priority list of pollution sources was developed, starting with the complete list in Table 4-2. Ranking criteria included pollutant type, source magnitude, and transport considerations.

Pollutant Type. As discussed in Chapters 2 and 3, historical water quality data indicate that violation of the fecal coliform standard for shellfishing is the only significant pollution problem in the EBWR. Snell Creek violates the Class B fecal coliform standard during both wet and dry weather, contributing significantly to shellfish closures in the EBWR. Therefore, the sources presented in Table 4-2 which would not contribute to current fecal coliform shellfishing standard violations are of lowest priority. These sources include the proposed Brookwood Road and Charlotte White Road land developments and the auto salvage facility on Charlotte White Road. The auto salvage facility is likely to discharge metals, sediments and hydrocarbons due to the presence of junk automobiles and bare ground. The proposed developments do not contribute to current standard violations. However, since in the future they could contribute to such violations, they can be addressed by regulatory means.

Source Magnitude. In the second ranking phase, pollution sources were prioritized based on their relative magnitude. This ranking is based on field observations, existing water quality data, and interviews with local representatives. As discussed in Chapters 2 and 3, historical water quality data indicate the Pimental dairy farm near the confluence of Snell Creek and the EBWR is the most significant source of bacteria in the watershed. The data also indicate significant bacteria loads from Route 88 especially along the central tributary of Snell Creek. Therefore, these two sources are considered high priority for bacteria control. Historical studies in the EBWR have attempted to determine the bacteria contribution from septic systems within the watershed. For example, data near homes known to be out of compliance with Title V have been collected. These data do not show increases in bacteria levels in the EBWR downstream of the failed systems, and data collected within Snell Creek also do not implicate septic systems.

In conjunction with source magnitude ranking, an effort was made to estimate the fecal coliform bacteria loadings from the identified sources. A summary of these loadings are given in Table 4-3. There are many inherent problems with attempting to accurately estimate bacteria loads from these sources. Some of these problems include the lack of site specific data on each source, the extremely high variability of bacteria concentrations, and the extensive data required to derive a statistically valid estimate. The source loadings for Snell Creek can be checked to some extent using the in-stream water quality database established. Where a large number of samples exist for a station, the log mean bacteria counts upstream and downstream of a source provides some indication of the long-term average strength of that source. Such checking could be accomplished using available data for certain sources including the Pimental farm and part of Route 88. In general, however, the estimates are order of magnitude at best. They are more suited as relative comparisons between source loadings, and as a rough check on the ranking system.

The loads in Table 4-3 indicate the dominance of agricultural land and directly discharged stormwater runoff as bacteria sources. These sources must be given the highest clean-up priority for the Snell Creek demonstration project.

Transport Considerations. The priority of the remaining sources was based upon transport considerations, such as whether pollution load is attenuated by

TABLE 4-3. SNELL CREEK FECAL COLIFORM BACTERIA SOURCE LOADING ESTIMATES

Pollution Sources	Source Area	Estimate Source Concentration (MPN/100 ml)	Estimate Loading (MPN/day)	% Total Loading
1. Pimental Farm[a]	30 acres	2.3×10^4	4.7×10^{10}	70
2. Costa Farm[b]	15 acres	1×10^4	1.0×10^{10}	15
5. Route 88[a]	6000 linear feet (piped)	5×10^3	3.4×10^9	5
6. Main Road[b]	500 linear feet (overland)	1×10^3	3.7×10^8	< 1
7. Drift Road[b]	4500 linear feet (overland)	1×10^3	3.4×10^8	< 1
8. Pratt Avenue[b]	1000 linear feet (overland)	1×10^3	6.2×10^7	<0.1
9. Septic Systems[c]	100 systems	1×10^2	7.3×10^7	< 1
10. Parking Lots[b]	2 acres	5×10^3	2.2×10^8	< 1
11. Remaining Drainage Area	940 acres	1×10^2	6.4×10^9	10
Total[a]	1000 acres	1×10^3	6.8×10^{10}	

a. Estimated from available in-stream data.
b. Estimated from U.S. EPA (1983) with refinements for overload flow.
c. Assumed conservative concentration at point where plume enters river.

vegetation or infiltration. In this comparison, sources in close proximity to Snell Creek were ranked above those which discharge distally. Sources with clear paths to the waterway, such as ditches or gulleys, were given higher priority than those which must travel through natural filters such as forested or grassy areas. Applying this criterion, the Pimental Farm, located directly on Snell Creek, and Route 88, which has a piped drainage system discharging into Snell Creek, have the highest priority. Septic systems and sheet surface runoff from areas like Main Road, Drift Road, and the parking lot on Main

watershed. The process proceeded from a watershed profile to a detailed list of the sources within the watershed. Criteria were then applied to rank those sources which can be most effectively controlled to optimize water quality improvements. Highest on the priority list are the two dairy farms and drainage from Route 88. By focusing implementation efforts, tangible water quality improvements can be realized more quickly and cost-effectively.

Snell Creek Pollution Source Profile	Pollutant Type	Source Magnitude	Transport Considerations	Priority Sources
1. Pimental Dairy Farm				●
2. Costa Dairy Farm				●
3. Brookwood Rd. Development	X			
4. Charlotte White Development	X			
5. Route 88 Drainage				●
6. Main Road Runoff			X	
7. Drift Road Runoff			X	
8. Pratt Ave Runoff			X	
9. Septic Systems		X		
10. Charlotte White Auto Salvage	X			
11. Domestic and Wild Animals		X		
12. Parking Lots		X		

FIGURE 4-5. PRIORITIZATION OF NONPOINT SOURCES IN SNELL CREEK WATERSHED

REFERENCE

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Environmental Protection Agency, 1987. Setting Priorities: The Key to Nonpoint Source Control.

Massachusetts Department of Environmental Quality Engineering, 1987. Buzzards Bay Research Bacteriological Data Report - 1986

CHAPTER FIVE

ASSESSMENT OF BEST MANAGEMENT PRACTICES

In this chapter, a range of pollution control measures or best management practices which address the water quality problems identified in Snell Creek are identified, evaluated and screened. Based on the water quality evaluations conducted in earlier chapters, the practices presented focus primarily on bacteria control, although control of other potential contaminants such as nutrients and solids are also addressed. Each control practice is described and assessed with respect to various technical, environmental and socio-economic criteria. Based on this process, appropriate control measures are selected to be part of the recommended plan. This plan is described in detail in Chapter 6.

BMP Assessment Criteria

Based on the discussions and evaluations presented in this chapter, BMP's are selected for implementation in the recommended nonpoint source control plan. This selection is based on a variety of qualitative and quantitative factors. In this section, the BMP screening and assessment criteria considered important for development of a nonpoint source control plan are presented.

Technical Feasibility. To be technically feasible, a BMP must be buildable in the area being considered for its use. Such factors as land area requirements, site constraints (size, elevation, slope), land ownership, and potential permitting problems are considered.

Monetary Factors. This category includes both cost and funding availability. Costs include both capital and operations and maintenance costs for a given BMP. Given the limited funding currently available for nonpoint source control, availability of funding is a critical concern. In general, BMP's costing more than several hundred thousand dollars would be extremely difficult to justify, given current funding availability. This factor ties together with BMP cost, since a technically feasible or desirable BMP may not be economically feasible.

Water Quality Improvements and Benefits. The main purpose of nonpoint source control is to effect a desired level of water quality improvement in Snell Creek and the EBWR. In particular, as set forth in earlier chapters, at least a one order of magnitude (90 percent) reduction in bacteria loading from Snell Creek is sought. In addition, where possible, reduction in nutrients and solids loadings will be sought, although these are considered far less important than bacteria.

Public and Agency Support. Support of pollution control measures is gaged in part through a series of public and Project Advisory Group meetings, as well as through extensive discussions with various individuals representing these groups. This support is further gaged by the technical comments received on various project outputs and reports. In addition, agency support will be sought in selected cases through funding applications for implementation.

Experience of Other Nonpoint Source Control Efforts. NPS control programs already implemented elsewhere can be used to gain knowledge on what is expected to work, and what problems may arise. Such programs include the Massachusetts Clean Lakes Program, the USDA Rural Clean Water Program implemented in Westport, various activities ongoing as part of the Buzzards Bay program (such as the construction and testing of stormwater infiltration BMP's at Electric Avenue Beach), and other test cases cited in various literature and programs.

Demonstration Value. For this project, it is of special interest to demonstrate methods for NPS control which can be effectively implemented in other coastal areas where similar problems exist. It is also important to select BMP's which can be implemented in other areas of the EBWR outside of the Snell Creek watershed.

The above criteria are all utilized during screening, development and assessment of BMP's described in the following section.

Identification of Best Management Practices

Best management practices (BMP's) as used in this report is a general term which could include any pollution control practice. This term is also often interpreted to mean low-cost, nonstructural types of control measures. It is important to stress low-cost, nonstructural control methods where feasible due to the limited funding resources within which nonpoint source control programs must currently be implemented.

Extensive efforts at development and implementation of nonpoint source control methods have resulted in identification of numerous potential BMP's which could be utilized in the EBWR. The list of possible BMP's may be narrowed to reflect those applicable to the pollution sources which exist in the Snell Creek study area. Based on these sources, which were described in detail in Chapter 4, a list of potential BMP's is given in Table 5-1.

[redacted] (1988) compiled a list of BMP's applicable to pollution sources in New England. The [redacted] (1989) has developed extensive BMP descriptions with planning considerations and design criteria for agricultural BMP's. Other sources include [redacted] (1987), Metropolitan [redacted] (1987), EPA (1987), [redacted]982 a, b, c), [redacted]84) and others.

The following paragraphs describe and assess BMP's for each major type of pollution source (agricultural, urban runoff and land disposal) which occurs in the Snell Creek drainage area. In addition, a number of non-structural, institutional BMPs are assessed. Following this, a summary assessment of BMP's is provided as a final basis of selection for inclusion in the recommended plan.

[redacted]

AGRICULTURE

- Fencing /Livestock Exclusion
- Stormwater Infiltration
  - Filter Strips
  - Pasture and Hayland Planting
- Water Management
  - Roof Runoff Control
  - Runoff Diversion
- Waste Management Practices
  - Waste Storage
  - Waste Utilization

URBAN RUNOFF

- Source Control
  - Solid Waste Management
  - Street Sweeping
  - Catch Basin Cleaning
  - Commercial/Industrial Runoff Control
  - Soil Erosion Control
  - Snow Removal and Deicing Practices
  - Air Pollution Reduction
  - Animal Waste Removal
  - Fertilizer and Pesticide Control
- Stormwater Infiltration
  - Filter Areas and Buffers
  - Infiltration Basins
  - Porous Pavement
  - Wetland Treatment
- Storage
- Treatment

LAND DISPOSAL (On-Site Systems)

- Sewering
- Alternative Disposal Systems

NONSTRUCTURAL/INSTITUTIONAL

- Regulation and Enforcement
- Tax Incentives
- State BMP Financing
- Local BMP Financing
- Beneficiaries Finance BMPs
- Public Education

Agricultural Best Management Practices

This section presents a variety of best management practices, which can generally be described as animal waste control systems, to control bacteria loading to Snell Creek including fencing/livestock exclusion; stormwater infiltration including filter strips and pasture and hayland planting; water management including roof control and runoff diversion; and waste management practices including waste storage, waste utilization, and composting.

[redacted] Unrestricted grazing areas which allow livestock to enter nearby waterways may result in decreased streambank stability and direct deposition of feces and urine into surface waters. Livestock can be restricted from entering waterways by erecting wood or electric fencing between grazing areas and waterways. During several recent site visits to the Pimental farm, however, there were no areas observed where livestock have direct access to Snell Creek. [redacted]

Stormwater Infiltration. This section describes several means of promoting infiltration of stormwater from feedlots, barnyard areas, and grazing areas including filter strips and pasture and hayland planting.

[redacted]- A filter strip of vegetation is designed to remove sediment, nutrients and bacteria from runoff through filtration, deposition, infiltration, adsorption, decomposition and volatilization, thereby reducing pollution and protecting the environment (Soil Conservation Service, 1989). EPA (1987) states that filter strips have become recognized as an effective BMP for control of agricultural sources of bacteria. Planning considerations include type and quality of pollutant, timing of planting, soil type, frequency of discharge, area configuration, and slope. Design considerations may include need for a settling basin to remove manure and other solids and other detention facilities between the waste source and the filter strip.

Maintenance requirements include repair of small channels and periodic removal of accumulated sediment. If livestock have access to the filter strip, the area should be fenced off. If the filter strip is to be used as a grazing area, livestock should be managed such that grass height is maintained between 6 and 12 inches. Livestock should only be allowed on the filter strip when the ground is dry and firm.

[redacted] - Pasture and hayland provide water quality benefits similar to those of a filter strip. Pasture and hayland, however, are not designed to treat polluted runoff from feedlots and barnyards. Managed pasture and hayland reduce erosion and promote infiltration while providing quality grazing areas. [redacted]d. Planning considerations include lime fertilizer requirements, erosion control, seed mixture, and soil drainage. Species commonly used to establish pasture include alfalfa, orchardgrass, and timothy.

In order to maintain vegetation in pastureland, grazing must be controlled by regulating the number of cattle per unit area or by dispersing livestock with fencing and livestock should be removed when grass is 2 inches tall. Pasture should be mowed once each year prior to August 1 to control weeds and brush. If fields are mowed for mulch or hay, mowing should take place annually and fields should not be mowed closer than 3 inches.

[redacted] The concept of using filter strips and pastureland has received both public and project advisory group support and it is generally felt that filter strips and pastureland are [redacted] measures that will effectively achieve water quality improvements. [redacted] (Soil Conservation Service, 1984). [redacted] respectively (Soil Conservation Service, 1984). These BMPs would have excellent demonstration value since they could be used at a number of other farms in the Westport area and since significant water quality improvements could be expected.

Water Management. This section describes strategies to protect water quality through runoff management including roof runoff control and runoff diversion.

[redacted] Farm buildings form impervious surfaces and result in increases in runoff in the vicinity of feedlots and barnyards where animal wastes typically collect and conditions are usually muddy. Uncontrolled roof runoff may collect in these areas, forming gulleys and resulting in export of sediment and bacteria. [redacted]. One effective strategy to control polluted runoff from barnyard areas involves diversion of relatively clean roof runoff away from muddy animal holding areas. Methods to [redacted] include roof gutters with downspouts possibly leading to concrete channels or subsurface culverts. This runoff is directed downgradient of any animal holding or grazing areas or to an infiltration basin if soil conditions allow. For small buildings without gutters on permeable soils, infiltration trenches filled with crushed stone around the buildings drip edges may allow infiltration.

Costs for roof runoff control vary widely depending on the selected technique. Due to the costs and labor requirements associated with concrete channels and subsurface drains, a system consisting of roof gutters with downspouts and diversion ditches is recommended. Most components of this system could be installed by the landowner. [redacted] Should formations of these gullies be eliminated, direct hydraulic connections between animal holding areas and Snell Creek would be eliminated and the integrity of strip areas will not be threatened by roof runoff.

[redacted] - Livestock are typically confined to specific holding areas or tend to congregate near ponds in open grazing fields. These areas are significant localized sources of bacteria, especially during wet weather. One method of reducing polluted runoff from such areas is to divert runoff from upgradient areas through construction of culverts, dikes, ditches, terraces or benches. Diversion systems can range in cost from very expensive structural underground collection and diversion systems to nonstructural methods such as small excavated ditches which need only to be maintained. Due to the configuration of buildings and animal holding areas, the topography of the Pimental Farm, and the costs associated with diversion structures, runoff diversion is not recommended for the Pimental Farm. Establishment of filter strips and pasture will preclude the need for diversion by infiltrating runoff.

Waste Management Practices. Manure accumulation and runoff or storage of manure in open areas presents a major potential source of fecal coliform contamination in adjacent waterways, especially during wet weather. A number of waste management schemes are evaluated below including waste storage and utilization and composting.

[redacted]- This practice involves construction of facilities and use of equipment for the storage and utilization of livestock waste for the control of surface runoff water to permit the recycling of animal waste into the land (Soil Conservation Service, 1989). Animal waste storage facilities include [redacted] and [redacted]. Storage facilities are combined with waste utilization through manure spreading, irrigation, or composting.

[redacted]. As discussed in Chapter 4, when Mr. Pimental entered into a RCWP contract in 1982, the Soil Conservation Service recommended construction of a manure pit in which to store manure. Since manure at the Pimental is removed daily and is not stored in open areas subject to rainfall or runoff as observed during several site visits, [redacted]

Urban Runoff Best Management Practices

As discussed in Chapter 4, Route 88 is the most significant source of urban runoff in the Snell Creek watershed. Pollutants washed off the roadway during wet weather travel through this piped drainage system and discharge directly to Snell Creek. Potential methods of controlling bacteria loading from such a piped drainage system include source controls, storage, promotion of infiltration, and end-of-pipe treatment. This section presents a variety of urban best management practices to control bacteria loading from Route 88 as well as smaller drainage systems.

Source Controls. Source control measures include actions within a drainage basin which effectively reduce the stormwater pollution before it is washed off by rainfall and enters the receiving waters. Source controls do not usually require large capital expenditures. However, they are generally labor-intensive; therefore, the associated maintenance costs can be high.

Solid Waste Management - Although intentional disposal of waste material on streets and sidewalks is prohibited, it is practiced commonly. This street litter commonly includes metallic, glass, and paper containers; cigarettes; newspapers; food wrappers; and a variety of other such items. If not removed from the street surfaces by cleaning equipment, these items often end up in stormwater discharges. This can result in visible pollution due to the floatable nature of many of these items.

Enforcement of anti-litter ordinances is generally given a relatively low priority by law enforcement agencies due to the limited personnel and funds, and the difficulty of identification and conviction of violators. Public education programs and conveniently placed waste disposal containers may both be effective, low cost alternatives. [redacted] However, since the results of such a program are dependent on voluntary cooperation, no level of effectiveness can be predicted. While such an education program is desirable, it can not be considered a reliable bacteria control alternative.

[redacted]- Street sweeping is often considered a practical best management practice (BMP) for stormwater pollution control. Frequent street [redacted]. The first-flush of pollutants from streets and other tributary areas to a drainage would be reduced if accumulations were prevented. However, street sweeping requires high maintenance costs and has been shown not to remove significant amounts of bacteria. Thus, it is unlikely that substantial reductions in bacterial pollution will result from more frequent cleaning.

[redacted]- Regular cleaning of catchbasins can remove accumulated sediment and debris that could ultimately be discharged from storm drains. The frequency of catchbasin cleaning varies, but is typically [redacted] and is targeted towards maintaining proper drainage system performance rather than pollution control. Research by EPA has determined that a frequency of catchbasin cleaning of 2 times a year maintains effective pollutant removal. The option of increased catch basin cleaning, [redacted] and like street sweeping, it is also maintenance intensive.

[redacted] - Commercial and industrial lands can contribute quantities of [redacted] to drainage systems. In the study area, such contaminants may runoff into combined sewers from gasoline stations, auto salvage yards, and parking lots. Pretreatment of runoff from these areas may be achieved by installing and maintaining oil and grease separators in catch basins and area drains. However, there are currently [redacted] and such pretreatment would have little impact on bacteria reduction.

[redacted]rol - Properly vegetated soils will not erode and thus will not be transported through the storm drains during wet weather. Controlling soil erosion is important in two respects: (1) [redacted] in receiving waters, block sunlight and in general create a nuisance; (2) [redacted]. Nutrients and metals fixed onto soil particles may be released and become available for aquatic plant uptake or intake by organisms.

In the study area, there do not appear to be any major sources of continuous soil erosion except agricultural lands, which were addressed under agricultural BMP's.

[redacted] - This abatement measure involves limiting the use of chemicals for snow and ice control to the minimum necessary for public safety. This in turn would limit the amount of chemicals, primarily salt, and sand washed into the collection system and ultimately discharged from stormwater. Since little or no bacteria reduction would occur, this option is not considered viable.

[redacted] One method of controlling pollutant loadings from urban runoff is to limit the amount of pollutants that are contributed to local air. Particulate and gaseous pollutants in air are carried to the ground by rainfall. Air born particulates also settle to the ground during dry weather.

[redacted]
Reducing automobile emissions of lead and zinc would likely decrease their concentrations. However, it is extremely difficult to quantify the potential reduction in stormwater pollution associated with air quality improvement. It is doubtful that there would be any reduction in bacterial pollution, hence this option is not considered realistic.

[redacted] Essentially, this refers to removing animal excrement from areas tributary to stormdrains. As with air pollution control, this is not likely to effect significant control of urban runoff, and is questionable in terms of implementability. However, it is anticipated that some (although unpredictable and probably minor) reduction in bacteria load may be achieved. This best management practice can be addressed by a [redacted]

[redacted] - Fertilizers and pesticides washed off the ground during storms contribute to the runoff pollutant levels. Controlling the use of these chemicals on municipal lands can help reduce the pollutant load. Care should also be taken to properly store and protect chemicals from exposure. Since most of the problems associated with these chemicals are a result of improper or excessive usage, a public education program may be worthwhile. Control of these chemicals, however, is not expected to achieve bacteria reduction in the drainage area.

I [redacted] Such a program could encourage a number of activities including proper disposal of household chemicals and motor oil, animal waste control, regular cleanup of litter, and control of pesticides/fertilizer application.

[redacted] Methods to infiltrate stormwater into the ground prior to direct discharge into receiving waters can be highly effective in removing bacteria, solids, and certain nutrients and metals. It is a desirable BMP approach because high bacteria removals (over 99 percent) can be obtained, even in permeable soils, and because costs are lower than more structurally intensive methods such as end-of-pipe treatment. While generally no pumping or power costs are involved, some maintenance is usually required.

Infiltration methods are being studied, utilized and tested as part of the Buzzards Bay project, particularly at Buttermilk Bay. Leaching facilities have been constructed at [redacted] Bourne (Metcalf & Eddy, 1989). [redacted]

[redacted] Filter areas and buffers are similar to the filter strip as described under agricultural BMPs. In this system, the drainage system is altered through diversion or detention to promote overland flow through natural vegetation which acts as a filter to decrease the runoff velocity, allow solids to settle, and promote infiltration. Design considerations include type of pollutant and expected flow and load, type of vegetation present and slope. In general, bacteria in road runoff does not attach to sediments and infiltration is required to remove bacteria.

Therefore, unless very large areas are used, these systems are not effective in removing bacteria from urban runoff, especially for systems with extensive drainage systems like Route 88. Secondary roads with lower and less concentrated flows may be better candidates for installation of filter areas and buffers. [redacted]

[redacted] In order to promote infiltration within piped drainage systems, infiltration basins may be constructed within the drainage system. A typical stormwater infiltration catch basin is shown in Figure 5-1. EPA (1974) showed in "Water Quality Management Planning for Urban Runoff" that during the first ½-inch of rainfall, an intensity of 1.0 inch/hour for thirty minutes is considered heavy enough to remove 90 percent of the pollutants from pavement. This phenomenon, in which the majority of pollutants are "washed-off" paved surfaces at the beginning of a rainfall event, is known as the "first flush". Using this rule of thumb, [redacted]

According to the Roffinolfi and Fletcher (1981), [redacted] Infiltration basins could be coupled with grassed filter areas rather than the existing concrete channels which convey stormwater to a collection system and subsequently to Snell Creek. Constraints associated with this option, however, include potential erosion of the roadway or its banks and frost heaves. [redacted]

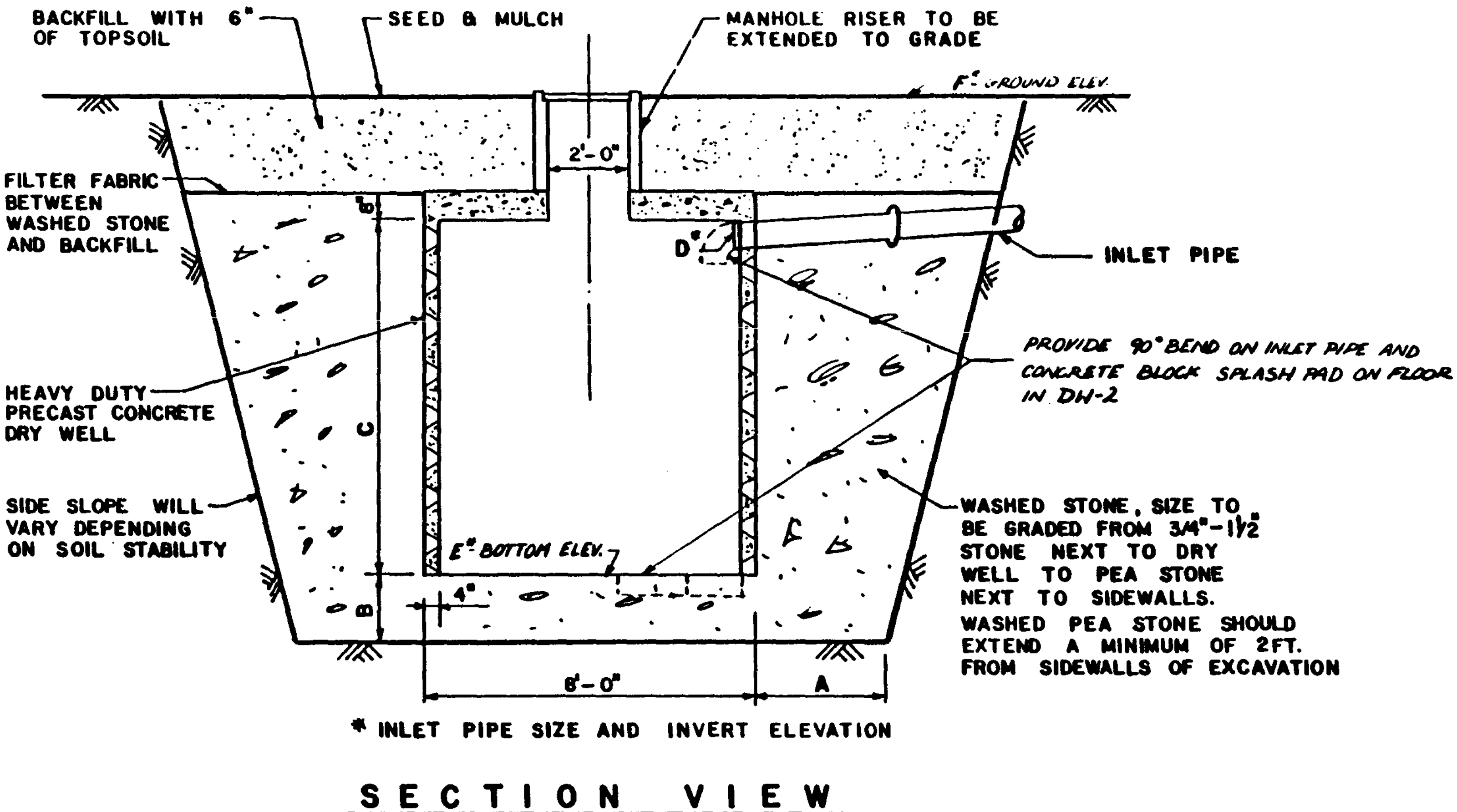

FIGURE 5-1. TYPICAL STORMWATER INFILTRATION CATCH BASIN

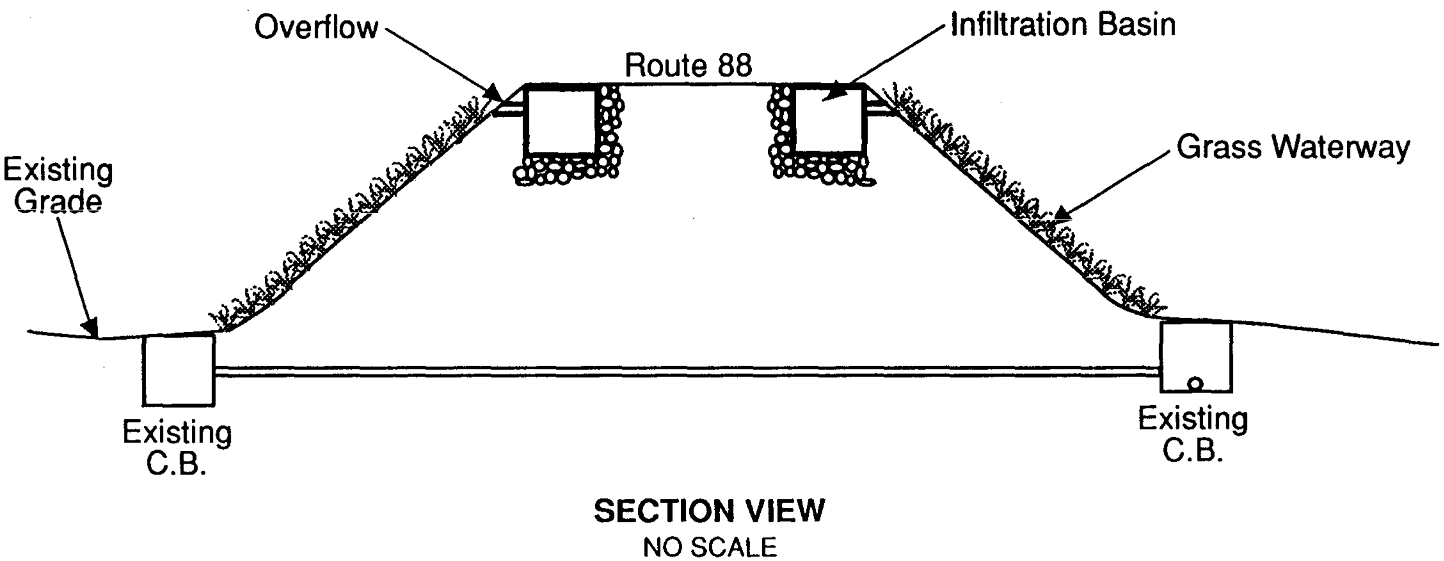

FIGURE 5-2. CONCEPTUAL INFILTRATION CATCH BASIN DESIGN FOR ROUTE 88

A variation of infiltration basins that may be more acceptable for use at Route 88 involves the [redacted] es in fill [redacted] This option would require placement of suitable permeable fill in mounds adjacent to Route 88. Catch basins (non-infiltration) would be placed on Route 88 to collect runoff and direct it to leaching gallies. [redacted]

For drainage systems that are in soil with sufficient depth to groundwater, [redacted] These systems maintain the storage capacity of the existing catch basins while providing additional storage and infiltration. Figure 5-4 illustrates a typical catch basin and dry well configuration. The implementation of these systems is limited to areas where the groundwater level is greater than ten feet below the ground surface. Also, a single dry well can only accommodate up to one acre of runoff from impervious surfaces. [redacted]

[redacted] Porous pavement consists of porous top course of varying thickness covering a layer of gravel over a crushed stone recharge bed. Porous pavement provides temporary storage and promotes infiltration in otherwise impervious areas, and is typically designed to enhance groundwater recharge rather than pollution control. Porous pavements can be installed over existing impervious pavements, keeping the replacement costs about equal to the original installation costs. However, these systems are not as effective as porous pavement installed over pervious soil (EPA, 1987). This technique is most frequently used in small but highly erodible areas subject to considerable traffic such as parking lots. [redacted]

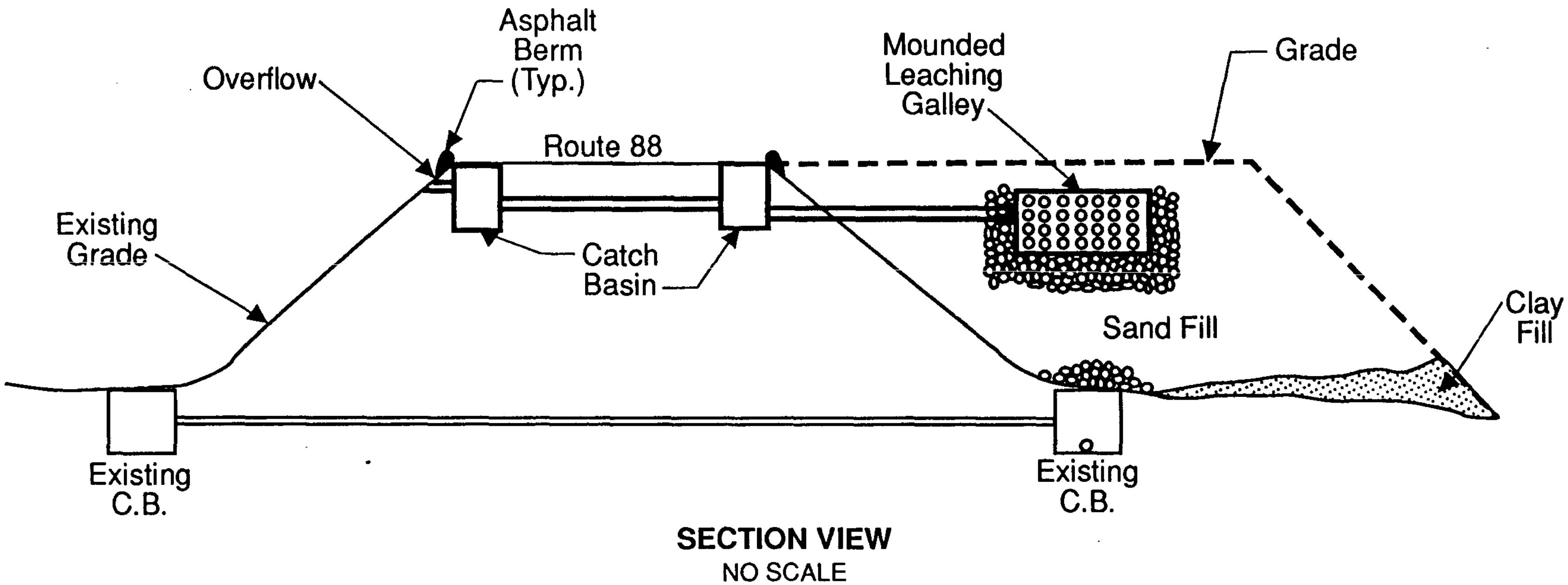

FIGURE 5-3. CONCEPTUAL MOUNDED LEACHING GALLEY DESIGN FOR ROUTE 88

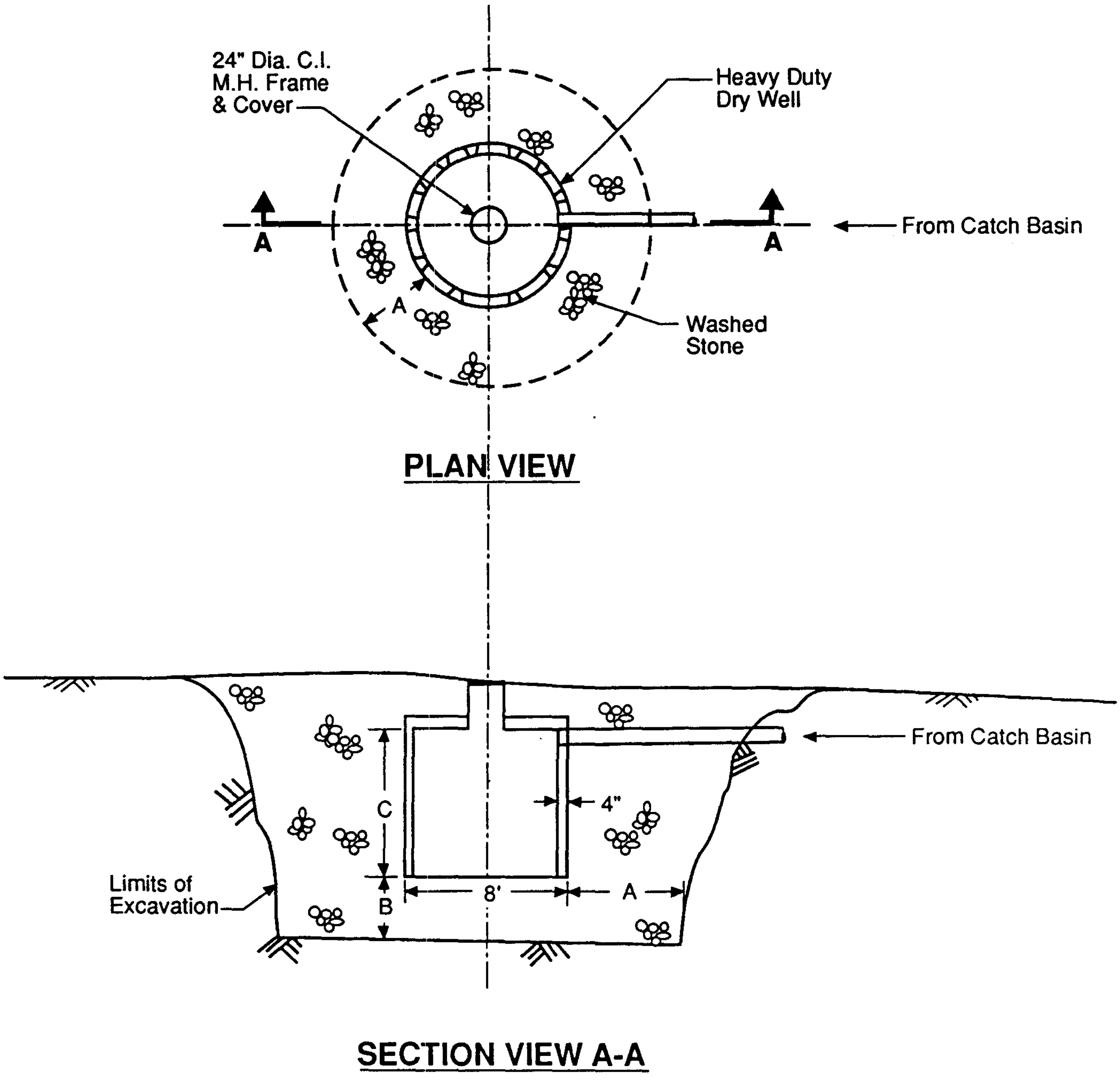

FIGURE 5-4. TYPICAL DRY WELL

[redacted] - Wetlands provide natural detention and filtering areas through vegetation and infiltration. Use of wetlands to treat stormwater may not be permittable, however, under the Massachusetts Wetlands Protection Act Regulations which do not permit alteration of wetlands. Discharge of large volumes of polluted stormwater to existing wetlands may constitute a significant negative impace and would not likely be permitted by the local conservation commission. Further, there are no suitable existing wetlands to serve as treatment areas for runoff from Route 88. Through excavation and planting of wetland vegetation, wetlands may be created to treat stormwater. Wetlands, however, are more effective in removing solids and nutrients and filter areas would be preferred over wetland creation for bacteria removal.

Storage. The use of storage for urban runoff control can involve in-system or off-line facilities. In-system facilities rely on excess capacity in the drainage system to control peak discharges. Off-line storage includes such facilities as retention/detention ponds. Storage facilities are generally used for hydraulic control of peak flows. For example, conservation commissions routinely require that pre- and post-development flows cannot be altered. Storage facilities are not generally used for urban runoff pollution control unless in combination with treatment methods. Given that their feasibility for bacteria removal is limited, unless in combination with high cost treatment methods, further consideration of these methods is not warranted.

[redacted]. Numerous end-of-pipe treatment methods for bacterial control exist. These include physical, chemical and biological methods in various combinations, often with disinfection for bacteria removal. These methods are normally used to treat wastewater or combined sewage, and are rarely used to treat stormwater because of the high cost. Since these methods involve land acquisition, significant environmental impact and high cost, and are beyond the limits of available funding for nonpoint source control, they will not be considered further.

Land Disposal Best Management Practices

As discussed in Chapter 4, there are no water quality data collected in studies of the EBWR and Snell Creek that indicate bacteria loading from septic tanks. In many areas of the watershed of the EBWR and Snell Creek, however, due to inadequate soil conditions and improperly installed or undersized systems, septic tanks may be a significant source of fecal coliform in certain areas or intermittently depending on weather conditions and occupancy.

Due to widespread concern over the impact of septic tanks on water quality, several potential BMPs to control discharge of fecal coliforms from septic tanks are evaluated below including sewering, and alternative disposal systems. Nonstructural/institutional methods of controlling bacteria from septic tanks are discussed later in this chapter.

Sewering. Sewering involves the construction of underground sewage conduits to convey sewage from an entire community to a municipal wastewater treatment facility. Although sewerage would effectively eliminate on-site system failures, no failures or surface breakouts have been observed either directly or through water quality analyses and sewerage may not improve bacterial water quality significantly. Further, such a recommendation would not likely receive public support, may be prohibitively expensive, and may not be eligible for funding through the state construction grants program in the near future. Thus, sewering is not recommended to control bacteria from septic tanks at Snell Creek.

Alternative Disposal Systems. Alternative wastewater disposal systems include pressure sewerage systems, vacuum sewerage systems, package wastewater treatment plants and large on-site systems to treat sewage from a group of homes. Like sewering, these systems may be effective in preventing septic system breakout. There is, however, no evidence of widespread breakout problems in Westport and construction of these systems may not result in significant water quality improvements. In addition, these systems may not be eligible for state funding and would not likely receive public support or local or private funding.

Cons. [illegible] dropping this section

[redacted]

In addition to the various structural means to control nonpoint sources, a number of nonstructural or institutional means of nonpoint sources control have been evaluated. This section presents a number of nonstructural and institutional means to control agricultural runoff, urban runoff, and bacterial contamination from on-site wastewater systems including regulation and enforcement; tax incentives; state, local and beneficiary financing of BMPs; and public education. It must be noted that enactment of local bylaws or regulations must occur through the town meeting process. Further, there is currently no local or state institutional framework to grant tax incentives for BMP installation, and there is no basis to charge polluters or beneficiaries a fee to generate revenue for pollution control. Thus, the implementability of several of the BMPs described below is questionable in the absence of widespread public and political support.

Regulation and Enforcement. Opportunities for regulatory control of pollution include bylaws, regulations, enforcement, and incorporation of measures to address water quality concerns in local permits issued by the health department, planning board, and conservation commission. Local environmental bylaws and regulations may be enacted to conserve health; to provide for water, water supply, drainage, sewerage, open space and conservation of natural resources; and to prevent blight and pollution of the environment. A zoning bylaw may be adopted to protect designated land uses with critical environmental concerns from inappropriate uses of land (SRPEDD, 1989). Sample bylaws and regulation have been developed by the Southeast Regional Planning and Economic Development District (1989) under contract to EPA Buzzards Bay Project. This section describes potential regulatory means to control nonpoint source pollution from agriculture, urban runoff, proposed developments, and subsurface disposal systems.

Agriculture - There are a myriad of federal, state and regional agencies dealing with agriculture including the U.S. Department of Agriculture, the Environmental Protection Agency, the Massachusetts Department of Environmental Management, the Massachusetts Department of Food and Agriculture, and the Massachusetts Soil and Water Conservation Districts. Most of the programs implemented by these agencies, however, provide technical and financial assistance and do not serve in a regulatory or enforcement capacity. The strategy for control of agricultural nonpoint sources, as presented in the Massachusetts Nonpoint Source Management Plan (DEP, 1988), suggests source identification, prioritization and control through BMPs, education and technical assistance rather than a regulatory approach. One method to control agricultural pollution is through establishing agricultural districts through zoning bylaws. Additional opportunities for enforcement include enforcement of Clean Water Act Section 402 NPDES regulations related to concentrated animal feedlot areas.

Urban Runoff (Existing and Future) - Water quality in Snell Creek and other areas in the EBWR system is directly influenced by the cumulative effect of existing development and activities in the watershed and resultant urban runoff in the drainage basin. Future development represents a threat of further deterioration in water quality. Within the Snell Creek watershed, as much as 90 percent of the acreage, or 900 to 950 acres, could be developed with home sites under current zoning. Development of any significant fraction of that property could generate impacts in terms of surface runoff quality and quantity, erosion, sedimentation, disruption of natural drainage patterns, coliform bacteria and leachates from septic tanks, and other potentially damaging effects. There are at least two proposed residential development projects being considered within the Snell Creek watershed.

Within well-established municipal authority, there are numerous tools available that can be of major assistance in controlling water pollution from new development. A set of enhanced municipal tools constitutes an ideal future complement to a program of direct structural improvements designed to mitigate existing conditions. If implemented successfully, water quality controls on proposed development would help to minimize any adverse impacts. This section discusses existing and potential future regulatory means to control urban runoff from existing and future development. [redacted], along with a brief description and a commentary on each method.

Source?

TABLE 5-2. WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES

Techniques to consider	Description	Comments
A. Zoning Strategies		
1. Environmental Overlay District MA Genl. Laws, Chap. 40A	By imposing a protection overlay over any base district(s) desired, special requirements addressing surface runoff, as well as subsurface intrusion, can be established for all development within that zone.	Is only as strong as the special standards created for it, and is best supplemented by other zoning tools.
2. Special Performance Zoning MA Genl. Laws, Chap. 40A	Ties the impact of any development directly to the physical carrying capacity of the land on which it lies. Explicit performance criteria are needed. Carrying capacity for each district must be determined.	Requires extensive technical analysis and review process, which must engender developer opposition and require a professional staff or consultant capability.
3. Special Permit Authority C. 40A, Sec. 4	By making certain uses conditional and requiring special review and permitting, the community gains great power to: require appropriate site design; mitigate on- and off-site impacts; and even to share mitigation costs.	Provides community with opportunity to set protective standards and subsequent mitigations and, unlike most other methods, offers a means to levy fair-share costs as a legally supportable quasi-impact fee. Potentially, a powerful tool. Well-established technique, but could be subject to legal challenge if all uses in a district are conditional.
4. Site Plan Review (As in No. 1 above.)	Allows designated types of developments to receive a detailed administrative review, in regard to basic site features such as driveways, building siting, drainage patterns.	More limited in scope than most other tools, and they are more constrained as an environmental protection tool.
5. Performance Standards (Not the same as No. 2 preceding.) (As in No. 1 above.)	Quantifiable limits are set on objectionable or nuisance conditions, such as noise, glare, dust, heat, odors, etc., and can be expanded to cover various environmental protection areas.	Focuses on impacts rather than development, so it treats all parties equitably, clearly and objectively. Standards can differ, however, from existing federal or state regulations for the same impact.

A. Zoning B. Subdivision C. Health Regs → might want to reformat

TABLE 5-6 (Continued). WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES

Techniques to consider	Description	Comments
A. Zoning Strategies (Cont.)		
6. Open Space Residential Districts C. 40A, Sections 2 and 9	Uses clustering options and variable lot size provisions (even if only single family detached homes are involved) as a means of preserving open space.	Tends to be ignored by developers, unless several factors are present, such as: bonus unit incentives; clear and comprehensive open space system goals and definitions; and streamlining of administrative procedures.
7. Stormwater Management By-Law (Infiltration Requirements)	Provides a method for diverting surface runoff entirely away from wetlands, and, in rural areas, for maximizing recharge/infiltration into subsurface of soil.	Can also be handled under: environmental overlay district, site plan review, or performance standards. If adopted, there should be a reciprocal clause within subdivision control.
8. Transfer of Development Rights C. 40A, Sec. 9	Transfer development rights from the "sending" or protection zone to the "receiving" or development zone, usually by sale of such rights. Theoretically, a major planning tool to keep development away from where it's not desired, and into where it is sought.	Is difficult and controversial to plan for, particularly designating receiving sites. It is also hard to assess monetary value of the development rights in an equitable manner.
9. . Earth Removal By-Law . Sedimentation/ Erosion Control By-Law . Nutrient Loading By-Law	Provides standards for managing pollution from all construction sites, permanent sites and agriculture, by setting quantitative limits and requiring structural improvements of various types.	Can be implemented as separate by-laws outside of zoning, and similar provision can (and should) be placed into subdivision regulations.
10. Floodplain Districts	Provides a degree of shoreline protection by limiting building below 100-year storm elevation.	Most communities, including Westport, have already adopted, in order conform to requirements of federal flood insurance.

TABLE 5-6 (Continued). WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES

Techniques to consider	Description	Comments
B. ~~Regulatory Strategies:~~ Non-Zoning		
1. Subdivision Control Amendments MA Genl. Laws, Chapter 41, Sections 81K-81GG	Subdivision control regulations can be amended to contain numerous requirements for stormwater management, environmentally sensitive land development practices, and design standards.	There are two distinct limitations: (1) subdivision control applies only when land is being divided, but not in cases of new construction on already-divided property; and (2) the improvements exacted as a result of the subdivision control process have traditionally applied largely to on-site improvements.
2. Board of Health Powers (Public Health) MA Genl. Laws, Chap. 111 and Chap. 41, Sec. 81-U; Title V specifically governs on-site sewage disposal	The traditional land-related functions of local Health Boards, septic permits, non-residential establishment inspections, subdivision review, sewer/water connections, etc., can be expanded to include broader powers over almost any environmental risk, provided the risk is apparent and demonstrable.	There must be a clear and present danger to public health, which can be difficult to document, particularly from non-point sources. Rewrite: best technique
3. Wetlands Protection Act MA Genl. Laws, Chap. 131, Sec. 40	Can be applied more aggressively in a public health hazard situation, such as requiring additional buffers along statutory wetlands, when a relatively large development is constructed.	Exceeding the narrow interpretation of the statute in terms of what is required, would impel a verification of clear and present danger by the Conservation Commission and probably by MA DEP.
4. Groundwater and Aquifer Protection By-Laws	By creating a special overlay district, objectionable uses can be prohibited, recharge areas preserved, buffers created, and conditional permit requirements and conditions instituted.	Often functions as a special permit granted by Board of Appeals or other designated authority.

TABLE 5-6 (Continued). **WATER POLLUTION CONTROL FROM NEW DEVELOPMENT: POTENTIAL LOCAL REGULATORY TECHNIQUES**

Techniques to consider	Description	Comments
B. Regulatory Strategies: Non-Zoning (Cont.)		
5. Underground Fuel Storage Regulations	Offers a means of monitoring and upgrading petroleum tanks.	Becomes part of either building-related codes (building, housing, life safety, plumbing and wiring codes), or part of public health regulations.
C. Other: Negotiated Techniques		
1. Conservation Restrictions M.G.L. Chap. 181, Secs. 31-33	(Voluntary) Agreement between a land owner to keep all or part of his property in a mostly unaltered state and the Conservation Commission. Owner still pays some property taxes and maintains the property in full, but receives in return life occupancy rights.	Low cost means of preserving open space, but is a voluntary method and therefore limited in application.
2. Conservation Easements MA Genl. Laws, Chap. 184 and Chap. 232, Secs. 1 and 2	Within any regulatory review, but particularly in subdivision control, conservation easements and buffers can be negotiated by Planning Board and bound as a recorded deed attachment.	Probably not a method for saving large open space tracts in their entirety, but can be helpful on environmentally important segments.

The existing institutional and statutory framework for regulating urban runoff is not cohesive. On the federal level, amendments to the Clean Water Act of 1987 established a municipal and industrial stormwater discharge permit program. This program will not apply to Westport, however, due to the low population of the Town and lack of a large municipal storm sewer system. Local water quality controls could be implemented through new regulations or bylaws or by using existing development review regulations. Potential local tools described in Table 5-2 include conservation bylaws and local subdivision and site plan review regulations for nutrient loading control and stormwater management through the planning board. Existing means of control, as described in Table 5-2 include the Wetlands Protection Act and the Subdivision Control Act implemented by the conservation commission and the planning board. In either case, the purpose of such controls would be mainly to limit any increase in bacteria loading, and secondarily to limit nutrient and solids loading, to the receiving waters. The paragraphs below complement Table 5-2 and describe, in more detail, potential new regulations and means of using existing regulations for water quality protection.

[redacted] Stormwater runoff pollution control bylaws have been implemented by some communities. Although they are currently not common, they are becoming more frequent as the recognition of stormwater as a nonpoint pollution source increases. One example bylaw enacted by the Town of [redacted] (Article 7, Section 30 of the General Bylaws) is as follows (Southeastern Regional Planning and Economic Development District, 1989):

> " In order to protect the quality of the waters of the harbor and other wetlands within the town limits, no road or other surface shall be regraded, constructed, or maintained in such a manner as to divert or direct the flow of runoff, defined as including storm water or any other surface waters, excepting natural pre-existing water courses, into any wetland, as defined in Massachusetts General Laws Chapter 131, Section 40. Uncontaminated runoff shall be directed in such a way as to recharge the groundwater within the lot where it originates and in such a manner as not to alter natural runoff into any wetland, nor to cause erosion, pollution or siltation into or towards any wetland."

While this bylaw does not specifically mention bacteria, it would allow for bacteria control by requiring on-lot groundwater infiltration. However, this type of bylaw may not be workable in areas of poor soil infiltration capacity.

In Falmouth, Massachusetts, where there are extensive water resources combined with rapid development in areas without public sewer facilities, a nutrient loading by-law has been established for controlling development. Under this by-law, developers are required to determine the nutrient loading of the proposed development and evaluate the impact of this increased loading on the water body. Pre-established criteria are used to define the loading from the development. If the proposed development will push the receiving waters to or above the pre-established critical level in terms of eutrophication, the regulations call for the developer to present mitigating measures to reduce the nutrient loading. One disadvantage of establishing a town by-law of this nature is the fact that it may be cumbersome for the town to administer. Due to the uncertainty involved in precisely predicting critical nutrient loading levels and associated impacts, it is also possible that the by-law would be disputed frequently. As a long-term objective, however, it would be advisable for the town to explore adoption of some type of bylaw aimed at control of stormwater pollution.

Existing Development Review - A simpler method of controlling impacts due to development would be through use of existing regulatory reviews which are already required. One example of this is when a project requires wetlands review through the conservation commission. The Wetlands Protection Act Regulations (310 CMR 10) require that anyone planning work in or within 100 feet of a wetland must submit a Notice of Intent to the local conservation commission. The conservation commission enforces the regulations by issuing an order of conditions which either denies the project or requires that certain conditions and mitigating measures be incorporated into the project design to protect the functions of nearby wetlands and waterways which include, among others, protection of public and private water supply, prevention of pollution, protection of land containing shellfish, protection of fisheries, and protection of wildlife habitat. Such conditions may include measures to mitigate the short-term impacts of construction and other measures to mitigate long-term changes in runoff quantity and quality. A common order of condition prevents new developments from increasing the peak runoff rate of a parcel of property. With this restriction, new developments are required to construct stormwater retention/infiltration basins and/or leaching fields.

These facilities could be designed to infiltrate runoff into the ground, and prevent direct discharge to the receiving waters. The facilities are designed for a particular runoff event (e.g. 50 yr. storm), and allow no more than the existing peak runoff to be discharged. This type of regulation would be easier to enforce since the hydrologic calculations are more directly computed and less debatable than pollutant loading calculations. Infiltration facilities must be used with caution, however, in areas of critical groundwater supply resources. In general, with the requirement that retention facilities be designed to infiltrate runoff, the effectiveness in reducing bacteria and nutrient loading would be enhanced. Although projects not regulated under the Wetlands Protection Act could not be reviewed, this could be a particularly effective strategy in Westport due to the large amount of wetlands. Planning board review of other proposed developments, as well as MEPA review, may allow further opportunities for town input on pollution control requirements.

It seems appropriate to initiate development of a "standard order of conditions" for use by town agencies which could be quickly implemented and used when appropriate. Such a condition could be patterned after the common hydrologic condition aimed at preventing increased runoff, however it could be modified to be more specific to pollution control. Potential conditions may include requirements for sumps and oil/gasoline traps, and inspection and maintenance. A longer term objective would be to develop specific new by-laws to control such activity.

Subsurface Disposal Systems - On-site wastewater disposal is currently regulated by Title V: minimum requirements for the disposal of sanitary sewage (310 CMR 15.00). Title V governs the siting, design and construction of septic systems and is administered by local boards of health. Although local boards of health may adopt stricter regulations than those of Title V such as a local bylaw requiring inspection of on-site systems, it is often a difficult process due to local politics and the tough situation of enforcing regulations against one's neighbors. In general, enforcement, proper care and maintenance, rather than stringent regulation, are the best means to assure that such systems will serve the purpose intended and prevent danger to public health and the environment (DEP, 1988). The DEP is currently initiating an effort to review certain aspects of Title V including system maintenance, setback requirements, and determination of maximum groundwater elevation, and may ultimately develop revisions to Title V to recommend for promulgation to the commissioner of DEP.

It is generally agreed that local boards, especially boards of health, are underutilized in enforcing health and conservation regulations. Accordingly, the Division of Water Pollution Control is initiating a program of technical and legal assistance to local communities on Title V administration and enforcement.

Tax Incentives. Tax incentives involve abatements on taxes to farmers for establishment of greenways or buffers strips along waterways, or to farmers and developers for construction of pollution control facilities. Such incentives are not currently in place through federal or state programs and are not anticipated. Federal financial assistance for farmers comes in the form of cost sharing through a number of USDA programs.

State BMP Financing. One potential source of funding for BMPs is through the Massachusetts Nonpoint Source Program. Although the program was initiated several years ago, none of the intended $400,000,000 have been appropriated for nonpoint source control projects. On April 14, 1988, Senator Robert A. Durand proposed legislation for a Massachusetts Nonpoint Source Pollution Control Program. The legislation provided seventy-five percent funding for feasibility studies, design, and implementation of best management practices, and up to ninety-five percent funding for innovative projects. Although this program represents an excellent potential source of future funds for prioritized nonpoint source control projects, there is currently no funding available.

Local BMP Financing. Revenues for BMP construction and maintenance may be creatively generated locally through attachment of stormwater control fees to a utility bill and by requiring developers to pay in advance for stormwater facility maintenance. These methods may require local or state regulations not currently in place. Local financing of BMPs may require a property tax increase. Stormwater BMPs may gain voter appeal if combined with other public works projects such as road improvements and maintenance.

Beneficiaries Finance BMPs. Construction and maintenance of BMPs may be financed by those who benefit directly from their positive impact on water quality. Ideally, this technique would involve an organization to which all the beneficiaries of water quality improvements must belong. This organization could collect and administer funds for bacteria control through stormwater control, lobbying and public education. In the case of Westport, this BMP would require the formation of an organization to administer this effort. Prerequisites would involve extensive coalition building in the town and considerable education of shellfishermen and town officials.

Public Education. Public education is an effective means of keeping local citizens informed of implementation activities and to educate individual property owners of what contributions they can make to improving local water quality. Public education could serve to increase residents awareness of proper system inspection and maintenance. Septic system efficiency can be improved by reducing the amount of solid waste entering the system. Use of garbage disposals contributes substantial quantities of organic material and suspended solids to septic systems, thereby increasing the rate of sludge and scum accumulation in the systems. Reducing these and other solid wastes from septic systems will reduce the amount of organic materials and suspended solids discharged from the systems, and will also provide for a reduction in nutrient loads from the septic tanks. Additional septic system efficiency is possible through reduced hydraulic loading. Water saving devices such as waterless toilets, water-saving showerheads and flush dams for toilet tanks will help to reduce hydraulic loading thereby reducing discharge of effluent to groundwater and increasing phosphorus removal. Hydraulic loading can also be reduced by expanding the septic systems of summer cottages which have been converted to permanent residences. In addition, there are a variety of other household practices that can be altered to reduce export of bacteria and nutrients from residential properties including use of low phosphorus-containing detergent, organic slow-release fertilizer use, and proper grass clipping and leaf disposal.

Public education could be achieved through public meetings, distribution of educational materials, seminars, newspaper and TV coverage, and coalition building. A meeting could be held in the form of a symposium in which a variety of pollution control related subjects could be discussed. Meetings could be conducted by the DEP or their consultant with the town and the watershed association in order to answer questions and present educational material. Educational materials could be distributed which describe the nature of water quality problems and behavioral modifications which may help to alleviate those problems.

Summary of BMP Assessment

A summary matrix of the various BMP's considered for use in the Snell Creek watershed is presented in Table 5-3. In this table, the BMP's are compared against the criteria defined at the outset of the chapter.

Based on the results of this assessment, the following BMP's are selected for incorporation into the recommended plan:

- Agricultural
  - Filter strips and pasture and hayland planting
  - Roof runoff control
- Urban Runoff
  - Infiltration practices at Route 88 and Kirby Road
  - Selected source controls through public education
- Institutional/Nonstructural
  - Regulation and Enforcement
  - Public Education

TABLE 5-3. SUMMARY OF BMP ASSESSMENT

BMP	Technical Feasibility	Monetary Factors: Capital	Monetary Factors: O&M	Monetary Factors: Funding	Water Quality Improvements	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
Agricultural									
Fencing	X	Low	Low	X	+	+	X	X	• Already implemented at Pimental Farm
Filter Strip	X	Moderate	Low	X	+	+	X	X	• Design constraints related to number of livestock and other site conditions • Requires considerable management of livestock by landowner
Hayland Planting	X	Low	Low	X	+	+	X	X	• Requires management of livestock and maintenance by landowner
Roof Runoff Control	X	Moderate	Low	X	+	+	X	X	• Critical to divert roof runoff from animal holding areas • Must be combined with conveyance channels on the ground
Runoff Diversion	-	Low	Low	X	-	+	-	-	• Not feasible at Pimental Farm due to topography
Waste Storage and Utilization	X	High	Moderate	-	-	-	+	-	• High capital cost • Manure management already adequate at Pimental Farm

what do these symbols mean?

TABLE 5-3 (Continued). **SUMMARY OF BMP ASSESSMENT**

BMP	Technical Feasibility	Monetary Factors Capital	O&M	Funding	Water Quality Improvements	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
Urban Runoff									
Source Controls	X	Low	Moderate	X	-	+	X	X	• Does not achieve WQ goals • Implement through public education
Infiltration	X	Moderate	Low	X	+	+	X	X	• Feasibility depends on soil type and groundwater elevation • Effective for bacteria, nutrient, solids and metals removal • Low maintenance
Storage	X	High	High	-	-	-	-	-	• No bacteria removal
Treatment	X	High	High	-	+	-	-	-	• High capital cost • Environmental Impacts
Land Disposal									
Sewering	X	High	High	-	-	-	-	-	• High capital cost
Alternative Disposal Systems	X	High	Low	-	-	-	-	-	• High capital cost • Likely public opposition

TABLE 5-3 (Continued). **SUMMARY OF BMP ASSESSMENT**

BMP	Technical Feasibility	Monetary Factors			Water Quality Improvements	Public and Agency Support	Other NPS Control Efforts	Demonstration Value	Comments
		Capital	O&M	Funding					
Nonstructural/ Institutional									
Regulation and Enforcement	X	Low		-	-	-	-	-	• Requires extensive coalition building and public support
Tax Incentives	-			-	+	+	-	+	• No programs in place
Local Financing	-			-	+	-	-	+	• Town funding not available
Beneficiaries Financing	-			-	+	-	-	+	• Complex organizational requirements
Public Education	X	Moderate	Low	+	+	+	+	+	• Builds public awareness and support

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CHAPTER 6

NONPOINT SOURCE MANAGEMENT PLAN

This chapter integrates the steps required to implement the best management practices recommended in Chapter 5. Each BMP is described and information is also provided on critical elements of BMP implementation including:

- Responsibilities of the municipality, DEP, consultants, and other involved parties
- Implementation schedule including planning, design, construction, and monitoring
- Cost estimates for design, construction and monitoring

In addition, institutional and regulatory aspects of the implementation are discussed including consistency with local, state, and federal regulations; funding sources; and permitting requirements.

Recommended Plan

The recommended plan for the watershed of Snell Creek consists of several major elements including:

- Enhance existing water quality sampling programs
- Implement agricultural best management practices at the Pimental and Costa farms
- Implement stormwater best management practices at Route 88 and Kirby Road
- Utilize existing environmental regulations and enact local zoning or conservation bylaws oriented toward nonpoint source control
- Conduct a public education program
- Conduct pre- and post-implementation BMP monitoring and wet weather sampling
- Water Quality Analysis

These recommendations are described in detail in the following sections.

Enhance Existing Water Quality Sampling Programs. As discussed in Chapters 2 and 3, extensive water quality sampling efforts have been conducted by a variety of federal, state and local organizations. These data allow a general assessment of water quality, but optimization of sampling program locations, frequencies and parameters would allow more quantitative assessments to be made. The following recommendations are aimed at optimization of existing sampling programs:

- Develop a uniform sampling protocol for use by organizations collecting water quality data in Snell Creek and the EBWR
- Conduct an interagency working session to maximize sampling efforts
- Collect accurate stream flow measurements
- Refine the WRWA map of the watershed of Snell Creek to show exact sampling station locations and prepare supporting sampling information

Sampling Protocol - Ongoing data collection programs are being conducted by the Division of Marine Fisheries, the U.S. Department of Agriculture, the Westport River Watershed Alliance and the Westport Board of Health. These groups should adopt a uniform sampling protocol in order to establish a more quantitative water quality database to supplement that established under this demonstration project. This data collection protocol should be implemented immediately and followed for all subsequent sampling including during and after implementation of BMP's. Sampling information should be recorded in a format compatible with the database established for this project as described in Chapter 3, which could easily be adapted to other data management systems such as STORED, DATATRIEVE, RBASE or DBASE. Field and laboratory data should be recorded on data sheets similar to that presented in Appendix B with data fields including:

Collection Program	-	eg. Massachusetts Shellfish Monitoring Program
Sample Number	-	Program Specific

Laboratory Number	-	Program Specific
Station Number	-	Station number should be consistent with past programs and a graphic and verbal description of the station should be recorded
Date Collected	-	Month/Day/Year
Time Collected	-	Hour/Minute
Date Analyzed	-	Month/Day/Year
Sampling Technique	-	Grab or Composite
Tide Stage	-	Low, High, Flood, Ebb
Parameter	-	Refer to parameter code list in Appendix B
Concentration	-	Of Constituent
Units	-	Milligrams per liter for conventional parameters and #/100 milliliters for bacteria analysis
Flow	-	As recorded a the time of sampling in cubic feet per second or in liters per second as appropriate for extreme low flow conditions
Rainfall	-	Record rainfall on the day the sample is collected and on the previous day
Laboratory	-	Indicate the name of the laboratory that conducted the analysis
Analytical Technique	-	EPA or Standard Methods identification number and detection limits
Comments	-	Any special comments related to field conditions or observations

New sampling procedures should be adopted to ensure the representativeness and comparability of the data sets being assembled. Representativeness is defined as the extent to which data define an environmental condition. In order to achieve this goal, samples must be collected at consistent locations, and accurate flow and weather conditions must be recorded. Data sets being collected at different times and places by different groups using the same procedures can be made comparable by coordinating efforts. The ability to compare data sets is particularly critical when a set of data for a specific parameter is applied to an action level, permit limits, criteria or standards (Fairless and Bates, 1989). For example, appropriate detection limits should be selected to insure that field program objectives are met. Field samplers must be familiar with the objectives of the sampling program so that appropriate logical choices can be made in response to changing field conditions. Exact station locations must be selected to facilitate flow measurements and sampling station locations should be marked on a map.

Interagency Sampling Effort Coordinations - It is recommended that the DEP and other organizations currently collecting data in Snell Creek and the EBWR attend an interagency working session to maximize sampling efforts. Through a meeting and a tour of the creek, the group could agree on exact sampling locations, coordinate sampling schedules to distribute sampling temporally and avoid duplication of effort, discuss methods to measure stream flow, and coordinate maintenance of the data base established as part of this demonstration project.

Stream Flow Measurement - Stream flows were estimated in Chapter 3 empirically. In order to quantify pollutant loading accurately, however, flow measurements need to be collected in Snell Creek concurrently with water quality sampling. Flow measurement in small, rocky streams can be difficult due to lack of uniformity in depth and rate of flow through a cross-section of the stream. Thus, reliable equipment and techniques, and a consistent sampling station must be used throughout the program. A point near the downstream end of the creek must be established in order to develop a rating curve, to allow depth measurements to be taken as an efficient substitute for detailed flow monitoring. It is recommended that a Marsh-McBirney or similar velocity meter be used to establish the rating curve. In order to assure consistent sampling at the same location, a map of the flow measurement station should be developed, showing exact sampling locations and benchmark.

Develop Sampling Program Map - The Westport River Watershed Alliance maintains maps of the watershed of the EBWR, including Snell Creek. It is recommended that sampling stations be located on this map, and supporting information on each station be developed. This supporting information would include a sketch, photographs, river cross-section plot, and location of the specific sampling point and any benchmark.

Agricultural Best Management Practices. As shown in Chapters 3 and 4, agricultural areas in the watershed are significant sources of fecal coliform bacteria to Snell Creek. Thus, it is recommended that agricultural best management practices be implemented on the Pimental farm and the Costa farm. In the development of the plans described below, several issues were considered including the uncertainty of the dairy business in New England and across the country, especially for the small farm, and the lack of regulatory and economic impetus for the farmer to control pollution. Since reduction of bacteria loading from the Pimental Farm was considered critical to the success of the project, a number of meetings were held with Mr. Pimental in order to develop a management plan that was acceptable to him. The plan presented below was developed in close consultation with the Soil Conservation Service and the Agricultural Stabilization and Conservation Service. A plan to address potential pollution from the Costa farm is also outlined, however, this farm is not considered as high a priority as the Pimental farm.

Pimental Farm - A site visit, in coordination with USDA, was conducted on August 17, 1989 to discuss concepts for pollution control with Mr. Pimental and to agree on an approach. His reluctance is clearly related to his past experience with the SCS funded and designed feedlot constructed on his property several years ago. This includes difficulties with its operation and considerable pressure from USDA to return the feedlot to USDA compliance. At this time, Mr. Pimental is not amenable to accepting financial assistance or extensive on-site assistance. Although actions by Mr. Pimental to improve water quality are voluntary, he recognizes the need and has agreed to implement the BMP's outlined.

Overgrazing - Mr. Pimental plans to construct, in the near future, a new barn in which he will house part of the approximate 375 head of livestock currently on the farm. Following construction of the barn, he plans to keep the livestock inside more often and to close off the stalls in his USDA-funded feed lot which violate his RCWP contract. This measure, in itself, could result in a reduction in export of fecal coliform from the farm by reducing deposition of manure in grazing areas near Snell Creek. Due to the large number of livestock on the farm and unrestricted grazing, however, it is felt that overgrazing will persist following construction of the additional barn. Much of the grazing area is without groundcover. Livestock are allowed to graze in areas close to Snell Creek that slope toward the creek and are highly susceptible to erosion. Filter strips and pasture planting will reduce the impact of overgrazing on water quality. Mr. Pimental has agreed to install filter strips, plant his grazing fields, and manage his livestock such that groundcover is maintained. A specific plan for planting and livestock management was developed with the assistance of the Soil Conservation Service. The plan is described by grazing field numbered 1 through 4 as described on Figure 4-2 in Chapter 4.

Fields 1 and 2 - Each of these fields serves as a holding area for approximately 50 cattle. The fields have little vegetation with the exception of weeds, provide little filtration or infiltration, and likely allow significant bacteria loading to Snell Creek, especially during rainfall. The objective of the management plan outlined below is to confine livestock to specific holding areas in the most elevated parts of the fields and to establish filter strips downgradient of the animal holding areas. Specific steps are outlined below and are depicted in Figure 6-1.

1. Fence off gully that transects the fields near Drift Road.
2. Fence off an approximate 2-acre (100' x 400') area at the most elevated part of each field to serve as an animal holding/feeding area.
3. Prior to mid-May or after August but before frost, plant pasture mix on the remainder of the fields downgradient of the animal holding areas. Pasture mix should include, tall fescue turf mix at 25 pounds/acre, orchardgrass at 5 pounds/acre and perennial ryegrass at 15 pounds/acre.

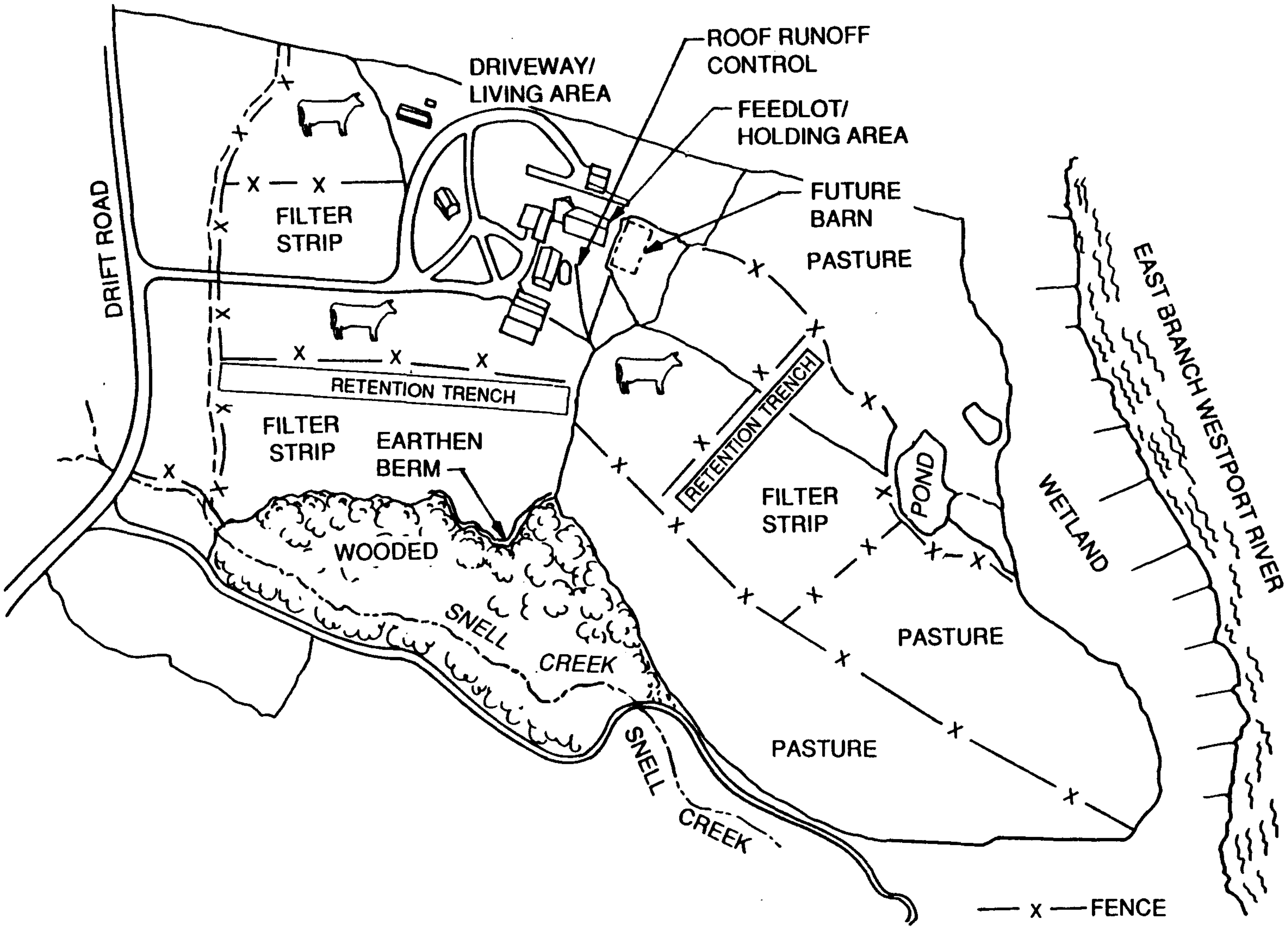


FIGURE 6-1. PIMENTAL FARM SCHEMATIC. RECOMMENDED PLAN

4. Exclude livestock from filter strip until grass height exceeds 6 inches.

5. After grass height exceeds 6 inches, either

   a. permanently exclude livestock from the filter strips and manage as hayland, or
   b. manage livestock grazing to maintain grass heights ranging from 6 inches to 12 inches.

6. Should filter strips be managed as grazing areas, always exclude livestock from the area when wet to preserve vegetation.

7. At most upgradient portion of filter strip areas, excavate detention/infiltration trenches designed to provide retention for a 24-hour, 25 year storm. These trenches should extend to the full width of the filter strips and will serve to equalize flow entering the filter strips.

A large marshy area is located adjacent to Snell Creek between the creek and Field 1 where approximately 50 livestock feed and graze. The water quality of the standing water in this area was clearly and adversely influenced by the adjacent grazing area. The area discharged to Snell Creek through a small channel that formed at the lowest elevation. A number of potential remedial measures were discussed including excavation of a detention pond and/or construction of an earthen berm adjacent to Snell Creek to detain the runoff water and to eliminate the direct connection between the marshy area and Snell Creek. It is recommended that the direct connection between Snell Creek and this marshy area be eliminated by the placement of a small earthen berm as depicted on Figure 6-1. Constraints on creating detention in this area include the elevation of the groundwater and design constraints related to construction of a dam for detention. Although this structure would be overtopped by large storms, such a berm would eliminate the direct connection to the creek which apparently carries some flow even during relatively dry periods. In addition, a fence should be erected to keep cattle out of this wet area and to protect the berm. Following installation of the filter strip, contamination from this area will be reduced considerably and discharges from this area will only occur intermittently.

Fields 3 and 4 - These two areas combined, provide grazing area for approximately 250 milking cows. Like the small fields near Drift Road, the vegetation in these areas provides little filtration. The south part of field 4 is in the watershed of Snell Creek. The remainder of this area, however, drains directly to the EBWR. Although BMPs installed in this area will not directly influence water quality in Snell Creek, a management plan for this area is provided below as part of an overall management plan to address water quality problems emanating from this farm. Specific steps for fields 3 and 4 are depicted in Figure 6-1.

1. Fence off gully/stream that extends between barn area and pond.

2. Establish a fenced 2 to 3 acre animal holding/feeding area at the most elevated area.

3. Prior to mid-May or after August but before frost, plant pasture mix, as specified above, on a 3-acre filter strip as shown on Figure 6-1.

Conduct steps 4, 5, 6 and 7 as for Fields 1 and 2.

8. Plant remainder of fields with orchardgrass.

Roof and Road Runoff- Runoff from several barns, roads, the feedlot and milkhouse flows unrestricted past feeding areas, manure storage areas and grazing areas, resulting in formation of ditches and uncontrolled runoff from heavy use areas. Several potential means of controlling this runoff were discussed with Mr. Pimental including gutters, downspouts, concrete channels, and diversion structures to convey water away from these unsanitary areas. Although concrete channels would be expensive, roof gutters and small diversion trenches would be affordable and could be installed by the farmer. The following activities are recommended to separate roof and road runoff from heavy use areas. These activities are shown on Figure 6-1.

1. Direct runoff from access and perimeter roads to the drainage ditch between Fields 1 and 4.

2. Construct roof gutters on existing building and the barn to be constructed and divert flow to the drainage ditch between Fields 1 and 4.

3. Regrade as needed, especially in the manure loading area, to prevent ponding near manure handling areas and near animal holding area.

Education and Follow-up- The long-term success of the filter strips and pasture or hayland described above will in part be a function of how they are managed. It is critical that livestock be excluded from these areas initially while they are being established, when the areas are wet, and when grass height is less than six inches. One method of educating farmers on conservation is to tour farms where conservation measures are being practiced. As suggested by the Soil Conservation Service (1989), it is recommended that Mr. Pimental be taken on a tour of several farms in Vermont where such measures are utilized.

In order to meet a schedule consistent with the implementation of other recommended BMPs, the measures described above should be implemented during 1990 and 1991. Since compliance is voluntary, it is recommended that representatives of USDA and DEP or their consultants conduct further visits with Mr. Pimental to discuss the project and track his progress.

In the event that Mr. Pimental is not able to implement some of the BMPs for financial reasons, it is recommended that an offer of assistance be extended, especially for construction of the detention berm adjacent to Snell Creek. This may require some design assistance from an engineering firm or SCS and may require that a contractor be hired. Although Mr. Pimental is currently opposed to accepting government funds, a memorandum of understanding could be offered to allay his concerns about post-construction obligations. The memorandum of understanding should outline specific activities and responsibilities for all required tasks including local coordination and farmer contact, design and specifications, bid administration, construction inspection, maintenance and monitoring. A construction and maintenance easement would also be needed to ensure access to the property.

This approach, which combines an easement and sharing of responsibilities through a written agreement, has been used under the Massachusetts Clean Lakes

Program to implement agricultural best management practices in Berkshire County as part of the Pontoosuc Lake restoration project. It is recommend that the agreement developed for the Pontoosuc Lake project be used as a model for this demonstration project.

Costa Farm - The Costa Farm, a relatively small farm with about 45 cattle and several hogs, is located at the northwesternmost portion of the watershed of Snell Creek. Although most of the farm is within the watershed of Snell Creek, the barn and milkhouse area is located on the drainage divide between the watersheds of Snell Creek and Kirby Brook. This farm is rented by Mr. Costa to a dairy farmer from New Bedford. Mr. Pimental reported that this farm may undergo a change in ownership during the next year.

Based on review of aerial photographs, grazing areas are fully vegetated and no erosion problems were identified. On August 17, 1989, Metcalf & Eddy and USDA conducted a site visit to survey operations at the farm. During the site visit it was apparent that there is little management of manure at this farm. A concrete pad and the yard adjacent to the milkhouse were covered with fresh manure. USDA representatives felt that since the farm is rented and because the farm is small, manure management problems would be difficult to address (due to the cost of manure storage and treatment and the assumed economic status of the landowner). Fortunately, the area of the milkhouse where most of the manure management problems were observed is not in the watershed. The area in the vicinity of the small ponds that are the headwaters of Snell Creek, however, was also observed to be in poor condition and manure was present on the ground near the ponds.

Since the farm is small and the number of livestock present is appropriate for the size of the farm, and since grazing fields are vegetated, filter strips and pasture planting are not necessary at the Costa Farm. Rather, it is felt that proper handling of animal wastes will adequately address bacteria export in both watersheds.

It is recommended that when the farm is sold, representatives of USDA, DEP and the town approach the new landowner. At that time, a more detailed assessment of manure handling practices can be made and suggestions for improvements can be developed. Further, if financial incentives are required, it is recommended that an offer of assistance be made and that a memorandum of understanding be developed between participating groups, as was outlined for the Pimental Farm.

Stormwater Best Management Practices. Existing water quality data, as well as literature values, indicate that runoff from Route 88 is a significant source of fecal coliform bacteria to Snell Creek. In addition, a portion of Kirby Road has a piped drainage system discharging to Snell Creek. As concluded in Chapter 5, it is recommended that these stormwater sources of bacteria be addressed as part of this management plan. This section presents a conceptual design to construct mounded leaching galleys in the state highway right-of-way and to construct a dry well at Kirby Road to eliminate this direct discharge to Snell Creek and promote infiltration.

Route 88 - The Route 88 drainage system extends for the length of the roadway and discharges to Snell Creek in three locations. As was illustrated in Figure 4-3, stormwater enters the drainage system through concrete waterways. A reinforced concrete pipe conveys the stormwater to Snell Creek. Installation of the recommended system involves removal of the existing concrete waterways and construction of catch basins in the roadway shoulder, directing flow to mounded leaching galleys constructed within fill material placed adjacent to the road. This system will promote infiltration of the road runoff until it reaches capacity, when the balance of the runoff will overflow directly to Snell Creek.

Route 88 crosses Snell Creek three times, and each crossing has its own associated drainage system. Figure 6-2 illustrates the final configuration of this Route 88 drainage system with the eight leaching gallies in place. The southern-most drainage system would requires two mounded systems to treat runoff. The central system would also require two mounded leaching galleys, and the northern system would require four. Figure 6-3 provides a plan and cross-section view of a mounded leaching galley. Each of the eight gallies would be approximately 30 feet long with the mounds being approximately 50 to 60 feet long and 20 feet wide.

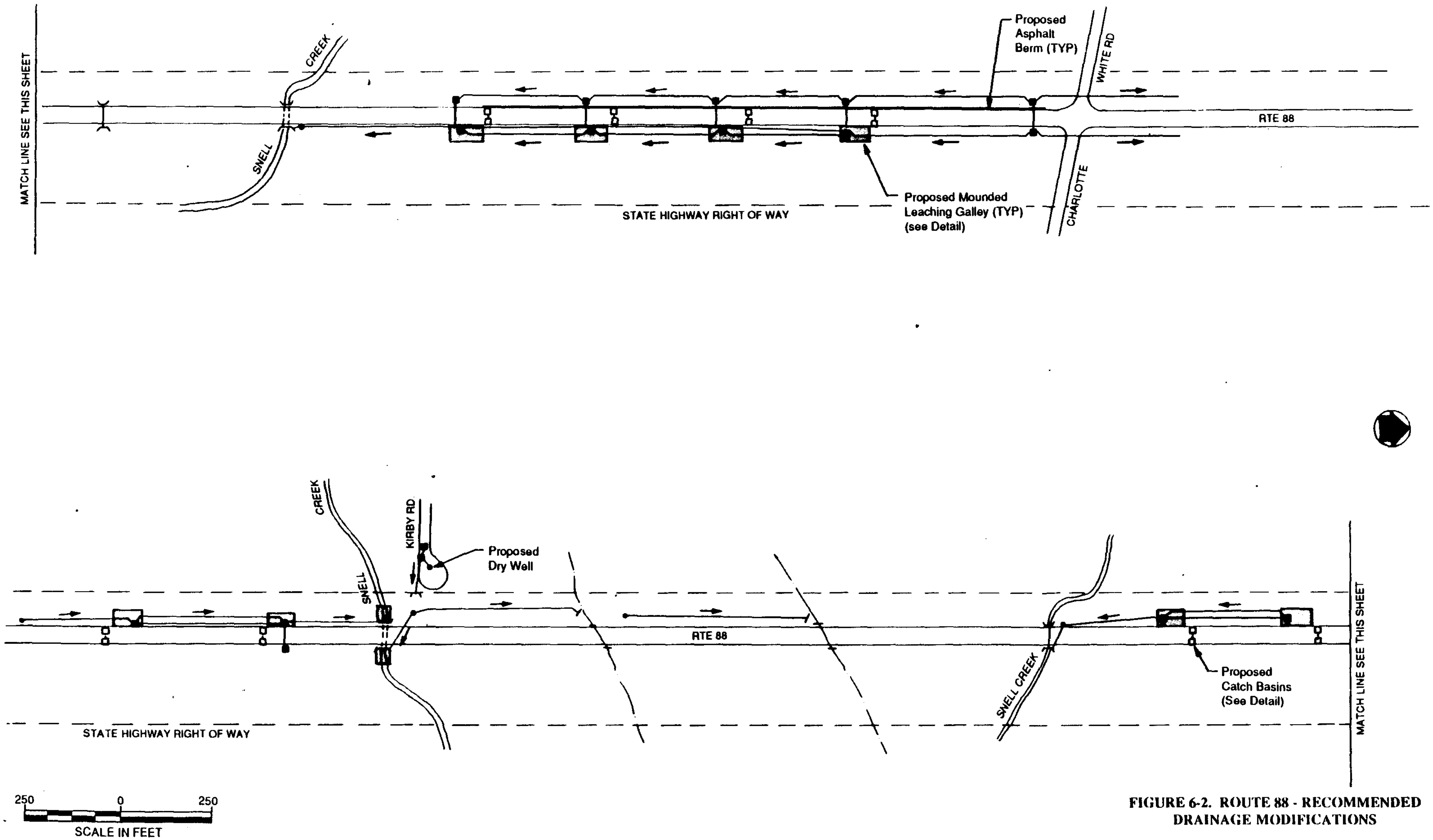
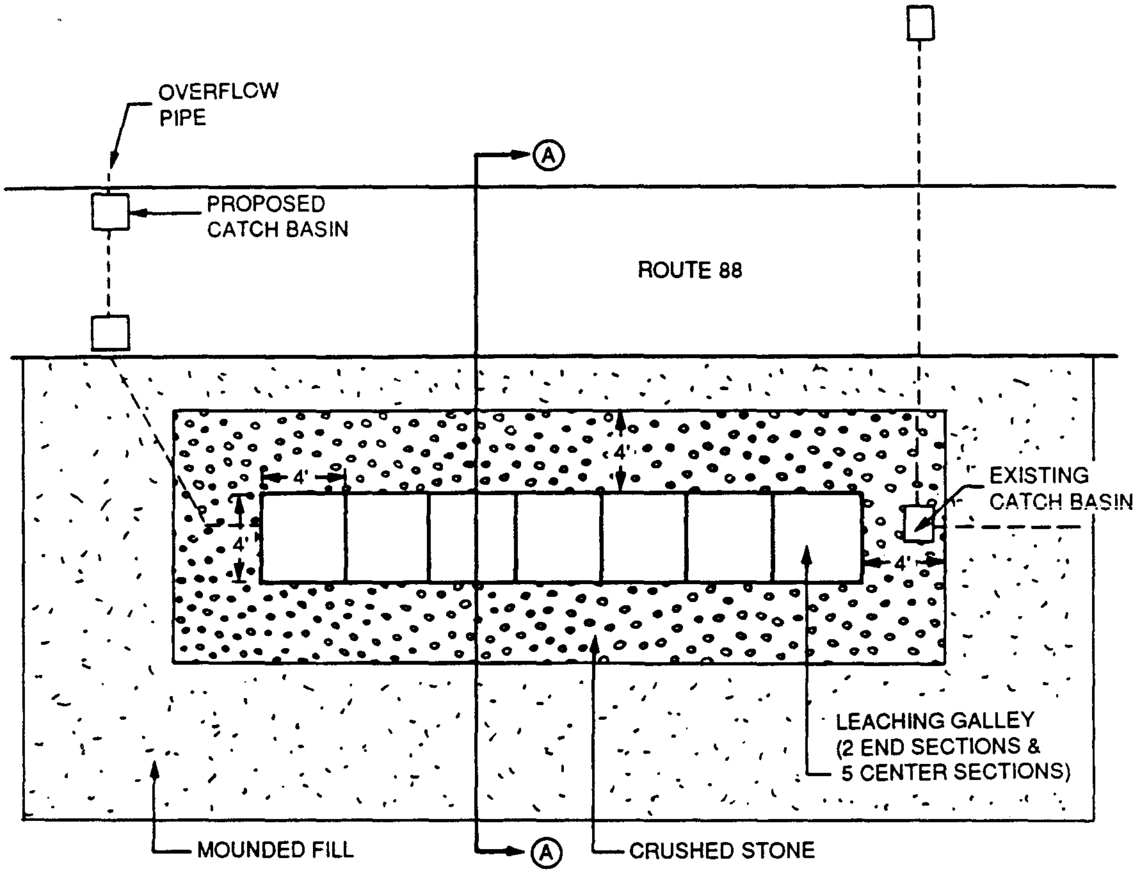
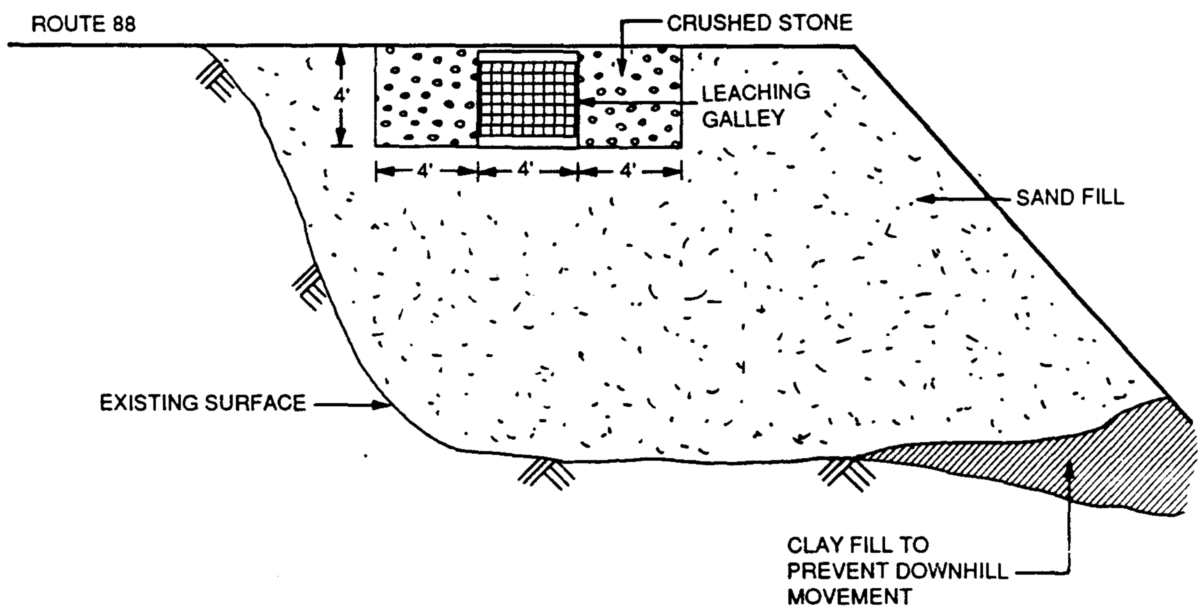


FIGURE 6-2. ROUTE 88 - RECOMMENDED DRAINAGE MODIFICATIONS





CROSS SECTION A-A
NOT TO SCALE

FIGURE 6-3. ROUTE 88 - MOUNDED LEACHING GALLEY DETAIL

Kirby Road - Kirby Road is a medium density residential roadway off Main Road, which ends in a cul-de-sac approximately 100 feet west of Route 88. This roadway has a small drainage system which currently discharges directly to Snell Creek. The cul-de-sac at the end of Kirby Road is 10 to 15 feet higher in elevation than Route 88. Therefore, the recommended plan for this system involves installing a large dry well at the end of the system and discharging the overflow into the wooded area, thereby eliminating the direct connection to Snell Creek. Stone rip rap at the outlet of the overflow pipe would be installed to reduce erosion. A conceptual design for this recommendation is illustrated in Figure 5-4.

The recommended plans for Route 88 and Kirby Road both require the design of structural modifications to the existing drainage systems. These designs are based upon a one inch/hour intensity, 1/2 hour duration rainfall event. In an EPA-sponsored study, Water Quality Management Planning for Urban Runoff (EPA, 1974), it was found that during the first 1/2 inch of rainfall an intensity of one inch/hour for 30 minutes is considered sufficient to remove 90 percent of pollutants from pavement. Also, over 90 percent of the rainfall events occurring produce less than one inch of precipitation and even fewer have intensities greater than one inch/hour. Therefore, designing the infiltration systems for this one inch/hour intensity and providing overflows for greater intensity storms results in treatment of more than 90 percent of the rainfall runoff. In addition, an urban runoff BMP manual from the Metropolitan Washington Council of Governments (1987) states that designing infiltration structures for a one inch/hour storm results in 90 percent removal of bacteria from runoff. Thus, these structures are sufficient for effective pollutant removal and are significantly smaller than structures designed for 10-year or 25-year design storms.

Route 88 is a state highway, owned and operated by the Massachusetts Department of Public Works. The DPW is currently administering a fund of $5 million designated to address runoff problems on state roads. Accordingly, it is recommended that the DEP approach the DPW regarding the obtaining of funding for this component of the project. The improvements could be designed and bid, and the construction could be supervised by the Division of Water

Pollution Control and the DPW or a consultant with review from the Town of Westport. Maintenance of the catch basins and leaching galleys should be provided by the DPW. Kirby Road, however, is owned by the Town of Westport. Whereas the design, bid administration and construction could be provided by the Division of Water Pollution Control or an engineering consultant in conjunction with the Route 88 improvements, the Town of Westport should construct or fund the construction of this minor drainage improvement. Funding for this recommendation could be sought through the EPA Buzzards Bay Project Minigrants program should additional funds become available. Maintenance of the dry well should be conducted by the Town.

Regulatory Controls. In order to develop a BMP aimed at preventing increased pollution loading from proposed development, a two-phased approach is recommended. Initially, a standard order of conditions should be developed which would prevent substantial increases in bacteria load (as well as nutrient and solids load). Secondly, a bylaw should be developed and ultimately adopted which would be specific to runoff pollution control in the EBWR. The standard order of conditions should be developed by the Westport Conservation Commission with assistance from the DEP or their consultant. Once developed, coordination with the conservation commission, board of health, and planning board would be required to obtain concensus on the intent, wording, and appropriate instances for its use.

Second, it is recommended that the Town consider development of pollution control bylaws. Currently, a pollution control bylaw is under development as part of the Buzzards Bay project which can be used as a model. For development of a town bylaw, it is proposed that the Massachusetts CZM, in conjunction with the Buzzards Bay program as well as other shellfish protection efforts, be responsible for drafting language. These proposed regulations could provide a model for most coastal areas in the Commonwealth. Taking this approach, involved communities such as Westport would then be given an opportunity for review and input. Finally, the Town itself would be responsible for its adoption, with any appropriate changes. In addition, it is recommended that the town of Westport review and scrutinize the potential means of water pollution control outlined in Table 5-2, to assist in developing an appropriate set of local pollution control bylaws.

Public Education Program. Although no septic system outbreaks were discovered during field reconnaissance efforts, soil conditions in Westport are not ideal for subsurface disposal of sanitary sewage. Occasional outbreaks and groundwater impacts could be reduced by proper maintenance of septic systems and by improved practices in the home. Short of a mandatory program of septic tank maintenance, improved maintenance could be accomplished through a public education/outreach program. Since it would be impractical to approach only residents in the watershed of Snell Creek, it is recommended that a town-wide education program be conducted. The recommended public education program would consist of:

- A public meeting
- Distribution of education materials
- Media coverage through newspaper articles and cable TV, and
- Coalition building through the Westport Board of Health and local environmental groups

Through surveys conducted under the Massachusetts Clean Lakes Program, septic tank owners frequently are not aware that their system is undersized or that it should be cleaned and inspected on a regular basis. Proper septic system use and maintenance is of particular concern. Poor household practices often contribute to system failure or overload; a few examples are indicated as follows. Cooking grease can be containerized in regular household refuse; paper products, tissues, plastic wrap and aluminum foil also can be disposed of in the home garbage. White toilet paper should be used instead of colored tissue, because the latter inhibits bacterial processes. Hazardous and toxic household substances (e.g., paints, solvents, disinfectants, lubricating oil, medicines, etc.) should never be placed into the on-site system, and should be disposed of at an acceptable off-site location. Large quantities of vegetable and fruit waste and coffee grounds should go into the home garbage or be composted.

A public meeting could be held in Westport in the form of a symposium on water quality to educate septic tank owners on harmful activities, such as improper garbage disposal use, and on means of reducing hydraulic loading such as water-saving showerheads, and proper maintenance procedures, including regular pumping and inspection. Additional subjects that could be addressed as part of the symposium include:

- A demonstration project update to report on the status of implementation of other recommendations by the Division of Water Pollution Control.
- Results of the Adopt-a-Stream project being conducted by the Westport River Watershed Alliance
- An update on the Comprehensive Conservation and Management Plan being prepared for Buzzards Bay by Coastal Zone Management
- An update on the development of the Massachusetts Nonpoint Source Program by the Division of Water Pollution Control

The meeting/symposium could be organized by a consultant with assistance from the Westport River Watershed Alliance. The meeting or symposium should be advertised by local and regional newspaper articles; newsletters such as EPA's Buzzards Bay Project newsletter, the Westport River Watershed Alliance's River News and CZM's Coastlines; notification of project advisory group members and town officials; posting in public buildings; and through cable TV advertising and coverage.

Additional public outreach can be achieved through distribution of educational materials. Pertinent materials have been prepared by a number of agencies and should be used to develop materials specific to Westport. Previously prepared materials which could be used directly or adapted for use in Westport include documents prepared by the New Jersey Department of Environmental Protection (1987) as recently adapted by the Westport River Watershed Alliance for use in Westport, Heufelder (1989), and the Lake Cochituate Watershed Association (1985). These materials could be prepared by the DWPC or its consultant with assistance from the Westport River Watershed Alliance, and should describe the nature of local water quality problems and behavioral modifications that could help to alleviate these problems such as septic tank maintenance, reduced water consumption and solids loading. These educational materials could be distributed town-wide using a number of town and private mailing lists and could be distributed widely as an insert to the EPA and CZM newsletters described above. Public education can be enhanced by newspaper articles, cable TV advertising, and coalition building through cooperation between town departments such as the conservation commission and health department and local environmental groups such as the Westport River Watershed Alliance.

BMP Effectiveness Sampling. Snell Creek fecal coliform bacteria levels increase dramatically in Snell Creek during wet weather, resulting in shellfish standard violations in the EBWR. While ongoing sampling programs will provide baseline data over a wide range of conditions, it is recommended that wet weather sampling be conducted by the Division of Water Pollution Control, or its consultant. A detailed protocol should be developed for sampling in Snell Creek during wet weather, modelled after the protocol developed earlier in this section for routine sampling programs, with the following amendments:

- Sample multiple stations within the creek including Station 1 just upstream of the mouth
- Sample stations upstream and downstream of suspected sources (such as Route 88 and the Pimental farm)
- Conduct sampling at regular intervals including the first flush and for a period before, during, and after a storm event
- Analyze samples for bacteria, nutrients and solids
- Collect stream flow data

The wet weather data will be used for source quantification and BMP effectiveness evaluation, and will allow calculation of wet weather loading to the EBWR. In order to provide data before and after BMP implementation in the vicinity of suspected sources, it is recommended that water quality samples be collected upstream and downstream of the Pimental Farm, Route 88 (three locations), Main Road, Drift Road, the parking lot at Main Road, areas of suspected septic tank breakout including the ditch on Pratt Road, and the wetland area west of Main Road. Samples should be collected at regular intervals at each station for a minimum of 4 to 8 hours depending on the size of the storm. Samples should be properly preserved and handled and should be analyzed for bacteria, nutrients, and solids. Stream flow data should also be collected at each station at each sampling interval. Samples should be collected on two occasions prior to implementation and during similar meteorological conditions on two occasions after implementation.

In addition to the above measures outlined for Snell Creek, it is recommended that sampling efforts be augmented at Kirby Brook. As shown through calculations in Chapter 3, Kirby Brook contributes 20 to 30 percent of the fecal coliform loading at Hix Bridge station. Kirby Brook ranked second in the demonstration area selection process and is recommended as the next area on which to focus nonpoint source control efforts.

The sampling recommendations outlined above should be implemented as soon as is practical. A suggested schedule is outlined later in this chapter. These efforts could be conducted by the DEP, through a cooperative interagency effort, or through a contract with a consultant. The sampling effort could be supplemented by other agencies already conducting regular sampling by adjusting sampling schedules to collect pre- and post-storm routine samples, by providing transportation within the sampling area and a local meeting place from which to deploy workers and to drop-off, composite and preserve samples.

Water Quality Analysis. Following collection of routine water quality samples before and after construction, as well as pre- and post-implementation wet weather sampling, it is recommended that these data be analyzed. Flow measurements collected during this period will allow refinement of loading estimates and will allow an assessment of the success of the recommended pollution control measures. It is recommended that this analysis be conducted by the Division of Water Pollution Control or its consultant.

Implementation Responsibilities

In order to implement the recommendations described in this chapter, extensive interagency cooperation and coordination will be required and agreements and contracts must be established between a number of federal, state, and local groups. Proposed implementation responsibilities for each major component of the program are summarized in Table 6-1.

In order to initiate the implementation phase of this project, several administrative actions must be conducted by the DEP. One task relates to obtaining professional services of an engineering consultant if required. Another administrative task that may be vital to the implementation of all the recommendations described herein is the development of a memorandum of understanding establishing an interagency agreement on specific implementation and funding responsibilities. This agreement would include water quality sampling, analysis and management; design and coordination of agricultural BMPs; design, permitting, bid administration, construction supervision, and maintenance of stormwater BMPs; public education; and reporting.

TABLE 6-1. IMPLEMENTATION TASKS AND RESPONSIBILITIES

Task	Responsibility
Administrative	
Overall Program Coordination	Division of Water Pollution Control
Develop Interagency Memorandum of Understanding	Division of Water Pollution Control
Water Quality Sampling and Analysis	
Continue Sampling in Snell Creek and the EBWR	Soil Conservation Services Division of Water Pollution Control Westport River Watershed Alliance Westport Board of Health Division of Marine Fisheries
Conduct Interagency Sampling Coordination Working Session	Division of Water Pollution Control Soil Conservation Service

TABLE 6-1 (Continued). IMPLEMENTATION TASKS AND RESPONSIBILITIES

Task	Responsibility
Develop Detailed Watershed Map with Sampling Stations	Westport River Watershed Alliance
Maintain Database for Snell Creek and Hix Bridge	Division of Water Pollution Control
Conduct BMP Effectiveness Sampling	Division of Water Pollution Control
Water Quality Analysis	Division of Water Pollution Control
Agricultural Controls	
Develop Water Quality Management Management Plan for Costa Farm	Soil Conservation Service
Install Fencing, Filter Strips, Pasture, Roof Gutters and Earthen Berm	Mr. Jose Pimental
Conduct Educational Activities at Pimental Farm	Soil Conservation Service
On-Site Coordination and Follow-up at Farms	Soil Conservation Service Agricultural Stabilization and Conservation Service
Stormwater Controls	
Designs, Specifications, Permitting, Contract Documents, Bid and Construction Administration for Stormdrain Modifications for Route 88 and Kirby Road	Division of Water Pollution Control Department of Public Works Town of Westport
Construct Stormdrain Modifications	Contractor
Maintenance of Catch Basins, Leaching Galleys and Dry Well	Town of Westport Department of Public Works
Institutional/Nonstructural Controls	
Develop Pollution Control Bylaws and Standard Order of Conditions	Coastal Zone Management Westport Conservation Commission and Planning Board

TABLE 6-1 (Continued). IMPLEMENTATION TASKS AND RESPONSIBILITIES

Task	Responsibility
Prepare and Distribute Educational Materials	Division of Water Pollution Control Westport River Watershed Alliance Environmental Protection Agency
Public Meeting/Symposium	Division of Water Pollution Control Westport River Watershed Alliance Town of Westport - all Boards Coalition for Buzzards Bay Environmental Protection Agency Coastal Zone Management Department of Environmental Management
Prepare Press Releases	Division of Water Pollution Control

Cost Estimates

Preliminary cost estimates have been prepared for each of the major program components described in this chapter and are presented in Table 6-2. Tasks to be conducted by existing programs have not been assigned costs.

Schedule

The overall schedule of activities for the implementation phase is outlined in Figure 6-4. The schedule includes consultant selection, water quality sampling and analysis, design and construction, maintenance, monitoring, public education, and regulatory activities.

Regulatory Requirements

This section outlines regulatory requirements associated with the recommended plan. Since no fill is being placed in wetlands or waterways and since no federal permits are required, the only permit that will be required for this project will be an order of conditions for work in the buffer zone and banks

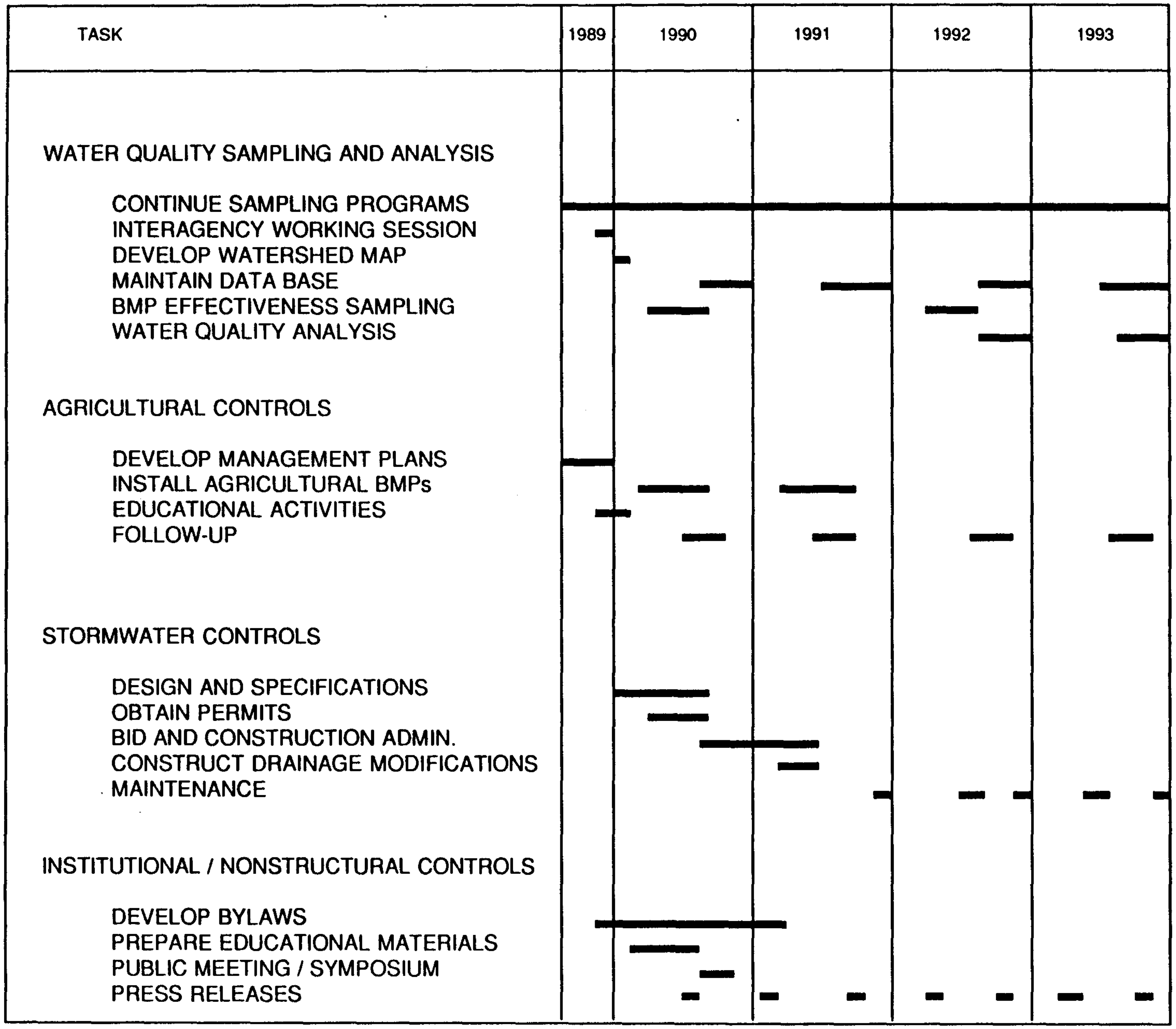


FIGURE 6-4. IMPLEMENTATION SCHEDULE

of Snell Creek including pasture planting and earthern berm construction at the Pimental farm and modifications to the drainage system at Route 88. MEPA compliance will depend on the final design of the Route 88 drainage improvements. NEPA compliance is not anticipated to be necessary.

TABLE 6-2. COST ESTIMATES FOR PROGRAM COMPONENTS

Item	Estimated Cost ($)
Water Quality Sampling and Analysis	
Continue Sampling in Snell Creek and the EBWR	*
Conduct Interagency Sampling Coordination Working Session	*
Develop Detailed Watershed Map with Sampling Stations	*
Maintain Data Base for Snell Creek and Hix Bridge	12,000
Conduct BMP Effectiveness Sampling	40,000
Water Quality Analysis	16,000
Agricultural Controls	
Develop Water Quality Management Plan for Pimental Farm	2,000
Install Agricultural BMPs	
Fencing	25,000
Filter Strips	2,000
Pasture Planting	4,000
Roof Gutters and Diversion	10,000
Earthen Berm	2,000
Conduct Educational Activities	2,000
On-Site Coordination and Follow-Up	4,000

TABLE 6-2 (Continued). COST ESTIMATES FOR PROGRAM COMPONENTS

Item	Estimated Cost ($)
Stormwater Controls	
Design	
Engineering Design, Plans, Specification, and Contract Documents	50,000
Obtain Permits	12,000
Bid Administration	10,000
Construction	
Materials	150,000
Labor	250,000
Construction Supervision	21,000
Maintenance	3,000(1)
Institutional/Nonstructural Controls	
Develop Pollution Control Bylaw and Standard Order of Conditions	*
Prepare and Distribute Educational Materials	18,000
Public Meeting/Symposium	18,000
Prepare Press Releases	6,000

(1) Annual Cost

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